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"Rural Prosperity and Secondary Crops: Towards Applied Pro-poor Research and Policies in Asia and the Pacific"
Bogor, Indonesia, 6-9 December 2005

Farming a Way Out of Poverty

Forgotten Crops and Marginal Populations in Asia and the Pacific

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Foreword

A regional workshop on "Rural Prosperity and Secondary Crops; Towards Applied Pro-Poor Research and Policies in Asia and The Pacific" was held during 6 - 9 December 2005 in Bogor, Indonesia, to discuss the findings and implications from sixteen case studies dealing with the role of secondary crops in rural poverty alleviation. Part of these case studies were based on field results obtained in the framework of the project "Identification of Pulling Factors for Enhancing the Sustainable Development of Diverse Agriculture in Selected Asian Countries (AGRIDIV)" implemented by CAPSA in collaboration with eight countries. Other cases were developed in a co-operative research effort with other countries and regional/international organizations in order to achieve a wider presentation of the diversity that characterizes the Asia-Pacific region.

Invited participants included the national scientists who authored the case studies and policymakers, providing feedback on the cases and participating in the discussions. International organizations (AVRDC, CIP and CIAT) also contributed with discussion papers. The workshop included three days of case study presentations and discussion and it concluded with a one-day working group synthesis session focusing on key factors and implications for the design of successful pro-poor policies as well as research and development activities.

I am pleased to publish these proceedings as a record of the workshop, and hopefully as a benchmark for better thinking and more efficient ways to ensure that benefits from the development of secondary crops reach poor, rural people.

I thank all participants for their indomitable enthusiasm, for their dynamism and their sturdy commitment to the writing of the final versions of their papers. I also thank Matthew L. Burrows and Lisa Svensson for their efforts in compiling and editing this volume, and to Agustina Mardyanti and Fetty Prihastini for taking care of production and publication issues. Finally, I express my sincere appreciation to the Government of Japan for funding the project and supporting the workshop.

September 2006

Taco Bottema
Director
UNESCAP-CAPSA

Secondary Crops, Rural Poverty and Policy Bias

Robin Bourgeois[*]

International organizations and the governments of Asian and Pacific countries claim to have placed the First Millennium Development Goal, halving poverty and eradicating hunger by 2015, as their utmost priority. Yet, policies seldom reflect this commitment in the field. Lack of effective political will, the resulting lack of commitment, manifold biases in policy-making on poverty, and financial and climatic shocks are recognized: "*…in the rush to achieve other political and economic objectives,* [rural development] *has received a generally low priority in national development* (UNESCAP, 2003)[1]".

Asia and the Pacific still count for some 900 million extremely poor rural people. East and South Asia still represent two-thirds of the world's poorest people and the rural poor are one of the most deprived and widespread categories. Of these, at least 375 million live in mostly marginal dry upland areas where the dependency of the local population on the various sub-sectors of agriculture, and that on secondary crops in particular, is large. Poor and marginal farmers depend on them as their main source of income as well as staple foods and in times of crisis these crops provide the primary means for food-security and minimizing hunger.

While ESCAP (2004) indicates that: "Agriculture has the highest potential for growth and poverty alleviation in the short and medium terms in many developing countries in the region as the majority of the poor live in rural areas and draw their livelihood from agriculture[2].", according to the 2003 World Development Report, rural populations living in fragile areas have doubled over the last fifty years.

The rural poor face several challenges affecting their development potential:

- Limited, and in many cases deteriorating, natural resources (soil fertility, water availability) and hostile environment (slopes, altitude, remoteness).
- Limited policy attention for technological development in the production and processing of secondary crops.

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[1] Syed M. Naseem, 2003. Rural Development and Poverty in South Asia. UNESCAP Development Paper No. 23, Thailand, 2003.

[2] Economic and Social Survey of Asia and the Pacific 2004, UNESCAP, 2004.

- Poor infrastructure (transportation, communication, energy) and insufficient attention from development institutions (education, health, investment).
- Socio-cultural marginality (power, voice, land rights, tenure) and limited local economic opportunities (agriculture, off-farm, urban employment).

Secondary crops have the potential to contribute, however, to improve the livelihoods of poor rural populations, as sources of raw materials for new or rapidly developing processing industries, in addition to their important uses as fresh and dried foods. For example, the food industry uses more and more starch as well as flour from these crops; the feed industry is developing at a high rate and demands products derived from a wide range of crops and their by-products. Product transforming industries find in secondary crops a cheap and appropriate source of renewable material. This potential requires conversion into pathways towards alleviation of local poverty. The challenge is thus to make the value added generated by this potential accrue to the rural poor through appropriate strategies and policies. Research and rural development policies in Asia and the Pacific have so far largely ignored the local and regional specificity and needs of the rural poor. Little attention is given to the potential these crops have for lifting the living standards of rural populations. Little attention is given to the mostly marginal populations to whom these crops contribute both in terms of food security and occasionally cash.

As there is an urgent need to raise the awareness and commitment of scientists and policymakers on the importance of these crops, CAPSA in association with ICFORD, the Indonesian Government and the Japanese Government, organized a four-day regional workshop with 17 contributions from 14 Asian and Pacific countries[3] and four regional/international organizations[4] in December 2005. The workshop focused on rural prosperity and secondary crops, with special attention on applied pro-poor research and policies, drawing from successful experiences and practices in the region.

With the idea of going beyond the exposé of case studies, the authors mutually presented their papers and interacted with invited national policymakers from the participating countries (see List of participants) so as to expand the debate from field results and scientific approaches to more practical policy and implementation issues. A full day of working group sessions was organized to facilitate interaction between all participants and

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[3] They include eight countries from the UNESCAP-CAPSA AGRIDIV project, namely Bangladesh, India, Indonesia, Lao People's Democratic Republic, Myanmar, Sri Lanka, Thailand and Viet Nam. In addition seven countries, Cambodia, China, Nepal, PNG, the Philippines and Pakistan were invited.

[4] GFU/FAO in Italy, CIP in Indonesia, CIAT in Thailand and AVRDC in Taiwan.

provide more substantiation on how the lessons learned from the cases could be turned into pro-poor action.

This book presents these experiences and synthesises the results, illustrating how the crops of the Poor, sometimes called 'secondary crops' or 'under-utilized species', can genuinely contribute to achieving the first MDG; that it is possible for policymakers and research managers to translate their political commitment to improve the lives of millions of rural poor into concrete actions and positive results.

This book is organized in three Parts preceded by an Introduction explaining the rationale of the conference and the methodological framework used for the presentation of the case studies. They are followed by a Synthesis section. Part I 'An Ignored Potential' groups six cases. Two of them have a regional scope and four focus on specific countries (Bangladesh, Cambodia, India and Myanmar). All intend to reveal various aspects of the potential of secondary crops in relation to poverty alleviation.

Part II 'Ignored Local Dynamics' digs further revealing how secondary crops practically contribute to the welfare of marginal rural populations. Five of the six papers presented in this part elaborate on local cases to depict local experiences in five countries (Lao People's Democratic Republic, Nepal, Papua New Guinea, Thailand and Viet Nam) while a sixth case illustrates a regional picture of the impact of a tuber crop in Asia.

Part III highlights, through five more cases covering six countries (China, Indonesia, the Philippines, Sri Lanka, Thailand and Viet Nam), that pathways out of poverty do not only go through productivity improvements but also through a different type of link with the resource poor populations.

The results of intensive interactions and working group discussions among the participants, scientists and policymakers are presented in the Synthesis. In its first section it provides a more profound understanding of the key factors related to the improvement of the well being of the rural poor, often looking beyond the secondary crops. The second section synthesises how the workshop participants see practical ways to design more applied pro-poor policies and research programmes.

The papers and their discussions provide a large panorama of secondary crops' potential for poverty alleviation, of the dynamics currently taking place in many countries, and of the changes which they bring to the lives of the rural poor. We hope that they will also contribute to open pathways out of poverty for the marginal rural populations in Asia and the Pacific.

People, Crops and Change: Comparative Case Study Methodology

Robin Bourgeois[*]

Raising awareness among research managers and policymakers regarding the potential secondary crops have for poverty alleviation requires two important steps. The first consists of generating such knowledge; the second in disseminating it. As far as knowledge generation is concerned, it appears that, actually, the need is for empirical, factual, specific and concrete knowledge as well as for the larger picture illustrated by local evidence.

The first dimension is needed to convince practitioners that indeed this potential exists and is used to the benefit of resource poor populations. The second is required to expand the reflection beyond the local root-based and anecdotic level into a more comprehensive framework. A comparative case study seems the most relevant and feasible methodology given the topic, the audience and the resources available.

Because a case study consists of a detailed examination of a specific unit of analysis, this approach, as a heuristic tool, fitted with the first need. The case study approach helps to understand the specificity of the context and thus to relativize it. By devoting more time to a more detailed analysis it helps to uncover interactions and relationships between variables. It combines various sources of information from a literature review to direct interviews, including data collection. Altogether these characteristics enhance the reliability of the information.

However, a case study has a limited inductive effect and for the purpose of raising awareness a complementary approach is required. This approach consists of multiplying the cases so as to permit cross-case analyses, based on similarities and differences. Therefore, a common framework for the case study was elaborated in order to facilitate the discussion of similarities and differences by reducing the noise of irrelevant variables.

The common framework proposed to the authors consisted of a comprehensive analysis of a successful case where resource poor rural populations in disadvantaged areas had directly benefited from the potential of a secondary crop through either research or policy actions (people, crops and change).

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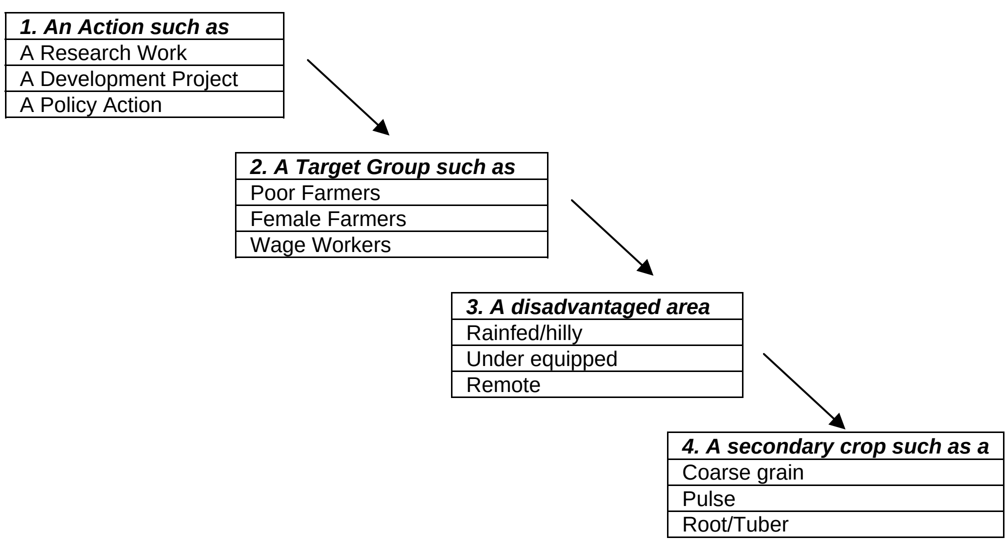
A resource poor population was defined as a population living in rural areas and belonging to the lowest decile in terms of income distribution. Authors were requested, as far as possible, to provide evidence of the fulfilment of this condition in relation to the characteristics of the population studied.

A disadvantaged area was generally considered as rainfed, remote and poorly equipped. Papers again were expected to provide evidence that the local conditions of the target population corresponded with this definition.

A research or policy action was defined as a specific intervention in a specific area for a specific target group that introduced a significant (positive) change in the welfare of the target group due to a change in its relation to a secondary crop. The initiative of an individual scientist, a local research activity/programme, the local implementation of a policy, were all acceptable as long as they represented a source of change. However, it was considered that a failure story could be acceptable as a case study as long as the same framework was applied.

Thus, schematically, each country case could be portrayed as follows:

Framework of a case study



In addition, authors received common guidelines to ensure that they provided the same type of information as follows:

(i) *Presentation of the situation of the target group before the intervention.*

This section presents information about the characteristics of the rural poor population before they benefited from the change: (location, size, and indicators of the state of the group in relation to the type of change introduced). If the potential change is not related to income, the paper did not have to include economic data. However, all papers should include quantitative and qualitative figures.

(ii) *Presentation of the action that led to the improved situation of the target group.*

Section (ii) depicts the change that occurred, that is the action implemented that led to a significant improvement in the situation of the target group. Quantitative and qualitative data are required as regards, where, when, how the changes took place, and who were the key players.

(iii) *Presentation of the situation of the target group after the intervention*

This section highlights the characteristics of the rural poor population after they benefited from the change, documented with quantitative and qualitative figures.

(iv) *Analysis of the reasons for success*

In section (iv) the author is expected to review and highlight the factors that contributed to the success of the case. Several dimensions can be taken into consideration and discussed such as, economic, technological, socio-cultural and political aspects. Whenever possible, comparisons with other successful or unsuccessful similar cases in the country was appreciated.

(v) *Lessons for applied pro-poor research and policies*

In section (v) authors conclude their papers with an attempt to characterize the key features of applied pro-poor research or policy that may effectively target rural populations in disadvantaged areas.

As a result, the 13 country case studies presented during the workshop have the following features.

Country	Commodity	Type of change	Place	Target group
India	Maize	Improved cultivars	Northern and Central	Resource poor farmers
Cambodia	Soybean, mung bean, maize, sesame, peanut	Diversification	Kampong Cham and Battambang	Upland crop farmers
Bangladesh	Lentils, millet, maize, potato, mung bean, sweet potato	Diversification	Maize growing area	Poor farmers
Lao PDR	Job's tear	Marketing	Luang Prabang	Upland farmers
Nepal	Finger millet	HY disease resistant varieties	Rainfed uplands	Upland poor farmers
Viet Nam	Maize	Maize feed development	Northern Mountains	Upland poor farmers
Sri Lanka	Maize	Forward Sales Contract	Highlands	Small farmers
Thailand	Soybean	Value added	Uplands	Ruamjai Women's Group
Myanmar	Green gram	Transition to market	Lowlands	Farmers and landless labourers
Papua New Guinea	Yam	Improved variety	Markham Valley hills and dry plain	Rural poor population
Philippines	Maize	Farmer Scientist Programme	Cebu and Siquijor	Upland communities
Indonesia	Cassava	Small-scale processing	Lampung	Small-scale farmers/ co-operatives
China	Sweet potato	Small processing machinery	Sichuan	Small households/ entreprises

This table shows a remarkable diversity of countries ranging from large open ones (China, India, Indonesia) to small, landlocked ones (Lao People's Democratic Republic, Nepal, Cambodia), from South Asia to Southeast and East Asia, with a diversity of cultures and agro ecological conditions. Secondary crops' diversity is also well represented with all major groups (coarse grains, roots, pulses and tubers). The types of change also include great diversity ranging from the more traditional technological changes (introduction of new varieties) to more economic ones (post-harvest processing, diversification) or social and institutional ones (contracts, training/education).

Such diversity is an asset for the purpose of providing evidence of the contribution secondary crops can make to poverty alleviation. It is also a challenge for the elaboration of more comprehensive understanding of how the "people-crop-change" system operates and leads to improved living conditions of the concerned population. The challenge is to find, throughout this diversity, the regularities or similarities upon which one could elaborate and draw up a more comprehensive picture, as well as derive a more global understanding that, in turn, could be used as a reference for enhancing the situation of rural poor populations.

This challenge was directly tackled with the help of the workshop participants, both the scientists who wrote and presented the papers and the invited policymakers who discussed them. The numerous interactions among them took place during the presentations and during the special working day dedicated to group discussion. The orientation of the group discussion covered two topics: i) key factors in improving the well-being of the rural poor, and ii) practical implications for designing pro-poor research and policies. The results of these working groups' sessions were discussed in a plenary session and aggregated into a common output. They are presented in Part IV as a conclusion.

An Ignored Potential

The five papers grouped under the header of Part I “An Ignored Potential” provide a much needed introduction to secondary crops and their potential for poverty alleviation in the context and environment of rural populations in Asia.

Mubarik Ali, Umar Farooq and Abedullah, in “A Neglected Frontier”, stigmatize the laxity in pulses research and development efforts in South Asia that, according to them, led to substitution of diversified crop rotations with continuous cereal-cereal or cereal-cash crop rotations, the sustainability of which is now being questioned. Their study looks into the benefits of pulses beyond annual farm-level returns and provides evidence on the role of these crops in sustaining long-term agricultural productivity, enhancing micronutrient availability, improving the health and performance of school children, and increasing the earning capacity of poor workers, all of which can lead to food security in South Asia.

Then, R.P. Singh, Ranjit Kumar and N.P. Singh discuss the “Livelihood Security of Resource Poor Maize Farmers in India”. They highlight that the adoption of very promising maize hybrid cultivars in traditional maize growing states, such as Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh and their impact on productivity, farm income and livelihood security is still low. The authors castigate the negligence of policies and poor infrastructure, in particular marketing services as the key reasons for this lack of impact on the livelihood security of poor farmers in the region.

Chan Phaloeun, Lor Bunna, Men Sarom, and Bob Martin take a reverse approach and describe in “Upland Crops Potential for Rural Economic Development in Cambodia” the socio-economic situation of farm households and intend to identify which non-rice upland crops (among maize, soybean, mung bean, sesame, and peanut) have potential as a means of poverty alleviation and food security development in Kampong Cham and Battambang provinces. Showing that the area under upland crops in Cambodia has increased dramatically during the last five years, they argue that secondary crops in their diversity can provide sufficient food for consumption all year round and substantially increase farm family income.

As an illustration, in the context of a country in transition to market economy, Than Than Win and Aung Kyi in “Green Gram Diversification and Commercialization in Myanmar”, show that after opening exports to private traders, the cultivation of green gram boomed.

Their analysis witnesses the bounty a secondary crop may bring to local populations, not only the farmers and traders in this case but also the poorest landless labourers.

Last but not least in Part I, Jahangir Alam Khan's paper on "Secondary Crops and Poverty Alleviation in Bangladesh" examines the possibilities of promoting diverse agriculture and agribusiness with selected secondary crops such as maize, millets, lentil, mung bean, potato and sweet potato for poverty alleviation in Bangladesh. According to this study, a one per cent increase in secondary crops area would result in a 0.3 per cent increase in household income. Yet, Bangladesh shows a pattern similar to India; the priority given by farmers to irrigated rice cultivation and to wheat limits the attention the so-called "minor" cereals and pulses receive and abates diversification.

A Neglected Frontier

Mubarik Ali, Umar Farooq** and Abedullah****

Abstract

The laxity in pulses research and development efforts in South Asia has led to the stagnation in their yield and a loss of their competitive position in the cropping system resulting in the substitution of diversified crop rotations with continuous cereal-cereal or cereal-cash crop rotations, the sustainability of which are now being questioned. The per capita consumption of pulses has plummeted as their relative prices increased despite a large increase in imports to South Asia. These cheap sources of protein and iron have become out of the reach of the poor, and micronutrient deficiencies are widespread. This study looks into the benefits of pulses beyond annual farm-level returns and provides evidence on the role of these crops in sustaining long-term agricultural productivity, enhancing micronutrient availability, improving the health and performance of school children, and the increasing earning capacity of poor workers and women, all of which can help improve food security in South Asia. Based on these advantages, the case for public support is made to promote pulses beyond market forces. Such support should come through the promotion of technological innovations. The research should focus on high-yielding, short-duration, uniformly maturing, disease resistant, and input, especially irrigation, responsive varieties. Efforts to develop appropriately cooked dishes, which can enhance the availability of micronutrients and are palatable under local conditions as well as nutritional education for women should also be supplemented with technological innovation in production. The successful experience of AVRDC in integrating mung bean into cereal based cropping systems in South Asia may be replicated throughout the region, thereby transforming pulses from subsistence to commercially profitable crops.

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Introduction

The Green Revolution of the 1970s and 1980s focused on cereals, and neglected pulses, which traditionally formed an integral part of the diet and farming systems. Low public efforts seeking to improve these crops led to the substitution of diversified crop rotations with continuous cereal-cereal or cereal-cash crop rotations, the sustainability of which is now being questioned (Ali and Byerlee, 2002; Pingali and Hiesey, 2001; Ali, 1996; Huang and Rozelle, 1995; Cassman and Pingali, 1995; Pagiola, 1995; Byerlee and Siddiq, 1994; Flinn and De Datta, 1994; Byerlee, 1992). On the consumption side, while the average per capita consumption of cereals has nearly reached the recommended level, a cereal-dominated and unbalanced diet has become common in South Asia. Per capita consumption of pulses has plummeted as their relative prices increased despite a large increase in imports to the region. These cheap sources of protein and iron became out of the reach of the poor, and micronutrient deficiencies have become widespread (Calloway, 1995; Bouis and Novenario-Reese, 1991; Walker and Ryan, 1990; Kurz and Johnson-Welch, 1994).

In research and development, the benefits of pulses are hardly evaluated beyond the farm-level and are confined to a single crop-cycle basis. The long-term advantages of these crops in terms of enhancing the sustainability of farming systems, and improving the health as well as working capacity of the poor are ignored. This study looks into the benefits of pulses beyond the crop-cycle returns and provides evidence on the role of these crops in sustaining long-term agricultural productivity, improving the health of school children and their performance, as well as the earning capacity of the poor workers.

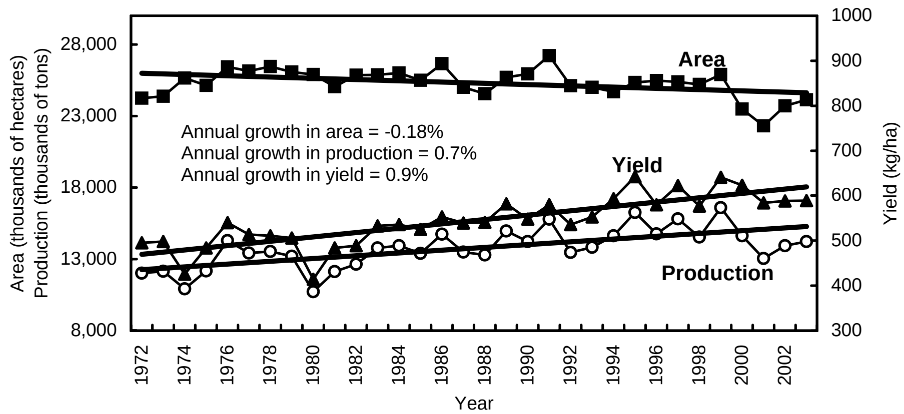
The paper is arranged in the following order. Section 2 quantifies the trends in pulses area, production, trade, share in cropping systems, per capita availability, budget share and prices. Section 3 explains the factors behind these trends in terms of research and development outcomes, demand elasticities and the continued subsistence nature of these commodities with a few exceptions where technological innovations have been introduced. Section 4 goes into the economics of pulses, comparing the short-term benefits and long-term residual and sustainable advantages of pulses cultivation. The nutritional advantages of pulses and its impact on human productivity and economic performance are quantified in section 5. Section 6, concludes that the promotion of pulses in South Asia can bring food security in terms of sustainable cropping systems, a balanced diet, and improved productivity of poor workers and school children.

Macro trends in pulses

Production

Pulses are grown on about 25 million hectares in South Asia, producing 14 million tons, with an average per hectare yield of 600 kg during 2003. The total area under pulses in South Asia virtually remained stagnant at 24-25 million hectares during 1972-2003. There was a nominal increase in production from 12 million tons in 1972 to 14 million tons in 2003 with average annual growth of 0.7 per cent per annum. This increase entirely came from the improvement in per hectare yield from about 500 kg per hectare in 1972 to nearly 600 kg/ha in 2003 (Figure 1). This implies that no significant development in the actual production of pulses has taken place in South Asia.

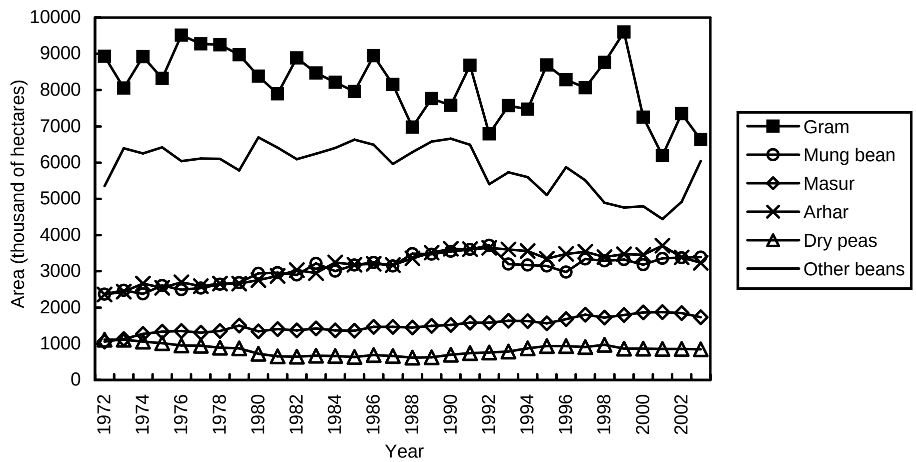
Figure 1. Trends in area, production and yield of pulses in South Asia



Source: See Appendix 1.

By commodity, there were some improvements in per hectare yield of gram, lentils, dry beans and other pulses (Appendix 1). However, increasing trends in the area under *arhar* (pigeon pea), mung bean and *masur* (lentils) were observed (Figure 2). As statistics on the area under pulses are more reliable than yields, increasing trends in the area under these crops suggest that there may be some improvements in the production technologies of these crops.

Figure 2. Trends in the area under major pulses in South Asia

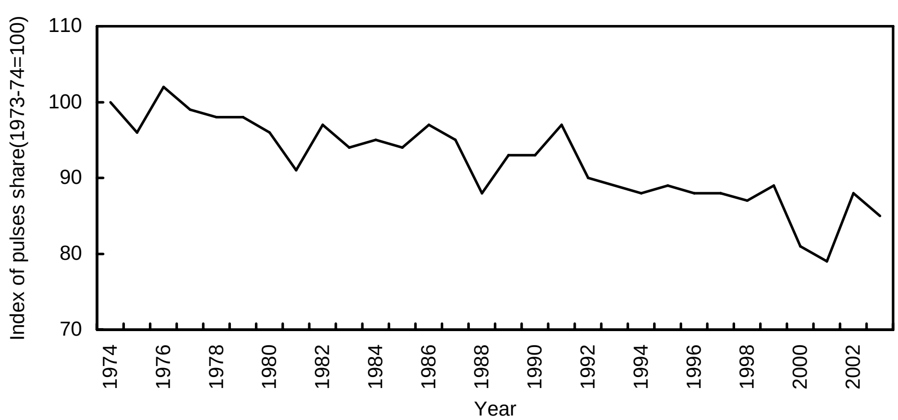


Source: See Appendix 1.

Share in the cropping system

Because of the relatively higher expansion in the area planted to other crops, the share of pulses in total area has declined overtime. The index of pulses share in total cropped area decreased from 100 in 1974 to 85 in 2003, with a minimum of 79 during 2002 (Figure 3). As pulses are leguminous crops, this decrease has negative consequences on the sustainability of the whole copping system.

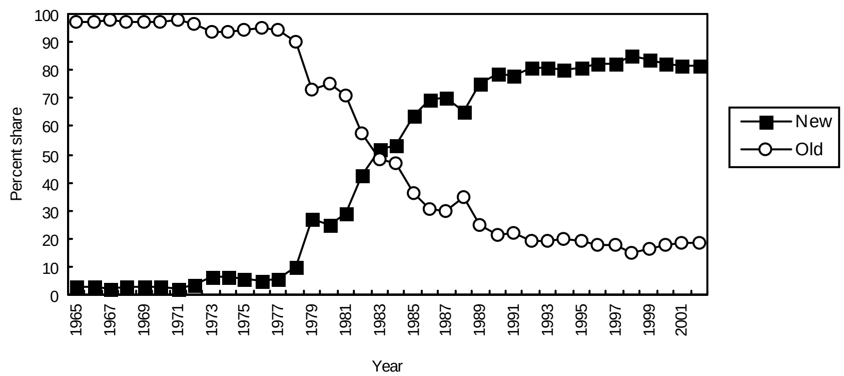
Figure 3. Trends in the index of pulses share in total cropped area of South Asia



Source: Estimated from the FAOSTAT-Agriculture (agricultural production) data.

More important than the decline in share was the shift of pulses cultivation from the intensive and agriculturally favourable irrigated lands to less intensive and agriculturally marginal rainfed areas. For example, the share of major mung bean growing districts in Pakistan Punjab decreased from 97 per cent in 1970 to almost 19 per cent in 2003, while the share of new mung bean growing districts (mainly rainfed) increased from 3 per cent to 81 per cent over the corresponding period (Figure 4). This shift in pulses area coincided with a fast decline in the use of green manure crops (Ali, 1998), further risking the sustainability of these systems.

Figure 4. Trends in the relative share of new and old mung bean growing districts in Pakistan Punjab



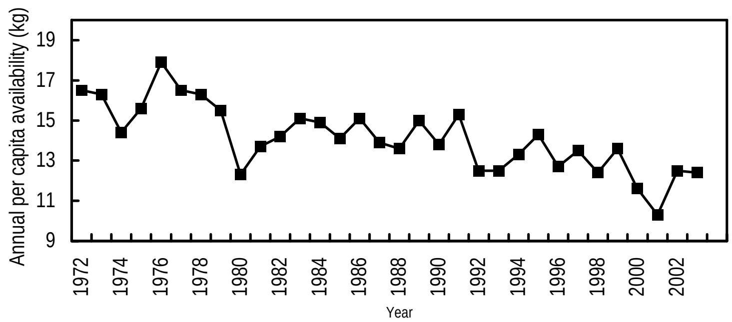
Source: Estimated from district level data for mung bean in GOP (various issues). The new districts for mung bean are Layyah, Bhakkar, D.G. khan, and Mianwali, while all other districts of Punjab are old districts.

Per capita availability

As the production of pulses did not increase as rapidly as the population, the per capita annual availability of pulses (defined as production plus imports less exports divided by population) has plummeted from about 17 kg in 1976 to 12 kg during 2003, with a minimum of 10 kg during 2001 (Figure 5). The decline was more serious in some countries, like Bangladesh, than others.[1] This decline deprived the poor from cheap protein and mineral sources, with the consequence of micronutrient, especially iron, deficiencies among poor sections of South Asian societies.

[1] These trends are similar to the ones established from the data reported in FAO food balance sheets for various years, except that per capita availability of pulses for every year is slightly higher in our case than in FAO data because the latter makes a discount for the seed and feed requirements as well. However, these trends contradict with household consumption survey data in India and Pakistan where pulses consumption is shown to have a stagnant or slightly increasing trend. We do not have anyway to reconcile these contradictions, except to argue that these surveys have adopted different definitions of pulses in different years. Increasing pulses prices in real or in comparative terms and increasing imports (see next two sections) all support the declining per capita availability in pulses.

Figure 5. Trends in the per capita availability of pulses in South Asia

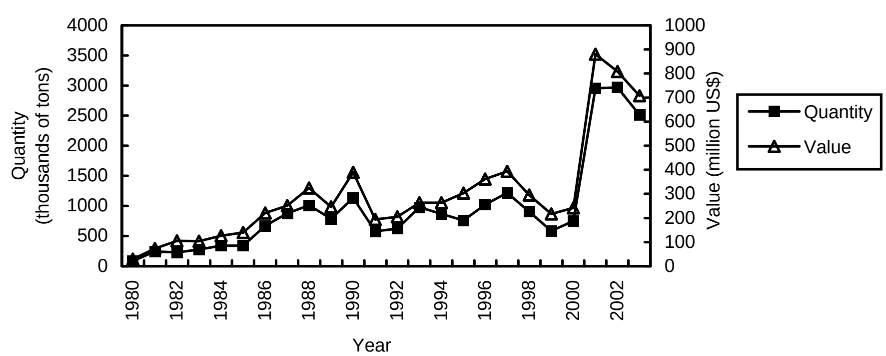


Source: Estimated from the total production of pulses and population of South Asia. For pulses production, see Appendix 1. The population estimates of South Asia were obtained from FAOSTAT-Agriculture (population).

Trade

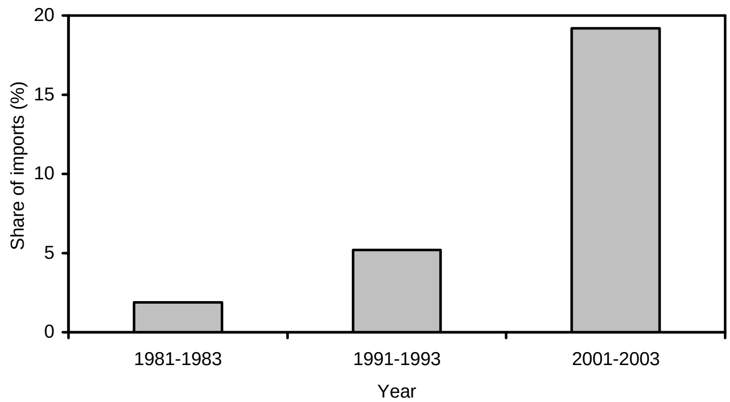
The inferior nature of pulses in consumers' preference is normally blamed for the above trends. Therefore, a drop in their demand and consumption is considered as a natural consequence of rising income. However, this is refuted with the fast growing international trade in pulses, especially during recent years, suggesting that there is, in fact, demand pressure on the domestic supply of pulses. The trade deficit in pulses of the region was about US$ 880 million during 2001 (Figure 6). The import net of export of the region has reached close to 3 million tons. The share of imports to domestic production increased from less than 1 per cent in the early 1980s to about 20 per cent in the early 2000s (Figure 7). The deficit in pulses trade has consumed almost 42 per cent of the earnings from cereal trade.

Figure 6. Trends in trade deficit in pulses in South Asia



Source: FAOSTAT-Agriculture (agriculture and food trade).

Figure 7. Share of pulses imports to domestic production of South Asia

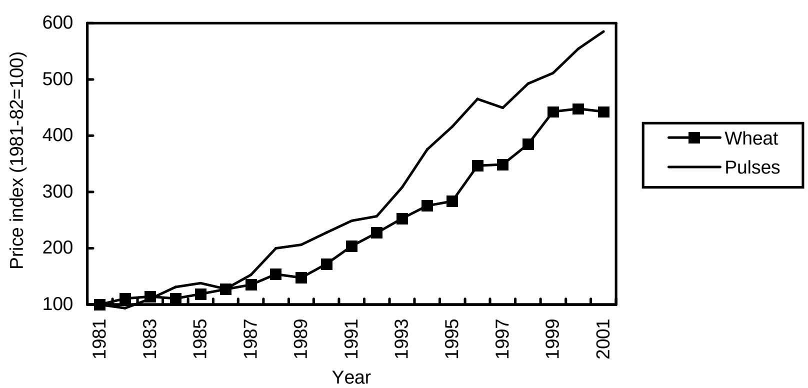


Source: For pulses production see Appendix 1. The data for pulses imports were obtained from FAOSTAT-Agriculture (agriculture and food trade).

Prices

Another indication of the demand pressure for pulses is the increase in their relative price index. In South Asia, the relative increase in the prices of pulses was much higher than of other basic foods, such as cereals and beef. For example, during 1981-2001, the pulses price index in India drifted 32 per cent above the wheat price index (Figure 8). This occurred despite tremendous growth in the imports of pulses to dissipate the price pressure in recent years.

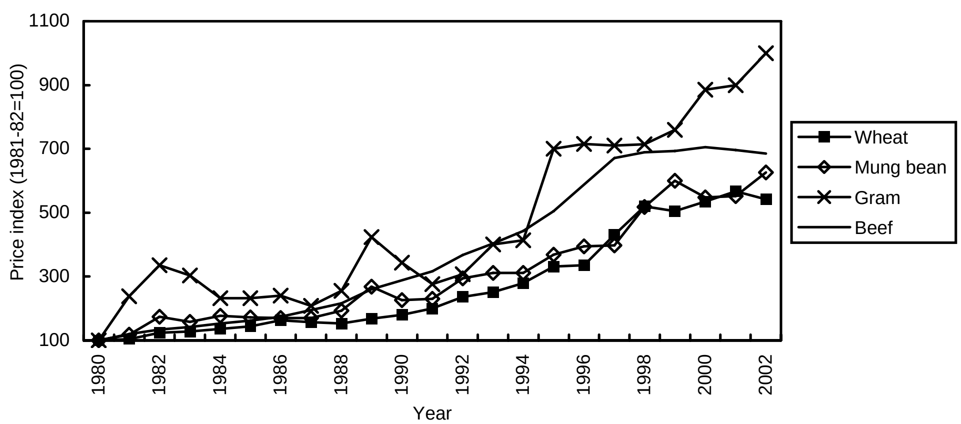
Figure 8. Trends in wholesale prices of pulses and wheat in India



Source: GOI (various issues).

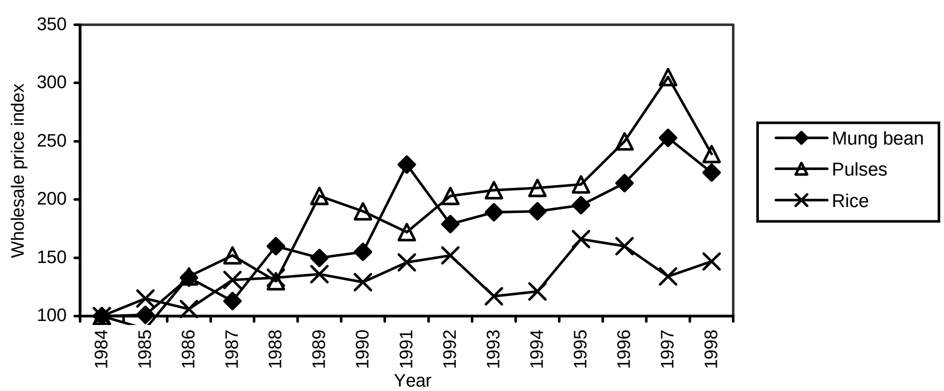
Similar trends in pulses prices were observed in Pakistan (Figure 9) and Bangladesh (Figure 10). However, it should be noted that the successful introduction of new varieties and production technologies in mung bean cultivation in Pakistan kept its prices in line with the prices of cereals (Ali *et al*., 1997). When such technologies were not available, as in the case of gram, the hikes in prices were much higher. Moreover, other protein and mineral rich foods, such as beef, also became expensive and, thus, became out of the reach of poor people. All this exacerbated micronutrient deficiency in South Asia.

Figure 9. Trends in pulses, wheat and beef retail prices in Pakistan



Source: GOP (various issues).

Figure 10. Trends in retail prices of pulses and rice in Bangladesh



Source: Abedin *et al*., 1999.

Impact on the poor

The higher increase in pulses prices than other foods did not benefit the poor farmers as pulses growing farmers lost their relative competitiveness against cereals because of faster technological changes and better market and policy support for the latter. Conversely, although no data is available on pulses by income group to see specifically how the poor were affected by these trends, the estimates of demand elasticities of pulses by income group have indicated higher own-price elasticities for the poor (see for example, Farooq and Ali, 2004). This suggests that increases in pulses prices would more strongly impact upon poor consumers.

Pulses share in food expenditure

Despite the steep decrease in per capita availability, due to the rising prices of pulses, their share in food expenditure has not declined so rapidly (Table 1). This is another indication of consumers' positive preference for pulses.

Table 1. Budget share (percentage) of major food items in India and Pakistan

Food group summary	India[a]				Pakistan[b]			
	1972-1973	1977-1978	1986-1987	200-2001	1970-1971	1979-1980	1990-1991	200-2001
Cereals	49.9	45.7	35.4	35.1	32.1	23.9	20.7	25.4
Pulses	6.6	6.5	6.3	5.5	3.6	3.7	3.5	2.4
Livestock products and fish	15.2	17.8	22.1	21.2	24.4	28.2	31.2	30.3
Fruits and vegetables	7.8	9.0	11.7	13.2	6.7	9.3	14.2	10.9
Others	20.6	21.1	24.5	25.0	33.2	34.9	30.4	31.0

Source: [a] FAO, 1993; [b] GOP (various issues).

Factors behind the macro trends

Lack of technological innovation

Pulse production suffers from insufficient from technological innovation. Especially during the 1970s and 1980s in South Asia, as reflected by the number of pulses compared to cereal varieties released during this period in Pakistan (Table 2). Although, pulses varieties released during the 1990s increased, this effort not supported by an adoption campaign parallel to cereals. This laxity triggered a stagnation in the yield of pulses. On the other hand, per hectare yield of cereals improved from 1.1 tons/ha^{-1} in 1972 to 2.5 tons/ha^{-1} in 2003, at an average annual rate of 2.59 per cent (Figure 11).

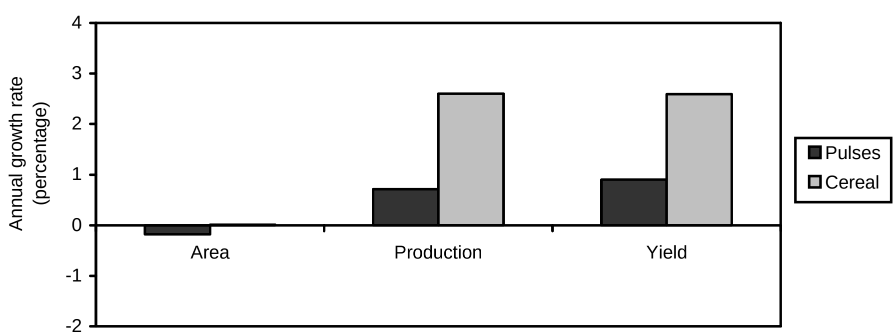
Table 2. Number of varieties released of wheat, cotton and pulses in Pakistan since the 1970s

Period	Wheat	Cotton	Pulses				
			Gram	Lentil	Mash	Mung bean	Total
1970s	13	7	0	0	0	0	0
1980s	20	12	2	1	0	5	8
1990s	35	27	12	3	4	7	26
2000s	25	21	11	3	1	2	17
Total	93	67	25	7	5	14	51

Source: Hussain *et al*., 2005.

There were some successful examples of technological innovation, like mung bean in Pakistan where production jumped from 32,000 tons during 1981 (GOP, 1982) to 140,000 tons in 2004 (GOP, 2005), but these scarce examples fail to create dynamism in the whole sub-sector in the region. There is evidence showing that an increase in pulse production does in fact enhance its consumption. For example, Abedin *et al*. (1999) have shown that in Bangladesh the consumption of mung bean by farmers, in irrigated areas where new mung bean varieties are being introduced, is higher than its average at the national level. Similar trends in mung bean consumption at the country level were observed when mung bean production increased in Pakistan during the 1980s and 1990s.

Figure 11. Annual growth rates of cereals and pulses yield in South Asia during 1972-2003



Source: FAOSTAT-Agriculture data.

Demand elasticities

The negative trend in pulse consumption in the region is usually explained assuming pulses as inferior goods. However, studies have consistently shown positive income elasticities for pulses. However, contrary to cereals, pulses generally have high own-price but low positive income elasticities (Table 3). Therefore, the decline in food legume consumption during the 1970s and 1980s can be attributed to the disproportional increase in pulses prices combined with high demand elasticity, rather than to an increase in income.

Table 3. Demand elasticity for pulses in South Asian countries

Country	Own price	Expenditure
Bangladesh	-0.48	0.23
India	(-1.34)-	0.64
Nepal	-	0.26
Pakistan	(-0.31)-(-0.55)	0.19
Sri Lanka	-	0.22

Source: For expenditure elasticity, Kumar *et al*. (2003); for own-price elasticity in Pakistan, Ali and Abedullah (1998) and Ali and Farooq (2006); for India, Vijayalakshmi *et al*. (2003); and for Bangladesh Ahmad and Shams (1994).

The boost in income and population will continue to place pressure on the demand for pulses in the future. Assuming the relative prices remain unchanged, it is projected that demand for pulses will increase by 17 per cent in the high-income group compared to 9 per cent among the low-income group, because of the higher increases in income of the former group. Including the impact of both income and population but keeping the relative prices constant, it is estimated that the demand for pulses in South Asia will increase by about 50 per cent from about 16 million tons in 2000 to 24 million tons in 2025 (Kumar *et al*., 2003). However, with the current rate of technological innovation, production will increase only 22 per cent thus widening the demand-supply gap. Unless additional supply relieves this demand pressure, it will further push pulses prices up and reduce consumption, thus creating more imbalances in the diet. This will impact more on the poor because of higher own-price elasticity for this group compared to the high-income group.

Lackluster response to policy incentives

The lack of technological innovation in pulses kept their production largely subsistence in nature and a small portion of it comes to market (Table 4). Therefore, their production is wrongly considered to be unresponsive to policy incentives such as price, input subsidies, etc. However, in reality the percentage of pulses sold in the market is comparable or even higher than cereals.[2]

[2] For example, the farm surplus for rice is around 50 per cent in Bangladesh (Hussain, 1998).

Table 4. The percentage of marketable surplus of different pulses in India

Pulse	Percentage of market supply
Gram	40
Arhar	50
Urad	61
Masoor	54
Mung bean	59
Overall	48

Source: Kyi *et al*., 1997.

The hypothesis of pulses responsiveness to policy tools was tested by Ali and Abedullah (1998) for Pakistan Punjab using district-level data on pulses production and prices during 1971-1994.[3] The long-run supply elasticity with respect to own price was either small or insignificant, except in mung bean where technological innovation had transformed a previously subsistence crop to a commercial crop. The supply elasticity with respect to cropping intensity was either negative or insignificant suggesting that pulses largely remained in low cropping intensity and low fertile areas marginal for the production of main cereal crops.[4] The elasticity with respect to irrigated area was insignificant in all cases, suggesting that pulses production had not benefited from the investment in irrigation infrastructure largely due to a lack of water responsive varieties. After controlling the effect of relative prices, irrigation and cropping intensity, the coefficient for trend was either insignificant or negative, except for mung bean, suggesting a lack of technological advancement in pulses production (Table 5). This analysis suggests that technological development can make pulses responsive to policy incentives.

Table 5. Long-run supply response of major pulses in Pakistan Punjab

Independent variable	Mung bean	Gram	Mash	Lentil
Mung bean price	1.178	0.770	-	-0.537
Gram price	1.215	-	-	0.237
Mash price	-1.812	-2.24	-	-
Lentil price	1.055	-	-	0.340
Wage rate	-1.449	-	-	-0.706
Irrigated area (%)	-	-	-	-0.675
Cropping intensity	-	0.715	-	-0.355
Trend	0.056	-0.100	-	-0.070

Source: Ali and Abedullah, 1998.
Note: The elasticities with respect to competing crops are not reported here to keep the discussion focused, but can be seen in the original source.

[3] The supply function of individual pulses was defined as a function of its own price and the prices of competing crops, wage rates, investment in irrigation (captured through a variable on the proportion of irrigated area), pressure on land to produce food and raw materials (captured by a variable on cropping intensity defined as area under all crops in a year divided by cultivated area), and technological changes (captured through trend variable). All prices were normalized with fertilizer prices, and Nerlovian adjustment process was assumed in production. For more details see Ali and Abedullah (1998).
[4] The only exception to this was gram, which is mostly associated with wheat production and grown on the unused wheat area in Pakistan.

Economic of pulses production

Short-term returns

Pulses normally generate low returns in absolute terms when estimated on a single crop-cycle basis. These are the poor-man's crops as they involve low production costs and low risk, depicted by relatively small coefficients of variation in yield (Table 6). However, the benefit-cost ratio in pulses cultivation is comparable with cereals in India and better in Pakistan where cereal prices are now competitive with international market prices (Table 6).

Table 6. Economics of pulses, cereal and vegetable cultivation in India and Pakistan

Crop	India (1997-1998)[a]				Pakistan (2001-2002)[b]			
	Total cost (US$/ha)	Net revenue (US$/ha)	B-C ratio (%)	CV in yield (%)	Total cost (US$/ha)	Net revenue (US$/ha)	B-C ratio (%)	CV in yield (%)
Onion	452	359	79	34.9	555	180	32	8.9
Wheat	224	103	46	34.0	270	134	50	3.4
Paddy	234	43	18	25.0	333	206	62	6.4
Gram	127	52	41	25.0	103	34	33	4.0
Arhar/Mash	135	38	28	10.1	57	57	100	2.3
Mung bean	86	22	25	12.4	126	81	64	1.3

Source: [a] The cost per kg of output during 1997-97 was taken from "Cost of Production of Important Crops During 1983-1984 to 1997-1998, Department of Agriculture and Cooperatives, Ministry of Agriculture, Government of India posted on the website *http://agricoop.nic.in/statistics/cost.htm*. This was converted into cost per hectare by multiplying it with average per ha yields of the respective crop reported in FAOSTAT-Agriculture data (for mung bean see Appendix 1). The prices used in estimating gross revenue were taken from http://agricoop.nic.in/prices.htm (section on farm produce prices). The B-C ratio was estimated as net-revenue divided by total cost.

[b] Ali and Byerlee, 2003.

Note: The values in local currency were converted into US$ using US$ 1 equal to INR 45 and PKR 60 factor.

Although pulses are considered as subsistence crops for poor farmers with low input intensity, profitability and CV, at the same time about 15 per cent of total pulses production, worth US$ 3.0 billion, is traded globally compared to 12 per cent of cereal production. This implies that the poor and subsistence are not *inherited* attributes of pulses; otherwise there would be only marginal international trade. These features of pulses, in fact, are the outcome of public policies, particularly in South Asia that have been massively involved in the development of cereals and have almost ignored pulses. These policies are *de facto* not pro-poor and have undervalued the nutritional contribution of pulses and welfare of women and children who are more seriously affected by micronutrient deficiencies in the region.

Pulses to conserve resources

Joshi *et al*. (2000) estimated that the transfer of rice or wheat area to pulses will cost 19-49 per cent profit to farmers and reduce food grain production by 64-76 per cent, but will require substantial additional 49-61 per cent fixed resources. On the other hand, it will save a significant amount of groundwater and soil nutrient resources in the long-term (Table 7).

Table 7. Trade-off (percentage change) in replacing rice or wheat with legumes in Karnal district, Haryana, India, 1996-1997[a]

Indicators	Pigeon pea	Chickpea	Lentil
Profit	-49	-19	-41
Food grain	-76	-64	-76
Fixed resources	-57	-49	-61
Groundwater	+95	+85	+83
Soil nutrients	+65	+73	+75

Source: Joshi *et al.,* 2000.
[a] In the rice-wheat cropping system, rice was substituted by pigeon pea, and wheat by chickpea and lentils.

Residual effects

Many agronomic studies have shown the impact of legume cultivation on the residue soil nitrogen and long-term improvement in soil structures and water retention capacity. Here we quantify these benefits in economic terms. For this purpose, yields, costs and returns were compared for different cropping systems with and without legumes. Two studies, one from Indian Punjab and one from the southern Pakistani Punjab are referred here. Indian Punjab represents an intensive rice-wheat system with high inputs and yields, while southern Pakistani Punjab represents low input intensity and low wheat yield. In each case mung bean was integrated in the existing cereal based cropping systems, which significantly improved the net returns of these systems (Table 8). This was achieved through improved productivity of cereal crops and additional returns from mung bean in the case of Indian Punjab, and lower production costs of cereals in the case of Pakistani Punjab.

Table 8. Economic comparison of the cereal based cropping system with and without mung bean in the system

	Gross revenue (US$/ha)	Total cost (US$/ha)	Net return (US$/ha)	Benefit-cost (ratio)
Indian Punjab (2002)[a]				
Mung bean	345	159	186	1.2
Only rice or wheat	671	221	450	2.0
Fallow-paddy-wheat	1 343	442	901	2.0
Mung bean-paddy-wheat	1 755	608	1 148	2.0
Pakistan Punjab (1996)[b]				
Mung bean	277	139	138	2.0
Fallow-wheat	365	274	91	1.3
Mung bean-wheat	385	217	168	1.8
Other crop-wheat	373	287	87	1.3

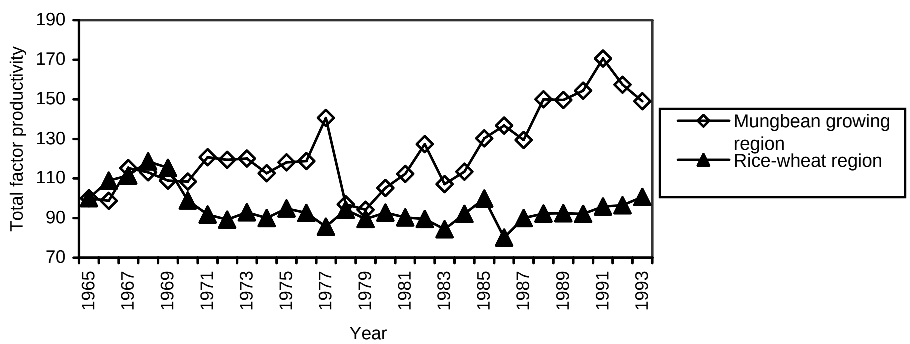
Source: [a] Grover *et al.*, 2003 ; [b] Ali *et al.*, 1997.
The original values in local currency were converted into US dollar using US$ 1 = INR 45 and US$ 1 = PKR 30 conversion factor for the respective year.

It should be noted that in Indian Punjab, strong bias for cereal research has dramatically improved yields, kept mung bean yields low and cereal prices high, and consequently mung bean could not compete with cereal crops (rice or wheat) even if its residual benefits are included. On the other hand, low wheat yields in southern Punjab and low wheat prices in the country made mung bean economically more attractive than wheat even without including the residual benefits of mung bean.

Long-term effects

The productivity impact of pulses in the cropping system is not only restricted to the following crops, it improves the productivity of the whole cropping system in the long-term. This was estimated by comparing the trends in total factor productivity (TFP) of the whole cropping production system of different regions in Pakistani Punjab. Since the introduction of modern varieties in mung bean cultivation in the mung bean-growing region of Pakistani Punjab took place during the early 1980s, its cultivation in the region expanded from 66,000 hectares in 1981 (GOP, 1982) to 256,000 hectares in 2004 (GOP, 2005). Due to this expansion, the residual impact of mung bean spread to a larger wheat area, and TFP of the system increased at much a higher rate than for the rice-wheat system (Figure 12).

Figure 12. Trends in TFP across regions in Pakistan Punjab



Source: AVRDC, 1998.

Joshi (2004) also quantified the role of pulses in the sustainability of the rice-wheat cropping system (RWCS) by regressing the growth in TFP in the Indo-Gangetic Plains (IGP) of India on legume area along with a trend variable. The effect of legume area on TFP was positive and highly significant suggesting that an expansion in legume area in IGP can contribute positively to sustaining the productivity of the RWCS in the region.

Ali *et al.* (2004) regressed the growth in TFP in the Pakistani Punjab on the share of different crops in the cropping system along with relative prices of major crop groups, index of technological changes, infrastructure, human capital, as well as soil and water quality parameters. The study reported a significant and positive relationship between TFP and pulses share. In fact, TFP elasticity was second highest with respect to pulses share after commercial crops, while cereal share had negative influence on the growth of TFP (Table 9). This suggests the long-term sustainability of pulses in the cropping system.

Table 9. Role of crop diversity in TFP in Pakistan Punjab (Dependent variable TFP)

Crop share	Impact on TFP		Total TFP elasticity
	Coefficient	Standard error	
Cereals	-0.5901***	0.1985	-0.5901
Commercial crops	0.3680***	0.1174	0.3680
Minor crops	-0.2935*	0.1951	-0.2935
Vegetables	0.0835**	0.0386	0.0835
Fruits	0.1379**	0.0718	0.1379
Pulses	0.2942**	0.1235	0.2942

Source: Ali *et al*., 2004.
* significant at the 5 per cent level
** significant at the 10 per cent level
*** significant at the 20 per cent level

Nutritional and human productivity impacts

Nutrient effects of pulses

Pulses are rich sources of protein, iron and vitamins. Some pulses, like khesari daal, roasted gram, and soybean are more condense sources of energy than cereals. Some are richer sources of niacin than even mutton and beef (Table 10).

Pulses are not only dense, but also relatively low-cost sources of protein and iron. For example, the average price of iron per 100 mg of mung bean in India is US$ 1.3, compared to US$ 35.9 of mutton and US$ 0.8 and US$ 23.6 in Pakistan respectively (Table 11).

Due to the decrease in consumption of pulses in South Asia, their contribution in nutrient supply have also dropped. Currently, pulses contribute 5-7 per cent of the consumption of protein, 5-9 per cent of iron, 9-11 per cent of vitamin B_1, and 6-10 per cent of niacin (Table 12).

Table 10. Nutrient content (per 100 g) of various food items in South Asia

Food item	Energy (Kcal)	Protein (gm)	Calcium (mg)	Iron (mg)	Vitamin-A (micro-gm)	Vitamin-B_1 (mg)	Vitamin-B_2 (mg)	Niacin (mg)
Arhar	175.00	12.00	73.00	2.70	132.00	0.45	0.19	2.90
Black gram daal	186.00	12.40	111.00	3.10	0.00	0.16	0.19	1.60
White gram whole	186.00	12.40	111.00	3.10	0.00	0.16	0.19	1.60
Mung bean	175.00	12.00	58.00	4.80	53.00	0.11	0.22	2.00
Lentil	178.00	13.20	69.00	2.20	0.00	0.15	0.20	2.40
Mash	174.00	12.00	77.00	3.80	38.00	0.42	0.20	2.00
Dry peas	315.00	19.70	75.00	7.05	39.00	0.47	0.19	3.40
Soybean	432.00	43.20	240.00	10.40	426.00	0.73	0.39	3.20
Khesari, dhal	345.00	28.20	90.00	6.30	120.00	0.39	0.17	2.90
Roasted gram	369.00	22.50	58.00	9.50	113.00	0.20	0.19	1.30
Black gram flour	186.00	12.40	111.00	3.10	0.00	0.16	0.19	1.60
Rice	364.00	6.70	19.00	1.00	0.00	0.12	0.04	1.90
Wheat flour	259.00	8.80	80.00	4.35	0.00	0.00	0.00	0.00
Milk	106.00	4.10	184.00	0.20	26.00	0.04	0.19	0.10
Mutton	198.00	18.80	8.00	0.60	14.00	0.09	0.27	3.10
Beef	250.00	17.30	6.00	2.80	23.00	0.05	0.17	3.22
Green peas	93.00	7.20	20.00	1.50	83.00	0.25	0.01	0.80
Carrot	38.00	1.10	30.00	1.30	5 988.00	0.03	0.04	0.80
Banana	108.00	1.20	12.00	0.80	98.00	0.03	0.02	0.40
Mango	60.00	0.60	6.00	0.20	1550.00	0.02	0.04	0.60
Orange	25.00	0.80	13.00	1.00	300.00	0.06	0.04	0.40

Source: Awan, 1993; Gopalan *et al*., 1989.

Table 11. Average price of protein and iron (US$/unit) from selected food items in India and Pakistan

Food item	India (2001)		Pakistan (1997)	
	Protein/100 g	Iron/100 mg	Protein/100 g	Iron/100 mg
Mutton	1.2	35.9	0.8	23.6
Fish	0.5	1.7	0.5	1.7
Mung bean	0.5	1.3	0.3	0.8
Pigeon pea	0.4	1.6	0.3	1.0
Urd bean	0.6	1.8	0.3	1.1
Arhar	0.5	2.3	0.3	1.1

Source: Estimated from the GOP (1997) for Pakistan and GOI (2001) for India by using the nutrient content table of Awan (1993) and Gopalan *et al*. (1989), respectively. The original values in local currency were converted into US$ using US$ 1 = INR 45 and US$ 1 = PKR 40 conversion factor for the respective year.

Table 12. Nutrient contribution (percentage) of pulses in India and Pakistan

Nutrient	Pakistan	India
Energy	2.0	2.2
Protein	4.8	6.7
Calcium	3.3	3.6
Iron	8.7	5.3
Vitamin-A	0.3	0.9
Vitamin-B_1	10.9	9.1
Vitamin-B_2	5.7	7.1
Niacin	9.8	6.1

Source: Estimated from GOP (1997) for Pakistan and GOI (2001) for India using the nutrient content table of Awan (1993) and Gopalan *et al*. (1989) respectively.

There are various ways to enhance the contribution of pulses in nutrient supply. First, technological innovation should be promoted in micronutrient dense pulses, such as mung bean. Secondly, as variation exists among different strains of the same pulse, therefore, there are chances to enhance the nutrient density of pulses through breeding manipulation. For example, new mung bean varieties such as PUSABOLD-1 (Pusa Vishal) contain 6 mg of iron per 100 g raw seed (Vijayalakshmi *et al.*, 2001) compared to 3.3 or 3.5 mg in the traditional varieties (Gopalan *et al*., 2000). Thirdly, developing new dishes of pulses that are appropriately cooked to enhance micronutrient availability but are more tuned to the local taste can also be tremendously helpful. Finally, generating nutritional awareness, especially among women about the nutritional importance of pulses, will be very helpful to enhance the contribution of pulses in nutrient supply.

Devadas (2001) reported that iron absorption and bioavailability from the diet can be enhanced if consumed with vitamin C-rich foods such as tomato, cabbage, cauliflower, coriander and lime juice. Applying the same principle, the *in vitro* iron bioavailability in mung bean can be enhanced using such vegetables compared with the traditional solo mung bean cooking (Vijayalakshmi *et al.*, 2001). The availability can be increased from 5-8 per cent in traditional cooking to 12-13 per cent with new recipes (Table 13).[5]

Table 13. *In vitro* iron bioavailability of standardized mung bean recipes

Recipes	*In vitro* iron bioavailability (%)
Traditionally prepared recipes	
Mung bean sundal	7.69
Mung bean masiyal	5.75
Mung bean pesarattu	8.20
Mung bean-yam kootu	8.39
Mung bean-snake gourd kootu	2.96
Mung bean-tomato adai	4.98
Mung bean dosai	7.56
Iron bioavailability-enhanced recipes	
Mung bean-cauliflower kootu	13.25
Mung bean-cabbage kootu	13.09
Mung bean-coriander leaves kootu	12.53
Mung bean sundal with carrot	12.24
Mung bean-tomato masiyal	12.39

Source: Vijayalakshmi *et al*., 2001; Sathya *et al*., 2002.

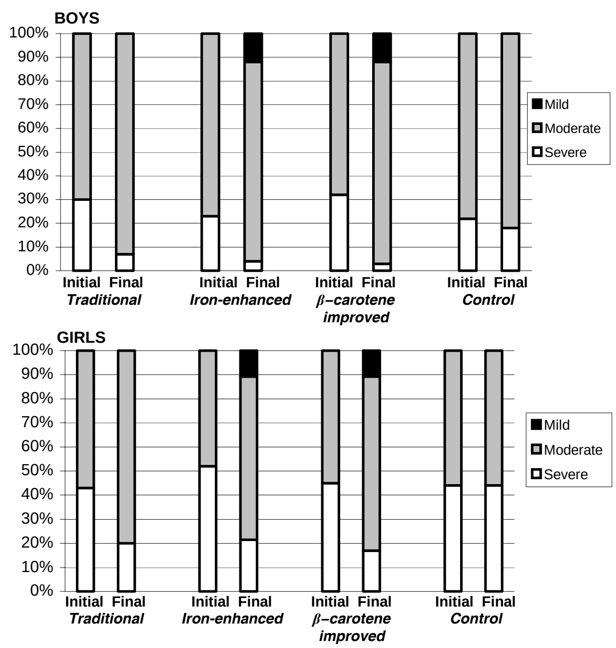
The AVRDC-The World Vegetable Center, in collaboration with Avinashilingam Institute for Home Science and Higher Education for Women (AIHSHEW), conducted a feeding trial on school children from October 1999 through October 2000 in Coimbatore City of Tamil Nadu, India (Vijayalakshmi *et al*., 2001). In total, 225 children participated in the study (113 boys and 112 girls). Of these, one group of 50 children received a daily supplementation of a traditional mung bean preparation (TR), two groups of 50 children

[5] It is worth mentioning that the new recipes were well accepted by the Indian population in Tamil Nadu.

each received a daily supplementation of bioavailability-enhanced mung bean preparations (IR1 and IR2), and the control group of 75 children received no supplementation. Height and weight measurements were taken quarterly for every group; hemoglobin levels were taken before and after supplementation based on the finger prick method and analysed using the cyanmethoglobin method (Gowenlock, 1988).

Figure 13 shows how supplementation affected the prevalence of anemia among boys and girls. Supplementation improved blood iron values in all groups of boys and 15 per cent of boys receiving bioavailability-enhanced mung bean preparations improved in health status to being only mildly anemic (10–11 g/dl). Some girls remained moderately or severely anemic after supplementation, although the incidence of sever anemia fell among girls as well. Furthermore, improvements in blood iron values were made, especially for groups that received the iron bioavailability-enhanced mung bean preparation. In the control group, the percentage of severely and moderately anemic boys and girls did not change over the period. In general for both boys and girls, supplementation greatly improved blood iron values but could not overcome moderate anemia (Figure 13).

Figure 13. Anemia prevalence among boys and girls before and after pulses supplementation



Source: Developed from the data in Vijayalakshmi *et al*., 2001.

Human health effect

Pulses make an important contribution to healthy eating because their effect on blood glucose is less than that of most other carbohydrate-containing foods. In one study, nine adults with Type 2 diabetes ate dried peas as part of a mixed meal and then later ate a mixed meal made with potatoes. Their blood glucose and insulin levels were lower after eating the mixed meal made with dried peas than after eating the mixed meal made with potatoes (Schäfer, 2003). A different study looking at healthy people found that those eating a chickpea-based meal had lower blood glucose and insulin levels than those eating wheat-based meals (either a whole grain plus wheat bran or white bread) (Nestel *et al*., 2004). These findings and others show that pulses can be useful for diabetics because they cause less of a rise in blood glucose than potatoes or wheat-based foods.

Pulses are cholesterol free and are low in fat (except soybean and peanut), and the fats in pulses tend to be unsaturated, containing both monounsaturated and essential polyunsaturated fatty acids. With their high levels of fiber, low levels of fat, no cholesterol but some phytosterols, it is not surprising that increasing pulse consumption can reduce blood cholesterol (Geil and Anderson, 1994; Mathur *et al*., 1968; Anderson and Gustafson, 1988; Shutler, 1989; Simpson *et al*., 1981; Anderson *et al*., 1990ab), which reduces the risk of cardiovascular disease (Mann, 1987; Truswell, 1994). In a large study of almost 10,000 men and women in the USA, those who ate pulses four or more times a week had a 22 per cent lower risk of coronary heart disease and 11 per cent lower risk of cardiovascular events than those who ate pulses less than once a week (Bazzano *et al*., 2001). It appears that this health benefit was independent of other health habits since adjustments of other important confounders of cardiovascular disease resulted in minimal change in the risk estimates.

Human productivity effect

In an attempt to quantify the effect of food diversity on human earning capacity, the wage rates of 1,652 Pakistani rural workers were regressed on the food shares of different food items along with other factors affecting the wage rate using two-stage least square method in order to control endogeneity in the food share.[6] The food shares of all major food items had expected positive signs and were highly significant. This implies that increasing the share of any food items, *ceteris paribus*, will improve workers earning capacity. However, the magnitude of these parameters varied across food groups. The estimated wage elasticity of food shares was highest for fruits and vegetables followed by pulses. This

[6] For more details of this study, see Ali and Farooq (2004).

suggests that reallocation of food budget from the groups (such as dairy products and wheat) having low elasticities to the ones bearing higher elasticities (like fruits, vegetables and pulses) can improve the earnings of poor workers in Pakistan (Table 14).

Table 14. Effect of relative food group shares on earning capacity in Pakistan

Food group	Elasticity of wage earning
Wheat	0.320
Pulses	0.352
Dairy products	0.212
Meats	0.345
Fruits and vegetables	0.545

Source: Ali and Farooq, 2004.

Weinberger (2005) estimated the impact of mung bean research through enhanced iron availability on women's labour productivity in Pakistan Punjab. First, the impact of iron intake (as well as hemoglobin iron) on the wage rate was estimated assuming iron intake and the wage rate were endogenously determined. At the sample mean, an increase in the blood hemoglobin level by 1 g/dl was estimated to raise daily wages by PKR 9.17. The elasticity of bioavailable iron is 0.056, while for blood hemoglobin it is quite high at 2.3. The impact of modern varieties and improved cultural practices for mung bean was shown to increase the bioavailable iron from 16.6 g/annum in 1985 to 37.0 g/annum in 1995. Compared to total iron intake, the increase in total bioavailable iron was 0.07 per cent in 1985 and 1.1 per cent in 1995. This amounts to an additional annual income of about PKR 9.0 per working woman per annum. Assuming there were 7.8 and 11.7 million female workers in the country in 1985 and 1995 respectively and 50-60 per cent of women are anemic, the cumulative discounted nutritional benefit of technological innovation in mung bean production over the 10-year period was estimated at US$ 8-10 million. This secondary impact does not include the impact on the male and youth labour force in the country. Extrapollating the impact to the total population, the study claims that the indirect impact is comparable to the direct impact of US$ 19.0 million calculated for the same period in Ali *et al*. (1997).

The AVRDC-The World Vegetable Center and AIHSHEW mung bean feeding trials in Tamil Nadu, India also established the productivity effect of greater mung bean consumption among school children. All three groups that received supplementation recorded increases in their stamina compared to the control group and significant differences were also apparent across feeding groups (Table 15). However, there is no clear evidence that the groups receiving bioavailability-enhanced recipes fared better than the children that received the traditionally prepared recipe.

Table 15. Changes in productivity parameters

Activity	Group	Mean	SD (%)	Change	t-test
Sit-ups (boys)	TR	18.4 a1	2.2	31.3	-8.74
	IR1	17.5 a	3.2	25.9	-8.05
	R2	16.9 a	3.6	33.5	-7.41
	Control	13.7 b	3	-1.1	0.28
100-m run (boys)	TR	9.8 b	0.6	12	-6.74
	IR1	10.3 a	0.5	19.6	-12.99
	IR2	10.2 a	0.6	16.4	-18.64
	Control	9.0 c	0.5	1.3	-1.3
Long-jump (girls)	TR	2.7 a	0.2	5.7	-9.08
	IR1	2.5 b	0.2	5	-5.49
	IR2	2.6 ab	0.2	5.3	-4.84
	Control	2.4 c	0.2	-1.7	1.92

Source: Vijayalakshmi *et al*., 2003.

Summary and policy implications

The laxity in research and development efforts on pulses in South Asia has led to the substitution of diversified cropping with continuous cereal-cereal or cereal-cash crop rotations, the sustainability of which is now being questioned. Pulses cultivation was forced to more onto marginal lands and did not benefit from irrigation and other agricultural infrastructure development. These crops remained subsistence, low-input intensive and low profitability, not because they had inherited these attributes but because they were deprived the fruits of technological innovation that can transform them from subsistence to commercial crops. With no significant innovation in pulses production in South Asia, yields remained stagnant for decades, supplies lagged behind demand and prices skyrocketed in the region. However, the inflated retail prices did not reach the farm level and were insufficient to compensate the lost competitiveness of the crops compared to cereals thanks to rapid technological innovation in the latter. Therefore, domestic supply remained almost stagnant and high pulses prices simply induced imports. Once the centre of pulses production, South Asia now has to spend nearly one billion US dollars on pulses imports.

With a steep increase in pulses prices along with high demand and low-income elasticities, per capita availability declined by more than 30 per cent in South Asia. This is despite the surge in pulses imports, which now contribute about 20 per cent of total supply. As the cost of other micronutrient sources, especially iron, remained high a serious iron deficiency was created in the region. The poor and neglected were affected most by these trends. The latest estimates suggest that about 75 per cent of women in the region are anemic to some degree (ACC/SCN, 2000). Sustained budget share in the public's diet over the period despite increasing prices and positive income elasticity suggest that pulses are not inferior goods in South Asia. Economic studies have predicted a continued increase in pulses demand and a burgeoning supply-demand gap, thus creating more upward pressure on pulses prices and further aggravating micronutrient deficiencies among the poor in the region.

The region now has to make a choice between importing pulses at the cost of more than US$ 300 per ton and exporting rice at the value of about US$ 120 per ton, even though the yield of the former is one-third of the latter. If market forces were allowed to work freely and policy biases against pulses removed, shifting crop area from main cereals to pulses could clearly produce economic advantages, especially in the long-term.

In fact, we advocate public support to expand pulses beyond market forces because of their impact on the sustainability of the cropping system, health of the poor and labour productivity. As both producers and consumers will benefit from expanded pulses production, both should share the burden of policy intervention. Such intervention should take the form of the promotion of technological innovation and its adoption, rather than curbing imports or establishing parastatal marketing organizations parallel to cereals. Technological innovation should focus on high-yielding, short-duration, uniform maturing, disease resistant and input, especially irrigation, responsive varieties and development efforts should focus on overcoming marketing constraints. Such technologies will not only transform pulses from subsistence to commercial crops but also help restore them from marginal production areas to intensive areas. Integrating pulses into the cereal based system in South Asia will improve food security on small farms by increasing income and enhancing the sustainability of the production systems. AVRDC experience of such integration in the case of mung bean in Pakistan and Bangladesh may be replicated throughout the region for other pulses as well.

Pulses are not only dense but also cheaper sources of protein and iron. However, wide variation in nutrient bioavailability exists among different ways of handling, processing and cooking of the same pulse. The bioavailability of pulses can be enhanced by developing appropriately cooked dishes, which are locally acceptable and palatable. Nutritional education must be provided to women through electronic media to complement such efforts. This will not only enhance the food security of the poor in general, who can rely on pulses for the cheaper sources of protein and iron, but also improve the health, productivity and earning capacity of neglected people in society, especially women and children.

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Appendix 1.

Area, production and yield of individual pulses in South Asia during 1971-2004

Area (Thousand of hectares)

Year	Total	Gram	Mung bean	Lentil	Pigeon pea	Dry peas	Beans	Other pulses
1971-72	24 242.9	8 935.3	2 366.5	1 063.1	2 362.2	1 115.3	5 351.0	3 043.0
1972-73	24 372.7	8 058.9	2 470.6	1 131.1	2 441.0	1 109.3	6 394.8	2 757.8
1973-74	25 650.1	8 926.3	2 380.1	1 269.0	2 663.1	1 058.2	6 252.0	3 097.0
1974-75	25 141.3	8 318.6	2 608.6	1 336.9	2 548.4	1 012.7	6 423.5	2 881.8
1975-76	26 435.9	9 516.5	2 490.5	1 352.0	2 693.8	956.9	6 037.6	3 364.3
1976-77	26 132.0	9 273.5	2 536.2	1 310.2	2 591.0	948.1	6 115.2	3 313.7
1977-78	26 451.7	9 248.2	2 640.5	1 348.2	2 656.7	895.5	6 101.3	3 519.6
1978-79	26 084.1	8 979.1	2 688.4	1 498.6	2 660.5	872.3	5 790.3	3 555.9
1979-80	25 892.4	8 387.4	2 938.1	1 341.9	2 756.7	723.3	6 698.7	3 012.4
1980-81	25 054.5	7 895.6	2 955.5	1 406.3	2 868.5	650.2	6 412.4	2 817.8
1981-82	25 856.1	8 885.0	2 898.6	1 368.9	3 031.6	645.8	6 095.0	2 884.8
1982-83	25 870.4	8 473.5	3 214.2	1 425.4	2 952.3	672.9	6 248.7	2 820.2
1983-84	26 003.8	8 217.2	3 006.6	1 371.8	3 245.2	661.3	6 408.9	3 028.2
1984-85	25 503.6	7 958.6	3 174.7	1 363.3	3 176.3	634.4	6 630.5	2 531.1
1985-86	26 659.8	8 951.2	3 239.4	1 465.6	3 205.9	690.8	6 488.7	2 582.5
1986-87	25 003.7	8 151.7	3 148.4	1 464.4	3 170.6	662.6	5 959.2	2 418.4
1987-88	24 563.2	6 981.8	3 492.6	1 450.3	3 357.1	619.9	6 290.1	2 341.5
1988-89	25 695.7	7 761.7	3 470.1	1 492.8	3 512.4	624.6	6 577.6	2 218.6
1989-90	25 940.1	7 581.0	3 549.8	1 518.4	3 624.0	694.5	6 662.1	2 284.2
1990-91	27 216.7	8 680.5	3 604.4	1 585.3	3 616.3	739.5	6 491.6	2 473.5
1991-92	25 121.0	6 790.5	3 719.1	1 581.2	3 650.3	762.1	5 409.6	3 170.4
1992-93	25 012.3	7 569.2	3 202.3	1 634.0	3 604.6	789.6	5 729.9	2 460.6
1993-94	24 687.0	7 476.0	3 169.5	1 625.9	3 560.6	871.6	5 605.0	2 357.5
1994-95	25 328.8	8 695.8	3 148.9	1 562.6	3 346.1	935.8	5 103.6	2 527.0
1995-96	25 463.8	8 285.0	2 979.7	1 679.5	3 478.5	939.9	5 876.5	2 212.8
1996-97	25 388.3	8 069.5	3 337.8	1 799.5	3 545.6	912.4	5 511.8	2 202.5
1997-98	25 209.5	8 766.5	3 289.3	1 726.0	3 391.3	975.8	4 898.5	2 151.8
1998-99	25 885.7	9 605.7	3 321.3	1 794.6	3 468.0	864.2	4 764.6	2 059.3
1999-00	23 476.5	7 256.2	3 183.7	1 867.0	3 458.0	861.6	4 797.2	2 046.1
2000-01	22 308.9	6 188.7	3 353.1	1 875.8	3 708.1	857.9	4 439.9	1 881.4
2001-02	23 698.8	7 349.8	3 373.0	1 849.7	3 382.0	854.1	4 919.7	1 964.6
2002-03	24 137.2	6 633.2	3 396.4	1 729.2	3 232.0	846.5	6 044.0	2 248.9
2003-04	25 210.1	7 490.3	3 423.3	1 843.6	3 332.2	857.4	6 008.9	2 246.4

Production (Thousands of tons)

Year	Total	Gram	Mung bean	Lentil	Pigeon pea	Dry peas	Beans	Other pulses
1971-72	12 009.7	5 655.0	745.2	560.8	1 693.7	787.2	1 143.0	1 430.3
1972-73	12 147.9	5 129.1	844.6	541.3	1 938.7	614.9	1 982.0	1 102.8
1973-74	10 932.6	4 750.1	694.5	600.7	1 419.2	532.9	1 637.7	1 299.5
1974-75	12 175.5	4 739.0	844.5	672.7	1 846.8	643.6	2 105.1	1 331.4
1975-76	14 288.5	6 566.2	839.9	705.2	2 114.6	674.8	1 819.4	1 580.3
1976-77	13 424.4	6 174.7	919.4	640.3	1 742.0	577.1	2 057.4	1 334.6
1977-78	13 529.5	6 188.7	924.0	637.1	1 950.7	509.3	1 856.9	1 485.4
1978-79	13 202.4	6 474.3	747.6	704.7	1 904.9	487.5	1 458.4	1 443.8
1979-80	10 716.6	4 009.1	1 031.0	577.3	1 774.3	353.4	1 938.5	1 056.5
1980-81	12 138.4	4 755.9	1 119.2	719.7	1 975.3	408.4	2 067.3	1 131.9
1981-82	12 652.3	5 092.0	1 217.5	738.5	2 255.0	405.6	1 883.6	1 095.7
1982-83	13 788.3	5 703.6	1 422.3	724.6	2 006.6	449.3	2 305.8	1 202.2
1983-84	13 942.1	5 357.8	1 145.0	777.8	2 594.7	471.1	2 194.8	1 423.3
1984-85	13 399.0	5 180.5	1 266.2	791.4	2 601.1	429.7	2 072.2	1 075.2
1985-86	14 747.1	6 407.4	1 171.7	909.3	2 457.5	524.8	2 140.0	1 161.0
1986-87	13 480.0	5 220.8	1 321.4	912.8	2 289.0	484.9	2 172.5	1 100.8
1987-88	13 281.5	4 299.0	1 527.7	914.7	2 295.3	477.5	2 745.8	1 041.3
1988-89	14 962.8	5 583.8	1 355.6	996.9	2 733.3	512.9	2 767.4	1 032.0
1989-90	14 228.0	4 760.0	1 493.1	970.4	2 763.1	559.3	2 812.8	892.2
1990-91	15 778.6	6 006.0	1 491.9	1 111.6	2 431.7	705.0	2 290.2	1 764.5
1991-92	13 462.4	4 733.3	1 395.3	1 054.7	2 147.2	651.6	2 706.3	791.5
1992-93	13 828.8	5 012.8	1 514.9	1 085.3	2 350.4	646.7	1 990.1	1 248.2
1993-94	14 628.6	5 403.7	1 333.7	1 053.4	2 711.4	736.6	1 959.2	1 449.3
1994-95	16 266.4	6 924.3	1 190.8	1 076.6	2 166.2	765.2	2 482.2	1 677.3
1995-96	14 757.3	5 613.1	1 140.4	1 032.4	2 331.3	738.1	2 614.0	1 305.1
1996-97	15 799.9	6 321.1	1 461.4	1 290.9	2 678.9	824.4	1 747.0	1 490.1
1997-98	14 545.6	6 799.8	1 089.7	1 115.7	1 872.0	814.9	1 634.5	1 232.4
1998-99	16 588.5	7 595.6	1 297.6	1 238.2	2 731.3	795.1	1 614.0	1 328.9
1999-00	14 627.7	5 844.1	1 220.0	1 381.9	2 715.5	811.2	1 298.5	1 368.7
2000-01	13 038.3	4 446.0	1 198.5	1 219.8	2 272.9	795.1	1 619.4	1 496.4
2001-02	13 944.0	5 892.0	1 219.1	1 264.7	2 287.0	877.2	1 209.9	1 204.5
2002-03	14 225.4	4 514.6	1 248.5	1 131.4	2 237.0	801.9	2 593.3	1 709.1
2003-04	16 167.6	6 466.5	1 280.5	1 411.2	2 458.0	867.2	1 986.8	1 707.9

Yield (kg/ha)

Year	Total	Gram	Mung bean	Lentil	Pigeon pea	Dry peas	Beans	Other pulses
1971-72	495	633	315	528	717	706	214	470
1972-73	498	636	342	479	794	554	310	400
1973-74	426	532	292	473	533	504	262	420
1974-75	484	570	324	503	725	636	328	462
1975-76	540	690	337	522	785	705	301	470
1976-77	514	666	363	489	672	609	336	403
1977-78	511	669	350	473	734	569	304	422
1978-79	506	721	278	470	716	559	252	406
1979-80	414	478	351	430	644	489	289	351
1980-81	484	602	379	512	689	628	322	402
1981-82	489	573	420	539	744	628	309	380
1982-83	533	673	443	508	680	668	369	426
1983-84	536	652	381	567	800	712	342	470
1984-85	525	651	399	581	819	677	313	425
1985-86	553	716	362	620	767	760	330	450
1986-87	539	640	420	623	722	732	365	455
1987-88	541	616	437	631	684	770	437	445
1988-89	582	719	391	668	778	821	421	465
1989-90	548	628	421	639	762	805	422	391
1990-91	580	692	414	701	672	953	353	713
1991-92	536	697	375	667	588	855	500	250
1992-93	553	662	473	664	652	819	347	507
1993-94	593	723	421	648	762	845	350	615
1994-95	642	796	378	689	647	818	486	664
1995-96	580	678	383	615	670	785	445	590
1996-97	622	783	438	717	756	904	317	677
1997-98	577	776	331	646	552	835	334	573
1998-99	641	791	391	690	788	920	339	645
1999-00	623	805	383	740	785	942	271	669
2000-01	584	718	357	650	613	927	365	795
2001-02	588	802	361	684	676	1027	246	613
2002-03	589	681	368	654	692	947	429	760
2003-04	641	863	374	765	738	1011	331	760

Source: Except mung bean, FAOSTAT-Agriculture (agricultural production) data downloaded on 30th February 2005 from the website: http://faostat.fao.org/faostat/form?collection=Production.Crops.Primary&Domain=Production&servlet=1&hasbulk=&version=ext&language=EN. For mung bean, it is aggregated from the country-level data collected by the Socioeconomic Unit of AVRDC from its national partners who referred to their respective national agricultural statistical offices. The FAOSTAT data for “other pulses” was adjusted by deducting the mung bean data from it.

Livelihood Security of Resource Poor Maize Farmers in India

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Abstract

This study highlights the impact of technological innovation in maize production in traditional maize growing states, *viz.* Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh and its impact on productivity, farm income and livelihood security. Although the impact of improved technologies has been very promising, the adoption of such technologies by the majority of farmers in the region has been low. Hybrid cultivars yield more than 4 tons per hectare as opposed to less than 2.5 tons per hectare for traditional cultivars during the *Kharif* (rainy) season. Similarly, during the *Rabi* (winter) season, yield from hybrids is about 6 tons per hectare and around 4 tons per hectare from composite cultivars. Furthermore, the cost per unit of output has declined by 22 to 43 per cent with hybrid cultivars, making maize more profitable than competing crops like paddy and wheat, and has considerably boosted the income of the farmers. The low adoption of these technologies is primarily due to lukewarm policy support and poor infrastructure, particularly market services in the traditional maize growing regions. Though the region contributes large quantities of maize to total production, districts lack value addition facilities. Greater emphasis on developing such facilities bolstered with technological improvements in maize production would result in vast improvements in productivity as well as farmer income and thereby enhance livelihood security.

Introduction

Maize is one of the most important CGPRT (Coarse Grains, Pulses, Roots and Tubers) crops that is gaining significance in the Indian economy. Today, this crop contributes over INR 80 billion annually to India's GDP and generates more than 550 million man-days of employment per year. Maize, which has great potential as human food, animal feed as well as large number of industrial uses, has emerged as the third most important

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cereal crop in India after rice and wheat. Moreover, in India, it is a major staple food for millions of poor people, and more than 50 per cent of the maize produced is used as animal feed. The 2003-2004 forecast for the country's total maize production is estimated to be 14.72 million tons, harvested from 7.42 million hectares of cultivated land. Research findings from a recent study by the International Food Policy Research Institute (IFPRI) show that, due to consumers' higher demand for meat in which maize is principally used, maize production is predicted to exceed the production of rice and wheat in coming years (Delgado *et al*., 1999).

Globally, India ranks fifth in terms of maize area after USA, China, Brazil and Mexico; but the country only ranked seventh in its production. While many countries like Kuwait, Israel, Jordan and Italy harvest more than 10-15 tons of maize grain per hectare, the average maize yield in India is a mere 2 tons per hectare (Singh *et al*., 2003). In addition, there is high variability in maize yield within the country. Maize yield in the southern states like Andhra Pradesh and Karnataka is much higher than states in northern India like Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh and Punjab, which are considered to be the traditional maize growing states. These states, which constitute around 50 per cent of the total maize area in the country, could not reap, with a few exceptions, the benefits of technological developments in the maize sector.

Maize can provide a huge opportunity to capture the global markets, particularly in both near and far-east Asian countries where meat preferences are rising. Against this backdrop, the present study attempts to reveal the impact technological changes have had on maize yield and farmers' income in the five selected northern states, home to nearly 42 per cent of India's population. Since maize cultivation is intertwined in the culture of these states, any efforts to promote this crop would go a long way in the sustenance of livelihood, while, simultaneously, boosting the country's share in the global maize market.

Data and methodology

For the purpose of the present study, secondary as well as primary data were utilized. In the case of secondary data, the major focus was on analysing the changes, firstly, in area, production and yield of maize during1990-2001 for the major maize growing states of the country and, secondly, the different uses of maize at the national level since 1980. The data was collected from the Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

Primary data regarding different aspects of maize production was collected from 300 maize growers from five states of northern India: Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh during the crop year 2002-2003 under the National Agricultural Technology Project (NATP's) entitled, "Technological Change and Production Performance in Irrigated Maize-based Agro-ecosystems: Interplay of Economic, Technological and Institutional Factors" (Research report, 2004).

Expansion and importance of maize

Grown in a wide range of production environments, maize area in the country has grown rapidly. The adoption of improved cultivars and crop management practices have further increased the continuous growth of maize yields. Total maize area in the country expanded from 3.36 million hectares in 1950-1952 to 6.53 million hectares in 2001-2002. Among all the states, Karnataka witnessed the highest increase in maize area. Conversely, in states like Uttar Pradesh, Punjab and Bihar, maize area has significantly decreased due to the expansion of rice area.

Table 1. Production performance of maize in the major growing states

State	TE 2001-2002			Period 1990-2001			
	Area (share of India's total maize area, %)	Production (share of India's total maize production, %)	Yield kg/ha	Growth rate (%)		Coefficient of variation (%)	
				Area	Yield	Area	Yield
Selected states	**56.84**	**49.20**	**1 674**				
Bihar	11.36	13.18	2 184	0.44	2.88	9	13
Madhya Pradesh	13.30	10.87	1 537	-0.33	2.75	2	20
Punjab	2.53	3.60	2 671	-1.46	3.54	7	17
Rajasthan	14.93	9.41	1 186	0.28	1.93	3	19
Uttar Pradesh	14.71	12.14	1 554	-1.40	1.60	6	14
Other States	**36.96**	**45.20**	**2 271**				
Andhra Pradesh	7.14	12.05	3 177	4.28	3.94	19	16
Gujarat	6.29	5.44	1 628	1.56	3.86	6	25
Himachal Pradesh	4.59	5.79	2 377	-0.48	1.68	2	9
Karnataka	9.49	14.41	2 859	9.11	0.00	34	10
Maharashtra	4.46	3.34	1 410	8.36	2.38	30	26
Jammu & Kashmir	5.01	4.17	1 567	1.07	-0.48	4	8
All India	**100 (6.53)[a]**	**100 (12.28)[b]**	**1 882**	**1.11**	**2.56**	**4**	**11**

Source: Agricultural Statistics at a Glance (various Issues).

Note: TE = Triennium Ending.

[a] area in million hectares.

[b] production in million tons.

In all the states there is a trade-off between rainy season maize and the preferred rice production and, therefore, rice area has expanded steadily to the detriment of maize. As Table 1 shows, the five selected states constitute around 57 per cent of the country's total maize area and nearly 50 per cent of total maize production. On the other hand, the six other states, which are also listed in Table 1, cover only 37 per cent of maize area but due to higher yields contribute 45 per cent of total production. It can also be observed that during the period 1990-2001, the selected states had either minor or negative growth rates in maize area. However, yield growth rates in these states has been impressive. Though, it is surprising to note that during the same period, growth in maize yield stagnated in Karnataka state, a major maize producer in the country. Moreover, significant growth in maize area in Andhra Pradesh, Karnataka and Maharashtra has been coupled with very high variability in the growth rates within those states, which is indicated by the high coefficient of variation (CV) numbers presented in Table 1. The average coefficients of variation for yield and area growth for all the 11 states in Table 1 are significantly higher than the average national level CV except for maize area in the five selected states.

Maize yield per hectare in India has nearly doubled in 35 years. The national average yield output was almost 1.9 ton per hectare in 2001-2002 (Table 1), while in 1966-1967 the average output per hectare was barely 1 ton (Table 2). This increase is to a large extent attributable to the spread of improved cultivars and crop management practices. As shown in Table 2, India's maize area under high-yielding varieties (HYV) has grown from just above 6 per cent in 1966-1967 to almost 60 per cent of the maize area in 1996-1997. The percentage of maize area under irrigation schemes has also increased, which covered around 14.5 per cent in 1966-1967 to just above 22 per cent in 1996-1997 (Table 2). Along with the expansion of HYV and irrigation, the national average maize output has steadily risen as shown in Table 2. However, as compared to the world average of 3.8 tons per hectare, the maize yield in the country is still very poor and remains a major concern for India. (Singh *et al*., 2002).

Table 2. Maize yield and area under HYV and irrigation in India

Year	Yield (kg/ha)	Maize area under HYV (%)	Maize area under irrigation (%)
TE 1966-1967	993	6.09	14.65
TE 1971-1972	1 049	8.64	16.18
TE 1981-1982	1 100	30.12	19.26
TE 1991-1992	1 509	46.23	22.20
TE 1996-1997	1 628	58.40	22.07

Source: Agricultural Statistics at a Glance (various Issues).

Rising yields coupled with steady expansion in area (particularly winter maize in some parts of the country) led to strong growth in maize production, exceeding 11 million tons in 1999-2000.

Adoption of improved cultivars

Following the seed policy reforms in the late 1980s, many private companies began to conduct maize research, which was earlier the domain of the public sector. This transformation led to a spurt in the development and dissemination of new improved maize cultivars.

Although farmers in the selected northern states allocate significantly less acreage to improved maize cultivars compared to other states in India, it has been observed that farmers in each district of the surveyed states are increasingly growing different HYV maize cultivars (Table 3).

Table 3. Distribution of maize area under different types of cultivars

State	Maize area per farm (ha)	Local variety (%)	Improved cultivars (%)		
			Composite	Hybrid	Total
Bihar- *kharif*	1.50	49.83	42.02	8.15	50.17
Bihar- *rabi*	1.35	Nil	26.52	73.48	100.00
Madhya Pradesh	0.94	12.75	19.15	68.10	87.25
Punjab	1.37	7.60	4.80	87.60	92.40
Rajasthan	1.19	61.34	3.36	35.29	38.65
Uttar Pradesh	0.54	75.93[a]	3.70	20.37	24.07

Source: Field survey, 2002-2003; NATP Project.
Note: [a] Includes commonly grown *Jaunpuri1*, *Jaunpuri Safed* and *Meerut* local maize cultivars.

To examine the adoption of improved maize technology, a technology adoption index was developed (see Appendix 1). This adoption index includes the adoption of modern varieties and recommendations for fertilizer application and irrigation schemes, and can therefore be considered as a catch-all of farmers' technology adoption practices. From the results of the adoption index, the farmers were classified into three adoption categories: Low, Medium and High adoption, as displayed in Table 4. It was observed that the majority of farmers (54 per cent) in the five states are low adopters of modern technology. Only 26 per cent of the farmers in the survey fall under the category of 'high adoption'. The trend is very similar across all the selected states except in Punjab where 80 per cent of the farmers are "high adopters", and Uttar Pradesh where almost 50 per cent of the farmers are "high adopters" and the other half are "medium adopters".

Table 4. State-wise distribution of sample farmers across the levels of adoption of improved maize technology

State	Low adoption (0-33%)	Medium adoption (34-66%)	High adoption (67-100%)
Bihar	87.20	12.80	Nil
Madhya Pradesh	97.00	3.00	Nil
Punjab	7.00	13.00	80.00
Rajasthan	73.00	24.33	2.67
Uttar Pradesh	2.83	48.67	49.00
Overall	**54.22**	**19.45**	**26.33**

Source: Field survey, 2002-2003; NATP Project.

Impact of improved cultivars on maize yield and cost of production

Technological advancements in maize have led to the development of various promising cultivars in the form of hybrids or composites for several regions or locations that suit local adaphic factors. Over the years, farmers have adopted these high-yielding cultivars in varying proportions. However, as discussed in an earlier section, owing to a skewed adoption scenario, the majority of farmers are harvesting very low yields even with the hybrid cultivars. Maize farmers' yields in the five selected states are compared in Table 5. In the *Kharif* (rainy) season, maize yields from different cultivars, namely traditional, composite and hybrids are compared, and during the *Rabi* (winter) season only yields from hybrids in three states are compared. Hybrids and composite cultivars raised maize yields in all the five states. Average yields using traditional cultivars is less than 2 tons per hectare; for composite cultivars the mean output in four cultivating states is approximately 2.8 tons, while the average yield from hybrid varieties is 3.4 tons per hectare. During the *Rabi* season, the yields vary between 4 and 6 tons per hectare. However, as the CV numbers indicate in Table 5, there is high variability within each state and for the different types of cultivars.

Table 5. Yield differential and variability among selected maize growing states

State		*Kharif*			*Rabi*
		Traditional	Composite	Hybrid	Hybrid
Bihar	Yield (kg/ha)	1 919	2 284	2 151	5 990
	C.V. (%)	14.07	7.77	36.86	12.27
Madhya Pradesh	Yield (kg/ha)	1 577	2 867	3 547	n.c.
	C.V. (%)	20.02	15.81	26.57	-
Punjab	Yield (kg/ha)	1 969	3 266	3 625	n.c.
	C.V. (%)	14.82	16.35	13.94	-
Rajasthan	Yield (kg/ha)	1 667	2 552	3 773	4 000
	C.V. (%)	33.47	17.72	18.13	11.04
Uttar Pradesh	Yield (kg/ha)	2 489	n.c.	4 240	5 143
	C.V. (%)	36.39	-	17.30	12.44

Source: Field survey, 2002-2003; NATP Project.
Note: n.c.= not cultivated.

Fluctuations in maize yield using hybrid varieties has been more pronounced during the *Kharif* season compared to the *Rabi* season. It is also evident that there is huge difference between the yield of traditional and improved (composite/hybrid) cultivars. In Uttar Pradesh, local maize varieties like *Jaunpuri 1, Jaunpuri Safed* and *Meerut local* generate higher yields than local varieties in other states and, in some cases even higher than composite and hybrid cultivars. This could be a plausible reason why much higher average yields of *Kharif* traditional variety are achieved in the state than in other states. Hybrid cultivars during the *Rabi* season performed better than their counterparts in the *Kharif* season. This has opened up new vistas in maize cultivation in different states, particularly in Bihar and Southern Rajasthan.

The rationale behind crop improvements lies in crop productivity enhancement and reductions in per unit production costs. The improved maize cultivars in these states satisfy the criteria. As it may be observed from Table 6, average production costs in the four states have declined by more than 20 per cent with the adoption of composite cultivars compared to traditional cultivars during the *Kharif* season. Similarly, if compared with hybrid cultivars, average production costs in the five states are around 28 per cent lower. Production costs during the *Rabi* season are not compared as most of the farmers only grow hybrid cultivars.

Table 6. Reduction in production costs due to the adoption of improved cultivars

State	*Kharif* Traditional (Rs/q)	*Kharif* Composite (Rs/q)	Reduction due to composite (%)	*Kharif* Hybrid (Rs/q)	Reduction due to hybrid (%)
Bihar	305	224	26	198	35
Madhya Pradesh	364	317	13	277	24
Punjab	326	246	25	247	24
Rajasthan	595	395	33	337	43
Uttar Pradesh	365	n.c.	n.a.	285	22

Source: Field survey, 2002-2003; NATP Project.
Note: n.c. = not cultivated, n.a. = not available, Rs/q = Rs/quintal.

Profitability of maize cultivation *vis-à-vis* competing crops

Global changes in agricultural markets are expected to influence the prospects of cultivation of every crop, and maize is not an exception. Moreover, the Government price support mechanism has acted in favour of maize thereby for poor farmers. The minimum support price (MSP) for maize, which was around Rs 2,000 per ton in the early 1990s, has more than doubled in 2002 (Figure 1). The MSP of maize during the last two decades has more or less moved in parallel with fine cereals, suggesting equal importance with maize, which is a key crop for resource poor farmers. However, due to insufficient procurement mechanisms for maize crops, maize farmers have not benefited from the price support which could have augmented their incomes and improved their livelihoods. This could have also provided protection against the erratic seasonal price fluctuations.

Figure 1. Trend in minimum support price of major cereals

Source: Ministry of Agriculture, Government of India.

To examine the competitiveness of maize production, a simple exercise was carried out to compare the net return received, more specifically the input costs subtracted from the gross output value for traditional, composite and hybrid maize during the *Kharif* season, and for hybrid maize in the *Rabi* season. These calculations were then compared to competitive crops in the five selected states. Competing crops were selected on the basis of the extent of cultivation area, namely the crop with the largest area in the selected states of the study. In Bihar, Punjab and Uttar Pradesh, during the *Kharif* season, the competing crop is paddy, while in Madhya Pradesh soybean is the competitor, and groundnut in Rajasthan. Bihar, Rajathan and Uttar Pradesh are the only states in the survey that grow hybrid maize during the *Rabi* season and the competing crop in these three states is wheat.

As Table 7 shows, during the *Kharif* season hybrid maize is a competitive crop in the selected states except in Punjab, where rice is more profitable. Hybrid maize during the *Rabi* season generates a higher net return in two states, while the net return for groundnut in Rajasthan is higher than for maize. The output/input ratio in most of the selected states in the survey was higher for maize than its competitor crops. In the case of Punjab, compared to maize cultivation, paddy cultivation is highly mechanized, which reduces labour costs.

From Table 7 it can also be observed that the net return of hybrid cultivars is significantly higher than for traditional cultivars. For example, the net return from hybrid cultivars in Punjab is about 60 per cent higher than from traditional maize varieties, while in Rajasthan the output of hybrid varieties is almost eight times as high compared to traditional cultivars.

Table 7. Economics of cultivation of maize and its competing crops

Particular	*Kharif* season (Rs/ ha)				*Rabi* season (Rs/ ha)	
	Traditional maize	Composite maize	Hybrid maize	Competing crop[a]	Hybrid maize	Competing crop[b]
Bihar						
Input cost	5 849	5 773	6 531	12 163	16 932	14 479
Output value	9 672	11 554	14 778	15 477	29 446	21 409
Net return	3 823	5 781	8 248	3 577	12 514	6 930
Output/input ratio	*1.65*	*2.00*	*2.26*	*1.27*	*1.74*	*1.48*
Madhya Pradesh						
Input cost	5 625	8 604	10 546	10 087	-	-
Output value	6 889	12 076	16 917	15 944	-	-
Net return	1 264	3 472	6 371	5 857	-	-
Output/input ratio	*1. 22*	*1.40*	*1.60*	*1.58*	-	-
Punjab						
Input cost	6 427	8 009	8 956	13 160	-	-
Output value	13 035	17 935	19 637	32 502	-	-
Net return	6 608	9 925	10 682	19 341	-	-
Output/input ratio	*2.03*	*2.24*	*2.19*	*2.47*	-	-
Rajasthan						
Input cost	9 506	10 212	12 881	14 663	17 070	15 639
Output value	10 841	16 538	22 895	13 527	24 722	26 081
Net return	1 335	6 326	10 014	-1 126	7 652	10 442
Output/input ratio	*1.14*	*1.62*	*1.78*	*0.92*	*1.45*	*1.67*
Uttar Pradesh						
Input cost	8 601	-	12 295	9 716	12 857	10 426
Output value	11 915	-	22 217	19 229	27 990	24 732
Net return	3 314	-	9 922	9 513	15 133	14 271
Output/input ratio	*1.39*	-	*1.81*	*1.98*	*2.18*	*2.37*

Source: PRA Survey, 2004-2005; AGRIDIV Phase II Project.

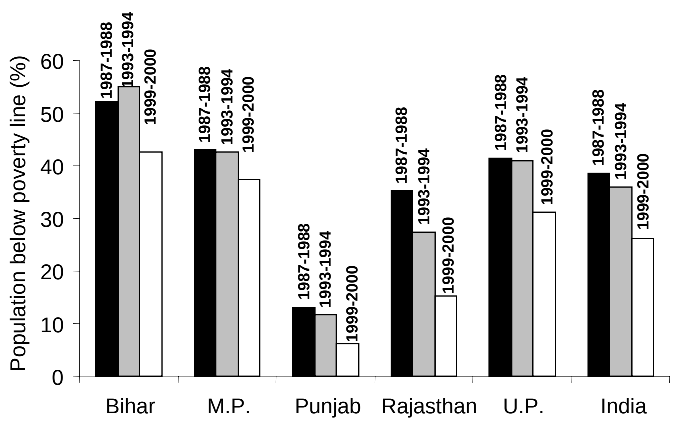
Note: [a] Competing crops during the *Kharif* season: Paddy in Bihar, Punjab and Uttar Pradesh; Soybean in Madhya Pradesh; and Groundnut in Rajasthan.

[b] Competing crops during the *Rabi* season: Wheat in Bihar, Rajasthan and Uttar Pradesh.

Poverty scenario in selected states

The incidence of poverty is estimated by the Planning Commission on the basis of a large-scale quinquennial Sample Survey on Household Consumer Expenditure conducted by the National Sample Survey Organisation (NSSO). The latest official estimates of poverty relate to 1999-2000 of the 55th NSSO round and indicate that there was a significant decline in the proportion of people living below the poverty line; from 51.3 per cent in 1977-1978 to 26.1 per cent in 1999- 2000, and in the absolute number of poor from 328.9 million to 260.3 million people. In spite of the country's impressive reduction of poverty, there are significant variations in the incidence of poverty across states and between rural and urban areas. Among the selected states, except Punjab and Rajasthan, the population below the poverty line remains higher than the national average (Figure 2). These states are the traditional maize growing pockets and even today maize is cultivated on a large share of the agriculture land, which is predominantly utilized by marginalized resource poor farmers.

Figure 2. Population below the poverty line in selected states of India



Source: Planning Commission, Government of India.

Improved livelihoods of maize growing farmers

As mentioned earlier, maize growing farmers in the selected states generally have access to small and marginalized land holdings in fragile and resource poor regions. The crop is very important for their income and livelihoods, as for some farmers maize is a single income-generating crop. With the introduction of HYV cultivars and increased irrigation coverage in the surveyed states, maize growing farmers have recorded sizeable yield gains. The yield levels have recorded growth rates of 1.60 in U.P to 3.54 in Punjab with states like M.P. and Bihar recording growth rates of nearly 2.80 per cent during the nineties. Crop coverage under irrigation has steadily risen and is now nearly a quarter of the total acreage in the surveyed states. Moreover, the HYV maize cultivars now cover almost two-thirds of the total maize cultivated area.

Adoption of HYV maize in all the selected states has given encouraging results. The results show that HYV and composite cultivars have increased *kharif* maize yields in all five states in the survey (Table 8). In Madhya Pradesh and Rajasthan, yields increased by 125 per cent with the HYV cultivars, while in Punjab and Uttar Pradesh yields rose by 84 and 70 per cent, respectively. In Bihar, the yield increase from HYV cultivars was significantly lower with only 12 per cent. Yield increases with composites were lower but still positive, except for Bihar, increasing yields by almost 20 per cent.

Table 8. Effect of technological change on the yield and return from *kharif* maize cultivation

State	Traditional cultivar	Composite cultivar	Percentage increase over traditional	Hybrid cultivar	Percentage increase over traditional
Effect on maize yield (ton/ha)					
Bihar	1.92	2.28	19.02	2.15	12.09
Madhya Pradesh	1.58	2.87	81.80	3.55	124.92
Punjab	1.97	3.27	65.87	3.63	84.10
Rajasthan	1.67	2.55	53.09	3.77	126.33
Uttar Pradesh	2.49	n.c.	n.a.	4.24	70.35
Effect on net return (INR/ha)					
Bihar	3 823	5 781	51.22	8 248	115.75
Madhya Pradesh	1 264	3 472	174.68	6 371	404.03
Punjab	6 608	9 925	50.20	10 682	61.65
Rajasthan	1 335	6 326	373.86	10 014	650.11
Uttar Pradesh	3 314	n.c.	n.a.	9 922	199.40

Source: PRA Survey, 2004-2005; AGRIDIV Phase II Project.

As Table 8 also shows, farmers' net returns are significantly higher due to improved maize varieties. The increase in yield due to technological changes has led to significantly higher farm earnings for maize farmers. It is evident from the table that the net return has increased from nearly 50 per cent to as high as 373 per cent with composite cultivars, while hybrid cultivars have increased net returns by 62 per cent in Punjab to as much as 650 per cent in Rahjastan. This has far-reaching consequences on maize farmers' livelihoods and also for the state economy.

Increased area under HYV maize has provided significant benefits to maize farmers. If the sampled farm households are considered as representative for the state, and the percentage of maize area under HYV on those households is considered representative for the state as a whole, it can be observed that the net return increase is in the range of INR 563 million in Punjab state to INR 3,058 million in Madhya Pradesh state (Table 9). Madhya Pradesh is considered to be one of the poorest states in the country. Consequently, if the land under HYV maize cultivation continues to grow, it would further benefit the resource poor farmers. This additional revenue from the adoption of technological improvements in maize cultivation would accord substantial acknowledgement in ensuring the livelihood security of the resource-poor farmers.

Table 9. Changes in state revenue due to the adoption of HYV maize

State	Maize area (thousand of ha)	Maize area under HYV[a] (%)	Maize area under HYV[b] (thousand of ha)	Increased net return due to HYV maize (INR/ha)	Increase in net return due to HYV maize cultivation under a different scenario (INR million)	
					Business as usual	Increase in area under HYV by 10%
Bihar	687.5	73.77	507.169	3 191.5	1 618.63	1 780.49
Madhya Pradesh	958.2	87.25	836.030	3 657.5	3 057.78	3 363.56
Punjab	165	92.4	152.460	3 695.5	563.42	563.42
Rajasthan	1 017.4	38.65	393.225	6 835	2 687.69	2 956.46
Uttar Pradesh	974.7	24.07	234.610	6 608.116	1 550.33	1 705.37

Source: Field survey, 2002-2003; NATP Project.

Note: [a] based on field survey during the year 2002.

[b] calculated from total maize area in the state and percentage of maize area under HYV.

Conclusions

Maize is one of the most important cereal crops in India and more than 50 per cent of its produce is used as animal feed. The present study highlights the adoption patterns of improved maize technology pertaining to India's traditional maize growing states, *viz.* Bihar, Madhya Pradesh, Punjab, Rajasthan and Uttar Pradesh located in the northern part of the country. Together these states account for 57 per cent of the country's maize area but contribute less than half of total maize production, which is probably due to the low adoption of modern technology by the majority of farmers in the region. The impact of the adoption of modern technologies has, however, been very promising. Average yield in the five selected states with hybrid cultivars during the *Kharif* (rainy) season is around 3.5 tons per hectare and around 2.7 tons per hectare with composite cultivars compared to less than 2 tons per hectare with traditional cultivars. During the *Rabi* season, hybrid cultivars achieved yields of between 4 and 6 tons per hectare in the three states that grow maize during the winter season. Furthermore, with the composite variety, the cost per unit of output fell by 13 to 33 per cent, while hybrid cultivars reduced costs by 22 to 43 per cent compared to local varieties. Consequently, maize has become a more profitable crop than its competitors like paddy and wheat. Moreover, the government's support prices were also considerably favourable for maize as well as for other fine cereals.

The recent spurt in yield levels accruing from the increased level of adoption of hybrids in the traditional maize growing areas has opened up many vistas to be exploited in the future. This has raised the income and enhanced the livelihoods of maize farmers in the region. However, technological developments in the maize sector in the past did not make much headway in the high potential northern and central states due to weak parastatals and a lack of realistic price support mechanisms. Furthermore, due to the enormous potential attached to maize with regards to diverse uses in the industrial sector, for example starch and various derivatives as well as various processed food products, demand for the crop is set to rise. Thus, the growing awareness and renewed thrust towards the hitherto neglected processing sector in poor regions will also boost off-farm employment opportunities.

Due to the lack of market infrastructure and its major functionaries such as assembling, drying and processing, maize farmers located in this part of the country are unable to take advantage of the opportunities provided by trade liberalization. Hence, the removal of institutional and infrastructural bottlenecks on the one hand and a technological push for the adoption of high-yielding cultivars as well as renewed thrust for the maize processing industry on the other, requires sincere policy intervention to bolster maize production, enhance the livelihoods and ensure food security for poor farmers in maize growing regions.

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Appendix 1.

The adoption of technology mainly includes the area under high-yielding varieties (HYVs), appropriateness of irrigation level and dosages of fertilizers. Therefore, the technology adoption index is computed by using the formula:

$$\left[TAI_i = \frac{1}{5}\left[\frac{AH_i}{CA_i} + \frac{NA_i}{NR_i} + \frac{PA_i}{PR_i} + \frac{IA_i}{IR_i} + \frac{KA_i}{KR_i} \right] \times 100 \right]$$

where,

i = Number of farmers, say 1,2,3, …, n.

TAI_i = Technology Adoption Index of i^{th} farmer

AH_i = Area under modern maize varieties (ha)

CA_i = Total area of maize (ha)

NA_i = Quantity of nitrogen applied to maize (kg/ha)

NR_i = Recommended dose of nitrogen for maize (kg/ha)

PA_i = Quantity of phosphorous applied to maize (kg/ha)

PR_i = Recommended dose of phosphorous for maize (kg/ha)

IA_i = Actual number of irrigations applied

IR_i = Recommended number of irrigations

KA_i = Actual amount of potash applied to maize (kg/ha)

KR_i = Recommended amount of potash applied for maize (kg/ha)

Trends of maize exports from major exporting countries and their share in total exports to Asian countries were examined with FAOSTAT data. Maize yields and the maize farm gate price in those countries were compared with farm gate prices in India so as to understand competitive advantage/disadvantage of Indian maize on the global market.

Even today, maize represents a significant share of gross cropped area in the study states and is primarily grown by small and marginal farmers.

Composite, as well as hybrid maize has proved to be more profitable than competing crops in all selected states except Punjab. The costs of cultivation of wheat is much higher than cultivation of hybrid maize. On the other hand, the productivity of wheat is on par. Thus, the farm level analysis infers higher profitability of maize than the competing crops.

In Bihar, all three types of maize had a higher net return in both seasons than the competing crop. The highest net return in Bihar was for hybrid maize in the *Rabi* season, while the highest output/input ratio was for hybrid maize in the *Kharif* season. In Rajahstan during the *Kharif* season all maize cultivars were also competitive with the competitor crops, in fact, the net return for groundnut was negative. Punjab was the only state where both the ratio and net return were lower for hybrid maize in the *Kharif* season compared to the competing crop.

Wherever maize cultivation is practiced during the winter season, the increase in yield and thereby return has increased more than that during the rainy season (*kharif)*. During the winter season the adoption of HYV has been observed to be 100 per cent, therefore the increase in yield and net return has not been compared in the table.

Upland Crops Potential for Rural Economic Development in Cambodia

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Abstract

This paper describes the farms and farmer families in socio-economic terms and identifies issues that are important in developing and exploring cropping options for producers and indicates where the government might best invest to promote equitable rural economic development. A number of non-rice upland crops have been investigated as a means of poverty alleviation and food security development in Kampong Cham and Battambang provinces. Data on the production practices and costs and returns of maize, soybean, mung bean, sesame and peanut products was collected by randomly interviewing farmers from both provinces. It was found that maize yields were generally higher than soybean and mung bean, probably due to the availability of commercial hybrid seeds. Yields of peanut and sesame were relatively low but the average prices received were lower for maize than other crops. The findings also indicate that the area used to cultivate upland crops in Cambodia increased dramatically over the last five years. Non-rice upland crops can provide sufficient food for year-round consumption and substantially increase farm family income. However, the production of these crops in upland areas varies according to agronomic practices, market demand, capital and sources of income.

Introduction

Resolving problems in the agricultural sector is the key to poverty reduction in Cambodia. More than 80 per cent of the population live in rural areas and more than 70 per cent of the nation's labour force is involved in agriculture. Although they have the capacity to produce food for their own consumption, 36 per cent of the rural population is below the poverty line compared with 15 per cent in Phnom Penh (Nesbitt, 2005). The Cambodian government aims to support the transformation of agriculture into a driving force for sustainable economic growth, poverty reduction and employment generation by promoting

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crop diversification, commercialization and agro-industrial development (SEDPII, 2001; RCG, 2004). Improved agricultural production in Cambodia is expected to result from diversification from traditional wet season lowland rice production to double cropped, rice-based production systems and from the expansion of non-rice upland cropping.

Non-rice upland crops can overcome severe constraints in crop production and reduce food shortages among the rural poor. Among other crops, upland crops such as maize, soybean, mung bean, sesame and peanut can be considered as potential sources of income for farmers throughout the country. These crops are also the basis of economic activity for most farmers, and can be found nearly everywhere in the country, in both upland and lowland areas (Chea *et al*., 2001). These crops can produce sufficient food for consumption throughout the year, substantially increase farm family income and improve human nutrition. Earlier findings also indicate that new varieties and improved planting methods can be provided on a large scale that can raise crop production (Ouk *et al*., 2001).

The present study aims to provide information and knowledge on how to improve farmers' income through crop diversification in upland areas. In Cambodia, upland fields with marginal water supply for rice can also be utilized for crop diversification. Based on Landsat Imagery of 1993, 1.25 million hectares of land are potentially available for crops other than rice, and another 2.3 million hectares of shrub land may also have the potential for agriculture (World Bank/FAO, 1996). As approximately 200 thousand hectares is currently used for upland crops (Table 1), this preliminary assessment suggests the possibility of a 6-20 fold increase in upland cropping and agroforestry. Security considerations have until recently limited the utilization of these areas. Now that those concerns have eased, population pressure and market access factors are likely to be key drivers of the expansion of upland cropping, similarly to northern and northeastern Thailand in the 1960-70s (Chiang Mai University and Chulalongkorn University Social Research Institute, 1983). In fact, non-rice upland crops such as maize, soybean, mung bean, sesame and peanut have been grown and dramatically expanded in many places under upland conditions (Table 1).

Table 1. Production of major crops in Cambodia (Area: 1,000 ha, Production: 1,000 tons)

Crop	Legend	1967	1980	1994	1998	2000	2001	2002	2003	2004
Rice (Grain)	Area	2 513	1 440	1 494	2 094	2 318	2 241	2 113	2 315	2 374
	Production	2 456	1 717	2 223	3 509	4 026	4 099	3 822	4 711	4 170
	Unit yield	0.98	1.19	1.48	1.79	2.11	2.07	1.91	2.10	1.98
Maize	Area	117	101	52	44.9	71.5	80.2	80.5	93.4	91.2
	Production	150	101	55	48.5	156.9	185.6	148.9	314.6	256.7
	Unit yield	1.28	1.00	1.05	1.08	2.19	2.31	1.85	3.37	2.81
Cassava	Area	2	17	11	8.8	16.3	14.2	19.6	25.7	22.8
	Production	23	152	65	66.5	147.8	142.3	122.0	330.6	362.1
	Unit yield	11.5	8.9	5.90	7.6	9.1	10.0	6.2	12.9	15.9
Mung bean	Area	47	36	28	25.2	24.9	29.43	39.8	44.9	39.1
	Production	25	10	17	9.2	15.1	17.2	23.9	31.8	45.3
	Unit yield	0.53	0.28	0.60	0.37	0.61	0.58	0.60	0.71	1.16
Soybean	Area	8	4	26	30.9	33.3	32.0	33.4	53.1	84.9
	Production	7	3	23	27.7	28.1	24.7	38.7	63.2	110.3
	Unit yield	0.88	0.75	0.88	0.90	0.84	0.77	1.16	1.19	1.30
Peanut	Area	-	-	-	9.7	10.4	11.9	13.8	14.6	19.2
	Production	-	-	-	6.6	7.5	8.9	9.7	18.5	21.5
	Unit yield	-	-	-	0.68	0.72	0.75	0.70	1.27	1.12
Vegetables	Area	43	48	35	37.7	33.7	35.3	34.4	36.1	32.6
	Production	n.a.	106	197	217.3	195.9	184.6	163.2	139.6	179.1

Source: MAFF, 1998-2004 and Martin *et al*., 2005.

Study sites and research methods

The main reasons why crop diversification has not progressed more rapidly are; lack of physical and human resources required for agricultural development, dependency on unpredictable rainwater due to insufficient irrigation systems, as well as poor infrastructure, agro-business and marketing systems. To examine these constraints, a series of questionnaires were compiled and data collected in two provinces from farmers in upland areas. The main objectives of the present study are to describe the farms and their families in socio-economic terms and to identify issues that are important in developing and exploring cropping options for producers and which measures the government might best invest to promote equitable rural economic development.

The survey was conducted in Kampong Cham province, around 170 km northeast of Phnom Penh, and in Battambang province, about 310 km northwest of Phnom Penh. Within these provinces the districts of Chamkar Leu and Tboung Khmom in Kampong Cham, and Kamrieng, Sampaov Loun and Ratanak Mondol in Battambang were studied (Figure 1). In these areas, non-rice upland crops such as maize, soybean, mung bean, sesame, cowpea and peanut are grown.

Figure 1. Provinces of Cambodia

Source: JICA-PDAFF, 2004.

Average annual rainfall is 1,588 mm in Kampong Cham and about 1,300 mm in Battambang and there is a tendency for bimodal peaks of rainfall in Kampong Cham with a dry period common in July or August. About 80 per cent of the annual precipitation is received in both provinces during the rainy season. In agricultural terms the start of the wet season is important for Cambodian farmers, and there appears to be more variability during March in Kampong Cham than Battambang. In general, the effects of insufficient rains are mostly felt in the upper fields and less in the lower fields. Rains may cease earlier resulting in late season drought, particularly for the late crops growing in the fields with small levees. Erratic and unpredictable rainfall is the only source of water for rainfed lowland rice but is not suitable for non-rice upland crops. Excessive rains in the early wet season cropping from May to June cause flooding in some parts in the rainfed upland areas, leading to erosion, and this can adversely affect the yield of crops during the reproductive stage. For example, the peanut harvest may be delayed or in some cases impossible. Flash floods laden with silt can damage levees and submerge the crop for several days, as well as causing significant destruction to the crops. Without a reliable water source farmers cannot plan their cropping activities. Therefore, most of the cropping activities and timing is dependent on the unpredictable rains.

Most of the soils in upland areas of Chamkar Leu and Tboung Khmom districts are from the Labansiek and Kampong Siem group (White *et al*., 1997). Labansiek soil appears on the sides of the hills or mountains and has a red colour, clayey texture surface soil with a crumb structure and clayey sub-soil, while Kampong Siem soil dominates the lower areas with a black colour, clay-textured surface soil with a crumb structure and clayey sub-soil. There are approximately 200 thousand hectares of land in Kampong Cham suitable for upland cropping (MAFF, 2004-2005). Mung bean, maize, soybean, sesame, cowpea and peanut can be grown as inter-cropping between young rubber trees, which is a significant industry with exports to Viet Nam.

The districts of Kamrieng, Sampaov Loun and Ratanak Mondol in Battambang in the northwest of Cambodia also have significant areas of fertile upland forest soils. Such areas, which belong to the Khmer Rouge, have been cleared of forest since 1996 for the production of upland crops, particularly non-rice upland crops such as maize, soybean, mung bean and peanut (JICA-PDAFF, 2004 and Martin *et al*., 2005). The soils in Battambang upland areas are fertile and have black or dark grey clay-textured topsoil, which forms deep, wide cracks over clay-textured subsoil.

A farm survey was undertaken to extract information from a number of locations in these two provinces. Battambang and Kampong Cham were selected as developing farming systems for crop diversification because these two provinces have the largest areas of concentrated upland cropping in Cambodia. Both provinces have low poverty rates, which is probably due to their cash crop production (NPRS, 2002) and it is expected that technologies developed in these provinces can be transferred to adjacent provinces such as Pailin and Banteay Mean Chey that have higher poverty incidence.

The survey conducted in the areas studied was funded under two ACIAR-funded projects: Assessing Land Suitability for Crop Diversification and Farming Systems Research for Crop Diversification in Cambodia (Martin *et al*., 2005). In each location, general observations about fields and cropping patterns were made by the survey team. Interviews were undertaken through a detailed questionnaire consisting of 25 open-ended and multiple-choice questions. The questionnaire sought information concerning farmers' background, source of household income, household assets (including land holding), cropping patterns and type of soil. These questions were initially adapted from a previous

Cambodia rice survey (Chea *et al*., 2001). A pilot test was also conducted prior to the full-scale survey in 2004.

The interview team first approached the village to obtain permission and seek co-operation for the survey. Thereafter, farmers were randomly chosen and the number of interviewees was determined by the time and resources available to the interviewers. A total of 162 farmers were interviewed, 91 in Battambang and 71 in Kampong Cham (Table 2). The total number of farm families and total population of the two districts are also shown in Table 2.

Table 2. Sample and population information survey in 2004

	D I s t r i c t s			
	Sampaov Loun	Kamrieng	Rattanak Mondol	Total
Battambang Province				
Sample farms interviewed	24	36	31	91
Total farm families	4 489	7 478	6 427	18 394
Total population	20 313	35 482	32 895	88 690
Kampong Cham Province	Chamkar Leu		Tboung Khmom	Total
Sample farms interviewed	47		24	71
Total farm families	22 961		37 928	149 579
Total population	122 010		184 202	306 212

Source: Martin *et al*., 2005

Results

The survey was conducted to assess the resources (land, labour, capital) available to the upland farmers in these districts and provinces, as well as the constraints to non-rice upland crop production. In order to consider ways of improving the situation in these provinces, it was necessary to analyse the characteristics of the farms and their households.

The average age of the respondents in the different districts varied between 43 and 47 years (Table 3). While most household heads were male, a sizeable proportion of survey respondents were female, with the highest proportion of female respondents (45 per cent) in Rattanak Mondol district, followed by Kamrieng (31 per cent), Sampaov Loun (29 per cent), Chamkar Leu (28 per cent) and Tboung Khmom (21 per cent). These figures imply that females are not just involved but also share the responsibilities associated with farming, indicating that both males and females play important roles in farming The average family consists of five to seven members, with two-three dependents. The average level of education of all respondents was very low, three to four years of education, which might be a constraint in developing and using better production methods and technologies. Off-farm work was very low, being zero for three districts and very limited in Rattanak Mondol and Chamkar Leu.

Table 3. Household details from survey in 2004

	Unit	Sampaov Loun	Kamrieng	Rattanak Mondol	Chamkar Leu	Tboung Khmom
Survey respondent						
Age	yrs	43.7	46.1	46.4	45.2	43.5
Schooling	yrs	3.3	3.7	3.8	3.4	4.0
Percentage of males	%	71	69	55	72	79
Head of household						
Age	yrs	43.2	47.9	48.5	45.4	43.6
Years school	yrs	3.4	4.1	3.9	3.5	4.1
Percentage of males	%	96	100	90	100	100
Residents in household						
Family size	no.	5.9	6.6	5.4	5.2	5.2
Work off farm	no.	0	0	0.2	0.3	0
Dependents	no.	2.8	3.2	2.5	2.0	2.5

Source: Martin *et al*., 2005.

Table 4 shows the average area of upland crop farms owned in the study's five locations. The average upland crop farm area varied from 1.8 hectares (Tboung Khmom) to 9.5 hectares (Sampaov Loun). Some farm plots were rented to and from other households. The results show that the farms in the present study are larger than the rice farms in one village survey conducted by Chea *et al.*, 2001, who reported rice areas of 0.2 to 2.0 hectares per farm family.

Table 4. Average farm area in the five districts

Land area (ha)	Sampaov Loun	Kamrieng	Rattanak Mondol	Chamkar Leu	Tboung Khmom
Land owned	9.5	5.9	3.6	3.6	1.8
Rented out	2.0	0.1	0.1	0.1	0.2
Rented in	0.0	0.1	0.4	0.6	2.8
Area operated	7.5	5.9	3.9	4.0	4.4

Source: Martin *et al*., 2005.

Results from the questions regarding loans are shown in Table 5. Information was collected for crop loans and all loans in terms of amount borrowed, duration, source and frequency of loan. About 44 per cent reported having crop loans and 61 per cent having loans of any type. The highest percentage of farmers surveyed who had crop loans were in Sampaov Loun (63 per cent) and Kamrieng (72 per cent). In Battambang, Thai traders may influence loans by financing maize seed and other crop inputs in contract farming systems. For all loans a similar trend is visible. In Kamrieng and Sampaov Loun districts 79 to 97 per cent of the respondents reported that they have loans, while in the other three districts fewer farmers have loans.

Crop loans were generally short term (averaging less than 12 months). Results from other surveys on interest rates indicate that Cambodian farmers pay at least 3 per cent in interest. As shown in Table 5, both the amount and loan provider vary from year to year, while interest rates seem to alter during seasons and between years.

Table 5. Loans and borrowing per farm with loans

	Unit	Sampaov Loun	Kamrieng	Rattanak Mondol	Chamkar Leu	Tboung Khmom
Crop loans						
Response[a]		15/24	26/36	10/31	14/47	7/24
Amount Borrowed	thousand riel	3 403	1 755	670	390	400
Duration	months	11	10	8	6	6
All loans						
Response[a]		19/24	35/36	14/31	24/47	7/24
Borrow each year?	% yes	46	66	36	50	71
Same amount each year?	% yes	13	26	14	13	14
Same lender?	% yes	29	29	43	45	71
Rates vary seasonally?	% yes	50	43	14	27	0
Rates vary annually?	% yes	17	49	0	18	0

Source: Martin *et al*., 2005.
Note: [a] Number of response/number in sample.

Farmer ownership of capital and machinery varied between districts (see Table 6). In general, farmers in Rattanak Mondol, Chamkar Leu and Tboung Khmom owned more traditional items, such as draft animals, mouldboard ploughs and ox carts, whereas farmers in Sampaov Loun and Kamrieng had a higher proportion of tractors and disc ploughs. Data from the interviews indicates that most farmers use traditional farming tools. The main machinery for upland farmers include draft animals and ox carts. Ox ploughing is still popular in the villages and about half of all households own an ox and plough. Villagers often have ox carts, while buffalos are rare in these areas. Most people own sickles and hoes, implying that almost all farmers have them at each house. Some farmers in the study areas own hand tractors within trailers, which are utilized for both land preparation and transportation. Spray units were owned by a substantial number of farmers, while pumps, tubewells and threshers were used in some districts only. Compared to most other parts of Cambodia, farming is more mechanized in the northwestern districts of Battambang. In 2002, Battambang province had 737 private owned tractors, compared with 205 tractors in Kampong Cham province (MAFF, 2003).

Table 6. Capital items owned

	Unit	Sampaov Loun	Kamrieng	Rattanak Mondol	Chamkar Leu	Tboung Khmom
Draft animal	% with	21	17	81	36	50
	av no.	3.4	4.3	2.7	2.4	3.1
Tractor	% with	25	6	6		21
	av no.	1	1	1		1
Disc plough	% with	21		3		1
	av no.	1.4		1		
Mouldboard plough	% with	4		39	19	21
	av no.	1		1.5	1	1
Spray unit	% with	58	50	35	34	39
	av no.	1.1	1	1.2	1.3	1.2
Pump	% with			10	6	
	av no.			1	1	
Tube well	% with	4	3	16	6	
	av no.	1	1	1	1	
Ox cart	% with	17	6	55	26	25
	av no.	1	1	1	1	1
Thresher	% with	8			4	17
	av no.	1			1	1
Other	% with	13	8		26	8

Source: Martin *et al*., 2005.
Note: Units are percentage of sample with the item and average number of items per farm.

The percentage of farms growing crops of particular types in the target areas is shown in Table 7. Rice is grown on farms in each district, although less so in Sampaov Loun. Soybean, mung bean and maize were the most widely-grown crops. Sesame was grown in some areas, with peanut and cowpea being less popular. Expected crop planting for 2004 are also presented in Table 7.

Table 7. Crops grown and planting plan for 2004

Crop	Sampaov Loun	Kamrieng	Rattanak Mondol	Chamkar Leu	Tboung Khmom
Crop grown in 2003 (% of sample)					
Rice	4	53	68	34	63
Maize	96	94	52	26	8
Soybean	100	61	74	100	100
Mung bean	83	78	74	72	100
Peanut	0	22	23	2	0
Sesame	8	53	32	6	42
Cowpea	0	22	3	53	4
Planting intentions in 2004 (% of sample)					
Rice	8	78	68	32	63
Maize	96	94	65	28	8
Soybean	100	92	71	96	96
Mung bean	58	78	71	70	87
Peanut	8	22	32	11	0
Sesame	25	89	35	17	54
Cowpea	0	19	0	64	4

Source: Martin *et al*., 2005.

The results of upland crop production and income within each district in the target five areas are presented in Table 8. As expected, maize yields are the highest (2.6-5.0 t/ha), but maize prices are much lower at US$ 0.08 to 0.10 per kilogram, compared to soybean (US$ 0.24 to 0.28) and mung bean (US$ 0.25-0.33) in all districts. Maize seeds are not set aside for future planting. The yields of the other upland crops were generally low, more specifically 0.3 to 0.4 tons per hectare for cowpea, 0.7 to 1.0 tons per hectare for peanut, and 0.3 to 0.7 tons per hectare for sesame. Prices for these three crops range from US$ 0.28 to 0.65 and a small amount of seeds are kept for planting, and in some cases for human consumption.

Table 8. Average crop figures by district

Crop and Item	Unit	Sampaov Loun	Kamrieng	Rattanak Mondol	Chamkar Leu	Tboung Khmom
Maize						
Area sown	ha	6.3	4.2	1.4	1.2	-
Yield	t/ha	4.8	3.7	2.6	5.0	-
Price	$/kg	0.08	0.07	0.08	0.10	-
Soybean						
Area sown	ha	3.8	0.9	1.7	1.9	3.1
Yield	t/ha	1.0	1.2	1.0	1.2	1.2
Price	$/kg	0.27	0.28	0.24	0.25	0.26
Mung bean						
Area sown	ha	1.4	1.2	0.9	1.4	2.9
Yield	t/ha	0.7	0.5	0.3	0.2	0.2
Price	$/kg	0.30	0.33	0.25	0.27	0.28
Peanut						
Area sown	ha	-	0.6	0.7	1.0	-
Yield	t/ha	-	0.7	1.7	1.0	-
Price	$/kg	-	0.48	0.67	0.30	-
Sesame						
Area sown	ha	-	1.3	1.4	1.2	1.4
Yield	t/ha	-	0.3	0.4	0.5	0.7
Price	$/kg	-	0.49	0.32	0.39	0.35
Cowpea						
Area sown	ha	-	1.2	-	1.0	-
Yield	t/ha	-	0.3	-	0.4	-
Price	$/kg	-	0.30	-	0.28	-

Source: Martin *et al*., 2005.

Table 9 shows statistics of wet season crops from the Department of Planning and Statistics, Ministry of Agriculture Forestry and Fisheries (MAFF). Data on harvested area and yields for five crops in the two provinces are presented. Comparing Table 8 and 9, it shows that the average yields presented in Table 8 appear to be higher in both provinces for maize, lower for soybean in Kampong Cham, lower in both provinces for mung bean, and roughly equivalent for peanut and sesame.

Table 9. Selected Cambodian wet season crop statistics 2002-2003

Crop	Province	Harvested area (ha)	Yield (ton/ha)	Production (tons)
Maize	Kampong Cham	4 058	1.18	4 782
	Battambang	30 409	2.96	90 092
Soybean	Kampong Cham	19 272	1.45	27 872
Mung bean	Kampong Cham	8 125	0.56	4 544
	Battambang	8 849	0.72	6 348
Peanut	Kampong Cham	2 890	0.46	1.333
	Battambang	1 723	1.30	2.240
Sesame	Kampong Cham	11 167	0.54	6.019
	Battambang	240	0.55	132

Source: Ministry of Agriculture, Forestry and Fisheries 2003-2005.

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An additional farmer survey was conducted in Battambang and Kampong Cham provinces in 2005 to obtain detailed information regarding crop inputs, harvest and prices. The summary of the gross margin (crop income less variable costs, but not fixed costs) in the study areas are shown in Table 10. The gross margins of soybean and mung bean in Kamrieng were higher than in other districts, whereas in Tboung Khmom, the gross margin of soybean production was negative because the variable costs were very high. For maize, the gross margin in Chamkar Leu was much higher than in other districts.

Table 10. Summary of gross margin

District	Crop gross margin (US$/ha)				
	Soybean	Mung bean	Maize	Sesame	Peanut
Kamrieng	399	379	80	39	
Sampaov Loun	373	55	169	125	
Ratanak Mondol	255	207	99	-77	
Chamkar Leu	211	11	264	119	124
Tboung Khmom	-1	8	-	54	195

Source: Martin *et al*., 2005.

The farmers in the survey were also asked about their reasons for not growing particular crops. The results are presented in Table 11. From these results the main concerns of these farmers were a lack of knowledge, concerns about profitability, land/soil constraints, labour and equipment issues, and agronomic and climate risk. None of the farmers stated capital constraints and lack of varieties as reasons for not producing specific crops. This type of information is valuable in developing a research agenda.

Table 11. Reasons for not growing particular crops

	Maize	Soybean	Mung bean	Peanut	Cowpea	Sesame
Reasons for not growing crops						
Marketing					3	
Profitability	2		2	1	2	
Seed costs				2		
Capital constraint						
Labour/equipment		2	4	4		3
Agronomic risks			1		4	3
Lack of varieties						
Climate/drought		1	3			
Agronomy constraint						
Theft	1					
Lack of knowledge	1	3			1	1
Land/soil constraints	3	4		3		2

Source: Martin *et al*., 2005.

Discussion

The results presented herein provide some insights into non-rice upland crops produced in Kampong Cham and Battambang provinces and the potential for improving production. Low yields of particular crops in the study areas have major impacts on food shortages and poverty levels. Low crop productivity is attributed to erratic rainfall (drought and floods), low yield potential of traditional varieties, small farm sizes, and inadequate farm labour. These constraints are also common in other parts of the country, especially in rainfed upland areas (Lando and Mak, 1994).

Soil fertility is one of the most serious constraints to non-rice upland crop yield improvement (White *et al*., 1997). Upland soils in the study areas generally vary in fertility (Pheav *et al*., 2003), probably as a result of continuous cultivation without adequate nutrient replacement for nutrient losses by plant uptake, runoff, erosion and leaching. Previous results from elsewhere on similar soils in the same areas have reported deficiencies in nitrogen and phosphorus, and occasionally potassium (Lor *et al*., 1996; Pheav *et al.*, 1996). Other macro- and micro-nutrient disorders are also evident. The results further found that although the low fields have the most fertile soil, some soils are still poor in terms of nitrogen and phosphorus content. In addition, a number of problem soils exhibit acidity and/or high salt concentrations in some areas (White *et al*., 1997; Pheav *et al*., 2003).

It is common to cultivate traditional varieties in upland areas and this system normally has low annual productivity. Results from farmer group discussions suggest that farmers prefer varieties with higher yield and earlier maturity than the local common varieties, especially, commercial varieties. Commercial or breeder seeds of a number of upland crop varieties are available in some parts of Cambodia, but they are very expensive.

Every farmer cultivates several varieties but the purity and quality of the seeds may be quite low. Farmers normally produce their own seeds. Poor seed storage results in low seed quality, and farmers often have to solve the problem by using high seeding rates.

Inadequate labour, drought power, and cash are common socio-economic constraints which beset upland farmers. The same problems have also been found elsewhere in Cambodia by Lando and Mak (1994). Competition for labour and drought power is exacerbated during labour intensive farm activities such as land preparation and planting, and during the harvest. Furthermore, labour exchange is not commonly practiced in most of the study areas. According to field observations, farmers use their own labour for harvesting and transporting. Their economic position also limits their ability to purchase drought power and chemical fertilizers.

Upland crops such as maize, soybean, mung bean, sesame and peanut are sources of income for farmers throughout the country. Such crops can produce sufficient food for consumption all year round and substantially increase farm family income. The following recommendations would expand the production of secondary crops in upland areas:

- Small irrigation systems should be established in upland areas. Irrigation will supply dry season crops as well as supplement wet season crops, so the upland cropping system can be intensified;
- Provide farmers with improved varieties for upland farming. Several non-rice upland crop varieties released by DALLI and CARDI have been introduced by the district agronomists, and other organizations as well as farmers have good perception in testing these varieties and some of them have rapidly been adopted;
- The young generation of farmers is well educated and should provide a good pathway for the introduction of new technology;
- The Royal Government of Cambodia should expand support services such as agricultural research and extension; and
- Provide subsidized seeds and fertilizer as well as examine the need for an increased supply of rural credit.

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Green Gram Diversification and Commercialization in Myanmar

Than Than Win and Aung Kyi***

Abstract

The purpose of this study is to discuss the rapid transition of a rural economy led by the diversification and commercialization of secondary crop production, especially pulses. This study is based on a rural micro survey in Thonegwa Township (Thonegwa west and Letpangyo), Yangon division. Secondary data was obtained from Department of Agriculture Planning (DAP), Myanma Agriculture Service (MAS) and Central Statistical Organization (CSO). The cultivation of green gram began in 1984/85 in Thonegwa, but under the socialist economy, exporting the crop by private traders was forbidden. The sown area of green gram expanded in Thonegwa dramatically after market liberalization in 1989 and grew from 144 hectares in 1988/89 to 41,061 hectares in 2002/03. The net revenue for pulses is 3.7 times higher than paddy and 1.6 times higher in terms of cash income. The cost-benefit ratio for green gram production (3.5) is greater than that of rice (1.4). Moreover, the impact on landless labourers is evidenced through an increase in employment opportunities in terms of harvesting pulses. Daily expense per capita was found to total less than US$ 0.5, indicating significant changes in housing conditions, durable goods and assets owned by those involved in green gram production who remain in Thonegwa. It can be concluded that farmers, landless labourers and traders benefit from diversification and the commercialization of green gram and factors attributable to the success include the existence of an export market, the nature of the crop itself and the development of infrastructure. With regard the sustainable development of the pulses industry in Myanmar, much room remains for improvement in areas such as appropriate processing techniques, storage facilities and credit provision, as well as quality and quantity standardization and legal infrastructure.

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Background

There are more than 15 kinds of pulses growing in Myanmar of which green gram, black gram, pigeon pea, chickpea, cow pea and soybean are the most important in terms of export value. Pulses, a good source of vegetable protein, are regarded as important crops for both domestic consumption and export. From an economic standpoint, pulses are valuable crops not only to farmers, traders and processors, but also for the entire country as their production and marketing play vital roles in the agricultural sector and Myanmar's economy.

The purpose of this study is to discuss the rapid transition of a rural economy led by the diversification and commercialization of CGPRT (coarse grains, pulses, roots and tubers) crops, in particular pulses, that has taken place in Myanmar. Specific attention is given to the dissemination of the new production system and income generation, both for farmers and non-farmers, and the development of rural marketing systems. The discussion is based on the findings of a field survey that will provide policy implications to reform the agricultural sector of Myanmar.

The current study focuses on the most positive part of the reform, namely the case of green gram, one of the few areas that has produced a successful outcome. The study is based on the rural micro-survey with the assistance of UNESCAP-CAPSA in Thonegwa, which is about two hours by car from the capital Yangon. The study was conducted in two villages namely Thonegwa west and Letpangyo, based on representatives of the green gram farmers. Simple random sampling technique was used in the selection of respondents with the assistance of village level agreements as well as the development council and extension manager from Myanma Agriculture Service. A structured interview of selected farm households was conducted during the survey period. Moreover, this survey approach was supplemented by focus group discussions with villager elders, knowledgeable villagers and representatives from community-based organizations. In total, 64 respondents (54 farmers and 10 marketing intermediaries) were interviewed in October 2004 and in August 2005. For each respondent, primary data was collected such as social characteristics, cost of production, yield per acre, total income and expenditure. Secondary data was obtained from the DAP, the MAS and the CSO.

The study area

Geographically, there are six distinct regions in Myanmar, namely western mountain ranges, northern mountain ranges, eastern mountain ranges, delta area of the Ayeyarwaddy and Sittaung rivers, coastal strips, and, finally, the central plains and dry zone. However, administratively, Myanmar is divided into seven states and seven divisions.

Yangon division is situated in the delta area and has four districts. Yangon is the capital of the division and the country. Thonegwa is located in the southern district of Yangon division, 35 miles from Yangon city. Thonegwa has a long history, founded in 1152, and is situated at the crossing of three creeks. The township is one of the major green gram *Pedesein* growing areas of Myanmar. Thonegwa township encompasses 64 village tracts and 166 villages. The total area of Thonegwa is 322 square miles and is bordered by Thanlyin township to the west, the Gulf of Mottama to the east, Kyauktan township to the south and Khayan township to the north.

The population of Thonegwa township is about 146,130, of which 28,220 people (20 per cent) live in the town, while 80 per cent live in the villages (Table 1).

Table 1. Demographic features of Thonegwa township in 2003

Location	Total population	Number of male	Percentage of male	Number of female	Percentage of female	Sex ratio (M/F)
Thonegwa township	28 220	13 940	49.40	14 280	50.60	97.62
Villages	117 910	58 540	49.65	59 370	50.35	98.60
Township total	146 130	72 480	49.60	73 650	50.40	98.41
National	**52 232 600**	**25 964 800**	**49.71**	**26 267 800**	**50.29**	**98.83**

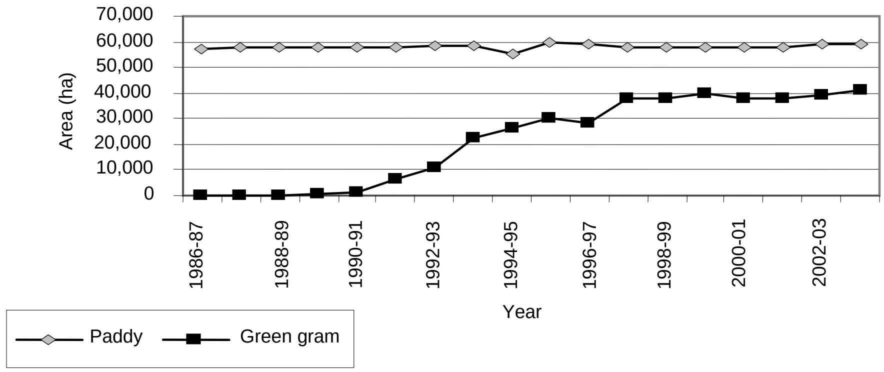
Source: Statistical Yearbook and MAS, Thonegwa township.

Overview of agriculture

The total land area of Thonegwa township is 84,302 hectares, of which agricultural land occupies 59,704 hectares, 71 per cent of the total. Almost all, 98 per cent, of the farmland is paddy fields, while 1 per cent is orchards and less than 1 per cent is Niper palms.

Thonegwa is a typical rural area in lower Myanmar with a simple cropping pattern. During the rainy season, rice is grown on rainfed fields, followed by green gram in the dry season, which is the major second crop. Rice is the most important staple food in Myanmar. On the other hand, green gram is an important export crop for the country nowadays. Prior to the spread of green gram, this area, during the wet season, was a mono-crop paddy producing area, while groundnut and sunflower were cultivated on a limited scale for home consumption during the dry season. Figure 1 shows changes in the cultivated area of paddy and green gram since 1986.

Figure 1. Crop sown area in Thonegwa



Source: MAS, Thonegwa.

The significant growth in green gram area was achieved as a result of double cropping, using residual moisture in Thonegwa following the monsoon rice. The cultivation of green gram began in 1984/85 in the Thonegwa area. At that time, it was a rather new crop. Furthermore, MAS in Thonegwa introduced green gram to a few village tracts in the township by providing 25 seed baskets. During the socialist economy, exporting the crop was not permitted by private traders. Therefore, the production of green gram remained purely for domestic consumption. The sown area of green gram expanded dramatically in Thonegwa after economic liberalization in 1989. Production sky-rocketed from 144 hectares in 1988-1989 to 41,061 hectares in 2003-2004. In fifteen years, the area under green gram multiplied by 285. Paddy area, on the other hand, remained level at around 60,000 hectares during the same period. Due to the monumental expansion in Thonegwa, the township now boasts the country's largest green gram sown area (Table 2). Consequently, Thonegwa has been endowed special status for green gram cultivation.

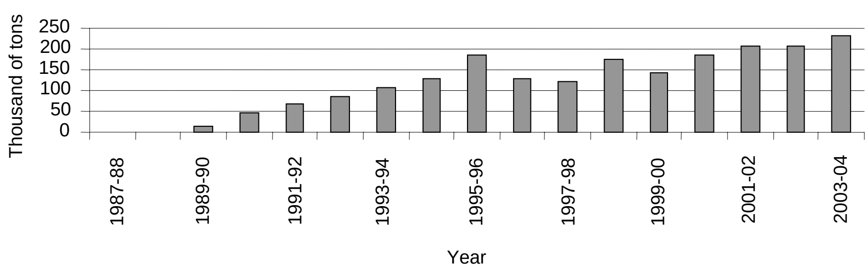
During the same period, the farmers in Thonegwa switched from local green gram to the exotic variety *Pedi-shwewa*, in response to export market demand. *Pedi-shwewa* is brighter in colour and larger in size, therefore, the price of the exotic green gram is higher. As Figure 2 shows, the export volume of green gram ranges from 50,000 tons in 1988-1989 to 233,000 tons in 2003-2004.

Table 2. Green gram production at the township level in 1998-1999

Township/Division	Sown area (thousands of hectares)	Contribution to national production (%)
Thonegwa/ Yangon	38.00	5.38
Kayan/ Yangon	32.78	4.64
Magway/ Magway	28.73	4.07
Natmauk/ Magway	27.92	3.95
Thanatpin/ Bago	25.90	3.67
Chauk/ Magway	25.49	3.61
Kawa/ Bago	21.85	3.09
Minbu/ Magway	19.42	2.75
Kantbalu/ Sagaing	18.61	2.63
Mawlamyingyun/ Ayeyarwady	17.00	2.41
Waw/ Bago	16.59	2.35
Nyaungoo/ Magway	15.39	2.18
Myaing/Magway	14.97	2.12
Pakkoku/ Magway	14.59	2.06
Salin/ Magway	14.16	2.00
Total	**331.40**	**46.91**

Source: FAO, MOAI, Agricultural Marketing in Myanmar, 1999.

Figure 2. Export volume of green gram



Source: Statistical Year Book, CSO.

The Simpson Index of Diversity (SID) is utilized to assess the extent of horizontal crop diversification. Equation 1 shows the equation to calculate SID.

Equation 1.

$$\mathbf{SID = 1 - \sum_{i=1}^{n} Pi^2}$$

Where SID is the Simpson Index of Diversity and Pi is the proportionate area of the ith crop with total cropped area. The index ranges between 0 and 1. If the agricultural system is specialized, the index moves towards 0; more diversified agriculture returns a figure closer to 1.

The SID of Thonegwa was calculated to be 0.1 in 1987-1988, a time when rice production was dominant. Thereafter, the SID value has increased continually, to 0.51 in 2002-2003 as a result of the expansion of green gram. The cropping intensity and level of diversification situation of Thonegwa is shown in Table 3.

Table 3. Crop diversification in Thonegwa (thousands of hectares)

	Thonegwa (1987-1988)	Thonegwa (2003-2004)	National (2003-2004)
Net sown area	57.161	58.980	11 040
Total sown area	59.539	102.791	16 722
Cropping intensity (%)	104	174	152
Simpson Index of Diversity (SID)	0.10	0.51	0.83

Source: DAP, MAS, Thonegwa Township and survey results.

Profile of respondents

Based on the number of landless people and the distance from town, Thonegwa West and Letpangyo villages in Thonegwa township, Yangon district, were selected to analyse the extent of agricultural diversification. Thonegwa's agriculture consists of entirely lowland rainfed areas. The village has access to the main paved road and is about 5 miles to Thonegwa town. Most farmers travel to town by bicycle. As there is a river in the village, water transportation is also used.

Letpangyo village is situated about 10 miles from Thonegwa township. In Letpangyo, unpaved dirt roads are available in the dry season and it takes approximately 30 minutes by jeep to reach town. Most of the villagers use bicycles and bullock carts in the dry season as well as river-faring vessels.

Landless people account for approximately 40 per cent or residents in Thonegwa West and 64 per cent in Letpangyo. Forty per cent of Myanmar's population are landless. Table 4 shows the demographic features and landholding status of the two villages.

Table 4. Number of households by size of landholding in the study villages

Particular	Thonegwa West		Letpangyo		Total	
Landless	168	(40%)	597	(64%)	765	(57%)
0-2 ha	82	(19%)	129	(14%)	211	(16%)
2-4 ha	113	(27%)	75	(9%)	188	(14%)
>4 ha	12	(4%)	69	(7 %)	81	(6%)
Others (not involved in agriculture)	43	(10%)	58	(6%)	101	(7%)
Total household	**418**	**(100%)**	**928**	**(100%)**	**1 346**	**(100%)**
Total number of farm HH	207		273		480	
Total area of farming (ha)	1 020		763		1 783	
Average farm size (ha)	4.93		2.80		3.87	
Number of sub villages	2		5		7	
Total population	2 266		3 742		6 008	
Average HH size	5.42		4.03		4.73	

Source: MAS, Thonegwa township.
Note: HH = Household.

The majority of landless people work as agricultural labourers, but there are also carpenters, teachers as well as construction and mill workers.

The number of landless people continues to rise because when a son or daughter marries, the parents allocate part of their land to the couple, or illegally sell the land to repay outstanding debt. They have no other option than to seek waged employment, which is largely dominated by casual labour on agricultural farms. The mounting pressure to generate extra income is felt by the landless and small farmers and, as a result, they seek other income generating opportunities that typically are low skilled and poorly paid.

The structure of village administration is basically the same as in other parts of the country. The Village Tract Peace and Development Council (VTPDC) is the primary body. The council consists of four members including a chair and a clerk. Furthermore, village leaders for each sub-village and the heads of each ten households are assigned as part of the informal administration network.

In total, 54 households, or 11 per cent of the farm households, were selected for the present study. Most respondents have completed primary education.

Table 5 shows the average household size, as well as the sown area of paddy and green gram in the two study villages. The cultivated area of green gram of the sample farmers is almost the same as the area set aside for paddy. This implies that all sample farmers grow green gram as a second crop after the monsoon paddy, food crop. Thonegwa township is relatively near to the sea and therefore, the water has a high saline percentage, and irrigated cultivation is not possible in the dry season. As a consequence, the government does not recommend the cultivation of summer paddy in Thonegwa.

Table 5. Size of holding and sown area of the sample farmers

Particular	Thonegwa West	Letpangyo	Total
Number of sample HH	28	26	54
Total population of sample HH	148	120	268
Average HH size of sample	5.29	4.62	4.96
Percentage of sample HH in total farm HH	13.53	9.52	11.25
Total farm area of sample HH (ha)	144.56	91.54	236.1
Average farm size of sample HH (ha)	5.16	3.52	4.34
Net sown area of sample HH (ha)	143.75	91.54	235.29
Total sown area of paddy by sample HH (ha)	143.75	91.52	235.27
Total sown area of green gram by sample HH (ha)	140.11	90.65	230.76

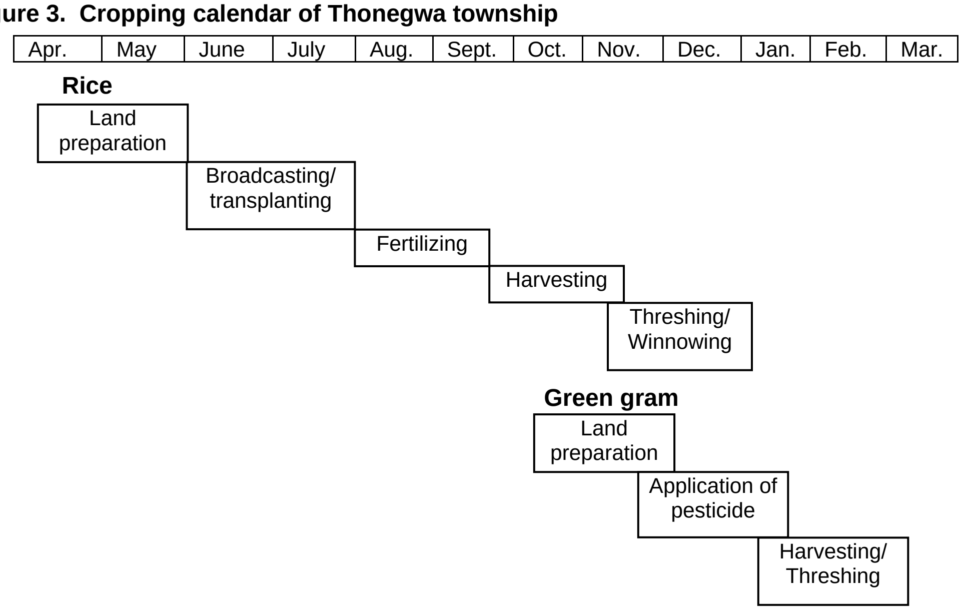
Source: Field survey.

Production and impact on farming

Before the spread of green gram, paddy was the only crop that could provide some cash income to the farmers, however, due to the large volume required for home consumption and wage payments together with the state procurement quota at that time, the commercialization of agriculture was hardly possible.

With the country's shift to a market economy, green gram spread, and this also changed the cropping calendar of Thonegwa as Figure 3 shows. Rainfed paddy cultivation continues to begin with land preparation in May with its growing season during the monsoon from May to November followed by green gram cultivation, from November to February. The cultivation of green gram starts directly after the harvesting of paddy. It is necessary to plant green gram seeds when there is still residual moisture in the soil. Therefore, the farmers are pressed to start cultivation as soon as the paddy harvest is complete. Farmers hire tractors for ploughing and harrowing. During the peak season, the tractors operate almost 24 hours per day. The harvested paddy is left intact until the planting of green gram is completed. From the farmers' point of view, the cultivation of green gram at an appropriate time is more important. The green gram takes only 2.5 to 3 months to be ready for harvesting.

Figure 3. Cropping calendar of Thonegwa township



Source: Field observations.

The success of crop cultivation depends on its yield. Farmers in the study area have long and extensive experience in crop selection, forecasting the weather and yield estimation. The yields of pulses they obtained are higher than the national average. Nonetheless, the yield levels are lower than several neighbouring countries and the harvest must be improved. Average yields of rice and green gram in Thonegwa West and Letpangyo are shown in Table 6.

Table 6. Crops yields of the sample farmers

Type of crop	Thonegwa West	Letpangyo	Average
Rice			
- Average sown area (ha)	5.13	3.52	4.325
- Average yield (mt/ha)	3.34	3.33	3.335
- Max yield (mt/ha)	3.61	3.51	3.56
- Min yield (mt/ha)	1.80	1.70	1.75
Green gram			
- Average sown area (ha)	5.00	3.49	4.25
- Average yield (mt/ha)	1.10	1.09	1.095
- Max yield (mt/ha)	1.29	1.21	1.25
- Min yield (mt/ha)	0.81	0.81	0.81

Source: Field survey.

In this section, the costs and revenues of paddy and green gram are compared based on the cost of production and farm household survey. Since the market economy reform in 1988, liberalized trade has been an important encouraging factor to grow pulses. Comparatively, the cost of production of pulses is lower than other seasonal crops. The prime reason for farmers' interest in growing green gram is clearly the good returns from pulses cultivation in the mid and long term. The net revenue for pulses is 3.7 times higher than that of paddy. It is certainly an attractive crop for farmers as it creates an additional income without affecting the cultivation of paddy. Table 7 shows the prices, costs and net revenues of rice and green gram.

Table 7. Cost-revenue structure of sample crops (2003-2004)

Village	Yield (mt/ha)	Farm gate price (kyat/mt)	Cash income (kyat/ha)	Total cost (kyat/ ha)	Net revenue (kyat/ha)
Thonegwa West					
- Rice	3.34	51 637	172 467	115 350	57 117
- Green gram	1.10	243 260	267 586	75 500	192 086
Letpangyo					
- Rice	3.33	48 231	160 611	115 400	45 211
- Green gram	1.09	241 586	263 329	75 920	187 409
Average					
- Rice	3.335	49 934	166 539	115 375	51 164
- Green gram	1.094	242 423	265 458	75 710	189 747

Source: Field survey.
US$ 1 = 1,000 kyats.

A cost-benefit analysis was conducted to estimate cost-benefit ratios (CB) for rice and green gram production. The CB for green gram production was 3.5 compared to 1.4 for rice. Since green gram production attained a higher cost-benefit ratio it is more attractive for farmers. Thus, green gram production is beneficial for resource poor farmers.

Overall, in both villages, it can be summarized that the introduction of pulses has improved the livelihoods of most farmers that have cultivated pulses. As a result, land holders have increased their income as well as the landless as they have more work opportunities. However, the gains are disproportionate, as large land owning farm households that can afford tractors, can also earn extra income by leasing the tractor.

Before the expansion of pulse cultivation, there were few employment opportunities except for post-harvest operations of paddy, either on-farm or off-farm. Some male labourers found employment collecting fuel wood, repairing palm-leaf roofs or digging ponds from time to time, but most female labourers had no opportunities. However, the spread of pulse production has generated almost 30 days annually of constant employment for both male and female farm labourers at harvest time, mainly in February in the study area. The study team tried to estimate the labour absorption of green gram production for the whole country, but data is unavailable. Whatever the main occupation of the household is, the redundant labourers in the household, and even the children, can make full use of these opportunities, contributing to the annual income flow of the household.

Table 8 shows the wages paid to hired labour. The figures are daily rates. Note the difference between male and female wages in the study villages. This difference is related to the toughness of the task performed by the men. Therefore, the wage difference is not gender bias though this may not always be the case. Children can earn at least 500 kyats per day during this period. Labour migration can be seen from dry zone areas to this area during the green gram harvest.

Table 8. Daily wages in the study area (kyat)

Village	Contracted Agri-labour (including meal)		Seasonal-labour (daily waged)		Other-labour	
	male	female	male	female	male	female
Thonegwa West	1 200	800	1 000	600	600	500
Letpangyo	1 200	800	1 000	600	600	500

Source: Field survey.
US$ 1 = 1,000 kyats.

Many landless labourers receive wages in advance, as their weak economic background hinders access to informal credit from relatives or friends. As long as these agricultural labourers have to depend on this arrangement, the emergence of additional opportunities for credit access by pulses production deserves positive assessment. Therefore, it is clear that among agricultural labourers, the poorest segments are the main beneficiaries from the increase in employment opportunities created by pulse operations.

Income and expenditure

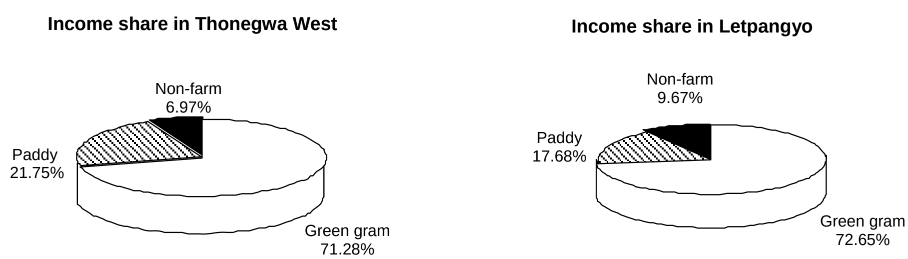
The respondents' average annual income was calculated as displayed in Table 9. Average total income for farmers in the study area was 1,123,822 kyat (US$ 1,124) per year, of which farm income accounted for 1,033,320 kyat (US$ 1,033) and non-farm income contributed 90,502 kyat (US$ 91). Hence, 92 per cent of total income stems from farm income and 8 per cent from non-farm income. Seventy-two per cent of farm income is attributable to green gram production and 20 per cent paddy. Consequently, green gram is the major income source in the study area.

Table 9. Income share of sample farmers (Kyat/year)

Type of income	Thonegwa West	Letpangyo	Average	Percentage
Farm income	**1 253 440**	**813 200**	**1 033 320**	**91.95**
- Income from green gram	960 430	654 057	807 244	71.83
- Income from paddy	293 010	159 143	226 076	20.12
Non-farm income	**93 942**	**87 062**	**90 502**	**08.05**
Total income	**1 347 382**	**900 262**	**1 123 822**	**100.00**

Source: Field survey.
US$ 1 = 1,000 kyats

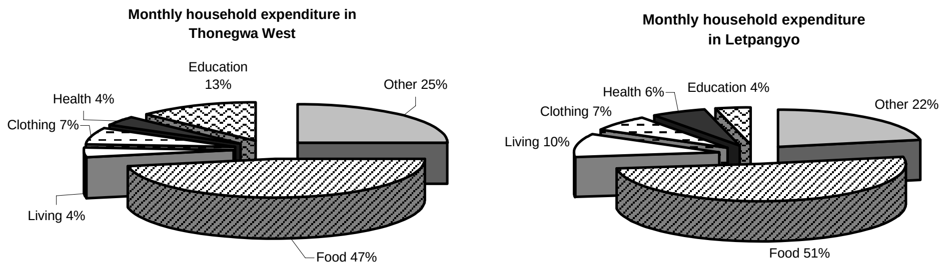
Figure 4. Income share



Source: Field survey.

The average annual expenditure of the respondents was also calculated as shown in Figure 5. Food expenditure represents the highest share in total expenditure and accounts for almost half of the household budget in both villages.

Figure 5. Monthly household expenditure



Source: Field survey.

Expenditure per capita was also estimated in the study (Table 10). Daily expense per head was found to be less than US$ 0.5 using the current market exchange rate, namely US$ 1 equivalent to around 1,000 kyats (local currency).

Table 10. Annual expenditure per capita (kyat)

Type of expense	Thonegwa West	Letpangyo	Average
Food	**76 764**	**92 779**	**84 772**
- Cereal, oil, pulses and vegetables	40 730	48 545	44 638
- Meat, eggs and milk	36 034	44 234	40 134
Non- Food	**85 361**	**90 145**	**87 753**
- Living	6 567	18 177	12 372
- Clothing	11 006	12 499	11 753
- Health	6 429	11 784	9 106
- Education	20 495	7 784	14 140
- Other	40 684	39 901	40 382
Total	**162 125**	**182 924**	**172 525**
Daily expense			
Kyats/day	444	501	473
$/day	0.44	0.50	0.47

Source: Field survey.
US$ 1 = 1,000 kyats

Although the average daily per capita expenditure was only 473 kyats, there has been a significant increase in the respondents' living conditions. As Table 11 shows, the number of houses with brick walls, houses with timber floors and corrugated zinc roofs have increased during the last 15 years.

Table 11. Housing conditions

Type of house	Thonegwa West Before 1988-1989	Thonegwa West After 1988-1989	Letpangyo Before 1988-1989	Letpangyo After 1988-1989	Total Before 1988-1989	Total After 1988-1989
Wall						
- Brick	-	2	-	2	-	4
- Timber	18	20	10	22	28	42
- Bamboo	10	6	16	2	26	8
Floor						
- Brick	-	-	-	-	-	-
- Timber	13	28	12	26	25	54
- Bamboo	15	-	14	-	29	-
- Earth	-	-	-	-	-	-
Roo f						
- Corrugated zinc sheet	10	22	10	24	20	46
- Nipa palm	18	6	16	2	34	8
- Thatch	-	-	-	-	-	-
Storey						
-Two	2	22	20	16	22	38
-Single	26	6	6	10	32	16

Source: Field survey.

Approximately half of the households in the study own TVs, while only four households own cars or motorcycles. Eighty-five per cent of the households own bicycles (Table 12).

Table 12. Durable goods and assets owned by sample farmers

Type of assets	Thonegwa West number of assets	Thonegwa West number of owned HH	Letpangyo number of assets	Letpangyo number of owned HH	Total number of assets	Total Average assets owned by sample HH
Generator	8	8	8	8	16	0.30
TV/ video	18	16	12	12	30	0.56
Cassette/ radio	12	10	8	8	20	0.37
Car/ motorcycle	2	2	2	2	4	0.07
Bicycle	38	20	40	26	70	1.30

Source: Field survey.

Table 13 shows the heads of livestock and farm equipment the households own. The average household in the study owns 26 chickens and three cattle/buffalo. Ten households own tractors and 44 households have ploughs.

Table 13. Livestock and farm equipment owned by the sample farmers

	Thonegwa West		Letpangyo		Total	
Type of livestock	number of livestock	number of owned HH	number of livestock	number of owned HH	number of livestock	Average livestock owned by sample HH
Cattle/ Buffalo	94	24	86	26	180	3.33
Sheep/ Goat	6	2	-	-	8	0.14
Pig	12	4	6	6	18	0.33
Poultry	1 109	26	316	18	1 425	26.39
Type of equipment	number of equipment	number of owned HH	number of equipment	number of owned HH	number of equipment	Average equipment owned by sample HH
Cart	24	20	20	20	44	0.81
Hand tractor	-	-	2	2	2	0.04
Tractor	4	4	6	6	10	0.19
Ploughing implement	30	24	24	20	54	1.00
Harrowing implement	18	16	16	16	32	0.59
Thresher	2	2	-	-	2	0.81

Source: Field survey.

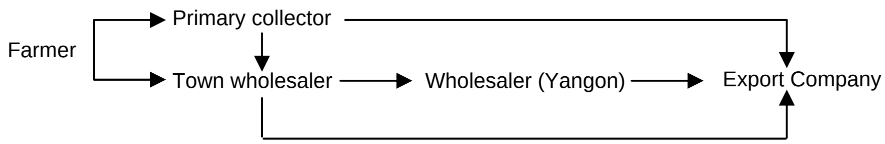
Market mechanism and processing

In general, most of the farmers sell their produce to primary buyers who come to the villages, or farmers sell their produce directly at the market in the nearest town. The primary buyers sell the produce almost directly to the wholesalers and keep the crops for a maximum of one week. Buyers working capital is between 100,000 kyats and 2 million (US$ 100 to 2,000). The majority of wholesalers can only store 5,000 baskets (about 163 metric tons) of pulses at a time. Town wholesalers' working capital ranges from 300,000 kyats to 80 million kyats (US$ 300 to 80,000).

Individual sales of green gram also occur within three months of the harvest due to the urgent need for cash and difficulty in storing the green gram. The payments between farmers and traders are in cash. Wholesalers in town or primary collectors receive 1 per cent of the product value as an overhead charge in addition to the transportation and labour charges.

Wholesalers’ net profit from green gram sales range between 60 kyats and 80 kyats per bag. Most transactions are made directly in cash. Green gram trading is relatively profitable and is more impressive than the gains for rice traders, which probably has many explanations, including that the trading period for green gram is much shorter than for rice, the profit from green gram per bag is higher than for rice, and the marketing chain of green gram (Figure 6) is rather simple compared with the paddy trade.

Figure 6. Marketing chain of green gram



Source: Field survey.

Farmers are well informed of crop prices in both villages as they receive crop price information from a number of sources. As Thonegwa West is situated near town, farmers obtain information directly from buyers in town. The Letpangyo villagers have less possibility of visiting town so the price information is provided by bus drivers or primary collectors.

The extent of processing of pulses depends on their final use. Most of the pulses are traded in Yangon and Mandalay markets for export as fresh produce, involving only limited grading and sorting. Machine splitting of husks is gaining popularity, although peeled pulses command a lower price at market due to the low level of technology that results in damaged pulses. There are about 500 enterprises involved in this processing. These enterprises comprise only of large and medium sized businesses and do not include the large number of smaller operations scattered around the country.

There are no processing plants of pulses in Thonegwa West and only one rice mill. The farmers sell their green gram as fresh produce to Yangon market where cleaning and grading take place.

Both villages have great potential to produce value-added products, such as protein extract, sweet paste for local and foreign markets, split grain with or without husk, vermicelli, sauce and a variety of snacks. However, due to the low level of technology used for processing, access to stable and reliable supplies of electricity and limited access to credit are significant problems that processors face in developing the pulses industry.

Conclusion and policy implications

Based on the results of this study, it can be concluded that farmers, landless labourers and traders benefit from diversification and the commercialization of green gram production and processing. It has been successful in creating employment and income for the majority of the rural population. There are only winners in this development and it has raised the general economic level of the study areas. However, the income generated by pulse production has not been high enough to allow the poorest segment of the rural population to escape from persistent poverty. At the same time, improvements in the income distribution are ambiguous. Although the landless labourers, especially the poorest strata, could also gain additional income, it seems that the benefits to farmers and marketing intermediaries are much larger.

Several factors have contributed to the success of green gram in Thonegwa West and Letpangyo villages. First, there are several large neighbouring importing countries, for example India. Second, green gram is a genuine cash crop. Third, infrastructure development such as the construction of the Thanlyin Bridge over Bago River to Yangon, and the establishment of a commodity trading centre in the 1990s.

Considering the sustainable development of the pulses industry in Myanmar, there is still much room for improvement in post-harvest handling such as good processing technology and storage facilities. Moreover, appropriate credit allocation, quality and quantity standardization of the produce and improved legal systems are also required. Everything cannot be done simultaneously, but a long-term policy regarding pulses should be formulated. In addition, the study case of green gram clearly shows that both farmers and traders respond well to market opportunities. The marketing policies should therefore be formulated towards the expansion of market openings of each agricultural crop.

Cost of production for rice farmers in Thonegwa

No: of sample farmers	54
Total sown area of rice	235.27 ha
Average farm size	4.36 ha

Item	Unit	Unit cost	Amount of input (unit/ha)	Total cost (kyat/ha)
Seeds	Kgs	99	103	10 300
Fertilizer	Kgs	221.5	50	11 075
FYM	Tons	2 500	3	7 500
Land preparation				**29 500**
- Ploughing	Family labour (ad-m/d)	1 500	8	12 000
- Harrowing	Family labour (ad-m/d)	1 500	8	12 000
- Leveling	Family labour (ad-m/d)	1 500	3	4 500
- Applying FYM	Family labour (m/d)	500	2	1 000
Crop management				**26 500**
- Nursery	Family labour (m/d)	500	3	1 500
- Seedling	Hire labour (m/d)	500	7	3 500
- Transplanting	Hire labour (m/d)	500	25	12 500
- Water management	Hire labour (m/d)	500	5	2 500
- Weeding	Hire labour (m/d)	500	10	5 000
- Fertilizing	Hire labour (m/d)	500	3	1 500
Harvesting and post-				**30 500**
harvesting	Family labour (m/d)	1 500	3	4 500
- Binding and carting	Hire labour (m/d)	500	20	10 000
- Harvesting	Hire labour (m/d)	500	32	16 000
- Threshing and drying				

Total Cost (kyat/ha)	115 375
Total Returns (kyat/ha)	166 539
Yield (mt/ha)	3.335
Price (kyat/mt)	49 934

Cost of production of green gram farmers in Thonegwa

No. of sample farmers	54
Total sown area of green gram	230.76 ha
Average farm size	4.27 ha

Item	Unit	Unit cost	Amount of input(unit/ha)	Total cost (kyat/ha)
Seeds	Kgs	200	38	7 600
Fertilizer	Litre	1 400	3	4 200
Pesticide	Litre	1 455	2	2 910
Land preparation				**26 500**
- Stubble cleaning	Hire labour (m/d)	500	15	7 500
- Ploughing	Family labour (ad-m/d)	1 500	6	9 000
- Harrowing power tiller	Hire labour (m/d)	2 000	5	10 000
Crop management				**14 000**
- Leveling	Family labour (m/d)	1 500	3	4 500
- Broadcasting	Family labour (m/d)	500	3	1 500
- Weeding	Hire labour (m/d)	500	10	5 000
- Spraying	Family labour (m/d)	500	3	1 500
- Fertilizing	Family labour (m/d)	500	3	1 500
Harvesting and post-				**20 500**
harvesting	Family labour (m/d)	500	10	5 000
- Harvesting	Hire labour (m/d)	500	16	8 000
	Family labour (m/d)	500	15	7 500
- Threshing and drying				

Total Cost (kyat/ha)	75 710
Total Returns (kyat/ha)	265 211
Yield (mt/ha)	1.094
Price (kyat/mt)	242 423

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Secondary Crops and Poverty Alleviation in Bangladesh

Jahangir Alam Khan[*]

Abstract

This study was conducted in selected areas of Bangladesh to examine the possibilities of promoting diverse agriculture and agribusiness with secondary crops towards poverty alleviation. Of the coarse grains, pulses and tuber crops (CGPRT crops), maize, millet, lentil, mung bean, potato and sweet potato were covered. Results of the study show that these crops have substantial potential for crop diversification, processing, value addition and employment generation. These crops are economically profitable, fit well in the farming system and have comparative advantage in production. The study revealed that if the area under CGPRT crops was increased by 1 per cent, the annual income of a household would be increased by 0.3 per cent. The cost and revenue structure of various processing industries shows that the processing of CGPRT crop products is substantially profitable and contributes significantly to employment generation and poverty alleviation. However, farmers in large part have shown reluctance to diversify and produce more of these crops. The main reason is that rice is the staple food of the Bangladeshi people and with the expansion of irrigation facilities farmers find it more suitable to cultivate rice. Concomitantly, they increased cultivation of wheat due to the availability of modern varieties. Consequently, the cultivation of minor cereals and pulses has received low attention by the farmers. As a result, the progress of crop sub-sector diversification has been very slow over the years. In order to enhance the speed of diversification, special programmes should be undertaken to encourage the production, processing and marketing of CGPRT crops in the country. Higher budgetary allocation is required to serve this purpose. Moreover, regional co-operation regarding the research and development of CGPRT crops and versatile uses of their products is required to promote diversification and enhance the sustainable development of agriculture to alleviate poverty in the region.

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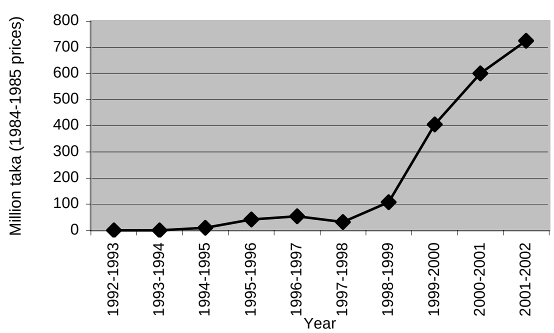
Introduction

Agriculture in Bangladesh remains the single most important sector of the economy, employing 62 per cent of the country's total labour force. The role of agriculture is crucial for food security, sustainable economic growth, employment generation and poverty alleviation.

The crop sector dominates Bangladeshi agriculture, accounting for 55 per cent of agricultural GDP in 2004-2005 at current prices. Rice, wheat, pulses, oilseeds, sugarcane, potato, vegetables, jute and tea are the main crops of Bangladesh. Rice dominates the country's crop sector with more than 75 per cent of the total cropped area under rice cultivation.

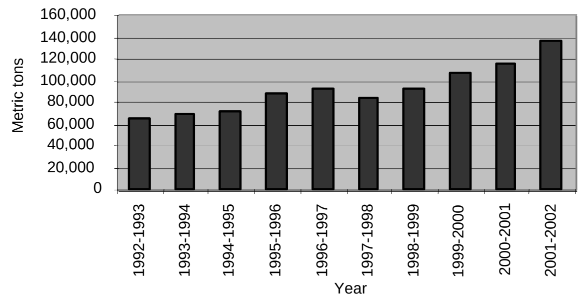
New seed-fertilizer-irrigation technology has favoured rice and wheat production to achieve self-sufficiency in food grains. As a result, the production of food grains has expanded at an annual growth rate of 2.8 per cent over the last 31 years primarily due to research and development efforts since the early 1970s. Meanwhile, some secondary crops including coarse grains (CG), pulses (P), roots and tuber crops (RT) (CGPRT), which occupy a significant portion of the cropped area, became less attractive. These crops, which are grown in less favoured environments, have been largely untouched by the growth process and have been in a declining trend in recent years. Bangladesh has become more dependent on imports of maize (Figure 1) and pulses (Figure 2) to meet the growing demand for food, animal feed, fuel and for industrial purposes.

Figure 1. Imports of maize to Bangladesh



Source: Bangladesh Bank.

Figure 2. Imports of pulses to Bangladesh



Source: Bangladesh Bank.

This paper presents the current status of the main secondary crops and examines their potentials to promote the sustainable development of diverse agriculture and agribusiness for poverty alleviation in Bangladesh.

This paper reports the potential effects on poverty alleviation of promoting diverse agriculture and agribusiness with secondary crops in Bangladesh. Seven CGPRT crops: maize, *kaon* millet, *chena* millet, lentil, potato and sweet potato were selected. First, the paper investigates the status of CGPRT crops in Bangladesh. Thereafter, profitability and potential comparative advantage of producing CGPRT crops and their importance in the farming system are analysed. The marketing system of CGPRT crops and their products are subsequently examined. Next, income elasticity of some crops are presented, followed by an analysis of the poverty in Bangladesh. Finally, some policy recommendations are provided.

In September to December 2003, data was collected from 400 respondents in 12 districts through field visits using a structured questionnaire. In addition, rapid rural appraisal (RRA) techniques and participatory rural appraisal techniques (PRA) were used to collect data on different variables.

Moreover, a total of 100 CGPRT crop-growing farmers, with at least 14 farmers producing the same crop, were interviewed during 2003/04 to generate data on the cropping system. In addition, 40 small-scale processors, ten large-scale processors, ten pulse processors and ten market intermediaries were also interviewed.

Status of secondary crops in Bangladesh

The agricultural sector in Bangladesh is dominated by crop production and crop agriculture is dominated by rice production. Rice contributes about 69 per cent to the value of crop output. Other crops including vegetables, fruits, tubers, spices, jute, sugarcane, pulses and oilseeds also make significant contributions to the total value of crop output (Table 1). However, the extent of crop diversification is low because cereals (rice and wheat) alone represent more than 72 per cent of the value of crop output in Bangladesh.

Table 1. Share of different crops in total value of crop output

Crop	2000/01	2001/02	2002/03	Average
Rice	69.28	68.16	68.77	68.73
Wheat	3.51	3.46	3.15	3.37
Other cereals	0.11	0.40	0.43	0.32
All cereals	72.90	72.02	72.35	72.42
Potato	3.21	3.45	3.48	3.38
Sweet potato	0.39	0.33	0.30	0.34
Tubers	3.60	3.78	3.78	3.72
Vegetables	4.74	4.68	4.66	4.69
Pulses	1.95	1.99	1.94	1.96
Oilseeds	1.58	1.51	1.42	1.50
Spices	3.38	3.30	3.22	3.30
Jute	2.25	2.51	2.25	2.34
Cotton	0.13	0.29	0.24	0.22
Sugarcane	2.31	2.26	2.29	2.29
Fruits	4.02	4.36	4.57	4.32
Tobacco	0.27	0.27	0.26	0.27
Tea	0.88	0.85	0.84	0.86
Others	1.99	2.18	2.18	2.11

Source: Bangladesh Bureau of Statistics, 2001.

Cereals occupy 81 per cent of gross cropped area in Bangladesh, with rice and wheat constituting about 80 per cent of total cropped area. Coarse grains occupy 0.79 per cent and maize occupies 0.23 per cent of total area under cultivation. Some of these crops are less capital intensive and better suited to rainfed conditions.

The major coarse grains in Bangladesh are maize and millets. In terms of production, millets constitute only 0.22 per cent of total grain production while maize constitutes 0.66 per cent. In recent years, maize has displayed an impressive growth rate of 15.13 per cent. There has been a sharp increase in area, production and yield of maize over time and it has been recognized as the third most important food grain crop in Bangladesh. Maize covers 1.7 lakh (1 lakh = 100 thousand hectares) of land and is grown both during the summer and winter seasons. However, winter maize is the most important and accounts for about 84 per cent of the country's maize harvest. Average production per hectare is 5.7

tons. The area and production of millets have stagnated over the last three decades and they deserve attention from researchers and policymakers.

Pulses occupy 3.3 per cent of gross cropped area. Significant pulses include lathyrus, lentil, mung bean, black gram, chick pea, field pea and pigeon pea. In terms of area, production and yield, lathyrus and lentil are the two most important pulses in Bangladesh.

Total area and production of pulses have shown a long-term increasing trend but have declined in recent years. Although the productivity of pulses has only slightly increased, it has been enough to compensate for the decrease in area cultivated. There was little gain in yield rate of pulses due to the adoption of new techniques, but this was more than offset by the decline in area under cultivation. The nominal prices of pulses have increased over time in the domestic market, which are much higher than world market prices.

Tubers account for 2.10 per cent of the total cropped area. The principal tuber and root crops are potatoes and sweet potatoes, which occupy 276 thousand hectares and produce 3.44 million tons. The area, production and yield of potato have increased, while that of sweet potato have sharply declined over time. Currently, potato accounts for 87 per cent of the total production of tubers in the country.

Sweet potato is grown in all districts of Bangladesh, particularly on strips of sandy river embankments. Due to its low unit price, the rural poor use sweet potato as a substitute for rice. The decline in production of sweet potato is a burden on the poor people, particularly at times when the price of rice becomes very high.

The magnitude of crop sector diversification was determined over time using the Simpson Index of Diversity (SID). For computation of SID, all crops grown in Bangladesh were grouped into eleven categories. They include rice, wheat, minor grains (maize and millets), pulses, tubers, oil seeds, spices, vegetables, sugarcane, jute and other crops. The index showed an upward trend over time; from 0.37 in 1972/73 to 0.42 in 1989/90, and 0.43 in 2001/02. The result shows a slow improvement of crop sector diversity in Bangladesh over the last three decades.

Yield, profitability, comparative advantage and income

The average yield of CGPRT crops on sample plots is shown in Table 2. Farmers in the study areas have vast experience in producing one or several CGPRT crops and the yield rates they obtain are higher than the national average. The higher outputs measured in our survey correspond very closely to results of other studies conducted in recent years (Alam, 2005).

Farm gate prices for different CGPRT crops are also presented in Table 2. Most farmers sell their surplus during the harvest time and the average prices for the year 2002/03 determined by this survey were very close to national average harvest time prices.

The present study examined both financial and economic returns over variable and full costs. An analysis on financial returns shows moderate returns per unit of land for each crop (Table 2). Economic returns exceeded financial returns when the cost of tradable inputs was low and if non-tradable inputs dominated the total cost. On average, CGPRT crops use fewer inputs per unit of land than other major crops (Alam, 2005) and generate satisfactory returns over full and variable costs. The returns were high for potato, maize and pulses primarily due to the adoption of new production techniques. On the other hand, returns were low for millets due to the non-adoption of improved cultivation practices. The observed yield rate was reasonably high for sweet potato even under traditional systems of production and farmers can derive substantial profit from their cultivation.

Table 2. Financial and economic returns from CGPRT crops in Bangladesh

Crop	Yield per hectare (kg)	Farm gate price (taka/kg)	Financial return per hectare (taka)		Economic return per hectare (taka)	
			Over full cost	Over variable cost	Over full cost	Over variable cost
Maize	5 738	6.77	13 535 (1.49)	18 591 (1.80)	9 709	14 765
Cheena	1 721	6.55	3 991 (1.55)	7 825 (2.69)	4 480	7 568
Kaon	1 525	6.95	3 415 (1.47)	6 409 (2.53)	4 478	7 472
Potato	26 966	5.12	56 011 (1.68)	71 008 (2.06)	56 118	71 115
Sweet potato	12 868	3.34	14 062 (1.51)	19 114 (1.86)	19 586	24 639
Lentil	932	24.55	4 901 (1.27)	13 284 (2.34)	5 648	14 031
Mung bean	1 189	23.75	9 445 (1.55)	15 641 (2.53)	11 248	17 444

Source: Field survey, 2004.
Note: Bracketed figures are benefit/cost ratios.

The impact of public policy regarding financial incentives for CGPRT crop production was examined by calculating the nominal protection coefficient (NPC), nominal rate of protection (NRP), effective protection coefficient (EPC), effective rate of protection (ERP) and domestic resource cost (DRC) for maize, millets, lentils and potato from the 1970s to 2001. Reference prices for each crop were based upon FOB world price at the port of an important exporting country of each commodity. These prices were brought to the import parity level assuming that imports compete with domestic production at the producer level.

NPC is the simplest indicator of price distortion, which is expressed as:

$$NPC = \frac{P_i^d}{\quad}$$

Here P_i^d is the domestic producer price of the commodity i and P_i^b is the border price of that commodity at import parity level. This was also measured in the form of NRP, which is denoted as $NRP_i = NPC_i - 1$. If NPC is greater than 1 and NRP is greater than 0, it indicates that the public sector is protecting domestic production. When NPC is less than 1 and NRP is less than 0, subsidizes are not paid to domestic producers. Data in Table 3 shows that NPCs are less than 1 and NPRs are negative for all the secondary crops. The level of protection declined further during the 1990s due to the withdrawal of input subsidies and output support as well as import liberalization.

Using Corden’s (1957) method, the effective protection coefficient (EPC) was calculated from the NPC. EPC includes prices of both outputs and tradable inputs. If EPC is less than 1, producers receive negative protection and they have comparative disadvantage on the world market. The study also measured this indicator in the form of effective rate of protection (ERP), which is expressed as $ERP_i = EPC_i – 1$ (Huda and Talukder, 2000). As Table 3 shows, EPC is below 1 and ERP is negative for all commodities during the entire period except for lentils, which was slightly above 1 during the 1980s. Thus, producers of secondary crops in Bangladesh have not been subsidized. Domestic production of maize and pulses may require substantial protection if the country wishes to curb imports of these commodities.

Table 3 also shows the domestic resource cost (DRC), which is an indicator of how efficient a country can produce a product with domestic factors. A country will increase production of a particular product if it can be produced domestically at a lower cost compared with importing the same good (Bruno, 1972).

When DRC is less than 1, it implies that a country has comparative advantage and will gain from producing more units of the product at home instead of importing it from other parts of the world. If the DRC exceeds 1, the opposite is true. The results show that Bangladesh has had comparative advantage in producing maize, millets, lentil and potato, as the DRC values are below 1 during the entire period. The value is positive for potato even at export parity level during the most recent years (Alam, 2005). Thus, Bangladesh has the potential for export promotion and import substitution through the diversification of the crop sector by promoting CGPRT crop production.

Table 3. Comparative advantage of producing CGPRT crops in Bangladesh

Crop/Year	NPC	NRP	EPC	ERP	DRC
Maize					
1970s	0.852	-0.148	0.986	-0.014	0.591
1980s	0.888	-0.112	0.940	-0.060	0.643
1990s and after	0.773	-0.227	0.802	-0.198	0.639
1974-2001	0.836	-0.164	0.90	-0.10	0.628
Millets					
1970s	0.960	-0.040	0.995	-0.005	0.590
1980s	0.860	-0.140	0.868	-0.132	0.526
1990s and after	0.600	-0.400	0.604	-0.396	0.491
1974-2001	0.783	-0.217	0.796	-0.204	0.529
Lentil					
1970s	0.642	-0.357	0.657	-0.343	0.629
1980s	1.018	0.018	1.035	0.035	0.835
1990s and after	0.650	-0.350	0.647	-0.353	0.615
1974-2001	0.784	-0.216	0.793	-0.207	0.700
Potato					
1970s	0.475	-0.525	0.470	-0.530	0.204
1980s	0.370	-0.630	0.354	-0.646	0.189
1990s and after	0.254	-0.746	0.232	-0.768	0.147
1974-2001	0.351	-0.649	0.226	-0.774	0.177

Source: Author's calculation.
Note: NRPs can be expressed in percentage terms.

Some CGPRT crops (potato, maize, sweet potato) utilize a higher number of man-days while others (mung bean, lentil, kaon, cheena) employ more family labour (Alam, 2005a). These crops also ensure employment for rural labourers throughout the year in the production process, industrial utilization and agribusiness. Many female workers are involved in the processing of CGPRT crops. Moreover, farmers produce a few common secondary crops, which protect soil health and the environment. In the study areas, average gross cropped area was found to be 1.37 hectares per farm of which 0.75 hectares (approximately 55 per cent) was cultivated with CGPRT crops that contributed 39.1 per cent of the total agricultural income (Table 4). The share of CGPRT crops in total household income was about 33.4 per cent and the results indicate that CGPRT crops contributed significantly to annual household income.

Table 4. Share of CGPRT crops in agricultural income and total household income in the study areas

Crops	Net return (Tk/ha)	Average income (Tk/farm)	Percentage of total agricultural income	Percentage of total income
Potato	89 476.50	14 316.24	28.71	24.48
Sweet potato	18 468.70	738.74	1.48	1.26
Maize	21 838.40	2 402.22	4.82	4.11
Lentil	7 368.52	663.16	1.33	1.13
Mung bean	12 843.00	642.15	1.29	1.10
Kaon	4 943.17	593.18	1.19	1.01
Cheena	3 082.03	154.10	0.31	0.26
All CGPRT crops	**n.a.**	**19 509.80**	**39.13**	**33.36**
Others	n.a.	30 348.20	60.87	66.64
Total agric. income (Tk)	n.a.	49 858	100.00	n.a.
Total income (Tk)	n.a.	58 478	n.a.	100.00

Source: Field survey, 2004.
Note: n.a. = not available.

A regression analysis was carried out to quantify the impact of diversified agricultural systems on household income. The regression model was specified as follows:

$Y = f(X_1, X_2, X_3, D)$

The relationship between household income and the relevant variables as specified was as follows:

$\ln Yi = \ln a + b_1 \ln x_{1i} + b_2 \ln x_{2i} + b_3 \ln x_{3i} + b_4 D + u_i$

Where, Y = Total annual income per household (taka)

a = Constant

X_1 = Family size (number of members)

X_2 = Area under CGPRT crops (hectares)

X_3 = Area under other crops (hectares)

D = Dummy variable (if there is income from off-farm sources D = 1, otherwise D = 0)

u_i = Error term

b1, b2, b3 and b_4 = Coefficients of each variable to be estimated

Results of the regression analysis are displayed in Table 5 and show that if the area under CGPRT crops was increased by 1 per cent, annual household income would rise by 0.3 per cent. The value of adjusted R squared was 0.89, which implies that the regression analysis from the collected data is reasonable.

Table 5. Regression results of household income

Parameter	Variable	Coefficient	t-value	Level of significance
Family size	X_1	0.09	0.98	Insignificant
Area under CGPRT crops	X_2	0.30	2.92	1% level
Area under other crops	X_3	0.38	3.45	1% level
Income from off-farm sources	D	0.22	4.20	1% level
Constant	a	6.03	22.66	-
Adjusted R squared	R^2		0.89	

Source: Author's calculation.

Trade liberalization and CGPRT crops

Bangladesh has liberalized its economy through reductions in tariff rates and the withdrawal of agricultural subsidies nationwide, but as a least developed country, has been exempt from reduction commitments. The un-weighted average tariff rate for all agricultural products declined from 55 per cent in 1991/92 to 15 per cent in 2002/03. Subsidies on irrigation and fertilizers declined from 2.5 per cent of the value of unassisted output in 1988/89 to 0.45 per cent in 2002/03. Moreover, agriculture exports are only partially subsidized. However, the impact of trade liberalization policies has not been beneficial to the agricultural economy of Bangladesh. Total agricultural exports have increased by about 2 per cent annually, while agricultural imports increased by 9 per cent per year during the 1990s. Imports of maize and pulses increased significantly over the same period. Furthermore, commercial imports of food grains grew and the magnitude of food aid dropped over the same period. Against this backdrop, more investment on yield increasing technologies and the adoption by farmers of improved technologies are necessary for the country to be self-sufficient in food and snacks. Also, protection and support are necessary for the domestic processing industries that prepare snacks from CGPRT crops, enabling them to compete on the global market.

Marketing and processing of CGPRT crops

The interviewed farmers generally sell their produce at the farm gate or rural assembly markets at a relatively low price. Over 80 per cent of major CGPRT crop products are marketed, while less than 20 per cent are kept for home consumption and seeds (Table 6). *Cheena* and *Kaon* are grown on poor soil under harsh conditions and very poor farmers grow these crops primarily for consumption. Less than half of the produce of these crops is sold at the market. They preserve seeds from their own produce in a traditional way. In the case of maize, farmers predominantly use hybrid seeds, which they purchase from NGOs, where the most important is the Bangladesh Rural Advancement Committee (BRAC). Only some local seeds are set aside for future planting.

Table 6. Disposal pattern of CGPRT crop products

Crop	Disposal pattern (percentage of total production)				
	Consume	Sale	Gift	Seed	Total
Maize	0.83	98.31	0.76	0.10	100.00
Cheena	48.80	44.96	1.17	5.07	100.00
Kaon	62.66	32.86	1.24	3.24	100.00
Lentil	8.96	78.40	1.17	11.47	100.00
Mung bean	6.29	87.07	0.66	5.98	100.00
Potato	2.67	89.41	1.60	6.32	100.00
Sweet potato	12.53	82.85	3.21	1.41	100.00

Source: Field survey, 2003.

Regarding marketing costs and the returns of CGPRT crops, intermediate traders incur direct costs for different activities and they also earn profit in the course of commodity transfers to the consumers. Thus, the total direct cost incurred and the net profit (net marketing margin) earned by transferring a commodity from the farmer to the consumer is the gross marketing margin. The rate of return on capital is calculated by dividing the net marketing margin (profit) by farm gate price plus the direct marketing costs (Alam, 1993).

Farm gate price, aggregated marketing cost and margin, as well as the consumer price of CGPRT crops were reported by Alam (2005). It was noticed that the grower's share of the consumer price was well above 60 per cent for maize, millets and pulses, while the share was relatively low for potatoes and sweet potatoes. These are perishable products and the traders earn high profit adding a risk premium. Cold storage systems for potatoes were found to be satisfactory but a post-harvesting system is yet to be developed for sweet potatoes. Farmers are likely to benefit from cost reduction in the marketing and margin of tubers. There are signs of inefficiencies in the commodity market for perishable CGPRT crops. The rate of return on capital was high for tubers (35 per cent for sweet potato and 27 per cent for potato) and low for pulses and coarse grains.

Consumption patterns of different CGPRT crops differ with differences in locality, caste and human culture. Table 7 presents information on food items prepared from CGPRT crops in Bangladesh. Potato and sweet potato are primarily used in the form of vegetables and also as ingredients of different casual food items. Maize is used mainly for making commercial poultry feed. Cheena and kaon are used as a substitute for rice and for making frumenty (hulled wheat boiled in milk and flavoured with sugar and spices). Pulses are traditionally used to prepare soup. In addition, different forms of cakes, fried and boiled food items, paste food, soups and hotchpotch are prepared from CGPRT crops in Bangladesh.

Table 7. Household level consumption patterns of CGPRT crops

Forms of consumption	Potato	Sweet potato	Maize	Lentil	Mung bean	Kaon	Cheena
Rice substitute						✓	✓
Payes (frumenty)						✓	✓
Cake						✓	
Moa (ball-shaped snack)						✓	
Chitoi pitha (a sort of cake)						✓	
Muthi pitha (a sort of cake)						✓	✓
Dal (soup)				✓	✓		
Boiled food items	✓	✓	✓				
Fried food items	✓	✓	✓	✓	✓		
Vegetables	✓	✓					
Bhorta (paste)	✓			✓			
Chuka (soup)	✓	✓					
Khichuri (hotchpotch)	✓	✓		✓	✓	✓	
Poultry feed			✓				

Source: Field survey, 2004.

Processing CGPRT crops is carried out using both traditional and mechanical devices. Kaon and cheena are processed mostly by traditional devices at the household level (Alam, 2005a). A small portion of lentil and mung bean are processed at home for home consumption as *dal* (soup). Maize was almost entirely sold to the wholesalers at the market and only an insignificant portion is processed at the household level for consumption as maize powder (*sato*) and dairy feed. Three traditional appliances are used to process these crops. The appliances include *Dhenki* or *Dheki, Gail-chia* and *Janta.* Utilizing these appliances for processing CPGRT crops is, however, very time consuming. It was observed that the traditional appliances, on average, husked 1.5 to 2.5 kg of pulses per hour depending on the type of pulses. While, in contrast, a 30-horse power motor-operated machine husked 200 to 250 kg of whole pulse per hour and an automatic husking mill processed 500 to 600 kg of whole pulse per hour (Elias *et al.,* 1986).

It was noted that the traditional processing of CGPRT crops was principally undertaken by poor women to augment their income and, hence, improve their livelihoods. The cost of processing of different CGPRT crops and their products were calculated at the household level. It was found that the cost of processing per quintal of mung bean and lentil were Taka 40.50 and Taka 42.00, respectively, while the cost for maize, kaon and cheena were Taka 35.25, Taka 36.75 and Taka 37.71, respectively. The processing costs were minimal due to the use of low-cost female labour and traditional equipment. The cost of processing almost doubled when using the mechanical devices (Taka 95 to 120 per quintal of pulse depending on the total quantity processed). The cost of mechanical processing is high due to the high installation and operation costs of machinery.

Marketing system of CGPRT products

Food processing is an important component of agribusiness in Bangladesh. Food processing involves the application of scientific principles to the preservation or modification of primary food products to standardize the products and make them more appealing as well as to ensure food safety.

The large processors selected produce a wide variety of CGPRT crop based processed food with varying specifications and product characteristics. A detailed list of items includes ring chips (potato), ball chips (potato), curl chips (potato), potato crackers (potato), Chanachur (lentil, chick pea), Dal (mung bean, chickpea), Machmacha (lentil, chick pea) and Alubhujia (gram floor). The large-scale processors distribute their products through a developed and organized marketing network. The channel can be depicted as follows:

Processor → Commission Agent → Wholesaler → *Bapari*/Retailer → Consumer

An attempt was made to profile small-scale food processing activities based on CGPRT crops. The profile includes Chanachur (pulses and groundnut mix), Fuska (boiled potato and chick pea within a crispy ball), Fried/puffed corn, Chatpati (cooked potatoes and pulses), cake made of kaon/cheena, boiled sweet potato, French fries, Halim (spicy soup of pulses with mutton), Zilapi (coil shaped sweet) and fried potato slices.

The marketing channel for CGPRT crop based products processed by small-scale processors is simple. In most cases, the owners of the small-scale processing plants sell their product directly to the end consumers. They purchase raw materials from different shops and after preparing/processing the light food items they sell their product directly to the consumer.

Market participants of the marketing channel of large-scale processed products include processors, commission agents, wholesalers and retailers. Marketing margins of different traders of the large-scale processing units for CGPRT products were reported by Alam (2005a). It revealed that processors' marketing margins ranged from 23.5 per cent to 43.8 per cent of the consumer price and were greater than all other participants in the marketing channel for the large-scale processed products. Processors received higher margins because of substantial investment over long periods with risks and uncertainties and they play a significant role in distributing the products to the different regions. It was also found that wholesalers received the lowest marketing margin among the participants ranging from 1.1 per cent to 8.4 per cent of the consumer price because the wholesaler's investment period is short and he deals with a large volume of products. Retailers receive higher margins than wholesalers but lower than the commission agents, which ranged from 3.3 per cent to 20.9 per cent of the consumer price.

Alam (2005a) reported the cost and revenue structure associated with the business of small-scale processors. It was observed from the samples of small CGPRT crop processors that their net annual profit ranged from Tk 4,500 for millet cake to Tk 153,408 from Fuchka/Chotpoti production (Table 8). Per unit cost revenue and business profitability of small-scale processors were also analysed. The results show that their profits, as measured as per cent of each product's sell price, vary from 14.5 per cent for puffed corn to 72.5 per cent for potato flakes.

Table 8. Annual profits of processors and their profit as a share of unit price

Product	Annual profit (Tk)	Profit as percentage share of each product's sell price (%)
Sweet potato	7 900	35.9
Millet cake	4 500	43.0
Fuchka/Chotpoti	153 408	42.6
Chanachur mix	21 170	37.7
Jilapi	133 288	28.6
French fries	63 690	39.8
Puffed corn	27 500	14.5
Fried maize	15 050	30.2
Potato flakes	58 050	72.5

Source: Field survey, 2004.

The study showed that fried pulses generate a higher rate of profit for large-scale processors, while products made from potato, millet and sweet potato generate higher profits for small-scale processors.

An interesting aspect of agri-businesses utilizing CGPRT crops is the creation of employment opportunities for the poor. It was observed that thousands of men and women are engaged in processing, packaging and marketing of low-cost CGPRT products.

Income elasticities and demand for CGPRT crops

Using Household Expenditure Survey data from 2000, the present study estimated income elasticity of demand for products originating from CGPRT crops. Overall income elasticity of demand for such products was less than 1, in some cases it was very low, and in one case it was even negative. The estimates of income elasticity of demand for pulses and tubers were 0.42 and 0.23 respectively and the estimate for maize, barley and millets together was 0.62. The elasticities were high for lentils and mung bean, 0.89 and 0.98 respectively, while only 0.04 for gram and -0.26 for lathyrus (Table 9).

Table 9. Income elasticities of demand for CGPRT crops and required growth rates in production to satisfy domestic demand

Crop	Income elasticities		Required growth rate (%)		Recent growth rates (%)
	2000 (Actual)	2010 (Projected)	2001-2005	2006-2010	
All cereals	0.08	0.04	1.68	1.46	2.70
Rice	0.04	0.02	1.41	1.38	3.63
Wheat	0.71	0.35	3.88	2.70	5.65
Other cereals (maize and millets)	0.62	0.65	3.57	3.65	-0.93
All pulses	0.42	0.31	2.87	2.54	-3.72
Lentil	0.89	0.72	4.51	4.18	-3.04
Lathyrus	-0.26	0.01	0.49	1.34	-1.99
Gram	0.04	0.04	1.41	1.46	-17.41
Mung bean	0.93	0.75	4.65	4.30	0.84
Other pulses	0.15	0.11	1.93	1.74	-0.57
Tubers	0.23	0.15	2.21	1.90	7.63

Source: Author's calculation.

Note: Assuming that the population will grow at 1.4 per cent and per capita income will increase at 3.5 per cent in 2000-2005. For the next 5 years the population growth rate will slightly fall to 1.3 per cent, while per capita income is projected to increase by 4 per cent annually.

The elasticities are quite low for cereals. With the achievement of self-sufficiency in rice production in recent years, the elasticities for rice and wheat have declined and are expected to decline further until 2010. Conversely, the elasticities of other cereals, such as maize and millets are likely to increase slightly due to developments in the livestock and food processing industries in the country. Projections for the year 2010 show that the required growth rate in production of maize and millets to meet domestic demand is estimated at 3.7 per cent, which is the highest among cereals. Recent growth for maize has been quite impressive, but very low for millets.

Income elasticity of demand for pulses has declined from 0.6 in 1995/96 to 0.4 in 2000, which is predicted to decline further to 0.3 in 2010. With higher income, it is expected that people will prefer to consume more fish and livestock products to satisfy their protein requirements. As a result, the demand for lentil, mung bean and other pulses are likely to decline. However, the income elasticity of demand for lathyrus will increase due to its increasing use as feed. Thus, if domestic production should meet the increasing demand, the annual growth rate in production of each type of pulse will have to be maintained at between 1.3 per cent and 4.3 per cent, parallel to, or well above the population growth rate. Recently, production of almost all pulses has been experiencing negative growth.

The elasticity of roots and tubers has declined from 0.41 in 1995/96 to 0.23 in 2000 and is likely to decline further to 0.15 in 2010. The growth rate of roots and tubers is estimated at 1.9 per cent, which is substantially lower than the recent growth rate of 7.6 per cent.

Special promotional and incentive schemes are necessary to increase the production of pulses and millets, as the current growth rates for these products are well below estimated growth rates.

The rural economy of Bangladesh is characterized by an abundant supply of labour engaged in agriculture. Agricultural commodities are grown throughout the year with a seasonal surplus for several commodities. Agro-processing gives an opportunity to prevent post-harvest losses, create value-added products, generate employment, enhance farmer’s income and, hence, reduce the magnitude of poverty. Moreover, agro-processing could have considerable postive impacts on the female labour surplus.

As the country’s economy grows and urbanization accelerates, there is an increasing trend towards the consumption of foods that require more advanced agro-industrial systems. In the major towns and cities the emergence of a complex agri-food distribution systems including supermarkets is already visible. There is a strong realization for expansion of the agro-processing sector both at the entrepreneurial and policy levels. The Government of Bangladesh has provided incentives for agro-processing businesses and the establishment of agro-based labour-intensive industries in the country. However, people remain unaware of many agro-processing techniques and the linkages among production, processing and marketing of CGPRT crops, are still weak. Thus, the opportunities for growth in production, processing and utilization are only marginally realized.

Agricultural diversification and poverty alleviation

Bangladesh is a very poor country with GNI per capita (gross national income) of USD 440 and life expectancy at birth is 63 years (World Bank, 2006). Many poor people are unable to consume sufficient food, but CGPRT crop products are less expensive than other major food items and even the poorest of the rural poor have access to coarse grains, pulses and tubers. Thus, these crops play a vital role in lessening the burden of poverty and malnutrition in rural Bangladesh.

The incidence of poverty is alarming in rural Bangladesh, although a significant improvement has been made in recent years. Based on household expenditure surveys estimates show that the head count ratio of poverty in 1991-1992 was 58.8 per cent, while in 2000 people living in absolute poverty was reduced to 49.8 per cent (Table 10). Similarly, the extreme poverty rate declined from 42.7 per cent to 33.7 per cent over the same period. The improvement can be explained by a significant increase in domestic food-grain production and increases in per capita income that enhanced the purchasing power of poor people during the last decade. Nonetheless, the incidence of poverty is still very severe in Bangladesh. Trends in poverty gap and squared poverty gap measures suggest that a greater share of poor people are now closer to the poverty line than were at the beginning of the decade.

Table 10. Trends in magnitude of poverty (cost of basic needs (CBN) method)

	Upper Poverty Line (Absolute Poverty)			Lower Poverty Line (Extreme Poverty)		
	1991-1992	1995-1996	2000	1991-1992	1995-1996	2000
Head count ratio						
National	58.8	51.0	49.8	42.7	34.4	33.7
Urban	44.9	29.4	36.6	23.3	13.7	19.1
Rural	61.2	55.2	53.0	46.0	38.5	37.4
Poverty gap						
National	17.2	13.3	12.9	10.7	7.6	7.3
Urban	12.0	7.2	9.5	4.9	2.6	3.8
Rural	18.1	14.5	13.8	11.7	8.6	8.2
Squared poverty gap						
National	6.8	5.4	4.5	3.9	2.5	2.3
Urban	4.4	3.4	3.4	1.5	0.7	1.2
Rural	7.2	5.7	4.8	4.3	2.8	2.6

Source: Household Expenditure Surveys, 1991-1992; 1995-1996; 2000.

Note: The lower poverty line incorporates a minimal allowance for non-food goods, while the upper poverty line makes a more generous allowance.

The magnitude of poverty in Bangladesh has been declining at a very slow rate. An important reason is the slow growth rate of the rural economy, due to a steady decline in public expenditure on agriculture during the 1980s and the 1990s. The share of agriculture in total development expenditure declined from about 31 per cent in the early 1970s to less than 10 per cent in the first few years of the new millennium. Public expenditure on agricultural research accounts for only approximately 0.2 per cent of agricultural GDP. The premature shift of resources from agriculture to other sectors created a dampening effect on the rural farm and non-farm economies. In view of achieving the Millennium Development Goal (reducing the magnitude of poverty by 50 per cent by 2015), there is a need to redirect public policies and increase agricultural investment.

Poverty alleviation is the over-riding objective of the Fifth Five Year Plan of Bangladesh (GOB, 1998). The government has recently prepared a poverty reduction strategy paper in which priority is given to developing rural areas where most of the poor people reside. It has been envisaged that rapid agricultural growth will help sustain overall economic growth with better capacity to reduce unemployment and poverty (GOB, 2003). The expansion of CGPRT crops will promote diversification of the rural economy, raise income and wages, as well as provide cheap food to improve the nutritional status and food security of the people. Thus, growth in the production of minor cereals, pulses and tubers has the potential to reduce poverty.

CGPRT crops are cultivated by relatively poor farmers who have small-sized farms (Alam, 2005; 2005a). They cultivate these crops on poor soil under harsh conditions. As these crops require less inputs and less intercultural operations, CGPRT crops are suitable for resource poor farmers. However, as the area under irrigation and fine HYV (high yielding varieties) is expanding, CGPRT crops have shifted to even more marginal lands. Results of this study show, however, that the economic returns of these crops are still attractive and farmers can earn more money with less investment by producing CGPRT crops.

Although the consumption of CGPRT crop products is primarily associated with poverty, they have an important nutritional significance. For example, maize has higher nutritional value than rice in terms of protein, fat and minerals. Similarly, millets have higher value in terms of protein, fat, minerals and fiber content than that of rice. Pulses contains about twice as much protein as cereals. Pulses also contain amino acid lysine, which is generally insufficient in food grains. Thus, the consumption of CGPRT products can help reduce the magnitude of malnutrition in the country.

In order to meet demand from the increasing number of livestock and their higher productivity, feed resources have to be augmented. Pulses and coarse grains play a vital role in providing fodder for farm animals. After de-husking pulses and coarse grains, the bran is also used as a quality feed for animals. Thus, increased production of CGPRT crops can play a vital role in providing balanced nutrition to livestock and poultry to ensure higher productivity.

Bangladesh has the constitutional responsibility to meet the basic needs of all people in the country. The government plans to ensure the provision of basic needs to every citizen within the shortest possible time. For that purpose a pro-poor growth strategy has been emphasized. Promotion of CGPRT crops will help considerably to achieve this objective. This will require higher investment and technological advancement in the CGPRT crop sector, which is still lacking in the country. Currently, the share of CGPRT crops in the crop sector's total research budget is only about 2 per cent in contrast to their share of 6 per cent of the total cropped area.

Concluding remarks and policy recommendations

This study was conducted in some selected areas of Bangladesh to examine the possibilities of alleviating poverty by promoting diverse agriculture and agri-businesses with secondary crops. The crops under study included coarse grains (CG), namely maize, kaon (foxtail millet; *citeria italica*) and cheena (proso millet; *penicum miliceum L*.); pulses (P), namely lentil and mung bean; and roots and tubers (RT), namely potato and sweet potato. Thus, seven CGPRT crops have substantial potential for poverty alleviation through crop sector diversification, agri-business promotion, employment creation, income generation and reducing malnutrition. These crops are profitable and have comparative advantage in production. The demand for several CGPRT crops is expected to rise due to urbanization and increases in per capita income, and the scope of industrial uses of these crops is high in the country.

A higher growth rate in the CGPRT crop sector will promote growth in the non-farm sector through an increase in processing activities and agribusiness. Access to non-farm income is critical for poor people in raising their household income. The productivity growth in the non-farm sector requires improved technology, marketing support, investment in infrastructure and access to credit. A concerted effort is necessary to ensure these facilities for the alleviation of poverty in the country.

Crop sector diversification through the promotion of secondary crops has, however, been promoted very slowly in Bangladesh over the last three decades. Due to the expansion of irrigation facilities, farmers have paid more attention to growing rice and wheat for food security. Minor cereals, pulses and tuber crops, therefore, received less farmer attention although such crops are profitable. It is also simpler and less costly to diversify cropping systems through CGPRT crops, thus agricultural extension workers need to promote these crops.

Low yield is an important reason for farmers' reluctance to grow CGPRT crops and therefore, more resources for CGPRT research must be allocated to improve the varieties and farming practices. Moreover, CGPRT crops are principally grown in specific areas under harsh conditions. Therefore, area-based farmers' groups should be developed to enhance production, marketing and utilization of CGPRT crops. Institutional arrangements should be made to establish sufficient linkages between production, processing and marketing in rural areas.

The demand for secondary crops can be increased through processing, added value and product diversification. To meet this higher demand with domestic production, the agro-processing sector has to be specifically supported and protected from external competition. Thus, it is recommended that export subsidies for CGPRT and import duties on snacks made from secondary crops, be imposed.

The large-scale industries in Bangladesh need to process CGPRT crops at low cost and also need to improve the quality of the products. This will enhance their competitiveness in the domestic as well as the global market. Currently, a number of different snacks, which are becoming popular, are imported from various countries to Bangladesh. Through food standardization, product development and import duty on snacks made from CGPRT crops, domestic production can be stimulated.

The small-scale processing firms are not organized. In order to improve their efficiency and to gain consumers trust, they should form co-operatives and undertake regular authorized inspections to certify their products are safe and of high quality.

Research for the generation of new techniques of processing, preservation and product diversification is an important condition for the sustainable development of the agro-processing sector. The establishment of a new institute for research on agro-processing within the National Agricultural Research System may be required in the near future, which could be established within the Ministry of Agriculture.

Some neighbouring countries have long experience in processing CGPRT crops and preparing snack foods. Through an attractive incentive package these countries should be invited to Bangladesh to establish joint-venture industries.

An accelerated poverty reduction strategy for Bangladesh should focus on pro-poor growth. Priority areas for intervention include farm and off-farm economic activities, small and medium manufacturing enterprises, development of infrastructure, skills training and awareness building. The rural growth strategy would be driven by crop diversification, non-crop agricultural expansion and enhanced non-farm activities and livelihoods. CGPRT crops can play a vital role in each area creating employment and income opportunities for poor people and reducing the burden of poverty in rural areas.

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Ignored Local Dynamics

As Part II’s title “Ignored Local Dynamics” indicates, this set of six cases provides concrete, root-based evidence that secondary crops can genuinely contribute to enhance the living conditions of rural poor populations. They take us on a journey across Asia and the Pacific from Lao People’s Democratic Republic to Papua New Guinea.

Linkham Douangsavanh explains first how “Job's Tear Reduces Poverty in Mountains Areas of Lao People’s Democratic Republic”, using the case of Thapho village in the Luang Prabang province. There, job’s tear is planted after upland rice within a typical shifting cultivation system. Job’s tear is well suited to the ecosystem and provides poor farmers with work opportunities, thus improving income distribution in the village. The author advocates for further attention to derive more benefits from this crop to resource poor farmers.

In the other poor and landlocked country included in this research, H.K. Shrestha, M. Joshi follow a similar line to demonstrate that “Finger Millet Generates Income in Nepal”. Finger millet is grown in the Nepalese hills were harsh socio-economic and agroecological conditions prevail. There, an IFAD project introducing high-yielding disease resistant varieties (HYDRV) and related husbandry and processing technologies contributed to significantly improve the situation of the local population, including that of female farmers through reducing the physical burden of finger millet processing and opening to them additional income opportunities thanks to innovative and different value-added products.

Then, Jesse Anjen, Norah Omot and Raghunath Ghodake tell us that a “New Yam Variety Paves the Road to Prosperity in Papua New Guinea”. Their work on the introduction of an improved yam species in the Markham valley indicates substantial adoption and significant increases in planted area, productivity and production in two places, one with poor access and hillside farming (Intoap) and one more accessible, located on the plains (Mampin) As a result the authors state that the level of nutrients available for human consumption has risen by more than 100 per cent per hectare of cultivated area.

Nareenat Roonnapai, in “A Women’s Group Adds Value to Local Soybean in Thailand”, advocates local processing of locally cultivated products. According to Ms. Roonnapai, the local availability of soybean, by keeping processing costs to a minimum, enabled the Ruamjai Housewife Group in Sukhothai province to develop their processing industry to produce Chinese fermented soybean sauce. With support from the public sector and good governance principles this activity has led to the generation of added valued and more income gains for farm families.

“Maize Development Improves the Livelihood of the Poor in Viet Nam” argues Dao The Anh, showing that maize can become a vector of prosperity while answering the growing feed requirement of the swine industry. In the province of Son La, located in a remote area with a high rate of poverty, his study of the commodity chain documents a sequence starting with technological development that changed the Vietnamese maize industry by expanding cultivation areas, boosting productivity and consecutively contributing to change living standards and traditions in many areas, especially in areas of minority groups.

Part II ends on a more regional note with Keith Fuglie’s analysis of “The Impact of Potato and Sweet Potato on Poverty in Asia”. Mr. Fuglie uses quantitative and qualitative methods to assess the economic and poverty impacts of potato and sweet potato technologies, such as improved varieties, higher quality seeds, pest and disease management, and improved post-harvest utilization, reviewing evidence from a number of case studies. His conclusions show which improved potato and sweet potato technologies in Asia have had a significant impact on poverty reduction and a high rate of return on investment.

Job's Tear Reduces Poverty in Mountainous Areas of Lao People's Democratic Republic

Linkham Douangsavanh[*]

Abstract

Lao People's Democratic Republic is a mountainous country. Most of the hills and mountains are located in the northern part of the country where shifting cultivation is the predominant farming system. For the government of Lao People's Democratic Republic, rural development is central to national development; over 50 per cent of GDP is generated by the agricultural sector. Not only is agriculture the key sector of Lao's economy but most of the rural population is subsistence by nature. The objective of this paper is to investigate the history of production, marketing, consumption and policies related to Job's tear production in Luang Prabang province. Job's tear is one of the many important crops that people plant after upland rice. This study focuses on one specific area; Thapho village. In this study three methods are used to obtain information, namely: (i) collecting primary data using the RRA method; (ii) in-depth interviews; and (iii) personal observation (together with farmers and district officers). The lessons learnt from the study are that in the short term, villagers are working and the distribution of income in the village is improving, while the long-term impact is economic development and poverty reduction in the area. The study also outlines public policies for more effective rural poverty alleviation, which include developing farmer groups, developing extension services, improving the quality of Job's tear to meet market demand, building collaboration between related sectors at the district level (especially the District Agriculture office and District Trade), increasing Job's tear international competitiveness by improving efficiency and reducing production costs, enhancing research and development programmes, and also training extension workers.

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Introduction

Lao People's Democratic Republic is a mountainous country where shifting cultivation is the major farming system. Slash and burn is practiced in most parts of Lao People's Democratic Republic, but it is particularly dominant in the north. The practice is the primary cause of deforestation and the country's forest area has decreased from 12.7 million hectares in 1973 to 11.2 million hectares in 1989, and is currently about 10.2 million hectares, which is approximately 43.4 per cent of the total land area. Upland rice yields vary from 1.0 to 1.7 tons per hectare (Xenxua, 2004).

In Lao People's Democratic Republic, agriculture is the most important sector and the majority of the rural population are subsistence farmers. More than 50 per cent of Gross Domestic Product (GDP) is generated by the agricultural sector and the 1998/99 agricultural census recorded that 84 per cent of households are engaged in agriculture (Lao People's Democratic Republic, 2000). Moreover, the Fifth National Development Plan (2001-2005) emphasizes that rice is the country's most important crop (MAF and JICA, 2001) and restate its commitment to a national development strategy that prioritizes in agricultural production.

Shifting cultivation is one of the most important agricultural systems in Luang Prabang province, and there are several factors that influence production, such as; ethnicity, population pressure, land availability, soils and topography, food preferences, market access, and policies (Socio-economic and Land Management Research Components, 2002).

Upland farmers in Luang Prabang province plant Job's tear (*Coix lachryma-jobi L.*) primarily to market, but also, especially in northern rural upland areas, as an additional food source during food shortages. Job's tear used to be a valuable cash crop in Luang Prabang five or six years ago due to high demand from other countries, in particular Thailand. The demand has since fallen due to poor crop quality and variable prices. In Phonxay district, Job's tear is produced, but because of poor soil fertility and unfavourable geographic conditions the popularity of the crop is lower than in other districts of Luang Prabang province. However, the majority of the farmers are still willing to plant Job's tear.

The objective of this paper is to analyse the production, marketing, consumption and policies related to the production of Job's tear in Luang Prabang province. Job's tear is one of many important crops that farmers produce after upland rice. This study, which is an initial study, focuses on one specific area, namely Thapho village. Thapho is one of the many villages in Luang Prabang that has been selected through the provincial authorities' strive for forest protection. Data was mostly collected at the village and field levels through interviews. In addition, some data was gathered from the District Agriculture and Forestry Office (DAFO) and an export company in Luang Prabang city.

The study was conducted in three steps. First, primary data was collected using the rapid rural appraisal (RRA) technique. In the second step, in-depth interviews with key people were conducted, a focus group discussion was held and consultations took place with stakeholders, consisting of farmers' groups, heads of the village, elderly people and district officials. In the final step, the collected data was analysed, including statistical analysis, using Microsoft Excel.

Job's tear production in Luang Prabang province; a case study of Thapho village

Thapho village in Phonxay district is located approximately 60 km northeast of Luang Prabang city. Most people in the village are engaged in agriculture especially shifting cultivation. Profit from agriculture is very low, particularly for rice production. Nonetheless, rice is the most common crop in the area. In recent years, however, farmers have discovered upland crops like Job's tear and sesame to substitute rice that have the potential to generate higher profits even though the marketing remains weak.

Phonxay district is located in the north part of Luang Prabang province with a total area of approximately 2,000 sq km, bordering Pakxaeng to the north, Phoukhoun district to the south, Viengthong district of Hoaphan province and Phoukoud district of Xiengkhaung province to the northeast and to the west with Luang Prabang and Xiengnguen district with total area of 65,469 hectares.

Phonxay district is considered a poor district of Lao People's Democratic Republic. The majority of people are engaged in upland farming and the district does not offer many off-farm opportunities. As the upland shifting cultivation is rain fed, the farmers have sufficient food during years with good rains. In the district there are 203 households with paddy fields, 156 households with both small paddy fields and larger upland fields, 3,351 households practicing shifting cultivation, 59 households earning incomes from off-farm activities and services and 108 households are selling labour. There are 779 better-off households and 3,097 poor households. The standard of living is low, especially the people living in remote areas (Douangsavanh, 2004).

Phonxay district is a target district of the Government of Lao (GoL) for development and poverty reduction. Many projects funded by the GoL and non-governmental organizations (NGO) in Phonxay district support crucial infrastructure such as the construction of a road from the main road in Luang Prabang in 1999; a health centre; post office; schools; as well as agricultural research and extension. For farmers, the road is essential as it enables them to take their agriculture products to sell in towns like Luang Prabang city. There are a number of companies in the city, for example Vilaykoon, an export/import company that buys agricultural products from the farmers in Luang Prabang province to sell at the local markets and for export to Thailand and China.

Most farmers in Thapho village cultivate rice and Job's tear, while only a few cultivate maize and sesame. The main source of income, after crop production, comes from non-timber forest products (NTFP). Animal husbandry, selling labour, weaving and trading following the harvest are other sources of income in Thapho.

Thapho village has two main ethnic groups, Laolum and Khamoo. The Laolum group is slightly larger representing 53 per cent or 35 households, while Khamoo comprises of 31 households. The total population is 352. As Table 1 shows, the Khamoo people have larger families with almost six members compared to Laolum with less than five.

Table 1. Demographic profile of Thapho village

Description	Khamoo			Laolum			All
	Male	Female	All	Male	Female	All	
Number of households			31			35	66
Population	94	89	183	91	78	169	352
Average household size	3.03	2.87	5.90	2.60	2.23	4.83	5.33

Sources: Village head man of Thapho village, January, 2005.

An analysis of Job's tear farming in Thapho

The farming system used by the Laolum people is characterized by subsistence crop agriculture with extensive management and diversification as well as low quantities of inputs. Livestock, fisheries and home gardening are integral parts of the system. Labour is divided among many activities, with paddy production as the only activity receiving intensive labour. All other activities are managed when time is available. Intensive farming and cash cropping are primarily found in well irrigated areas where credit assistance and marketing activities are well developed. Laolum people engage in upland shifting agriculture practices due to land scarcity on the plains and declining rice production due to climatic unreliability over the last 15 years. However, their upland plots are often poorly managed leading to soil exhaustion, as shifting cultivation is not a traditional Laolum practice.

The Khamoo practice extensively managed and low-input subsistence farming, which is paddy dominated with less diversification than the Laolum, especially in animal husbandry and fruit production. Khamoo are sedentary and cultivate large areas in a more or less stable rotation cycle using only family labour, land and simple tools as inputs. The farm plots, whether cultivated or left fallow, are well known and are held by family, with usufruct and inheritary rights. The total area is contingent on family size and plots cannot be sold after they have become obsolete, as the ultimate right of ownership is vested in the community as a whole. Thus, the size and actual boundary of the agricultural area controlled by each family is an integral part of the Khamoo's social organization. The system is honored by everyone involved, while outsiders often appear to be unaware of these customary rights, or unwilling to recognize them, which is a source of conflict. On the other hand, increasing population pressure, due to births and migration, in many regions have forced the farmers to shorten traditional fallow periods, which in many cases seriously jeopardizes the sustainability of the Khamoo's agricultural production system (IFAD, 1990).

Thapho village, being one of the poorest villages in Phosay district, consists of steep hills and a valley with little flat land so paddy fields are mostly small pieces of land along the river. The total area of paddy fields in Thapho is only 4.45 hectares, while total upland area in 2004 was recorded as 76.5 hectares. The average upland area per household is 1.15 hectares distributed over two to three plots. Farmers often cultivate rice in upland areas but due to a rise in population pressure and poor soil quality, farmers substitute rice with other crops such as Job's tear and sesame. Gardens are common and used for many different purposes for example teak, maize, Job's tear, sesame and cabbage. Total garden area is 35 hectares.

Sixteen households, eight from the Khamoo and eight from the Laolum people, where randomly selected for the case study. Together these household total 19 hectares of upland area. As Table 2 shows, Job's tear is the most common upland crop and is cultivated on more than double the amount of land compared to rice. The results indicate that Laolum plant more Job's tear than Khamoo. Job's tear used to be the main source of income in the village. Laolum households own more land than Khamoo households, which is because the Khamoo people immigrated to the area more recently. Due to insufficient agricultural land the Khamoo people often have to sell labour.

Table 2. Farm products in Thapho village

Crop	Area (hectares)	Ethnicity	
		Khamoo (hectare)	Laolum (hectare)
Job's tear	12.5	4	8.5
Rice	5.5	3.6	1.9
Sesame	1	0.6	0.4
Total	19	8.2	10.8

Source: Survey January, 2005.

Buffalo, cattle, goat, pig and poultry are the most common domestic animals in the village. On average, each household in Thapho village has 1.06 cattle, 0.68 pigs, 1.28 goats and 14.39 poultry. There are five buffalos in the village.

Environmental problems are the main constraint to agricultural production. The land used to be covered by large trees and the soil had plenty of nutrition so agriculture was not a problem. However, after the rise in population and expansion of shifting cultivation, soil erosion is common and crop production has suffered.

Benefits of Job's tear farming for poverty alleviation

Rice is produced for household consumption while the main income stems from Job's tear. Middlemen from a village nearby buy the agricultural products. Depending on the quality, the price for Job's tear is 900-1,000 kip/kg, while sesame is 6,000 kip/kg. The sample households cultivate 0.5-1.8 hectares of Job's tear, while sesame is about 0.1-0.5 hectares. Average household annual income per capita is 1,035,400 kip from selling Job's tear and sesame. Table 3 shows a detailed description of production and crops sold in Thapho.

According to a group interview in the village, generally, the income of Thapho village residents mostly originates from agricultural products, especially from upland crops, such as Job's tear, sesame and others. Animal husbandry also generates some income though very little for most households. Gathering NTFPs and selling labour seem to be important for the poorer households. During a group interview farmers were asked to rank, from one to four, their activities in terms of importance. The most important crop is Job's tear, NTFPs and sesame are ranked second, and selling labour is the third, while the fourth most important is trading such as shopkeeper.

Table 3. Farm products for consumption and for sale

No.	Ethnicity	Parcel	Crop	Area (ha)	Yield (kg/ha)	Consume (kg)	Sell (kg)	Price (kip/kg)	Sold to:
1	Khamoo	1	Rice	0.5	1 200	600			
2	Khamoo	2	Job's tear	1	3 500		3 500	1 000	Middleman from nearby village
3	Khamoo	3	Sesame	0.5	200		100	6 000	Middleman from nearby village
4	Khamoo	1	Rice	0.45	1 800	810			
5	Khamoo	1	Job's tear	0.35	600		210	900	Middleman from nearby village
6	Laolum	1	Rice	0.4	300	120			
7	Laolum	1	Job's tear	1.1	3 500		3 850	900	
8	Khamoo	1	Rice	0.6	1 050	630			
9	Khamoo	1	Job's tear	0.3	1 100		330	900	Middleman from nearby village
10	Khamoo	1	Job's tear	1	400		400	1 000	Middleman from nearby village
11	Laolum	1	Job's tear	2.5	1 600		4 000	1 000	Middleman from nearby village
12	Laolum	2	Job's tear	1.8	1 200		2 160	1 000	Middleman from nearby village
13	Laolum	1	Rice	0.1	120	12			
14	Laolum	1	Job's tear	1.4	900		1 260	900	Middleman from nearby village
15	Laolum	1	Rice	0.6	900	540			
16	Laolum	1	Job's tear	0.4	375		150	900	Middleman from nearby village
17	Khamoo	1	Rice	0.4	1 050	420			
18	Khamoo	1	Job's tear	0.6	1 500		900	900	Middleman from nearby village
19	Laolum	1	Rice	0.8	1 650	1320			
20	Laolum	1	Job's tear	0.2	900		180	900	Middleman from nearby village
21	Laolum	2	Job's tear	0.6	875		525	900	Middleman from nearby village
22	Khamoo	1	Job's tear	0.3	800		240	900	Middleman from nearby village
23	Khamoo	1	Rice	0.3	600	180			
24	Laolum		Sesame	0.4	60		24	6 000	

Source: Survey January, 2005, by Socio-Economic Research Section, NAFRI.

The households' main activities are on-farm activities. In addition, some households participate in off-farm work such as construction away from the village or work in the garment industry in the city. A few land owners sublease their land or hire workers to undertake the farm work, while being engaged in other businesses such as small shops.

Job's tear production generates both on-farm and off-farm activities. The production creates jobs for villagers who improve their knowledge and skills. Although the farmers receive low income, they can boost their livelihoods with a better standard of living.

Laolum has gained more benefits from Job's tear than the Khamoo according to land holdings and cultivation conditions. Provincial authorities had planned to invest in improving the market system channel that aims to raise the price of products in terms of increasing the quantity and quality of products.

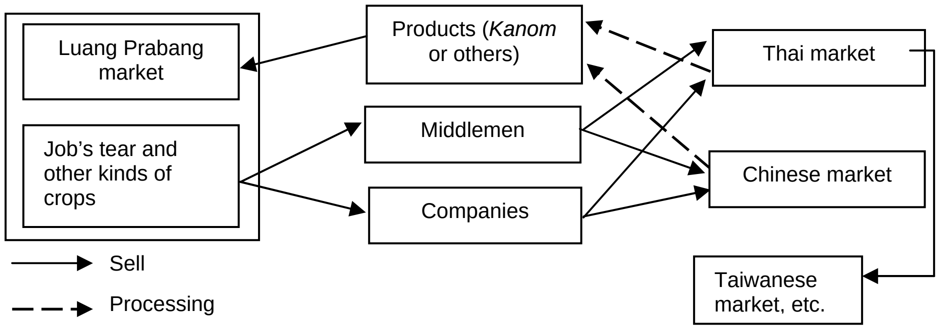
Trends in domestic and international markets for Job's tear

Job's tear is sold directly after harvest to middlemen and transported to private companies in Luang Prabang city, for example Vilaykoon and Phet Lama, for export to Thailand and China. Five years ago, when the market for Job's tear was good, most companies did not own machines to dry the crops, therefore importers in Thailand and elsewhere could control the prices. Some companies in Luang Prabang have now invested in drying equipment to strengthen their negotiation position. However, as the demand has dropped due to poor quality and limited post-harvest technology, their negotiation position remains weak.

Phonxay marketplace is a street market or block of shops along a road through the town centre, where villagers from the outlying areas bring their livestock, NTFPs and agricultural products to sell. In addition to the street market, there are three sub-district markets: Sopchia, which is a major permanent market for NTFPs; Huadong, near Jomtien, is a ten-day market, attended mainly by the Hmong people; and Nambo also a ten-day market on the main road from Luang Prabang, close to the Phonxay district.

Almost all Job's tear is sold in Luang Prabang and exported to Thailand and China for processing. Kanom is a kind of sweet that is made from Job's tear and coconut. Kanom and other kinds of processed products are imported and sold in Luang Prabang at a value-added price. This is shown in Figure 1.

Figure 1. Marketing system



Source: Field survey in Luang Prabang, 2001.

According to the Commerce Department in Luang Prabang, the provincial supply of Job's tear is more than sufficient to meet export demand, but the quality is low. Therefore, the processing of seedlings, drying and packaging, among others, must be improved. Furthermore, instead of exporting unprocessed crops, the country would profit by investing in processing Job's tear.

Domestic consumption of Job's tear is low even though no exact figures can be presented as no national statistics of the production of Job's tear exist.

Lessons learned

The case study has been an initiative step to discover more about Job's tear, mainly in Phonxay district. As time and budget are limited, the data collected provides only an overall view about the potential of Job's tear. Job's tear in Luang Prabang is primarily a cash crop. However, around Lao People's Democratic Republic Job's tear is also an important supplementary crop during food shortages, and the crop is also popular for making sweets.

Thailand and other countries have reduced their imports of Job's tear from Lao People's Democratic Republic because of low quality. As Luang Prabang province mainly exports to Thailand, it is vital to improve the quality of the production. The GoL, the private sector and villagers have comprehensive understanding regarding the problems of the production process, transportation and marketing, from production to consumption. To facilitate the development of Job's tear in villages such as Thapho, an agricultural extension service must be offered, with recommendations and information about the entire production chain, from land preparation to storage and transportation of the produce.

Potentials and constraints

Job's tear is a very suitable crop in Thapho due to the hilly area and low soil fertility that is found in most places. The crop requires little attention with weeding only performed once or twice during the growing season. In addition, the crop provides income even though the prices are much lower now compared with five years ago. However, the farmers are still willing to plant Job's tear.

Potentials

- Farmers have comprehensive understanding about the benefits of Job's tear production and they understand the current problems and how production can improve;
- The border between Viengkham district in Luang Prabang and Viet Nam could be opened to facilitate trade;
- The province has plans to expand market facilities, more specifically buildings and infrastructure in each district; and
- There is a provincial plan to build a supermarket in Luang Prabang, financed by the Chinese Government.

Constraints

- Narrow market;
- Low product prices;
- Lack of labour, mostly only family labour available;
- Low adoption of modern techniques in growing Job's tear; and
- Inadequate post-harvest technology for Job's tear.

Public policies affecting Job's tear farming and the processing industry

Currently, most domestic agricultural policies focus on rice and other major crops, therefore policies for Job's tear production and the processing industry are very limited. In this section, suggestions for policy implementations to promote Job's tear development are provided.

Associated organizations participate in market and price policy discussions. However, no price support programmes for Job's tear have been implemented and therefore, collaboration between related sectors; banks, the industry and agricultural extension services have to be supported. Furthermore, a focal point should be established to assist with contacts and interactions between various sources of credits. Examples of funds and credits include the village fund, individual funds, community funds, loans, government funds and international funds. These funds must include an infrastructure and technology development component. Furthermore, the funds must be transparent in their policy and technical design.

Active relationships should be facilitated between farmers and the processing and service industry to become aware of opportunities and demand from various sectors. For example, facilitate contractual agreements between farmers and companies that are supported by government agencies. Develop the production chain in the village to include post-harvest handling, processing, transportation, wholesale and retail. Government agencies should also promote agricultural technologies to enhance the quality of products and reduced costs in order to be competitive. It is important to attract national and international investment in agriculture and forestry, especially from large companies with funding and experience to realize a permanent and open market.

The Government of Lao recognizes the importance of infrastructure, that every district must have access to roads to enable the transportation of goods, products and materials between towns, district and provinces. The new construction of roads would help Job's tear plantations and deliveries to the markets that, in turn, would develop rural areas and reduce poverty.

Conclusions

To strengthen farmers' negotiating power, government agencies, banks etc. should facilitate farmers to form interest groups such as farmer organizations. This would enable farmers to speak with one voice and negotiate with large companies directly regarding quality and price, among others.

Extension services are vital to develop agriculture with appropriate techniques, improved varieties etc. It is also vital that extension workers receive adequate, up-to-date training for specific locations to ensure suitable recommendations to the farmers.

Detailed information about producers, middlemen and export companies is needed. Therefore, government agencies have to interview various stakeholders to provide efficient measures.

What is not consumed in the Thai market (for candy *kanom* and drinks) is exported to Taiwan. We do not know what happens to it in Taiwan. Reportedly, the Taiwanese also consume Job's tear, but it is also possible that it is being exported to the North American market, where it is used as an ingredient in specialty foods, foods for diabetics and organic foods.

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Annex
Case studies and village layout

Mr. Bounthong

Mr. Bounthong is considered as a new comer to Thapho village, his former village is Kiew Gna. He moved to Thapho in 2002. Kiew Gna village is too far from the main road and therefore difficult to transfer and access to basic amenities. Consequently, the authorities planed to move all residents of Kiew Gna village nearer the road. Mr. Bouthong is 48 years old. He is Khamoo. He did not finish primary school, but his experience on upland practices is over 35 years. His wife is also Khamoo and 34 years old, she can not read or write Lao. His family consists of six members with three females. For a long time, he had been engaged in upland rice shifting cultivation at his former village. After moving to Thapho village rice was not a suitable crop for the soil quality, so Job's tear was substituted for rice. Job's tear is easier to sell due to road access. The problem which his family is facing is price. Between last year (2003) and this year (2004) the price seems to have dropped significantly.

His family now only have three main labourers who can work full time in agricultural production: his wife, his elder daughter and himself. The other three family members are still children.

His family owns 0.8 hectares of paddy field, one parcel of upland area totalling 1 hectare, which he divided into two parts: one for Job's tear and the other (about 40 per cent) for rice. 'Although rice cannot be grown as well as Job's tear on my field, I have to put it into meet the urgent need for rice while we are waiting for the harvest of the major paddy field. Because the paddy field is not large enough and can be harvested later than upland rice". His upland field is mainly for Job's tear production and the paddy field is for rice cultivation in the wet season and maize in the dry season. It takes nearly 30 minutes to walk to his upland field while only 5 minutes to his paddy field.

The Bounthong family also keeps animals including as two heads of cattle and more than twenty poultry. He has no buffalo so land preparation on his paddy filed has to be done by a hired tractor.

In 2004, in the upland field the yield of rice was 800 kg per hectare and Job's tear was 900 kg per hectare. Normally, Job's tear should be more than he could harvest this year according to his experience, but this year it was affected by disease. In terms of paddy, he yielded 900 kg of rice in the wet season and 420 kg of maize grain.

The main income of his family is from Job's tear, accounting for 1,100,000 kip. Then maize and his animals earn him 500,000 kip each. Finally, NTFPs net him around 100,000 kip per year.

His family expenditure last year is grouped into main expenses. The largest to buy shelter, then medical treatment and food, and finally clothes.

Bounthong is the one of the villagers who depends on natural agricultural practices, and nature. When the weather is good his upland and paddy crops yields are good too. Therefore, his hope relies on technologies and crop varieties suitability to the environment and soil conditions. "Marketing is one factor that very important to support production practices and find out where to sell the product", he said. Last year, he sold his products to a middleman at a nearby village for only 900 kip/kg for Job's tear and 1,200 kip/kg for maize grain.

Bounkhong

Mr. Bounkhong was born in Thapho village. He is 39 years old and Laolum. He did not finish primary school. His wife is illiterate; she is also Laolum and 36 years of age. There are six members of his family: four male and two female. The labour force of his family is four, for the other two are still children and go to school. One of the four main labourers (his son) used to go to work in town as a construction worker when they were free from work.

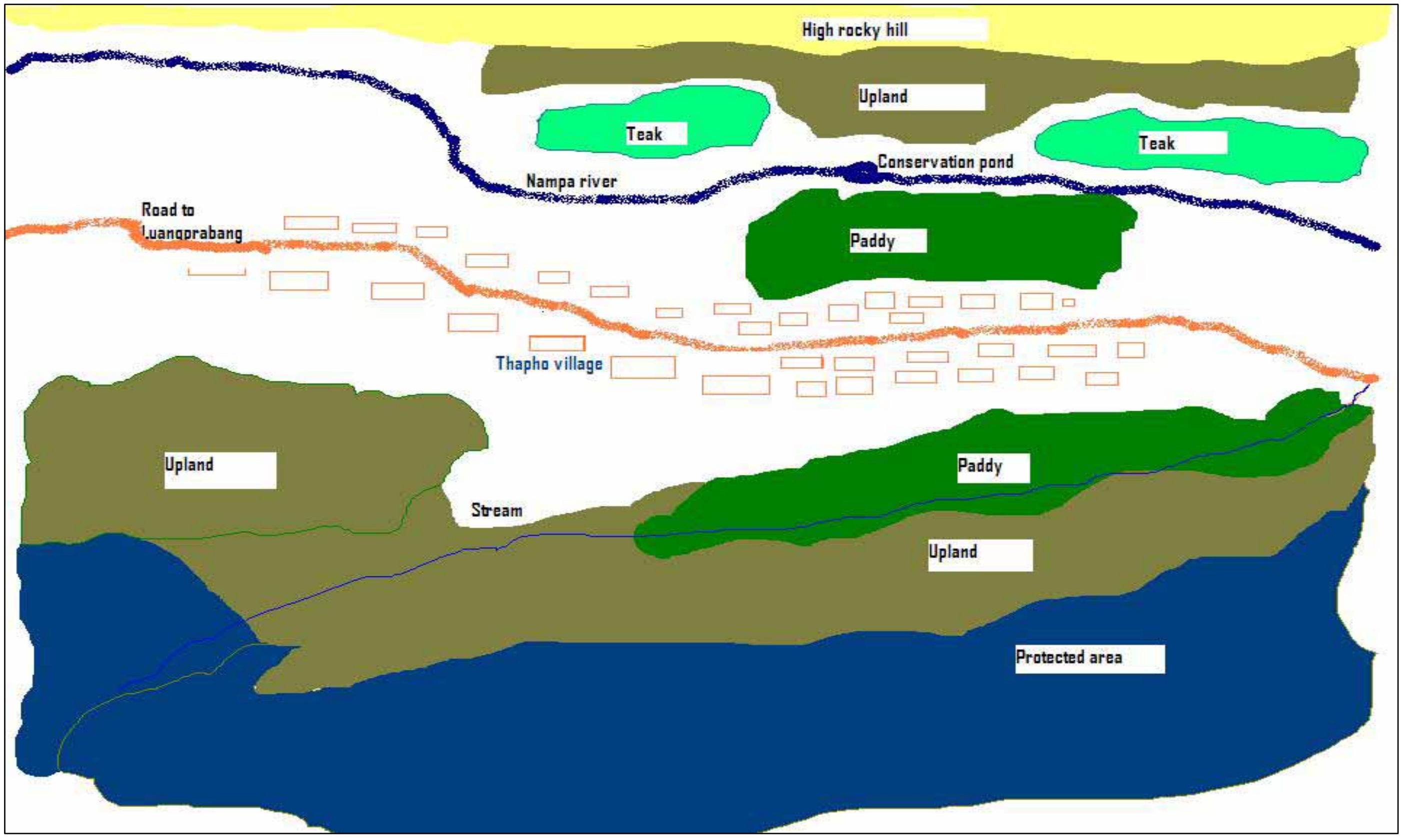
Mr. Bounkhong has 2 plots of upland fields: 1 hectare for and 0.6 hectares. The first being a 35-minute walk, and the second 15-minute walk. He has no paddy field or garden. In 2004, he divided his plots into two parts, the first part for rice (80 per cent) and Job's tear (20 per cent), and the second for just Job's tear.

Last year, he harvested 1,600 kg of rice and 1,875 kg of Job's tear. All his rice is for family consumption, Job's tear he sells at 900 kip/kg to a middleman in a nearby village.

His family raise two cattle and 65 heads of poultry. He claimed that poultry often dies from disease, especially in cold weather.

The main income of his family stems from Job's tear, and then selling labour in the town. Job's tear accounts for 1,575,000 kip/year. Unfortunately, he could not recall his son's wage.

Layout of Thapho Village, Luang Prabang Province



Finger Millet Generates Income in Nepal

H.K. Shrestha[*] and M. Joshi[**]

Abstract

Finger millet is an important crop of the Nepalese hills, especially in poor socio-economic domains under rainfed upland conditions. To enhance the contribution of finger millet to food security and income of the rural poor, IFAD supported a three-year research project on finger millet from 2002-2004. Various demand led research activities including market exploration for new value-added products were carried out using the participatory approach. Considering the yield gap in finger millet as a major constraint, on-farm research focused on high-yielding technology with disease resistant varieties. Farmers adopted high-yielding and disease resistant varieties with better crop husbandry practices at the project sites. Female farmers were aided, while pearling and milling finger millet grain, by modified machines, which were developed and established at different sites. Various innovative value-added products such as cookies, bread, cake, namkin and biscuits are becoming popular and being sold through various market outlets in Pokhara valley. Improving and extending high-yielding technology, recommended in the research with the help of R&D stakeholders for mass adoption, is imperative. Varietal improvements must continue to augment finger millet yield and input efficiency in the hill farming systems. Production should be industrialized by exploring various recipes based on finger millet. Raising awareness about value-added finger millet products through the mass media should be emphasized along with the overall monitoring role of the government as well as other stakeholders including private entrepreneurs.

Background

Finger millet is the fourth crop of Nepal in terms of cultivated area and production after rice, maize and wheat. It occupies an area of 259,130 hectares representing roughly 9 per cent of the agricultural area. Average yield is nearly 1.1 ton per hectare and total production in 2002/03 was almost 283 thousand tons (MoAC, 2004). Finger millet is mostly grown on hillsides by resource poor farmers under rainfed, upland ecosystem conditions. As

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finger millet returns considerable yields even under harsh environments and with low levels of inputs, it could be considered the most important crop for food security in the hills and mountains of Nepal (Upreti, 2003). Due to lengthy storability without any adverse effects from pests, it can play vital role in coping with unprecedented food shortages in the hills and sustain hill-farming systems. Moreover, the crop possesses high socio-cultural value among the country's indigenous peoples. Furthermore, finger millet straw is used as fodder for livestock, especially during winter season.

Finger millet is a highly nutritional rich food that can largely contribute to correct diets with protein and mineral deficiencies, in particular low-income segments of the population. Consequently, finger millet is important for the food and nutritional security of people living in remote hills and the marginal areas of Terai (plains) of Nepal (Joshi and Thakur, 2002). To reduce poverty by half in Nepal within the next ten years, as envisaged by the Millennium Development Goals (MDGs), there is no other way but to boost the production and marketing of farm commodities like finger millet, which are grown in resource poor areas and sustain the livelihoods of a large percentage of the population in Nepal.

The International Fund for Agricultural Development (IFAD) launched a project in 2002 entitled "Enhancing the contribution of neglected and underutilized species to food security and the income of rural poor". By increasing the production of finger millet the project aims to improve the livelihoods for the rural poor in Nepal. The project's four thematic areas include: (i) variety evaluation and production management; (ii) socio-economic study and local knowledge documentation; (iii) value-added product development and market promotion; and (iv) linkages with stakeholders and public awareness.

Objective and methodology

The objective of this study is to review the achievements made by the IFAD supported project for the promotion of finger millet. Specifically, the present study aims to:

1. Emphasize the importance of finger millet, its constraints and opportunities in Nepal;
2. Present the project's initiatives, success stories and lessons learned;
3. Recommend R&D policies for enhancing rural livelihood through finger millet production.

The present study is primarily based on reviews of the IFAD funded project's various publications such as the proceedings, annual reports and the field trip reports. In addition, contacts and informal interviews with concerned scientists, farmers, entrepreneurs and market intermediaries were carried out. In addition, at some of the project's sites, direct observations were also made. Finally, publications of authorized government agencies and scientific organizations were also used.

The paper opens by explaining how the project was implemented. Thereafter, the paper describes the agricultural situation prior to the project. Then, the project's results and achievements are discussed. Finally, concluding remarks and policy recommendations are provided.

Hill-farming systems

To analyse production limitations and the current status of finger millet in Nepal, the IFAD funded project first conducted several surveys. Thereafter, high-yielding technology packages, comprising of differing combinations of farming practices and finger millet varieties, were tested on farmers' fields through a participatory variety selection (PVS) programme. In total, 14 local landraces and five improved varieties were tested. As fungal diseases are problematic with finger millet, some resistant varieties were also tested. High-yielding local cultivars of finger millet were selected and a seed multiplication programme was conducted.

An economic analysis was carried out for different crop rotations. Various recipes with finger millet were also tested. Finger millet has a distinct flavour, which many people find unpalatable unless they are already accustomed. However, as a result of new technology, it is possible to reduce this particular flavour (Shakya, 2003) and various foodstuffs have been developed and tested, taking into account consumer preferences. Among the new products, cookies, biscuits, namkin, bread and cake were the more successful ones.

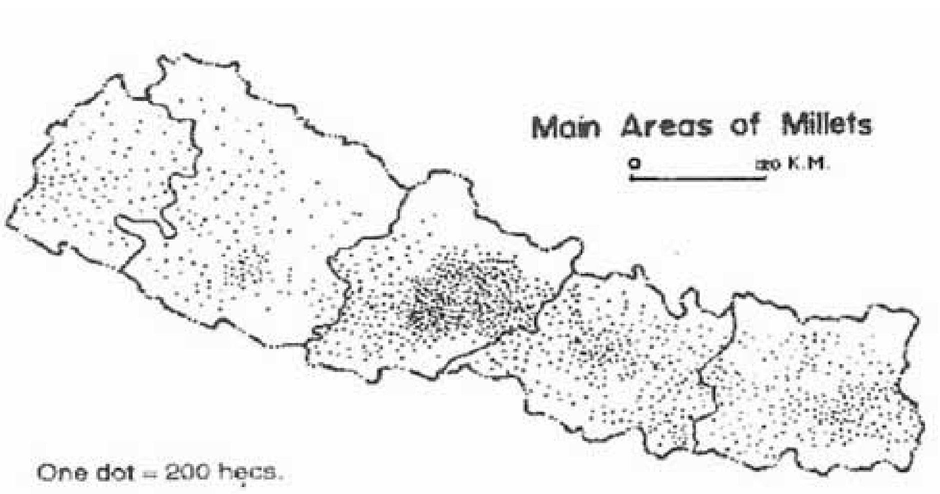
Training, exhibitions, food festivals and radio programmes were organized to promote the utilization of finger millet and its products. Various printed materials have been published and distributed to raise public awareness and improve finger millet's reputation. A folksong competition was also arranged to further draw attention to the benefits of producing and consuming finger millet.

A modified pearling machine was developed in partnership with an engineering workshop to remove the husk of millet grain that reduces processing time, which lessens the womens' workload. Furthermore, small-scale mills were selected and established at different sites, further lightening the workload of the women.

Prior to project implementation

Maize and finger millet are the two major crops grown in rainfed upland areas in the Nepalese hills. Improved as well as local cultivars of maize are commonly grown, while mainly local varieties are used for finger millet. Dalle is the most popular variety of the five local cultivars identified. The Dalle variety is very popular due to a number of preferred traits such as high grain yield, good taste, less lodging, compact fingers, drought resistant and palatable straw for livestock. Figure 1 shows the distribution of finger millet in Nepal.

Figure 1. Distribution of finger millet in Nepal



Source: Ministry of Agriculture and Co-operatives, 2004.

Table 1. shows the area and harvest of finger millet in five regions of Nepal.

Table 1. Area and harvest of finger millet in various topography and political regions in 2002/03

Region	Terai plains		Hill		Mountain		Total	
	Area (ha)	Harvest (ton)	Area (ha)	Harvest (ton)	Area (ha)	Harvest (ton)	Area (ha)	Harvest (ton)
Eastern	5 800	6 600	49 037	50 920	13 260	13 069	68 097	70 589
Central	3 730	3 928	35 022	35 855	24 320	29 284	63 072	69 067
Western	610	610	95 961	109 573	-	-	96 571	110 183
Mid western	160	110	12 200	14 211	8 100	7 865	20 460	22 186
Far western	500	480	4 930	4 930	5 500	5 425	10 930	10 835
Total	10 800	11 728	197 150	215 489	51 180	55 643	259 130	282 680

Source: MoAC, HMG/Nepal, 2003.

Two types of cropping pattern are used to produce finger millet. The most common practice, which is utilized on three-quarters of the total area, is relay cropping with finger millet and maize. The second type of cultivation is finger millet transplanted after the maize. All farmers allow the land to lay fallow for three months after the maize harvest (Table 2).

Table 2. Cropping patterns with finger millet in rainfed upland areas

Cropping pattern	Coverage (%)	Maize planting	Maize harvesting	Finger millet transplanting	Finger millet harvesting
Maize/finger millet-fallow	75	Mar.-Apr.	July-Sept.	July-Aug.	Nov.-Dec.
Maize- finger millet-fallow	25	Mar.-Apr.	July-Sept.	Aug.	Nov.-Dec.

Source: Field survey, 2003.

The maize/millet relay system is practiced at an elevation of 1,000 to 1,900 metres above sea level. A high diversity of finger millet landraces, which have adapted to a range of ecological conditions, can be found in Nepal. To date, three improved finger millet varieties, Dalle-1, Okhle-1 and Kabre Kodo-1, have been developed and made available. However, these improved varieties are not popular in the far-west hills, the Terai plains and high hills.

The involvement of women farmers in finger millet cultivation is substantial as they contribute with approximately 75 per cent of the total man-days required. Women also participate 55-85 per cent to decision-making regarding finger millet related activities. However, the wage rate for women is only 50 per cent of the mens', though women perform the same type of job.

In Table 3, cost and income are estimated from 1 hectare of finger millet production at one of the research sites. The cost-benefit ratio of finger millet cultivation is 1.08. Finger millet is a highly labour intensive crop and more than 85 per cent of total expenditure is composed of labour costs. Low yields and low farm gate prices also contribute to the ratio.

Table 3. Estimated income and costs of 1 hectare of finger millet

Activity and quantity	Quantity	(US$)
Labour days	287 (225 women, 62 men)	174.5
Seed	7.5 kg	3.75
Fertilizer urea	118 kg	24.78
Total cost of cultivation		**203.03**
Income from harvest	1 936 kg	**220.70**
Net profit		**17.67**
Cost benefit ratio		1.08

Source: Field survey, 2003.

Finger millet has a number of positive qualities. The following list shows some of finger millet's qualities and potentials:

- It is rich in minerals and therefore suitable for pregnant women, lactating mothers and baby food;

- The crop can be stored for lengthy periods and can consequently function as a food supplement or substitute during the recurring and frequent famines in the remote hill areas;
- Homemade liquor (both distilled and non-distilled) from finger millet is very popular and is produced throughout the hilly region;
- It is a suitable diet for diabetics because of the slow carbohydrates in finger millet;
- The fibre content in finger millet is very high; and
- An assortment of diversified products can be made from finger millet.

There are, however, also some constraints to finger millet production in Nepal. Finger millet is perceived as a low status food that is only consumed by those who have no other option. Different production systems require specific cultivars and it is a labour-intensive crop. In addition, the price of finger millet is very low.

Traditional uses of finger millet

The uses of finger millet vary among different ethnicities. It was found that families belonging to the Mongolian ethnic group use 60 per cent of their production in preparation of local beverages, 24 per cent for food consumption, 15 per cent for livestock feed, while 1 per cent is saved as seed (Khadka, 2003). Various kinds of local beverages namely *Jand/Chhyang, Hurre, Tungba, Saruwa, Rakshi* are prepared for home consumption as well as for sale. Among these, *Rakshi* is made by fermentation and distillation, while *Tungba* and *Chhyang* are produced using a simple method of fermentation. By-products of these beverages are used for livestock feed.

Families of other ethnic groups like *Brahmin* and *Chhetry* use half their finger millet harvest for animal feed, while 38 per cent is consumed as a staple food in the form of *Dhindo* (thick porridge) and *Roti* (local pan bread). The remaining 12 per cent is sold. Finger millet bread is coarse but through indigenous knowledge farmers soften their bread (Roti) by mixing finger millet flour with buckwheat flour. Millet straw is highly palatable to livestock and fetches high prices in the dry season.

Finger millet is also used for medicinal purposes, for example by mixing its flour with soybean and black gram flour, and the paste is utilized for healing bone fractures. It also has cultural value in religious festivals.

Limited public awareness of finger millet's positive effects on health and of its medicinal purposes are constraints to the market promotion of the crop. Urban and educated people also lack knowledge regarding the general nutritive value of finger millet.

Table 4 shows comparative figures of nutritive content for Nepal's four major cereal grains, namely millet, maize, wheat and rice.

Table 4. Nutrient content of finger millet in comparison to major cereals (per 100 g)

Characteristic	Millet	Maize	Wheat	Rice
Water (g)	13.1	12.0	12.2	13.7
Protein (g)	7.3	9.2	12.1	6.8
Fat (g)	1.3	3.9	1.7	0.5
Carbohydrate (g)	72	73.7	69.4	78.2
Fibre (g)	3.6	1.6	1.9	0.2
Minerals (g)	2.7	1.2	2.7	0.6
Calcium (mg)	344	20	48	10
Phosphorous (mg)	283	256	355	160
Iron (mg)	6.4	2.4	11.5	3.1
Thiamin (mg)	0.42	0.38	0.49	0.06
Calories	328	355	341	345
Carotene (mg)	42	90	29	0

Source: Central Food Research Laboratory, HMG/Nepal.

Project achievements

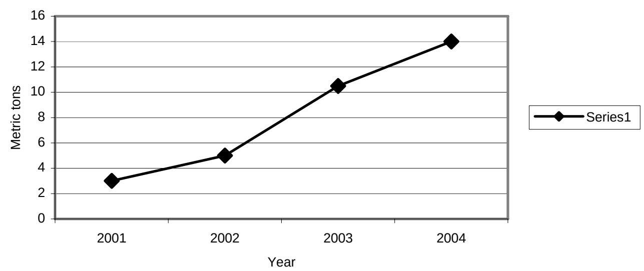
Several positive effects have been achieved through the project. Important local germplasms of finger millet were identified and conserved; various high-yielding indigenous cultivars and disease resistant improved varieties of finger millet were identified; the Agriculture Botany Division (ABD) of NARC has maintained 869 accessions of finger millet, most of which were local landraces. The best performing cultivars were disseminated through seed multiplication. Among the tested varieties, local cultivars yielded higher than the improved varieties although some susceptibility of disease was found in earlier varieties.

High-yielding technology packages, including new practices, were introduced and proved to be the most important factor for producing higher yields. It was found that local cultivars together with improved farming practices gave the highest yields of any other combination. Thus, farmers preferred local cultivars with a complimentary package of improved practices. Farmers improved their knowledge, attitude and skill regarding finger millet and its value-added products.

The workload of women has been reduced as a result of the project. Prior to the project women often had to walk long distances with heavy bags to mill the finger millet. The small-scale mills that have been established in many villages have reduced women's workload significantly. A modified pearling machine has also been developed, which further reduced the drudgery.

Marketing finger millet has resulted in higher demand. Demand for finger millet grain and flour as well as value-added products in Pokhara valley is increasing steadily, particularly in some stores (Bhandari, 2005). Four types of value-added products have been promoted and advertised by three entrepreneurs in Pokhara. The new products are: millet cookies, roasted millet based flour (*knophe*), bread and namkin. Value addition through product diversification in urban areas has helped increase consumption of finger millet and thereby raise the income of the farmers in rural areas. Figure 2 shows how the supply of finger millet has grown due to increased production of Shital products.

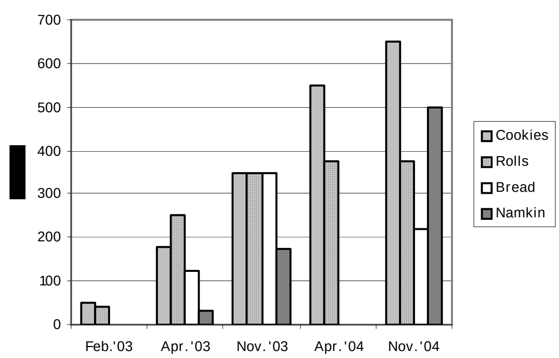
Figure 2. Supply of finger millet: a case of Shital products



Source: Survey, 2004.

Figure 3 shows the growth of Shital's processed products from finger millet. At the beginning of 2003, the company produced only cookies and rolls and in February 2003, production totaled only 50 packages of cookies and 40 packages of rolls. Towards the end of the project in 2004, the company's assortments had increased to include four products with significantly higher production.

Figure 3. Supply of value-added products of finger millet: a case of Shital products



Source: Survey, 2004.

As a result of the awareness raising activities, people came to know about the importance of finger millet products in urban and peri-urban areas of Pokhara. According to the Annapurna Pouroti and Kundhar Khaja Udyog bakery entrepreneurs, many shops and department stores are planning to sell finger millet products on a regular basis. Furthermore, people's perception of millet foods has changed in Pokhara valley. Instead of being perceived as a low status crop, finger millet is now appreciated as an important crop with high nutritional content.

Concluding remarks and policy recommendations

There are several important factors that have contributed to the project's success. The IFAD funded project was launched in partnership with "Local Initiative for Bio-diversity Research and Development (LI-BIRD)", an NGO that has long experience in participatory research and agricultural sector development. The project was also fully supported by co-operatives, bakery producers, market intermediaries and government institutions.

Instead of only focusing on improving the production technology of finger millet, the project team aimed at developing the complete chain from cultivation to product development and marketing. Upscaling activities were both horizontal and vertical. Horizontal refers to geographically spreading new technology by replication and adoption by farmers whereas vertical involves other sectors or stakeholder groups including local organizations to policymakers, donors, development institutions, and finally, investors at the international level (Sugino, 2005).

Some vital lessons were learned after the completion of the IFAD supported project. For the commercial production of value-added products of finger millet, it was found that high grain quality must be assured and guaranteed to processors and wholesalers. It is also clear that scientists must be proactive in the dissemination of new technology.

As the status of finger millet was very low and that its qualities were little known, increasing public awareness of the crop has been of significant value to drive the demand for finger millet. A folksong competition, food festivals and media coverage were found to effectively create public awareness. Fairs and festivals allowed direct interaction with potential consumers who could test new products and thus provide an immediate reaction to the processors regarding their products. To reach the rural population, information via the radio proved to be a powerful channel to raise awareness.

Technology generation may not be meaningful unless there is interest and the participation of farmers and entrepreneurs. Therefore the project utilized a participatory approach for the research and product diversification activities. Involvement of target groups in every step of the project, namely from problem identification to technology assessment is key to success. Farmers' participation in agricultural research involves more than only talking to farmers or allowing experiments in their fields (Bellon, 2001). It was learnt that participatory variety selection (PVS) could successfully identify farmers' preferences of varieties and landraces that lead to quick dissemination.

Policy recommendations

Based on the project's outcome it is vital to continue and improve the successful measures and further increase productivity, quality and demand for finger millet. As the national average yield of finger millet is still very low and its local cultivars were found susceptible to several diseases, it is important to continue the improved varieties including research on hybrids. Expanding the farmers' preferred landraces and exotic genotypes is required through national research and the extension system. The high biodiversity of finger millet varieties that Nepal possesses should be maintained for *in-situ* conservation.

The new policy agenda should include and place women farmers at the forefront of R&D activities, as their contribution to finger millet cultivation, recipe preparation as well as decision-making is significant. For example, pearling machines should be developed further and located in many more areas so as to reduce the workload of the women.

Processed finger millet products should be further developed and product marketing should be strengthened. Industrialization of high-quality alcohols with legal support is also important. The awareness programmes of finger millet's beneficial qualities, such as its nutritional value, should be continued.

In order to enhance the emerging business of value-added finger millet products, supply chain management is vital, which should be facilitated by government organizations responsible for agricultural market promotion. Supply chain management is a process that maintains effective relationships between the businesses of production and supply; from farm level to consumers, in order to meet consumers' preferences (Lokollo, 2004).

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New Yam Variety Paves the Road to Prosperity in Papua New Guinea

Jese Anjen, Norah Omot and Raghunath Ghodake[*]

Summary

This study assesses the impact of the introduction of an improved yam species in the Markham valley of Papua New Guinea (PNG) with a view to derive implications for policy and development. The study covers two distinct areas - the Intoap (poor access with hillside farming) and the Mampin (modest access with farming on plains) areas. Yams are a major staple food crop in the coastal regions of PNG and hold an esteemed place in cultural heritage. An improved species, *Dioscorea* rotundata from the International Institute of Tropical Agriculture (IITA) in Nigeria, was introduced in the mid 1980s. The PNG National Agricultural Research Institute (NARI) supplied the technical information, training and planting materials. Results from the study showed that the adoption of the Rotundata yam in the Intoap and Mampin areas has lead to an increase in the area under yam cultivation by 94 per cent, an increase in yam productivity by 117 per cent and an increase in yam production by 246 per cent. Also, the level of nutrients available for human consumption has risen by more than 100 per cent per hectare of cultivated area. Based on the successes, policy implications and recommendations are made. These include emphasis on crop improvement research; socio-economic research to appreciate and understand farmer behaviour and the environment in *ex-ante* and *ex-post* situations; the creation of sub-packages appropriate to various conditions and situations; utilizing multi-pronged and innovative approaches to technology development and transfer; establishing community based resource centres to distribute planting materials and for training; complementary and supporting mechanisms to commodity development such as product development, value adding as well as input and credit supplies and services; investment in rural infrastructure for market access and public services; and a need for well-informed demand and market access.

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Introduction

Improved agricultural technologies based on scientific research have been instrumental worldwide in raising the production potential of agricultural commodities and resources, thus creating stimuli for growth, development and prosperity. Such improved agricultural technologies are important catalytic agents in promoting agricultural growth and overall socio-economic development in Papua New Guinea (PNG). PNG is a developing country with 87 per cent of its population being dependent on agriculture. There is a huge untapped potential for agricultural development, which has yet to be exploited through the application of appropriate improved technologies and applied research. This potential is available not only to assure food security, raise incomes and provide comfortable livelihoods, but also to bring total prosperity and full development to the country (Ghodake *et al*., 2004).

While promoting improved technologies and the adoption of such technologies by the farming community is necessary, it is crucial to have a realistic understanding and assessment of potential impacts of new technologies on participating communities in rural areas. Such assessments, including socio-economic analyses, can form the basis of designing research and development (R&D) policies and development strategies to enhance economic growth and development. Similarly, policy and funding support from governments and donors can be solicited on the basis of such assessed impacts. Besides, experience obtained and lessons learned can be used for similar technologies in other areas of the country and elsewhere.

In PNG, tuber crops ensure survival in rural areas, especially for resource poor households in marginal and neglected areas. During recent years, food production in such areas has declined due to pests and disease, adverse growing conditions and lack of improved technologies. This has contributed to food insecurity. However, in some areas, improved technologies are now providing the necessary solutions for sustainable production in terms of improved productivity as well as tolerance to pests and disease.

This paper is based on a case study undertaken to assess the impact of an improved species of yam – *Dioscorea rotundata,* which is pest and disease resistant, higher yielding and tastier, in the Markham Valley of PNG. The valley is disadvantaged due to a seasonally dry climate, high population pressure, crop pests and diseases, as well as a lack of income earning opportunities. The study covers two distinct areas the Markham Valley: Intoap with hillside farming and poor access to infrastructure and markets, and Mampin with farming on the plains and modest access to markets. Using structured interviews and systematic research methods, the study assessed the following: (i) the characteristics of the rural poor population prior to the adoption of improved technology; (ii) actions that led to significant adoption and improved situations; (iii) the socio-economic impacts; and (iv) contributing factors that facilitated the change process.

Methodology

The Markham Valley was selected for this case study because the valley is resource poor in terms of soil, climate and agricultural systems. Major staple crops are banana, yam, taro, cassava, sweet potato, peanut and coconut. Intoap is an area isolated by the Markham River and is located more than one-hour walk from the main road, whereas Mampin, is an easily accessible area within a few minutes walk from the main road. Consequently, access to markets, inputs and supplies and local government services such as extension is much easier in the Mampin area than in the Intoap area. The access to services and goods allows the study to discern differences in causes and effects of adoption and the impact of improved technology. Both these areas are about 2.5 hours drive from the Morobe provincial capital, the main city of Lae.

This case study has two components. The first part consists of a desk-study, using geographical information systems (GIS), covering potentials and pressures on the agricultural system and the socio-economic activities of the Intoap and Mampin areas. This component also describes applied and adaptive research on yams, in general, and the transfer and adoption of the rotundata yam in these two areas, in particular.

The second component involves a detailed survey of the two study areas, in which 30 farmers from each area are interviewed using a structured questionnaire. The questions pertain to the importance of yam in the culture and society, production and productivity of the traditional and the rotundata yams, markets, transfer and adoption of the rotundata yam in the two areas.

Improved yam technology in the Markham Valley

The study area

The two study areas, Intoap and Mampin, are located in the Markham Valley at 400 metres above sea level. The Markham Valley is dominated by the floodplains of the Markham River and is characterized by grassland and a long dry season between June and December. The steep grassland terrain is not occupied, while the plains are used by people for low to moderate intensity cultivation (Hanson *et al*., 2001). Annual rainfall is close to 2,000 millimetres, mostly falling seasonally between January and May.

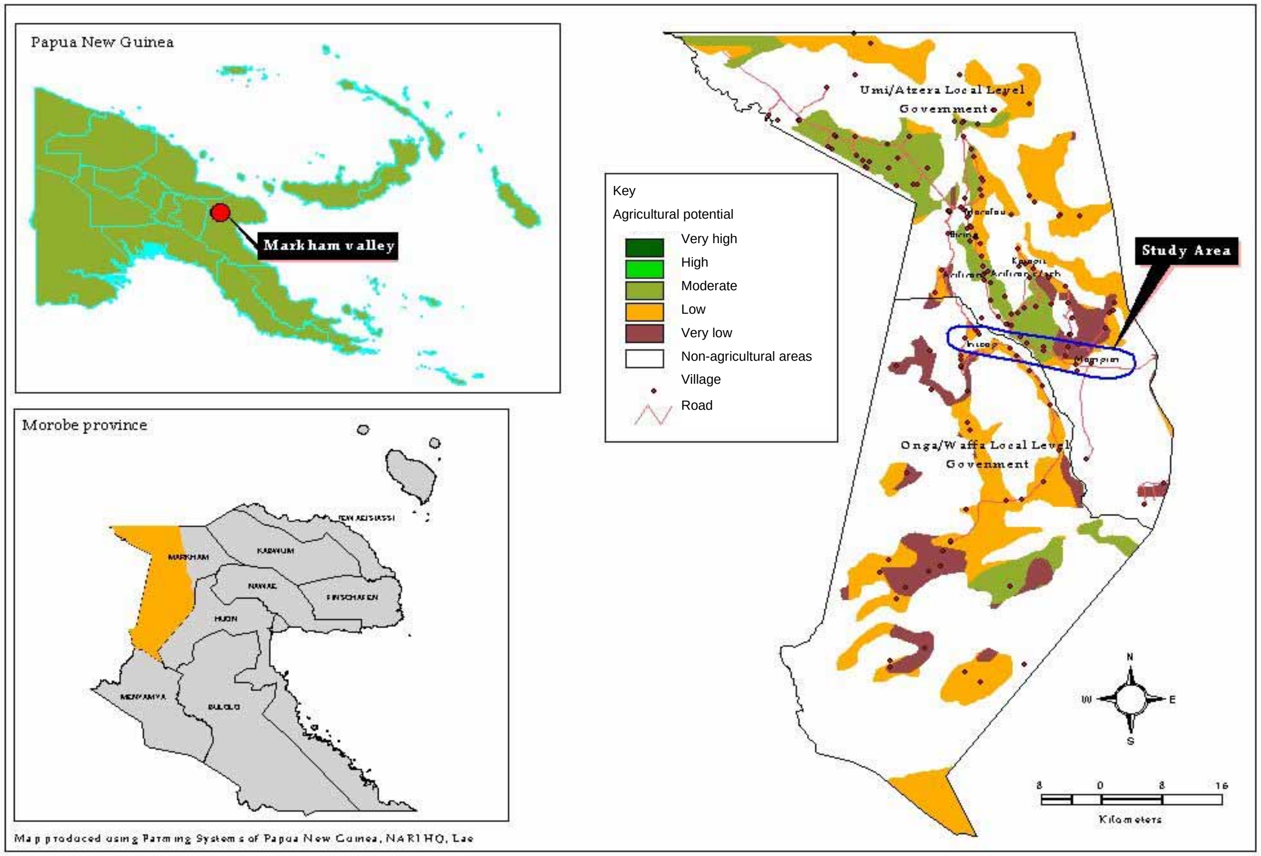
Intoap and Mampin are separated by the Markham River, with Intoap to the west of the river and Mampin to the east. As Map 1 shows, the productivity potential of the land is very low to moderate. A long dry season further reduces agriculture production. Agriculture is characterized by moderate intensity banana production with coconut as an important crop. Sweet potato, taro, cassava and peanuts are also produced and soil fertility is managed through crop rotation, with the two major staple crops banana and yam. Land improvement practices such as peanut rotation, tillage and mounding are utilized. In this marginalized area, pressure from the moderate intensity farming is evident. Low-income levels and few opportunities for improved livelihoods also characterize the two areas.

Yam is the second most important food crop in both areas, but its production is low due to pests, disease and poor soil fertility and the average harvest of traditional varieties ranges between 4 and 6 tons per hectare.

Betel nut, peanut, coconut, mango and watermelon feature as cash crops in these areas. Coconut is a lower input crop with a modest cash income, though a proportion of it is used for oil extraction and other domestic uses. Peanut is cultivated on an average of 0.01 to 0.50 hectares. Some major and minor staple crops, including yams, are also sold at the village and roadside markets and the urban market in the provincial capital, Lae. Until recently, betel nut was the main source of income for the Intoap and Mampin peoples, but due to a fungal disease the production of betel nut is now discontinued. Mango and watermelon are seasonal crops that also generate some income for farmers in both areas.

Traditional shifting cultivation is common practice at both sites. All activities involve none or low modern inputs and are generally labour intensive. The labour requirement for yam is much higher than other crops, especially for planting and harvesting. Yam gardening differs between the two areas. In the Intoap area, the common practice is to make yam gardens on the hillside. The growing vines from the traditional varieties are expected to entwine up the sloping hill. In the Mampin area, yam gardens are made on the plains. Most of the yam gardens are planted by mounding the soil. Gardens are planted in pure stands in separate gardens. At times, yam is planted in mixed cropping systems that are segregated by various crops or occupying a part of the garden. After two harvests of yam the land is put under another crop for rotational purposes. With the introduction of rotundata yam, the practice now is to harvest local yams and plant rotundata yam directly into the existing mounds.

Map 1. Study area in the Markham valley of Papua New Guinea – In perspective



Source: Survey.

Yams are planted and harvested seasonally throughout the lowlands (Bourke *et al*., 2004). In the Intoap and Mampin areas, the yam planting season begins in August and ends in January, with the main planting from September to December. The planting season coincides with the end of the dry season and the beginning of the wet season.

Staking is not commonly practiced for traditional yams in the study areas. With the introduction of rotundata yam, farmers were advised by researchers and extension officers to stake yams. Staking poles are of varying lengths with vines from two to three mounds, guided onto a single cut and erected pole.

Many yam pests and diseases have been reported in PNG. Yams are susceptible to pests and disease during all stages, from seedling to growth to post-harvest storage. Anthracnose, yam mosaic virus and other foliage diseases have considerable negative impacts on yam production in terms of tuber and yield losses. Depending on storage facilities, diseases can cause up to 50 per cent loss of fresh matter during storage. Such losses are associated with insects, nematodes and poor handling before, during and after the harvest.

Intoap's population is 1,200, while the population in Mampin is 2,200. The Intoap and Mampin flood plains have an average population density of 47 people per square kilometre. There is some migration across the Markham River from Intoap to Mampin and other areas in search of better facilities and close proximity to the highway, leading into the provincial capital. Land in both areas is owned by family clans and is passed on from father to son. A family unit can own between 0.5 and 5.0 hectares and in most cases, men have absolute control over the land use.

Major economic activities in these two areas include agriculture, tree crops, other type of businesses and wage jobs. Domestic agriculture includes vegetables, swine and poultry and staple crops, whilst tree cropping includes betel nut, coconut and more recently cocoa. Some people have ventured into some small spice crops like vanilla and cashew, while a few engage in inland aquaculture activities.

Business opportunities in the areas are very limited. A few people own public motor vehicles (PMVs) and small trade stores that typically sell essential items like soap, oil, tinned fish, sugar and salt. Wage jobs are primarily related to seasonal labour needs from other entrepreneurs and individuals. Hanson *et al*. (2001) estimated that income levels in the two areas are about Kina[1] 200 per person and year. However, as a fungal disease is

[1] PNG Kina 1 = US$ 0.34.

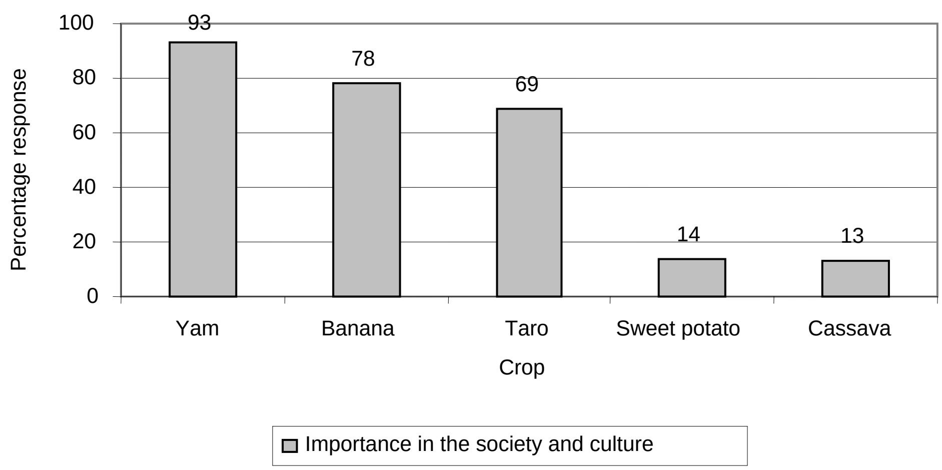
affecting the production of betel nut, the income levels in the two areas are now much lower, with Intoap being worse affected.

The poverty line in Papua New Guinea is between Kina 399 and Kina 461 per person annually (Gibson and Rozelle, 1998). For the farmers in Intoap and Mampin, having income levels substantially below the poverty line, poverty is the harsh reality of daily life.

Farmers in both areas are disadvantaged due to poor access to loans and other micro-credits, though co-operative groups may be able to secure agricultural loans from the Rural Development Bank. The bank is located in the major service centre of Lae. Poor infrastructure, lack of quality seeds and poor access to markets (in terms of limited transportation, high fares and freight charges) marginalizes the farmers further. People in Mampin, however, have ready access to the local government station and other services such as health, a primary school and banking services.

Yam is the second most important food crop after banana in terms of food production, but has higher cultural value than banana (Figure 1). Banana and taro are regarded as the second and the third most important crops in cultural activities.

Figure 1. Importance of food crops in society and the culture



Source: Survey.

In Intoap and Mampin, yam is used for various purposes such as a bridal dowry and marriages, traditional feasts, public events and gatherings and in exchange for other things such as food and in-kind payment for school fees, among others (Table 1).

Table 1. Major uses of yams in society and cultural activities

(responses in percentage[a])

Cultural activities	Intoap	Mampin
Marriage/bridal dowry	85	80
Feast and ceremonies	52	95
Public events and gatherings	37	55
Funeral/death ceremonies	41	40
Exchange	26	60
Prestige/announcement	4	70
Compensation	22	5
Others	48	10

Source: Survey.

Note: [a] These are multiple responses.

The improved technology – rotundata yam

In 1986, a PNG research scientist from the International Institute of Tropical Agriculture (IITA) in Nigeria introduced *Dioscorea Rotundata* yam seeds to PNG. The Rotundata seeds were then germinated in the laboratory and planted in a screen-house. Thirty varieties were established and were closely monitored for pests as well as disease attacks and the observations revealed that most of these varieties were tolerant to common pests and diseases of yams. The varieties were established in a germplasm collection for further research.

For almost a decade, the rotundata yam was maintained in the germplasm collection, at Saramandi Research Station[2] in the East Sepik province. During this period, no research was conducted and no significant efforts to give recommendations, promoting and distribution of the new varieties were carried out. In the mid 1990s, the scientist who brought the rotundata yam to PNG were recruited by the Department of Agriculture and Livestock (DAL) and placed at the Bubia Agricultural Research Station- now known as the Wet Lowland Mainland Programme of NARI (NARI WLMP), in Morobe province, and proactive work on yam was launched. NARI undertook a number of research activities at NARI WLMP, including germplasm management, variety evaluation, pest and disease identification, rapid multiplication technique (minisett technique), sequential planting, planting density, staking, weed management, genotype x environment interactions, studies on soil fertility as well as diagnosis and correction of nutritional disorders of the crop, storage and post-harvest observations, and cooking and eating qualities. This applied work was mostly undertaken in Morobe province but was appropriate to most yam growing provinces, including East Sepik province.

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[2] The Saramandi Research Station is under the East Sepik Provincial Government, and is not part of National Agriculture Research Institute (NARI). NARI became a statutory body in 1996 by an *Act* of parliament and absorbed most research programmes on food crops in the country, including yam work at Saramandi.

From this applied research, two varieties of Rotundata species, NRY 01 (TDr 90-1-1) and NRY 02 (TDr 66-5) achieved the best results and were thus recommended for dissemination to the farming community. Both varieties give an average yield of 60 tons per hectare and have good tuber shape, white flesh colour, good cooking qualities and a flavour that is well liked (Table 2).

Table 2. Yield and tuber characteristics of Rotundata lines maintained at NARI

Accession	Yield (tons/ha)	Tuber shape[a]	Tuber branching[b]	Flesh colour
66-5	66.6	Long-cylindrical	X	White
90-1-1	62.8	Long-cylindrical	M	Creamy white
90-1-8	62.0	Long-cylindrical	X	Creamy white
66-3	59.0	Long-curved	M	White
66-10	56.8	Long-cylindrical	M	White
90-1-9	52.8	Long-cylindrical	M	Creamy white
90-1-6	53.2	Fair	X	Yellow
90-1-4	52.0	Long-fair	M	White
66-9	51.0	Short (small)	X	White
66-8	48.8	Long-cylindrical	M	Creamy white
90-1-10	48.0	Long-fair	M	Creamy white
90-1-7	46.4	Short-fair	H	White
66-1	44.8	Cylindrical	X	White
90-1-5	44.0	Fair	X	Yellow
90-1-3	35.2	Long-fair	M	Creamy white
90-1-2	28.0	Cylindrical (hairy)	X	Yellow

Source: Risimeri, 2003 (unpublished data).
Note: [a] Fair = a well-formed tuber with good visual appeal to consumer;
[b] H = high branching; M = moderate branching; X = no branching.

Transfer and adoption of the improved technology

Intense dissemination work of rotundata yam began in 1996 by NARI WLMP, Bubia. The work included information on crop management and mini-sett techniques, supply of rotundata yam planting material and training on the mini-sett techniques. With funding from a World Bank project[3], a training manual on the mini-sett rapid multiplication technique was developed and widely disseminated. A management package was also developed as a NARI *TOKTOK*[4] Series and disseminated. A number of training sessions were conducted on the mini-sett techniques.

The rotundata yam planting and information materials were disseminated through a number of avenues including NARI open days, provincial agricultural shows, school field days, community field days, on-farm trials and demonstrations, print media and also through the efforts of other research and development organizations. Planting materials were also

[3] Project on Drought and Frost Response in PNG.
[4] A NARI TOKTOK is a small brochure in simple English, describing new technologies distributed by NARI. It is intended for smallholder farmers who understand only simple English.

distributed by the provincial DAL, non-government organizations and among farmers themselves.

Risimeri *et al*. (2002) observed that the NRY 01 (TDr 90-1-1) variety is well established in five provinces; namely East Sepik, Sandaun, Morobe, Western Highlands and Milne Bay. There are now as many as ten provinces growing these yams because of the wide-spread interest and continuous media reports of incredible productivity across the country.

The introduction of rotundata yam to Intoap and Mampin was through a prominent lady farmer, Mrs. Maria Linibi. She learned about the rotundata yam and the mini-sett technique from researchers at the NARI WLMP and later became the main source of information and material on the improved yams and in providing training on the mini-sett technique to villages in the Markham Valley. NARI, DAL, extension officers and farmers already familiar with the rotundata yam also provided information and training in Intoap and Mampin (Table 3).

Table 3. Sources of transfer of rotundata yam technology in the Intoap and Mampin areas (responses in percentage)

Source	Information on rotundata yam	Transfer of rotundata yam material	Information on minisett techniques	Training on minisett techniques	Total
A prominent lady farmer	29	34	34	36	133
Other farmers	29	29	36	27	121
NARI	24	19	29	25	97
DAL/Extension officers	24	3	5	14	46
Others (at market, etc)	5	20	7	13	45

Source: Survey.
Note: This information is based on multiple responses, meaning one respondent indicates more than one source.

Impact of rotundata yam

The actual number of households growing rotundata yam is not known, but based on discussions with respondents and from observations of gardens in the two study areas, it is estimated that about 80 per cent of the households in the Intoap area are growing rotundata yam while about 50 per cent grow rotundata yam in the Mampin area. The lower adoption in Mampin is because people have access to services, opportunities to sell their produce and they can easily exchange other goods or cash for yams with people from the Intoap area.

Yam is culturally important in both areas and certain features of rotundata yam fostered the adoption of the new varieties, which are highlighted in Table 4. Major reasons for adopting are curiosity, good taste, easy and rapid multiplication, as well as good growth and yield.

Table 4. Major reasons for adopting the improved yam technology

Reason	Percentage response[a]
Interest in the new yam species	35
Good taste of the R. yam	26
Rapid multiplication of planting material	17
Good growth and yield	16
Drought tolerance/food security	14
Taboo with traditional yams	3
Prestige	2
Others	28

Source: Survey.
Note: [a] Respondents could choose multiple reasons.

Despite the fact that rotundata yam was introduced to Intoap and Mampin during the 1996 cultivating season, adoption was slow and only in 2000 it accelerated rapidly. The reasons for the late adoption were the shortage of planting materials and some reluctance of early adopters to share planting materials.

Respondents indicated that early adopters, both progressive and poor farmers, were not willing to share their planting material because of the superior characteristics, in terms of yield and taste, compared to the local varieties. They were only willing to share with closer relatives and planting material was given away only in exchange for other food crops and pigs. A few people, however, obtained planting material through stealing tubers and seeds from gardens and research plots.

More than 60 per cent of all yam producers adopted both the mini-sett technique and the improved yam species in the two areas (Table 5). There appears to be some positive correlation between the adoption of these two components. Some of the respondents indicated that they were able to increase their planting material through the mini-sett technique. However, they obtained much smaller tubers than desired, so instead of cutting smaller setts, they would cut larger setts for planting.

Table 5. Adoption of the mini-sett technique and improved yam species

Location	Mini-sett technique (% respondents)	Rotundata yam (% household)
Intoap	72	80
Mampin	86	50
Both sites	79	65

Source: Survey.

The area cultivated under traditional yams remained the same before and after the introduction of rotundata yam in these areas (Table 6). This suggests that farmers are still maintaining the level and diversity of traditional yams. However, the introduction of rotundata yam has increased the area under yam cultivation by more than 90 per cent, suggesting that the improved technology has helped to expand the area under yams in a substantial way.

Table 6. Area under yam cultivation before and after the introduction of rotundata yam

I t e m	Intoap	Mampin	Total
Area under traditional yams before adoption			
- Number of respondents	25	22	47
- Area by all respondents (ha)	2.01	5.01	7.02
- Average area per respondent (ha)	0.08	0.23	0.15
Area under traditional yams after adoption			
- Number of respondents	27	22	49
- Area by all respondents (ha)	2.01	5.09	7.10
- Average area per respondent (ha)	0.07	0.23	0.14
Area under R. yams after adoption			
- Number of respondents	28	29	57
- Area by all respondents (ha)	2.15	4.41	6.56
- Average area per respondent (ha)	0.08	0.15	0.12
Total area under yams after adoption			
- Area by all respondents (ha)	4.16	9.50	13.66
- Average area per respondent (ha)	0.15	0.38	0.28

Source: Survey.
Note: The survey included 30 farmers in each area.

The area under rotundata cultivation is small in both areas. As Table 7 shows, 96 per cent of the farmers in Intoap cultivate rotundata on 0.075 hectares or less, while the average size of cultivation plot in Mampin is a bit larger. The difference is due to the good market access of Mampin so farmers cultivate larger areas for commercial purposes, while farmers in Intoap mainly cultivate for subsistence purposes.

Table 7. Area under rotundata yam in the two study areas (percentage of respondents)

Area (ha)	Intoap (n=28)	Mampin (n=29)	Average
0.050	75	60	67
0.075	21	10	16
0.125	0	17	9
0.175	4	3	3
0.200	0	10	5
Total	100	100	100

Source: Survey.

Under research conditions, yield has been shown to be around 60 tons per hectare. However, as the farmers in the two study sites have only adopted the new varieties and not the improved management practices and modern inputs, the yields are substantially lower than those obtained at research stations. Nonetheless, as Table 8 shows, yields with rotundata varieties are higher in both areas compared to the traditional variety. In Intoap, the average yield has increased by 20 per cent with rotundata, from 5.95 to 7.16 tons per hectare, while in Mampin the average yield has increased by 250 per cent, from 4.22 to 14.88 tons per hectare.

Table 8. Productivity of traditional and improved yams in the study areas

I t e m	Intoap	Mampin
Traditional yam (ton/ha)	5.95	4.22
Rotundata yam (ton/ha)	7.16	14.88
Productivity increase (%)	20	253

Source: Survey.

The total production of yams in Mampin is much higher than that in Intoap (Table 9). Although more farmers have adopted rotundata yam in Intoap than in Mampin, farmers in Mampin produce higher yields and have larger areas under cultivation. Total yam production in both areas, however, has increased by almost 250 per cent since the adoption of the rotundata yam.

Table 9. Production of traditional and improved yams in the study areas (tons)

I t e m	Intoap	Mampin
Traditional yam before R. yam adoption		
-Total production	11.96	21.14
- Average production per respondent	0.48	1.34
Traditional yam after R. yam adoption		
- Total production	11.96	21.47
- Average production per respondent	0.48	1.34
R. yam		
- Total production	15.39	65.62
- Average production per respondent	0.64	2.62
Total production of yams after R. yam adoption		
- Total production	27.35	87.09
- Average total production per respondent	1.12	3.96

Source: Survey.

Yam has been recognized as an important staple food contributing to the quality of diets through various main and minor nutrients. As shown in Table 10, compared to traditional yam, the rotundata variety has substantially higher content of all nutrients listed in the table. For example, rotundata yam contains twice as much calcium and iron compared with traditional varieties, and almost three times as much carbohydrate.

Table 10. Level of nutrients and calories from traditional and improved yams[b]

Nutrient	Milligram/ per 136 grams of yam[a]	Traditional yam (g/kg/ha)	Rotundata yam (g/kg/ha)
Vitamin C	16.5	606.6	1 334.6
Potassium	911.2	33 500	73 700
Manganese	0.5	16.75	40.4
Dietary fibre	5 300	19 4852.9	428 676.5
Carbohydrates	37 540	1 229 670.88	3 408 710.77
Sugar	680	23 542.25	61 745.43
Fat	190	6 577.98	17 252.4
Protein	2 030	70 280.55	184 328.26
Vitamin B_6 (pyridoxine)	0.3	11.03	24.3
Potassium	911	33 492.6	73 683.8
Calcium	19	698.5	1 536.8
Iron	0.7	25.7	56.6
Magnesium	24.5	900.7	1 981.6
Phosphorus	66.6	2 448.5	5 386.8
Zinc	0.3	11.03	24.3
Copper	0.2	7.4	16.2
Sodium	10.9	400.7	881.6
Vitamin E	0.5	16.75	40.4
Total	47 702.2	1 597 060.82	4 259 420.76
Percentage increase in nutrient level			
Moisture content –(70%)	95 380	3 302 147.27	9 660 704.13

Source: www.nutrientdata.com (27 October 2005).
Note: [a] Information source = www.nutrientdata.com.
[b] Metric unit 1,000 mg = 1 g.

According to the respondents, the rotundata yam is perceived to be free of any pests and diseases (Table 11), suggesting significant tolerance. Similar observations have been made in other areas of the country. Traditional yam varieties, on the other hand, are perceived to have 30 per cent tolerance.

Respondents from the Mampin area indicated higher tolerance to pests and diseases from traditional yams than respondents from the Intoap area[5].

Table 11. Tolerance to pests and disease perceived by the farmers

Item	Intoap (% of respondents)	Mampin (% of respondents)	Total (% of respondents)
Tolerance to pests			
- Traditional yam	8	61	34
- Rotundata yam	100	100	100
Tolerance to disease			
- Traditional yams	8	65	37
- Rotundata yams	92	96	94

Source: Survey.

[5] In the Mampin area, the major crops grown are banana and yams (in separate gardens) with very few other crops such as peanuts and watermelons for market. With fewer yet tolerant crops like R. yams, there are fewer incidences of pests and diseases. On the other hand, the Intoap area has a variety of crops grown (such as banana, yam, taro, sweet potato, cassava and other vegetables), in dense and often in mixed gardens, with less tolerant crops like traditional yams and others, and hence this area appears to have more incidence of pests and disease.

In both areas, the respondents have enhanced their skills and knowledge concerning the improved rotundata yam technology. These skills include the mini-sett rapid multiplication technique, staking the vines and developing the nursery to grow cut sett pieces from yam tubers. Traditionally, head setts are planted so that only one plant can be obtained from a tuber. With the introduction of the mini-sett technique, more planting material can be obtained per tuber. Due to its isolated location, the enhancement level compared with before the introduction of new varieties has increased much more in Intoap than in Mampin. For example in the Intoap area, yams are not commonly staked, but those receiving training have observed that staking contributes positively to yield.

About 30 per cent of farmers have received some form of training on the improved technology, especially on the mini-sett technique and on crop-management practices. Most farmers have received this training indirectly from their friends and relatives.

Both types of yams contribute greatly to food security during adverse weather conditions brought about by both drought and wet periods (Table 12). However, rotundata yam has been distinctly recognized for food security during drought in both areas.

Table 12. Yam for food security

Item	Intoap	Mampin	Aggregate
During drought			
- Number of respondents	28	26	54
- R. yam (% response)	25	39	32
- Traditional yams (% response)	0	0	0
- Both types of yams (% response)	75	61	68
During wet season			
- Number of respondents	28	24	52
- R. yam (% response)	0	21	32
- Traditional yams (% response)	0	0	0
- Both types of yam (% response)	100	79	68

Source: Survey.

Approximately 32 per cent of the farmers state that with the adoption of improved rotundata yam, food security has increased. Prior to the adoption, people were highly dependent on banana as the major staple food with supplements from other root and tuber crops. Rotundata yam has helped to improve not only the level of food production but also to supplement other food crops grown for human consumption.

Data gathered in the study areas shows that the prices for yam the producers receive range from Kina 2 to 25 per tuber, depending on tuber size. Due to its higher quality and better taste, rotundata yam commands a higher price with an average price of Kina 1.1 per kg compared with Kina 0.6 per kg for traditional yam. With an average yield of 5 tons per hectare in both study areas, traditional yam can generate a gross income of Kina 3,000, while rotundata yam with an average yield of 11 tons per hectare can generate about Kina 12,000.

Only producers with good access to nearby markets are able to sell their produce. Farmers from Mampin have good access to the market and tend to sell substantially more of their produce than farmers from Intoap. However, an increasing number of farmers in Intoap have started to sell parts of their yams as ware and seed yams. A large proportion, up to 50 per cent, of the rotundata produce is sold. While this percentage is only 15 to 20 for the local yams. More yam could be sold if farmers could access market information about demand, price information and value adding, which would lead to an expansion in cultivated area.

Rotundata yam is an emerging cash crop to the people in the study areas. Farmers are beginning to sell their excess produce to earn cash to acquire other basic necessities. One farmer reported that she earned about Kina 150-200 per market visit. Overall, she makes four to five visits annually, earning a total of Kina 600-1,000.

The increase in the sales of rotundata yam has positively influenced the local economy. Farmers with excess supply of rotundata yams make numerous trips to the markets to sell their yams and thus, transportation demand has increased and the farmers' higher incomes have made them more important as consumers.

Like traditional yams, rotundata yam is also used as barter payment with other food crops and services. Sixty-eight per cent of the respondents indicated that they use rotundata yam in such an exchange for store goods, clay pots, peanuts, hiring labour and even pigs.

About 47 per cent of the respondents use rotundata yam for a porridge called "*chari",* which is a favourite dish among young children and old people, while 53 per cent responded that they do not process the produce. As there is no processing of yams in the area and elsewhere in the country, there is wide scope to utilize rotundata yam in downstream post-harvest processing, into products such as flour, noodles and chips.

Yam cultivation is considered as a man's job, but women participate to some extent in cultivating smaller gardens, weeding and maintenance. When asked about the implication of cultivating rotundata yam on women's labour, about 50 per cent of the respondents indicated that the cultivation of rotundata yam required less labour from women than cultivating traditional yams (Table 13). Nevertheless, women can play a very important role in promoting and marketing the crop. Therefore, there is potential for greater participation by women, if this leads to higher income.

Table 13. Womens' labour for the cultivation of rotundata, compared to traditional, yams

(percentage)

I t e m	Intoap	Mampin	Average
More labour time	4	11	7
Less labour time	50	52	51
Similar amount of work as for traditional yam	46	37	42
Total	100	100	100

Source: Survey.

Indicated by 94 per cent of the respondents, the cultivation of rotundata yam has not exacerbated soil fertility or soil erosion. The farmers in the study areas practice mounding, tillage and crop rotation as part of soil-management practices. Farmers leave land fallow instead of intensive cropping to further enhance soil management. Due to long dry seasons, soil erosion is not usually a problem.

Concluding remarks

The study has conclusively established significant positive impacts on improved productivity, production, food security, cash income as well as sustained farming and cultural activities in the Markham Valley of Papua New Guinea. However, it took almost 20 years and considerable effort from the early introduction of rotundata yam in PNG until the improved varieties and management were successfully adopted by the farmers. Yam producers in the valley have been selective in terms of adopting specific components of the improved technology packages, so as to be appropriate to their environment, resource base, skill level and risk aversion. Greater gains can be made in terms of broad-based socio-economic development by designing and implementing research and policies that target less developed areas and resource poor farmers.

Initially, there was no effective networking and innovative partnership among the progressive farmers, trainers, material suppliers and researchers to disseminate the improved technology. Consequently, the adoption of the new technology by the farming community has been slower than necessary. Information about multiply planting material was also lacking initially.

Farmers are not aware of the demand for yams in the country, as they have no access to market information. Institutional buyers and retail food outlets are the major buyers of yam but farmers have no information on the levels of demand and their quality requirements. Given the limited demand for fresh yams in nearby areas, processing and value adding of yam could generate demand. Furthermore, the majority of the households do not use modern inputs in their farming because they are resource poor farmers.

Therefore, for commercial activities including yam, farmers require access to credit, improved skills, modern inputs and services. However, improved natural resource management and low input technologies are likely to be more relevant for low potential areas and/or regions with weak infrastructure and inadequate or modest market access. Although higher yields can be obtained if modern inputs are used, the rotundata yam gives better yields than traditional varieties even with low inputs.

Food security has improved for subsistence farmers in remote areas subsequent to the introduction of rotundata yam. Farmers in areas with better market access have adopted, though selectively, this technology at a much higher intensity and productivity, thus contributing not only to food security but also to their income as well as the commercialization of the local economy. The area under yam has doubled with the adoption of rotundata yam and production has increased more than three-fold, suggesting that the improved technology has significantly improved productivity. The rotundata variety is also tolerant to pests and disease, and thus gives a higher level of certainty and sustainability in productivity and production. Rotundata yam has also helped reinforce the cultural status of yams in society and is being widely used in various cultural activities.

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A Women's Group Adds Value to Local Soybean in Thailand

Nareenat Roonnapai[*]

Abstract

The Ruamjai Housewife Group of Sri Nakhon district, Sukhothai province was organized in 1993 with the major objective of generating value-added products from locally available farm products to generate more income for the farm families. Currently, processing Chinese fermented soybean grain sauce is the group's main enterprise. The potential of the group revolves around its industriousness, the local availability of raw materials, a house with processing equipment, production planning and continued transfers of production technology. However, limitations exist in terms of book keeping, know-how and management skills, the market for the group's product is still emerging and processing techniques are still limiting the standards of the product which has yet to be certified from the responsible agency. Factors contributing to the success of the group include strong leadership, willingness to make sacrifices and a good attitude, technical assistance from the public sector on processing technology, harmony within the group and benefit allotment to all members. Moreover, local availability of the soybean keeps processing costs to a minimum.

Introduction

The Ruamjai Housewife Group 456, which was established in 1993, processes soybean in time spared from other farm activities. Between 1993 and 1997 the group produced soybean paste, chili herbal sauce and salty, preserved eggs. The production capacity of the Chinese fermented soybean grain sauce was 25-30 dozen large bottles per month, sold at a price of 100 baht per dozen, thus generating an annual income of 30,000 to 36,000 baht. Initially, the chair's house was utilized as the establishment. Then, in 1995, the village head allocated a quarter rai of land to temporarily house the farm processing activity. The difficulties faced by the Housewife Group include an undersized market for the products, which were sold locally in the province, lack of book-keeping know-how and

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management skills, and also limited time for the production and processing of the soybean, as all the members had to work principally on their paddy fields.

The Ministry of Agriculture and Co-operatives has made an attempt to promote soybean as a second crop after rice because local demand for soybean continues to be high. Furthermore, a second crop reduces the risks associated with lower rice prices and from attacks by pests and disease due to successive rice cultivation. Soybean requires less water than rice and improves soil fertility, which reduces the need for chemical fertilizers. Therefore, a policy that promotes farm housewife groups has been implemented with the purpose of farm processing, using own produce and/or locally available crops, and a dividend payback to group members. Against this backdrop the farmers can work in the low season through processing activities, earning and saving money, which in turn, leads to more investment in sustainable farm development.

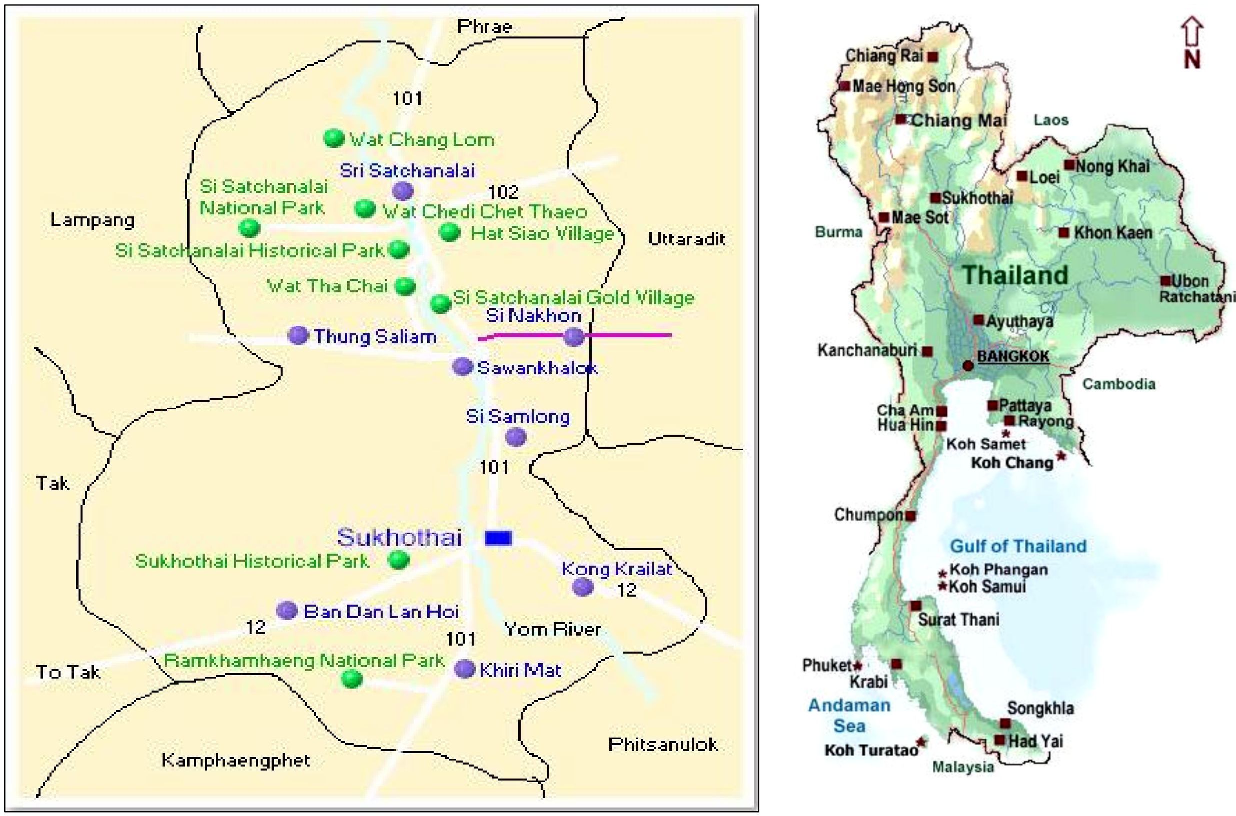
In 1998, the Ruamjai Housewife Group received 92,000 baht of financial support from the local Tambon (sub-district) Organization Administrative (TAO), which is a government body, to build a processing establishment. In addition, the provincial community development office provided processing equipment valued at 100,000 baht. From the tambon off-school programme centre of the Ministry of Education, the tambon agricultural home-economics agent, and the provincial farm extension worker, the Ruamjai group received training on processing knowledge coupled with management training. The Agricultural Extension Department provided a revolving loan fund of 160,000 baht, at no interest and unspecified repayment terms, namely to be paid at a time when having repayment ability.

The present study aims to analyse the business potential of the Ruamjai Farm Housewife Group, as well as constraints, to provide policy recommendations to promote production and the diversification of secondary crops.

General information of the study area

The Ruamjai Farm Housewife Group 456 is located in Bungprayod village, Maplub, a sub-district of Si Nakhon district in Sukhothai province. Si Nakhon district is indicated with a line on Figure 1. To the east of the village is Uttaradit province. The area of the village is 2,900 rai, or 5 sq km, characterized by low-lying terrain.

Figure 1. Map of Thailand and Sukhotai province



Source: Royal Thai Survey Department, 2004.

There are 112 families in Ban Buengprayod and the village's population totals 469, comprising of 226 males and 243 females, which represents 7.44 per cent of the Klong Maplub subdistrict's population (Table 1). Regarding the economic situation, farming is the primary occupation for most of the families; 51 households are engaged in rice production, 15 households in field crop farming, 27 in horticultural crop farming, 69 in animal husbandry, and six families are occupied with off-farm work.

Table 1. Population, land area and agricultural land

I t e m	Whole Kingdom	Sukhothai Province	Klong Maplub Subdistrict	Bungprayod Village
Population (persons)	63 090 000	595 971	6 303	469
Total land (rai)[a]	320 696 888	4 122 556	19 855	2 900
Farm holding land (rai)	131 059 974	2 065 494	17 012	2 228
- Paddy	65 220 587	1 304 581	9 020	1 582
- Upland field	28 241 647	515 988	6 526	437
- Fruit trees	26 584 191	228 638	1 466	209

Source: National Statistical Office, 2003.
Note: [a] 1 sq km is approximately 580 rai.

The business establishments in the village comprise of one multipurpose open yard, one Chinese fermented soybean grain sauce house, two food shops, six grocery stores and two small fuel stations. Most of the village people have completed primary education and the village has one community learning centre, one newspaper stand, and one basic community health centre. With respect to infrastructure, the village has two asphalt roads totalling 4 kilometres in length and a 2 kilometres long lateritic road. All households have access to electricity. A natural river, which is 60 metres wide and 1,500 metres long, runs through the village, and a pond, 80 metres wide and 540 metres long, is also in Bungprayod village. In addition, there are four deep wells drilled by the Royal Irrigation Department.

Locally value-added soybean

Currently, the main business of the group is the production and sale of soybean paste as soybeans are produced by almost all households within Bungprayod village and in nearby villages. The production capacity in 2004 was 60 dozens of bottles per month. The group earned 103,680 baht per annum and gained a profit of 24,883 baht. In 2005, the capacity increased to 90 dozen bottles per month and sold at 110 baht a dozen, therefore, the income between January to October was 99,000 baht. The annual income for 2005 is expected to be 118,800 baht. In addition, local farm produce in excess supply such as lime is brought under simple processing and is also for sale, while Chinese soy sauce is currently under trial and marketing is yet to commence.

The allocation of benefits to the group's members is as follow. After sales, wages are paid, which total about 70 per cent of the profit with 20 per cent used as a dividend payment every six months. The remaining 10 per cent is set aside by the group for further investment. In 2003 alone, the profit of 24,883 baht was divided for the wages of 17,418 baht, a dividend of 4,977 baht and the rest was kept for further investment by the group. Approximately 60 per cent of the products are sold within the province, while 40 per cent in the neighbouring provinces.

The extra income generated from sales of the processed farm products also contributes to the group's savings. At the beginning of every month each member has to deposit between 30 and 100 baht. As such, the group's total savings were 80,000 baht in 2004, with average savings of 2,700 baht per member. In 2005, the savings between January and October totalled 90,000 baht.

The group is invited to participate in public development activities during certain official holidays such as the King's birthday of December 5 and the Queen's birthday on August 12. Furthermore, the group participates in arranging public exhibits of their products at fairs organized within the district and province. The group also takes part in cultural, spiritual and children's events in the village. The farmers would like to participate more in community activities as they are aware of the advantages of group effort.

The business side of the group is now progressing in several aspects. From its establishment the number of members has risen dramatically, from 15 in 1993 to 53 members in 2005. Furthermore, management skills have improved. Firstly, the Housewife Group Committee appoints a designated chairman, vice-chairman and committee members and the group has a secretary working on the member list. The committee selects a cashier to keep track of receipts, expenses and controlling money requests as well as provisioning payments. There is also a public relations and market promotion person within the group, working on information services, seeking market access and taking responsibility for the exhibition of their products. An advisory group to the Housewife Group has also been formed and is composed of the village head, village committee and members of the Tambon Administrative Organization. In addition, representatives of the public agencies, mentioned earlier, have been supporting the businesses of the group. In 1993, the shared investment, required by each member, was 1,500 baht and in 2003 is totalled 30,000 baht but that has now increased to 60,000 baht at present.

The product is yet to be examined and certified by the Food and Drug Department (FDO) and the consumers are therefore not overly confident in the group's products.

However, the sanitation measures in the processing house have been improved and the fungi content of the product is currently undergoing improvement.

Prior to an application for standardization accreditation with the Food and Drug Organization (FDO), a request for a food-processing establishment and a production license for food by food type classified by the FDO, must be completed. The requests need to be documented with food formula and recipes, processing methods as well as food quality. The provincial public health office is handling the application. To acquire the necessary documentation, an inspection of the processing facility is carried out initially; recommendations are thereafter provided concerning improvements to be made to the plant and production methods. The accreditation will boost consumer confidence in product quality and improve the value-added products of the Housewife Group, which aims for sustainable production.

Striving for 13 years, the emerging processing business of the Ruamjai Farm Housewife Group 456, with its small number of members, as well as small production and income, has annually gained profit that is well shared between the group's members. The following factors have contributed to its success:

- The managing committee has a good and unique leadership of devotees that is well accepted by all group members.
- The committee is very industrious. Consultative meetings are regularly held to solve problems. It is diligent about going on study tours which attempt to improve the quality of the group's products. Bookkeeping is performed. Rules and regulations of the group are clear and well complied. A new committee is selected every four years.
- Dividends are regularly paid twice a year to the members. The members are enthusiastic about co-operating with the simple farm processing.
- Saving is encouraged. A portion of the dividend received is saved in the form of a career fund, which aims to reduce the need for taking loans.
- Support from government agencies is well provided along with the family income enhancement policy through value-added products. Therefore, the government bodies located in the regions play a major role in encouraging various farm and community groups to conduct their activities steadily and in a sustained manner. The support covers many areas, such as funding of housing for processing, provision of processing equipment, investment funds and training on processing techniques. Furthermore, the public sector often invites the group to display its

product exhibitions of food and other goods in the district and in the provinces. As a result, the group's products are now well recognized in the Sukhothai province as well as in adjacent provinces.

- The group is well organized and work plans are formulated, which include a production plan, a quality-enhancement plan, a marketing plan, group development plan, and assessment performances. Every year an annual performance report is conducted.
- The production cost of soybean paste is relatively low and its price is competitive against the larger firms that distribute equivalent products nationwide. The local and year-round availability of raw materials are associated with freshness. Moreover, the local crops have a higher protein content than imported soybean. There is no burdensome transportation costs and the group operates its own premises and equipment.

Public support is very important in creating a plan, or a project, to increase the income of farm families and farmer groups. In this regard, the province of Sukhothai has adopted a major development strategy to create continuous economic activities in the agricultural sector by providing marketing knowledge to the supplementary enterprises in the province which focus on poor villages in order to alleviate poverty. Consequently, the provincial government's agencies have promoted projects to raise household income. One of the provincial strategies is to increase the value of agricultural products. To achieve this, a promotional processing project has been launched for 25 agricultural products. One of the commodities is the soybean paste of the Farm Housewife Group in Bungprayod. The Provincial Administrative Organization (PAO) has formulated the project entitled Farm Processing Housing Improvement, based on Good Manufacturing Practices (GMP). There are two programmes within the project; the promotional processing programme, which organizes processing training courses, and the promotional production programme, which includes the Ruamjai Farm Housewife Group's soybean crop and processing of the Chinese fermented soybean grain sauce.

There are five supplementary earning groups in ten villages in the Klongmaplub sub-district that make both processed food and non-food products. All five groups are given access to TAO-funds for local processing and to build processing related facilities, for example small scale processing houses. If a group requires capital, a project proposal must be formulated. After the proposal has been approved by the village head, the proposal is sent to the TAO. Based on fund availability, the proposals are then judged on operational guidelines and responsibilities within the proposed project, and its estimated benefits.

Potentials, constraints and recommendations

From this case study, several salient potentials, constraints and recommendations can be made. Production and marketing potentials of the organization exist. The group always tries to strengthen its organization, and its efforts are concerted. In addition, the group strives for changes, growth and income accumulation. Processing technology transfers from public agencies are well accepted in the attempt to enhance productivity. Furthermore, the Farm Housewife Group takes study tours to visit similar processing farm groups in other provinces and thereafter transfer the new knowledge component to its members. In the group's attempt to improve product quality, it seeks co-operation with outside bodies, namely the TAO and the Village Committee.

The group is also facing several constraints and difficulties, such as the white flies that sporadically attack soybean cultivation. To control the pest, some agro-chemicals are used that force the group to move its acquisition of soybean to other areas. The cost of production and marketing tends to rise. The expenditure includes the procurement cost of soybean, sugar, salt, and packaging. Transportation costs are also increasing because of higher fuel prices. Furthermore, low product quality, especially the product colour and fungi colonies, fails to meet the standard regulations. In addition, the packaging is old-fashioned and unattractive, and a lack of expertise in accounting and poor management skills prevail. Although work plans are set, group members are still short in management ability. The market for the product is too small as the product is only sold within the district and the province. On the other hand, as all members are engaged in rice cultivation, processing is only carried out once a month during spare time and, therefore, the production volume is not large enough to expand to other areas.

To improve the Farm Housewife Group's and other similar processing co-operatives' profitability, six recommendations are addressed herein. First, research to develop pest and disease controls with no or minimal usage of agro-chemicals is necessary in order to control the white fly. Second, research and development on products and subsequently transferring the research results to the farmers and farmers' organizations would also help to improve the quality of the processed products. Third, training is vital and therefore government agencies, including academic institutions, should take a leading role in disseminating information to farmers regarding product quality, advanced processing, storage and modern packaging in order to meet consumers' preferences and food safety standards. Training on management skills and marketing are also important. Fourth, improve the marketing plans and public relations. Various media should be approached, including the radio and advertisements on the local governmental websites. Although an increase in price may be necessary due to additional costs, a food safety guarantee would attract consumers. Finally, as the Housewife Group's work capacity is limited the production volume is low, so it could be worth hiring additional labour.

Conclusions

The public agencies in Sukhothai province have encouraged the Ruamjai Farm Housewife Group to operate the farm processing business to add value. Soybean paste production is the group's main product. Currently, the processing capacity is increasing, along with income and profit. The profit dividend is divided for the individual group member's savings and a collective fund for further farm investments. Family income increases with the extra earnings from the processed crops rather than the usual sale of unprocessed soybeans. The farm investment fund reduces farmers need to take loans from financial institutes and increases their ability to repay outstanding loans.

Factors contributing to the success of the group are numerous, including strong, devoted leadership, industriousness, and public support of various kinds. Seeing the advantages of group efforts, the members actively participate in the processing business. Availability of local raw materials for the Ruamjai Farm Housewife Group, leads to lower processing costs compared to competing processing firms.

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Maize Development Improves the Livelihood of the Poor in Viet Nam

*Dao The Anh, Vu Trong Binh and Dao Duc Huan**

Abstract

The agricultural sector in Viet Nam has achieved stable and sustainable growth over the last 15 years, with specialization in husbandry, more specifically swine. Additionally, maize has become the main ingredient of swine feed. The province of Son La is considered as the new maize basin of Viet Nam, located in a remote area with a high poverty rate. A study of this commodity chain helped draw the following conclusions:

- Technological development has changed the Vietnamese maize industry by expanding cultivation area and improving productivity.
- Production development has contributed to changes in living standards and traditions in many areas, especially in areas populated by minority groups.
- The actual structure of the maize commodity chain has negative impacts on the market access of poor people.

Together with production development, the demand for maize from husbandry and feed production continues to rise and domestic maize production cannot satisfy this demand. Furthermore, current impacts of public extension are not decisive in this development, except hybrid variety development. Policy recommendations focus on a strategy to develop adequate extension services in remote areas in parallel with the promotion of farmer organizations to ensure the country's maize competitiveness through international trade integration.

Background

From 1980 to 1990 maize cultivated area in Viet Nam grew by an average of just 1 per cent annually, whereas rice production expanded rapidly, and fully met domestic demand (Figure 1). Maize was increasingly used for animal feed. However, the use of new varieties was limited and the average yield in 1990 was still only 1.55 tons per hectare.

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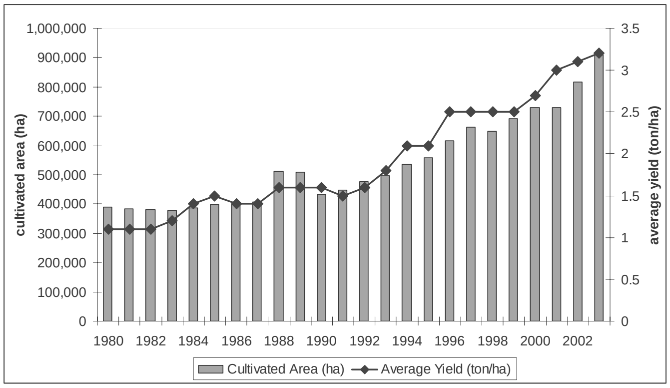
Figure 1. Viet Nam's maize production, 1980-2003



Source: Vietnam Statistical Yearbook, 1980-2003.

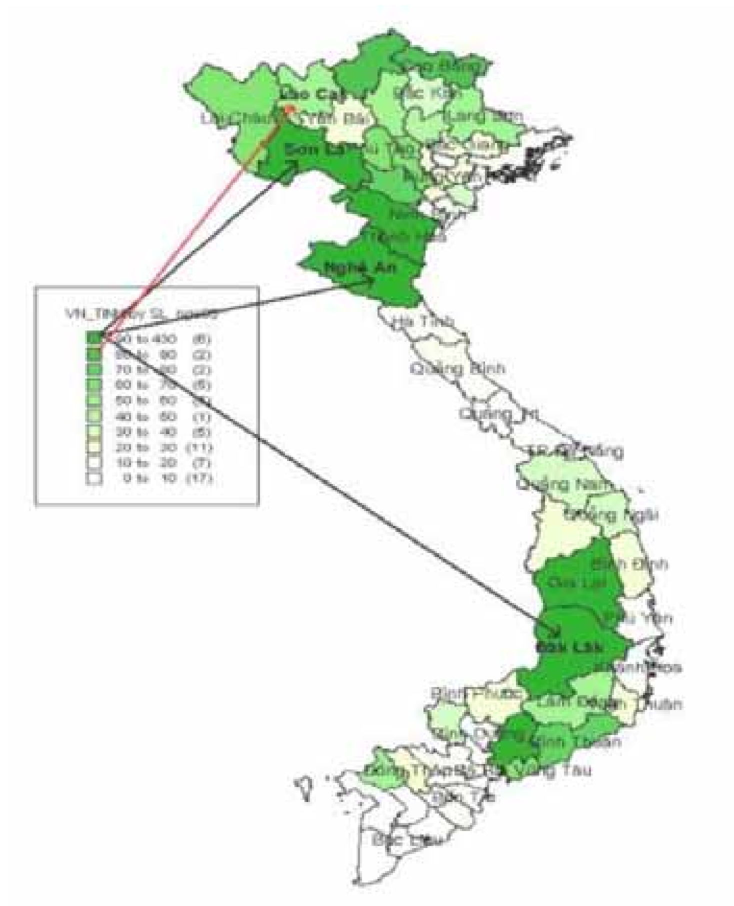
The animal husbandry sector grew quickly in the period of 1990-2003 and the demand for maize as animal feed steadily increased. The policy of granting land-use rights for sloping land also stimulated maize production. Furthermore, investment in large-scale animal feed processing companies in Viet Nam boosted maize demand.

The cultivated area of maize increased from 431,800 hectares in 1990 to 909,800 hectares in 2003. In 2002, hybrid maize was used on 80 per cent of the total maize area. The average yield rose to 2.7 tons per hectare in 2000 and in 2003 the average harvest yielded 3.2 tons per hectare. Production in 2003 totalled 2.9 million tons (dry substance). Furthermore, maize production is becoming more diversified in the cropping year with the emergence of winter maize in Nghe An, Dak Lak and Quang Binh, and stronger market-orientation of maize growers in the northeastern province such as the Son La, which used to be almost exclusively subsistence production.

The Government of Viet Nam (GoV) has approved a national seed development programme, including specific research and development on maize seeds, especially hybrids. The Institute of Maize Research under the Ministry of Agriculture and Rural Development (MARD) is leading the development of high-yielding maize varieties that are suitable for different ecological zones and affordable to the farmers. Some domestically developed maize varieties have been successful, for example the LVN10 variety widely used in Son La, Hoa Binh and other provinces. However, the national budget between 1999 and 2004 for hybrid maize development of national varieties and breed programmes was only VND 4.1 billion (approximately US$250,000), while the entire research funding for the Institute of Maize Research totaled just VND 8 billion (around $500,000) during the period 2001-2004.

Map 1. Production of maize of provinces in Viet Nam, 2003

Gross output of maize in 2003 (thousands tons)



Source: Statistic Yearbook data, 2004.

The government provides specific transportation and price subsidies (*tro gia tro cuoc*) for maize seed and fertilizers, which are targeted towards marginalized areas and poor farmers to promote trade in mountainous areas, through provincial authorities and service companies. The provinces also provide additional subsidies on seed, fertilizers and/or transport to encourage farmers to apply new technologies for higher yields. These subsidies are also directed towards the development of a second maize crop on hilly slopes in Son La. However, the total subsidy level is extremely low and declining. Furthermore, fertilizers are utilized to grow rice in the valleys and a range of secondary crops, hence only a negligible part is used for maize production. For maize the share of fertilizer has increased but the poorest farmers still only use limited amounts of fertilizer. Consequently, the fertilizer subsidy is irrelevant for marginalized farmers.

A few additional subsidies and support measures should also be mentioned. Loans from the Bank for Social Policy targeted at the poorest households in the poorest communities are often used for investment in fertilizer or livestock. As the loans are subsidized the interest rates are a few per cent lower than commercial rates. The loans are typically VND 5 million (just over US$ 300) or less, to be repaid over a period of normally more than one year. An upper estimate of 5 per cent subsidy on the annual interest provides a maximum US$ 12 per year in subsidy per targeted poor household. Subsidies are provisioned for inputs to demonstration models intended for improved (hybrid) maize farming, and also for training costs in agricultural extension activities, which are limited to a few communities and farmers. The total state budget from 1993 to 2003 for extension programmes focusing on maize farming was VND 9.95 billion (less than US$ 700,000).

Scope and methodology of the study

This study focuses on three elements: (1) an analysis of market changes in international and domestic maize markets; (2) assessing the characteristics of maize-based household production; and (3) farmers whose primary income is maize and their potential integration possibilities into a new international maize market. For this purpose, we conduct the case study in Son La province, where maize production growth has been most rapid in recent years. Mai Son district in Son lL province is one of the most production intensive regions in Viet Nam.

We selected two communes to conduct a household survey, of which one has developed commercial maize and has access to market. The other commune is poor and faces constraints to maize production and market access. Prior to meeting with the households, we implemented surveys and an assessment of the current situation of the local maize market was also carried out. Moreover, information was gathered on existing product channels and the mechanisms involved in the exchange of goods in order to link market and production activities. A market overview, supply and demand relationships, linkages between product channels, and consumption in the local and delta areas were also investigated. Based on the results of the commercial system survey, we selected two villages from the two communes that have different production conditions and characteristics.

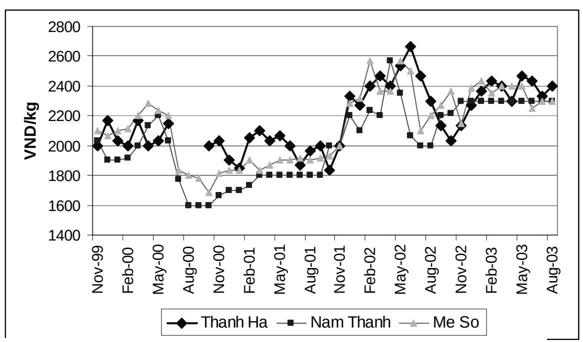
In each village 20 households were surveyed. The households were classified according to poverty level and maize production. The survey aims to clarifying each household's situation, with a focus on the poorest households and their possibilities to access different local channels, as well as a description of the limits that the poorest households, which cannot access new market channels, have.

The paper starts with a short overview of the developments in Viet Nam's maize market since the 1990s. Then the results from the case studies in the two areas in Son La are presented. Market participation in the province and its impacts on poverty alleviation is provided in the penultimate section. Finally, conclusions and policy recommendations are offered.

Trends in imports, exports and the domestic market

Viet Nam's maize prices have shown an average upward trend over the period 1999-2003 with seasonal price fluctuations. Figure 2 presents the maize retail prices in the Red River Delta.

Figure 2. Maize retail prices in Red River Delta markets

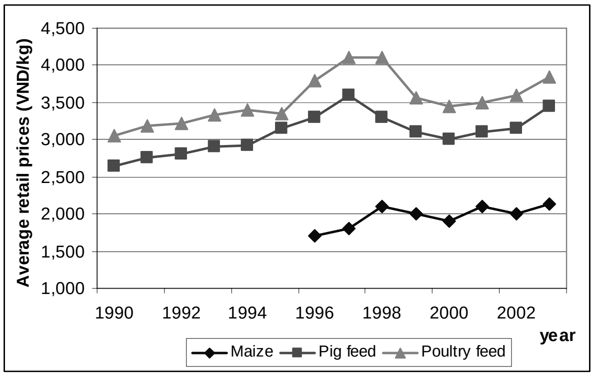


Source: Vietnam Agricultural Science Institute, 2004.

After rice, maize is the most important staple food crop grown in Viet Nam. Maize is also important as an input for animal feed. In the period of 1993-2003, the growth rate in pig production increased by 5.3 per cent per year and poultry by 7.1 per cent. The share of animal feed in total maize production increased from about 20 per cent in 1990 to about 70 per cent in 1997, and has remained more or less stable since. These numbers include maize for fodder on farms and maize sold and processed by the animal feed industry.

Figure 3 shows the retail prices of poultry and swine feed as well as maize. In 2002, the retail price of poultry feed was approximately VND 3,750 per kilo, slightly less for swine feed at VND 3,500 per kilo and significantly less for maize, about VND 2,100 per kilo.

Figure 3. Average retail prices of maize, pig feed and poultry feed in Viet Nam

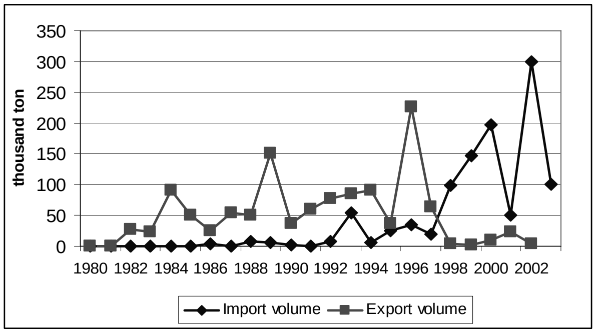


Source: The Government Pricing Committee, 2003.

Maize constitutes about 35-40 per cent of each ton of processed animal feed. Domestic animal feed prices have risen in recent years in parallel with domestic maize prices. However, the correlation is not strong and seasonal fluctuations in maize prices are not reflected in animal feed prices.

The animal husbandry sector has developed rapidly since the late 1990s and has boosted domestic demand. However, this higher demand could not be met by domestic production, and consequently Viet Nam changed from a net exporter of maize to a net importer. Annual imports of maize fluctuate strongly, and as shown in Figure 4, the overall trend since 1997 has been climbing. In 2002, maize imports were less than 15 per cent of total domestic production, while maize exports remain virtually zero.

Figure 4. Annual maize imports and exports to and from Viet Nam



Source: Informatic Centre of the Ministry of Agriculture and Rural Development, 2003.

Case studies in Son La: rapid maize growth and its impact on the poor

Son La has comparative advantage for maize cultivation in terms of land and climate. A new factor fostering the development of maize in Son La has been rapid market[1] development. The demand for maize from animal husbandry and the cattle feed processing industry has created conditions that allow farmers to expand their cultivation. Maize production on sloping land in the mountains totaled an area of almost 65,000 hectares in 2002. Son La has become the leading maize producing province in the north and has been an important maize supplier to the Red River Delta market.

Comparative analysis of diverse maize farming systems in Son La

Mai Son is a district in Son La province that specializes in maize. Production in the district has developed strongly, especially in terms of productivity, with many hybrid maize varieties such as Bioseed, DK999, DK888 and LVN 10. These are advanced scientific achievements and have effectively been applied by farmers. Many areas have achieved productivity of 50-60 quintals per hectare and average yields in Mai Son district increased from 19.3 quintals per hectare in 1995 to 43.2 quintals per hectare in 2002. This specialization was primarily attributable to the market, due to high maize demand in the Delta. However, the market impact varies in the communes as access to infrastructure differs in the various regions. We conducted the study in two communes with contrasting conditions; Phieng Pan and Co Noi in Mai Son district.

[1] Maize commodity sector in the North of Viet Nam, 2002 - Dao Duc Huan, Vu Trong Binh, Dao The Anh – Agriculture Subject – Vietnam Institute of Agricultural Sciences and Techniques.

Phieng Pan Commune – an area with poverty reduction challenges

The case study of Phieng Pan commune focuses mainly on the contribution of maize intensification for poverty reduction. Being a commune in a remote area where ethnic minorities like the H'mong and the Sing Mun live, socio-economic development issues in general and agricultural development in particular, give Phieng Pan the following characteristics:

- Maize production by poor farmers is underpinned by policies such as allowances and subsidies for seeds and support funding for farming;
- Cultivation is chiefly shifting cultivation on the hillsides. The area set aside for rice production is not large enough and is not evenly distributed among areas. Many villages do not have wet rice fields. Maize is still retained for human consumption. Animal husbandry activities are undeveloped.
- Farmers often sell their maize directly from the fields as they lack facilities for crop storage. Local maize is dried on the fields. Transportation of maize encounters many problems, especially in the rainy season that coincides with the main maize harvest. As a result, private traders can often pay less than the actual price for maize.
- Hybrid varieties of maize were introduced in 2000.

Co Noi – a developed area with market access but environmental issues

Co Noi is the commune with the largest contribution to the district’s budget. With favourable market access, located next to Highway Six, access to modern technology like hybrid seeds and fertilizers, and with nutritional basalt soils, Co Noi has become the most specialized farming centre of Mai Son district.

The production system is rather simple with three principal crops. Wet rice that is cultivated at the base of the fields to make use of the natural water streams. Maize is the main crop. In 2003, the maize area accounted for 49 per cent of the total cultivated area. Sugar-cane is a new crop in the commune and was introduced in 2001 in accordance with Son La’s policies to alter the crop structure. In 2003, the sugar-cane area amounted to 507 hectares of flat land.

Currently, agricultural production is mainly rainfed and intensification is therefore difficult. Under current conditions, farmers chose to cultivate and expand maize on the hill sides. Swine husbandry remains underdeveloped because the farmers lack production skills, and instead, maize has become a significant crop. However, there are still a number of problems in the existing production process, such as poor transportation during the rainy season, and issues surrounding the impoverished land are yet to be resolved.

Poor farmers emerge through the inequality of land where the poorest households sell their land, or rent out land, so they can be hired by other people. Farmers who rent land are mainly from the plains. They have developed production by introducing intensive farming methods. However, the area is not expensive due to irrigation difficulties. In 2003, the total irrigated area was only 14.7 hectares. Intensification of maize production causes severe soil erosion on sloping land.

Production systems of various categories of household

The income poverty line defined by the government is VND 80,000 per capita per month. The main factors leading to differences in income levels are the size of cultivated area, intensity of farming and the number of heads per household. The households are divided into three categories; poor households, medium households and well-off households. In Table 1, the characteristics of three categories in the two communes are displayed.

Table 1. Characteristics of production systems of various household categories

Criteria	Unit	*Co Noi*			*Phieng Pan*		
		Poor	Medium	Well-off	Poor	Medium	Well-off
Rate of household	%	18.5	40.7	40.7	25.64	46.15	28.21
Production conditions							
No. of heads/HH	Persons	8.60	7.09	6.09	7.50	7.44	7.00
Labour/household	Persons	2.80	2.73	2.64	3.10	2.56	2.91
Agricultural land	m^2	12 080	21 090	34 955	17 540	25 009	32 432
Forest land	m^2	800	909	5 000	1 000	9 700	7 728
Production system of farming households							
Maize	m^2	10 800	14 090	24 182	15 490	22 550	28 818
Rice - Rice	m^2	800	2 227	773	2 050	2 459	3 614
Sugar cane	m^2	0	4 227	7 000	-	-	-
Rice - Bean	m^2	480	545	3 000	-	-	-
No. of pigs/HH	Heads	1.0	0.0	0.4	0.9	2.2	4.1
No. of cattle	Heads	1.2	1.3	2.8	1.8	2.5	6.0
No. of poultry	Heads	19.0	9.2	13.2	5.8	15.7	28.2

Source: Survey by the Agrarian System Department, VASI, 2005

Table 2. Summarizes the three household categories in Co Noi and Phieng Pan.

Table 2. Characteristics of the households in Co Noi and Phieng Pan Communes

	Co Noi commune	Phieng Pan commune
Poor households	• 18.5 per cent of the total number of households. • Labour availability, little agricultural land. • Wet rice production is insufficient to ensure food safety. • Intensification of maize is still limited.	• 25.6 per cent of the total number of households. • Available labour, little agricultural land. • Wet rice production is insufficient for family food demand. • Commercial maize production is at low levels and very much depends on external investment.
Medium households	• 21,090 m^2 of agricultural land. • Agricultural diversification with maize, sugar cane and wet rice. • Intensification of production is high.	• 46.15 per cent of the total number of households. • Production systems based on rice and maize but the land conditions are better than for the poor households.
Well-off households	• 40.7 per cent of the total number of households. • Few heads per household and plenty of land. • Food safety is secured so it is possible to investment in commodity production, especially in maize and sugar cane.	• More than 28,800 m^2 of maize land, households of this type have the highest level of intensive farming. • Cattle husbandry is important for the household.

Source: Survey by the Agrarian System Department, VASI, 2005.

Intensification of maize production

Farmers in Co Noi early undertook commercial maize production development prior to Phieng Pan and they also invest in fertilizers. Intensive farming has been practiced in Co Noi for a relative long period and in many maize milpas, maize has been grown for the last 15 years. As no additional measures to improve the soil have been implemented it is now degraded and extra investment in fertilizer has to be made annually to maintain productivity. As shown in Table 3, farmers in Co Noi produce between 5.4 and 5.7 tons per hectare compared with 3.7-4.5 tons per hectare in Phieng Pan i.e. about 27 to 46 per cent higher yields. However, fertilizer usage is significantly higher in Co Noi where the farmers use almost 3.5 times as much fertilizer. In Phieng Pan the poorest households' average usage of fertilizer is about 160 kilograms per hectare and the richest use approximately 270 kilograms per hectare, while in Co Noi the better off households use less fertilizer than the poorest and medium households, but they still achieve higher yields. Also, poor and medium income households hire substantially fewer workers than the richer households.

Table 3. Production efficiency of different household categories

Criteria	*Co Noi*			*Phieng Pan*		
	Poor	Medium	Well-off	Poor	Medium	Well-off
Productivity (kg/ha)	5 668	5 369	5 706	3 664	4 357	4 502
Total cost (VND/ha)	1 898 995	2 284 115	2 127 201	885 378	909 785	1 054 074
Turnover (VND/ha)	10 523 222	10 291 572	11 216 264	5 602 533	7 373 975	7 792 931
Profit (VND/ha)	8 624 227	8 001 247	9 083 011	4 717 155	6 464 191	6 738 857
Labour productivity (VND/day)	50 767	52 614	60 176	32 698	51 328	55 451
Quantity of materials used per hectare of maize						
Seed quantity (kg)	18.64	19.68	19.24	16.42	18.64	18.33
Nitrogenous fertilizer (kg)	*139.71*	*267.98*	*223.29*	*47.56*	*99.02*	*154.48*
Phosphate (kg)	*273.96*	*256.13*	*346.77*	*108.75*	*82.90*	*119.62*
NPK (kg)	*278.88*	*226.67*	*106.57*	*0.00*	*2.63*	*0.00*
Total fertilizer (kg)	692.55	750.78	676.64	156.31	184.55	274.10
Hired labour (person)	5.04	3.04	11.73	6.02	2.13	8.06

Source: Survey by the Agrarian System Department, VASI, 2005.

In Phieng Pan, there is a greater difference in agricultural intensification between the various categories of household than in Co Noi. Phieng Pan is relatively far from the main road and commercial maize production with hybrids was only introduced in 2000, also, due to access difficulties, seeds are often of low quality. Many farmers lack know-how regarding chemical fertilizers and new hybrid varieties. Furthermore, farmers often lack market updates such as the possibility to sell corncobs rather than corn seed, which require less post-harvest handling. Therefore, to improve farmers' knowledge, extension support from the government is required.

The role of maize in the households

The income gap between the poor, medium and well-off groups is considerable. The well-off households in Phieng Pan generate more than 4.5 times as much income than the poor households and in Co Noi the richer households have almost four times more income (Table 4). Household income in the two areas is highly dependent on maize cultivation, of which poor households are more reliant. While the income from maize to poor households accounts for up to 78 per cent in Co Noi and 76 per cent in Phieng Pan, the figures for well-off households are only 61.5 per cent and 65 per cent, respectively. Hence, the income of well-off households is more diversified. Sugar cane is a relatively good supplementary source of income in Co Noi, while animal husbandry in Phieng Pan helped well-off households augment their income. Thus, poor households are more vulnerable to changes in the maize market, as supplementary sources of income for this household category are very limited.

Table 4. Income structure of different farmer households

Criteria	Unit	*Co Noi*			*Phieng Pan*		
		Poor	Medium	Well-off	Poor	Medium	Well-off
Rate of household	%	18.5	40.7	40.7	25.64	46.15	28.21
Average income	VND/cap/month	111 579	204 466	493 898	102 515	211 603	378 542
Rate of income from cultivation	%	94.04	89.21	95.01	97.97	95.06	79.63
Rate of income from maize/Total income	*%*	*78.08*	*57.66*	*61.54*	*76.27*	*78.68*	*65.10*
Rate of income from rice/Total income	*%*	*3.73*	*3.29*	*1.65*	*20.22*	*15.43*	*13.91*
Rate of income from other crops/Total income	*%*	*12.22*	*28.26*	*31.82*	*1.48*	*0.95*	*0.61*
Non-agricultural income rate	%	3.02	10.79	3.68	1.32	2.04	10.11
Income from animal husbandry	%	2.94	0.00	1.31	0.70	2.90	10.26

Source: Survey by the Agrarian System Department, VASI, 2005.

Diverse market participation and impact on the poor

Material supplies, such as seeds and fertilizers, are an indispensable part of the production process. Household income is thus highly dependent on input prices and the prices also affect household investment decisions.

Farmers' choices of supply sources depend on the household's cash availability. Private suppliers offer credit, which government suppliers do not. Therefore, poor households with little cash and which require credit are more reliant on private companies. As shown in Table 5, richer households prefer to buy their inputs from government agencies rather than the private alternative, as the former provide better product quality.

Table 5. The number of households purchasing production materials from various sources

(percentage)

	Co Noi			Phieng Pan		
	Poor	Medium	Well-off	Poor	Medium	Well-off
Seed purchases						
From the government	40.00	63.64	63.64	0.00	16.67	18.18
From private traders	60.00	36.36	36.36	100.00	83.33	81.82
Fertilizer purchases						
From the government	40.00	63.64	63.64	10.00	44.44	45.45

Source: Survey by the Agrarian System Department, VASI, 2005.

The effects from changes in market prices on production are quite similar for the two markets of seeds and services. However, changes in prices of fertilizers have the greatest impact on production. Consequently, poor households are effected less due to their limited use of fertilizer compared to the better-off households.

Farmers in Son La province participate extensively in the market through the amount of maize sold that they produce. In Co Noi, between 96 per cent and 99 per cent of the maize is sold to the market by farmers, which shows that there are no real differences in production purposes between the three household strata (Table 6). In Phieng Pan the percentage of maize sold was slightly less, varying from about 90 per cent to almost 94 per cent. As shown in Table 6, maize that is not sold is mainly used for human consumption and only a small portion is used for animal feed in Phieng Pan. In most cases, maize used for human consumption is only used as traditional food and not as a substitute for rice. However, many poor households experience food shortages and during such periods they have to consume their maize for survival. Therefore, the amount of maize that is used for human consumption accounts for the higher percentage in Phieng Pan than Co Noi. However, the human consumption is still only between 5 and 10 per cent of total maize production.

In both areas, well-off households harvest more than double the amount of poor households and they are able to sell their produce at slightly higher prices (Table 6). One of the reasons for the higher prices received is that those households are able to sell frequently, which allows them to sell when the prices are higher. Better-off households also tend to sell to various types of buyers, namely collectors, traders and transporters that allow them to sell to the highest bidder. Poor households don’t have the same opportunities because they often have bought their inputs on credit and are in need of cash. Even though the poorest households have slightly more family labour available these households hire considerably fewer workers and, overall, poor households have access to less labour compared to well-off households.

There are differences in the market participation capacity between the various categories of households. Farmers can time sales and the quantities sold, although poor households often have fewer chances to select the number of sales due to financial debt pressure. The poorer the household is, the higher the rate of selling maize only once per crop cycle. This could also be interpreted as a result of the difficult conditions of labour and transport.

Table 6. Participation in the maize grain market

Criteria	Unit	Co Noi			Phieng Pan		
		Poor	Medium	Well-off	Poor	Medium	Well-off
Maize quantity/year	Kg	6 440	7 355	13 814	6 022	10 224	14 273
Amount sold /year	%	97.2	99.0	96.1	89.74	93.66	90.97
Amount eaten by humans	%	2.8	1.0	3.9	9.78	5.39	7.80
Amount of maize for husbandry/year	%	0.0	0.0	0.0	00.48	1.00	0.93
Number of HH selling once	%	80.00	72.73	54.55	70.00	61.11	36.36
Number of HH selling twice	%	20.00	27.27	27.27	30.00	22.22	27.27
Number of HH selling three times	%	0.00	0.00	18.18	0.00	16.67	36.36
Sales to collectors	%	77.78	72.22	63.64	60.00	72.73	81.82
Sales to traders	%	22.22	16.67	9.09	40.00	18.18	0.00
Sales to transporters	%	0.00	11.11	27.27	0.00	9.09	18.18
Free sales	%	40.00	63.64	45.45	20.00	27.78	54.55
Sales to material suppliers	%	60.00	36.36	54.55	80.00	72.22	45.45
Product sales price	VND/kg	1 857	1 917	1 966	1 529	1 692	1 731

Source: Survey by the Agrarian System Department, VASI, 2005.

When evaluating difficulties in production and trade, we have focused on the following three factors that closely relate to the market; fertilizers, product selling price and transportation services. Farmers in Son La were asked to state the importance of these three factors in terms of their maize production. The results from the survey are displayed in Table 7. High fertilizer prices and transportation difficulties are viewed as much more of a threat than the price of maize. From the sample, poor households' responses are also separately displayed in Table 7. For example, only 25 per cent of this group feel that transportation difficulties will exacerbate their maize production as compared with 36 per cent the total sample. This outcome does of course reflect the poor households' investment possibilities, but often these households only recognize one market and lack knowledge about the casual relationship in the maize market.

Table 7. Production difficulties faced by farmers in Son La

(percentage of households)

	Son La	
	Poor	Total
High cost of fertilizer	25.0	33.2
Low price of maize	5.0	5.7
Transportation difficulties	25.0	35.7

Source: Survey by the Agrarian System Department, VASI, 2005.

Conclusions and policy recommendations

Based on the general assessment of maize production and market development, we can clearly be aware of the development tendencies and changes in consumption as well as production. Many countries influence the global market through their implementation of policies that lead to market distortion, which further creates difficulties for the integration and adaptation of new members of the World Trade Organization (WTO). This study helped draw the following conclusions regarding production, consumption and demand, as well as products and service.

Production

Technological developments, in terms of hybrid seeds, have changed the Vietnamese maize industry by expanding cultivation areas and boosting productivity. Domestic production has formed large specialized areas like the areas in Son La province. However, maize production has also triggered environmental problems.

Production development has contributed to improve people's livelihoods, in particular for the poor, in many areas, especially in areas with minority groups. As poor farmers own small farms, they need to co-operate to revive services, in particular regarding post-harvest. It seems plausible that the difference in the selection of sales agents and the dependence on fertilizer suppliers have caused the difference between the groups of farmers. Poor farming households are more dependent on suppliers and collectors. They have very few chances of direct transaction with traders, or transporters, due to other binding priorities.

Consumption and demand

The demand for maize for animal husbandry and fodder production continues to increase and domestic maize production cannot satisfy the demand. Furthermore, the demand for human consumption is still important for ethnic groups in Son La province. Animal husbandry production has formed specialized areas such as the Red River Delta, which has become the engine of development.

Product and service orientation

The maize market in Son La is relatively active. The development of private systems and increasing levels of professionalism of the trading agents exemplify this. Different levels of market participation by different categories of household has resulted in a complicated chain from the market all the way down to the fields, while local and governmental policies for production support are not comprehensive and not in the interest of the farmers. It is also important to offer small farm households advice regarding agricultural products and input markets so this group can be less dependant on the credit offered by private traders. As Viet Nam is a part of globalization, increasing maize imports will economically affect the well-off households as they have the highest farm investment with the most intensive agriculture. However, the poor households will suffer the most, due to a reduction in income, especially in the areas where maize is the sole provider such as the farmers in Son La province.

Policy recommendations

We conclude the paper by recommending a number of policies that will support Viet Nam's maize producers. Vital for sustainable maize production is for the government to support and promote agricultural practices that are environmentally friendly; strengthen maize production for domestic food security, particularly for home-grown food crops of specific household groups in remote areas; and improve intra-branch maize diversification by marketing for niche markets such as artisan local wine production and sweet maize for the urban market.

In the context of the WTO, in addition to international trade policy, the concrete support measures generally fall in the WTO's 'Green Box', which facilitates improvements in production, processing and marketing.

Poor maize producers require adequate public extension services for farm inputs and credit, in order to access good quality seeds to sustain their production systems. It is therefore important to develop and strengthen producer groups' initiatives for collective action to enable better market access and market information. Furthermore, improve the pre-processing and storage capacity for maize farmers and introduce post-harvest technologies to improve the grain quality. Farmers' credit and savings groups including women and the youth should be encouraged further where low interest rates on credit should go hand in hand with the promotion of sustainable agricultural technologies. In order to be fully successful, adult literacy in ethnic minority communities must be addressed.

Agriculture in upland areas must be improved and public plant breeding organizations should therefore focus their resources on suitable varieties, primarily traditional varieties, for the upland ecology. Research, development and promotion of high-yielding varieties for the better-off commercial farmers should chiefly be left to the private sector. It is also important that plant protection is further developed. Terrace developments and vegetation-cover methods in upland areas together with small-scale irrigation schemes can make maize production sustainable, and help develop local agricultural production. Finally, improve transportation conditions, especially in remote villages, for example with 'production roads' to maize fields in specialized areas, for example in Son La province.

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The Impact of Potato and Sweet Potato on Poverty in Asia

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Abstract

Secondary root crops like potato and sweet potato play very important roles in the livelihoods of poor rural households in Asia. Therefore, improvements in the productivity of these crops are likely to have significant and positive impacts on poverty reduction. Over the past two decades several new technologies for potato and sweet potato (crop varieties, higher quality seed, pest and disease management, and improved post-harvest utilization) have been developed and adopted by farmers in Asia. This paper uses quantitative and qualitative methods to assess the economic and poverty impacts of these technologies. First, a planning method is developed that uses net present value and poverty indicators to anticipate which new technologies are likely to have the most impact on poverty reduction. Then, evidence from a number of case studies of farmer adoption of new technologies is reviewed. The impacts of these technologies on the income of poor farm households as well as broader impacts on the rural economy are assessed. A qualitative scoring model is introduced that evaluates the impact of new technology on a set of poverty indicators. Research to develop improved potato and sweet potato technologies in Asia is found to have generated significant impacts on poverty reduction as well as giving a high rate of return on investment. The quantitative impact assessments and the qualitative scoring

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model indicate that certain technology is likely to have greater relevance for poverty reduction than others.

Introduction

With the largest number of the world's poorest people living in rural Asia, and a strong correlation between where the rural poor live and where potato and sweet potato are grown, increasing the productivity and value of these crops seems likely to represent a significant opportunity to reduce poverty. The International Potato Center (CIP) has been collaborating with Asian agricultural research systems on potato improvement since the mid-1970s and on sweet potato improvement since the mid-1980s, and to-date some important impacts have been realized. My objective in this paper is to review the economic impacts of CIP-related technology in Asia and assess their contribution towards poverty alleviation. In the next section of the paper I discuss poverty and poverty dynamics in Asia and how poverty indicators influence research prioritization at CIP. Following this, I review some *ex-ante* projections that CIP made in the mid-1990s on the potential economic and poverty impacts from CIP-related technology in Asia. This assessment was the product of a strategic priority setting exercise that analysed both the kinds of technologies that were likely to have the greatest impact and where these impacts were likely to occur. The assessment showed that Asia, and China in particular, held the largest potential economic impacts from CIP-related technology. In the third section I review the results of several *ex-post* impact studies of potato and sweet potato technology adoption in Asia. These studies indicate that in some cases the projections on impact made a decade ago were probably too optimistic, but in other cases the actual impacts have exceeded expectations. So far the largest global impacts of CIP-related technology have occurred in China, as the *ex-ante* impact analysis predicted. Moreover, there appears to be a significant "pro-poor" impact from many of these technologies, given that farmer adoption has generally occurred in relatively poor regions where small-scale farm households predominate.

Potatoes and poverty in Asia

To increase the impact of research on poverty alleviation, CIP has accorded priority to working in countries and regions where poverty levels are high and where potato and/or sweet potato play an important role in the food and agricultural system. In 2004, CIP published a new vision for its global research programme which identified 35 developing countries that met these criteria as the first priority for CIP. In Asia, these countries include

China and Korea Democratic People's Republic in northeast Asia; Viet Nam, Indonesia, Myanmar, the Philippines, Lao People's Democratic Republic and Papua New Guinea in Southeast Asia; India, Nepal, Bangladesh and Pakistan in South Asia, and some former Soviet republics in Central Asia and the Caucasus (International Potato Center, 2004). In its new Vision, CIP considered how it could contribute to the alleviation of several dimensions of poverty, including raising the incomes of very poor households by raising crop yield and market value, alleviating hunger and malnutrition directly by improving the availability of food staples for food insecure households, and reducing child and material mortality through the biofortification of food crops. To identify priority countries, CIP combined measures of the importance of potato and sweet potato per capita and the extent of extreme poverty in a country or region.

Because of the importance of poverty measures for allocating resources to agricultural research and development, it is useful to discuss what these measures mean in some detail. The most widely used measure to compare welfare among countries and regions is average per capita income measured in "purchasing-power-parity" (PPP) dollars. PPP dollars adjust for differences in purchasing power that a United States Dollar has among countries when converted into the local currency at the market exchange rates. For example, at the official exchange rate of 8.21 Chinese Renminbi per United States dollar in 2004, the Gross Domestic Product (GDP) per capita of China was $1,272. But at the PPP-adjusted exchange rate China's GDP per capita was $5,495 (World Bank, 2005). This is because the cost of many common consumer goods like housing, food, clothing, health care, and other services were cheaper in China than in the United States at market rate of exchange. Therefore, PPP dollars provide a sounder basis for making economic welfare comparisons among countries.[1]

Average per capita GDP or income is a limited measure of poverty because it does not take into account how evenly national income is distributed amongst the population. Better measures of poverty are the average income of the poorest 10 or 20 per cent of the population, the number of persons living below a poverty line at a given point in time, or the "poverty gap," which is related to the average income of those subsisting below the poverty line. Most countries have defined a poverty line that is usually based on a minimum amount of income required to purchase a certain amount of food and other basic necessities.

[1] The PPP exchange rate also has limitations. For example, it does not take into account differences in the cost of goods within different regions of a country or between rural and urban areas. It also assumes similar weights to a common bundle of goods across countries, although consumption patterns differ markedly across countries.

However, poverty lines as defined by governments differ among countries, and for making poverty comparisons among countries it is useful to rely on a common poverty threshold. The World Bank has developed poverty measures based on the number of persons subsisting on less than PPP $1/day and PPP $2/day. These poverty lines are measured in terms of PPP dollars so they reflect common purchasing power across countries. Persons subsisting on incomes below PPP $1/day are generally not able to acquire a minimum standard of basic necessities and are considered the absolute or extreme poor. People living on between PPP $1/day and PPP $2/day are generally able to obtain sufficient income for basic needs but may not be able to afford many amenities such as health care and education for their children. Moreover, this group remains highly vulnerable to unfortunate circumstances beyond their control. They are at serious risk of slipping into the extreme poverty category if a family member becomes ill or loses work, if crops fail, or if a natural or man-made disaster occurs. A further measure of the intensity and prevalence of poverty is the "poverty gap." The poverty gap is the difference between the poverty line and the median income of those subsisting in poverty, expressed as a percentage of the poverty line. For example, if a country has 50 per cent of its population subsisting on below PPP $1/day and a poverty gap of 20 per cent, this means that the median income of the 50 per cent living in poverty is only 80 per cent of the poverty line, or PPP $0.80/day.

Some welfare and poverty measures are presented for selected Asian countries in Table 1. The first group of countries consists of low income countries with an average per capita GDP under PPP $2,000. Nepal, Bangladesh and Lao Peoples' Democratic Republic all fall into this category. Although estimates of GDP are unavailable for Myanmar, Timor Leste and Democratic People's Republic of Korea, they also probably fall into this group. The second group consists of lower-middle income countries that have GDP per capita between PPP $2,000 and PPP $3,000. Pakistan and Viet Nam are the largest countries in terms of population that fall into this category. The third group of countries are considered middle income countries with per capita GDP between PPP $3,000 and PPP $6,000. China, India, Indonesia, the Philippines and Sri Lanka are included in this group. China has experienced rapid growth in per capita GDP over the past two and a half decades allowing it to graduate from a low income to middle income country.

Table 1. Population, income and poverty in selected Asian countries

Country	Population 2004 (million)	GDP/capita 2004 (PPP dollars)	Poverty rate (latest available year, PPP $) (% <$1/day)	(%< $2/day)	Poverty gap[a] (% of PPP $1/day)	Rural poor share of total poor[b] (%)	Children malnourished (% of age group)	Potato and sweet potato area (hectare per 1 000 persons)
DPR of Korea	22.7	n.a.	n.a.	n.a.	n.a.	n.a.	45.2	98
Myanmar	49.9	n.a.	n.a.	n.a.	n.a.	n.a.	41.6	9
Timor Leste	0.9	n.a.	n.a.	n.a.	n.a.	n.a.	46.7	7
Nepal	25.2	1 485	39.1	80.9	11.0	91.2	50.5	66
Bangladesh	140.5	1 875	36.0	82.8	8.1	77.9	48.5	24
Lao PDR	5.8	1 935	26.3	73.2	6.3	84.2	40.7	46
Mongolia	2.5	2 039	27.0	74.9	8.8	n.a.	24.6	41
Pakistan	152.1	2 210	17.0	73.6	2.4	72.5	36.8	8
Cambodia	13.6	2 338	34.1	77.7	9.7	n.a.	44.6	8
Papua New Guinea	5.6	2 564	n.a.	n.a.	n.a.	90.1	n.a.	253
Viet Nam	82.2	2 704	3.8	39.7	0.5	91.9	36.5	38
India	1 079.7	3 115	35.3	80.6	7.2	75.7	44.9	16
Indonesia	217.6	3 583	7.5	52.4	0.9	n.a.	42.2	12
Sri Lanka	19.4	4 173	5.6	41.6	0.5	n.a.	20.4	6
Philippines	83.0	4 558	15.5	47.5	3.0	53.8	32.1	20
China	1 296.5	5 495	16.6	46.7	3.9	61.3	14.2	81

Source: World Bank, 2005.

Note: [a] The Poverty Gap is the difference between the median income of the poor and the poverty line of PPP $1/day, expressed as a percentage of the poverty line.

[b] The share of poor living in rural areas is derived from national poverty lines for rural and urban populations.

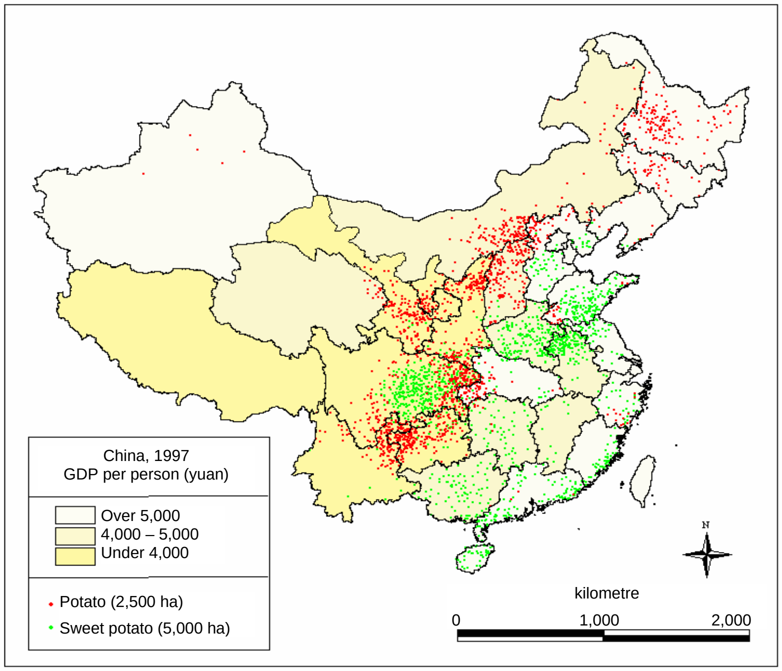
There is a negative but weak correlation between the average per capita GDP and the poverty rate. While growth in average per capita GDP can be expected to reduce poverty, the data in Table 1 indicates that some countries have been more successful than others in reducing poverty earlier in the growth process. Viet Nam, in particular, has been very successful in reducing the number of extreme poor even though it is still a lower-middle income country. India has tended to lag behind in poverty reduction despite a level of per capita GDP that places it in the middle income category. The figures on poverty rates demonstrate that extreme poverty remains widespread in Asia. Of the countries listed in Table 1 for which data on poverty is available, there were 723 million people living in extreme poverty in 2004, of which nearly 500 million were living in rural areas. Most of the rural extreme poor were concentrated in India (289 million) and China (132 million). While extreme poverty occurs mostly in rural areas, urban poverty as a share of total poverty will likely rise in the future with the growing urbanization of Asia.

The estimates of the poverty gap provide an indication of the increase in income that would be required to lift most of the poor out of poverty. In Nepal, with a poverty gap at PPP $1/day of 11 per cent, an increase in the income of PPP $0.11/day among the very poor would be expected to cut the poverty rate of 39.1 per cent in half, since the poverty gap is referenced on the median income of those in poverty. The figures in Table 1 show that there is a close correlation between the poverty rate and the poverty gap: as the poverty rate declines, the poverty gap also closes such that the task of lifting the remaining poor out of poverty becomes easier.

We can make the mistake of thinking of those in poverty as a rather well defined group, whereas in fact poverty is a very dynamic process. Studies that have tracked households over time in developing countries have found that there is high mobility both out of and into poverty, especially when a large share of the population subsists near the poverty line. Crop failures, family illnesses, general macroeconomic conditions and other factors cause household incomes to fluctuate from year to year and month to month. Therefore, when we talk of a poverty rate, or percentage of people living in poverty, it only gives us a picture of poverty at a point in time. Over a longer period, the share of the population experiencing extreme poverty can be much greater. An ICRISAT (International Crops Research Institute for the Semi-Arid Tropics) survey that tracked about 100 households in south India over a nine-year period found that while the poverty rate over the period ranged between 40 and 60 per cent, nearly 90 per cent of households experienced extreme poverty at least one year out of the nine ((Walker and Ryan, 1990). Households with per capita income between PPP $1/capita and PPP $2/capita are the most vulnerable to slipping back into extreme poverty. Policies that aim to eliminate extreme poverty should therefore not ignore these households. More than 60 per cent of the population of the countries listed in Table 1 earn less than PPP $2/capita, and about 70 per cent of these reside in rural areas.

Potato and sweet potato can play a critical role in helping to reduce poverty in developing countries. These versatile commodities are widely grown in marginal environments where there are large concentrations of poor. It is no coincidence that these poor people have chosen root and tuber crops as a major part of their livelihood system. These crops have high food-yield potential, short growing seasons, perform well in marginal environments and are good sources of nutrition. Potato, in particular, has a strong and growing market demand, and is considered in most of Asia as a high-value crop. Although market demand for sweet potato is more limited, it is an extremely versatile crop that performs well even with low external inputs and in marginal environments. Furthermore, the entire plant – roots as well as vines – is widely used as animal feed. The correlation between where sweet potato and potato are grown and where poor people live is illustrated for the case of China in Figure 1. Production of these crops is concentrated in interior provinces of China where per capita income growth has lagged behind the rapidly industrializing coastal provinces, and where most of China's poor now reside.

Figure 1. Poverty and potato/sweet potato production in China



Source: Robert J. Hijmans, International Potato Center, 2001.

Anticipating economic and poverty impacts of new crop technology

In the mid-1990s, CIP led by chief economist Thomas Walker conducted a strategic prioritization exercise to identify research opportunities likely to have the greatest economic and poverty impacts. CIP scientists were asked for their judgements about the likely economic impacts of specific kinds of potato and sweet potato research in developing countries, or in the case of China and India, in various provinces or states. For example, scientists passed judgements about what yield increases were likely from CIP's breeding programmes and how much adoption was likely to take place (Walker and Collion, 1997). Then, the likely time path for impact – how long it would take to develop a new technology and how quickly farmers were likely to adopt it – was estimated. With such data, Walker estimated a Net Present Value (NPV) from investments in alternative research endeavors. The NPV is the sum of annual net benefits (benefits to farmers minus costs of research and extension) from research over a planning horizon (in this case, 20 years), with a discount factor applied to future net benefits. This is a measure of the economic return to research. The NPV gives greater weight to larger impacts that are likely to occur sooner, and ones that require relatively less investment in research and dissemination to achieve. The economic model considered only the direct benefits of new technology on farmers, and did not take into account the effects on consumers (through lower food prices) or multiplier effects on rural economies. Potential impacts on poverty were determined by weighting total economic impacts by the extent of poverty in a region.

The results of this planning exercise indicated that large economic and poverty impacts could be anticipated from CIP-related potato and sweet potato technologies in Asia, especially China (Table 2). The net present value of these impacts exceeded US$1 billion (in 1996 dollars). China was expected to account for almost half of the projected impact, followed by India, Viet Nam and Indonesia. The large projected impacts for China should not come as a surprise, since in the early 1990s, China accounted for nearly 70 per cent of sweet potato area and 44 per cent of potato area in developing countries (FAO, 2005).

Among specific technologies considered, research on breeding high starch-yielding sweet potato varieties and the control of potato late blight (*Phytophtora infestans*) were expected to have the largest economic impacts. Increasing starch (or dry matter) yield in sweet potato was expected to be particularly beneficial to help meet the growing industrial demand for starch in China, and for use as animal feed throughout Asia. Late blight is considered to be the most significant disease of potato worldwide, and the breeding of resistant varieties as well as improving pesticide management were expected to bring large gains in potato yield as well as lower input costs. Other technologies expected to bring large benefits to Asia included use of True Potato Seed[2] as an alternative to clonal seed tubers (especially in South Asia), improved seed systems (primarily for virus control) for both potato and sweet potato, improved post-harvest utilization of sweet potato, and control of bacterial wilt disease (*Ralstonia solanacearum*) in potato. Integrated management of insect pests was expected to bring benefits primarily to tropical and sub-tropical regions of Asia where pest pressures are relatively high.

[2] True Potato Seed, or TPS, are the small botanical seeds found in the small fruits of the potato plant. These seeds can be used in lieu of tubers to grow potatoes.

Table 2. Projected impact of selected potato and sweet potato technologies in Asia, 1996-2015 (Net Present Value - 1996 million US$)

	China	India	Viet Nam	Indonesia	Bangladesh	Nepal	Philippines	Pakistan	Others	Total - Asia
Potato technologies										
Late blight control	100.0	82.0	2.7	3.7	15.9	13.6	0.3	5.1	3.1	226.5
True Potato Seed	39.8	50.1	1.8	0.0	0.0	15.9	0.6	4.5	0.5	113.2
Virus control and improved seed systems	83.1	0.0	3.2	4.1	16.8	0.0	0.2	0.0	0.3	107.7
Bacterial wilt control	51.0	0.0	0.0	4.9	0.0	5.4	0.3	0.0	0.0	61.6
Integrated pest management	0.0	0.0	0.0	16.5	15.2	8.2	0.0	0.0	0.4	40.3
Improved cropping systems	0.0	15.6	0.0	0.0	3.4	0.0	0.0	0.0	0.0	19.0
Improved potato storage	0.0	11.2	0.0	0.6	0.0	0.0	0.0	0.0	0.0	11.8
Sweet potato technologies										
High starch yield varieties	161.9	23.9	51.0	20.4	9.4	0.0	10.6	0.0	0.4	277.5
Improved post-harvest utilization	90.3	3.4	13.9	5.7	1.4	0.0	2.9	0.0	0.0	117.5
Virus control and improved seed systems	64.1	0.0	8.4	2.7	1.6	0.0	4.2	0.0	1.1	82.0
Integrated pest management	0.0	7.8	23.6	19.0	1.5	0.0	2.5	0.0	0.1	54.5
Total	590.1	194.0	104.5	77.5	65.2	43.1	21.7	9.6	5.8	1 111.6

Source: Walker and Collion, 1997.

Table 3. Anticipated benefits of potato and sweet potato research reaching the poor

By country	Benefits to poor households (million US$)	Share of total benefits (%)	By technology	Benefits to poor households (million US$)	Share of total benefits (%)
			Potato technologies		
China	287.4	48.7	Late blight control	148.7	65.7
India	152.0	78.3	True Potato Seed	73.1	64.6
Viet Nam	70.3	67.3	Virus control and improved seed systems	85.5	79.4
Indonesia	25.9	33.4	Bacterial wilt control	27.9	45.3
Bangladesh	47.7	73.2	Integrated pest management	23.0	57.0
Nepal	32.6	75.7	Improved cropping systems	15.0	78.8
Philippines	4.6	48.1	Improved potato storage	8.7	73.7
Pakistan	4.6	48.1	**Sweet potato technologies**		
Others	9.5	53.2	Improved post-harvest utilization	8.7	73.7
			High starch yield	139.7	50.3
Total-Asia	634.7	57.1	Improved post-harvest utilization	54.1	46.0
			Virus control and improved seed systems	28.7	35.0
			Integrated pest management	30.3	55.6

Source: Walker and Collion, 1997.

Walker and Collion (1997) assessed the impact of these technologies on poverty by looking at the extent of extreme poverty in the regions where adoption was expected to occur. For China and India, poverty rates were used for the major potato/sweet potato-growing provinces or states where adoption was expected. They found that the share of total benefits likely to accrue to poor rural households was exceptionally high, about 57 per cent of total benefits. The reason is simply that in Asia, most potatoes are sweet potatoes, which are grown on small farms in relatively poor areas. In South Asia, for example, the highest concentration of poor resides in the lower part of the Ganges River Valley (Uttar Pradesh, Bihar, West Bengal states of India, Bangladesh) where potato is widely grown as a winter crop in rotation with rice. In China, potato is grown primarily in interior provinces such as Sichuan and Yunnan in the southwest and Inner Mongolia and Gansu in the north, areas that have not enjoyed the same economic growth as the coastal provinces.

Certain types of technologies were anticipated to have relatively larger impacts on poverty due mainly to the high poverty rates of the areas where adoption was expected to occur. Technologies that were estimated to have “poverty content” of over 70 per cent of total benefits included strengthening potato seed systems, improving potato cropping systems and improving the storage of potatoes. The technologies expected to deliver the largest benefits to the poor were the same technologies that were expected to have highest total benefits, namely, potato late blight control and high starch-yielding sweet potato varieties. That is, these research topics received top priority ranking both for their expected total economic impact and for their expected contribution towards poverty reduction.

Evidence of technology diffusion and impact

Since the projections made in the mid-1990s, CIP and its national partners have conducted a number of economic evaluations of adoption (and non-adoption) of new technology by farmers. Such studies have documented significant impacts for a number of technologies. In other cases, expected impacts did not materialize and CIP scientists reevaluated these cases to understand why significant adoption did not occur. For example, an economic assessment of new, small-scale potato storage methods for potatoes in South Asia showed that despite lowering storage losses, the new method was unlikely to be adopted by farmers due to its high investment cost (Fuglie *et al*., 2000). True Potato Seed (TPS) is another technology where expectations of potential impact have been attenuated. Although TPS was adopted on about 10 per cent of the potato area in Viet Nam and in some areas in South Asia and China, a global assessment of TPS by CIP showed that it was unlikely to be economically feasible except under special circumstances (Chilver *et al*., 1999). Conversely, impacts from other technologies have exceeded expectations. By 2004, sweet potato virus-free planting material, a technology developed jointly by CIP and the Shandong Academy of Agricultural Sciences, had been adopted by farmers on about 800,000 hectares in Shandong, Anhui and Sichuan provinces of China (Fuglie *et al*., 1999), far higher than the projection of 573,000 hectares by 2015 (Walker and Collion, 1997).

Table 4 provides a status report on the adoption of CIP-related technology in Asia as of 2004, and compares this against what was anticipated by Walker and Collion (1997) for 2015. The single largest impact achieved so far has been from the adoption of virus-free sweet potato planting material in China. Another area where significant progress was achieved is the diffusion of new technologies to control potato late blight. Co-operation 88, a variety developed jointly by CIP and the Yunnan Normal University, spread to around 100,000 hectares in Yunnan province. Walker and Collion (1997) projected that the predominate area of late blight impact would be South Asia, although evidence now suggests that the more immediate impacts will occur in southwest China, Yunnan and Sichuan in particular. There have also been important impacts with virus resistant varieties in northern China (variety CIP-24), and prospects for further dissemination of virus-resistant varieties in northern China appear to be good. For TPS, there has been some limited diffusion of TPS in Viet Nam, Nepal, India and China, but further spread of this technology appears unlikely. For sweet potato, CIP-related high-starch yielding varieties are only now becoming available in some parts of China and Southeast Asia. Farmer adoption of these varieties was just beginning in the early 2000s and is expected to accelerate in the coming decade (Fuglie *et al*., 2002).

Another area where CIP may have over-anticipated the impact was for technologies to increase sweet potato utilization and value. Some success has been achieved but prospects for further adoption of CIP-related post-harvest technologies remain uncertain. The two major areas where CIP has invested in sweet potato utilization research are small-scale starch and noodle processing and animal feed. In China, there has been significant expansion in sweet potato utilization for both processing and animal feed over the past 25 years, brought about in response to economic reforms and changing food consumption patterns (Huang *et al*., 2003). In the 1990s, CIP in collaboration with the Sichuan Academy of Agricultural Sciences successfully developed some improved, small-scale starch and noodle processing equipment that was manufactured locally and sold to thousands of rural households in Sichuan. By the late 1990s, large-scale processing began to dominate sweet potato processing in China. Small-scale processors have continued to exist either by supplying intermediate products to large processors, such as crude starch for further refining, or lower-quality final products to local markets. However, there have been a number of independent sources of improved technology for sweet potato processing, especially the private sector, and it is difficult to identify the share of CIP-related research to these developments (Fuglie *et al*., 2004). Regarding improved sweet potato utilization for animal feed, assessments of farmer adoption in pilot studies from Sichuan (Pezo, 2004) and Viet Nam (Fuglie *et al*., 2005) have shown that there are significant opportunities for improving the efficiency of these systems, such as achieving higher feed-to-meat conversion ratios and more rapid weight gain in pigs. However, so far agricultural policy and extension services have paid scant attention to the millions of small-scale, backyard pig producers[3] who are the major users of sweet potato for feed, focusing their attention instead on larger-scale, specialized animal producers who tend to use grain-based and commercial feed. The sweet potato-pig production system is of huge significance in Asia, with probably over 100 million households currently engaging in backyard pig production. Although eventually economies of scale will likely cause backyard animal production to recede into decline, it will very likely remain a major component of the Asian agricultural system for a few decades more. The extent to which impact can be achieved with this technology will largely depend on whether policy-makers pay greater attention to small-scale producers.

The estimates of technology adoption shown in Table 4 suggest that by 2004 CIP-related technology had been adopted on about 1 million hectares in Asia. The great majority of adoption had taken place in China. Based on household survey and other data collected and analysed by CIP and Chinese researchers, the direct economic impacts of these technologies appear to be more than US$ 280 million annually (Table 5). These direct effects are further multiplied in the rural economy through their effects on trade and consumption. In a middle-income country like China, multiplier effects from higher agricultural production are likely to be on the order of 1.3 to 1.5 times the direct impacts (Haggblade *et al*., 1991). In other words, a one dollar increase in technology-induced agricultural income generates an additional $0.30 to $0.50 in other sectors of the rural economy. This implies that the total economic impact from CIP-related technology in China's is between US$ 370-420 million per year.

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[3] "Backyard" pig producers are rural households who typically keep one or a few pigs for fattening on crop residues and household wastes. The profitability of backyard pig production in Asia depends on availability of feed and labour resources that have very low opportunity cost (Chen and Rozelle, 2003).

The new technologies described in Table 5 have been adopted by at least 8 million rural households in China. These households comprise a population of more than 30 million persons. Calculating net benefits in terms of PPP dollars per capita per day shows that direct economic benefits from adoption averaged between PPP $0.046/capita/day in the case of CIP-24 and PPP $0.165/capita/day in the case of Co-operation 88. Moreover, due to China's land tenure policy, which has promoted an egalitarian distribution of agricultural land among peasant households, these benefits have been widely and evenly shared amongst the adopting households. In fact, evidence from a village survey on the impact of virus-free sweet potato planting material in Shandong found that households in poorer, more remote areas of the province captured a larger share of the benefits than richer households because the poorer households tended to have more area planted to sweet potato (Fuglie *et al*., 1999). Applying the poverty weights reported in Walker and Collion (1997) for the provinces in China where these technologies were adopted implies that the number of poor persons who benefited from CIP-related technology in China was at least 9.6 million. Importantly, in each of the cases listed in Table 5, the per capita benefits exceeded the 'poverty gap' for China (which was PPP $0.039/capita/day in 2001, the latest data available from the World Bank, 2005). Thus, the economic benefits of improved potato and sweet potato technologies appear to be capable of lifting most of China's extreme poor who adopted this technology above the PPP $1/day poverty threshold. However, given the reality of poverty dynamics, these gains are probably not sufficient to assure that these households permanently escape poverty. So long as they remain near the poverty threshold, they are likely to experience episodes where they fall below it.

Table 4. Adoption of new potato and sweet potato technologies in Asia

Technology	Locations of successes so far	Estimated area of adoption in 2004 (thousands of hectares)	Area projected for 2015 (thousands of hectares)	Are expectations likely to be attained?
Potato technologies				
Late blight control	Yunnan China Philippines, Viet Nam	200	644	Yes, if dissemination of new varieties can be accelerated
True Potato Seed	Viet Nam, Nepal, India, Yunnan China	15	135	No. Economic assessments have shown that applications of TPS will be more selective.
Virus control and improved seed systems	Northern China	40	345	Yes, if dissemination of new varieties can be accelerated
Bacterial wilt control		--	125	No.
Integrated pest management		--	143	No. Dissemination of IPM technology has proven to be complex and costly.
Improved cropping systems	West Bengal, India	5	39	Yes. Adoption of double rice transplanting in potato-rice system is beginning to take off.
Improved potato storage		--	135	No. Economic assessment of storage technology showed that adoption is unlikely
Sweet potato technologies				
High starch-yielding varieties	Viet Nam, Indonesia, Sichuan	10	1 633	Yes. Improved varieties just now becoming available.
Improved post-harvest utilization	1. Starch processing Sichuan China	10	844 (all)	1. Starch processing: No, private sector has become dominant source of new technology.
	2. Animal feed Viet Nam, Indonesia, Sichuan	15		2. Animal feed: Possible, if policies give more attention to backyard pig production.
Virus control and improved seed systems	Shandong, Anhui, Sichuan, China	800	573	Yes, have already exceeded expectations.
Integrated pest management	FFS ICM : Indonesia	5	373	No. Dissemination of IPM technology has proven to be complex and costly.
	Total impact (thousands of hectares)	1 100	4 989	

Sources: Walker and Crissman, 1996; Chilver *et al*., 1999; Fuglie *et al*., 1999; Fuglie *et al*., 2001; Fuglie *et al*., 2002; Fuglie *et al*., 2004; Fuglie *et al*., 2005; and authors' estimates.

Table 5. Economic and poverty impacts of potato and sweet potato technologies in China

Technology	Year first adopted	Provinces where technology was adopted	Adoption area	Direct economic benefits	Number of persons benefiting from adoption	Improvement in per capita income of adopters [a]
			(thousands of hectares, est.)	(million yuan/year)	(thousands)	(PPP $/cap/day)
Potato variety (CIP-24) with virus & drought tolerance	1984	Nei Mongol, Gansu, Ningxia, Shanxi	40	40	1 200	0.046
Sweet potato virus-free planting material	1994	Shandong, Anhui, Sichuan [b]	800	2 100	26 400	0.109
Potato variety (Co-op-88) with late blight resistance	1995	Yunnan	100	100	840	0.165
Other potato varieties (Er Potato 1, CFK 69.1, Chuanyu 4 and 39, others)	1995-2004	Hubei, Sichuan, Yunnan	100	100	2 000	0.046
Total			>1 000	>2 300	>30 400	

Sources: Song Bofu *et al*. (1996) for CIP-24 impact; Fuglie *et al.* (2001) for impact of sweet potato virus-free planting material; impact of Co-operation 88 based on preliminary results of an on-going study; case of other potato varieties extrapolated from other potato variety impact assessment studies.

Note: [a] The conversion factor between the Yuan and PPP dollars was 2.0 in 2004 (World Bank, 2005).

[b] Estimated area adoption of virus-free sweet potato planting material include 460,000 ha in Shandong, 240,000 ha in Anhui and 100,000 ha in Sichuan.

A broader assessment of the implications of new technology on poverty

The case studies reported above on the impacts of potato and sweet potato technology in Asia have taken a rather narrow view of economic and poverty impacts of agricultural technology adoption. These studies have generally not considered, for example, the implications of supply increases on market prices and how this might affect the distribution of technology benefits among producers and consumers. To evaluate new technology on a broader range of development issues, including equity, gender bias and the environment, Walker (2000) developed a qualitative scoring model to assess a number of other kinds of impacts. A score of +1 means that the technology is expected to have an especially favourable impact on a particular aspect, a score of 0 implies a neutral impact and a score of -1 implies a negative impact.

The evaluation criteria developed by Walker (2000) are listed at the bottom of Table 6. The first set of evaluation criteria considers a number of poverty and equity aspects. The relative poverty of the country, region and recommendation domain where technology adoption is expected is compared with a regional or international average. In addition, within the recommendation domain, the technology is scored as to whether poor farmers are likely to adopt the technology at the same rate as well-off farmers, and whether women and children are likely to benefit from adoption to the same degree as male members of households. Finally, if the technology enables a crop to be harvested during a “hunger” season of the year, it receives an additional positive score. The second set of criterion focuses on the consumption side: who is likely to benefit from higher quantities of food supplied at lower prices? Positive scores are given for crops that are staple foods of either urban or rural consumers. The third set of criterion addresses a number of additional issues, such as whether the new technology will increase demand for hired labourers, reduce production risk, generate significant multiplier effects on the rural economy, improve the health of malnourished consumers, and whether adoption is likely to benefit areas that have historically been left behind in economic development.

As with any impact assessment, scoring potential impacts of agricultural technology on these issues requires knowledge of the socio-economic and market conditions, as well as an understanding of the technology itself. Therefore, scoring is best attributed by a multidisciplinary team consisting of social and biological scientists. While it is possible to develop quantitative models to measure impacts on any of these criteria, the advantage of a qualitative scoring model is that it requires considerably less resources and is more transparent to non-specialists and policymakers. It is also a useful exercise to identify key issues for more in-depth impact assessment study.

To illustrate this approach, Table 6 displays the scores for some CIP-related technologies in selected regions of Asia. We should emphasis that the scores reported in Table 6 are subjective. In terms of country poverty, potato late blight control in South Asia receives a +1 because India and Bangladesh have an exceptionally high incidence of poverty while sweet potato high-starch varieties in Sichuan receive a -1 because China as a whole is relatively well off compared to other developing countries. Spatial poverty looks at those particular areas within a country where adoption is likely to occur and compares the incidence of poverty in the impact areas to the country average. Both potato late blight control and sweet potato high-starch varieties scored +1 on spatial poverty because the Ganges River basin and southwest China are relatively poor regions within their respective countries. For poverty and gender, we scored sweet potato high-starch varieties with +1 because of the increasing proportion of women farmers and female-headed rural households in rural China. As more young men migrate to cities and coastal provinces in search of work, technologies that improve farm productivity in rural China are likely to be of particular benefit to women, children and the elderly who have been left behind to tend the farm. Potato in India receives a negative score on consumption because it is not a staple of the poor but rather a vegetable predominantly consumed by the urban middle class. However, this is changing. Over the long run, the price of potato in South Asia has fallen relative to other foods and to income (Horton, 1987), and potato is gradually becoming an important food for rural poor as well (Bouis and Scott, 1996). Potato late blight control in South Asia also scores well on a number of other aspects: it is likely to reduce yield fluctuation and risk, reduce reliance on chemical means of control (benefiting the health of farmers and the environment), and provide more employment for landless labourers. While this scoring exercise is based on one’s subjective judgment, it does provide a checklist for assessing a wider range of poverty impacts beyond only income per household. However, unlike the quantitative impact economic models described earlier in the paper, the qualitative scoring approach is not very adept at distinguishing between projects that foster large and small impacts. Therefore, it is preferable to use a qualitative scoring model in combination with a quantitative assessment model for assessing research impacts and setting research priorities.

Table 6. Qualitative scoring model of technology impacts on poverty

	P LB	SP HDM	P Virus	P TPS	SP Util.	SP IPM	P BW	SP Virus	P IPM
Dominant area of impact (share of projected poverty benefits):	SW Asia (61%)	SW China (48%)	N China (84%)	SW Asia (74%)	SW China (67%)	SE Asia (78%)	SW China (79%)	China (64%)	SW Asia (76%)
Poverty aspect [a]									
Production and poverty									
Country poverty	+1	-1	-1	+1	-1	0	-1	-1	+1
Spatial commodity poverty	+1	+1	+1	+1	+1	0	+1	0	+1
Poverty of the recommendation domain	0	0	0	0	0	0	0	-1	0
Poverty and adoption	0	0	0	+1	-1	0	0	+1	0
Poverty and gender	0	+1	+1	0	+1	0	+1	0	0
Growing season poverty	0	0	0	0	0	0	0	0	0
Consumption and poverty									
Poverty and commodity consumption	-1	0	0	-1	0	0	0	0	-1
Poverty and rural consumption	-1	0	0	-1	0	+1	0	0	-1
Other aspects of poverty									
Poverty and landless labour	+1	0	0	+1	0	0	0	0	+1
Stochastic poverty	+1	0	+1	0	0	+1	+1	0	+1
Poverty and linkages	0	+1	0	0	+1	0	0	0	0
Poverty and health	+1	0	0	+1	0	0	0	0	+1
Losers versus gainers	0	0	0	0	0	0	0	0	0
Total score	3	2	2	3	1	2	2	-1	3

[a] For explanations of the poverty aspects, see Appendix 1.

Scores: +1 = positive differential impact of technology on poverty of specified group
0 = no differential impact
-1 = negative differential impact

P LB = Potato late blight management
P Virus = Potato virus-resistance
P TPS = True Potato Seed
P BW = Potato bacterial wilt management
P IPM = Potato integrated pest management
SP HDM = Sweet potato high dry matter varieties
SP Util. = Sweet potato utilization/new markets
SP IPM = Sweet potato integrated pest management
SP Virus = Sweet potato virus-free planting material

Summary and conclusions

Improvements in potato and sweet potato productivity have had, and will likely continue to have, significant and positive effects on poverty reduction in Asia. Results from a number of case studies of *ex ante* and *ex poste* impact assessments showed that investments in potato and sweet potato research and development generated not only high economic returns but also resulted in significant benefits to poor agricultural households in Asia. An important lesson from this review, however, is that research is a lengthy and risky investment: while overall returns are likely to be high, investments today may take a decade or more to generate significant impacts and some projects will fail while other projects will exceed expectations. An on-going programme of impact assessment can help identify likely successes and failures relatively early in the technology development cycle in order to help direct Research and Development resources to projects with the greatest potential.

Impact assessment of agricultural technology can include a number of dimensions. One useful criterion is the economic return, or net present value, of the investment in research and extension. This measure provides a ready means of comparing economic impacts among alternative investments. Another important criterion is the impact of adoption on the incomes and welfare of poor rural households. Analysis of income and poverty impacts based on household surveys is the preferred method but is costly and time consuming. There are many additional dimensions of poverty that can also be assessed, such as effects of technology adoption on equity, gender, landless labourers, hunger, malnutrition and the environment. Qualitative scoring models provide a relatively simple and low-cost way to assess these additional dimensions of impact. However, even such models are likely to require both specialized technical and social science knowledge to be used effectively. They are best used in combination with quantitative economic assessments.

While the case studies in this review focused on CIP-related technologies, there are other examples of successful potato and sweet potato R&D in Asia that could be cited. The national agricultural research systems of India and China in particular, have independently developed several new crop varieties, crop management methods and post-harvest utilization technologies that have enhanced the productivity and value of these crops. As the analysis in this paper showed, there continues to be significant scope for developing and extending further improvements in productivity and utilization of these commodities in Asian food systems.

The high returns to research in potato and sweet potato improvement in Asia partly reflects a low level of investment: because relatively little has been done to improve these crops, the yield gap between actual and potential yield remains large and the marginal product of research is therefore high. It should be emphasized that the high returns to research are social returns and not private returns. Low investment by the private sector can be explained by “market failure,” or the fact that in countries without strong institutions protecting intellectual property rights in agriculture, it is difficult for the private sector to capture the economic benefits of research. It is even more difficult to explain why governments do not invest more to improve these commodities. The most likely explanation is that since producers of these commodities tend to be poor and live in remote areas, their interests are not properly heard or considered in policy circles. Nevertheless, for governments or international bodies committed to poverty alleviation in Asia, a strategy that includes potato and sweet potato research offers significant opportunities for pro-poor development.

Endnotes

In principal, some of the benefits from agricultural technology adoption are shared by consumers through lower prices resulting from an increase in agricultural supply. However, when a large share of a crop is consumed on the farm where it is produced (either as food or animal feed), as has historically been the case with potato and sweet potato in many areas of China, then the farm households adopting the technology remain the primary beneficiaries. Nevertheless, over the past couple of decades there has been a trend towards greater commercialization of these commodities in China, especially potato as a vegetable among urban consumers and sweet potato for industrial starch. Our expectation is that these markets are likely to be fairly price-elastic (implying relatively small price effects from increases in supply) due to strong demand-substitution possibilities (other vegetables in the case of potatoes and maize in the case of starch and feed). However, understanding the market effects from technological change in potato and sweet potato in the case of China is a subject requiring further study.

A legacy of China’s egalitarian farm structure is that agricultural growth has provided an effective means for poverty alleviation (Ravallion and Chen, 2004). This also appears to have been the case in Viet Nam, where land reform resulted in a similar leveling of farm size (Bonschab and Klump, 2004). The relationship between agricultural growth and poverty reduction in regions where there are large numbers of landless or near-landless rural poor, such as India, appears to be considerably weaker (Besley *et al*., 2004). In these situations, it may take more careful attention to technology design and dissemination strategies to achieve poverty reduction, such as through positive impacts on farm employment, efforts to reach marginalized farmers, as well as price reductions on basic food staples (Hazell and Haddad, 2001).

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Appendix 1

Producer poverty and rural equity:

- Country poverty: Does the developing country rank in lower, middle or higher tercile on a head-count poverty index?
- Spatial poverty: Are producers of the crop poorer, the same or richer than average farmers in the country?
- Poverty in the recommendation domain: will the technology benefit a greater proportion of poorer or richer regions where the crop is grown within the country or region?
- Poverty and adoption: Are poorer rather than richer farmers likely to benefit within the same region?
- Poverty and gender: Is the technology especially attractive to women farmers?
- Growing season poverty: Is the crop harvested during a “hunger” season?

Consumer effects:

- Poverty and commodity consumption: Is the crop consumed as a staple food or does it enter the diet as a higher price vegetable in urban consumption?
- Poverty and rural consumption: Are poorer rural households net consumers of the crop?

Other effects:

- Poverty and landless labour: Will the technology increase or reduce employment of rural landless labourers?
- Stochastic poverty: Will the technology reduce or increase crop yield or price risk?
- Poverty and linkages: Does the technology have strong or weak multiplier effects in the rural economy?
- Poverty and health: Does the technology improve or worsen farmer or consumer health?
- Losers versus gainers: Are there any groups that will be made worse off by the technology ("left behind" areas)?

Changing the Links with the Poor

The case studies reveal that not only technologies such as new varieties, post-harvest processing or economic opportunities such as emerging markets or diversification can sublimate the potential of secondary crops. Indeed, as Part III “Changing the Links with the Poor” bares witness, more social or institutional changes may also synergize with secondary crops to enhance living conditions for resource poor rural populations in marginal areas.

The evidence begins with “A Participatory Approach to Cassava Production in Thailand and Viet Nam” presented by Watana Watananonta, Tran Ngoc Ngoan and Reinhardt H. Howeler. Cassava, the third most important food crop in Southeast Asia is usually grown by smallholders in marginal areas of sloping or undulating land, with high erosion risk. The authors show how farmer participatory research enhanced the adoption of soil conserving practices and improved the sustainability of cassava production under a wide range of socio-economic and bio-physical conditions. Participating farmers’ willingness to adopt practices to reduce erosion, while at the same time obtaining short-term benefits from the adoption of new varieties and other improved practices is estimated to have earned them 157 million US dollars in annual gross income increase over the past ten years.

Another case of changing relations with secondary crop farmers is provided by Josefina M. Lantican in “Farmer-Scientist Training Programme and Corn in the Philippines”. The objective of the programme conducted in various communities in upland areas was to provide maize farmers direct access to agricultural scientists to develop their technical and scientific capabilities. Ms. Lantican indicates that the impact on productivity was such that farmers’ income increased ranging from 44 per cent to more than 225 per cent. Yet, the impact of the programme on poverty alleviation was less significant with 13 per cent people lifted above the poverty line. However, in other communities the socio-economic conditions of almost 40 per cent of the trained farmers tremendously improved.

Institutional arrangements with the private sector also benefits secondary crop farmers, argues A.R.M. Mahrouf in “Contractual Marketing Arrangements and Maize in Sri Lanka”. In Anuradhapura, a major maize area where it is predominantly a rainfed crop in the highlands cultivated during the wet season by small-scale farmers, his study of the Forward Sales Contract introduced by the Central Bank of Sri Lanka reveals a significant price increase along with yield increase. While the functioning of this system requires further improvement it is gaining popularity and it has transformed maize cultivation from subsistence farming to a more commercial nature.

According to Masdjidin Siregar in "Small-scale Tapioca Processing Development in Indonesia", one constraint that small and resource poor farmers face is organizational power to enter in downstream activities and benefit from further processing of their agricultural products. In the case of the development of small-scale tapioca processing units managed by individuals or by farmers' co-operatives initiated by the Provincial Government of Lampung, the author recognizes that the objective was to counterbalance the oligopsonistic power of large tapioca processing units. His analysis of the results of this local policy on income and employment generation in the cassava commodity system indicates that units managed by co-operatives did not survive while the ones managed by individuals could, thanks to managerial competence. However, the dependency on large scale units was not completely severed, especially for drying tapioca during the wet season.

This question of scale rebounds with the case presented by Keith O. Fuglie, Jiang Xie, Jianjun Hu, Gang Huang, and Yi Wang on "Processing Industry Development and Sweet Potato in China". In Sichuan, four million metric tons of sweet potato roots are processed into starch and starch products each year, mostly by farm households or small rural enterprises using labour-intensive methods. Using a survey of 113 small enterprises and interviews with managers of four large enterprises in Sichuan, the authors found that adoption allowed small firms to modestly increase their scale of production and profitability while continuing to rely primarily on family labour. Structural changes towards large-scale processing are occurring in the sweet potato agro-industry in Sichuan. While policies appear to favour large enterprises, there has been an explicit policy effort to ensure small enterprises and farm households benefit from this agro-industrialization.

A Participatory Approach to Cassava Production in Thailand and Viet Nam

Watana Watananonta[*]*, Tran Ngoc Ngoan*[**]*and Reinhardt H. Howeler*[***]

Abstract

Cassava (*Manihot esculenta* Crantz) is the third most significant food crop in southeast Asia, where it is usually grown by smallholders in marginal areas on sloping or undulating land. In order to enhance the adoption of soil conservation practices and improve the sustainability of cassava production under a wide range of socio-economic and bio-physical conditions, farmer participatory research (FPR) was undertaken. The FPR methodology was initially developed at 2-3 sites in Thailand, Viet Nam, Indonesia and China respectively. Based on the results of these trials, farmers at the pilot sites readily adopted better varieties, fertilization and intercropping practices, and many farmers began planting contour hedgerows to control erosion. In the second phase of this Nippon Foundation supported project, farmer participatory approach for technological development and dissemination was further developed at about 90 pilot sites throughout Thailand, Viet Nam and China. Since becoming aware of the seriousness of the erosion in their cassava fields, farmers have shown a willingness to adopt simple but effective practices to reduce erosion while at the same time obtaining short-term benefits from the adoption of new varieties and other improved practices. The trials by farmers on their own fields of new cassava varieties and fertilization practices in addition to soil conservation practices was found to be crucial for the adoption of more sustainable production practices. The resulting hikes in cassava yields in Thailand and Viet Nam over the past ten years have raised the annual gross income of cassava farmers by an estimated US$ 157 million.

Introduction

Cassava (*Manihot esculenta* Crantz) is usually grown by smallholders in upland areas on poor soils with low or unpredictable rainfall. In the northeastern and eastern regions of Thailand, cassava is often grown on gentle slopes, but in the northern part of Viet

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Nam it is grown on steep slopes; in both cases soil erosion can be serious. Since most cassava farmers are poor, they do not apply sufficient fertilizer to cassava and this can lead to a decline in soil fertility, which in turn exacerbates low yields. Past research by the Kasetsart University, Thailand, has shown that cassava cultivation may cause twice as much soil erosion than mung bean, and three times as much as maize, sorghum and peanut (Puttacharoen *et al*., 1998).

Research on erosion control practices indicates that soil losses due to erosion can be markedly reduced by various agronomic practices combined with simple soil conservation practices including agronomic practices such as minimum or zero tillage, mulching, contour ridging, intercropping, fertilizer or manure application, and closer plant spacing. Soil conservation practices include terracing, hillside ditches and planting contour hedgerows of grasses or legumes. Unfortunately, farmers seldom adopt such conservation measures because they may be in appropriate for the specific circumstances of the farmers, either from an agronomic or a socio-economic standpoint (Howeler, 2001).

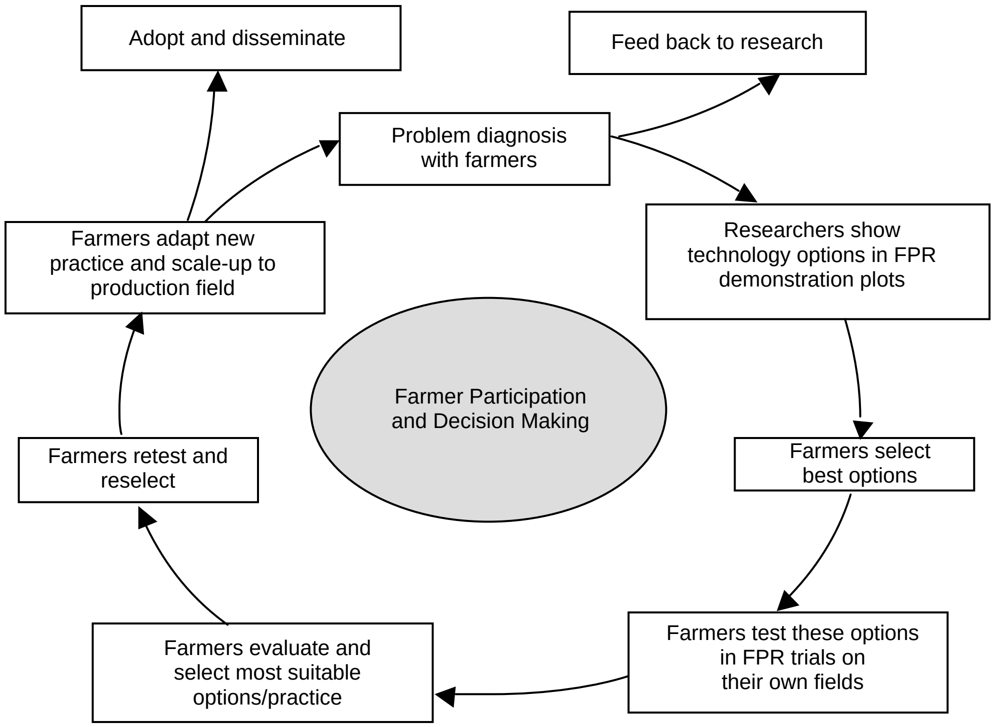
Since 1994, the Nippon Foundation in Tokyo, Japan has supported the project "Integrated Cassava-based Cropping Systems in Asia: Farming Practices to Enhance Sustainability". It has developed and used farmer participatory research (FPR) and extension (FPE) methodologies.

Materials and method

First Phase (1994-1998)

The first phase of the project was conducted in Thailand, Viet Nam, Indonesia and China. The project was co-ordinated by the International Center for Tropical Agriculture (CIAT) and implemented in collaboration with research and extension organizations in each of the four countries. During an initial training course on farmer participatory research (FPR) methodologies, each country designed a work plan to implement the project. The steps in the process, from diagnosing the problem to the adoption of suitable solutions, are shown in Figure 1. The salient feature of this approach is that farmers participate in every step and make all the important decisions.

Figure 1. Farmer participatory model used for the development of sustainable cassava-based cropping systems in Asia



Pilot site selection

Suitable pilot sites were pre-selected in areas where cassava is an important crop, where it is grown on slopes and erosion is a serious problem. Detailed information obtained through Rapid Rural Appraisals (RRA) at each site was reported by Nguyen The Dang *et al*. (1998) and Vongkasem *et al*. (1998). Table 1 is a summary of the information obtained from RRAs conducted at several pilot sites in Thailand and Viet Nam. Detailed information from each site can serve as baseline data to monitor progress and evaluate the impact of newly adopted technologies. After conducting the RRAs, the most suitable pilot sites (villages or subdistricts) were selected for the development and dissemination of new varieties and production practices.

Table 1. Characteristics of five pilot sites from the Farmer Participatory Research (FPR) trials in Thailand and Viet Nam in 1994/95

	Thailand		Viet Nam		
	Soeng Saang	Wang Nam Yen	Pho Yen	Thanh Ba	Luong Son
Mean temp. (°C)	26-28	26-28	16-29	25-28	16-29
Rainfall (mm)	950	1 400	2 000	~1 800	~1 700
Rainy season	Apr.-Oct.	Apr.-Nov.	Apr.-Oct.	Apr.-Nov.	May-Oct.
Slope (%)	5-10	10-20	3-10	30-40	10-40
Soil	± fertile loamy Paleustult	± fertile clayey Haplustult	infertile sandy loam Ultisol	very infertile clayey Ultisol	± fertile clayey Paleustult
Main crops	cassava rice fruit trees	maize soybean cassava	rice sweet pot. maize	rice cassava tea	rice cassava taro
Cropping system[a]	C monocrop	C monocrop	C monocrop	C monocrop	C+T
Cassava yield(t/ha)	17	17	10	4-6	15-20
Farm size (ha)	4-24	3-22	0.7-1.1	0.2-1.5	0.5-1.5
Cassava (ha/hh)	2.4-3.2	1.6-9.6	0.07-0.1	0.15-0.2	0.3-0.5

Source: Adapted from Howeler and Henry, 1998.
Note: [a] C = cassava, T = taro.

Demonstration plots

The demonstration plots were established by research organizations of both countries in areas not too far from the pilot sites. They had many alternative measures available, such as the application of chemical fertilizers, green manures, closer plant spacing, intercropping with different crops and contour hedgerows of different grasses or legume species. Farmers from the selected pilot sites visiting these demonstration plots were asked to discuss and score the usefulness of each treatment. They selected three to four suitable measures that they considered most useful for their own fields. Table 2 shows that the farmers from different sites have differing priorities and, thus, the options were ranked accordingly.

Table 2. Ranking of conservation farming practices by cassava farmers in Thailand and Viet Nam, 1995/96

	Thailand		Viet Nam	
	Soeng Saang	Wang Nam Yen	Pho Yen	Thanh Hoa
Farmyard manure (FYM)				2
Medium NPK	5			
High NPK				
FYM + NPK				1
Cassava residues incorporated			5	
Reduced tillage	4			
Contour ridging		2		
Up-and-down ridging				
Maize intercropping	2			
Peanut intercropping		5		
Mungbean intercropping				
Black bean intercrop+Tephrosia Hedgerows			1	4
Tephrosia green manure			3	5
Tephrosia hedgerows			4	
Gliricidia sepium hedgerows				
Vetiver grass barriers	1	1	2	3
Brachiaria ruziziensis barriers	3	4		
Elephant grass barriers				
Lemon grass barriers		3		
Stylosanthes barriers				

Source: Adapted from Howeler and Henry, 1998.

In both the demonstration plots and FPR erosion control trials on farmers' fields, a simple methodology was used to measure soil loss due to erosion in each treatment. Plots were laid out carefully and exactly along the contour on a uniform slope; it is important that runoff water does not enter the plots either from above or from the sides. Along the lower side of each plot a ditch was dug and covered with plastic; small holes in the plastic allowed runoff water to seep away, while eroded sediments remained on the plastic. These sediments were collected and weighed monthly or at least 2-3 times during the cropping cycle. After correcting for moisture content, the amount of dry soil loss per hectare was calculated for each treatment. This simple methodology gives both a visual as well as a quantitative indication of the effectiveness of the various practices in controlling erosion (Howeler, 2001, 2002; Watananonta *et al*., 2003).

FPR trials

After farmers had decided to conduct FPR trials, researchers and extensionists discussed the trials with the collaborating farmers, such as the types of trials and the treatments to be tested; project staff helped farmers establish the trials and provided the necessary materials. During the crop season, researchers and extensionists visited the farmers several times to discuss and solve their problems. At the time of harvest, collaborating farmers and project staff harvested all the cassava trials together, recording the data on yield and soil loss from each treatment, which were then presented to the participating farmers and others interested. The results were then discussed at the meeting and the best treatments were selected accordingly, either for immediate adoption or for retesting in the following year's trials (Howeler, 2001; Watananonta *et al*., 2003).

Second Phase (1999-2003)

The second phase of the project was implemented by five research and extension organizations in Thailand, six in Viet Nam and three in China (Table 3). During the second phase, the emphasis shifted from the development and use of farmer participatory research (FPR) methodologies to farmer participatory extension (FPE) in order to reach more farmers and foster widespread adoption. Activities included:

Cross-site visits

Farmers from new sites visited existing sites where the project had been conducted and where new technologies had already been adopted.

Farmer field days at harvest

Local officials and farmers from the village and surrounding communities are invited to evaluate each treatment in the FPR trials, including the root yield and the amount of soil sediment eroded from each plot. In this way, the farmers learn and absorb information to make decisions about technologies suitable for their own specific conditions. Farmers then discuss and plan actions to be carried out the following year.

District level field days

The purpose of these large-scale field days is to disseminate selected technologies to nearby villages and sub-districts. During the field day, experienced farmers share their knowledge with other farmers.

Provincial level field days

At this level, approximately 1,000-1,500 farmers and officials from nearby provinces are invited to attend the field day. Reporters from newspapers and television stations are also invited to report on project activities through the mass media.

FPR training courses

Initial courses were organized by CIAT to train project staff in FPR methodologies. Additional courses were organized to train local extension workers and key farmers in cassava technologies and farmer participatory approaches. Furthermore, CIAT also supported the training of trainers in advanced courses abroad.

Results

First Phase (1994-1998): Farmer Participatory Research (FPR)

FPR trials

Table 4 shows a typical example of an FPR erosion control trial conducted by six farmers having adjacent plots on about a 40 per cent slope. Contour hedgerows of vetiver grass, *Tephrosia candida* and pineapple reduced erosion to about 30 per cent of that on the check plot, while intercropping with peanut and planting vetiver hedgerows also markedly increased net income. Farmers clearly preferred the measures that were most effective in both raising net income and reducing soil erosion, such as hedgerows of vetiver grass or pineapple. The results of many other FPR trials have been reported by Nguyen The Dang *et al*. (2001) and Vongkasem *et al.* (2001).

Table 3. Partner institutions in the second phase of the Nippon Foundation cassava project in Asia

1. Research and extension organizations in Thailand
-Department of Agriculture (DOA)
-Department of Agricultural Extension (DOAE)
-Land Development Department (LDD)
-Kasetsart University (KU)
-The Thai Tapioca Development Institute (TTDI)
2. Research and extension organizations in Viet Nam
-Thai Nguyen University of Agriculture and Forestry (TNUAF)
-National Institute for Soils and Fertilizers (NISF)
-Viet Nam Agricultural Science Institute (VASI)
-Hue University of Agriculture and Forestry (HUAF)
-Institute of Agricultural Sciences of South Viet Nam (IAS)
-Tu Duc University of Agriculture and Forestry (TDUAF)
3. Research and extension organizations in China
-Chinese Academy for Tropical Agricultural Sciences (CATAS)
-Guangxi Subtropical Crops Research Institute (GSCRI)
-Honghe Animal Husbandry Station of Yunnan

Table 4. Effect of various crop management treatments on the yield of cassava and intercropped peanut as well as the gross and net income and soil loss due to erosion in a FPR erosion control trial conducted by six farmers in Kieu Tung village of Thanh Ba district, Phu Tho province, Viet Nam in 1997 (third year)

Treatment[a]	Slope	Dry soil loss	Yield (t/ha)		Gross Income[c]	Product. costs	Net income	Farmers ranking
	(%)	(t/ha)	Cassava[b]	Peanut[b]	(million dong/ha)			
C monocult., with fertilizer, no hedgerows(TP)	40.5	106.1	19.17	-	9.58	3.72	5.86	6
C+P, no fertilizer, no hedgerows	45.0	103.9	13.08	0.70	10.04	5.13	4.91	5
C+P, with fertilizer, no hedgerows	42.7	64.8	19.23	0.97	14.47	5.95	8.52	-
C+P, with fertilizer, *Tephrosia* hedgerows	39.7	40.1	14.67	0.85	11.58	5.95	5.63	3
C+P, with fertilizer, pineapple hedgerows	32.2	32.2	19.39	0.97	14.55	5.95	8.60	2
C+P, with fertilizer, vetiver hedgerows	37.7	32.0	23.71	0.85	16.10	5.95	10.15	1
C monocult., with fertilizer, *Tephrosia* hedgerows	40.0	32.5	23.33	-	11.66	4.54	7.12	4

Source: Howeler, 2001.

Note: [a] Fertilizers = 60 kg N + 40 P_2O_5, + 120 K_2O/ha; all plots received 10 t/ha pig manure
TP = farmer traditional practice

[b] Cassava: fresh roots; peanut: dry pods

[c] Prices: cassava (C) 500 dong/kg fresh roots
peanut (P) 5,000/kg dry pods
US$ 1 = approx. 13,000 dong

Up-scaling and adoption

Having selected the most promising varieties and production practices from the FPR trials, farmers are generally inclined to test them on small areas of their production fields, making adaptations if necessary. Some practices may appear promising on small plots, but are rejected as impractical when applied to larger areas; this may be due to a lack of sufficient planting material, for example vetiver grass, or a lack of markets to sell the products, namely pumpkin or lemon grass. Also, to be effective, hedgerows need to follow the contour rather precisely; otherwise they can cause serious gulley erosion by channelling runoff water to the lowest spot. Contour hedgerows also force farmers to plough along the contour, which is difficult and more costly; moreover it makes planting in neat straight lines, using tight strings as a guide, impossible. Thus, there are very practical reasons why farmers may be reluctant to adopt some of these soil conservation practices. Table 5 shows the particular technologies that farmers had adopted in the two countries at the end of the first phase of the project.

Table 5. Technological components selected and adopted by participating farmers

Technology	Thailand	Viet Nam
Varieties	Kasetsart 50[c] Rayong 5[c] Rayong 90[b]	KM60[c] KM94[a] KM95-3[c] SM1717-12[a]
Fertilizer practices	15-15-15 156 kg/ha[c]	FYM 10 t/ha (TP)+ 80 N+40 P_2O_5+ 80 K_2O[b]
Intercropping	monoculture(TP) C+pumpkin[a] C+mungbean[a]	monoculture(TP) C+taro(TP) C+peanut[c]
Soil conservation	vetiver barrier[c] sugarcane barrier[a]	*Tephrosia* barrier[c] vetiver barrier* pineapple barrier*

Source: Howeler, 2001.
Note: [a] some adoption
[b] considerable adoption
[c] widespread adoption
TP = traditional practice; FYM = farmyard manure.

Second Phase (1999-2003): Farmer Participatory Research (FPR) and Extension (FPE)

As the objective of the second phase was to ensure the widespread adoption of more sustainable production practices by as many farmers as possible, it was necessary to markedly expand the number of pilot sites and to develop farmer participatory extension

(FPE) methodologies to disseminate the selected practices and varieties to many more farmers.

Farmer participatory research (FPR)

Whenever the project was extended to a "new" site, the process outlined above was re-initiated, namely an RRA was conducted, interested farmers visited demonstration plots and/or made a cross-visit to an already established site, FPR trials were conducted and the results discussed and eventually those varieties or practices most suitable for their own conditions were adopted. Table 6 shows the number and types of FPR trials conducted in Thailand and Viet Nam during the second phase of the project. While initially farmers were mainly interested in testing new varieties, fertilization, intercropping and erosion control practices, during the later part of the project they also wanted to test the use of organic or green manures, weed control, plant spacing and even leaf production and pig feeding. During five years of the second phase of the project, farmers on their own fields conducted 922 FPR trials. Tables 7 through 10 show a few examples of the various types of FPR trials conducted by farmers in different sites in Thailand and Viet Nam.

Table 6. Number of FPR trials conducted during the second phase of the project in Thailand and Viet Nam

Country	Type of FPR trial	1999	2000	2001	2002	2003	Total
Thailand	Varieties	11	16	16	19	25	**87**
	Erosion control	14	10	6	-	11	**41**
	Chemical fertilizers	16	6	23	17	17	**79**
	Chem.+ org fertilizers	-	-	10	11	11	**32**
	Green manures	-	-	13	11	15	**39**
	Weed control	-	-	17	5	10	**32**
	Plant spacing	-	-	3	-	2	**5**
	Intercropping	-	-	16	7	-	**23**
		41	**32**	**104**	**70**	**91**	**338**
Viet Nam	Varieties	12	31	36	47	35	**161**
	Erosion control	16	28	29	30	23	**126**
	Fertilization	1	23	36	24	24	**108**
	Intercropping	-	14	32	31	26	**103**
	Weed control	-	3	-	-	3	**6**
	Plant spacing	-	1	7	19	8	**35**
	Leaf production	-	-	2	2	1	**5**
	Pig feeding	-	-	11	16	13	**40**
		29	**100**	**153**	**169**	**133**	**584**
Total		**70**	**132**	**257**	**239**	**224**	**922**

Source: Adapted from Howeler, 2004.

Table 7. Results of an FPR variety trial conducted by one farmer in Am Thang commune, Son Duong district, Tuyen Quang, Viet Nam in 2002/03

Treatment[a]	Cassava yield	Gross income	Production costs	Net income	B/C	Farmers' Preference[b]
	(t/ha)	(1 000 dong/ha)				(%)
Vinh Phu (local)	20.70	10 350	4 330	6 020	2.39	7.9
La Tre (SC205) (local)	21.40	10 700	4 330	6 370	2.47	10.5
KM60	29.20	14 600	4 330	10 270	3.37	21.0
KM94	37.50	18 750	4 330	14 420	4.33	94.7
KM95-3	32.80	16 400	4 330	12 070	3.79	26.3
KM98-7	25.40	12 700	4 330	8 370	2.93	10.5

Note: [a] fertilized with 1,100 kg/ha of 7-4-7 fertilizers = 1.43 million dong/ha.
[b] out of 38 farmers.

Table 8. Average results from three FPR erosion control trials conducted by farmers in Suoi Rao and Son Binh villages, Chau Duc district, Baria-Vungtau, Viet Nam in 2003/04

Treatment	Dry soil loss	Cassava yield	Maize+ hedgerow	Gross income[a]	Production costs[b]	Net income	Farmers' preference
	(t/ha)	(t/ha)	yield (t/ha)	(1 000 dong/ha)			(%)
Cassava monoculture, no hedgerows	77.12	26.34	-	10 536	6 079	4 457	20
C+ pineapple hedgerows	11.65	27.02	-	10 808	6 279	4 529	0
C+ *Paspalum atratum* hedgerows	12.18	30.13	11.40	12 052	6 279	5 773	65
C+ vetiver grass hedgerows	9.94	28.33	8.84	11 332	6 279	5 053	15
C+ maize intercrop	14.30	17.86	3.25	10 394	7 969	2 425	0

Note: [a] Prices: cassava dong 400/kg fresh roots
maize 1,000/kg dry grain
[b] Costs: labour 20,000/man-day
cassava fertilizers 1,279,000 dong/ha
maize fertilizers 550,000 dong/ha
cassava stakes 500,000 dong/ha
maize seed 440,000 dong/ha
labour for cassava without HR (210 md/ha) = 4.2 million dong/ha
labour for maize (40 md/ha) = 0.8 million dong/ha
labour for fertilizer application (5 md/ha) = 0.1 million dong/ha
labour for hedgerow cutting/maintenance = 0.2 million dong/ha

Table 9. Results of an FPR fertilizer and manure trial conducted in Khut Dook village, Baan Kaw, Daan Khun Thot, Nakhon Ratchasima, Thailand in 2002/03

Treatments[a]	Root yield (t/ha)	Starch content (%)	Gross Income[b]	Fertilizer cost[c]	Production costs[c]	Net income
			(1 000 B/ha)			
No fertilizers or manure	18.75	25.0	21.56	0	10.87	10.69
Chicken manure+rice hulls, 400 kg/rai	30.42	26.2	34.98	2.50	17.15	17.83
Pelleted chicken manure, 100 kg/rai	26.70	21.1	30.71	2.00	15.39	15.32
15-7-18 fertilizer, 50kg/rai	29.68	24.1	34.13	2.66	16.73	17.40
13-13-21 fertilizer, 50kg/rai	32.22	27.4	37.05	3.13	17.89	19.16
16-20-0 fertilizer, 50kg/rai	26.08	25.9	29.99	2.50	15.61	14.38
15-15-15 fertilizer, 50kg/rai	30.36	26.9	34.91	2.81	17.07	17.84

Source: Howeler, 2004b.

Note: [a] 1ha = 6.25 rai

[b] Prices: cassava baht 1.15 /ton irrespective of starch content

[c] Costs: chicken manure 1.0 /kg
pelleted chicken manure 3.20/kg
15-7-18 8.50/kg
13-13-21 10.0/kg
16-20-0 3.0/kg
15-15-15 9.0/kg
Harvest + transport roots 270/ton
cassava production without fertilizer or harvest 12,757/ha

Table 10. Average results from five FPR pig-feeding trials on adding ensiled cassava leaves, conducted by farmers in Huong Ha commune, A Luoi, Thua Thien-Hue, Viet Nam in 2001/02

Treatment	No. of pigs	Life weight (kg) initial	Life weight (kg) 3 months	LWG[a] (g/day)	FCR[b] (kg DM/kg gain)	Feed cost[e] (VND/kg gain)
Control diet[c]	6	24.30	52.50	313.3	4.83	10,745
Control +13% ECL[d]	6	26.92	57.75	342.5	4.36	7,862

Note: [a] LWG = live weight gain

[b] FCR = feed conversion ratio

[c] Controlled diet of rice bran, ensiled cassava roots (32 per cent as DM), fish meal and sweet potato (SP) vines

[d] Thirteen per cent ensiled cassava leaves replaced part of fish meal, and all SP vines; cassava leaves had been ensiled with 20 per cent fresh grated cassava roots

[e] Prices: rice bran dong 2,000/kg
fish meal 6,000/kg
cassava roots 320/kg
fresh SP vines 400/kg
cassava leaves 3,000/20 kg

Farmer participatory extension (FPE)

The following farmer participatory extension methods were found to be very effective in raising farmers' interest in soil conservation, in disseminating information regarding improved varieties and cultural practices, and in enhancing the adoption of soil conserving practices:

Cross-visits

Farmers from new sites were usually taken to visit older sites that had already conducted FPR trials and had adopted some soil conserving technologies. These cross-visits, in which farmers from the older sites could explain their reasons for adopting new technologies was a very effective way of farmer-to-farmer extension. After the cross-visits, farmers in some new sites decided to adopt some of the technologies immediately, while others decided to conduct FPR trials in their own fields first. In both cases, the "FPR teams" of the various collaborating institutions, together with provincial, district or subdistrict extension staff, helped farmers to establish the trials, or they provided the seeds or planting materials required for the adoption of the new technologies.

Field days

At harvest time, field days were organized at the sites in order to harvest the trials and discuss the results. Farmers from neighbouring villages were usually invited to participate in the field days to evaluate each treatment in the various trials and to discuss the pros and cons of the various practices or varieties tested.

In a few cases, large field days were also organized with the participation of hundreds of neighbouring farmers, school children, local and high-level officials, as well as representatives of the press and TV. The broadcasting and reporting of these events also helped to disseminate the information about suitable technologies. During the field days farmers explained the results of their own FPR trials to the visiting farmers, while extension pamphlets and booklets concerning the farmer-selected technologies were distributed.

Training

Research and extension staff involved in the project had previously participated in Training-of-Trainers courses in FPR methodologies, including practical training sessions with farmers at some of the pilot sites. While some participants were initially skeptical, most course participants became very enthusiastic about this new approach once they started working more closely with the farmers.

In addition, 2-3 key farmers from each site together with their local extension agent were invited to participate in FPR training courses. The objective was to learn about the various FPR methodologies, the basics of conducting experiments as well as the implementation of commonly selected technologies, such as setting out contour lines or the planting, maintenance and multiplication of hedgerow species. By spending several days together on these courses, the farmers and extensionists got to know each other well, and were encouraged to form a local “FPR team” to assist other farmers in their community conduct FPR trials or adopt new technologies.

Community-based self-help groups

Realizing that effective soil conservation practices, such as the planting of contour hedgerows, can best be done as a group, farmers from a few sites decided to form their own “soil conservation group”. These community-based self-help groups are similar to “Land Care units” that have been very effective in promoting soil conservation in the Philippines and Australia. Subsequently, the Department of Agriculture Extension in Thailand encouraged farmers to set up these groups as a way of organizing themselves to conduct FPR trials, to implement selected practices and to manage a rotating credit fund, from which members of the group can borrow money for production inputs. Thus, by 2003, a total of 21 “Cassava Development Villages” had been established in the pilot sites in Thailand. Each group requires at least 40 members, must elect five officers to lead the group, and establish their own by-laws concerning membership requirements, the election of officers and use of the rotating fund, among others. The formation of these groups helped decisions on collective action and strengthened the community, while people gained confidence and the group became more self-reliant. When necessary, the group can request help from local or national extension services, obtain information about certain production problems, or receive planting material for vetiver grass or other species for hedgerows or green manures. Some groups started their own vetiver grass nurseries to have planting material available when required.

Adoption

After conducting their own FPR trials, or subsequent to a cross-visit to another village where trials were being conducted, farmers often decided to adopt one or more technologies on their production fields with the hope of raising yields or income and protecting the soil from further degradation.

In Thailand, practically all the cassava area is now planted with new varieties and about 75 per cent of farmers apply some chemical fertilizers (TTDI, 2000), although usually not enough nor in the right proportion. As a result of the FPR fertilizer trials, farmers started to apply more K, due to the official fertilizer recommendation for cassava being changed from an NPK ratio of 1:1:1 to 2:1:2. After trying various ways of controlling erosion, most farmers selected the planting of vetiver grass contour hedgerows as the most suitable. By the end of 2003, about 1,038 farmers had planted a total of 1.63 million vetiver plants, corresponding to about 145 km of hedgerows (Howeler *et al*., 2003; 2004a, 2004b, 2005; Vongkasem *et al*., 2003).

In August 2002 a participatory monitoring and evaluation (PM&E) study was conducted in four pilot sites in Thailand where the project had been initiated at least four years previous. Using focus group discussions and participatory evaluation methodologies, data was collected on the extent of adoption of the various technologies and the reasons for the adoption or non-adoption. Table 11 shows that new varieties had been adopted in 100 per cent of the cassava growing areas at all four sites. The application of chemical fertilizers varied from 79-100 per cent, vetiver hedgerows were planted on 22-55 per cent of the cassava area, green manures on 0-50 per cent and intercropping was not adopted at all, mainly due to a lack of labour to manage the intercropping.

Table 11. Extent of adoption[a] of various cassava technology components in four pilot sites in Thailand in 2002

Technological component	Baan Khlong Ruam Sra Kaew		Thaa Chiwit Mai Chachoengsao		Sapphongphoot Nakhon Ratchasima		Huay Suea Ten Kalasin	
	(ha)	(%)	(ha)	(%)	(ha)	(%)	(ha)	(%)
Varieties	480	100	469	100	396	100	228	100
Chemical fertilizers	480	100	469	100	364	92	180	79
Vetiver grass hedgerows	139	29	94	20	218	55	89	39
Green manures	72	15	0	0	0	0	114	50
Intercropping	0	0	0	0	0	0	0	0

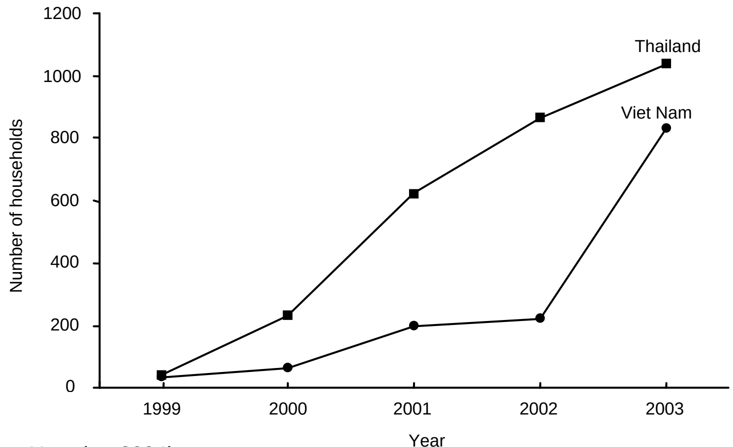
Source: Howeler, 2004b.

Note: [a] Estimated by farmers at each site during Participatory Monitoring and Evaluation (PM&E) in August 2002.

Figure 2 shows how the number of farmers at the pilot sites adopting various soil conservation measures increased each year, primarily in Thailand but subsequently in Viet Nam too.

Data in Table 12 indicates that the adoption of soil conservation practices in all sites in Viet Nam raised yields, ranging from 13.5 per cent in 2000 to 23.7 per cent in 2002. As a result of the adoption of soil conservation practices, gross income, both per hectare and per household, also increased markedly over time. Results from both FPR trials and on-station research also indicate that the beneficial effects of contour hedgerows in terms of raising yields and abating erosion increased over time (Howeler *et al*., 2005). This is principally because the planting of contour hedgerows, almost independently of the species used, will result in natural terrace formation, which over time reduces the slope and enhances water infiltration, thus reducing run-off and erosion. Well established hedgerows also become increasingly more effective in trapping eroded soil and fertilizers. Unfortunately, most FPR erosion control trials are conducted for only 1-2 years at the same site, so farmers do not quite appreciate the increases in beneficial effects that result over time. This coupled with the fact that planting and maintaining hedgerows requires additional labour and money for seed or planting material, and that hedgerows take some land out of production and have initially little beneficial effect on yield, has hampered the more widespread acceptance and adoption of these soil conservation practices.

Figure 2. Number of farmers adopting soil conservation measures on their cassava fields in FPR pilot sites in Thailand and Viet Nam from 1999 to 2003



Source: Howeler, 2004b.

Table 12. Extent of adoption of soil conservation practices and the estimated increase in yield and gross income of farmers in the FPR pilot sites in Viet Nam from 2000 to 2003

Year	Number of Households (n=831)	Area with soil conser. (ha) (area=612 ha)	Cassava yield (t/ha)		Percentage yield increase	Increase in gross income (US$)		
			Farmers' practice[a]	With soil conservation		total	per household	per ha
2000	62	21.12	12.11	13.75	13.5	865	13.95	41.00
2001	200	59.87	16.50	19.95	20.9	4 592	22.96	76.70
2002	222	88.85	20.60	25.48	23.7	11 582	52.17	130.35
2003	831	612.00	20.60[c)]	25.48[c)]		61 658	74.20	100.75
Total	**831**	**612.00**				**78 697**		

Source: Tran Ngoc Ngoan, 2003.
Note: [a] Farmers' practice includes most new technologies except soil conservation.
[b] Fresh root price: in 2000 350 VND/kg
in 2001 350 VND/kg in north, 200 in central and 290 in south
in 2002 400 VND/kg
in 2003 320 VND/kg (estimated)
US$ 1= VND 14,000 in 2000 and VND 15,500 in 2003
[c] Yields estimated from 2002.

Table 13 shows in more detail how the adoption of various technologies increased over time in one commune in Pho Yen district of Thai Nguyen province, Viet Nam, where the project first began in 1994. Since 1995 farmers have conducted FPR trials on new varieties, more balanced fertilization, intercropping and erosion control. After some years of testing, farmers initially adopted new varieties and intercropping on small areas of their land.

Table 13. Impact of the adoption of new cassava varieties and improved production practices on the livelihoods of farmers in Tien Phong commune, Pho Yen district of Thai Nguyen, Viet Nam

Year	Variety or practice[a]	No. of farmers	Cassava area (ha)	Cassava yield (t/ha)	Peanut yield (t/ha)	Gross income[b] (million dong/ha)	Production costs (million dong/ha)	Net income (million dong)[e]	Total net income (million dong)[e]
1994[c]	Vinh Phu	115	50	8.5	-	3.40	2.93	0.47	23.50
	New varieties	0	-	-	-	-	-	-	-
			50						**23.50**
2000	Vinh Phu	n.a.[d]	n.a.	21.5	-	n.a.	n.a.	n.a.	n.a.
	New varieties	25	1.31	30.9	-	15.45	4.36	11.10	14.54
	Intercropping	37	2.59	29.3	0.81	18.70	6.16	12.54	32.48
	Erosion control	4	0.20	24.7	-	12.35	4.66	7.69	1.54
			>4.10						**>48.56**
2001	Vinh Phu	61	2.17	22.7	-	11.35	4.36	6.99	15.17
	New varieties	122	4.70	29.0	-	14.50	4.36	10.14	47.66
	Intercropping	40	3.38	26.2	0.77	16.94	6.16	10.78	36.44
	Erosion control	4	0.20	n.a.	-	n.a.	n.a.	n.a.	n.a.
			10.45						**>99.27**
2002	Vinh Phu	18	0.64	25.4	-	12.70	4.33	8.37	5.36
	New varieties	100	5.16	33.7	-	16.85	4.33	12.52	64.60
	Intercropping	118	3.69	32.3	1.73	24.80	6.13	18.67	68.89
	Balanced fert.	48	2.95	33.4	-	16.70	4.83	11.87	35.02
	Erosion control	5	0.18	25.4	-	12.70	4.63	8.07	1.45
			12.62						**175.32**
2003	Vinh Phu	n.a	n.a.	n.a.	-	n.a.	n.a.	n.a.	n.a.
	New varieties	225	17.00	36.8	-	18.40	4.33	14.07	239.19
	Intercropping	120	11.00	36.0	0.67	21.35	6.13	15.22	167.42
	Balanced fert.	54	3.40	33.6	-	16.80	4.83	11.97	40.70
	Erosion control	5	0.60	27.0	-	13.5	4.63	8.87	5.32
			>32.00						**>452.63**

Source: Howeler, 2004b.

Note: [a] In Tien Phong farmers traditionally grow mainly Vinh Phu variety but have now largely changed to KM 95-3 and KM 98-7; the new practices include intercropping with peanut, balanced fertilization of 10 t/ha of pig manure plus 80N-40P_2O_5-80 K_2O, and erosion control by contour hedgerows of *Tephosia candida*.

[b] Price of cassava in 1994: 400 VND/kg fresh roots.
Price of cassava in 2000-2003: 500 VND/kg fresh roots.
Price of peanut in 2000-3003: 5,000 VND/kg dry pods.

[c] Data from RRA at the start of project.

[d] n.a. = data not available.

[e] US$ 1 = 11,000 dong in 1994, about 15,500 dong in 2003.

This was followed by better fertilization and erosion control; the latter was adopted by only a small number of farmers as most cassava fields in the commune are on gentle slopes or on terraced land. It is clear that the adoption of new technologies raised yields significantly, of both the local variety Vinh Phu and the new varieties, mainly KM 95-3 and KM 98-7. The gradual rise in yield, from 8.5 tons per hectare in 1994 to 36.8 tons per hectare in 2003 was accompanied by an expansion of the area using new technologies, resulting in about a 20-fold increase in net income and marked improvements in the livelihoods of farmers in this commune.

Table 14 summarizes the extent of the adoption of new cassava technologies at FPR pilot sites in 15 provinces of Viet Nam during 2003 and the resulting increase in gross income due to the higher yields obtained. Although balanced fertilization produced the greatest yield increase, it was not adopted over a very wide area. New varieties were most widely adopted resulting in the greatest increase in gross income. The total annual increase in gross income due to the adoption of new technologies at the FPR sites was estimated at US$ 1.67 million or $72.92 per household.

Table 14. Extent of adoption of new cassava production technologies in FPR pilot sites in 15 provinces of Viet Nam in 2003/04, the effect on cassava yields, and the increase in gross income resulting from the yield increase at those sites

Technology component	No. of households	Area (ha)	Cassava yield (t/ha)		Increase in gross income		
			Farmers' practice[a]	Improved technology	total ('000 US$)[b]	per hh (US$)	per ha (US$)
New varieties	14 820	7 849	19.93	28.95	1 462	98.65	186
Balanced fertilization	1 710	607	21.37	30.50	114	66.67	188
Soil conservation practices	831	612	20.60	25.48	62	74.19	101
Intercropping	4 250	160	29.95	28.94	15[d]	-17.32	94
Root and leaf silage for pig feeding	1 172	-[c]	-	-	12	10.24	-
Total	**22 833**	**9 228**			**1 665**	**72.92**	**-**

Source: Tran Ngoc Ngoan, 2003.
Note: [a] Farmers' practice usually includes most new technologies except the technology being tested.
[b] Based on a price of 320 VND/kg fresh roots in 2003/2004; US$ 1 = VND 15,50.
[c] 3,370 pigs.
[d] Increase in gross income from the harvest of intercrops.

Impact assessment

In order to determine more precisely the effect of this project on the adoption of new technologies, an impact assessment was performed by an independent consultant. The consultant organized focus group discussions and collected data from farmers at eight representative project sites, four sites in Thailand and four in Viet Nam, as well as from farmers living within 10 kilometres of those sites who had not participated in the project.

Table 15 shows the percentage of the 767 households who have adopted various technologies. New varieties were adopted[1] by nearly all cassava farmers at the eight sites in Thailand and by 70 per cent of farmers in Viet Nam; the use of chemical fertilizers had been adopted by 85-90 per cent of households at the eight sites in each country; intercropping by nearly 60 per cent of households in Viet Nam, but by only 13 per cent in Thailand. Contour ridging was adopted by about 30 per cent of households in both Viet Nam and Thailand, while contour hedgerows were adopted by 23 per cent of households in Thailand and 25 per cent in Viet Nam; in Thailand these hedgerows were almost exclusively vetiver grass, while in Viet Nam most farmers preferred the planting of *Tephrosia candida* or *Paspalum atratum*, as they are easier to plant (from seed) and can also serve as a green manure and animal feed respectively. Thus, it is clear that adoption of specific practices varies from site to site, depending on local conditions and traditional practices. Table 15 also indicates that there were significant differences in the adoption of almost all the technologies between participating and non-participating farmers (with the exception of contour ridging and the use of chemical fertilizers in Viet Nam), with participating farmers having a greater extent of adoption than non-participating farmers. In this case, “participants” were defined as farmers who had conducted at least one FPR trial and/or had participated in an FPR training course, while “non-participants” had done neither, but may have attended a farmer field day organized by the project. It can be seen that new varieties and the use of chemical fertilizers were readily adopted by both participants and non-participants, while the adoption of soil conservation practices and intercropping was less widespread and largely limited to participating farmers. This clearly illustrates the difficulty of achieving spontaneous and widespread adoption of soil conservation practices.

How does the adoption of these new technologies translate into higher yields and income? Figure 3 shows the cassava yields that farmers reported before and after the project, corresponding more or less to the second phase of the project, or from 1999 to 2003. In Thailand the yields of participating farmers increased from 19.4 to 25.8 tons per hectare (33 per cent), while the yields of non-participating farmers increased from 15.5 to 20.3 tons per hectare (31 per cent); in Viet Nam, project participants increased their yield from 13.7 to 28.2 tons per hectare (106 per cent) while non-participants increased their yield from 14.3 to 23.9 tons per hectare (67 per cent) (Lilja *et al*., 2005). Thus, in both countries yields jumped markedly, but these increases were greater for participants than for non-participants, especially in Viet Nam. For comparison, Figure 3 also shows the increase in

[1] Planted on 50 per cent or more of the farmer’s total cassava area.

yield for the whole country, as reported by the Food and Agriculture Organization (FAO) during approximately the same time period. Yields for the whole of Viet Nam are considerably below those reported by farmers in the focus groups; but the yield increases are similar to those reported by the non-participants. In Thailand the initial yields in the country were similar to those of non-participating farmers, but post-project yields were much higher for participants as well as nearby non-participants than for the country as a whole. This indicates that participating farmers benefited most from their experiences but that nearby farmers also benefited indirectly from the project.

Table 15. Extent of adoption (per cent of households)[a] of new technologies by participating and non-participating farmers in the cassava project in Thailand and Viet Nam in 2003 (n=767)

	Thailand			Viet Nam			Full sample		
	Partic.	Non-partic.	Total	Partic.	Non-partic.	Total	Partic.	Non-partic.	Total
Varieties									
-100% improved varieties	100	88.0	91.1***	50.0	38.8	42.9***	73.2	67.3	69.1***[b]
-75% improved varieties	0	11.7	8.6	5.6	6.7	6.3	3.0	9.6	7.6
-50% improved varieties	0	0.3	0.2	26.2	18.3	21.1	14.0	7.9	9.8
-25% improved varieties	0	0	0	4.0	5.4	4.9	2.1	2.3	2.2
-No improved varieties	0	0	0	14.3	30.8	24.9	7.7	13.0	11.3
Soil conservation practices									
-contour ridging	52	22	30***	35	31	33	43	26	31***
-hedgerows	60	10	23***	50	12	25***	54	11	24***
-vetiver grass	60	10	23***	10	3	5**	33	7	15***
-*tephrosia condida*	0	0	0	38	6	18***	20	3	8***
-*paspalum atratum*	1	0	0*	12	2	6***	7	1	3***
-pineapple	0	0	0	2	1	1	1	0	1
-sugarcane	2	1	1	0	0	0	1	0	1
-other hedgerows	3	0	1*	7	1	3***	5	1	2***
-no soil conservation	21	72	59***	23	58	45***	22	67	53***
Intercropping	28	8	13***	79	49	59***	55	25	34***
-with peanut	1	1	1	47	33	38***	26	14	18***
-with beans	0	0	0	27	29	29	14	12	13
-with maize	3	10	5***	2	3	3	6	3	4*
-with green manures	19	4	8***	0	0	0	9	2	4***
-with other species	3	2	2	39	15	24***	22	7	12***
Fertilization									
-chemical fertilizers	98	86	89***	85	86	86	91	86	87***
-farm-yard or green manure	55	25	33***	74	60	65**	65	40	48***
-no fertilizer	0	13	9***	12	8	9	6	11	9*

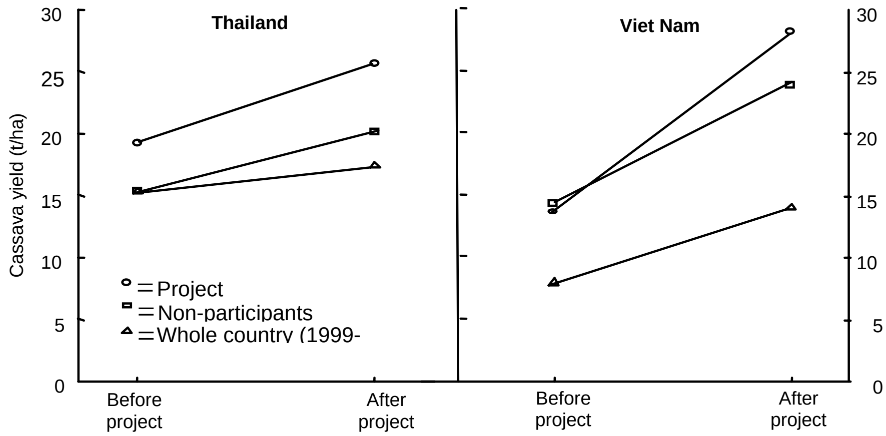
Source: Lilja *et al*., 2005.

Note: [a] Percentages may total more than 100 per cent as households can adopt more than one type of technology simultaneously

Significant differences between participants and non-participants: * P<=0.10 ** P<=0.05 *** P<=0.01

[b] Level of significance in this case refers to differences between participants and non-participants in terms of the categorical distribution, not the adoption level.

Figure 3. Average cassava yields of farmers participating in the Nippon Foundation cassava project



Also included are nearby but non-participating farmers, before the project started and at the end of the project. Data originates from PRRA census forms collected from 417 households in Thailand and 350 households in Viet Nam. For comparison the national average cassava yields in 1999 (before) and 2003 (after) are also shown.
Source: Howeler, 2004b.

Table 16 shows that during the past ten years the average cassava yields in both countries increased; by 5.62 tons per hectare in Thailand and 6.05 tons per hectare in Viet Nam. The increased yields triggered annual increases in gross income received by farmers of about US$ 203 million in the two countries, and about US$ 325 million in all of Asia. In addition, farmers in Thailand received higher prices due to the higher starch content of the new varieties. This was achieved not only by this project, but by the collaborative effort of many researchers, extensionists, factory owners and farmers, with strong support from the national government.

Table 16. Estimation of the annual increase in gross income due to higher cassava yields resulting from the adoption of new cassava varieties and improved practices in Thailand and Viet Nam, as well as in Asia as a whole.

Country	Total cassava area (ha)[a]	Cassava yield (t/ha)[a]		Yield increase (t/ha)	Cassava price ($/tons)	Increased gross income due to higher yields (million US$)
		1994	2004			
Thailand	1 050 000	13.81	19.43	5.62	25	147.5[b]
Viet Nam	370 500	8.44	14.49	6.05	25	56.0
Total Asia	3 508 103	12.93	16.64	3.71	25	325.4

Source: Howeler *et al*., 2005.
Note: [a] Data from FAOSTAT for 2004.
[b] In addition, farmers also benefited from higher prices due to higher starch content in Thailand.

Conclusions

Research on sustainable land use conducted in the past has primarily concentrated on finding solutions to the bio-physical constraints, and many solutions have been proposed for improving the long-term sustainability of the system. However, farmers have actually only adopted very few of these solutions, mainly because the research ignored the human dimension of sustainability. For new technologies to be truly sustainable they must not only maintain the productivity of the land and water resources, but they must also be economically viable and acceptable to farmers and the community. To achieve the latter objectives farmers must be directly involved in the development, adaptation and dissemination of these technologies. A farmer participatory approach to technological development was found to be very effective in developing locally appropriate and economically viable technologies, which in turn enhances their acceptance and adoption by farmers.

Establishment of FPR trials is initially time consuming and costly, but a critical number of people have been trained and become enthusiastic about the use of this approach, including participating farmers. Both the methodology and the selected improved varieties or cultural practices will spread rapidly. The selection and adoption of farming practices that are most suitable for the local environment and in tune with local traditions will improve the long-term sustainability of the cropping system, to the benefit of both farmers and society in general.

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Farmer-Scientist Training Programme and Corn in the Philippines*

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Abstract

Cognizant of the need to increase corn productivity and profitability, especially in upland areas, the Farmer-Scientists Training Programme, which was piloted in a barangay in the province of Cebu in 1994, was replicated in various barangays (community) in Central Visayas in 1995 and 1999 through 2000. The objective of the programme was to provide corn farmers, especially those in upland communities, direct contact with agricultural scientists to develop their technical and scientific capabilities to grow corn and other crops using appropriate technologies. It also aimed to strengthen the agricultural research and extension capabilities of local government units as well as state universities and colleges to render better services in their areas of responsibility. After 2-3 years of implementation, the impact on corn productivity was strong and farmers' income increased ranging from 44 per cent to 227.5 per cent. The overall increase was 129.3 per cent. The impact of the programme on poverty alleviation, however, was low where only 13.6 per cent of the 1,010 surveyed were lifted above the poverty line. Notwithstanding, considerable impact was obtained in other communities, where the socio-economic conditions of 36.8 per cent of the trained farmers tremendously improved. With the success in achieving the objectives of FSTP it has been foreseen to create spill-over effects in neighbouring communities and benefit more farmers in time and eventually propel agricultural development.

Acknowledgements

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Background

Corn is the third most dominant crop grown in the Philippines in terms of area planted, next to rice and coconut. The country produces some 4.7 million tons of corn annually on a total of 2.5 million hectares. Of the total output, 59 per cent is composed of yellow corn, while the rest are the white varieties. Yellow corn is primarily used as an ingredient in livestock and poultry feed formulation, while white corn is used as a staple food by 20 per cent of the country's population, especially those situated in impoverished parts of the country, like the Visayas and Mindanao. White corn is also utilized in the manufacture of starch, gluten as well as a complement to bridge the deficit in yellow corn production, together with imported yellow corn. Currently, the country produces only 76 per cent of the domestic demand for corn.

While corn plays a significant role in the Philippines' agricultural economy, its potential for higher productivity has not been harnessed to the fullest. In 2004, average production was 2.14 tons per hectare, 3.3 tons for yellow corn and 1.43 tons for white. Low productivity stems from various causes; the most prevalent are erratic climatic conditions, occurrences of pests and disease and a lack of seeds of open-pollinated varieties and hybrids. Aside from inadequate funding support from the government for research and development, the problem is compounded by the low adoption of technologies by farmers, inadequate post-harvest facilities, and the high cost of transporting the grains to the market.

Although there are available technologies that could be employed by farmers to increase productivity, the extension service, which was decentralized from the Department of Agriculture to the local governments in 1992, has not been very effective. In many regions of the country, many of the extension workers are specialists, hence not well equipped to address specific problems outside of their areas of expertise. In many cases, the coverage area of the extension workers are too large and their regular visits to the farmers are constrained by a lack of logistic possibilities and support from the local government units due to budgetary limitations. Further, many governors and mayors provide limited logistic support to food production programmes; they accord higher priority to projects that potentially will promote their political interests in a shorter time period.

Another major problem of corn production is the low price of corn paid to farmers. Due to the lack of farm-to-market roads it is difficult for farmers to transport their fresh produce quickly enough. Therefore, they are forced to sell directly to traders with narrow margins rather than suffer greater losses due to deterioration of the crop.

Although corn production is not a profitable business, farmers nonetheless plant corn as it has a certain market and, thus, some income. They grow other high-value crops only for home consumption because of market uncertainties. As corn productivity has not improved, production is usually insufficient to supply the needs of farmers and their families. Generally, corn farmers live below the poverty line.

To improve corn production and farmers' livelihoods, the Department of Agriculture, through the Bureau of Agricultural Research, funded Farmer-Scientists Training Programmes during 2001-2004 in three southern provinces.

Project background

The Farmer-Scientists Training Programme (2001-2004) is a project that was developed after the corn-based Farmer-Scientists Research, Development and Extension Training Programme, a programme that was piloted in 1994 in Colawin, Argao, in the province of Cebu. The aim was to address poverty among the highland farmers in the area. This was initiated by Dr. Romulo G. Davide, a Professor Emeritus of the University of the Philippines at Los Baños (UPLB), upon seeing the corn farmers in his native barangay in profound poverty. Using part of his cash award for winning the Department of Agriculture-Gawad-Saka Outstanding Agricultural Scientist Award, he initially funded the project with the small amount of PhP 500,000 (approximately US$ 9,000), supplemented by limited funding support from the Bureau of Agricultural Research (BAR). Supported by volunteer scientists from UPLB, the project was implemented in partnership with the different government and non-governmental institutions concerned with poverty alleviation of farmers and the country's food security programme.

Prior to programme implementation, Cebu province produced an average corn yield of 0.5 tons per hectare, which only supplied 50 per cent of white corn demand from the province's population of nearly 2.9 million. Due to the programme, farmers in Cebu currently produce 3-6 tons per hectare. Inspired by the success, the programme was expanded to another two towns in Cebu in 1995 and in 1999. Impressed by the ability of the programme to raise corn productivity at the project sites, the Cebu governor proclaimed the expansion of FSTP to all corn-growing municipalities of the province in 2000, with the objective of increasing the average yield of 0.5 tons per hectare to 3 tons within a period of three years.

The project was also expanded to other barangays in the provinces of Occidental Mindoro (in Southern Luzon), Siquijor and Negros Oriental.

Encouraged by the support of the governor, Dr. Davide expanded the programme to other barangays in 2000 in Cebu with larger funding support from BAR. The project was implemented in partnership with the Department of Agriculture- Region 7, local government units (LGUs), state universities and colleges (SUCs), other concerned agencies of the Department of Agriculture (DA) and some non-governmental organizations (NGOs).

Central Visayas, where the provinces of Cebu, Siquijor and Negros Oriental are located is the second largest producer of white corn in the country and the seventh in yellow corn production. It produces an average of 167 thousand tons of corn from 240 thousand hectares, 95 per cent of which is white corn. While the national average corn yield is 2.14 tons per hectare (3.30 tons and 1.43 tons for yellow and white corn, respectively), the average yield in the Central Visayas is very low, about 0.75 tons per hectare, 1.53 tons for yellow corn and 0.71 tons for white (Table 1 and 2) based on the benchmark survey, which was conducted prior to the project. Corn farmers' income in the selected barangays in Cebu and Siquijor stem from the sale of corn, small quantities of other cash crops, livestock and poultry. Their incomes are very low, ranging from PhP 1,395.16 (US$ 25.60 based on the exchange rate of PhP 54.50 to one dollar) to PhP 8,844,58 (US$ 162.28). It was only in Bayawan City in Negros Oriental where corn farmers were much better off, earning an average of PhP 14,709.02 (US$ 269.89). The landholdings were very small, averaging 0.5 to 1.7 hectares.

Farmers reported that the major problems in corn cultivation include the inadequate supply of fertilizers and seeds of high-yielding, open-pollinated corn varieties and hybrids. Other major problems were a lack of capital, technical assistance, an inefficient marketing system, and farmers were not provided sufficient support to empower themselves to achieve socio-economic progress.

Table 1. Volume of corn production, area planted, yield per hectare, Philippines, 2000-2004

	2000	2001	2002	2003	2004
Total corn production (mt/ha)	4 511 104	4 525 012	4 319 262	4 615 625	5 413 386
Yellow corn	2 621 766	2 607 358	2 522 333	2 562 941	3 185 956
White corn	1 889 338	1 917 654	1 796 929	2 052 684	2 227 430
Area planted (ha)	2 510 342	2 486 588	2 395 446	2 409 828	2 527 135
Yellow corn	936 934	921 476	892 328	844 885	964 788
White corn	1 573 408	1 565 112	1 503 118	1 564 943	1 562 347
Yield per hectare (mt)	1.79	1.82	1.80	1.92	2.14
Yellow corn	2.80	2.83	2.83	3.03	3.30
White corn	1.20	1.23	1.20	1.31	1.43

Source: BAS Online Statistics Database, Bureau of Agricultural Statistics, Department of Agriculture, Quezon City, Philippines.

Table 2. Volume of corn production, area planted, yield per hectare, Central Visayas, the Philippines, 2000-2004

	2000	2001	2002	2003	2004
Total corn production (mt/ha)	137 536	154 011	166 960	192 061	183 995
Yellow corn	10 664	10 025	11 006	10 807	12 267
White corn	130 630	145 680	154 887	174 840	165 212
Area planted (ha)	228 981	238 438	241 833	244 699	244 259
Yellow corn	10 818	10 025	11 006	10 807	12 267
White corn	218 163	228 413	230 827	233 892	231 992
Yield per hectare (mt)	0.60	0.64	0.69	0.78	0.75
Yellow corn	0.64	0.83	1.10	1.59	1.53
White corn	0.60	0.64	0.67	1.31	0.71

Source: BAS Online Statistics Database, Bureau of Agricultural Statistics, Department of Agriculture, Quezon City, Philippines.

Objectives

The main objective of the Farmer-Scientists Training Programme (FSTP) was to provide corn farmers, especially those in the upland communities, direct contact with agricultural scientists to develop their technical and scientific capabilities to produce corn and other crops, utilizing appropriate farming technologies. It also aimed to strengthen the agricultural research and extension capabilities of the local government units, state universities and colleges. Specifically, the programme aimed to:

1. Enrich the corn farmers through lectures on value formation, changing their attitudes towards team work, co-operation, and the sharing of technical information;
2. Equip farmers with scientific knowledge and technologies for corn-based farming systems;

3. Apply integrated pest management (IPM) using biological control agents and natural enemies of pests and disease-causing organisms and the proper use of pesticides only when necessary;
4. Make farming a business enterprise through the formation of farmer associations, co-operatives and market networks;
5. Develop self-reliant and self-sustaining farmers and communities through maximum production of corn and other economic crops to supply market demand and
6. Strengthen the leadership of farmers in their respective communities.

Methodology

Project management

The FSTP project in Cebu was operated by a management team with the Provincial Agricultural Officer (PAO) as the overall co-ordinator and all the Municipal Agricultural Officers (MAOs) and Agricultural Technicians (ATs) involved as members of the team, together with assigned staff from DA-Region 7, DA's Agricultural Training Institute-Research Centers, PAO office, state universities and colleges (SUCs) and non-governmental organizations (NGOs).

Selection of farmer-participants

The farmer-participants were selected based on the following criteria:

- Should have at least three years of actual experience in growing corn on his own land of at least 0.5 hectares;
- Ability to read and write;
- Good communication skills;
- Law abiding with friendly disposition;
- Good moral character between 18 and 60 years old; and
- Willing to share and transfer his/her learned or developed technologies to fellow farmers.

Benchmark survey

A benchmark survey covering the thirteen project sites was conducted to examine the agricultural profile of the area and determine the socio-economic status of the farmer-participants prior to project implementation. Based on the survey, the farmers plant corn twice a year. They grow corn primarily for home consumption and sell the surplus to neighbours or corn traders coming to the area. Other sources of income are derived from the sale of vegetables planted in rotation with corn, and other produce like fruits, poultry, livestock, and in some cases from farm and non-farm employment. In many cases, corn production was insufficient to even last for a few weeks post harvest.

Programme components

The programme was composed of three phases. Phase I included value formation and research exposure, as well as providing experience in conducting research studies in corn production and post-harvest handling and marketing. The first part, value formation, was included to inspire the participants in terms of spiritual and moral values for the love of God, country and the people. Hence, each meeting started with prayers and singing the national anthem. Research experience, the second component of phase I, included the establishment of experimental plots of corn by farmers with the assistance of scientists. By doing so, farmers were given hands-on experience in the conduct of different experiments covering land preparation, seed treatment, fertilization, plant population density, control of pests and disease, testing the yield performances of open-pollinated varieties (OPV) and hybrids, corn-based intercropping trials, and testing other technologies that would boost productivity.

The farmers themselves gathered data every second week from their experimental fields such as a germination inventory, plant growth and height, as well as the yield at harvest time. They observed the occurrences of pests, disease and weeds and discussed their summarized data in groups during reporting time in class. Specifically, these activities included:

- Comparing the effects of bio-N with those of chicken manure in combination with organic and inorganic fertilizers;
- IPM strategies;
- Making weekly observations on plant growth, presence of insect pests, disease, weeds, and others;
- Identification and classification of harmful and beneficial insects and weed species; and
- Testing the growth and yield performances of different corn hybrids and varieties.

The volunteer plant breeder taught the farmers how to observe and collate data on the agronomic characteristics of each hybrid or variety and how to produce hybrid corn. Divided into several groups, each group of farmers was required to present an oral report of his observations on the experimental plants and activities assigned by the scientists. Carried out twice a month, reporting was completed before the scientists later joined the discussions with farmers. The report covered farmers' observations on their experiments, problems identified, as well as causes and actions taken to solve the problems. Topics relevant to actual problems on plant growth, disease, weeds and others were also discussed. The scientists provided explanations on the specific problems and instituted the necessary measures to remedy the situation.

Technical empowerment

The scientists provided the farmers with lectures and discussions on the principles and applications of relevant technologies to be used in improving corn production. Lectures covered topics such as soil fertility determination, using soil test kits, seed selection and variety improvement, use of IPM in pest and disease control, storage, and marketing issues. Towards the end of Phase I, lectures on marketing strategies through the formation of co-operatives and market networks were given. After the completion of training, participants were awarded certificates by the Dean of the UPLB College of Agriculture and were considered alumni of the college. This was a guarantee that the participants were ready to proceed to Phase II of the programme.

Phase II: On-farm experimentation and technology adoption

During phase II of the programme, farmers were given the opportunity to replicate their research experience from phase I, by testing different technologies on their own farms. They were closely supervised by the MAOs or ATs assigned with the experts from partner-agencies like the UPLB College of Agriculture, DA-Region 7, BAR, Agricultural Training Institute (ATI), Cebu State College of Science and Technology (CSCST), LGUs concerned, non-governmental organizations (NGOs) and others.

The experiments were conducted either in groups or individually. They covered IPM to control the corn borer or corn weevil by removing the tassels of the corn plants, a comparative study of organic fertilizers vs. inorganic, use of Bio-N, and trials of different corn varieties and hybrids, among others. For the experiment, farmers used a randomized block with 2-3 replications per treatment. They were supervised by scientists during the laying out of their on-farm experiments and were instructed on how to gather data, similar to the experiments taught in Phase I.

The farmers were required to meet and present their findings at least once a month as well as discuss the results and problems encountered during the conduct of their experiments. Upon graduation, they were awarded Certificates of Achievement, certification that they could efficiently teach other farmers how to apply the technologies covered.

Phase III: Farmer-to-farmer R&D and technology transfer

Phase III, the final part of the programme, consists of R&D and technology transfer from farmer-to-farmer that is intended to continue even after the termination of the project. The farmer-scientists were assigned to extension work in their respective communities or barangays. Extension work covered technology transfer and utilization. They were required to share the technologies learned as farmer-scientists with untrained farmers under the supervision of the MAOs, ATs and the scientists involved. As in Phase I, the new farmer participants established group experiments to acquire technical knowledge in corn production. The farmer-scientists themselves decided on the best fertilizer combination to use, best varieties/hybrids to plant and what IPM technologies to apply to insure optimum corn production.

The farmer-scientists conducted weekly fieldwork and meetings to discuss with the participating farmers the data they had gathered, problems encountered, and action taken. A scientist would meet the group once or twice per month to discuss and classify study results. A scientist with expertise in IPM or plant breeding was also invited to further explain the principles of IPM or plant breeding and how to develop hybrid corn based on the results of their studies. After their experiments, the farmers were expected to apply their newly acquired technologies on their own farms in the succeeding cropping season.

Two extension models were used in Phase III, namely: the “Adopt-a-Barangay” and “Adopt-a-Farmer” models. Under the first model, more than ten untrained farmers in the barangay underwent Phase I and Phase II under the leadership of the farmer-scientist concerned. In the second model, 2-5 untrained farmers who were neighbours of the farmer-scientist learned the different technologies without undergoing Phases I and II training. These two models would provide a farmer-scientist options on what modality to adopt to share his/her learned technologies, whether within his whole barangay or “Adopt-a-Farmer”.

Upon completion of Phase III, the farmers-scientists were awarded certificates from the UPLB College of Agriculture. Under the Adopt-a-Farmer model, the adopted farmers were awarded certificates of participation.

Farmer-scientists who completed all three phases served as the link between farmers and scientists, extension workers, as well as other stakeholders from government and non-governmental institutions engaged in agricultural and rural development. The farmer-scientists conducted co-operative experiments with other farmers, particularly when testing technology for farm adoption.

Post Phase III, participation of the UPLB scientists was greatly reduced. They were consulted on an on-call basis, only when needed by other participating SUCs and LGUs. The LGUs were expected to already be capable of taking over the expansion of the programme with assistance from the farmer-scientists in their areas of responsibility. This would ensure faster dissemination of the programme to other parts of the country. Through time, the scientists would gradually withdraw from the programme and ultimately hand over their responsibilities to the MAOs, Agricultural Technicians and farmer-scientists.

Results

Phase I

Appendix Table 1 shows detailed results from the yield data gathered during Phase I of the programme. The following points summarize the salient findings:

- Regarding land preparation, no ploughing and no weeding treatment returned the lowest yield compared with one or two ploughing treatments.
- As expected no fertilizer application gave the lowest yield. The use of organic fertilizers like chicken manure in combination with Bio-N microbial fertilizer, urea or complete 14-14-14 fertilizer gave much higher yields than when only one type was applied alone. In one barangay, for instance, yields of 3.48 tons per hectare when chicken manure plus Bio-N were applied, an increase of 138 per cent, while no fertilizer application gave a yield of 1.47 tons per hectare.
- In the variety/hybrid trials, a number of open pollinated varieties (OPV) and hybrids gave much higher yields than local varieties. The OPVs and hybrids produced 4-8 tons per hectare compared to 0.5-2 tons per hectare produced from local varieties.
- In the plant density trial, the population of 1-2 plants per hill gave a much higher yield than those with 4-5 plants per hill, which was the usual practice of the farmers before the implementation of the programme. In one barangay experiment (in Ronda) one plant per hill gave 3.6 tons per hectare compared to 1.91 tons per hectare using five plants per hill.
- In the detasseling trial, the removal of the tassels or flowers of the plant every three rows, leaving the tassels of the fourth row intact, every 40-50 days after planting gave a yield increase of 41 per cent (from 3.4 to 4.8 tons per hectare). Detasseling was carried out to control corn borers.

Phase II

In Phase II, 13 municipalities in Cebu and one city in the pilot area in the province of Negros Oriental were covered. Some of the major findings from the Phase II on-farm trials are as follows:

1. Results from the variety trials in Cebu show that all the OPVs tested gave much higher yields compared to the local variety. The yields with the OPVs ranged from 3-7.4 tons per hectare (Table 3). Low yields in other towns like Ronda, Argao, Carcar and in some towns in Cebu, Siquijor and Negros Oriental could be attributed to the dry weather that prevailed 2-3 weeks subsequent to planting. This represent a great breakthrough as farmers previously had to purchase corn just a few weeks post harvest due to the very low yield of 0.5-1.0 ton per hectare they had obtained.

2. In Siquijor province, the farmer-scientists in the two municipalities (Lazi and Maria) reported high performances of OPVs and hybrids tested on their own farms. The 49 farmer-scientists in Lazi obtained an average yield of 5.11 tons per hectare (Table 3). Among the open pollinated varieties the highest yield obtained was 7.7 tons per hectare, while the highest yield with hybrids gave 9.25 tons per hectare. In Maria municipality, similar positive outcomes were experienced with OPVs and hybrids with an average yield of 4.25 tons per hectare. Yields were lower in Maria due to dry weather that begun shortly after planting. However, from all the trials, an average of 2.78 tons per hectare was still obtained, which is a significant improvement prior to FSTP implementation.

3. In Bayawan City, the OPVs and hybrids were also found to give much higher yields than the local variety, in spite of the heavy rains that flooded the experimental farms. The OPVs gave yields ranging from 3 to 5.2 tons per hectare. Furthermore, the hybrids gave yields as high as 10.6 tons per hectare. Consequently, the farmers were convinced to plant more high-yielding OPVs and hybrids the following cropping season to supply the markets. The average yield obtained was 4.82 tons per hectare for all trials.

Table 3. Results from Phase II field trials conducted by the farmer-scientists, 2003-2004

Province and Municipality	Highest yield obtained field trials			Average yield per hectare (All trials)
	Variety	Fertilization	Detassling	
	Tons per hectare			
A. Cebu				
1. Carmen	5	-	7	3.41
2. Ronda [a]	3	2.3	3.8	3
3. Argao [a]	3.9	-	-	3.99
4. Aloguinsan	7	6	3	4.57
5. Barili	4	3.5	4.8	2.9
6. Carcar [a]	5.67	4.8	4.8	4
7. Bantayan	8	4.6	-	4.07
8. Balamban	4.2	6	-	5.91
9. Ginatilan	7.4	7.4	7.7	4.89
10. Sibonga [a]	4	2.26	4.46	3.73
11. Pinamungahan [a]	4.05	2.26	-	3.6
12. Consolacion	4.2	4.2	3.4	3.24
13. Toledo City	2.8	7.8	-	4.06
B. Siquijor				
1. Maria [a]	5.5	5.7	-	2.78
2. Lazi [a]	9.25	9.25	-	5.11
3. Enrique Villanueva [a]	5.19	5.2	4.38	4.44
C. Negros Oriental				
1. Bayawan City [a]	8.4	4.08	-	4.82

Source: Davide, R.G. *et.al*., 2004.
Note: [a] Affected by dry weather 2-3 weeks after planting.

4. Results from the fertilizer trials show that other organic fertilizers such as chicken manure and inorganic fertilizer, like urea or complete fertilizer (14-14-14), combined with Bio-N could greatly increase the yields of OPVs and hybrids. The farmer-scientists observed that growing corn with application of fertilizers is the most profitable practice.

5. Intercropping corn with mung bean, peanut, sweet potato, cassava and other crops could greatly increase farm productivity and income. Likewise, detasseling corn was found adaptable in corn-based farming systems, namely removing the corn tassels or flowers every third row, leaving the fourth row with tassels/flowers intact, 40-50 days after planting. This practice not only controlled corn borers that laid their eggs in the tassels but also increased yield by 40 per cent. The use of 1-2 plants per hill, rather than the traditional 4-5 plants per hill, also produced higher yields by 50 per cent.

Phase III

Phase III is the extension component of the Farmer-Scientists Training Programme (FSTP). Holistic in scope, the third phase was tailored especially for marginal farms to improve farm productivity and farmers' socio-economic conditions. Farmers graduating from the first and second phases of the programme proceeded to the third phase in an attempt to transfer their new technical knowledge to their fellow farmers in their respective barangays, using either adopt-a-farmer or adopt-a-barangay model becoming Barangay Agricultural Scientist Technicians (BAST) on a voluntarily basis.

Within the period 2003-2004, five municipalities in Cebu conducted FSTP-Phase III and a total of 412 farmers graduated. Using the technologies developed by the farmer-scientists, the adopted farmers were also able to boost productivity and income. All the farmers in each barangay were given the opportunity to adopt FSTP technologies, thus improving farm productivity as well as their socio-economic conditions. The average and highest yields obtained by the adopted farmers ranged from 2.42 to 5.11 tons per hectare.

A partial survey was conducted in 12 municipalities and one city in the province of Cebu in 2004 to determine the effects of the programme on the economic status of the trained farmers. The survey shows that the programme triggered considerable positive impact on farmers' income when adopting corn production technologies. On average, farmers' annual income rose by 143 per cent after adopting the new technologies, but as Table 4 shows, the income increases varied among the municipalities. Argao municipality reported the largest aggregate annual net income of PhP 1.94 million among the thirteen municipalities covered by FSTP, followed by Toledo City and Barili with PhP 1.82 million and PhP 1.7 million, respectively.

Based on partial results, only 13.5 per cent of the 1,045 participating farmers interviewed rose above the poverty line after 2-3 years of FSTP implementation (2001-2004). This is expected as it normally takes 7-10 years for projects to have wider impacts. There are sites, however, where impacts are significant. In Toledo City, for instance, 36.8 per cent of the 106 farmers escaped poverty. In other municipalities like Bantayan and Carmen 23.7 to 29.5 of the trained farmers managed to abate their poor living conditions. The rapid jumps in income from corn production at barangay and municipal levels could be manifested through the transformation in the farmers' living conditions. Aside from sufficient food supply, they were able to buy home appliances such as refrigerators, television sets, radios, cell phones and motorcycles. The motorcycles provided them additional sources of income by using them as public utility vehicles. Others were able to purchase plots of land, establish convenience stores to raise additional capital for corn production, purchase vehicles to transport their farm produce directly to the local markets, and improve their houses. There are farmers who can now support the college education of their children.

Table 4. Effects of the FTSP programme on farmers' income

Municipality	Class[a]	Number of Barangays	Number of farmers	Average	Annual income	Increase (%)
Balamban	2nd	11	35	5 767.14	17 277.23	199.58
Bantayan	2nd	12	38	15 643.42	37 697.37	140.98
Consolacion	2nd	8	37	11 924.32	34 077.03	185.78
Argao	3rd	25	281	6 904.63	18 845.55	172.90
Barili	3rd	25	133	10 994.20	18 758.70	70.60
Badian	4th	18	37	20 105.41	28 905.59	43.77
Carmen	4th	9	41	9 646.34	28 846.34	199.03
Pinamungahan	4th	23	34	4 323.53	14 158.82	227.48
Alcantara	5th	6	113	4 583.18	9 489.64	107.05
Ginatilan	5th	14	36	9 083.33	19 722.00	117.12
Malabuyoc	5th	10	51	6 341.18	14 011.76	120.96
Aloguinsan	5th	11	103	3 618.83	9 169.05	153.40
Toledo City	-	32	106	17 222.64	37 605.66	118.35
Total		**204**	**1 045**			

Source: Davide, R.G. *et al*., 2004.

Note: The Argao and Barili survey was conducted in April-July 2002. FSTP started in Argao in July, 1994 and in Barili in October, 1995. This shows how effective the FSTP has been in poverty alleviation.

[a] Refers to the income range of municipalities (1st Class - PhP 50 million or more, 2nd Class - PhP 40 million or more but less than PhP 50 million, 3rd Class - PhP 30 million or more but less than PhP 40 million, 4th Class - PhP 20 million or more but less than PhP 30 million, 5th Class - PhP 10 million or more but less than PhP 20 million, 6th Class - below PhP 10 million).

Still, many of the trained farmers, especially in fifth class municipalities of Cebu, are still living below the poverty line. But with the progressive increase in the trained farmers' productivity, it is foreseen that many of these farmers will be alleviated from poverty in the next 4-6 years, if given adequate support for the purchase of agricultural inputs like fertilizers and seeds as well as the provision of market assistance.

Other activities related to the FSTP

Farmer-scientists (F-S) Field Days and Congresses

A thousand delegates comprising of farmers, students and other participants attended the field days. The farmer-scientists were accompanied by their respective PAOs, MAOs, ATs, mayors, vice-mayors, Sanguniang Barangay (Barangay Advisory Board) members and other local officials.

The field days involved field tours to corn and poultry farms of FSTP graduates and OPVs/hybrid trials at the FSTP Farmer Research and Extension Centres. Farmer delegates were given the opportunity to observe the yield of corn plants inter-cropped with sweet potato, mung bean and peanut.

Local officials, provincial governors, mayors and other municipal and provincial officials attended the F-S congress. It was during this congress that testimonies on the success of FSTP were presented and problems affecting FSTP implementation were discussed. Seeing the benefits of the programme the governors were convinced to pledge financial support to the programme for the purchase of fertilizers, seeds and other farm inputs required by the farmers.

Lesson learned

1. The Farmer-Scientists Training Programme (FSTP) could not be successfully implemented without the moral and financial support of the mayors, barangay advisory boards, MAOs, ATs, barangay captains, provincial governors, PAOs and provincial advisory boards. They are the key players to the success of FSTP as they are instrumental in providing the corn farmers the capital to buy the inputs for the field trials of cash-strapped farmers and in buttressing the scientists in attaining the objectives of the programme. The provision of financial support by local officials is vital as some farmer-participants, though willing to join the FSTP, had to back out due to a lack of capital.

2. The Department of Agriculture should strengthen its corn crop improvement programme and facilitate the production of seeds in partnership with the private sector.

3. FSTP should not be implemented at the municipal level without the commitment and leadership of the mayors and other officials.

4. Before starting FSTP in any province or municipality, defined roles and guidelines for mayors, MAOs, ATs, PAOs, resource persons/experts from the DA Regional field Offices, DA-BAR, ATI, the DA Regional Integrated Agricultural Research Centers (RIARCs), and those from UPLB, SUCs, and NGOs who would be involved as partner-agencies must be discussed before project implementation. The function of each participating institution must be stipulated in a memorandum of understanding (MOU) executed among them. The provisions of the FSTP Manual of Operation should be followed for the success of the programme.

5. The project should be evaluated and reviewed at the pilot sites so that the reviewers/evaluators can receive first-hand information on field operations of FSTP. There should be a panel of experts selected to represent various aspects of the project, from biological, economic, social and cultural to political issues. These experts should not only come from UPLB but also from other institutions like SUCs, LGUs or NGOs to ensure a holistic and impartial evaluation of the project.

6. There should be more action at the pilot sites, rather than holding frequent meetings in concerned offices to ensure the success of project implementation.

Conclusions and recommendations

The Farmer-Scientists Training Programme shows that technology and knowledge are powerful tools in propelling agricultural development. With the transfer of knowledge on the application of technology, farmers can realize considerable increases in farm productivity and profitability. Through the FSTP approach, corn farmers were able to dramatically increase productivity, after many years of stagnation with average yields of 0.5 tons per hectare. The programme also showcased the importance of utmost commitment and dedication of the people behind its success in attaining its objectives. Moreover, the programme was wholeheartedly accepted by most farmer-participants and impacted on many of the farmers’ socio-economic status after a short duration of 2-3 years. It also had a positive impact on the participants’ psychological well-being and eventually in enhancing the mayors’/governors’ rapport with their constituents, which could serve as common ground, giving rise to the conceptualization, planning and implementation of agricultural development projects.

The training approach, which was participatory, experiential and discovery-based was very effective in enhancing farmers’ perspectives on IPM, thus minimizing the application of pesticides and chemicals on the plants. Their healthy attitude, which was primarily induced by the need to increase productivity and income and by the values molded in Phase I, raised their overall know-how in corn-growing. It is believed that the knowledge the farmers acquired and the experience gained, coupled with visible benefits of the programme, will encourage farmers to continue to use the recommended practices. Instilling the importance of teamwork and co-operation was the basic premise for the farmers to bond together, which have served as a moving force towards attaining their goals and objectives.

The FSTP’s expansion and institutionalization in other corn-based areas would be of considerable benefit to the corn industry. To achieve this, the DA, through the BAR, should allocate funds for the national adoption of the FSTP. To ensure sustainability, the LGUs should do their part by appropriating funds to support implementation out of their 20 per cent food security component of the Internal Revenue Allotment. LGUs, agricultural research agencies, SUCs, NGOs and farmer organizations should establish a regional network to promote and strengthen research-extension linkages to facilitate information exchange in corn-based production systems. Co-operatives and farmer organizations should be formed/strengthened in order to gain leverage in the purchase of agriculture inputs at lower prices and in the marketing of corn and other produce at reasonable prices.

The FSTP, if continued, is expected to spill-over to other barangays and towns, as the trained farmers are willing to train other farmers to adopt the technologies they learned to improve the latter's living conditions. The trained farmers will uphold their motto "We gather knowledge to scatter", which instills in them the willingness to help other corn farmers. In due time, the FSTP approach will be institutionalized in corn-based areas, with the LGUs taking the lead in implementation. The ATI, as planned, should actively participate in the conduct of training ATs and corn producing farmers when FSTP is implemented nationally.

The project cost may be high but the longer-term effects could lead to corn self-sufficiency not only at the local, but national level. Improvement in corn productivity could possibly advance the country to a net exporter of corn.

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Appendix

Table 1. Results of FSTP Phase I group experiments conducted by the farmer- scientists

Treatments	Yield (tons/hectare)						
	Carcar, Cebu a/	Sibonga, Cebu b/	Ronda, Cebu c/	Larena, Siquijor d/	San, Juan, Siquijor e/	Siquijor Town f/	Enrique Villanueva, Siquijor g/
GROUP I - LAND PREPARATION							
No ploughing, no weeding	2.26	2.69	0.95		2.60	2.56	4.6
No ploughing, remove weeds	2.61	3.19	1.20		2.98	2.08	4.13
One ploughing	2.61	3.17	2.26	3.24	2.32	1.97	4.33
Two ploughing	2.78	3.39	2.78	3.28	2.90	3.00	5.38
GROUP II – FERTILIZER TRIAL							
No fertilizer	3.8	1.47	1.65	2.01	1.66	1.94	2.68
Chicken manure (CM) alone	3.8		2.17	2.98	2.36	2.14	4.47
Urea alone	3.9	2.52	0.93				
CM + urea	3.3	3.04	2.17			2.74	
Complete fertilizer alone	3.2	3.13	2.00		2.77	2.6	4.17
Complete fertilizer + urea		3.13	0.74				
Complete fertilizer + urea + CM	4.1						
CM + Bio -N	3.3	3.48		3.13	2.39		
Hog manure + Bio -N	3.6						
Bio -N + CM + urea	3.6	2.26	2.26			2.94	
Vital N alone	2.9	2.26	2.17				
CM + vital N		2.43					
Bio -N alone		1.91	1.63	2.80	2.07	2.90	4.82
Complete fertilizer + urea			0.74				
Vital N + CM + urea			1.74				

Continued ……

Table 1. Results of FSTP Phase I group experiments conducted by the farmer- scientists (continued)

Treatments	Yield (tons/hectare)						
	Carcar, Cebu a/	Sibonga, Cebu b/	Ronda, Cebu c/	Larena, Siquijor d/	San, Juan, Siquijor e/	Siquijor Town f/	Enrique Villanueva, Siquijor g/
GROUP II – FERTILIZER TRIAL							
Ammosol alone				2.78	3.16		
16-20-20 alone				3.02			
Greenbase (organic fert.) alone				1.64	2.14	2.10	
CM + ammosol				2.88	2.94		4.79
CM + 16-20-0				3.42			
Bio -N + CM + ammosol				2.20	3.00		4.65
Bio -N + CM + ammosol + 16-20+0				2.60			
Hog manure alone					2.77		
CM + (14-14-14)					2.27		2.43
Bio -N + CM + ammosol + 14-14+14						1.89	
Abbatoir waste (organic fert. alone)						1.57	
Bio -N + CM + urea + 14-14-14						4.08	4.98
GROUP III - VARIETAL TRIAL							
Tinigib	2.4	2.11	0.91	2.55	2.09	2.65	3.45
NCT	4.8						
VM2	3.3		2.12				
Pioneer	4.6						
IPB Var1	4.0			3.44	4.30	4.28	4.00
C818	6.0		2.93				
USM Var 12	4.1						

Continued ……

Table 1. Results of FSTP Phase I group experiments conducted by the farmer- scientists (continued)

Treatments	Yield (tons/hectare)						
	Carcar, Cebu a/	Sibonga, Cebu b/	Ronda, Cebu c/	Larena, Siquijor d/	San, Juan, Siquijor e/	Siquijor Town f/	Enrique Villanueva, Siquijor g/
GROUP III – VARIETAL TRIAL							
IPB Var 4 (W)		3.28		3.03	2.83	4.30	3.80
USM Var 5		4.23					
IES 8906		2.28		3.14	2.87	5.70	4.31
IPB 929 (Y)		4.05	1.82	3.14	4.41	4.80	4.80
IPB 911 (Y)		3.04	2.18	4.80	5.21	4.93	5.14
GSI 40		4.11	3.04				
GSI 88		4.75	3.09				
GSI 81							
USM Var 10			3.04				
30 M50				5.67	5.01	5.77	5.19
30 W30				4.30	4.92	3.80	4.95
Super Sweet				2.13	1.97	2.47	1.90
Macapuno				2.56	2.22	3.19	4.35
Pop Corn				0.99	0.28	2.47	1.34
GROUP IV - DETASSLING TRIAL FOR CORN BORER CONTROL							
Variety Planted: IPB 911							
Without detassling (IPB Var.4)	3.4	3.74	3.19	4.90	3.30	3.45	4.39
Detassle 3 rows (IPB Var.4)	4.8	4.46	3.78	3.37	4.25	3.92	3.22
Detassle 2 rows (IPB Var.4)	4.5	4.05	3.33	3.00	4.25	4.20	3.31

Continued ……

Table 1. Results of FSTP Phase I group experiments conducted by the farmer- scientists (continued)

Treatments	Yield (tons/hectare)						
	Carcar, Cebu a/	Sibonga, Cebu b/	Ronda, Cebu c/	Larena, Siquijor d/	San, Juan, Siquijor e/	Siquijor Town f/	Enrique Villanueva, Siquijor g/
GROUP IV - DETASSLING TRIAL FOR CORN BORER CONTROL							
Using 30 W 30							
Without detassling				3.14	4.32	4.20	4.32
Detassle 3 rows out of 4				3.81	4.07	4.00	4.38
Detassle 2 rows out of 3				4.12	4.59	4.06	4.35
GROUP V - POPULATION DENSITY TRIAL							
Five plants per hill	2.3	1.91	1.91	1.79	2.27	1.10	0.725
Four plants per hill	2.4	1.91	2.40	1.45	1.93	1.02	1.18
Three plants per hill	2.8	1.96	3.13	1.73	2.65	2.25	1.54
Two plants per hill	3.4	2.46	3.40	2.20	2.90	2.54	2.49
One plant per hill	4.3	3.01	3.60	4.20	2.94	3.45	2.54
GROUP VI - IPM							
No treatment	4.0	2.43	1.56	3.25	3.57	3.19	5.54
Spraying with BT at tassling stage	3.8	2.78					
Mulching w/ HM and release of earwigs	4.3	2.77	2.17	3.49	3.83	3.66	4.29
Release of Trichogramma	5.5	3.06	2.43	4.49	4.27	3.41	3.46

Continued ……

Table 1. Results of FSTP Phase I group experiments conducted by the farmer- scientists (continued)

Treatments	Yield (tons/hectare)						
	Carcar, Cebu a/	Sibonga, Cebu b/	Ronda, Cebu c/	Larena, Siquijor d/	San, Juan, Siquijor e/	Siquijor Town f/	Enrique Villanueva, Siquijor g/
GROUP VII - GERMINATION TRIAL							
Dry seeds	5.5	3.11	-	4.82	3.58	3.08	4.60
Seeds soaked in water for 2 hours	5.0	3.31	-	3.44	4.50	2.87	4.13
Seeds soaked in water for 4 hours	5.5	2.69	-	3.66	3.46	3.01	4.33
Seeds soaked in water for 8 hours	5.5	3.07	-	3.47	3.62	3.60	5.38
GROUP VIII - CORN-BASED INTERCROPPING TRIAL							
Corn alone	4.1			4.24		2.43	4.18
Corn + s. potato planted same time	3.5	2.78	2.60	2.72/0.34	4.33/0.10	2.67/0	2.07
Corn + mungo planted same time	3.4		2.00	2.66	4.52/0	2.50/0.31	3.2/0.28
Corn + peanut planted same time	3.4	2.04	3.40	1.87/0.26	3.85/0.97	1/76/0	2.69
Corn alone (IPB Var.4)		2.21	2.26				
Mungo alone		1.26	4.40			-	0.32
Sweet potato alone		9.26	0.53	1.62	1.22		
Mungo 2 weeks ahead of corn + cassava after 2 rows of corn		2.75					
Peanut alone			2.24		0.33	0.28	

Source: Davide, R. G. *et al*., 2004.

Table 2. Summary data on the FSTP Performance from August 2003 to October 2004 based on the number of farmer-scientist graduates and yields of graduates corn

Province and Municipalities	Number of farmer-scientists graduates				Average yield (tons/ha)	Highest yield (tons/ha.)		Number of Barangays
	Phase I	Phase II	Phase III	Total		OPV	Hybrid	
A. Cebu								
1. Aloguinsan	-	56	160	216	4.57	6.74	6.28	13
2. Argao	-	100	39	139	4.01	7.6	8	8
3. Balamban	-	58	-	58	3.89	6	-	13
4. Bantayan	-	38	-	38	4.07	4.8	8	11
5. Barili	58	-	-	58	-	4	4	12
6. Carcar	50	-	-	50	-	5.6	5.6	7
7. Carmen	-	32	29	61	3.68	7	7	11
8. Consolacion	-	45	-	45	3.24	-	4.20	9
9. Ginatilan	-	45	34	79	4.89	7.40	6.09	16
10. Moalboal	57	-	-	57	-	-	-	12
11. Pinamungahan	-	47	-	47	2.42	-	4.20	23
12. Ronda	54	-	-	54	2.59	3.09	-	14
13. Sibonga	59	-	-	59	3.74	-	4.75	15
14. Toledo City	-	55	150.00	205	3.34	7.80	8.00	38
15. Tuburan	104	-	-	104	-	-	-	29
Total	**382**	**476**	**412**	**1,270**				**231**
B. Siquijor								
1. Maria	49	48	-	97	3.95	3.30	4.25	18
2. Lazi	52	49	-	101	5.11	7.20	9.28	14
3. E. Villanueva	58	-	-	58	3.98	5.19	-	12
4. Larena	65	-	-	65	3.41		5.67 α	13
5. San Juan	62	-	-	62	3.41		5.21 α	14
6. Siquijor	57	-	-	57	4.17		5.77 α	30
Total	**343**	**97**	**-**	**440**				**101**
C. Negros Oriental								
1. Bayawan City	57	44	-	84	4.82	-	10.60	9
Total	782	617	412	1,794				341

Source: Davide, R.G. *et.al.*, 2004.

Contractual Marketing Arrangements and Maize in Sri Lanka

A.R.M. Mahrouf[*]

Abstract

Anuradhapura is one of the major maize growing districts in Sri Lanka; the crop is predominantly cultivated as a rainfed crop in the highlands during the *maha* season (wet season) by small-scale farmers (with an average farm size of about 0.87 hectares). The Central Bank of Sri Lanka introduced a contractual marketing system known as "Forward Sales Contract" (FSC) in 1999, through which producers and processors enter into an agreement to sell their produce at a reasonable pre-determined price. A study conducted revealed that during the 2004/05 *maha* season the average price received by maize growers increased by 79 per cent, average yield increased approximately three-fold, and also the average cost of cultivation rose from 17,882 Rs/ha in 1998 to 50,280 Rs/ha due to the high cost of adopting improved crop production technologies. The processors benefited through purchasing the required quantities of quality maize seeds at reasonable prices. They were also able to organize their processing, storage and trade activities more systematically and efficiently. Farmers reported their inability to dispose of their surplus farm produce and delays in receiving payments when adhering to marketing through FSC. Processors complained about poor produce quality, instances of farmers not honoring the FSC agreement and competition from imports. However, the FSC is gaining popularity among the farmers and has transformed the cultivation of this crop from subsistence farming to a more commercial nature in the district. Government intervention is necessary to facilitate the effective functioning of FSC.

KEY WORDS: *Maha* season**,** Forward Sales Contract, Rainfed cultivation, Small-scale farmer.

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Background

Maize is considered to be the second most important food crop grown in Sri Lanka after the food staple rice, in terms of area, agro industrial utilization and foreign exchange. Currently, 80 per cent of domestic demand for maize is imported. Anuradhapura is one of the major maize growing districts in the country and in 2003, 9,645 hectares were cultivated with maize producing 10,933 tons (Table 1).One of the major constraints encountered by small-scale maize growers in Sri Lanka is the difficulty of marketing the produce at reasonable prices. Low producer prices and low income received by the farmers due to the unavailability of adequate marketing facilities at the village level have discouraged farmers from growing maize and other secondary crops (Mahrouf, 2005). Therefore, the cultivated maize area has shown declining trends. As Table 1 shows, in 1994 the cultivated area of maize in Anuradhapura was almost 20,000 hectares, while in 2005 the area was 9,217 hectares, less than half. However, a marginal increase in the cultivated area can be observed in 2002, 2003 and 2005. The maize yield in the district fluctuates from year to year. In 2001 for example, total production was approximately 8,000 tons, while in 2005, the total harvest was about 27,000 tons, which represents the highest output during the 12-year period.

Table 1. Maize extent cultivated, production and average yield in Anuradhapura District (1994-2005)

Year	Extent (ha)	Production (tons)
1994	19 646	18 102
1995	13 691	19 541
1996	14 427	12 417
1997	12 989	13 150
1998	11 843	12 911
1999	10 640	18 153
2000	11 714	11 891
2001	7 549	8 037
2002	8 738	17 810
2003	9 645	10 933
2004	7 152	11 918
2005	9 217	27 128

Source: Provincial Department of Agriculture, North Central Province.

The Central Bank of Sri Lanka introduced a contractual marketing system for selected food crops in 1999 to ensure better prices for farmers, while at the same time guaranteeing supply to processing firms. The marketing arrangement is known as the “Forward Sales Contract" (FSC) system. This paper examines the benefits the FSC system generates to small-scale maize growers and processors, and identifies the reasons for success and also shortcomings in the system and suggests policies to enhance the implementation of the FSC system.

Maize cultivation in Anuradhapura District

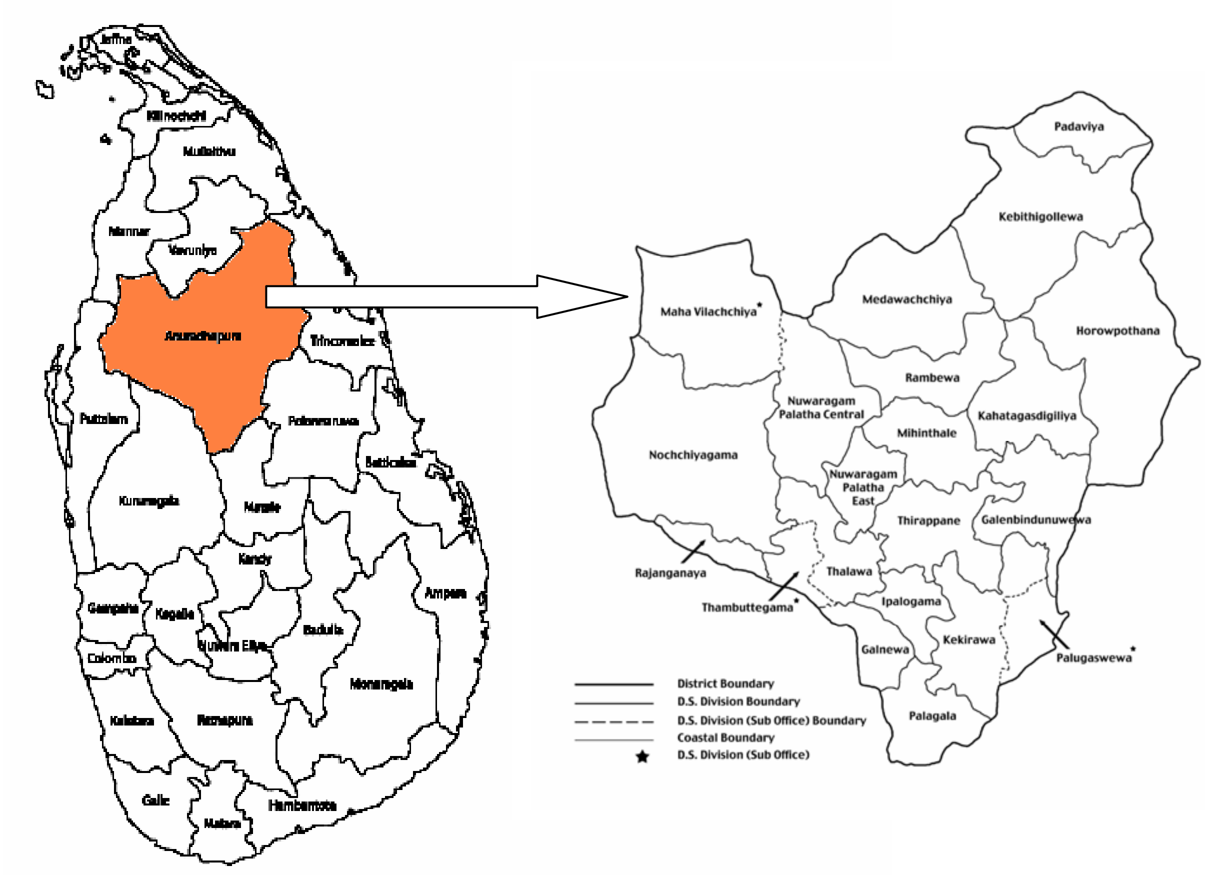
Anuradhapura is part of the North Central Province located in the Dry zone of Sri Lanka (Figure 1). The district, with an area of 7,179 square kilometres, accounts for 10.9 per cent of the country's total land area and the district's total population totalled 746,466 in 2001. About 92 per cent of the population is literate and the average family size was four in 2004.

A bimodal pattern of rainfall is prevalent in the area. Average annual rainfall varies from 1,000 millimeters to 1,800 millimeters (Figure 2). Approximately 60 per cent of the soils are Reddish Brown Earth (RBE). These soils contain little organic matter due to their fast decomposition rate resulting from high soil temperatures. Soil fertility at the top of the catena is generally depleted because of drainage problems associated with the topography.

Rainfall distribution determines two major cultivation seasons. The m*aha* season (wet season) is considered the most important for farmers and commences with the initial rains in late September and receives approximately 70 per cent of the total annual rainfall. The *yala* season (dry season) begins with rains in March and receives about 30 per cent of the total annual rainfall. Dry spells occur during March, and from June to August.

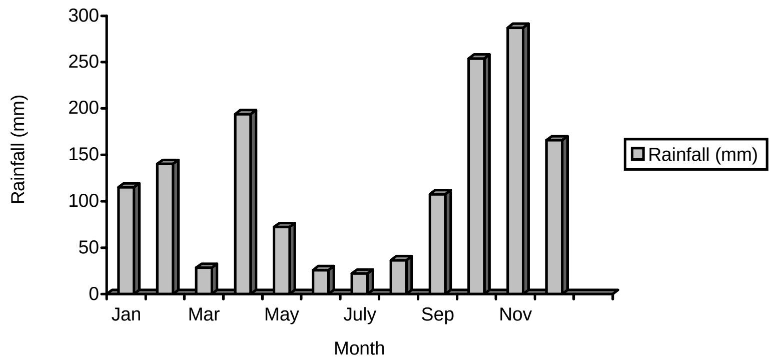
Paddy is grown on irrigated lowlands during both the *maha* and the *yala* seasons. A few secondary crops, the most popular being maize, are cultivated in some lowland areas during *yala*, particularly when the supply of irrigation water from tanks is not sufficient for paddy cultivation. Planting secondary crops during *yala* in irrigated lowland areas is usually carried out on smaller holdings ranging from 0.1 to 0.25 hectares. They are generally produced under "*bethma*" (shared system) with irrigation and land allocations agreed upon at the "*Kanna Meetings*" (seasonal meetings), which are conducted by the irrigation authorities in the beginning of the *yala* season. Although there are over 2,500 small-size irrigation tanks in the district most of the tanks require upgrading in order to store adequate water for cultivation during the dry season.

Figure 1. The Map of Sri Lanka Highlighting Study Areas in Anuradhapura District



Source: Department of Census and Statistics.

Figure 2. Average monthly rainfall in Anuradhapura



Source: Department of Meteorology.

On average, about 90 per cent of the total lowland area is cultivated with rice during *maha* and only 33 per cent is cultivated during the *yala* season (Department of Census and Statistics, 2004). Some of the uncultivated paddy lands with well-drained soils could be utilized for maize cultivation and other secondary crops during the *yala* season (Mahrouf, 2005). This would enhance the production of these crops and ensure a continuous supply of raw materials to the processing industry.

Maize and other secondary crops are generally cultivated in the highlands under rainfed conditions during the *maha* season in the form of monoculture or mixed cropping. Maize is planted during the months of September and October with the onset of rainfall, and harvested from December to February. The highlands are generally left fallow during the *yala* season. Maize was cultivated under slash and burn systems (*Chena*) in the past. However, current government regulations prohibit slash and burn methods in order to protect the forest and the environment.

A field survey carried out with 30 maize growers in Anuradhapura during the 2004/05 *maha* season revealed that the average holdings of maize growers was about 2.11 hectares, which comprise of 0.84 hectares of lowland, 0.63 hectares of highland and 0.64 hectares of homestead. The average area cultivated with maize during the same period was about 0.87 hectares. Since the cultivation is totally dependent on rainfall, the size of the farm varied according to the distribution of rainfall in different years. There was a considerable increase in the cultivated farm size in 2004/05 *maha* due to better rainfall.

More than 92 per cent of the population live in rural areas and depend mainly on agriculture for their food and income. Small-scale farmers are very poor and they farm primarily for household consumption. Approximately 17 per cent of Anuradhapura's population are considered poor households, based on the nutritional adequacy approach[1] in 2001 (Department of Census and Statistics, 2001). Unemployment is relatively low at 5.5 per cent as most people are engaged in farming. According to the field survey of 2004, about 80 per cent of maize growers reported cultivating on their own farms.

Maize yields have been low due to the use of traditional varieties, poor management practices and rainfed cultivation. In 1997/98 the average yield was 1.6 tons per hectare (Socio Economics and Planning Centre, 1999). In the same year, the average price for unprocessed maize was about Rs 8.00 per kilogram and the farmers incurred financial losses of Rs 5,038 per hectare. Farmers received a low price for their produce due to poor crop quality and poor access to proper marketing systems.

Marketing through Forward Sales Contracts (FSC)

The Central Bank of Sri Lanka initiated a Forward Sales Contract (FSC) system to market selected food crops in order to popularize the concept of a contractual marketing system among producers and buyers. The FSC is an agreement made between a buyer and a farmer, where the latter party is obliged to sell his or her produce to a buyer on a certain date at a pre-determined price that is acceptable to both parties. As a result of this contract, the farmer is provided with a stable market for his produce and the buyer has the opportunity to procure a guaranteed quantity and quality of raw material, which is supplied at a desired time and at a pre-determined price (Central Bank of Sri Lanka, 2003).

Prior to entering into an FSC both parties, namely farmer and buyer, will discuss and agree on the forward price, quantity to be supplied, quality of the produce, packaging, transportation and delivery, duration of supply, payment methods and provisions to reduce or increase the agreed price in unexpected situations.

Bank managers operating in Anuradhapura are the facilitators. They initiate preliminary discussions with farmers and buyers, and assist both parties to reach an agreement. In other parts of the country, the Regional Development Officers of Mahaweli Authority, Agrarian Services Department, Agriculture Department and several NGOs perform the function of facilitator. Facilitators assist both parties in deciding upon a

[1] Defining poverty in terms of adequacy in energy intake, households who spend more than 50 per cent of their expenditure on food and the average adult equivalent food expenditure is less than Rs 1,338.48 per month are considered as poor households.

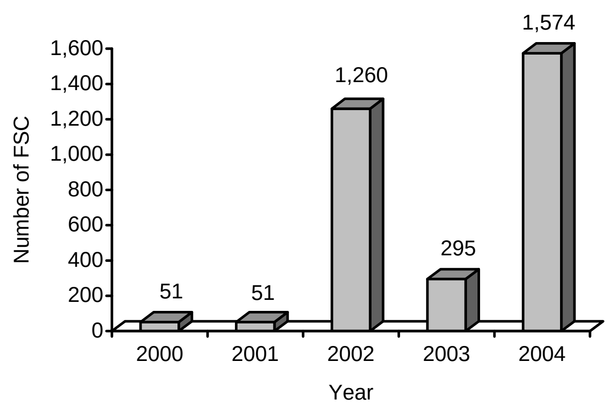
reasonable and realistic price. The forward price is generally calculated on the basis of production costs, crop quality, profit margins and import costs.

The contract agreements are signed between sellers and buyers on the basis of consensus by both parties and certified by the facilitators. Thereafter, if the farmer requires credit for his cultivation, a loan can be granted by presenting the FSC agreement to the Bank.

After harvest and when the produce has satisfactorily been delivered, the farmer receives a receipt from the buyer. By presenting this receipt to the bank, the farmer receives payment to the value of the crop subject to the deduction of any loan. The bank charges a certain percentage as a commission for providing the FSC service.

The FSC system was introduced to market maize in Anuradhapura during the 1999/2000 *maha* season. As Figure 3 shows, the development of FSC contracts has been substantial since the beginning of the programme. In both 2000 and 2001, 51 contracts were signed, while in 2002 FSC agreements rose to 1,260. In 2003, due to drought, only 295 contracts were signed, but in 2004 the number of contracts signed skyrocketed again and 1,574 contracts were signed.

Figure 3. Number of FSC's signed for maize in Anuradhapura with the Assistance of the Central Bank



Source: Central Bank Regional Office, Anuradhapura.

Two processors, namely KST Evergreen Pvt. Ltd. and Plenty Food (Pvt.) Ltd. were the two major firms that actively implemented the FSC programme in Anuradhapura during 2004 and 2005. World Vision, Grain Elevators Ltd. and Huruluwewa Farmer Company were three other agencies involved in Forward Sales Contract marketing in the area.

KST Evergreen Pvt. Ltd., which is basically engaged in purchasing dried cobs, processed about 2,000 tons of seeds during the 2003/04 *maha* season and 4,000 tons of seeds during the 2004/05 *maha* season through the FSC. The company signed FSC contracts with 835 farmers in 2004 and with about 1,100 farmers in 2005. KST Evergreen also purchased maize from farmers outside the FSC programme.

The purchase price agreed upon by KST Evergreen Pvt. Ltd. and the farmers was Rs 16.50 per kilogram for seeds and Rs 3.00 per kilogram for cobs in 2005. The processed seeds are sold to manufacturers for animal feed and also, at a higher price, as *Thriposha* for human consumption.

Plenty Food Pvt. Ltd., principally produces the human nutritional food *Samaphosa* from high quality maize free of aflatoxin. In 2005 the company signed FSC agreements with 474 farmers and purchased 1,525 tons during the *maha* season for Rs 17.50 per kilogram of high quality maize. Currently, the company purchases all their maize seed through FSC agreements, mainly in Anuradhapura and Moneragala districts. The details of the FSC programme implemented by KST Evergreen Pvt. Ltd. and Plenty Food (Pvt.) Ltd. in 2004 are presented in Table 2, which shows that the prices were lower at Rs 13.00 and Rs 16.00 per kilogram, respectively. With an annual requirement of 1,500 tons, Plenty Foods paid in 2004/05 Rs 17.50 per kilogram for high quality seed.

Credit services were arranged through Seylan Bank (Pvt) Ltd. and insurance schemes were facilitated through Ceylinco Insurance Ltd. The bank provided loans of Rs 7,500 to Rs 8,000 per acre for expenses involved in land preparation, purchases of seeds and fertilizers, while the companies arranged to supply hybrid seeds, fertilizers and packing materials. The companies have their own field staff and transport facilities to collect the harvest from the field.

Table 2. Forward sales contracts signed between maize farmers and processors in 2004

Name of the purchasing organization	Locations of the farmers	No. of FSC's signed	FSC price (Rs/kg)	Targeted production (kg)	Target farm Income (Rs)
Plenty Food Pvt. Ltd.	Mawathawewa	145	16.00	450 000	7 200 000.00
	Mawathawewa	54	16.00	150 000	2 400 000.00
	Himbutugolla	66	16.00	160 000	2 560 000.00
	Marathangalla	48	16.00	140 000	2 240 000.00
	Siwalakulama	19	16.00	42 000	672 000.00
	Hidogama	48	16.00	112 500	1 800 000.00
	Thammennawa	73	16.00	370 500	5 928 000.00
	Nachchaduwa	49	16.00	114 750	1 836 000.00
	Upuldeniya	56	16.00	192 750	3 084 000.00
	Mawathawewa	80	16.00	363 750	5 820 000.00
	Seewalakulama	101	16.00	304 500	4 872 000.00
KST Evergreen Pvt. Ltd.	Thaththirimale	95	13.00	353 250	4 592 250.00
	Galenbindunuwewa	92	13.00	249 000	3 237 000.00
	Wilachchiya	188	13.00	556 500	7 234 500.00
	Nachchaduwa	41	13.00	118 500	1 540 500.00
	Gambirigaswewa	20	13.00	132 750	1 725750.00
	Medyagama Nuwara Platha	48	13.00	138 000	1 794 000.00
	Mihinthale	193	13.00	566 250	7 361 250.00
	Kohatagasdigiliya	97	13.00	225 750	2 934 750.00
	Rambewa	61	13.00	148 500	1 930 500.00
		1 574		**4 889 250**	**70 762 500.00**

Source: Central Bank Regional Office, Anuradhapura, 2004.

KST Evergreen Pvt. Ltd. purchase seeds that are completely filled, void of impurities (dust, sand, coloured seeds), free of aflatoxin and with a moisture content of less than 14 per cent. The company has invested in automatic de-hulling, drying and cleaning machines at Mihinthale factory in Anradhapura, so the company prefers to purchase maize cobs. Depending on the moisture content of the cobs, the prices vary. The conversion rates applied by the company in fixing the price are presented in Table 3. Although selling whole cobs eases the difficulties of drying, de-hulling, cleaning and storing by the farmers, they expressed dissatisfaction about the conversion rates applied by the company.

Table 3. Conversion rates applied by KST Evergreen Pvt. Ltd. (percentage)

Moisture content of the Cobs	Weight deducted from total weight
30-35	40
25-29	33
20-24	27
15-19	23

Source: KST Evergreen Private Ltd.

Processors and small-scale maize growers believe that their profit margins have increased through the FSC system. About 30 per cent of the surveyed farmers sold their produce through FSC agreements. Table 4 presents the percentages of respondents selling their produce to different agencies and the average prices paid for unprocessed maize. Through the FCS farmers are able to obtain higher prices ranging from Rs 16.50 to Rs 17.50 per kilogram of maize in 2005. Prices offered by companies in the FSC programme raise the market price of maize in the area so other marketing agencies are compelled to pay higher prices to maize farmers. As a result, maize farmers not engaged in the FSC programme benefit too and receive better prices equating to Rs 15.00-15.50 per kilogram.

Table 4. Percentage of respondents selling their produce to different agencies and the average farm gate prices in 2005

Marketing agency	Percentage of farmers selling	Average producer price (Rs/kg)
K.S.T. Evergeen Pvt. Ltd. **(FSC**)	16	16.50
Plenty Foods Pvt. Ltd. (**FSC**)	12	17.50
World Vision (**FSC**)	2	16.50
Animal Feed Manufacturers	5	15.50
Traders/Assembling Agents	65	15.00

Source: Field Survey, 2005.

Table 5 shows the average yields, costs and net returns for maize farmers in Anuradhapura during the wet season from 1992 to 2005. Farmers who cultivated hybrid varieties adopted raw planting and applied fertilizers and as result realized an average yield of 4.8 tons per hectare in the study area during 2005, which is about a three-fold increase over the yields obtained in 1998. In contrast, the average yield obtained by farmers using non-hybrid maize was about 3.5 tons per hectare during 2005. As shown in Table 5, the average net return per hectare has substantially improved. From 1992 to 2001, the net returns are negative in most years, while from 2002 to 2005, along with significantly higher prices, the net returns are positive. In 1998, farmers received negative net returns per hectare amounting to Rs 5,038, compared with the average net returns in 2005 of Rs 25,168 per hectare, a five-fold hike. The average producer price in nominal terms was Rs 8.00 per kilogram in 1998 and Rs 15.50 in 2005. In real prices, the difference between 1997/98 and 2004/05 is smaller at Rs 6.79 per kilogram and Rs 8.93 per kilogram respectively.

Table 5. Average yields, cost and returns of maize cultivation in Anuradhapura during *maha*

Year	Total cost Rs/ha	Average yield kg/ha	Average price Rs/kg	Net return Rs/ha	Unit cost Rs/kg
1992	11 442.50	1 514.60	5.54	-3 051.59	7.55
1993	11 572.96	1 449.10	5.70	-3 313.09	7.99
1994	8 989.59	975.45	4.70	-4 404.97	9.22
1995	15 989.05	1 566.60	6.44	-5 900.16	10.21
1997	15 314.62	1 012.70	8.60	-6 605.40	15.12
1998	17 882.38	1 605.50	8.00	-5 038.38	11.14
1999	18 862.35	2 237.38	9.28	1 900.49	8.43
2000	21 881.48	2 642.90	8.12	-421.14	8.28
2001	21 672.77	2 223.00	8.23	-3 377.48	9.75
2002	25 085.22	2 897.31	14.27	16 259.42	8.66
2003	25 369.37	2 445.30	12.30	4 707.82	10.37
2004	38 791.23	2 548.00	15.30	159.75	15.22
2005[a]	50 280.49	4 803.62	15.50	25 167.57	10.44

Source: Socio Economics & Planning Centre, Department of Agriculture.
Note: [a] 2005 field survey data for hybrid maize cultivation.

According to the field survey, approximately 85 per cent of the respondents cultivated imported hybrid maize variety “Pacific” during the 2004/05 *maha* season, while 12 per cent planted *Ruwan* and 1 per cent used *Badra*. These three varieties represent the high-yielding, open-pollinated varieties recommended by the Department of Agriculture (Table 6). Non-FSC farmers in the study area were also motivated to adopt improved crop management practices due to greater awareness.

Table 6. Maize varieties cultivated during *maha* in 2004/05

Variety	Percentage of respondents cultivating
Pacific	85
Ruwan	12
Badra	1
Local/Unknown	2

Source: Field survey data, 2005.

The costs of production for FSC farmers are, however, relatively high due to the cost of planting of hybrid seeds, raw planting and application of fertilizers. During the 2004/05 *maha* season the average cost for FCS farmers was Rs 50,280 per hectare. The cost structure of different farm activities is presented in Table 7.

Table 7. Cost of Cultivation per hectare of maize cultivation for FSC farmers 2004/05 *Maha* Season
District: ANURADHAPURA (Rainfed cultivation)

Operation	Labour cost Rs/ha	Machinery and equipment cost Rs/ha	Material cost Rs/ha	Total cost Rs/ha
General land preparation	6 100.90			6 100.90
1st plough with 4wT		6 598.09		6 598.09
Seeding	4 848.10		3 649.17	8 497.27
Fertilizer application	3 847.35		6 834.31	10 681.66
Weeding and earthing up	7 109.07			7 109.07
Harvesting and drawing	7 804.48			5 807.91
Threshing	1 912.55	2 258.12		4 170.68
Transport produce to stores		1 314.92		1 314.92
Total including imputed cost	31 622.45	10 171.13	10 483.48	50 280.49
Total excluding imputed cost	5 827.88	10 103.72	10 062.42	25 167.57
Yield and return				
Average yield (kg/ha)				4 803.62
Price of produce (Rs/Kg)				15.50
Gross income (Rs/ha)				74 456.17
Profit including imputed cost (Rs/ha)				24 175.68
Profit excluding imputed cost (Rs/ha)				49 288.60
Per unit cost (Including imputed cost) (Rs/kg)				10.47
Per unit cost (Excluding imputed cost (Rs/kg)				5.24

Source: Field survey data, 2005.

The FSC system assures the processors the desired quantity and quality of maize seed at reasonable prices. The system allows processing firms to better plan their production and firms that import part of their raw materials can plan ahead and organize imports on time.

Discussion

The FSC system has become popular among maize growers in Anuradhapura and is now the district’s most important commercial system for maize. The FSC programme has also stimulated and influenced the maize market so non-FSC farmers also receive higher prices and have access to improved cultivation practices. Several economic, agro-ecological, technological, institutional and political factors have contributed to the success of the FSC programme in Anuradhapura.

The FSC programme assures a stable market to small-scale maize growers, ensures better prices for their produce and minimizes the risk of low prices during the peak harvesting season. Higher prices and profit margins have increased income of rural households, which has motivated the farmers to expand the area under maize cultivation and indeed more farmers are participating in the FSC programme.

Maize requires less water than rice and it successfully grows under rainfed conditions in the highlands. Consequently, farmers cultivate more maize when the distribution of rainfall is better. The favourable weather conditions prevalent during the 2004/05 *maha* season contributed to planting larger areas and the successful implementation of the FSC programme during the season.

Most maize farmers are resource poor farmers who have limited access to hybrid seeds and information of new production technologies. The arrangements that have been made through the FSC programme provide imported hybrid seeds, fertilizers and credit to farmers, which have made it possible for them to use these inputs and obtain higher yields and income.

The Department of Agriculture has developed a hybrid variety named *Sampath* to increase productivity. However, seeds of this variety were not available to farmers in this area during the *maha* 2004/05 season. Private sector participation in the production of hybrid seeds would increase the production and use of hybrid seeds. Development and dissemination of appropriate technology-packages adaptable under both rainfed and irrigated conditions are also vital in order to raise the current yield levels and for further expansion of FSC activities in the area.

Seylan Bank was the only bank that provided credit services to maize growers during the *maha* 2004/05 season. The farmers were able to secure bank loans for maize cultivation by submitting the FSC agreement without many obstacles. Participation of other banks would, however, facilitate the expansion of maize production under the FSC programme.

Some farmers complain about delays in receiving payment and about difficulties in selling their surplus to other processors. Currently, only two major processors participate in the FSC programme. In order to increase competition the government should facilitate more processors to take part in the programme.

Processors, on the other hand, complain about poor produce quality and about a few occasions when farmers did not comply with the FSC agreement. Training programmes about how to increase and maintain maize quality will enhance farmers' produce.

The Government of Sri Lanka intermittently introduces tariff changes to protect domestic maize production, while at the same time the government wishes to support the animal feed industry through maize imports. Recently, a 20 per cent Cess duty was imposed on maize imports. The government has also liberalized the importation of hybrid maize seeds. Current policies are favourable for the implementation of the FSC programme. At present, about 80 per cent of total domestic maize demand is imported, thus processing firms that implement the FSC programme encounter competition from imports.

The FSC is gaining popularity among maize farmers in Anuradhapura and it has transformed maize cultivation from subsistence farming to a commercial crop in the district. Government intervention is necessary to facilitate effective functioning of FSC through appropriate participation by both private and public sectors and to avoid any adverse effects on poor farmers and the processing industry.

Consistent trade policies and continuous commitment on the part of the government is vital for the expansion of maize cultivation through the FSC system of marketing, in order to enhance income and to alleviate poverty of resource poor farmers.

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Small-Scale Tapioca Processing Development in Indonesia

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Abstract

After Indonesia was hit by the monetary crisis in 1997, the Provincial Government of Lampung initiated the development of small-scale tapioca processing units managed by individuals or by farmers' cooperatives. The objective of the policy is to reduce, if not totally eliminate, the oligopsonistic power of large tapioca processing units. The aims of this paper are to evaluate the performance of small-scale tapioca processing units and to analyse the impacts of the policy on income and employment generation in the cassava commodity system (farming, marketing and processing). The results indicate that almost all units managed by co-operatives cannot survive while the ones managed by individuals can continue operating because of their managerial competence. To some extent, however, these units are dependent on large tapioca processing units, particularly when drying tapioca during the wet season. This implies that the role of small-scale tapioca processing units in generating income and employment is significant during the dry season but less significant in the wet seasons. Therefore, investment in small-scale dryers or ovens is necessary to generate income and employment in the wet season.

Introduction

After Indonesia's monetary crisis in 1997, the Provincial Government of Lampung initiated a development project for small-scale tapioca processing units funded by individuals, private companies and the provincial government. It is very likely that the low and fluctuating farm gate prices of cassava in Lampung stem from the oligopsonistic power of a few large-scale tapioca processors. In order to overcome the problem of low prices, to generate employment and to improve the rural economy, the provincial government initiated a project entitled Community Tapioca Processing Units or ITTARA (abbreviated from *Industri Tepung Tapioka Rakyat*). Contingent on the source of investment funds, the tapioca processing units are classified into three categories: (i) personally financed; (ii) financed by

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private-companies; and (iii) financed by local governments. An ITTARA unit is an autonomous business unit organized as a farmers' co-operative or a farmers' group.

Currently, local governments finance almost all ITTARA units, while several have been privately financed by companies but collapsed due to ineffective management and inadequate monitoring from responsible local government institutions and associated private firms. Conversely, most of the personally financed ITTARA units are still operating, though small-scale ITTATRA units lack oven facilities, and they are therefore still dependent on large-scale processors to dry their tapioca, especially during the rainy season.

The provincial government has, due to the unsatisfactory results from the ITTARA initiative, instructed the authorities in each district to rehabilitate all ITTARA units in their administrative area. It is still believed that the development of small-scale tapioca processing units is necessary to increase competition leading to higher prices and better access to information for cassava producers. Undoubtedly, the rehabilitation of small-scale tapioca processing units would be costly, as it would entail costs for selecting and training managers, as well as monitoring and supervising the units. Therefore, it is vital to perform a cost-benefit analysis of the rehabilitation plans to illustrate any potential impacts on poverty alleviation and employment, particularly in rural areas.

Research issues

Since Lampung is one of the major cassava-producing regions in Indonesia, many tapioca and dried cassava processing firms are operating in the region. Based on secondary data, however, these processing firms have problems of excess capacity. Thus, the price of cassava must be relatively high at least during lean harvest periods. Nonetheless, secondary data indicates that there is no clear relationship between monthly prices and monthly production of cassava. Therefore, it is relevant to investigate the market structure that generates this somewhat unexpected pattern.

The development of small-scale tapioca processing units under the ITTARA programme was initiated to help farmers cope with low and fluctuating cassava prices by directly linking the processing units to local cassava farming. Almost all ITTARA units that were financed by the provincial government have collapsed, while most ITTARA units financed by personal funds continued operating until recently. The question is, what are the factors of success? If the factors can be identified, will the provincial or district government plan to continue the development of ITTARA units? If yes, what are the sources of funds for rehabilitation of existing ITTARA units and the development of new ones? What conditions must be fulfilled by each processing unit to be eligible for either the rehabilitation programme or for the development of new ITTARA units?

Objectives and methodology

The current study has the following three objectives:

1. To analyse the impacts of small-scale tapioca processing units on the financial efficiency of cassava production, marketing and processing;
2. To analyse the impacts of small-scale tapioca processing units on income and employment generation in terms of cassava farming, marketing and processing; and
3. To determine factors influencing the failure or success of ITTARA units.

Two sites were selected for the study: one village under the ITTARA programme and one village that is not connected to the programme. Managers from both small and large tapioca processing firms, farmers, officials from the Office of Food Crops and Food Security as well as the Office of Co-operatives, Industry and Trade, and local extension workers, were all interviewed to make comparisons between the two villages and between tapioca processors. The potential impacts of the ITTARA programme were also evaluated.

The ITTARA Programme

Lampung province has accorded high priority to cassava development after paddy and maize because cassava can be used as a staple food, raw material for industry, animal feed and for export. In this major cassava-producing province, however, cassava farmers usually hold a weak bargaining position *vis-à-vis* middlemen and large tapioca-processing units. Farmers are also often unsatisfied with the substantial price-cuts made by the industry in relation to starch content. Large tapioca-processing units are often located far from the cassava fields and, consequently cassava farmers find it difficult to acquire information regarding prices and quality criteria. Instead, middlemen often provide such information to the farmers after the cassava has been sold to the units. Without external assistance, the weak bargaining position of the farmers is unlikely to change.

The ITTARA initiative aims to strengthening the farmers' bargaining position by implementing two major policy measures: (i) the development of numerous small-scale tapioca-processing units in cassava producing areas to foster a competitive market; and (ii) establish cassava price support without burdening the government's budget by setting up a particular ratio of cassava price to tapioca price (for example 9.5 per cent) to prevent the cassava farm gate price from drastically dropping. The level of price support is not rigidly determined because it is still dependent on agreements between the farmers and the individual ITTARA unit. In addition to generating higher income for the farmers, the development of numerous small-scale ITTARA units is also expected to generate employment in rural areas.

Policy actions designed to support the ITTARA Programme

To develop small-scale tapioca processing units in cassava producing areas, the following eight steps have been taken by the provincial government (Asnawi, 2002):

1. Selection of locations for the construction of ITTARA units;
2. Selection of farmers' groups to manage the development and operation of ITTARA units;
3. Providing farmers' groups with funds to invest and operate the ITTARA units;
4. Encouraging the development of supporting institutions such as Village Unit Co-operatives (KUD), ITTARA Co-operatives (KOPITTARA), and ITTARA Marketing Co-operatives (KOPASTARA);
5. Conducting training related to the management of ITTARA units, capital, technical matters, marketing and institutional systems;
6. Providing guidance on technical matters and tapioca marketing;
7. Facilitating co-operation between ITTARA units and private companies (for example Ajinomoto Indonesia Ltd.) to purchase tapioca from ITTARA units; and
8. Encouraging private companies (for example Bank Muamalat) to participate in developing ITTARA units.

Current status of ITTARA and its impact on cassava price

In 1987, long before the implementation of the ITTARA programme, the Governor of Lampung chaired a price committee to solve the problem of low and fluctuating cassava prices. The committee was composed of representatives of farmers, the Associations of Indonesian Feed Exporters (ASPEMTI), and the Association of Tapioca Processing Firms (ATTI). It was agreed by the committee that the farm gate price of cassava should be 13.6 per cent of the tapioca price, or 70 per cent of the FOB (free on board) price of dried cassava (*gaplek*).

Although the agreement stabilized the cassava price at processing units, the prices transmitted to the farm gate level were still below the agreed price ratio (Asnawi, 2002). It was stated in the Governor's Directive that the cassava area of each ITTARA unit should have a production capacity of 5 tons per day and each ITTARA unit must buy cassava from farmers at Rp 85 per kilogram and tapioca should be sold at Rp 900 per kilogram. Table 1 shows the price developments of cassava and tapioca during two periods: before the introduction of the ITTARA programme and with the ITTARA project. During the pre ITTARA period of 1995-1999, the average price ratio between cassava and tapioca was 7.6 per cent, while the average price ratio after the implementation of the ITTARA programme was almost 8 per cent. Although many of the ITTARA units failed, the programme has had a small positive effect on the price ratio. However, the cassava price is far below the target of 9.6 per cent. Furthermore, the price ratio fluctuates substantially from year to year and was, for example, 9.2 per cent in 2003, but just 5.5 per cent the following year.

Table 1. The ratio between cassava price and tapioca price before and after the ITTARA programme

Before ITTARA programme was in effect				After ITTARA programme implementation			
Year	Cassava (Rp/kg)	Tapioca (Rp/kg)	Price ratio (%)[a]	Year	Cassava (Rp/kg)	Tapioca (Rp/kg)	Price ratio (%)[a]
1995	76	841	9.0	2000	112	1480	7.6
1996	44	586	7.5	2001	153	1763	8.7
1997	62	791	7.8	2002	164	1849	8.9
1998	153	2096	7.3	2003	173	1878	9.2
1999	81	1235	6.6	2004	97	1763	5.5
GR (%/yr)	24.6	32.2	-7.3	GR (%/yr)	1.3/8.7	4.9/7.9	-5.0

Source: Office of Food Crops and Food Security.
Note: [a] Ratio of cassava price to tapioca price.
GR = Growth rates (per cent per year).

In 1998, a team was assigned to initiate the ITTARA programme in Lampung. It was proposed to develop 152 ITTARA units. Each unit receiving a maximum of Rp 150 million, including its working capital, and have a capacity of 2.5 tons of tapioca per day. To support this policy, Ajinomoto Indonesia Ltd. in collaboration with the provincial government, took part in the development of ITTARA (under a Memorandum of Understanding, 31 March 1998). Ajinomoto Indonesia Ltd. is a company that processes tapioca into flavouring products. As an initial step, the company planned to build five units with a daily capacity of 5 tons of tapioca. If successful, Ajinomoto Indonesia Ltd. would increase to 40 units with an investment of Rp 100 million per unit. The investment would be allocated as loans to an autonomous body in a village co-operative unit (KUD) with instalments for 10 years, while the collateral would be the processing unit itself (Zakaria, 2000).

In 2000, there were 123 ITTARA units. Depending on the source of investment capital, they are classified into three categories: personally financed (47 units), financed by private-companies (six units) and financed by the local government (70 units).

ITTARA's products, namely tapioca and its by-product *onggok* can be sold to food processing firms in Bogor and various industries in Semarang, Puwokerto, Malang and several cities in South Sumatra. Ajinomoto Indonesia LTD. alone requires 300 tons of tapioca per day to produce seasoning and plans to expand its capacity to 1,000 tons of tapioca per day. As sun dried tapioca is easier to expand/outstretch, the company prefers tapioca produced by ITTARA units to tapioca produced by large-scale tapioca processing companies, as ITTARA units use solar heat while large tapioca processing factories, use oven facilities to dry cassava. Aside from the domestic market, demand from Malaysia, the Philippines, Taiwan, European countries and USA also indicates prospective markets for tapioca produced by ITTARA units (Asnawi, 2002).

Although dried cassava using solar heat results in higher quality tapioca, solar radiation is not always adequately available in the rainy season. Since the ITTARA programme did not equip small-processing units with oven facilities, they must outsource their cassava to large-processing units during the rainy season, which costs around Rp 200 per kilogram. Thus, to reduce the costs for small scale processors, it is important to develop suitable ovens that can be used during the wet season.

Cassava economy at the study sites

The study was carried out in Rumbia sub-district of Lampung province. Rumbia is one of the sub-districts where several small-scale tapioca-processing units were established under the ITTARA programme. Two sample villages, Bina Karya and Restu Baru, were chosen in this sub-district. In Bina Karya, most cassava farmers sell their cassava directly to a small tapioca-processing unit, more specifically to an ITTARA processor. In Restu Baru, on the other hand, most cassava producers sell their produce via middlemen who further transport and sell the cassava to large tapioca processing firms.

Although there are several cropping patterns at each study site, the two study sites have a maize-cassava cropping pattern in common (Table 2). In order to eliminate as many differences as possible between the two sites 20 maize-cassava farmers from each village were randomly selected. Additionally, three middlemen, two ITTARA units and two large tapioca- processing companies were interviewed.

Table 2. Estimated proportion of area by cropping patterns in the study sites

Cropping pattern	Non-ITTARA site (%)	ITTARA site (%)
Paddy-cassava	0	15
Cassava-cassava	0	10
Maize-maize-vegetables	5	0
Maize-cassava [a]	40	65
Paddy-maize	0	5
Maize-(maize+cassava)	55	5
Total	100	100

Source: Field extension workers' estimation.
Note: [a] The sample cropping-pattern.

Most farming at the study sites consists of two seasons, wet and dry. The wet season is the period from October to January when the average monthly rainfall totals about 350 millimetres, while the dry season normally takes place from June to August with average monthly rainfall of 65 millimetres. The sample farmers in the two villages grow maize during the wet season with a planting distance of 20 x 70 centimetres. During the second crop season, the farmers grow cassava with a planting distance 80 x 100 centimetres. The sample farmers at the study sites cultivate on dry land only.

Farmers from the two sites grow cassava during the dry season because they consider cassava as a "saving crop" due to the low input expenditure and it provides moderate returns to the household. Cultivating cassava as the sole crop may reduce soil fertility drastically and, therefore, the farmers use relatively high quantities of organic fertilizers such as manure and compost to restore fertility.

The majority of hired labourers originate from adjacent villages, as there are few landless households in the two villages. There are two types of farm employment; the first arrangement is on a daily wage basis, while the second is on a task basis. The daily wage rates are Rp 12,500 per day for female labourers, Rp 15,000 per day for male labourers and Rp 25,000 per day for draught animals. In the second arrangement, the rates are Rp 250,000 per hectare for land preparation using draught animals, Rp 150,000 per hectare for planting or weeding, and Rp 200,000 per hectare for harvesting. Farmers who choose to hire on a task basis usually wish to save their time supervising labourers in order to have more for off-farm activities as an additional source of income.

Table 3 shows that ITTARA farmers use more family labour than hired labourers, while the opposite occurs at the non-ITTARA site. This is because the non-ITTARA farmers have, in general, larger farms and the village is relatively near to the sub-district centre, which provides better access to off-farm employment than the ITTARA farmers have. Thus, as the opportunity cost for family labour is low at the ITTARA site, the ITTARA farmers use less hired labour.

Table 3. Agriculture labour in cassava production, 2004

Labour category	Non-ITTARA site	ITTARA site
Male (man days)	62.3	60.6
Female (man days)	16.1	28.8
Draught animal (animal days)	3.1	8.0
Total labourers[a]	81.5	97.4
Proportion of family labourers (%)	34	55
Proportion of male labourers (%)	79	68
Total wages paid (Rp 1 000)	645	600

Source: Field survey.
Note: [a] Including labourers guiding the draught animals.

At both sites, the cassava plant materials used by farmers in the dry season are Thai (80 per cent) and Adira (20 per cent). Farmers at the non-ITTARA site use five types of fertilizers for cassava production, while farmers at the ITTARA site use only three types. Instead of using urea and KCL (potassium chloride), the ITTARA farmers use residues (*tetes*) and more manure (Table 4).

Table 4. Material inputs used in cassava production per hectare at the two study sites, 2004

Inputs	Unit	Non-ITTARA site			ITTARA site		
		Quantity	Price (Rp/unit)	Value (Rp 1 000)	Quantity	Price (Rp/unit)	Value (Rp 1 000)
Plant material	Kg	53	5 000	267	77	2 911	225
Urea	Kg	183	1 280	234	0	0	0
SP-36	Kg	70	1 550	108	14	1 550	21
KCl	Kg	39	2 378	93	0	0	0
Manure	Packs	4	6 000	26	13	5 000	65
Residues	Lt	0	0	0	4 000	91	383
Herbicides	Lt	2	34 211	57	0.62	37 111	23
Total	n.a.	n.a.	n.a.	784	n.a.	n.a.	718

Source: Field survey.
Note: n.a. = not applicable.

Table 5 shows the yield, costs and returns per hectare for cassava in the two villages. The average yield at the non-ITTARA site is about 22.5 tons per hectare, while the average yield at the ITTARA site is almost 7 per cent smaller, about 21 tons per hectare. Although the yield of cassava at the non-ITTARA site is somewhat higher than the ITTARA site, the value of production per hectare is almost the same because the ITTARA farmers receive higher cassava prices than the non-ITTARA farmers (Table 5). The price difference is attributable to ITTARA farmers selling their produce directly to a tapioca-processing unit, while non-ITTARA farmers sell their cassava to middlemen. Moreover, as Table 5 shows, the price/cost ratio is 2.95 for the ITTARA farmers, while it is 2.75 for the non-ITTARA farmers, which is due to higher costs for material inputs and paid labour for the latter.

Table 5. Costs and returns of cassava production per hectare, 2004

Items	Non-ITTARA site	ITTARA site
1. Yield (tons/hectare)	22.53	21.01
2. Prices (Rp/kg)	175	185
3. Production values (Rp 1 000)	3 943 (100)	3 887 (100)
4. Material inputs (Rp 1 000)	784 (20)	718 (18)
5. Paid wages (Rp 1 000)	645 (16)	600 (15)
6. Total costs (Rp 1 000): (4)+(5)	1 429 (36)	1 318 (34)
7. Returns to household resources (Rp 1 000): (3)-(6)	2 514 (64)	2 569 (66)
8. Returns to costs ratio (R/C): (3)/(6)	2.76	2.95
9. Generated income (Rp 1 000):(3)-(4)	3 159 (80)	3 169 (82)

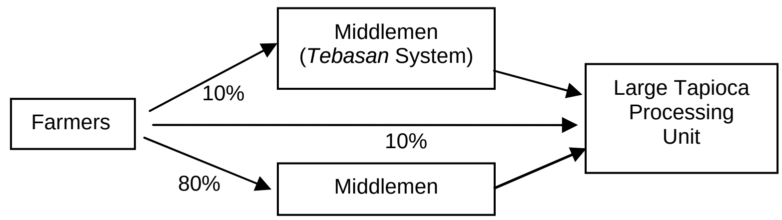
Source: Primary data.
Notes: Figures in parentheses are percentage of production value.

Cassava marketing

Cassava farmers can sell their cassava in the form of either fresh cassava or dried cassava (*gaplek*). Most of the sample farmers, however, sell fresh cassava because the incentive for the farmers to dry cassava is too small. For example, since the weight conversion factor from fresh cassava to dried cassava is 46 per cent, 100 kilograms of fresh cassava equals 46 kilograms of dried cassava. The current price of fresh cassava is Rp 175 per kilogram and the price of dried cassava is Rp 390 per kilogram, which implies that the incentive for the farmers is only Rp 440, or US$ 0.04 per 46 kilograms of dried cassava. Note that, depending on solar radiation, farm households require three to seven days to dry 100 kilograms of cassava.

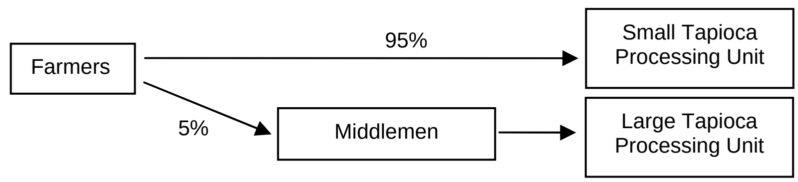
Figure 1 illustrates the marketing channel at the non-ITTARA site. Farmers sell either harvested cassava or cassava as a standing crop, known as *tebasan*, to middlemen, who then transport and sell the crop to large-scale processors. About 80 per cent of the farmers sell harvested cassava, 10 per cent sell through the *tebasan* system, and around another 10 per cent sell their cassava directly to a tapioca-processing unit due to the close proximity of their fields to a processing unit. The market channel in the ITTARA village is displayed in Figure 2. Most farmers sell their cassava directly to small tapioca processing units. In addition, farmers can sell a small amount of cassava, for example 50 kilograms, to the local small processing unit. Only about 5 per cent of them sell cassava to middlemen. Generally, the prices offered by the local, small-tapioca processing units are higher than the prices offered by middlemen. This is because the middlemen have higher transportation costs due to the greater distance of the large processing units compared to the local small processing units at the ITTARA site.

Figure 1. Marketing channel of cassava from non-ITTARA site



Source: Field survey.

Figure 2. Marketing channel of cassava from ITTARA site



Source: Field survey.

Currently, there are 58 active tapioca-processing companies in Lampung. Nonetheless, cassava farmers still do not have access to full information regarding the weighing procedures and starch content measurements. Note that when a seller is dissatisfied with the price offered by a buyer or a tapioca processing firm, it is not easy to seek another buyer since it incurs additional transportation costs.

At peak harvest time, a serious problem often arises because middlemen have to wait in long queues in front of the gates of tapioca-processing units. The waiting time exacerbates the quality of cassava and, in turn, reduce the selling price to tapioca producers (Pakpahan and Nasution, 1992).

It is clear from the above description that the market structure faced by cassava farmers is oligopsonistic due to a lack of perfect information concerning the way tapioca producers determine cassava price and starch content. This implies that tapioca producers are the price makers, while farmers and middlemen are price takers.

Table 6 shows that in the major cassava-marketing channel, a middleman at the non-ITTARA site pays on average Rp 35 per kilogram for the cost of transporting the cassava from the fields to large tapioca processing units. An additional Rp 25 per kilogram is required for loading and unloading. Hence, the profit for middlemen is Rp 30 per kilogram. It is worthwhile noting that processors' buying price at the non-ITTARA site is higher than that for the ITTARA site because of higher costs incurred by the middlemen.

Due to the involvement of middlemen at the non-ITTARA site, the marketing margin is higher and consequently, marketing efficiency is lower. This is indicated by the proportion of the farm gate price at the ITTARA site that is 74 per cent of the processor's buying price, while it is only 66 per cent at the non-ITTARA site.

Table 6. Distribution of cassava marketing margin by the major marketing channels at the study sites (Rp/kg)

Marketing margin and costs	Study sites			
	Non-ITTARA site		ITTARA site	
	Rp/kg	%	Rp/kg	%
1. Farm gate price	175	66	185	74
2. Processor buying price[a]	265	100	250	100
3. Marketing margin: (2)-(3)	90	34	65	26
4. Loading/Unloading (*ampera*)	25	9	30	12
5. Truck /oxcart or bicycle	35	13	35	14
6. Profit: (3)-(4)-(5)	30	11	0	0
7. Benefit/cost ratio: (3)/(4)+(5)	1.50	n.a.	n.a.	n.a.
8. Generated income: (3)-(5)	55	21	30	10

Source: Primary data.
See Figures 2 and 3 for the major marketing channels.
Note: n.a. = not applicable.
[a] After price adjusted for starch contents (*rafaksi*).

Tapioca processing industry

Cassava production in Lampung is used primarily for the tapioca processing industry and the *gaplek*/chip/pellet processing industry. As all cassava farmers in the study sell their produce to tapioca firms or units, only the tapioca processing industry is considered herein. This section focuses on three important aspects of the industry: demand for tapioca, supply of cassava as a raw material for tapioca production, and the profitability of the tapioca processing industry.

Tapioca is used in many industries such as for foods, textiles, chemicals and pharmaceuticals. By-products of the tapioca processing industry (*onggok*) are used for feed. To meet domestic and export demand for tapioca, tapioca production in Indonesia increased from 536.7 thousand tons in 2001 to 629.3 thousand tons in 2002, an increase of 17 per cent (BPS, various year.). Most cassava production in Lampung is used in the domestic food industry and only 2.3 per cent is exported. Table 7 shows the export quantities of dried cassava chips, tapioca and *onggok* flour from 2001 to 2004. The export volume of chips has more than doubled, while the quantity of the by-product *onggok* has declined from around 20,000 tons in 2001 to only 64 tons in 2004. The quantity of tapioca for export was around 13 to 14,000 tons during 2001-2003, but drastically increased to more than 170,000 tons in 2004 due to the Free Trade Agreement between ASEAN and China.

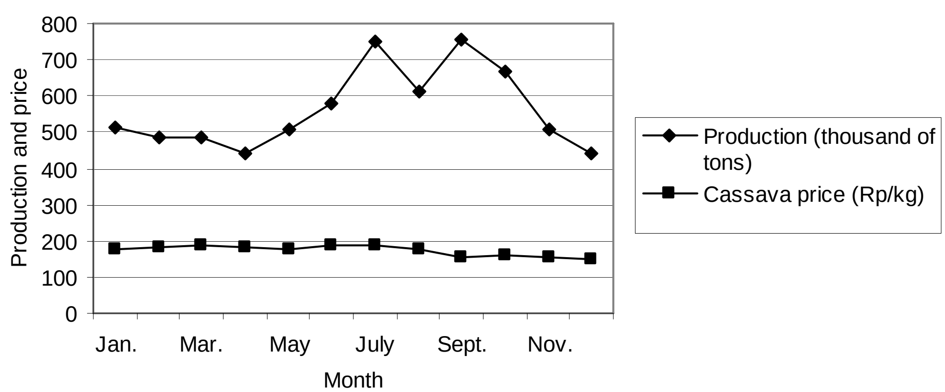
Table 7. Export of cassava products from Lampung

Products	Quantity (tons)				Value (1000US$)			
	2001	2002	2003	2004	2001	2002	2003	2004
Dried cassava chips	9 697	9 936	6 686	24 764	582	638	451	3 489
Tapioca	12 809	14 595	13 116	170 541	1 991	2 544	810	30 399
O*nggok* flour[a]	19 128	12 874	641	64	871	580	65	8

Source: Laporan Realisasi Perdagangan Luar Negeri Prop. Lampung. December, 2004. Office of Co-operatives, Industry and Trade, Lampung Province, Bandar Lampung.
Note: [a] *Onggok* is a by-product of tapioca processing.

To describe the supply side of cassava for the tapioca processing industry, it is worth scrutinizing the relationship between monthly production and monthly prices of cassava in Lampung. The relationship is somewhat complicated in the sense that there is no clear and consistent relationship between the two variables (Figure 3). This is reinforced by the very weak correlation between monthly production and monthly price of cassava in Lampung with a correlation coefficient of -0.14.

Figure 3. Monthly production and monthly prices of cassava in Lampung, 2004



Source of data: Office of Food Crops and Food Security.

Fluctuating production and prices certainly affect the management of both farming and processing units. Fluctuating prices do not encourage farmers to use new, high-yielding varieties with high starch content, and consequently, the productivity level of cassava remains low and far below its potential, which is more than 30 tons per hectare. Highly fluctuating production at the tapioca processing units to some extent creates uncertainty in the supply of raw materials.

The tapioca-processing industry in Lampung faces a problem of excess capacity because cassava production is not only used by the tapioca processing industry but also by the *gaplek*/chip/pellet processing industry. There are 49 tapioca-processing units and 12 *gaplek/*chip/pellet processing units in Lampung. The production capacity of the tapioca processing units varies from 1,000 to 90,000 tons of tapioca per year, while the annual production capacity of the *gaplek/*chip/pellet processing industry ranges from 10 to 150,000 tons. Collectively the 49 tapioca units have an annual production capacity of 1.2 million tons, equivalent to 6 million tons of cassava, and the 12 *gaplek*/chip/pellet processing firms' production capacity totals 1.5 million tons processed products per year, equivalent to 4.5 million tons of cassava. Hence, the total amount of cassava required by the two types of processing industries is around 10.5 million tons of cassava per year (Office of Food Crops and Food Security, 2004). Currently, total production of cassava is around 5 million tons per year and together, the two industries have an excess capacity of 5.5 million tons annually. However, depending on the location of the tapioca processing unit, a number of them face excess capacity during particular months but excess supply in others. This indicates that the prices created by the market mechanisms cannot optimally co-ordinate the marketing process from cassava farmers to processing units. Pakpahan and Nasution (1992) found that large processing units might take great advantage from cassava transactions because they have strong networks. Middlemen and truck drivers may also reap more benefit than the farmers because middlemen and truck drivers have access to relatively more information. Consequently, the problem of excess supply takes place both monthly as well as yearly. Production of dried cassava and tapioca is only around 20-50 per cent of the export quota, which is 500,000 tons.

Table 8 shows that a large tapioca-processing company requires 4,500 tons of cassava to produce 1,125 tons of tapioca, while a small tapioca processing unit requires 375 tons of cassava to produce 86 tons of tapioca. This implies that the conversion factor from cassava to tapioca in large and small tapioca processing units is 0.25 and 0.22 respectively. To produce 1 ton of tapioca, large and small tapioca processing units require 1.37 and 11.6 man-days respectively. In other words, employment opportunities in a small tapioca processing unit are around 8.5 times higher than large tapioca processing units.

Table 8. Cost structure, profit and income generation of large and small tapioca units for one month in Central Lampung

Items	Unit	Non-ITTARA (Large processing unit)			ITTARA (Small processing unit)		
		Quantity	Price/unit (Rp 000)	Value (Rp 000)	Quantity	Price/unit (Rp 000)	Value (Rp 000)
1. Output: Tapioca	Ton	1 125	2 150	2 418 750	86	2 000	172 500
By-product (*onggok*)	Ton	358	325	116 250	27	340	9 324
Total returns	Month	1	n.a.	2 535 000	n.a.	n.a.	181 824
2. Raw material (cassava)	Ton	4 500	265	1 192 500	375	250	93 750
3. Other inputs:							0
Diesel fuel	Lt	162 800	2.3	374 440	3 750	2.4	9 000
Kerosene	Lt	33 100	1.2	39 720	0	0	0
Others	Month	1	n.a.	113 350	1	n.a.	3 120
4. Fixed costs	Month	1	n.a.	45 340	1	n.a.	2 930
5. Labourers:							
a. Permanent labourers	Mm[a]	15	6 630	99 450	6	851	5 106
b. Contract labourers	Mm[a]	47	2 500	117 500	34	400	13 600
6. Profit:(1)-{(2) to (5)}	Month	1	n.a.	552 700	1	n.a.	54 318
7. B/C ratio: (1)/{(1)-(6)}	Month	1	n.a.	1.28	1	n.a.	1.43
7. Income generation: (5)+(6)	Month	1	n.a.	769 650	1	n.a.	73 024

Source: Field survey**.**
Note: [a] Mm = man-months;
n.a. = not applicable.

Since large tapioca processing units use ovens to dry the cassava, the share of “Other inputs” is 23 per cent of the total returns (Table 9). As the ITTARA units use solar heat to dry their cassava the share for “Other inputs” is substantially lower at 8 per cent. The profit share of total returns is 22 per cent and 30 per cent for the non-ITTARA and the ITTARA sites respectively. Labour efficiency is considerably lower at the ITTARA site with 0.0212 man-days per kilogram of tapioca as compared to 0.0003 man-days per kilogram of tapioca at the non-ITTARA factory.

Table 9. Factor shares of each input and profit in total returns for non-ITTARA and ITTARA tapioca processing units per kilo of cassava

I t e m	Non-ITTARA (Large processing unit)		ITTARA (Small processing unit)	
	Rp/kg	%[a]	Rp/kg	%[a]
1. Total returns	563	100	485	100
2. Raw material (cassava)	265	47	250	52
3. Other inputs	127	23	40	8
4. Labourers	48	9	50	10
5. Profit:(1)-(2)-(3)-(4)	123	22	145	30
6. Generated income:(4)+(5)	171	30	195	40

Source: This table is simplified from Table 8.
Note: [a] Percent of total returns.

In relation to the environment, large-scale tapioca processing plants create problems of waste and waste disposal. Pakpahan and Nasution (1992) found that the industry generated 539,909 tons of solid waste and 11 million cubic metres of liquid waste in 1987. The waste devastates the rivers, which are already very polluted and exceed the water quality limits.

Income generation and employment opportunities

Economic development is about generating income and employment for the people in an economy and it is particularly essential in a country where poverty incidence is relatively high. It is therefore important that any programme or development policy is evaluated on the basis of these criteria. Income generation here is equal to the value added (Hall and Taylor, 1986) and defined as the total value of outputs minus the total value of material inputs. In other words, income is nothing but the returns to land, labour and management in all sub-systems of a particular commodity system (Kawagoe *et al*., 1990). Income generation in a commodity system is simply a summation of the incomes generated in the three sub-systems (farming, marketing and processing). Output per hectare of any crop generates both employment and income, not only in farming itself but also in marketing and processing. For cassava commodity systems, employment in farming is much higher than in either the marketing or processing of the farm output.

To evaluate the ITTARA programme and its impact on employment opportunities and income, small- and large-scale tapioca processing units have been compared.

The total value of production, marketing and tapioca possessing of cassava from 1 hectare is Rp 8.4 million at the ITTARA site and Rp 8.3 million at the non-ITTARA site (Table 10). Income generation at the ITTARA site is only 2 per cent higher than at the non-ITTARA site. Conversely, employment generation at the ITTARA site is 60 per cent higher than the non-ITTARA site. In other words, further development of small-scale tapioca processing units would generate significant employment opportunities in rural areas.

Table 10. Income and employment generation in the production, marketing and processing of cassava per hectare

Stage	Employment generation (Man-days)		Income generation (Rp 1 000)	
	Non-ITTARA site	ITTARA site	Non-ITTARA site	ITTARA site
Production	82 (67%)	97 (50%)	3159 (38%)	3169 (38%)
Marketing	32 (26%)	42 (21%)	1239 (15%)	1156 (14%)
Processing	8 (7%)	56 (29%)	3853 (47%)	4091 (49%)
Total	122 (100%)	195 (100%)	8252 (100%)	8416 (100%)

Source: Computed from Tables 5, 6 and 8.
Figures in parentheses are percentages to the totals.

Discussion and lessons learned

The results from this study show that there are three differences between ITTARA site and the village not connected to an ITTARA unit. First, the ITTARA programme shortens the marketing channels that reduce the marketing margins. Non-ITTARA tapioca processing firms pay higher prices for cassava than the ITTARA units, however, farmers who are connected to an ITTARA unit receive higher prices for their cassava. Secondly, employment generation at the ITTARA site is 60 per cent higher than the non-ITTARA site. In other words, further development of small-scale tapioca processing units would generate significant employment in rural areas, which could potentially alleviate rural poverty. The third and final finding, is the higher negative impact that the large-scale tapioca processing firms have on the environment. In 1997, for example, from the total of 62 large-scale tapioca processing firms in Lampung, only 27 of them had wastewater treatment facilities that met wastewater quality standards, 30 of them nearly satisfied the standards, while the remaining five units fell far below the standards. In the ITTARA programme, each unit is equipped with several wastewater treatment units and tube wells such that the discharged wastewater satisfies quality standards (Asnawi, 2002).

Asnawi (2002) also found that factors causing the failure of ITTARA units funded by local authorities are numerous. The factors are: (i) inadequate managerial and technical skills of human resources in managing ITTARA units; (ii) insufficient investment capital and working capital; (iii) poor planning in the selection of location and the farmers' groups responsible to manage ITTARA units; (iv) the amount of tapioca produced has not been optimal due to inadequate equipment; (v) weak co-ordination among government institutions in locating ITTARA units, financing and controlling; (vi) inadequate supervision from responsible government institutions and private companies to provide financial support for the development of ITTARA units, and (vii) many ITTARA units cannot operate optimally due to insufficient working capital (Anonymous, 2000). Unlike ITTARA units funded by the government and private companies, most personally funded ITTARA units can continue operating because they have adequate managerial and technical skills such that the establishment and operation of such units are carefully planned, even without supervision from responsible government institutions (Hutagalung, 2000).

These constraints can be reduced considerably if all the individuals involved in managing an ITTARA unit are accountable for their performance and if the right incentives are in place. It is worth noting that local communities, in general, believe that government programmes, which support economic activities for rural poverty reduction, are "charity-funds" so the accountability of those who are involved in management (e.g. management of ITTARA units) is questionable. For example, in several cases of ITTARA management, the managers distributed the profits from ITTARA activities among themselves for personal gain, rather than re-investing in the collectively owned ITTARA unit. It is possible that these managers expected the government to provide them with yet another fund once the first was exhausted. In contrast, the managers of personally funded ITTARA units work carefully day-to-day to improve performance and profit because they are extremely concerned with their investment.

To avoid such failures of poverty alleviation programmes, the government should apply participatory methods at all stages (planning, implementation, monitoring and control, and evaluation) of the programmes. In the case of the ITTARA programme, for example, all members of farmers groups should participate in all stages such that any deviations from guidelines and objectives can be minimized through transparency. A participatory approach might be more costly than a "centralized approach" because it entails more time, higher budgets and human resources from government institutions responsible in providing guidance and training for local communities, but a participatory approach would be more effective in achieving the targets of poverty alleviation programmes. To rehabilitate ITTARA units that have already collapsed, the government can offer rehabilitation to local communities through a participatory approach or if this is unlikely, the government may offer rehabilitation to private companies.

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Processing Industry Development and Sweet Potato in China

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Abstract

Sweet potato has emerged as an important agro-industrial crop in Sichuan Province, China. By 2004, at least 2 million metric tons of sweet potato were processed into starch and food products in the province. This paper describes the development of the sweet potato processing industry in Sichuan and assesses its impact on farm households and the rural economy. Processed products of sweet potato became an important source of income for rural households following China's move to a market economy in 1978. In the 1990s, technical innovations were developed and adopted by many small-scale rural and household enterprises to improve efficiency in sweet potato processing. Rising consumer demand for processed food products also induced private-sector investments in large-scale agro-processing which greatly expanded the capacity and scope of the sweet potato processing industry. Marketing linkages were established between small- and large-scale enterprises with the former providing intermediate (primary) processing for large enterprises. Using a survey of enterprises and interviews with key informants, the authors find that the adoption of technical innovations allowed small-scale processors to increase scale of production, profitability and labour productivity. The emergence of modern, large-scale processing greatly expanded the marketing of sweet potato processed products and generated demand not only for sweet potato but also for primary processing by small-scale rural enterprises. While these developments have brought economic benefits to farm households and small rural enterprises, government policies appear to favour large-scale modern enterprises.

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Introduction

Sichuan is the largest grower of sweet potato in the world, producing more each year than any other province in China or any other country outside of China. Virtually all of Sichuan's sweet potato crop is grown on small farms, each producing 1-4 tons per year on a crop area of 0.05-0.20 hectares. Historically, most of this production would never leave the farm, being consumed by the farm family or fed to farm animals. Many farm households would convert a portion of their sweet potato crop into starch-based food products, such as noodles, as a way of improving storability and taste, but these products were primarily for home use (Timmins *et al*., 1992). When China began moving towards a market economy in 1978, restrictions on commercial sales of sweet potato and sweet potato products were lifted (Zhang, 1999). Since then, a vibrant sweet potato processing industry has developed, initially made up mostly of small, household enterprises and eventually including large-scale modern food processing factories. Huang *et al*. (2003) estimated that by 1997, around 4 million tons of sweet potato in Sichuan and Chongqing were processed into starch and food products, accounting for nearly one-fifth of sweet potato output in these provinces.

In the mid-1980s, the International Potato Center (CIP) entered into collaborative research on sweet potato with China's agricultural research system, (International Potato Center, 1995). One of CIP's first efforts involving sweet potato was a project with the Sichuan Academy of Agricultural Sciences (SAAS) on post-harvest utilization. The project's focus was to develop and improve mechanized processing equipment suitable for small-scale enterprises (Wiersema, 1992). By the early 1990s, improved machinery designs were available for several steps in starch and noodle production, including root washing, root-starch separating, automatic starch-paste stirring and heating for noodle making, as well as noodle extruding. Working with local machinery manufacturers, the SAAS-CIP project was able to promote the manufacture and sale of these machines to small enterprises (Gong, 1998).

In addition to public research and development efforts, China's emerging private sector was also active in promoting the sweet potato processing industry. The most significant private-led developments in sweet potato processing took place in the coastal provinces, like Shandong, where rapid industrialization was underway. There, both small- and large-scale processing enterprises produced sweet potato starch and starch products not only for the domestic market but also for export (Fuglie, Oates and Xie, 2006). Sichuan, which lies in the interior of China, did not industrialize as rapidly. Nevertheless, a number of modern food companies were established to produce sweet potato food products. One of the major food innovations was the development of packaged instant sweet potato noodles, which by the late 1990s were successfully competing alongside wheat flour instant noodles on supermarket shelves. The emergence of large-scale processing companies, some receiving government subsidies, introduced a new dynamic into the processing sector and created new challenges and demands on small-scale processors.

The purpose of this paper is to describe the development of the sweet potato starch processing industry in Sichuan and evaluate its economic effects on the rural economy. In particular, we are interested in assessing the impact of the adoption of machinery improvements on small, starch and noodle processors. We also discuss implications of government policies toward the sweet potato processing sector in Sichuan.

Methodology

To assess the impact of structural changes in the sweet potato processing industry in Sichuan, we first interviewed key informants from the public and private sectors and thereafter conducted a formal survey of starch[1] and noodle processing enterprises. Key informants described the organization and trends of the sweet potato processing industry, including market-chains and linkages between small and large producers.

For the survey, five townships in five different counties were identified that had significant levels of sweet potato production and processing by small-scale enterprises. Within each of these townships, a random sample of processing enterprises was selected and interviewed, for a total of 113 enterprises. In addition, for comparative purposes, owners of four large-scale sweet potato processing enterprises in Sichuan were also interviewed.

The large enterprise owners were asked about their annual production and costs, capital investment, labour use, marketing practices, as well as access to credit and technical support services, while the small-scale enterprise owners were asked if and when they had adopted mechanized methods for specific steps in starch and noodle production. For example, starch producers were asked whether they had adopted mechanized washers (for roots) and separators to grind and separate the starch from the sweet potato roots (traditionally, producers hand-wash the roots and use a manual 'hammer mashing' tool to

[1] Starch is sometimes confused with flour as a processed product. While both are fine powdery foodstuffs, flour is obtained by grinding and sifting grain or tubers, and thus contains all of the chemical constituents of plant tissue (carbohydrates, proteins, fats, etc). Starch, on the other hand, consists only of the complex carbohydrates found within cells of plants. The starch extraction process involves breaking down the cell wall to release soluble carbohydrates into a watery solution and screening out the non-soluble plant matter. The starch molecules are then left to settle and the water removed.

separate the starch). Starch producers were also questioned whether they adopted 'sour liquid," an innovation to speed up starch sedimentation.[2] Noodle producers were asked whether and when they adopted mechanized stirring equipment (to mix the starch paste) and extruding equipment (used to form the noodles from the paste). Traditionally, noodle production is a labour intensive procedure involving mixing starch with water, working the mixture by hand into dough and pressing the dough manually through a container with holes punched into the bottom. The wet starch strings then fall into a pot of boiling water (for gelatinization), thereafter transferred to cold water, and finnally sun dried (Timmins *et al*., 1992). The use of an extruding machine simplifies the process since the heat from the machine gelatinizes the starch sufficiently (Wheatley and Song, 2000). From such data we assess the economic impacts of small-scale mechanization by comparing the productivity, costs, value-added and profit between small-scale enterprises using traditional, manual methods and those that mechanized at least one major processing step.

Results

Structural change in sweet potato utilization and processing in Sichuan

The importance of sweet potato to the agricultural economy of Sichuan Province in China can hardly be understated. Sichuan is the largest producer of sweet potato in China and accounted for 13.5 per cent of global sweet potato production in 2003. Sweet potato production and area planted expanded rapidly up until the 1970s and were fairly stable during the 1980s and 1990s. During the 1990s, when Chongqing Municipality was still part of Sichuan Province, production averaged 23 million tons per year harvested from 1.4 million hectares (Table 1).[3]

In Sichuan, sweet potato production, processing and animal husbandry are all closely complementary activities. The crop is usually grown under rain fed conditions on hilly land where abundant top growth provides a defense against soil erosion. Not only are the storage roots used for food, feed and starch, but also the top growth (vines and leaves) is cut and collected for animal (mainly pig) fodder. Residue from starch processing is also used to feed farm animals and thereafter the manure is recycled as fertilizer.

[2] "Sour liquid' is a liquid fermentate usually derived from legumes and contains lactic acid bacteria. It is added to the starch water solution at the separation stage to speed sedimentation and improve final product quality. It acts by adjusting the pH of the starch solution (Wheatley and Song, 1999).
[3] Chongqing was part of Sichuan Province until 1997, when it became a separate municipality.

Table 1. Sweet potato production and utilization in Sichuan, 1950s to 1990s

	1950s	1960s	1970s	1980s	1990s
Production (1 000 tons)	11 884	13 058	20 018	20 627	23 060
Area planted (1 000 hectares)	1 336	1 321	1 384	1 314	1 405
Utilization (%)					
Direct food	65	60	50	20	11
Feed	14	19	29	60	60
Processing	3	4	5	10	19
Seed and waste	18	17	16	10	10
Quantity (1 000 tons) used for:					
Direct food	7 725	7 835	10 009	4 125	2 537
Feed	1 664	2 481	5 805	12 376	13 836
Processing	357	522	1 001	2 063	4 381
Seed and waste	2 139	2 220	3 203	2 063	2 306

Source: Production is annual average (fresh weight) during the decade, as reported in Agricultural Statistics of China annual issues. Estimates of utilization are from Huang *et al*. (2003).
Note: The figures in the table include Sichuan and Chongqing. Chongqing was part of Sichuan Province until 1997 when it was made a separate municipality.

While once a major food staple, the share of production consumed directly as food dramatically declined during the 1980s and 1990s, whereas utilization for animal feed increased (Table 1). By the 1990s, 60-70 per cent of sweet potato in Sichuan was used as animal feed, mostly directly on the farm where it was grown.

The utilization of sweet potato for food processing expanded rapidly following economic reforms that were introduced beginning in 1978. Prior to 1978, rural households were organized into communes and were barred from selling processed sweet potato products. Some sweet potato was processed into starch or alcohol by state-owned enterprises and some by communes for their own consumption. In 1978, communes were disbanded and farm households given long-term leases to farmland and greater freedom in deciding what to produce. While quotas on grain production were maintained for several years, sweet potato production and marketing were liberalized immediately. Farm households were free to grow and dispose sweet potato as they liked, provided they met their quotas for cereal grain (Huang *et al*., 2003).

Commercialization of sweet potato processing grew rapidly also in Sichuan after the reforms in 1978 (Zhang, 1999). Farm households that entered into commercial starch and noodle processing would use their own crop as well as buy sweet potato from neighbouring farms at harvest. They might even hire one or two additional labourers in addition to employing family labour for processing. Starch extraction would take place for a few weeks a year immediately after harvest. Technology was rudimentary and most processes were performed manually (Timmins *et al*., 1992). Marketing was primarily through local channels although clustering of rural processing enterprises facilitated the establishment of wholesaling centres for noodles and other sweet potato products (Zhang, 1999).

Efforts by the provincial government to support sweet potato processing included the development and promotion of machinery suitable for small-scale and household enterprises. The Sichuan Academy of Agricultural Sciences (SAAS) working together with the International Potato Center (CIP) introduced improvements in small-scale starch and noodle processing. By mechanizing certain processing steps, both scale and productivity could be increased. The SAAS-CIP project worked with several machinery manufacturers in Santai County in Sichuan to make a number of these processing machines commercially available. More than 12,000 machinery units were sold between 1991 and 2005 from the three most important manufactures of starch and noodle-making machinery in Santai County, generating sales revenue of over 40 million yuan (Table 2). Sales increased rapidly in the early 1990s and peaked in 1995 at 1,250 machinery units. Since then sales have been relatively stable at around 600 to 800 units per year.

Table 2. Sales of starch and noodle processing equipment in Sichuan

Year	Noodle-making machines		Starch-making machines		Total sales revenue (yuan)	Total units sold
	Sales revenue (yuan)	Units sold	Sales revenue (yuan)	Units sold		
1991	359 900	139	526 500	165	886 400	304
1992	871 900	275	1 243 200	378	2 115 100	652
1993	1 455 100	477	2 669 100	461	4 124 200	937
1994	1 555 800	509	1 851 800	571	3 407 600	1 080
1995	1 633 100	525	2 364 000	725	3 997 100	1 250
1996	1 254 100	325	1 730 400	479	2 984 500	804
1997	1 284 600	355	1 856 300	512	3 140 900	867
1998	1 354 000	367	1 829 500	507	3 183 500	874
1999	1 318 800	369	1 754 000	482	3 072 800	851
2000	1 167 700	334	1 781 800	497	2 949 500	831
2001	1 150 100	294	1 641 000	449	2 791 100	743
2002	1 154 800	310	2 040 700	563	3 195 500	873
2003	899 900	242	1 493 000	392	2 392 900	634
2004	894 300	241	1 307 700	348	2 202 000	589
2005	1 064 800	290	1 805 500	455	2 870 300	745
Total	17 418 900	5 051	25 894 500	6 984	43 313 400	12 035

Source: Authors' interviews with three manufacturing firms in Santai County, Sichuan, November 2005.

The pattern of development in small-scale sweet potato processing in Sichuan can be seen from the results of our survey of small processing enterprises. The five counties included in the survey account for about 12 per cent of sweet potato production in Sichuan and about 40 per cent of this production is used for agro-processing (Table 3).

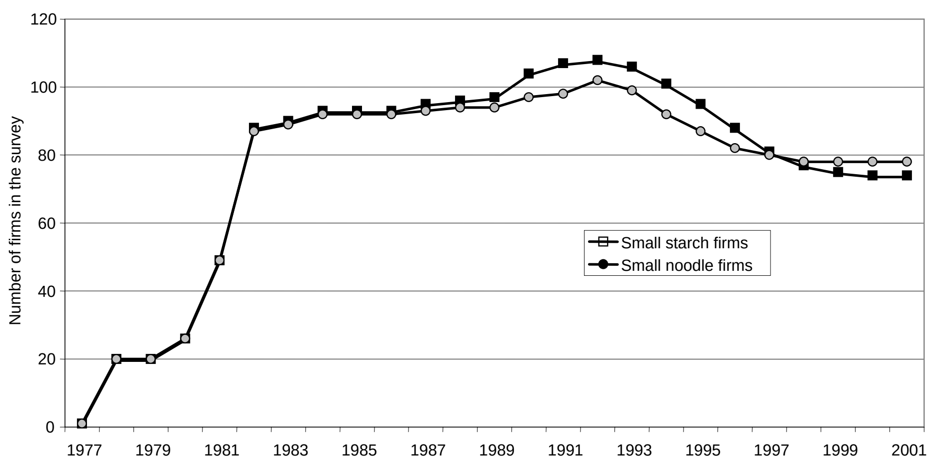
Table 3. Sweet potato production and utilization in five counties of Sichuan in 2000

County	Sweet potato production in 2000 (tons)	Sweet potato starch production in 2000 (tons)	Sweet potato utilization			
			Food (%)	Feed (%)	Processing (%)	Seed and waste (%)
Qionglai	145 070	8 269	7	40	38	15
Luojiang	41 030	2 031	13	42	33	12
Santai	405 000	24 908	17	30	41	12
Anyue	810 000	51 395	20	28	42	10
Ziyang	680 000	40 800	12	36	40	12
Total	2 081 100	127 402	16	32	41	11

Source: County agricultural departments.

Most of the 113 enterprises in our survey were established between 1979 and 1982 following the 1978 reforms (Figure 1). While most of these enterprises began as both starch and noodle producers, many eventually specialized in one type of product. By the time of the survey in 2002, 35 of the enterprises produced only starch, 39 only noodles and 39 both starch and noodles.

Figure 1. Establishment of small-scale sweet potato starch and noodle enterprises



Source: Authors' survey of 113 enterprises.

The survey also found evidence of clustering of similar firms by location (Table 4). For example, in Anyue County, enterprises specialize in noodle making, buying starch from other enterprises in surrounding areas. Noodle enterprises are organized into an association that operate a large wholesaling centre to facilitate marketing. In Santai, Ziyang and Qionglai counties, small-scale enterprises tend to produce crude starch and then sell the starch through contractual arrangements to large-scale food processing companies. The large-scale enterprises undertake final processing into fine starch, noodles and instant noodles. In Luojiang County, which was more isolated from other processors, small enterprises produced their own starch and then further processed it into noodles.

Table 4. Clustering of sweet potato processing enterprises by location

County	Number of small enterprises in survey	Starch producers	Noodle producers	Enterprises producing both starch and noodles	Predominate enterprise cluster
Qionglai	8	8	0	0	Enterprises specialize in starch production for sale to large food manufacturers.
Luojiang	32	32	32	32	Enterprises buy sweet potato roots from area farmers, extract starch, and make into noodles.
Santai	14	14	1	1	Enterprises specialize in starch production for sale to large food manufacturers.
Anyue	39	0	39	0	Enterprises buy starch from other villages and specialize in noodle production. Locality has large wholesale market offering several grades of noodles.
Ziyang	20	20	6	6	Most enterprises specialize in starch production for sale to large food manufacturers. Some also make noodles.
Total	113	74	78	39	

Source: Author's survey of sweet potato processing enterprises.

Besides the small-scale enterprises, another important part of the sweet potato processing industry in Sichuan is composed of large-scale processing factories. Prior to the 1980s, some sweet potato processing (mainly for alcohol and starch) was performed by large-scale state-owned enterprises. Following the liberalization of rules on private ownership and investment in China, and a growing urban demand for processed food products, new privately-owned processing companies were established during the 1980s. A survey by Tang *et al*. (1990) showed that by 1988 there were 17 large-scale starch and noodle factories, two large organic chemical factories and several alcohol enterprises, along with thousands of medium and small-scale processors.[4] By 2004 (according to the authors' interviews with key informants) there were at least 20 large-scale, 70 medium-scale and thousands of small-scale enterprises processing sweet potato into starch, noodles and snack foods (Table 5). In addition, there were at least five organic chemical factories and 50 alcohol-processing companies in Sichuan processing sweet potato starch and dried chips into final products. Although comprehensive statistics on the quantity of starch processed do

[4] Tang *et al*. (1990) included processing enterprises in Chongqing Municipality (part of Sichuan Province at the time).

not exist, based on an aggregation of enterprise-level data we estimate that about 2.1 million tons of sweet potato roots were processed into starch and other products in 2004, or about 12 per cent of total crop production in Sichuan. Our estimate differs from that reported in Huang *et al*. (2003) in Table 1, which also included processing in Chongqing Municipality.

The sweet potato processing industry in Sichuan was given policy encouragement in 2000 when the Government of China announced a policy to support "dragonhead" agro-enterprises, an initiative to propel agricultural restructuring and rural development (Ministry of Agriculture, 2000). This designation qualifies firms for subsidized loans, tax holidays and other means of government support. In order to maintain the dragonhead designation, an enterprise needs to demonstrate not only its economic viability but also that the farmers and rural areas supplying raw materials to the enterprise benefit (China Farmer Daily, 2003). By 2003, the central government had designated 372 dragonhead enterprises nationwide, including several large-scale sweet potato-processors in Sichuan (Lingohr, forthcoming). Provincial and local governments also designated additional firms with dragonhead status of their own and provided varying degrees of support.

So far, the developing of modern, large-scale sweet potato processing capacity in Sichuan appears to have expanded rather than contracted opportunities for rural, small-scale starch enterprises. As the data in Table 5 indicates, most of the primary processing of sweet potato continues to be carried out by small-scale enterprises close to the farms where sweet potato is grown, while most of the final product manufacturing is undertaken by medium- and large-scale enterprises. Large processing companies have generally found it advantageous to purchase crude starch from small and medium processors to make refined starch, noodles and other starch-based products, rather than invest in capital-intensive starch extracting equipment that can only be utilized a few weeks of the year (Wheatley and Song, 2000; Fuglie, Oates and Xie, 2006). To procure crude starch, large firms have developed a number of contractual arrangements with small-scale enterprises, including the provision of improved agricultural inputs as well as purchasing crude starch at guaranteed minimum prices (Lingohr, forthcoming). The small-scale enterprises, most of which are owned and run by farm families growing their own sweet potato, procure additional sweet potato roots from farmers in their communities. Keeping primary starch processing dispersed amongst small-scale processors probably also helps to reduce the negative environmental impacts from starch waste.

Table 5. Processing of sweet potato by product and size of firm in Sichuan in 2004

Type of enterprise	Primary processing (roots into coarse starch or chips) Number of enterprises	Quantity (tons of sweet potato)	Share by product type %	Final processing (coarse starch or chips into consumer products) Quantity (tons of final product)	Share by product type %
Starch & noodle enterprises					
Large-scale	15	8 000	0.6	105 000	80.8
Medium-scale	40	72 000	5.4	24 000	18.5
Small-scale	180 000	1 260 000	94.1	1 000	0.8
Total starch & noodle processing		1 339 500	100.0	130 000	100.0
Snack food enterprises					
Large-scale	5	n.a.		15 000	68.2
Medium-scale	30	n.a.		6 000	27.3
Small-scale	1 000	n.a.		1 000	4.5
Total snack food processing				22 000	100.0
Other processing					
Organic chemical enterprises [a]	5	n.a.		15 000	
Alcohol enterprises [b]	50	n.a.		50 000	
Total	181 145	2 100 000			

Source: Authors' estimates derived from interviews with industry and government sources.
Notes: [a] Chemical companies purchase fine starch for processing.
[b] Alcohol companies purchase roots and dried chips from farmers as well as fine starch for processing.

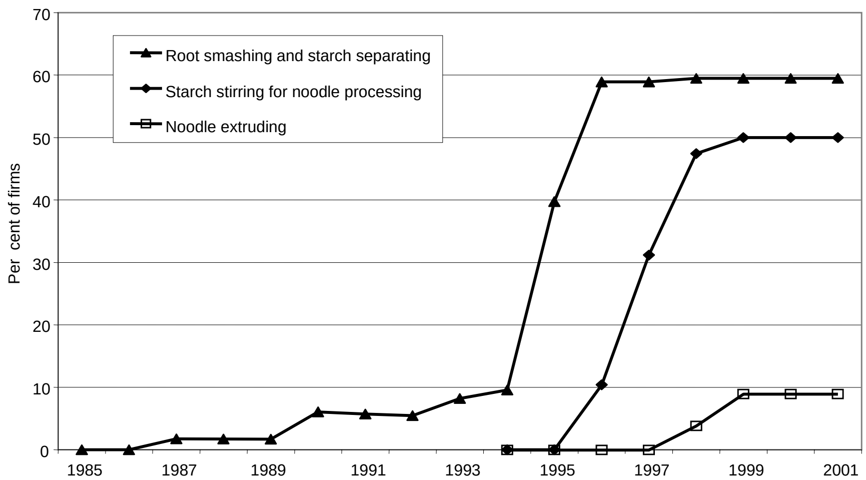
Direct competition between small and large firms in the markets for final processed products has been partly mitigated by market segmentation. Small-scale and home noodle makers produce a lower-quality product that is marketed, primarily through local trading networks to lower-income consumers (Zhang, 1999). With high and consistent product standards and extensive marketing networks, the large enterprises have been able to penetrate new markets such as modern supermarkets and export markets. Sichuan sweet potato noodles can now be found in most major cities of China as well as in some foreign countries. Over time it is likely that the market share of small-scale and home enterprises for final products will decline unless quality and grading standards can be significantly improved. With rising urbanization and disposable income, consumers are likely to prefer higher-quality brand-name producers such as those manufactured by the large, modern food processing factories.

Impact of mechanization of small-scale rural processing enterprises

Our survey of sweet potato processors provides information on the adoption of processing innovations by small-scale enterprises and how adoption affected their profitability, scale and efficiency. Most of the enterprises in the survey were established in the early 1980s, while the adoption of mechanization occurred mainly after 1993. For starch processing, the major innovations adopted were mechanization of starch separation and the use of “sour liquid” to expedite starch settling. Of the 74 starch processors in the survey, 60 per cent had adopted mechanized separators (Figure 2) and 81 per cent had adopted sour liquid by 2002. The major innovations adopted by noodle-makers were the mechanization of starch stirring and noodle extruding. Of the 78 noodle makers in the survey, half had adopted mechanized stirrers and 9 per cent had adopted extruder machines by 2002 (see Figure 2).

Mechanization has allowed small enterprises to increase their scale of production while still relying primarily on family labour. Starch processors that mechanized starch separating were able marginally to produce more than 5.8 tons of starch per season compared with only 1.4 tons per season by firms using manual methods (Table 6). However, the total labour in the mechanized firms was marginally higher than manual firms (77 worker-days per season compared with 63 worker-days per season for manual firms, a difference that is not statistically significant). Labour productivity (starch output per worker per day) of mechanized firms, however, is double that of manual firms. The quality of starch produced by both sets of firms appears to be similar, as each receive about the same price for starch. However, the starch extraction rate (dry starch yield as a percentage of fresh root rate processed) by mechanized firms was lower (14 per cent) compared with extraction by manual methods (18 per cent). The lower starch extraction rate from mechanized separators appears to contradict Gong (1998) but is consistent with the low extraction rates of 15 per cent by firms using mechanized separators examined by Wheatley and Song (2000, Table 3). The lower extraction rate by mechanized firms increased their raw material costs per ton of starch produced.

Figure 2. Mechanization of starch and noodle operations among small-scale processors



Source: Authors' survey of 113 enterprises.

Table 6. Impact of mechanization on small starch enterprises

	Unit	Enterprises using manual methods (n=22)		Enterprises with mechanized root smashing & separating (n=52)		T-test of significant difference between means[a]
		Mean	Standard deviation	Mean	Standard deviation	
Scale of production	tons starch/year	1.37	0.97	5.80	8.73	3.60
Employment	worker-days/year	63.45	30.25	76.75	89.19	0.95
Labour productivity	kg starch/worker/day	33.99	30.97	66.52	25.66	4.34
Starch quality (starch price received)	yuan/kg	3.00	0.00	2.98	0.14	-1.29
Starch extraction rate	%	0.18	0.02	0.14	0.03	-9.24
Pre-tax profit	yuan/year	1 006	1 276	2 084	4 073	1.72
Value-added	yuan/year	1 818	1 312	3 653	5 154	2.39
Unit cost of production	yuan/ton of starch	2 348	328	2 608	354	3.04

Source: Author's survey of sweet potato processing enterprises.

Note: [a] A T-test score of at least 1.96 in absolute value indicates the difference between means is significant at the 5 per cent level.

Value-added is total revenue minus cost of raw materials (roots, energy, materials). It represents a return to labour and fixed capital.

Pre-tax profit is equal to total revenue minus the cost of raw materials, labour (family and hired), and capital depreciation.

At the prevailing average wage and input prices reported by the enterprises in our survey, the adoption of mechanical starch separation did not have much affect on overall efficiency. In fact, at a daily wage rate or opportunity cost of 12.5 yuan per day for hired and family labour and a raw material cost of 300 yuan per ton of fresh roots, the unit cost of production per ton of starch was slightly higher for mechanized firms compared to firms using manual methods. However, the scale effect made mechanization profitable. Mechanized starch firms earned an average of 2,700 yuan in pre-tax profits per year, compared to 1,000 yuan per year for manual firms. The main effects of mechanization were to: (i) increase scale and profitability of starch production and (ii) substitute higher raw material use for lower labour use. It is likely that these factors provided the primary economic incentive to mechanize. If, in the future, the opportunity cost of labour rises relative to the cost of raw materials, which seems likely, then we expect further mechanization to take place.

Table 7 compares scale and productivity of manual and mechanized noodle processors. The most noticeable impact of mechanized noodle making is scale: enterprises that have mechanized starch mixing and/or noodle extruding produce on average almost 14 times more than enterprises using manual methods. Labour productivity (noodle output per worker per day) of mechanized firms is nearly 60 per cent higher than firms using manual methods. Although both sets of firms continue to rely primarily on family labour (about three workers per firm), mechanized firms generate more overall employment. Mechanized firms spend an average of two months per year making noodles compared with about two weeks per year for households using manual methods. However, the quality of noodles produced by hand appears to be higher than noodles produced by machine, as the average price of hand-made noodles is about 20 per cent higher. Nevertheless, the higher productivity and specialization achieved through mechanization in noodle-making led to a dramatic increase in earnings: profits of mechanized firms averaged 21,864 yuan/year compared with 1,250 yuan per year for firms using manual methods.

Table 7. Impact of mechanization on small noodle enterprises

	Unit	Enterprises using manual technology (n=32)		Enterprises with at least one major step mechanized (n=46)		T-test of significant difference between means
		Mean	Standard deviation	Mean	Standard deviation	
Scale of production	tons noodle/year	2.96	2.75	41.22	25.52	10.09
Employment	worker-days/year	38.63	62.93	165.39	101.27	6.53
Labour productivity	kg noodle/worker/day	150.28	51.64	238.42	29.04	8.91
Noodle quality (starch price received)	yuan/kg	4.14	0.16	3.44	0.33	-12.62
Pre-tax profit	yuan/year	1 693	1 493	23 852	14 768	10.10
Value-added	yuan/year	1 731	1 520	23 919	14 780	10.11
Unit cost of production	yuan per ton of noodle	3 135.1	23.3	3 139.5	11.0	0.98

Source: Author’s survey of sweet potato processing enterprises.

Aggregate economic and employment impacts of the sweet potato processing industry

Table 8, presents some estimates of the aggregate value-added, taxes paid and employment in sweet potato starch and noodle processing in Sichuan (we do not have sufficient information to derive these estimates for the alcohol and organic chemical processing enterprises). Value-added is defined as the return to the basic factors of production (land, labour and capital) after subtracting from gross revenues the cost of intermediate goods and services used in processing. Tax revenues (paid to local governments) are calculated as 5 per cent of the value of gross output. The tax rate was indicated by enterprises in our survey. Although these estimates are based on a relatively small sample of firms, we believe they provide a reasonable picture of the sweet potato processing industry in Sichuan.

We estimate that by 2004, sweet potato starch and noodle processing generated 613.5 million yuan in value-added to the Sichuan economy. Tax revenues paid to the local government totalled nearly 97 million yuan and total employment amounted to around 3.5 million work-days. Most of the employment was part-time by small-scale enterprises for primary starch processing. Employment in these enterprises was principally farm household labour for several weeks following the harvest of the sweet potato crop. Most of the value-added accrued to large-scale enterprises manufacturing final products like instant and regular sweet potato noodles. The situation appears to be one in which small enterprises generate most the employment while large enterprises capture most of the value-added from processing. Small-scale enterprises producing a homogeneous product in a competitive market are primarily price-takers with low profit margins. Large enterprises, on the other hand, are likely to be able to exercise some degree of market power due to their size and brand name product recognition and thus achieve higher profits and value-added.

Table 8. Economic and employment impacts from sweet potato processing in Sichuan

Item	Gross value-added	Taxes paid	Employment	
	million yuan	million yuan	worker-days	
Small-scale primary starch processing from roots	166.9	28.4	2 835 000	
Small-scale noodle processing from starch	0.5	0.2	5 000	
Medium- and large-scale primary starch processing from roots	10.6	1.8	180 000	
Medium- and large-scale noodle processing from starch	435.4	66.6	516 000	
Total	613.5	96.9	3 536 000	
Detailed estimation by enterprise type	Small-scale primary starch processing	Small-scale noodle processing	Medium- and large-scale primary starch processing	Medium- and large-scale noodle processing
Gross output (tons of primary starch or noodles)	189 000	1 000	12 000	129 000
Gross value of output (million yuan)	567.0	4.0	36.0	1 331.3
Cost of sweet potato roots or primary starch (million yuan)	378.0	3.3	24.0	573.3
Cost of other intermediate goods and services	22.1	0.1	1.4	322.5
Gross value added	166.9	0.5	10.6	435.4

Sources: Authors' enterprise survey and key informant interviews.
Gross value-added is the returns to land, labour and capital factors of production after subtracting payments for intermediate inputs from gross value of output.

The development of a sweet potato processing industry also affected farmers directly by raising the demand for, and therefore the market price of, their sweet potato crop. Fuglie (2006) shows that if market demand for a commodity increases by M per cent (measured as a percentage of initial market demand), then the per cent change on market price (Z) can be estimated as:

Equation 1 $$Z = \frac{M}{\eta + \varepsilon}$$

Where η is the (absolute value of) own-price elasticity of demand and ε is the price elasticity of supply. In the case of sweet potato in Sichuan, we estimate that processing accounted for about 12 per cent of crop utilization in 2004 (Table 5). Although estimates of sweet potato demand and supply elasticities are not available, it is reasonable to assume that these elasticities range between 0.2 and 0.5.[5] From Equation 1, assuming η=0.5 and ε=0.5 would imply that the utilization for processing increased the average market price of sweet potato by 12 per cent. Lower values of the elasticities will increase the value of Z. If η and ε equal to 0.2, then processing demand would have raise average crop price by 30 per cent. A reasonable assumption is, therefore, that the presence of the sweet potato processing industry in Sichuan raised the average market price for sweet potato by 12 to 30 per cent. Assuming that about 20 per cent of Sichuan's sweet potato crop is marketed (either as food or for processing), this implies that annual farm income increased by 114 to 246 million yuan.[6] The total impact on income of farm families and small, rural enterprises was, therefore, between 282 and 414 million yuan per year. In addition, some of the value-added accrued to medium and large enterprises (446 million yuan per year) was returned to rural households through wages received from employment at these enterprises (Lingohr, forthcoming). Other economic impacts, which are not included in these estimates, include the value-added and employment from the expansion in local machinery manufacturing, wholesale and retail trade in sweet potato and sweet potato products, and starch processing residues for feed in swine production.

Policies and the development of the sweet potato processing industry

Government policies played an important role in encouraging the development of a commercial sweet potato processing industry in Sichuan. The most significant policy was the move toward a market economy that begun in 1978. This greatly improved opportunities and incentives for crop production and agricultural value-added activities like agro-processing. As the non-farm economy grew, demand increased for food and food products. Starch-based processed food products exhibit high income elasticities in Asia (Fuglie, Oates and Xie, 2006).

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[5] Some recent evidence of supply and demand elasticities for agricultural commodities in Sichuan (wheat, rice, corn, pork and poultry meat) are given in Zhuang and Abbot, 2005. Although they did not include sweet potato in their model, we can infer some likely ranges for sweet potato elasticities from the estimates for other commodities, especially corn, since sweet potato is a close substitute with corn in both production and utilization (for animal feed) in Sichuan. Thus, there is likely to be similar price responsiveness for these commodities. The (absolute value of) own-price elasticity of demand for corn estimated by Zhuang and Abbot (2005) was 0.48, and ranged between 0.30 and 0.44 for the other commodities in their model. Their estimate of output supply elasticity for corn was 0.24. Supply elasticities ranged between 0.14 and 0.34 for the other commodities in their model.

[6] At the time of our survey, starch processors reported paying about 300 yuan per ton for fresh roots. Assuming that the expansion of processing increased average crop price by 12-30 per cent implies that without demand from processors, average crop price would have been between 32 and 69 Yuan/ton lower than the current price. Assuming 20 per cent of the current annual crop of 17.8 million tons is sold, this implies an increase in farm income from sweet potato sales of between 114 and 246 million yuan/year.

At the micro-level, government policies also affected the scale and structure of the sweet potato processing industry. Two policies previously mentioned are the support given by the Sichuan Government in the 1990s for mechanization of small-scale sweet potato processing enterprises, and more recently, special economic incentives for dragonhead agro-enterprises. In this section we use data from our survey of sweet potato processing enterprises to examine how government tax policies, credit policies and the provision of technical services affected sweet potato processing firms. In particular, we assess whether there may be scale biases in the administration of these policies, namely whether policies favour small or large enterprises. The presence of scale biases, whether intentional or not, may distort the process of structure change and influence how benefits from agro-processing are distributed within the rural economy.

Taxation. Both small and large enterprises in our survey reported paying local taxes of 5 per cent of gross revenue from product sales. Table 9 shows the effect of this tax on various types of sweet potato processing enterprises. Large enterprises achieve much higher value-added per unit of output than small enterprises. Thus, a flat tax on gross sales imposes a much higher effective tax rate on small enterprises. For small-scale noodle makers, taxes amount to 32 per cent of value-added, compared with only 7 per cent for large noodle enterprises. Small starch processors pay 22 per cent of value-added in taxes, but could reduce their tax burden if they convert their starch into noodles before sale. Such firms could reduce the tax rate on their value-added to about 12 per cent. However, these gains may simultaneously reduce potential efficiency due to product specialization.

Table 9. Effective rates of taxation on small and large processing enterprises

Item	Small starch processor selling starch [a]	Small noodle processor purchasing starch [a]	Small noodle & starch processor [a]	Large processing enterprises
Gross value of output (yuan/year)	13 355	94 936	94 936	40 803 840
Cost of raw materials (yuan/year) [b]	9 481	76 562	51 000	7 820 677
Cost of other purchased inputs (yuan/year) (energy, packaging, etc.)	767	3 558	8 639	3 420 303
Value-added of output (yuan/year)	3 107	14 816	35 298	29 562 861
Pre-tax profit (yuan/year)	1 763	10 798	23 619	26 114 864
Taxes paid - 5% of output (yuan/year)	668	4 747	4 747	2 040 192
Taxes paid as percentage of value added (%)	21.5	32.0	12.1	6.9
Taxes paid as percentage of profit (%)	37.9	44.0	20.1	7.8

Source: Authors' survey of sweet potato processing enterprises.

Note: [a] Based on mean values of small-scale processing enterprises in Authors' survey, including firms using mechanized and manual processing methods.

[b] Raw materials include sweet potato roots for starch processors and sweet potato starch for noodle makers. Large enterprises primarily made noodles (regular and instant), purchasing most of their starch needs from small processors and traders.

Credit. Another important policy by provincial and local governments has been the provision of credit services for investment and operating capital, as banking services are largely supplied by state-owned banks. Two of the four large food processing enterprises we interviewed had received capital investment loans from a state bank, while only one of the 113 small processors in the survey was given a loan for capital equipment. Lack of access to investment credit may be a major constraint preventing small firms from adopting mechanized processing methods. Credit was more widely available for annual operating expenses, especially for purchasing sweet potato roots for processing. All of the four large firms and 80 per cent of the small firms used formal credit for operating costs (Table 10). However, small enterprises had a shorter borrowing period and paid higher interest rates than the large enterprises.

Table 10. Use of credit by sweet potato processing enterprises in Sichuan

Item	Large enterprises (n=4)	Small enterprises (n=113)
Average capital investment (yuan)	12 700 000	3 000
Share receiving loan for capital investment (%)	50.0	0.9
Source of capital loan	local bank	local co-operative bank
Period of capital loan (months)	24.0	6.0
Interest for capital loan (% per year)	71.2	120.0
Share receiving loan for operating expenses (%)	100.0	79.6
Source of operating loan	local bank	local co-operative bank
Period of operating loan (months)	18.0	3.1
Interest for operating loan (% per year)	55.5	65.7

Source: Authors' survey of sweet potato processing enterprise.

Technical support. A third important government policy is to invest in research and the provision of technical advice. The Sichuan Academy of Agricultural Sciences (SAAS) is the principal public-sector agricultural research institute in the province and conducts research on sweet potato production and post-harvest utilization. Production research has provided new sweet potato varieties higher in yield and starch content. This has helped to increase supply and reduce the costs of raw materials for sweet potato starch utilization. In post-harvest research, the SAAS-CIP project improved the design of processing machines suitable for small-scale enterprises as well as developed new food products from sweet potato. Specialists from SAAS provided outreach and training services to firms that manufacture processing equipment and to processing firms. In our survey, all of the large processing companies had received technical advice from SAAS, while 31 per cent of the small-scale firms were provided with technical support (Table 11). Given that providing (or obtaining) information entails a large component of fixed cost per firm, larger firms are almost certainly likely to have better access to public and private technical support. This bias is partially offset, however, by the explicit targeting of research to improve machinery scaled to the needs of small processing enterprises.

Table 11. Sources of technical advice about sweet potato processing

	Large enterprises (n=4)	Small enterprises (n=113)
Sichuan Academy of Agricultural Sciences (%)	100	31
Sichuan University (%)	25	0
None (%)	0	69

Source: Authors' survey of sweet potato processing enterprises.

Discussion and conclusions

Economic reforms introduced since 1978 provided China's farmers with incentives to expand commercial production and the utilization of agricultural commodities, including sweet potato. In Sichuan, a marketing chain developed to link sweet potato production, primary starch processing, and final product manufacturing and marketing. Auxiliary industries provide machinery for small-scale processors and utilize starch residues for animal production. Public research organizations developed improved crop varieties and production methods as well as improved designs of starch and noodle processing equipment and new product innovations. Finally, government policies lent support to the establishment of agro-processing enterprises, especially ones like sweet potato processing that have strong linkages to the rural economy.

The development of a sweet potato processing industry in Sichuan contributed to rural economic development and poverty alleviation in a number of ways. First, there are the direct effects of adding value to the sweet potato crop through agro-processing in rural areas. We estimate that sweet potato starch and noodle processing generated 614 million yuan/year in value-added to the Sichuan economy and about 3.5 million work-days in new employment. About 27 per cent of the value-added and about 70 per cent of the employment stemmed from small-scale rural enterprises. The expansion in sweet potato utilization for processing likely raised the average crop price by 12 to 30 per cent over what the price would have been without this source of demand. This increased farm income from sweet potato crop sales in Sichuan by 114 to 246 million yuan/year. Other economic and social benefits were achieved through expansion in local machinery manufacturing, expansion of pig production from starch processing residues, increases in local government tax revenues, and lower environmental impact from starch processing waste due to dispersion amongst small-scale primary processors.

Future prospects for expanding the utilization of sweet potato in Sichuan look promising. The growing consumer demand in China for diverse, processed food products and convenience foods provides ample scope for expanding production of not only existing sweet potato products like instant noodles, but a range of new food products and snack foods. The new policy support for dragonhead enterprises has provided stronger incentives to the private sector to expand agro-industrialization in China, and sweet potato processing has qualified for this policy support because of its strong linkages to the rural economy. Finally, new technologies are becoming available that will further improve farm and processing efficiency. Notably, new, high-starch yielding crop varieties and agronomic practices will raise farm productivity and reduce the unit costs of sweet potato production. This will encourage more crop production and eventually reduce prices of raw materials for processors. Further improvements in processing machinery design, new starch-, flour- and nutritionally-based food products from sweet potato, and other technical innovations are under development. Heightened attention is being given to “green food” labeling (for nutrition and food safety criteria in food products) as well as environmental waste management from starch processing. All of these factors will contribute significantly to the further development of sweet potato agro-processing in Sichuan and help provide new income-generating opportunities for the rural population.

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Towards More Pro-Poor Research and Policies

Robin Bourgeois[*] *and Lisa Svensson*[**]

The fourth day of the workshop was allocated to working group discussions on two issues: key factors that played a role in improving the well-being of the rural poor, and practical implications for the design of pro-poor research and policies. Three groups worked in parallel and reported their results in plenary sessions.

Each session included brainstorming and discussion. Not only were factors discussed but also links and relations between the factors and their hierarchy, importance and causality. Participants were encouraged to use various types of representations such as trees, logical frames, pathways, scenarios and figures. CAPSA provided technical support to working group activities, such as assistance with visualization techniques, IT and reporting.

The following two sections synthesize the results of the working group discussions. This synthesis is based on the comparison and discussion of experiences in 16 countries and can be considered as a meaningful reflection on why secondary crops can contribute to poverty alleviation and how it can be realized through appropriate research and policy actions.

Improving the well-being of the rural poor - key factors

In this session the participants discussed and identified the main reasons (key factors) why the research projects, the policy measures or development actions presented in the various case studies reached the targeted population and positively impacted their well-being.

All groups succeeded in synthesizing, regrouping and depicting the factors they identified into a common frame. The starting point of this synthesis is presented in Figure 1 (adapted from the presentation of Working Group 2). The key factors are displayed in three categories. The "R&D" category corresponds to factors relating to the characteristics of successful research and development actions implemented; the "Policy" category refers to

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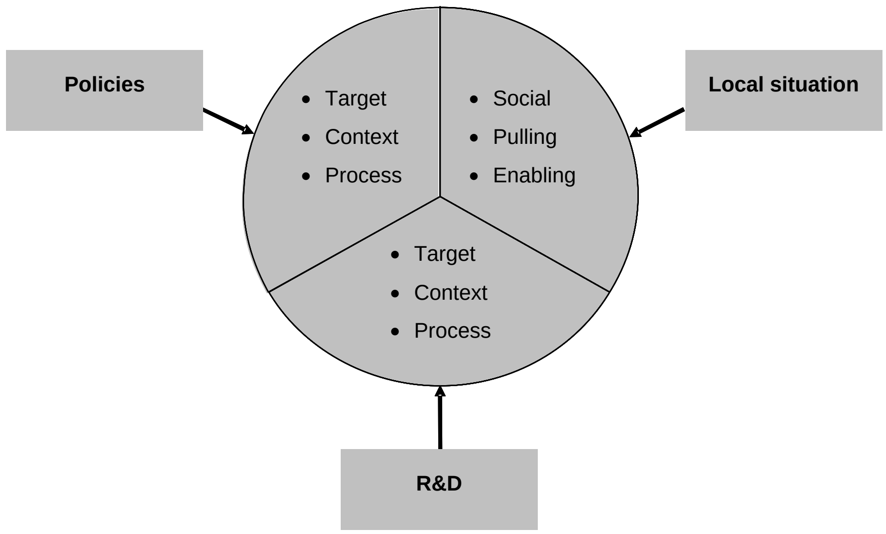
the form of external intervention taken which positively affected the well-being of the appropriate target group. The "Local Situation" represents specific factors linked to local conditions crucial for the success of the activity. Figure 1 displays these three categories and the key factors related to each. Details about the components of R&D, Policies and Local Situation factors, are shown in Figures 2, 3 and 4, respectively. These will be discussed hereafter in conjunction with supporting evidence from the case studies.

Figure 1. A typology of key success factors



Source: Based on group discussions during the conference *Rural Prosperity and Secondary Crops Towards Applied Pro-Poor Research and Policies in Asia and the Pacific,* Bogor, Indonesia, 6-9 December 2005.

Research and Development

Success factors in the case of research and development activities include: location specificity, poverty alleviation oriented and output oriented. In addition, successful cases deal with simple technology and are participatory based.

For many secondary crops, location specificity is not surprising since by definition most of these crops are found in very specific areas (finger millet, Job's tear, yam). However, location specific technologies and research do not only refer to the type of crops or varieties but also to the local social, ecological and climatic environments as evidenced by the success of yam in Papua New Guinea, the development of soybean processing in Thailand or finger millet in Nepal.

Participants defined the concept of simple technology with the following attributes:

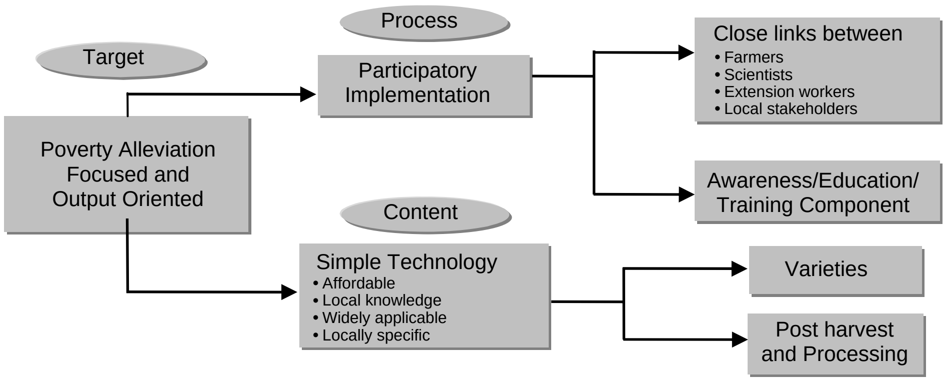
- Affordable: Fuglie, for example, describes small-scale potato storage methods in South Asia that reduce storage losses. Despite demonstrated reduced storage losses; farmers still did not adopt the new method, as the investment costs were too high. In Papua New Guinea, resource poor farmers were able to adopt the new Rotundata yam variety along with new technologies (e.g. rapid multiplication techniques) as a result of PNG's NARI wide and intensive dissemination programme. Farmers were provided free planting material and trained how to multiply the new yam breed.
- Incorporate Indigenous Knowledge: In Nepal, processors have developed a technique to soften bread by mixing finger millet flour with buckwheat flour. Finger millet flour is also used for medicinal purposes.
- Suitable to Local Social Conditions: Yam in Papua New Guinea is one of the major staple foods with high cultural value. Finger millet in Nepal also has significant cultural value. Another example of suitability to social conditions is the processing of soybean by farmers in Sukhothai province in Thailand in their spare time. Local adaptation is also clearly shown in Watananonta, Ngoan and Howeler's paper. The same participatory cassava programme was implemented in Thailand and Viet Nam, but due to local conditions and traditions, cassava producers selected different components of the technology package.
- Widely Applicable: The farmer training programme for new maize varieties and cultivation packages, as well as technology packages that are applicable to many areas in the Philippines, were reported by Josefina Lantican. Fuglie, Xie, Hu, Huang and Wang describe the sweet potato processing machinery development in Sichuan, China. Through support from the local government and the International Potato Centre (CIP), the small-scale sweet potato industry has developed and the machinery has been widely adopted. The authors estimate that approximately 12,000 machines for small-scale enterprises were sold in Santai County alone between 1991 and 2005.

However, these attributes might not be always compatible. For instance, the incorporation of local knowledge or suitability to local conditions may limit the scope of applicability. Actually, such attributes should not be considered concomitant but alternative with affordability a necessary condition. Technology that does not display any of the above-mentioned attributes is unlikely to succeed in improving the well-being of rural poor populations in marginal areas. Among potential technologies, the participants mentioned varieties that target either higher yields under specific conditions, improved nutrient content or reduced use of inputs as well as enhanced post-harvest methods and processing technologies. Rotundata yam in Papua New Guinea increased yam productivity by 117 per cent compared with traditional yam varieties due to disease and pest resistance and higher quality. In addition, the flavour of the new yam variety is preferred and the nutrient content increased by almost 100 per cent compared to PNG's traditional yam. In Nepal, new cultivation technologies increased the production of traditional finger millet varieties substantially and all the value-added products that were tested and marketed have raised farmers' income.

In addition, participants also mentioned two factors related to the implementation process of R&D activities highlighting the participatory nature of successful approaches with two key elements: establishment of close links between farmers, scientists and other stakeholders and an education/awareness or training component. Cases of a participatory approach are mainly found in Part III. In Thailand, China and Viet Nam, a farmer participatory research (FPR) approach was employed to develop suitable soil conservation practices and to test new cassava varieties, fertilization practices and cropping systems. Upon becoming aware of the significance of erosion, farmers adopted simple but effective practices to reduce erosion while at the same time adopting new varieties and additional improved practices. Josefina Lantican also reported on the success of the farmer-scientist training programme for the development of corn production in the Philippines.

Figure 2 is adapted from Group 2 modified with the results from the other groups and shows how the different factors relate together.

Figure 2. Articulation of R&D related factors of success



Source: Based on group discussions during the conference *Rural Prosperity and Secondary Crops Towards Applied Pro-Poor Research and Policies in Asia and the Pacific,* Bogor, Indonesia, 6-9 December 2005.

Policies

Poverty focus is also a key factor of successful pro-poor policies and government intervention. According to the participants, elements contributing to the focus on poverty include the existence of targeted economic objectives, such as improving farmers' terms of trade, as in Sichuan, China, where the development of sweet potato machinery was targeted towards small-scale or household enterprises. Another example comes from Papua New Guinea, where the new Rotundata yam, due to improved attributes, has higher value as a barter good and commands almost twice the price of traditional yam. Creating additional income opportunities emphasizing women is crucial, like in the case of finger millet in Nepal where the workload of women has significantly decreased due to the introduction of small-scale mills and pearling machines. Another example is the provision of capital/credit (easy access; simple procedure) to a specific group in Sri Lanka, where the forward sales contract system enables farmers to take out bank loans to invest in agricultural inputs for maize production. As the farmer is guaranteed to sell a certain quantity of maize at a certain price, the investments carry little risk. What seems to matter here is the combination of a clear objective and a clear identification of the beneficiaries. This was clearly not the case in India with maize and resulted in failure to buoy the economy of the poor. Jahangir Alam blamed Bangladesh's authorities' focus on irrigated rice cultivation and wheat for the failure to exploit potential secondary crops for poor household economies.

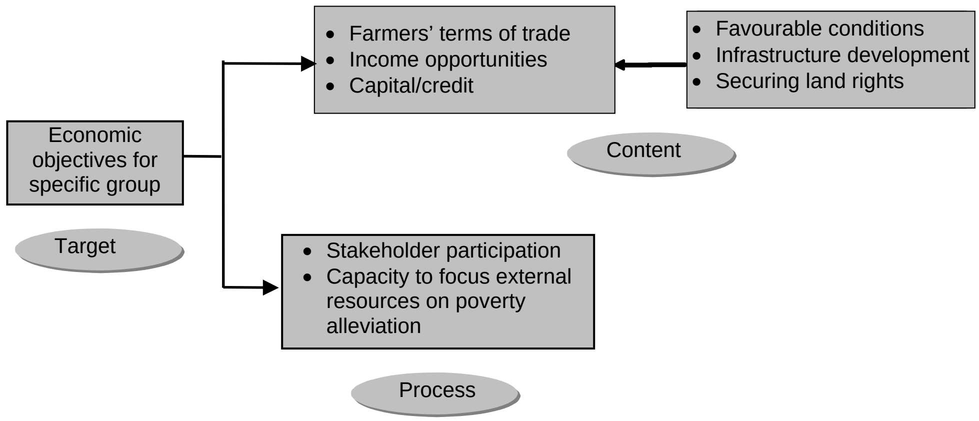
The second set of key factors relate to the general environment such as securing rights over land, which is demonstrated in Douangsavanh's paper concerning Job's tear.

The Lao Theung people in Lao People's Democratic Republic secure access and rights to land by usufruct. This system is honoured by the Lao Theung people, but is, however, not always understood by outsiders. This lack of awareness and sometimes respect for traditional rights has become a source of conflict. Infrastructure (roads, electricity, communications, irrigation) development in marginal areas is another factor that was highlighted by the participants. The importance of access to roads is demonstrated in the paper by The Anh, Trong Binh and Duc Huan, which compares two maize growing areas in Son La province in Viet Nam. Farm households in Co Noi have higher income and use more fertilizer due to its close proximity to the highway. In Papua New Guinea, an interesting situation developed with the new yam variety, where infrastructure clearly affected the pattern of technology adoption. The Rotundata yam was adopted by only a few farmers using a high level of inputs and an exclusive market focus in the more accessible Mampin area, while numerous farmers in the remote area of Inotap adopted the yam for their own consumption, with a lower input level.

The third component highlighted by the participants refers to the implementation process. This includes the capacity to focus external resources on poverty alleviation and the participation of the stakeholders in the design and implementation process. An example of this is found in the cassava programmes of Thailand and Viet Nam, where farmers and research and extension organizations together took all the important decisions regarding the design and methods for implementing the programme. In addition, they mentioned the inclusion of training opportunities for the target group and the importance of relying on people with good knowledge about local conditions for implementing the activities. A good example of this is the Farmer-Scientist Training programme in the Philippines, where scientists trained farmers how to conduct experiments with appropriate technologies to increase maize productivity. Thereafter, the farmer-scientists trained other farmers on the new varieties, cultivation methods and testing procedures.

Figure 3 is a representation of the links between such factors, adapted from the group presentations.

Figure 3. Key factors linked to successful policy intervention



Source: Based on group discussions during the conference *Rural Prosperity and Secondary Crops Towards Applied Pro-Poor Research and Policies in Asia and the Pacific,* Bogor, Indonesia, 6-9 December 2005.

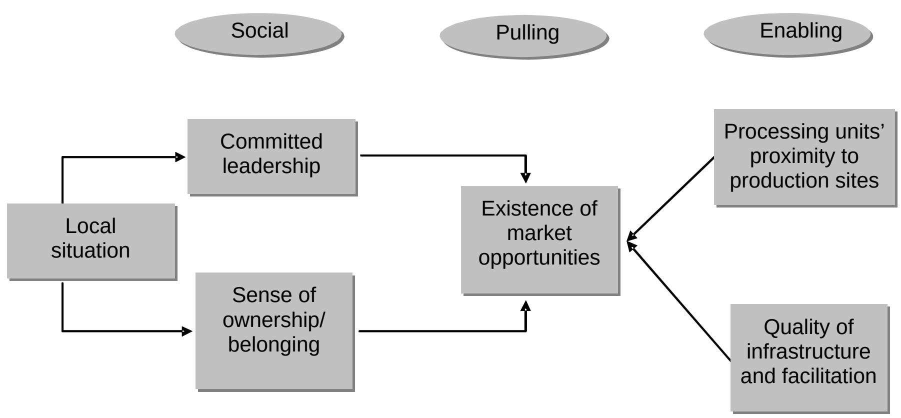
Local situation

Locally specific factors of success were classified into three categories: social factors, pulling factors and enabling factors. Social factors of success include committed leadership as shown in the case of yam in Papua New Guinea, and a sense of ownership/belonging. In Papua New Guinea an individual farmer learned about a new variety or cultivation technique and was thereafter committed to teach other farmers to improve their yam production. A sense of ownership/belonging is particularly visible in Indonesia where failures in the development of local small-scale processing occurred in co-operative units while individually managed processing units endured. A key local pulling factor is the existence of market opportunities as evidenced by Lingkham Douangsavanh in the case of Job's Tear in Lao People's Democratic Republic. Decreased demand from neighbouring countries due to poor quality has negatively affected farmers in Luang Prabang province. Win and Kyi also show that green gram diversification in Myanmar was feasible through the opening exports to private companies, which boosted domestic demand and impacted on the welfare or landless labourers. This can also take the form of contractual arrangements such as the forward sales contracts for maize in Sri Lanka.

Enabling factors identified by participants include the proximity of processing units to the production areas to sustain emerging market opportunities. Fuglie, Xie, Hu, Huang and Wang's paper highlights the expansion of small-scale rural enterprises, counting for about 70 per cent of the employment of processing firms, in the development of sweet potato processing in China. The quality of infrastructure and facilities was also considered on enabling factor. The quality of infrastructure should not, however, be a criterion for eliminating potential pro-poor actions relying on secondary crop development since an intrinsic character of marginal areas where these crops are grown is poor infrastructure. Rather, as indicated earlier, improvement of infrastructure is a factor that goes hand-in-hand with successful cases, such as illustrated in Douangsavanh's paper, which showed the importance of a newly constructed road for agricultural development. The road enables farmers in Thabo village to sell their produce in the city and receive market information as well as access to agriculture extension services.

This social-pulling-enabling trinity of key factors related to local situations is represented in Figure 4.

Figure 4. Key factors linked to the local situation and their interaction



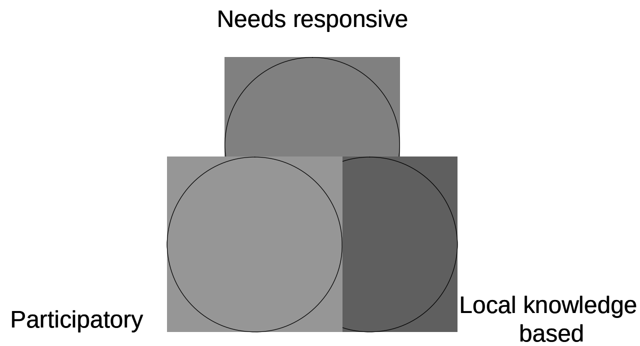
Source: Based on group discussions during the conference *Rural Prosperity and Secondary Crops Towards Applied Pro-Poor Research and Policies in Asia and the Pacific,* Bogor, Indonesia, 6-9 December 2005*.*

Designing pro-poor research and policies - practical implications

In this session the participants discussed how research activities, policies and development programmes can be made more pro-poor. They took into consideration the outputs of the first session (see above), the cases presented during the workshop, and their own experience. The synthesis hereafter highlights practical criteria/indicators that can be used to assess "ex ante" to what extent poverty alleviation is genuinely addressed in research, in policies and in development programmes.

One group proposed the evaluation of the "pro-poorness" of R&D or policies to be performed using a three point framework as indicated in Figure 5.

Figure 5. A three-category frame for pro-poorness evaluation



Source: Based on group discussions during the conference *Rural Prosperity and Secondary Crops Towards Applied Pro-Poor Research and Policies in Asia and the Pacific,* Bogor, Indonesia, 6-9 December 2005.

As 'Needs responsiveness' and 'Local knowledge based' correspond to content issues while 'Participatory' refers to management, we use hereafter an alternative framework proposed by another group, still consistent with the above-mentioned frame, that classifies criteria into two clusters, one dealing with the technical content of the action, and one related to the implementation process. This distinction reflects the output of the first session where this difference was explicitly made in the cases of R&D and Policy and was somehow implicit in the key factors linked with the Local Situation component.

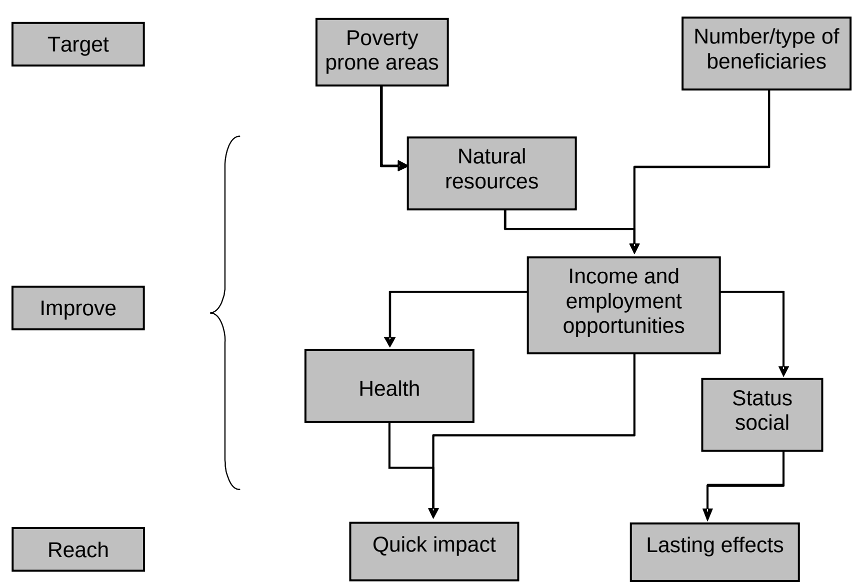
Indicators related to technical content

The case studies presented in the workshop have in common that the actions described had rather quick effects on the target group. A group proposed two sets of criteria with a staggered sequence, which has been further synthesized into a target-improve-reach process as displayed in Figure 6. The first step of setting specific criteria corresponding to geographic areas and socio-economic groups seems to be tautological, but is far from that. Too many allegedly pro-poor measures turn out to be so broad and generic that when implemented they fail to reach the expected geographical and human impact. A clear understanding of who the beneficiaries are and where they are is mandatory.

If genuine pro-poor actions are the key, then these should take place where well identified poor populations are located; this is the sense of the two "Target" indicators presented in Figure 6. In the sequence of assessing how pro-poor a R&D proposal or policy is the use of content related criteria comes second after defining target groups and areas. This is usually by-passed and consequently R&D projects or policies targeting poverty alleviation in agriculture become (physical) output oriented rather than people oriented. Policy design is often concerned with production increases, varieties and technologies. What is said here is that content depends on context and not vice versa. This is the meaning of having a "locally specific" approach to poverty alleviation.

However, the content has to address the needs of the poor and therefore some criteria will be always valid. These relate to four dimensions whose improvement is crucial for poor rural population: health, income and employment, social status and environment. Because the objectives are quick impact and long lasting, long-term investment such as education of the young is not considered. Participants in all groups expressed that criteria should help assess whether the needs of the poor are addressed and their situation likely to improve, the reason why it is called "Improve" in Figure 6.

Figure 6. A set and sequence of criteria for ex-ante pro-poor content assessment

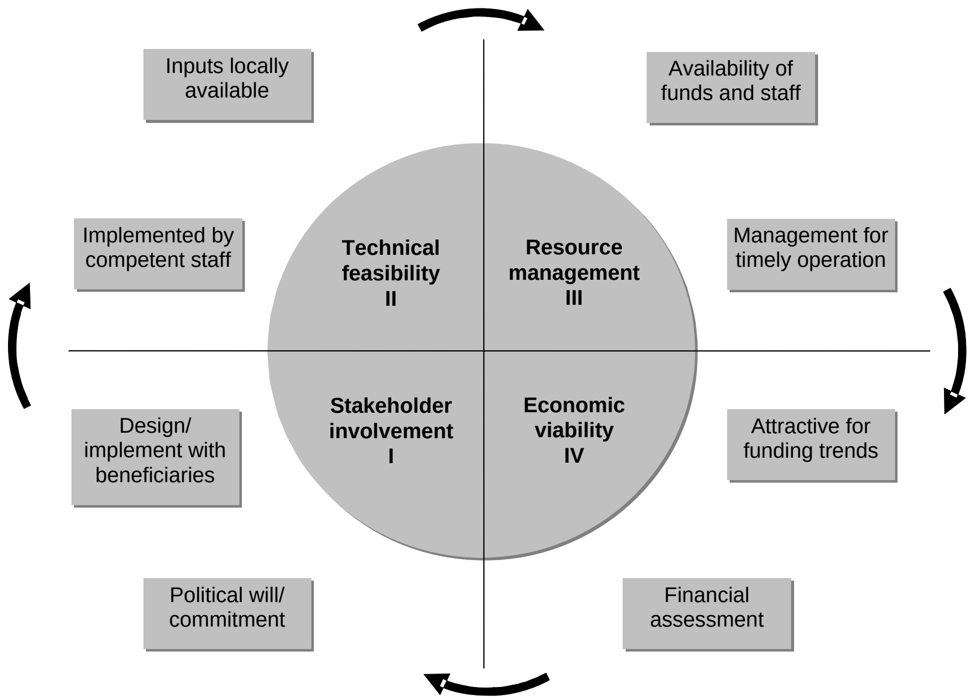


Source: Based on group discussions during the conference *Rural Prosperity and Secondary Crops Towards Applied Pro-Poor Research and Policies in Asia and the Pacific,* Bogor, Indonesia, 6-9 December 2005.

Indicators related to implementation

In the above mentioned staggered process, implementation received the full attention of participants in all working groups. In summary, they highlighted four domains and a certain number of related criteria useful to assess whether the implementation process was consistent with a pro-poor focus. These domains and criteria are presented in Figure 7.

Figure 7. A set and sequence of criteria for ex-ante pro-poor implementation assessment



Source: Based on group discussions during the conference *Rural Prosperity and Secondary Crops Towards Applied Pro-Poor Research and Policies in Asia and the Pacific,* Bogor, Indonesia, 6-9 December 2005.

Stakeholder involvement has been extensively highlighted in the case studies and is reflected here by two criteria: the extent of beneficiary participation in the design and implementation of the activities; and the political will/commitment to carry out the activity. The former was further detailed in one group as follows: distribution of the impact, empowerment of the poor through information and training, and empowerment of socially neglected people.

Technical feasibility refers to whether in the implementation process staff have the necessary competence. This and the existence of locally available resources/inputs would enable the activity to rely much more in its implementation on local capacity.

Resource management criteria include both the availability of funds and time as well as the timeliness of delivery. As most genuine pro-poor research or development actions have to take place in marginal areas with poor infrastructure, particular attention to how and when resources are available is crucial. Transparency and accountability were also highlighted.

Economic viability is the last criteria for assessment. It is given here in two dimensions, one is the classic financial assessment that is performed for any project and the other is the possibility to attract external sources of funding.

Figure 7 synthesizes the vision of the participants related to ex-ante assessment of the design and implementation process of pro-poor R&D or policy intervention. The cases discussed in the workshop and presented in these proceedings show that successful pro-poor research and/or policy intervention is the result of a combination of many factors related to the type of intervention itself, the local situation, the context and that the implementation process matters as much as the process of designing the technical content.

Appendix 1. Programme

Regional Workshop
"Rural Prosperity and Secondary Crops
Towards Applied Pro-Poor Research and Policies
in Asia and the Pacific"
Bogor, Indonesia
6 – 9 December 2005

Tuesday, 6 December 2005

08:00-09:00	Registration of participants	
09:00-10:00	Opening session: • Welcome statement by Dr. Ir. J.W.T. Bottema, Director of UNESCAP-CAPSA • Welcome address by Prof. Dr. Made Oka Adyana Manikmas on behalf of Dr. Ir. Suyamto Hardjosuwirjo, Director of Indonesian Centre for food Crops Research and Development (ICFORD) • Opening address by Dr. Hasanuddin Ibrahim on behalf of H.E. Dr. Anton Apriyantono, Minister of Agriculture, Republic of Indonesia	
10:00-10:15	Break	
10:15-11:15	Presentation of workshop objectives/organization by Robin Bourgeois and Tomohide Sugino	
11:15-12:15	Country case study presentation	
	India:	**Adoption of Maize Technology and its Impact on Livelihood Security of Resource Poor Farmers in India**
	Presented by:	Dr. R.P. Singh, Professor & Head, Division of Agricultural Economics, Indian Agricultural Research Insitute
	Discussant:	Dr. J.P. Mishra, Assistant Director General, ES & M – Economics, Statistics Workshop, ICAR
12:15-13:30	Lunch	
13:30-15:30	Country case study presentation	
	Cambodia:	**The Potential of Non-Rice Upland Crops for Rural Economic Development in Cambodia**
	Presented by:	Chan Phaloeun, Deputy Director, Cambodian Agricultural Research and Development Institute
	Discussant:	Lord Reasmey, Deputy Director General, Ministry of Agriculture, Forestry and Fisheries

	Bangladesh	**Promoting Diverse Agriculture and Agribusiness for Poverty Alleviation: A Study of Selected Secondary Crops in Bangladesh**
	Presented by:	Dr. Jahangir Alam Khan, Member Director, Agricultural Economics & Rural Sociology Div., Bangladesh Agricultural Research Council
	Discussant:	Dr. M. Abdul Quayyum, Chief, Scientific Officer and Head, On-Farm Research Division, Bangladesh Agricultural Research Institute
15:30-15:45	Break	
15:45-16:45	Regional case presentation **Food Security Through Pulses in South Asia: A Neglected Frontier**	
	Presented by:	Mubarik Ali, Agricultural Economist, Manager of Urban Peri-Urban Project for Southeast Asia and Afghanistan, AVRDC, Taiwan
	Discussant:	Prof. Hitoshi Yonekura, Department of Resource and Environmental Economics, Graduate School of Agricultural Science, Tohoku University

Wednesday, 7 December 2005

09:00:10:00	Country case study presentation	
	Lao People's Democratic Republic:	**Job's Tear Production in Luang Prabang Province, Northern Lao People's Democratic Republic: A Case Study in Tha Pho Village, Phonsay District, Luang Prabang Province**
	Presented by:	L. Douangsavanh, M.Sc. Head of Socio-economic Research Unit, National Agriculture and Forestry Research Institute
	Discussant:	-
10:00-10:15	Break	
10:15-12:15	Country case study presentation	
	Nepal:	**Contribution of Finger Millet in Income Generation and Livelihood Improvement in the Hills of Nepal**
	Presented by:	H.K. Shrestha, Nepal Agricultural Research Council
	Discussant:	Dr. M. Joshi, Chief, Training and Scholarship Division, Nepal Agricultural Research Council
	Viet Nam:	**The Rapid Maize Development and Livelihood of the Poor in Northern Mountain of Viet Nam, Case of Son La Province**
	Presented by:	Dr. Dao The Anh, Head of Agrarian System Dept., Vietnam Agricultural Research Institute
	Discussant:	Dr. Thrinh Khac Quang, Vice Director, Scientific and Technology, MARD
12:15-13:30	Lunch	

13:30-15:30	Country case study presentation	
	Sri Lanka:	**Mutual Benefits to Small-Scale Maize Farmers and Processors through Contractual Marketing Arrangements in the Anuradhapura District of Sri Lanka**
	Presented by:	A.R.M. Mahrouf, M.Sc., Deputy Director, Socio-Economics & Planning Centre, Department of Agriculture
	Discussant:	Dr. Chandrasiri Kudagamage, Director General, Department of Agriculture
	***Thailand**:*	**The Value-added Activity for Locally Produces Soybean by the Farm Housewife Group in Sukhothai**
	Presented by:	N. Roonnapai, M.Sc., Agro-Industry Expert, Office of Agricultural Economic
	Discussant:	Dr. Kajonwan Itharattana, Adviser, Office of Agricultural Economic
15:30-15:45	Break	
15:45-17:45	Regional case presentation	
	Farmer Participatory Approaches in the Development of Technologies to Achieve Sustainable Cassava Production in Thailand and Viet Nam	
	Presented by:	Dr. W. Watananonta, Field Crop Senior Expert, Thai Dept. of Agriculture, ex-coordinator of CIAT Farmer Participatory Research Cassava Project in Thailand
	Discussant:	Tomohide Sugino, UNESCAP CAPSA
	Economic and Poverty Impacts of Improved Technologies for Potato and Sweet Potato in Asia	
	Presented by:	Dr. Keith O. Fuglie, Senior Agricultural Economist, CIP Regional Office for Asia
	Discussant:	M. Parulian Hutagaol, UNESCAP-CAPSA
19:00	Dinner hosted by Director of UNESCAP-CAPSA	

Thursday, 8 December 2005

09:00:10:00	Country case study presentation	
	Myanmar:	**Diversification and Commercialization of Agriculture and its Impact on Rural Economy**
	Presented by:	Than Than Win, Staff Officer, Department of Agricultural Planning, Ministry of Agriculture and Irrigation
	Discussant:	Kyaw Ye, General Manager, Myanmar Agriculture Service, Ministry of Agriculture and Irrigation
10:00-10:15	Break	

10:15-12:15	Country case study presentation	
	Papua New Guinea:	**Towards Prosperity through Adoption of an Improved Tuber Crop – A Case Study of *Dioscorea rotundata* Yam in the Markham Valley Area of Papua New Guinea**
	Presented by:	Jessie Anjen, Outreach & Liaison Officer, NARI
	Discussant:	Dr. Raghunath Ghodake, Director General, NARI
	Philippines:	**Impact of the Farmer-Scientists Training Programme for Corn-Based Farmers in Selected Sites in Central Visayas, Philippines**
	Presented by:	Ms. J. M. Lantican, Head, Agriculture and Fisheries Policy Research Unit, Bureau of Agricultural Research
	Discussant:	Dr. Teodoro S. Solsoloy, Scientist 1 & OIC Assistant Director, Bureau of Agricultural Research
12:15-13:30	Lunch	
13:30-15:30	Country case study presentation	
	Indonesia:	**Impacts of Small-Scale Tapioca Processing Unit Development on Employment And Income Generation In Lampung**
	Presented by:	M. Siregar, M.Sc., Researcher, Indonesia Center for Agro-Socio Economic Research Development
	Discussant:	Ir. Sri Widiowati, M.App.Sc, Centre for Post Harvest Research and Development, IAARD
	China	**Development of a Sweet Potato Processing Industry and its Impact in Sichuan, China**
	Presented by:	Dr. Xie Jiang, Sichuan Academy of Agricultural Sciences
	Discussant:	Dr. Zhang Zhaoxin, Director, Division of Industry and Technology, Research Center for Rural Economy, Ministry of Agriculture
15:30-15:45	Break	
15:45-16:45	Regional case presentation **The Benefits that Can be Derived from Underutilized Species: An Under exploited Livelihood Option for Resource Poor People**	
	Presented by:	Paul Bordoni, Scientific Assistant, Global Facilitation Unit for Underutilized Species
	Discussant:	Dr. Made Oka Adyana Manikmas, Head of Programming & Evaluation Div., Indonesian Center for Food Crops Research & Development (ICFORD)
16:45-17:30	Wrap-up and working group preparation	

Friday, 9 December 2005

08:30-10:30	Working group activity **Key Factors for Improving the Well-being of Poor Rural Population** (Three working groups - resource persons Parulian Hutagaol, Tomohide Sugino and Robin Bourgeois)
10:30-10:45	Break
10:45-12:30	Presentation of each working group results Synthesis
12:30-13:45	Lunch
13:45-15:30	Working group activity **Practical Implications/Measures for Designing more Pro-poor Policies** (Three working groups - resource persons Parulian Hutagaol, Tomohide Sugino and Robin Bourgeois)
15:30-15:45	Break
15:45-17:00	Plenary session Presentation of working group results Synthesis
17:00-17:45	Conclusion and closure

Appendix 2. List of Participants

Regional Workshop
"Rural Prosperity and Secondary Crops
Towards Applied Pro-Poor Research and Policies
in Asia and the Pacific"
Bogor, Indonesia
6 – 9 December 2005

		Name/Title/Address
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