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Secondary Crops Based Farming Systems and their Integration with Processing and Marketing in Sri Lanka

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ESCAP

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

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List of Abbreviations

AGRIDIV	: Identification of Pulling Factors for Enhancing the Sustainable Development of Diverse Agriculture in Selected Asian Countries
ASC	: Agricultural Service Centre
CAPSA	: Centre for Alleviation of Poverty through Secondary Crops's Development in Asia and the Pacific
CGPRT Crops	: Coarse Grains, Pulses, Roots and Tuber Crops
DC&S	: Department of Census and Statistics
DOA	: Department of Agriculture
DRC	: Domestic Resource Cost
DS Area	: Divisional Secretariat Area
FCRDI	: Field Crop Research and Development Institute
FO	: Farmer Organization
FSC	: Forward Sales Contract
GDP	: Gross Domestic Product
HARTI	: Hector Kobbekaduwa Agrarian Research and Training Institute
HIES	: Household Income and Expenditure Survey
IPHT	: Institute of Post-harvest Technology
Maha Season	: Wet Season (Major Season)
MPCS	: Multipurpose Co-operative Societies
OFCs	: Other Field Crops
SID	: Simpson's Index of Diversity
TVP	: Textured Vegetable Protein
Yala Season	: Dry Season (Minor Season)

Foreword

Most Asian countries succeeded in multiplying major cereal production through the '*Green Revolution*'. This was made possible by the introduction of high-yielding varieties and policy support which promoted the construction of irrigation facilities and the use of modern inputs such as chemical fertilizers and pesticides. However, recently the growth in productivity of major cereals has reached a plateau. Agricultural diversification has a number of positive effects, among others, food security, risk mitigation, labour absorption and conservation of biodiversity. It is crucial to be aware of the driving forces and constraints to agricultural diversification to formulate policy options which realize the coexistence of sustainable agricultural development and poverty reduction in rural areas.

Responding to this vital need, UNESCAP-CAPSA conducted a three-year research project, 'Identification of Pulling Factors for Enhancing the Sustainable Development of Diverse Agriculture in Selected Asian Countries (AGRIDIV)', from April 2003, in collaboration with eight participating countries, namely Bangladesh, India, Indonesia, Lao People's Democratic Republic, Myanmar, Sri Lanka, Thailand and Viet Nam.

It is my pleasure to publish "**Secondary Crops Based Farming Systems and their Integration with Processing and Marketing in Sri Lanka**" as a result of the second phase of the Sri Lanka country study of the project. This volume presents rural surveys and case studies utilizing primary data to support policy recommendations to realize poverty alleviation through agricultural diversification.

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September, 2006

Taco Bottema
Director
UNESCAP-CAPSA

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Executive Summary

UNESCAP-CAPSA (formerly CGPRT Centre) launched a three-year research project, “Identification of Pulling Factors for Enhancing Sustainable Development of Diverse Agriculture in Selected Asian Countries (AGRIDIV)”, from April 2003, in collaboration with eight participating countries. Sri Lanka, as one of the participating countries, conducted a study in Phase I of the project on ‘Enhancing Sustainable Development of Diverse Agriculture in Sri Lanka’. The benefits of agricultural diversification as well as its driving and constraining forces were identified and tentative policy options towards the development of sustainable diversified agriculture for poverty alleviation were formulated in Phase I of the study. This report presents the findings of the Phase II study, which provides a descriptive and quantitative assessment of the performance of secondary crops-based farming systems and their horizontal integration in relation to private sector processing and institutional arrangements.

The specific objectives of the study are as follows:

- Analysis of constraints and opportunities extended to secondary crop growers through diversifying production;
- Analysis of constraints and opportunities with respect to households and small-scale enterprises to enhance diversification in production and consumption of secondary crop products;
- Investigation into the industrial importance of secondary crops and their products in the market and diversified ways of consumption;
- Quantitative analysis of the impact of diversified agriculture on the rural economy, welfare and environment;
- Analysis of government policies, institutional arrangements and other factors that determine the use of local secondary crops in agricultural processing; and
- Formulation of strategic proposals and measures to mitigate constraining factors to production expansion and industrial absorption of secondary crops at the national and farm levels.

Five priority crops, namely maize (*Zea may L*), finger millet (*Eleusine coracana L. Gaertn*), soybean (*Glycine max*), black gram (*Vigna mungo*) and mung bean (*Vigna radiata*) were selected for detailed study considering their contribution to the economy (import substitution, etc.), food security of rural poor, potential for agro-based industries, farmer income, potential for poverty alleviation, nutritional security and agro-ecological suitability. Anuradhapura district was selected for the field survey, as it is one of the few districts in the dry zone of Sri Lanka where secondary crops are cultivated extensively. Five Divisional Secretariat (DS) areas within the district were identified to collect primary data.

Thirty maize and 36 other secondary crop growers were randomly selected from the list of farmers available at the Agricultural Service Centre (ASC). They were interviewed using a structured questionnaire to collect information regarding their farming systems. Fifteen traders and five cottage level food processors from the same areas were also interviewed using an open questionnaire to collate information about their activities relevant to the marketing and processing of selected secondary crops. In addition, five small-scale poultry feed manufacturers were interviewed to gather data about the operations of the processing industry. Descriptive analysis is applied to determine the socio-economic environment of secondary crop farming systems. Ranking methods was used to prioritize the constraints and opportunities of agricultural diversification. Partial budgeting was used to estimate the costs and returns of secondary crop production.

The household profile of the respondents indicated that about 53 per cent of the maize growers and 41 per cent of other secondary crop growers are less than 45 years of age. All the maize growers and about 89 per cent of the other secondary crop growers were found to be literate. Farming was the main occupation and about 80 per cent of the maize growers and 75 per cent of the other secondary crop growers reported cultivating on their own farms. Of the total families, about 49 per cent were males. Out of the entire household labour force available, 80 per cent was engaged in on-farm employment. Rice and other field crop production were the major contributors to the total income of both farming groups providing about 77 and 75 per cent of the total income of the maize growers and other secondary crop growers respectively. A sizeable percentage of the populations in the study area depend on agriculture for their employment, income and livelihood. Strategies are needed to promote the cultivation of other secondary crops as commercial crops among the youth. The majority of the farmers are literate and appropriate training programmes are

necessary to enhance productivity and therefore farm income, which will attract the youth and women to take-up secondary crop production.

The average holding size of maize growers was about 2.11 hectares, which comprises of 0.84 hectares of lowland, 0.63 hectares of highland and 0.64 hectares of homestead. Average holding size of the other secondary crop farmers was 2.67 hectares, which it is relatively larger than the maize growers and consists of 1.07 hectares of lowland, 0.7 hectares of highland and 0.9 hectares of homestead. Cultivation on these lands does not have the assistance of irrigation facilities and totally depends on rainfall. Inadequate water during the *yala* season affects the expansion of food crop production. The average size of land actually cultivated with these crops during the 2004/05 *maha* season by the respondents was relatively smaller varying between 0.21 hectares and 0.87 hectares. Since the land holdings are small, there is a need to introduce appropriate farming systems as well as production and processing technologies to increase productivity and income.

Analysis of the farming systems revealed that secondary crops are generally cultivated on highland under rainfed conditions during the *maha* season in the form of mono or mixed cropping. These crops are planted during the months of September/October with the onset of rainfall and harvested in January/February. Soybean is planted in late January mainly to produce seed for the *yala* season. The highland is generally left fallow during the *yala* season. Rice-Rice is the predominant cropping pattern in lowland areas. Rice is the main crop cultivated during *maha*. Rice is cultivated during the *yala* season also depending on the availability of water in the irrigation tank. The respondents reported the occurrence of crop losses as well as partial abandonment of rice lands during droughts. Cultivation of secondary cops will be a viable option to overcome the drought situation and reduce the risks, as these crops require less water. The development and introduction of quick maturing, drought tolerant secondary crop varieties will be a better option to overcome such drought weather conditions.

There has been a considerable increase in the productivity of maize during recent years mainly due to the cultivation of hybrid varieties, improved crop establishment methods and the application of fertilizers. Farmers who cultivated hybrid varieties attained an average yield of 4.8 tons per hectare in the study area. The average yields obtained by the non-hybrid farmers were about 3.5 tons per hectare in the same district. The soybean yields achieved have been moderate, amounting to about 1.85 tons per hectare during the *maha* season. Finger millet, black gram and mung bean are generally cultivated on marginal lands

under rainfed conditions. The average yields obtained for these crops have been very low compared to their potential as the majority of the farmers grow traditional varieties. The development and introduction of appropriate crop production technologies are essential to increase productivity and reduce the yield gap under rainfed as well as irrigated farming conditions.

Net returns (including imputed costs for farmer-owned inputs) were also relatively high for soybean (Rs 24,228/ha) followed by maize (Rs 13,447/ha), black gram (Rs 10, 847/ha), mung bean (Rs 10,421/ha) and finger millet (Rs 9,579/ha). Family labour can be employed effectively in the cultivation of maize and other secondary crops, minimizing unemployment in rural areas. A comparison of rice and secondary crops in terms of the profit margin shows that maize and soybean provide a relatively more stable income to farmers than rice, under rainfed conditions.

Maize and other secondary crops require less water for the cultivation process compared to rice, and can be grown successfully under water deficit conditions as well as in major and minor irrigation schemes. Fallow rice lands with well-drained soils could be cultivated with these crops. Out of the total cultivable rice area only about 74 per cent was utilized during *maha* 2003/04 and 37 per cent during *yala* 2003. Some of these lands could be cultivated with maize and other secondary crops during *yala* through an appropriate planned and co-ordinated production programme at the national level. Farmers in the major producing areas could be organized into small groups to cover different *Yaya* (tracts) so that they could benefit from collective action at the village level.

Maize marketing is primarily in the form of green cobs as well as grain. A few organizations are engaged in purchasing dried cobs. The majority of commercial farmers sell their produce to collectors and traders in grain form. The grain purchased by the collectors is resold to wholesale traders and animal feed manufacturers on a commission basis. Some of the animal feed manufacturers purchase the grains directly from farmers. A small percentage of grain is sold at local fairs.

The Forward Sales Contract (FSC) System that was introduced by the central bank in 1999 is gaining popularity. Two processors, namely the KST Evergreen (Pvt.) Ltd. and Plenty Food (Pvt.) Ltd. were the major organizations actively implementing the FSC programme in Anuradhapura district during 2004 and 2005. The purchasing price agreed upon by KST Evergreen (Pvt.) Ltd was Rs 16.50/kg for seed and Rs 13.00/kg for cobs in the 2004/05 *maha* season. The Plenty Food (Pvt.) Ltd, which produces mainly nutritional food

for human consumption, namely *Samaposha*, offered Rs 17.50/kg for high quality maize. Farmers were able to receive higher prices of Rs 16.50/kg to Rs 17.50/kg for their produce through FSC agreements.

An FSC programme is also implemented in the district by Plenty Foods (Pvt.) Ltd. for soybean. About 70 per cent of the finger millet produced by the farmers is used for their own consumption and the balance is sold to collectors and traders. About 80 per cent of the black gram and mung bean produced is sold to collectors and traders while the remainder is used for consumption.

Unavailability of adequate marketing and storage facilities are major constraints to the cultivation of secondary crops. The establishment of these facilities at the village level is important to ensure a better prices and income for the farmers and to develop sustainable diverse agriculture in the country. More private sector investment is vital in the marketing of secondary crops. The forward sales contract system is gaining popularity among the farmers, however, government intervention is necessary to ensure their effective functioning, to avoid any adverse affects on the farmers as well as processors.

Maize and other secondary crops produced in the country are used for both animal feed and human food consumption. Maize is used as a major ingredient in the industrial processing of animal feed and several human foods. Soybean is mainly used in human food industries. Finger millet, black gram and mung bean are processed in cottage level industries for human food.

At present only about 20 per cent of the locally produced maize is used by the feed industry and the rest is imported. The animal feed industry is the major soybean consumer in the country today, however, it utilizes only defatted soybean meal, the total requirement of which is imported. A few private sector companies have recently started producing prawn feed which uses 98 per cent soybean.

The state controlled *Thriposha* (a high nutrient food) project, which provides high nutrient food for pregnant women and children uses maize and soybean. Two private sector medium-scale organizations; namely Plenty Food (Pvt.) Ltd., and Cereal Product (Pvt.) Ltd. are engaged in the production of *Samaposha* and *Ranposha* respectively using maize and soybean as their main ingredient. Apart from these organizations there are a large number of small entrepreneurs who produce various human foods using maize and soybean. Various soy food products have been developed by cottage level and medium scale

entrepreneurs. *Thriposha*, *Samaphosa*, *Ranposha*, *tempe*, soy meat, soy snacks and soy ice cream are some of the major food products manufactured locally.

Finger millet is processed as flour at the cottage level and used in the preparation of traditional Sri Lankan foods. Such cottage industries are prevalent in villages, where finger millet is milled, packetted and sold to external traders who partake in roadside marketing.

In Sri Lanka black gram and mung bean are consumed in large quantities in processed form for various food preparations. These products are processed using traditional methods. At present, only a small percentage of the black gram and mung bean produced is processed as the grain often splits due to a lack of suitable processing machinery. The difficulties in processing these products have impeded the development of the rural cottage industry.

At present, the animal feed industry is controlled entirely by the private sector. The industry's total output is about 415,000 tons per annum. A few large companies dominate the industry and three of them account for 70 per cent of annual production. The remaining production is covered by medium and small-scale manufacturers and self-mixing poultry feed producers. There are only 17 registered feed mills and their production capacity is at 80-90 per cent. In addition, to the registered feed mills, a few thousands small-scale poultry farmers are engaged in poultry feed production through self-mixing. No official data is available about their capacities, etc. In 2000, it was estimated that these millers produced about 80,000 metric tons of poultry feed for their own use and to sell. It is also reported that about 75,000 families are engaged in small-scale poultry production in the country.

The industrial demand for maize and soybean from the compound feed industry is expected to rise with the rapid growth in the poultry industry. According to the estimates, a 1 per cent increase in broiler and egg production would raise demand for maize by 0.5 and 0.35 per cent respectively. The derived demand for maize from the animal feed industry will total 344,920 metric tons in 2010, which represents about a three-fold increase compared to 2001. Many medium and large-scale poultry feed manufacturers (self-mixers) require training and credit facilities to enhance the use of locally produced maize and other raw materials. The quality of locally produced maize needs to be improved to be utilized in animal feed production.

The demand for soybean is also projected to increase both for human food and animal feed as a main protein source. Processed soy based food items are becoming popular among both vegetarian and non-vegetarian consumers. The soy meal requirement

for the animal feed industry is projected to increase up to 146,869 metric tons in 2010 due to growth in the poultry industry.

In recent times, due to an increase in the cost of agricultural inputs, the returns to farmers through the cultivation of finger millet, black gram and mung bean have become marginal. An effective way of overcoming this problem of low income is to initiate small, medium and large-scale agro/food processing enterprises in rural areas of the country. A farmer who processes 500 kilograms of finger millet per month earns about Rs 5,000 additional income. Promoting processing at the cottage level is beneficial towards the alleviation of poverty in rural areas. A farmer who processes about 1 ton of black gram or mung bean would receive an additional Rs 5,000 per month. Processing these crops generates employment opportunities, mainly for women in rural areas. Since most farmers growing these crops are engaged in subsistence farming and belong to the low-income category group, any technology that is introduced should be affordable and manageable by the rural sector. Cottage level processing of finger millet, black gram and mung bean has the potential to generate employment, particularly for women, and provide additional income to farm families. The introduction of appropriate processing equipment, credits and training is essential to develop cottage level industries.

In line with the introduction of open economic policies in 1977, the trade of maize and other secondary crops was liberalized in the late 1990s. The government also intermittently introduced tariff changes to protect domestic production of these crops as well as support the animal feed industry. The production of most secondary crops declined after trade liberalization. But it has ensured the expansion and sustainability of the animal feed industry through a continuous supply of raw materials at affordable prices. Therefore, liberalized trade policies had varied impacts on the production, marketing and trade of secondary crops.

Inadequate availability of water in minor tanks is a major constraint to expand the cultivation of rice and other food crops in Sri Lanka, mainly during *yala* season. The government of Sri Lanka, realizing the importance of improving tank irrigation facilities, has launched special projects for the renovation and rehabilitation of 10,000 minor and medium irrigation systems.

The Field Crop Research and Development Institute (FCRDI) of the Department of Agriculture (DOA) bears the mandate of developing new production technologies relevant to coarse grains and pulses in the country. Appropriate reforms have to be introduced to the

technology development systems towards secondary crop production suitable for rainfed as well as irrigated conditions, with emphasis on the development of hybrid varieties, improved soil fertility and water management practices; tank-based farming systems, post-harvest and processing technologies, product development and appropriate farm mechanization for small and commercial farms. More investment is required for research and development programmes on secondary crops.

The Institute of Post-harvest Technology has developed a number of processing machines to assist the processing of secondary crops by small farmers. Popularization of such machines is important to add value to secondary crops.

Although a sound extension system has been developed for paddy, concrete steps are yet to be taken to strengthen the extension process in respect of secondary crops. This could be achieved through the mobilization of adequate staff and providing them with training on secondary crops. Collective farmer group participatory activities, including women and the youth should be implemented for effective technology transfer, input supply, marketing and processing. Regional specialization of crops should be promoted for sustainable agricultural diversification through the cultivation of secondary crops. A system has to be developed to encourage all stakeholders engaged in the production of seeds to ensure adequate availability of quality stocks to the farmers at the village level.

The findings of the Phase II study indicate that agricultural diversification based on secondary crops has the ability to increase the efficiency of resource use, minimize production, price and income risks, respond to changes in demand and economic development, improve food security and nutritional security, contribute positive environmental impacts, boost employment, raise household income and alleviate poverty of the rural poor.

Future policies for sustainable secondary crop production should use an integrated approach towards (i) enhancing production; (ii) developing the marketing system; and (iii) promoting agro-based industries at the industrial and commercial levels to ensure household food security and nutritional security, generate employment, enhance income, alleviate poverty and improve the living standards of resource poor farmers.

1. Introduction

1.1 Background

Agriculture is the mainstay of the rural economy of Sri Lanka. It employs about 34 per cent of the labour force and contributed 19 per cent of GDP in 2004. The agricultural sector engages a major share of the natural resources of the country and high growth in this sector is crucial to alleviate poverty and ensure food security as well as rejuvenate economic activities in rural areas.

Rice is the staple food of the nation and the country has almost achieved self sufficiency through high investment in irrigation facilities, adoption of high-yielding varieties and improved production technologies. Agricultural diversification through secondary crops has the potential to improve food security, generate employment, offer positive environmental impacts and raise the living standards of rural communities. However, production of these crops[1] is inadequate to meet domestic demand. Furthermore, a decline in the production of most secondary crops has been observed during the last decade.

A study was undertaken in 2003 under the project entitled "Identification of Pulling Factors for Enhancing the Sustainable Development of Diverse Agriculture in Selected Asian Countries" (AGRIDIV), launched by CAPSA, to assess the socio-economic impacts of recent developments in the country, including trade liberalization, on the production of secondary crops, and identify constraints and opportunities towards sustainable development of diverse agriculture towards poverty alleviation. The study is divided into two phases and the major findings of Phase I are summarized in section 1.2.

1.2 Major findings of Phase I

Ten major secondary crops grown in Sri Lanka were studied in detail in relation to agricultural diversification and poverty alleviation. The crops include Coarse grains (maize and finger millet), Pulses (mung bean, black gram, soybean, cowpea and ground nut) and Roots and Tubers (potato, cassava and sweet potato). The Simpson's Diversity Index of 0.67 in 2003 indicated horizontal diversification of food crops. Vertical diversification is observed mainly in maize and soybean, which are used in both animal feed and human

[1] Secondary crops refers to maize, finger millet, mung bean, black gram, soybean, cowpea, groundnut, potato, cassava and sweet potato.

food. The development of agro-based industries would increase the utilization of these crops and create off-farm employment, primarily for the younger generation.

Although, secondary crops are grown in almost all regions, specialization quotient estimates demonstrated regional specialization. Potential exists to enhance the production and processing of secondary crops in these districts. However, appropriate soil and water conservation practices have to be adapted in order to avoid environmental degradation and sustainably develop diverse agriculture.

Analysis of DRC ratio indicates that while rice production is not competitive under rainfed conditions, mung bean and cassava have comparative advantage. It is therefore suggested that some of the marginal rice lands could be cultivated with potential secondary crops to generate additional income to farmers.

Despite the fact that the government has implemented several poverty alleviation programmes in the past, poverty remains a major problem in rural areas. Food and nutritional availability to the rural poor is relatively low compared to urban dwellers due to their low level of household income. The average per capita calorie intake per day by poor households has been estimated at 1,778 calories, which is relatively low compared to the per capita intake of non-poor households, estimated at 2,185 calories. Agricultural diversification based on secondary crops will improve food supply and nutritional availability in rural areas. Off-farm employment created through secondary crops owing to vertical diversification in storage, processing and expansion of input and output markets will raise wage rates and the income of rural populations. This would enhance their capacity to spend on non-food as well as food items and improve their general living standards.

Secondary crops are not consumed as staple foods, but consumed as breakfast foods, special preparations and snacks. The demand for most secondary crops for food consumption depends on availability, changes in consumption patterns and prices. Secondary crops, such as maize, soybean, cassava and sweet potato have shown greater potential for processing and value addition at the cottage level as well as for large-scale industries. It is estimated that derived demand for maize and soy meal in 2010 by the animal feed industry will be 344,920 and 146,869 metric tons respectively. To meet this demand, domestic production to be expanded. Direct investment processing industries are also needed to produce soy meal and cassava starch in-country.

Crops such as potato, soybean and black gram provide relatively higher returns than rice under current yield levels. Since secondary crops require less water compared to rice and can be successfully grown under major and minor irrigation systems such as agro-wells

during the *yala* (dry) season and since uncultivated rice land is available for agricultural diversification and some secondary crops can be inter-cropped with perennial crops, land is not a major limiting factor to the expansion of secondary crops. About 31 per cent and 54 per cent of the total available rice land are not cultivated during the *maha* (wet) and *yala* (dry) seasons respectively and utilizing some of this land with potential secondary crops would provide additional income to resource poor farmers.

As the cultivation of these crops also requires more labour and capital than rice, given the present tariff structure of most secondary crops, the income generated from smallholdings is inadequate to meet the household expenses of the resource poor farmers, which in turn discourages farmers from growing these crops. It is also worth noting that the risks involved in cultivation are also high due to crop damage by unpredictable weather. In addition, these crops require better land preparation and irrigation management that adds to the cost of production. In general, research information available to farmers on new production technologies is limited, which forces farmers to adopt traditional methods resulting in low productivity and poor quality. Furthermore, marketing, storage and processing facilities are not available at the village level, which inhibits the expansion of these crops. It is suggested that innovative policy options are required to enhance agricultural diversification and improve the income of the secondary crop farmers.

The major findings of the Phase I study are summarized in Table 1.1.

Table 1.1 Summary of major findings in Phase 1 study

Benefits of diversification	Driving or constraining forces	Measures and policy options
Increase efficiency of resource use	• Stagnating or declining secondary crop production • Gap between farmer yields and potential yields • Inadequate information on new technology • Uncultivated rice land available for cultivation of secondary crops • Comparative advantage • Regional specialization of crops	• Strengthen research and extension to boost productivity (improved varieties, farming systems, irrigation and drainage systems, pest management and post-harvest practices) • Exploit underutilized land and water resources • Regional crop specialization
Minimize production, price and income risks	• Profitability of secondary crops • Impact of trade liberalization • Low productivity • Poor marketing system • Inadequate processing facilities	• Increase productivity • Reduce marketing costs • Improve marketing facilities • Improve irrigation • Formation of farmer groups • Contract farming • Vertical integration • Promote processing (traditional and modern) • Provide micro credit facilities

Continued …..

Table 1.1 Summary of major findings in Phase 1 study (continued)

Benefits of diversification	Driving or constraining forces	Measures and policy options
Respond changes in demand and economic development	• Moderate growth rate, decline in employment and real wages in the agricultural sector • Rural poverty • Land fragmentation • Structural changes in marketing • Increasing demand for animal feed • Changing consumption patterns	• Promote processing (traditional and modern) • Private sector investment • Establish quality standards • Export promotion
Improve food security and nutritional security	• Population growth and increasing demand for food • Inadequate local production • Policies biased towards rice • Trade liberalization • Rural poverty • Low per-capita availability • Inadequate food diversification • Increasing demand for animal feed.	• Expand cultivation of secondary crops in underutilized land and water resources • Increase productivity • Stable government policies towards diversification • Promote food diversification • Revision of existing tariff policies
Increase employment and household income	• Increasing demand for employment • Declining profits from rice farming • Profitability of secondary crops • Income from marginal rice land • High labour and capital requirement of secondary crops • Resource poor farmers • Smallholding size	• Vertical integration • Promote traditional/modern processing • Improve marketing facilities • Promote commercial farming • Export promotion • Collaborative programmes with regional countries on trade and processing
Positive environmental impact	• Environmental degradation due to improper land and water use • Changes in biodiversity	• Promote soil and water conservation methods • Research and development on appropriate farming systems and crop rotation • Agro-biodiversity conservation

The findings of the study revealed that agricultural diversification based on secondary crops can (i) increase the efficiency of resource use; (ii) minimize production; price and income risks; (iii) respond to changes in demand and economic development; (iv) improve food security and nutritional security; (v) have positive environmental impacts; (vi) increase employment and household income; and (vii) alleviate poverty in rural areas.

The Annual Report of the Central Bank of Sri Lanka in 2003 stated that about 6.6 per cent of the population was identified as poor in terms of the lower poverty line (US$ 1 per day) and about 45 per cent to be below the higher poverty line (US$ 2 per day). According to the Household Income and Expenditure Survey (HIES) of 2001/02 (Department of Census and Statistics) about 24 per cent of households are considered poor based on the

nutritional adequacy approach[2]. The poverty level in rural areas (31.3 per cent) is more than three times that in urban areas (8.6 per cent). Over 70 per cent of the poor live in rural areas and the majority depend on agriculture for employment as well as household income.

In response, the government has agreed to the Millennium Development Goals for Sri Lanka targeting to reduce the proportion of people whose income is less than one US dollar per day to half between 1990-2015. To achieve this, it is necessary to enhance food production in the country as well as improve the poor's accessibility to food, through efficient mobilization and equitable allocation of land and water for food production. Given the benefits of agricultural diversification based on secondary crops as mentioned above, it is believed that such diversification could play a vital role in the process. Nevertheless, as several technological, institutional and policy constraints threaten the expansion and sustainability of agricultural diversification in the country (Table 1.1), proper integration of technologies and infrastructure facilities is required to reap the benefits of agricultural diversification at the national and farm levels.

1.3 Study objectives

The Phase II of the study is focused on descriptive and quantitative assessment of performance of secondary crops-based farming systems and their integration in relation to private sector processing and institutional arrangements. The study will clarify the impact of diversification and policy analysis from a farmer, consumer and industry perspective.

The specific objectives of the study are as follows:

1. To analyse the constraints and opportunities faced by secondary crop growers in diversifying production;
2. To analyse constraints and opportunities faced by households and small-scale establishments in diversifying production and the consumption of secondary crop products;
3. To investigate the industrial importance of secondary crops and their products in the market and diversified ways of consumption;
4. To conduct quantitative analysis of the impact of diversified agriculture on the rural economy, welfare and environment;

[2] Defining poverty in terms of adequacy in energy intake, those households which spend more than 50 per cent of their expenditure on food and average adult equivalent food expenditure is less than Rs 1,338.48 per month are considered as poor households in the HIES Reports-2002.

5. To analyse government policies, institutional arrangements and other factors that determine the use of local secondary crops for agricultural processing; and
6. To formulate strategic policies and measures to eliminate the constraints to secondary crop production expansion and its industrial absorption at the national and farm levels.

1.4 Scope of the study

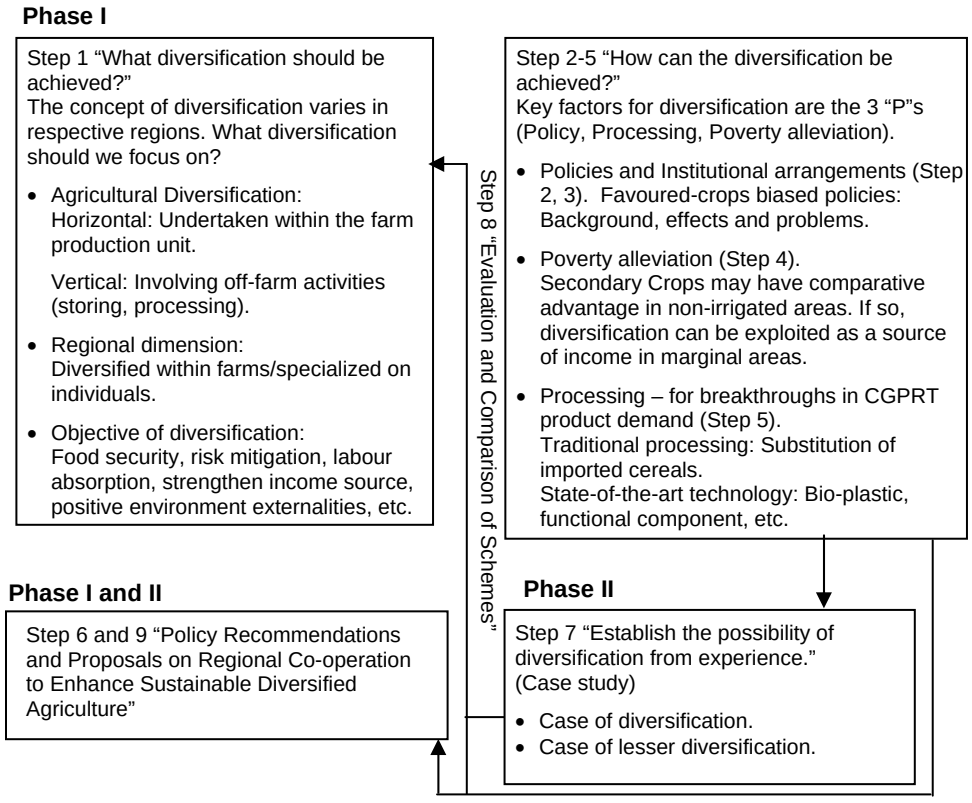
Inefficient resource use along with unfavourable government policies have adversely affected the production and utilization of secondary crops in Sri Lanka. As these crops are almost entirely produced and consumed by resource poor farmers, any decline in production will have a negative impact on their food security and income. Therefore, the study is focused on resource poor farmers, identifying the actual constraints faced by the growers, consumers and processors. The feasibility of policy recommendations proposed in Phase I of the study to formulate policy options to enhance diversification in production and consumption of secondary crops will also be evaluated in this study.

2. Conceptual Framework and Methodology

2.1 General conceptual framework

Phase I of the study covered the descriptive and quantitative analysis of the current status of secondary crop agriculture and the identification of its development constraints. Phase II of the study covers descriptive and quantitative assessment of the performance of secondary crops based farming systems and their horizontal integration in relation to private sector processing and institutional arrangements. This study is carried out in concordance with the "Roadmap to AGRIDIV", developed by UNESCAP-CAPSA Centre, as shown in Figure 1.

Figure 2.1 Roadmap of AGRIDIV



2.2 Research methodology

2.2.1 Selection of crops

Ten major secondary crops grown in Sri Lanka were studied in Phase I to examine the current status of production and identify the development constraints. Five priority crops (maize, finger millet, soybean, black gram and mung bean) were selected for Phase II considering the following criteria:

1. Contribution to the economy (import substitution, etc.);
2. Contribution to food security of rural poor;
3. Potential for agro-based industries;
4. Contribution to farmer income;
5. Potential for poverty alleviation;
6. Nutritional value; and
7. Agro-ecological suitability.

The cultivated area, annual production and average yields of selected secondary crops during 1993-2004 are presented in Annexes 1.1, 1.2, 1.3, 1.4 and 1.5. The export and import statistics of the selected crops are given in Annexes 2.1, 2.2, 2.3 and 2.4.

Maize (Zea may L)

Maize is the most important coarse grain cultivated in the country. It holds very high importance in the national economy. Maize is considered the second most important field crop grown in Sri Lanka next to rice in terms of the extent cultivated, foreign exchange required for imports and the generation of employment and income opportunities. It is also used as a major ingredient in animal feed production. Maize is considered a commercial crop in a major part of the Anuradhapura district, where forward sales contract are in operation. The area planted with maize during 2004 totalled 23,421 hectares with a production at 35.201 tons and average yield of 1.5 tons per hectare (Table 2.1). Total demand is expected to rise further with the growth in population and the poultry industry.

Table 2.1 Extent, production, average yield and imports of selected food cops, 2004

Crop	Extent (ha)	Production (mt)	Average yield (mt/ha)	Imports		
				Quantity (mt)	Value (thousands of Rs)	C.I.F. price (Rs/kg)
Rice	778 549	2 608 489	4.08	221 662	6 185 939	27.91
Maize	23 421	35 201	1.50			
Seed				84	12 137	144.06
Other				148 782	2 506 647	16.85
Finger millet	5 113	4 669	0.91	1 829	25 587	13.99
Soybean (seed)	1 294	1 890	1.46	1 607	47 104	29.31
Black gram	4 740	4 959	1.05	-	-	-
Mung bean	8 607	7 808	0.91	12 672	402 412	31.75

Source: Department of Census and Statistics.
Sri Lanka Customs.

The country imported 148,782 tons of maize to the value of Rs 2,506 million in 2004. In addition, maize products such as corn flour, cornstarch, corn oil, corn flakes and many other corn based products and by-products are imported into the country for different purposes. The CIF price rose from Rs 12.75 per kilogram in 2002 to 16.85 in 2004. About 90 per cent of the crop is rainfed and hence a major portion of grain production fluctuates depending on the prevailing weather conditions. Heavy yield losses are experienced during years of drought.

Finger millet (Eleusine coracana L. Gaertn.)

Finger millet is a popular grain solely utilized for human consumption. It is becoming popular as a health food and consumed in flour form. It is a soothing food for diabetics and a balanced food for the old, children and invalids. The area planted with finger millet has sharply declined over the past two decades due to the mounting uncertainty of shifting cultivation. Lowland areas with supplementary irrigation could be successfully converted to productive finger millet fields during the *yala* season. The area planted with finger millet in 2004 was 5,113 hectares with 4,669 tons of grain produced at an average yield of 0.91 tons per hectare (Table 2.1). In the same year 1,829 tons of finger millet was imported. The processing of this crop has the potential to develop cottage level industries in rural areas.

Soybean (Glycine max)

Soybean is rich in protein and used for human food and animal feed. The area planted to soybean during 2004 was 1,294 hectares, producing 1,890 tons (Table 2.1). Demand is expected to increase further with the growth in population and expansion of the poultry industry. The country imported 1,607 tons of soybean seed and 89,000 tons of soy meal in 2004. Soybean which is drought tolerant and has the ability to fix nitrogen, is ideally

suited to many areas particularly the highlands having no secured irrigation facilities and where soil fertility is depleted.

Black gram (Vigna mungo) and mung bean (Vigna radiata)

Black gram and mung bean are rich in protein and vitamins and consumed in different forms. These crops have the potential to be developed in cottage level industries in rural areas. The area planted with black gram during 2004 was 4,740 hectares, which produced 4,959 tons at an average yield of 1.05 tons per hectare (Table 2.1). The extent and production of mung bean was 8,607 hectares and 7,808 tons respectively in 2004. Both crops could successfully be grown on marginal land under rainfed conditions.

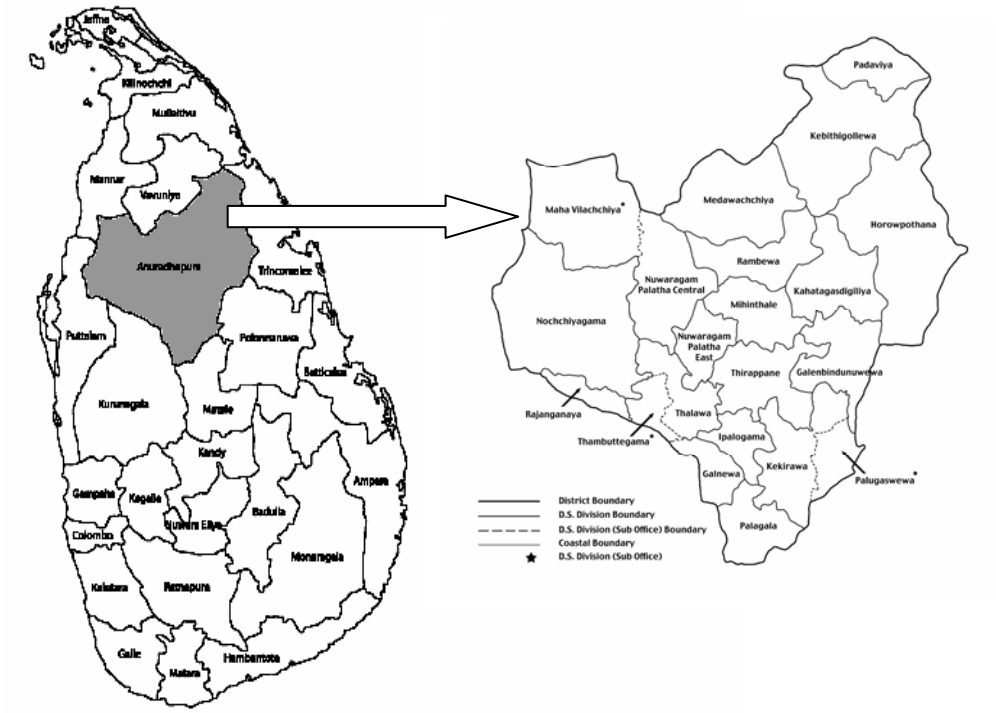
2.2.2 Selection of research site

Anuradhapura district was selected for study, as it is one of the few districts in the dry zone of Sri Lanka where secondary crops are cultivated extensively. Analysis of the specialization quotient confirms that the growing of maize finger millet soybean and black gram are principally concentrated within Anuradhapura district. The soils and weather conditions in the district are favourable for the cultivation of these crops. In addition farmers in selected villages of this district have begun to cultivate maize as a commercial crop. Therefore this district was selected for the study to collect information regarding commercial maize production as well as subsistence farming of other selected secondary crops. Five Divisional Secretariat (DS) areas were selected to conduct the field survey within the district based on the area cultivated with secondary crops. The study location is shown in Figure 2.

2.2.3 Selection of respondents and field survey

Thirty maize and thirty-six other secondary crop growers were randomly selected from the list of farmers available at Agricultural Service Centre (ASC) and interviewed using a structured questionnaire to collect information regarding their farming systems. The number of sample farmers selected from different DS areas are presented in Table 2.2. Fifteen traders and five cottage level food processors from the same area were also interviewed using an open questionnaire to collate information about their activities relevant to the marketing and processing of selected secondary crops. In addition five small-scale poultry feed manufactures were interviewed to gather data on the operation of the processing industry.

Figure 2.2 The map of Sri Lanka highlighting study areas in Anuradhapura district



Source: Department of Census and Statistics.

Table 2.2 The Divisional Secretariat area selected and sample size

DS area	No. of maize growers	No. of other secondary crop growers
Galenbindunuwewa	8	7
Rambewa	6	8
Nuwaragam Palatha Central	6	7
Thirappane	6	6
Maha Villachchiya	4	8
Total	30	36 [a]

Note: [a] The total number includes the following number of growers of different crops: Finger millet – 8, Soybean – 10, Black gram – 10, Mung bean – 8.

2.2.4 Analytical methods

Descriptive analysis is applied to determine the socio-economic environment of secondary crop farming systems. Ranking methods are used to prioritize the constraints and opportunities of agricultural diversification. Partial budgeting was used to estimate the costs and returns of secondary crop production.

3. Profiles of the Study Site, the Respondents and their Households

3.1 Profile of the study site

Anuradhapura district, which is a part of the North Central province, is located in the Dry Zone of Sri Lanka. The district, with an area of 7,179 square kilometres, accounts for 10.9 per cent of the total area of the country**.** The bimodal pattern of rainfall prevalent in the area as shown in Table 3.1. Average annual rainfall in the district varies from 1,000 to 1,800 milimetres.

Table 3.1 Average monthly rainfall and temperature (1994-2003) in Anuradhapura district

Month	Rainfall (mm)	Temperature	
		Maximum ^{o}C	Minimum ^{o}C
January	115.11	29.5	21.18
February	140.29	31.1	21.24
March	28.53	33.85	22.04
April	194.08	33.82	23.73
May	72.3	33.09	25.23
June	25.98	32.26	24.82
July	22.34	32.66	24.62
August	36.65	32.9	24.44
September	107.83	33.16	24.15
October	253.96	31.73	23.25
November	287.18	30.37	22.51
December	165.89	29.53	21.69

Source: Department of Meteorology.

Rainfall distribution determines two major cultivation seasons. The major season *maha,* which is considered to be the most important for farmers, starts with the initial rains in late September and receives approximately 70 per cent of the total annual rainfall. The *yala* (minor) season begins with the rains in March and receives about 30 per cent of the total annual rainfall. Dry spells occur during February and August.

Approximately 60 per cent of the soils are Reddish Brown Earth (RBE) while the remainder are predominantly Low Humic Clay soils. RBE soils contain little organic matter due to their fast decomposition rate resulting from high soil temperatures. They are highly responsive to nitrogenous fertilizers. Soil fertility at the top of the catena is generally depleted because of drainage problems associated with topography.

The total population of the district was 746,466 in 2001, of which 51 per cent were female. The majority of the population is in the age group of 15-49 years. About 92 per cent of the population is literate.

Farming systems vary throughout the district, depending on the soil, availability of irrigation water, rainfall pattern, farmers' knowledge, financial capability and marketing facilities. The extent of selected food crops in this district are presented in Table 3.2.

Table 3.2 Extent of selected food crops in Anuradhapura district (hectare)

Crop	2002/03 *Maha*	2003 *Yala*	2003/04 *Maha*	2004 *Yala*	2004/05 *Maha*
Paddy	64 169	25 641	35 559	2 680	256
Major	27 505	17 643	211 398	2 091	25 307
Minor	31 973	7 998	10 899	589	31 077
Rainfed	4 691	-	3 262	-	3 872
Maize	8 628	285	6 458	67	8 868
Finger millet	808	15	970	6	1 211
Big Onion	3 274	115	1 969	46	2 186
Soybean	111	591	143	42	233
Ground nut	270	77	295	19	348
Green gram	538	141	473	40	428
Cowpea	641	132	633	80	675

Source: Provincial Department of Agriculture.

Paddy is grown in irrigated lowland during both *maha* and *yala* seasons. Common cropping patterns in the lowlands include paddy-paddy, paddy-other field crops (OFCs)[3], paddy-vegetable and paddy-fallow. Their selection depends on the availability of water for irrigation.

A few OFCs, the most popular being coarse grains, pulses, chilli and vegetables, are cultivated in some lowlands during *yala,* particularly when irrigation water from tanks is not quite sufficient for paddy cultivation. The scale of *yala* planting of OFCs in irrigated lowlands is usually small, ranging from 0.1 to 0.25 hectares. They are generally produced under the *bethma* or 'Share System' with irrigation water and land allocation as agreed at the *Kanna Meetings* conducted by irrigation authorities at the beginning of *yala*. Although there are over 2,500 minor irrigation tanks in the district, most of them need rehabilitation to store adequate water for cultivation during *yala*.

[3] In Sri Lanka, Other Field Crops or Subsidiary Food Crops refer mainly to condiments (chilli and onions), coarse grains (maize and finger millet), pulses (mung bean, black gram, soybean and cowpea) and oil crops (ground nut and ginger). Root and tuber crops such as potato, cassava and sweet potato are considered vegetables.

OFCs are cultivated as rainfed crops primarily in the highlands during *maha* and as irrigated crops during *yala*. Common cropping patterns are OFC-OFC, OFC-fallow, paddy-fallow and paddy-OFC. Farmers sometimes grow paddy in the highlands during *maha* depending on the availability of enough standing water or supplementary irrigation during the drier parts of the season.

There are two types of highland in Anuradhapura district, i.e. *chena* highlands and settled highlands or homesteads. Seventy-two per cent of farm families living in Anuradhapura district cultivate *chena* land. *Chena* lands exist on jungle areas, usually some distance away from the farmer's residence. These *chena* lands are used under a system of shifting cultivation. Government restrictions on clearing new jungle areas in the district have reduced the fallow period to almost zero.

Settled highlands or homesteads are identified as those which are occupied by farm families. These lands have been cultivated continuously and are therefore, subjected to erosion and low soil fertility. Soil conservation practices and the use of fertilizer are necessary to obtain good yields.

Livestock, such as cattle, buffalo and poultry are components of the farming system in the area although not as important or have been generalized as crops. They provide organic manure and draught power for farm activities and additional food and income for the family.

The majority of farms in the district are less than 2 hectares in size. About 85 per cent of the holdings are greater than 0.01 hectares. Small-scale farmers are found to be very poor and produce primarily for household consumption. According to Department of Census and Statistics data based on the final results of the census and population and housing - 2001, 17.2 per cent of the population is considered to be poor in Anuradhapura district. Unemployment is relatively low (5.5 per cent) as most are engaged in farming. About 92.4 per cent of the population live in rural areas and depend mainly on agriculture for their food and income.

The national research institute, Field Crop Research and Development Institute (FCRDI) that is mandated with technology generation to achieve policy goals relating to field crops is located in this district at Maha Illuppallama. The technology developed by this institute is disseminated to farmers through the provincial extension system and is aimed at enhancing the production of other field crops in the country.

The national Institute of Post-harvest Technology (IPHT) is also located in this district, which functions as the main institute in Sri Lanka engaged in improving post-harvest

technology of cereals, pulses, oil seeds, other field crops, fruits, vegetables, ornamental plants and spices through research, training, extension and other development activities.

Both the public and private sectors supply inputs and purchase produce. Fertilizer is available at the central stores of the private and state Fertilizer Corporation in Anuradhapura through which stock is distributed to private traders and government outlets. At the village level, farmers purchase fertilizer from Agrarian Service Centers (ASC), Multi-purpose Co-operative Societies (MPCS) and private dealers. Seed materials and other inputs are available at ASCs as well as private dealers.

Credit is available through the two state banks, the Bank of Ceylon and People's Bank, as well as commercial banks, rural banks and Samurdhi Bank. In addition, the Central Bank of Sri Lanka has a branch in Anuradhapura to assist farmers with credit facilities as well as forward sales contracts.

Many parts of the farming area consist only of gravel or earth roads thus making travel extremely difficult during the wet season. Produce has to be transported to the market on foot or by bicycle, bullock cart or tractor. As the nearest marketing outlet is situated at least a couple of miles away from a farmer's residence, transport has become a serious constraint.

MPCS and ASCs function as public buying agencies at the village level, mainly for paddy. Private traders are the main purchasing agents of secondary crops. Some of them provide financial assistance to their regular customers through credits, which are settled with products at harvest time. Plenty Food (Pvt.) Ltd., KST evergreen (Pvt.) Ltd and few other private sector organizations have initiated a forward sales contract system through which farmers are provided inputs to grow maize and soybean and the products are purchased at a fixed price agreed upon at the beginning of the season. A few processors are engaged in cottage level processing of maize, finger millet, black gram and mung bean. Although this district produces large quantities of maize and soybean to be used in animal feed and as human food none of the large-scale poultry farms or animal feed producers are located in this district due to religious reasons.

3.2 Profile of the respondents and their households

3.2.1 The respondents

Age composition data shows that the maize growers are relatively younger than growers of other secondary crops. Age data reveals that about 53 per cent of maize growers and 41 per cent of the other secondary crop growers are below 45 years of age (Table 3.3).

Recent developments in the cultivation of maize as a commercial crop in the area have attracted younger farmers towards the cultivation of this crop. This has resulted in a need to formulate appropriate strategies to cultivate secondary crops as commercial crops to attract yet more youth.

Table 3.3 Age of respondents

Age group (Years)	Maize growers		Other secondary crop growers	
	No.	%	No.	%
26-35	6	20	7	19
36-45	10	33	8	22
46-55	8	27	13	36
Over 55	6	20	8	22
Total	30	100	36	100

Source: Field survey data, 2005.

Table 3.4 reflects the education level of the respondents. All the maize growers and about 89 per cent of the other secondary crop growers were found to be literate.

Table 3.4 Educational level of respondents

Education level	Maize growers		Other secondary crop growers	
	No.	%	No.	%
Illiterate			4	11
Primary level	12	40	17	47
Secondary level	13	43	11	31
Tertiary level	5	17	4	11
Total	30	100	36	100

Source: Field survey data, 2005.

About 40 per cent of maize growers and 47 per cent of other secondary crop growers have received basic education up to primary level. About 43 per cent of maize growers and 31 per cent of other secondary crop growers have received education up to secondary level. Overall, appropriate farmer training programmes for secondary crop production are needed to educate farmers.

The type of employment prevailing in the area is presented in Table 3.5. Farming was the main source of occupation and about 80 per cent of maize growers and 75 per cent of other secondary crop growers reported cultivating on their own farms. In addition, 66 per cent of maize growers and 67 per cent of other secondary crop growers reported working as farm and non-farm waged labour. Non-farm labour work was principally carpenters, masons, drivers and mechanics.

Table 3.5 Major employment sources

Type of employment	Maize growers				Other secondary crop growers			
	Major occupation		Minor occupation		Major occupation		Minor occupation	
	No.	%	No.	%	No.	%	No.	%
Work on own farm	24	80	10	33	27	75	7	19
Farm waged labour			10	33			10	28
Non farm waged labour			10	33			14	39
Salaried work	4	13			5	14		
Self employed	2	7			4	11	5	14
Total	30	100	30	100	36	100	36	100

Source: Field survey data, 2005.

Since a sizable number of the population depend on agriculture for their livelihood, crop diversification with secondary crops is considered a positive solution to improve employment, household income and food security in the study area.

3.2.2 Household profile

Table 3.6 illustrates the distribution of family size in the area. The average family size of maize growers as well as other secondary crop growers was four. None of the respondents reported having more than six members in their family.

Table 3.6 Household size and gender

Household	Maize growers	Other secondary crop growers	All households
Average family size	4	4	4
Percentage of males	49.2	48.8	49.0
Percentage of females	50.8	51.2	51.0

Source: Field survey data, 2005.

Of the total, about 49 per cent were male. A higher percentage of females indicates the necessity to formulate appropriate strategies to provide more opportunities to females in future agricultural development programmes. Development of the processing sector would provide more opportunities to the female population.

Of the entire household labour force available, 80 per cent is engaged in farm employment (Table 3.7). Eighteen per cent of the labour force is employed in non-farm work and 2 per cent was found to be unemployed as disabled. Farming is the main source of employment in the study area and the production of secondary crops has the potential to boost employment opportunities though processing and added value.

Table 3.7 Availability of labour force

	No. in maize growing households (n=30)	No. in other secondary crops growing households (n=36)	Total no. in all households (n=66)
Farm employment	68 (81%)	76 (78%)	144 (80%)
Non-farm employment	14 (17%)	19 (20%)	33 (18%)
Unemployed	2 (2%)	2 (2%)	4 (2%)
Total	84	97	181

Source: Field survey data, 2005.

The average annual household income of respondents, the sources of income and its distribution are presented in Table 3.8. The main sources of income were paddy, highland crops, regular jobs, labour and self-employment.

Table 3.8 Average annual household income (Rs per household) of respondents

Source of income	Maize growers (n=30) Average annual		Other secondary crop growers (n=36) Average annual	
	Income	%	Income	%
Paddy farming	37 772	29.0	41 952	32.9
Other field crops (including secondary crops)	62 404	48.0	54 321	42.5
Other agricultural activities	1 330	1.0	8 472	6.6
Monthly paid regular jobs	18 933	14.5	16 039	12.6
Wage labour	5 900	4.5	4 417	3.5
Self employed	2 290	1.7	489	0.4
Other income	1 644	1.3	1 893	1.5
Total annual income	130 273	100	127 583	100
Average monthly income	10 856		10 632	

Source: Field survey data, 2005.

The average annual household income of maize farmers was around Rs 130,273 while it was Rs 127,583 for other secondary crop growers. Average annual income from the cultivation of other field crops (including secondary crops) was relatively high for maize growers (Rs 62,404) compared to other secondary crop growers (Rs 54,321). But considering the overall situation, paddy and other field crops were the major contributors to total income of both farming groups providing about 77 and 75 per cent of total income of the maize growers and other secondary crop growers respectively. Since farming is the main source of food and income for the villagers, there is a need to expand production and income generated through this sector, particularly secondary crops, in order to improve food security and alleviate poverty in rural areas.

Average holding size for maize growers is about 2.11 hectares, which comprises of 0.84 hectares of lowland, 0.63 hectares of highland and 0.64 hectares of homestead.

Average holding size of farmers growing other secondary crops is 2.67 hectares, relatively larger than maize growers, and consist of 1.07 hectares of lowland, 0.7 hectares of highland and 0.9 hectares of homestead. This implies that farmers growing secondary crops in the study area own larger parcels of highland and homestead compared to most other districts in the country (Table 3.9). However, the cultivation of these lands is without irrigation facilities and totally depends on rainfall.

The smallholding size of lowland available for paddy cultivation is inadequate to meet the total routine household expenditure of the family. Small-scale farmers are found to be very poor and they farm primarily for household consumption. According to the Department of Census and Statistics, about 17.2 per cent of the population was considered poor in Anuradhapura district in 2001, based on the nutritional adequacy approach.

While low-lying land is relatively fertile, the highlands and homesteads are marginal lands with low productivity where cultivation of secondary crops is undertaken. Secondary crops have the potential to reduce poverty through improvements in farm income from production in highland areas and the homestead.

Table 3.9 Average land holding size (hectare) and land ownership of respondents

Ownership	Maize growers						Other crop growers					
	Lowland		Highland		Homestead		Lowland		Highland		Homestead	
	Extent	%	Extent	%	Extent	%	Extent	%	Extent	%	Extent	%
Own	17	67.7	8.3	43.6	8.9	46.3	28.5	73.4	11.5	45.8	15.3	47.3
Leased			1.0	5.4			3.8	9.9				
Tenure/*Ande* [a]	5.7	22.6					4.8	12.5				
Encroached/ permit	2.4	9.7	9.7	51.1	10.3	53.7	1.6	4.2	13.6	54.2	17.0	52.7
Total	25.1	100	19.0	100	19.2	100	38.7	100	25.1	100	32.3	100
Average holding size (ha)	0.84		0.63		0.64		1.07		0.7		0.9	

Source: Field survey data, 2005.
Note: [a] *Ande* = tenure system where share of the produce is given to the land owner.

The majority of farmers reported sole ownership of land. About 68 per cent of the lowland, 43 per cent of upland areas and 46 per cent of homesteads were owned by maize growers (Table 3.9). Similarly, about 73 per cent of the lowland, 45 per cent of upland areas and 47 per cent of homesteads were owned by other secondary crop growers. Over 50 per cent of the highlands and homesteads of both categories of growers were either land encroachment or owned through government permits. Productivity of these lands could be increased through soil fertility improvement programmes and providing legal rights to owners.

3.3 Concluding summary

The agro-ecological conditions of Anuradhapura district are favourable for the cultivation of a wider range of food crops such as paddy, secondary crops and vegetables. However, inadequate water during the *yala* season affects the expansion of food crop production in the area. Rehabilitation of minor irrigation tanks would be an appropriate strategy to enhance the production of food crops during *yala*, particularly secondary crops. This would undoubtedly be the most suitable approach adaptable to improve food security and farm income of rural poor farmers.

A sizeable percentage of the populations in the study area depend on agriculture for their employment, income and livelihood. Since the land holdings are small, there is a need to introduce appropriate farming systems as well as production and processing technologies to boost productivity and income from these small land holdings. Selected secondary crops have the potential to achieve these objectives. Maize, which is expanding as a commercial crop in the study area is grown mainly by the younger generation. Strategies are needed to promote the cultivation of other secondary crops as commercial crops among the youth. The majority of farmers are literate and appropriate training programmes are necessary to enhance productivity, farm income and to attract the youth and women to take-up secondary crop production and processing.

4. Analysis of Secondary Crop Farming Systems

4.1 Average size of farm operation

Secondary crops are generally cultivated in the highlands during the *maha* season. The average size of farm producing these crops during the 2004/05 *maha* season were relatively small, varying between 0.21 hectares and 0.87 hectares as shown in Table 4.1. The average cultivated areas of maize and black gram were relatively larger than finger millet, soybean and mung bean. Since cultivation totally depends on rainfall, the size of the cultivated area varies according to the distribution of rainfall. There was a considerable increase in the cultivated area during the 2004/05 *maha* season because of better rainfall.

Upland area available for cultivation is small and competition exists among the various crops. Hence, farmers cultivate only a portion of their highlands with maize and other secondary crops. As the cultivated area is small, organizing the farmers into groups would enable them to effectively transfer new technologies and organize input supply, marketing and processing.

Table 4.1 Average farm size during the 2004/05 *maha* season

Crop	Average cultivated area per farm (hectares)
Maize	0.87
Finger millet	0.21
Soybean	0.43
Black gram	0.70
Mung bean	0.30
Paddy	0.69

Source: Field survey data, 2005.

4.2 Cropping pattern

Maize and other secondary crops are generally cultivated in upland areas under rainfed conditions during the *maha* season in the form of mono or mixed cropping. These crops are planted during the months of September/October with the onset of rainfall and harvested in January/February. Soybean is planted in late January mainly to produce seed for the *yala* season. Upland areas are generally left fallow during the *yala* season. Crops such as maize and finger millet were grown under slash-and-burn systems (*Chena*) in the past. At present, the government does not permit such a system in order to protect the

forest and the environment. This is one of the factors that has contributed to the decline in cultivation of these crops.

Rice-rice is the predominant cropping pattern in low-lying areas. Rice is the main crop cultivated during the *maha* season. Rice is cultivated during the *yala* season as well, depending on the availability of water in the irrigation tank. Soybean is cultivated in the Huruluwawa major tank area during the *yala* season which is in May. At times when the water is inadequate for rice, farmers cultivate other crops such as chilli and vegetables. Any water remaining in the reservoirs at the end of *maha* is utilized to cultivate these crops during *yala*. The crops are cultivated on the well-drained rice soils or *akkarawelas* using minor tanks. When the availability water is inadequate to cultivate the entire area a *bethma* system is adopted. A portion of land is divided equally among all the farmers under this system.

The respondents reported a decline in extent cultivated and the occurrence of crop losses as well as partial abandonment of rice and other food crop fields during droughts. The cultivation of secondary crops is a viable option to overcome drought, as such crops require less water. The development and introduction of quick maturing, drought tolerant secondary crop varieties will provide a better option to overcome droughts.

On average, about 90 per cent of the total low-land area is cultivated with rice during the *maha* season and only about 33 per cent is cultivated during *yala*. Some of the uncultivated paddy land with well-drained soils could be utilized for the cultivation of maize and other secondary crops during *yala*. This would enhance the production of these crops and ensure a continuous supply of raw materials to the processing industry.

4.3 Farm productivity

There has been a considerable increase in the productivity of maize during recent years, primarily due to the cultivation of hybrid varieties, improved crop establishment methods and the application of fertilizers. The average yield of sample farmers was 4.2 tons per hectare during *maha* 2004/05 (Table 4.2). Farmers who cultivate hybrid varieties adopted raw planting and applied fertilizers and, as result, realized an average yield of 4.8 tons per hectare. The average yields obtained by the non-hybrid farmers were about 3.5 tons per hectare in the same district.

Favourable weather conditions, planting of hybrid varieties and the use of fertilizers contributed to high average yields in the study area. While crop failure was often reported with the cultivation of rice in upland fields due to drought, farmers obtained a better harvest

and income from maize cultivation. This indicates that agricultural diversification with crops such as maize reduces farming risks.

Table 4.2 Average yields of CGPRT crops in the study area during *maha,* 2004/05

Crop	Extent (ha)	Total production (kg)	Average yield (kg/ha)	Potential yield [a] (kg/ha)
Maize	26.3	111 196	4 228	5.0
Finger millet	1.52	1 889	1 243	3.5
Soy bean	4.25	7 874	1 853	3.0
Black gram	7.28	8 931	1 226	2.0
Mung bean	3.04	3 028	996	2.0

Source: Field survey data, 2005.
Note: [a] Research data from FCRDI.

About 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*; some of the high-yielding varieties recommended by the Department of Agriculture (Table 4.3). The importation and supply of hybrid seeds are handled by the private sector. In 2004, about 82 tons of hybrid maize seed was imported into the country. All the farmers who grow maize under forward sales contract agreements use the hybrid variety. They are provided with credit facilities to purchase and apply the recommended rates of fertilizers. As a result, the average yields of these commercial type farmers are much higher than other traditional farmers who have not adopted such practices.

Table 4.3 Crop varieties cultivated by the respondents during *maha*, 2004/05

Crop	Variety	Percentage of respondents cultivating
Maize	*Pacific*	85
	Ruwan	12
	Badra	1
	Local/Unknown	2
Finger millet	*Rawana*	2
	Local/Unknown	90
	Ravi	8
Soybean	PB1	100
Black gram	MI 1	64
	Local/Unknown	36
Green gram	MI 5	82
	Local /Unknown	7
	Imported	3

Source: Field survey data, 2005.

The soybean yields obtained by the respondents have been moderate, amounting to about 1.85 tons per hectare during the 2004/05 *maha* season. The farmers grew soybean under a forward sales contract system through which they are provided with PB 1 seeds as well as the necessary fertilizers.

Finger millet, black gram and mung bean are generally cultivated on marginal lands under rainfed conditions. The average yields obtained in respect to these crops have been very low compared to potential yields as the majority of the farmers grow traditional varieties, utilize poor quality seeds and poor crop management practices. The majority of farmers plant seeds of unknown varieties obtained from shops (Table 4.3). Less than 40 per cent of them have use any type of fertilizers in the cultivation of these crops.

The use of improved varieties and fertilizers has contributed towards increasing the yields of maize and soybean compared to other secondary crops for which these inputs were not applied. There exists a wide gap between potential yields and the actual yields obtained by the farmers. Improved irrigation facilities, the introduction of hybrids and appropriate crop production technologies would definitely enhance the productivity of maize and other secondary crops. The development and introduction of appropriate crop production technologies are essential to raise productivity and reduce the yield gap under rainfed as well as irrigated farming conditions.

4.4 Cost-revenue structure, farm profitability and labour use

The average cost of cultivation as well as the returns from maize, finger millet, soybean, black gram and mung bean reported by the respondents under rainfed conditions during the 2004/05 *maha* season are summarized in Table 4.4 with supportive data presented in Annexes 4.1, 4.2, 4.3, 4.4 and 4.5. The costs of production (including imputed costs of farmer owned inputs) was relatively higher than soybean (Rs 48,994/ha) followed by maize (Rs 47,120/ha), mung bean (Rs 34,579/ha), black gram (Rs 34,390/ha) and finger millet (Rs 28,753/ha). The cost of production for irrigated rice was much higher (Rs 53 294/ha) than the secondary crops.

Net returns (including imputed costs of farmer owned inputs) were also relatively higher for soybean (Rs 24,228/ha) followed by maize (Rs 13,447/ha), black gram (Rs 10,847/ha), mung bean (Rs 10,421/ha) and finger millet (Rs 9 579/ha).

Table 4.4 Costs and returns of maize and other secondary crops, *maha,* 2004/05

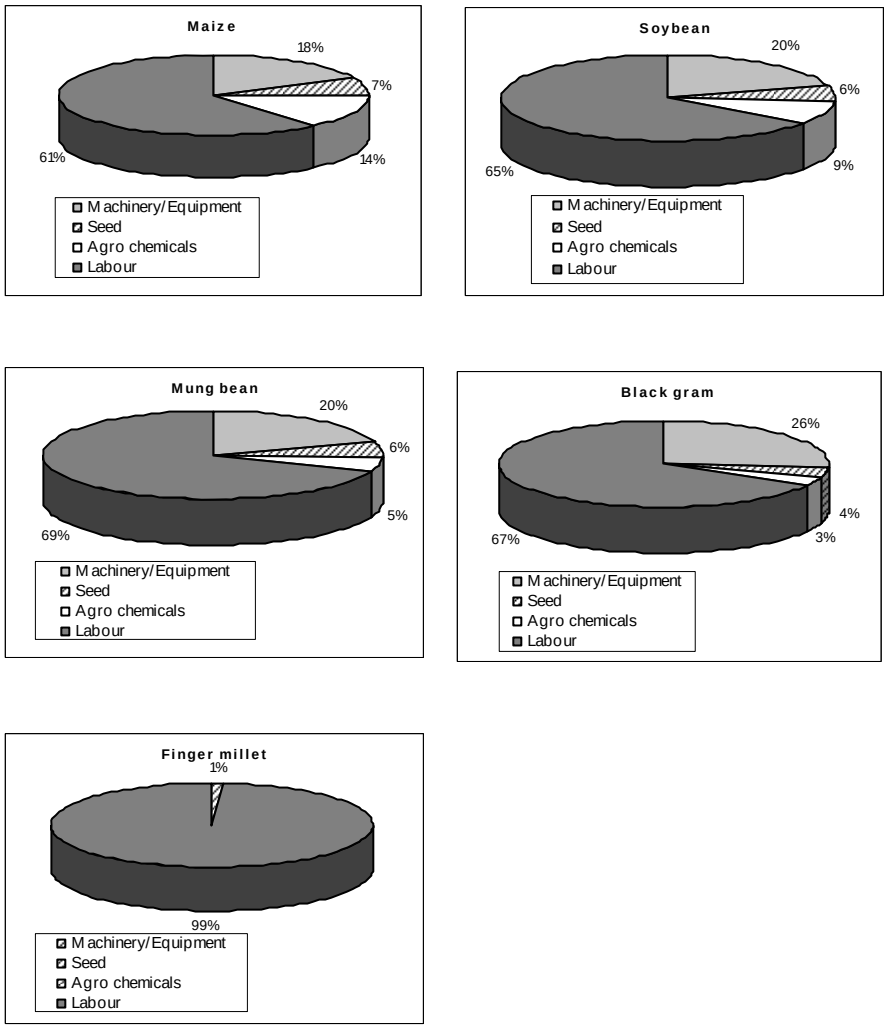
Crop	Cost of production (Rs/ha)		Net returns (Rs/ha))		Until cost of production
	Including imputed cost	Excluding imputed cost	Including imputed cost	Excluding imputed cost	Including imputed cost (Rs/kg)
Maize	47 120	22 435	13 447	52 419	11.15
Finger Millet	28 753	930	9 579	26 927	23.14
Soybean	48 994	25 843	24 228	47 379	26.44
Black gram	34 390	23 856	10 847	21 381	28.06
Mung bean	34 579	11 475	10 421	33 526	34.72
Rice(irrigated) [a]	53 294	34 041	29 617	48 856	9.55

Source: Field survey data, 2005.
Note: [a] Socio-economics and Planning Centre, Department of Agriculture.

The cost of production of soybean is also high owing to the planting of improved seed varieties and applying recommended levels of fertilizers. The cost of maize production is relatively high primarily due to the use of hybrid seeds and fertilizers, which are costly. The cost of labour, machinery for land preparation, agrochemicals and seeds for maize production are shown in Figure 3. About 82 per cent of the labour used is family labour. The cost of producing mung bean, black gram and finger millet is low due to the use of poor quality seeds and low application rates of fertilizers.

Net returns including imputed costs of labour are also higher for soybean and maize because of high yields and better prices during the season. Net returns including imputed costs of labour are low for other crops due to low yields and low prices. However, the net returns, excluding imputed costs of labour, are reasonable as the family cost is considered as a component of the cost of production. Farmers are able to sustain production of these crops mainly through the use of family labour. Boosting productivity and promoting crop processing at the cottage level is essential to raise the income from these crops and to alleviate poverty in the rural areas.

Figure 4.1 Major cost components of cultivation



Source: Field survey data, 2005.

4.5 Potentials and constraints to farm production

Current production levels of maize and other secondary crops are insufficient to meet the domestic demand for human food and from the animal feed industry. The domestic demand for maize and other secondary crops is expected to increase further with the rise in population and growth in the poultry industry. The Government of Sri Lanka, realizing the

need to bolster maize production and other secondary crops in the country, has prepared a five-year work plan for the production of these crops. The main emphasis is to focus on expanding the extent and boosting the productivity of these crops.

Maize and other secondary crops require less water compared to rice, and can be grown successfully under water deficit rainfed conditions as well as in major and minor irrigation schemes. Uncultivated rice lands with well-drained soils could be cultivated with these crops. The total cultivable rice area only about 74 per cent was used during *maha* 2003/04 and 37 per cent during *yala* 2003 (Table 4.5). Some of these lands could be cultivated with maize and other secondary crops during *yala* through an appropriate planned and a co-ordinated production programme at the national level.

Table 4.5 Gross asweddumized extent of paddy land and extent sown in 2003/04

Irrigation type	Asweddumized paddy land (ha)	*Maha* 2003/04		*Yala* 2004	
		Extent (ha)	Extent sown as % of total	Extent (ha)	Extent sown as % of total
Major scheme	329 798	269 129	82%	169 459	51%
Minor scheme	171 994	102 546	60%	39 007	23%
Rainfed	200 081	148 987	74%	49 421	25%
Total	701 873	520 662	74%	257 887	37%

Source: Department of Census and Statistics.

A wide gap exists between the yields obtained by farmers and the potential yields as indicated in Table 3.6. This yield gap indicates that there is greater scope to increase the productivity of these crops through the introduction of improved crop production technologies. This would make the products competitive on the world market.

In the cultivation of maize and other secondary crops, family labour could be employed effectively, which would minimize unemployment in rural areas. A comparison of rice and secondary crops in terms of profit margins shows that maize and soybean provide more income to farmers than rice under present yield levels.

Although there is the potential to expand the extent and boost production of these crops, it is constrained by various factors at the farm level. Some of the problems expressed by the respondents are presented in Table 4.6.

Table 4.6 Production constraints expressed by the respondents to the cultivation of maize and other secondary crops

Constraint	Ranking of the constraint by respondents		
	Maize	Soybean	Other secondary crops
Risk of yield losses under rainfed water stress conditions	1	1	2
Inadequate availability of seeds of new varieties			1
High cost of quality seeds (hybrids)	2	3	8
Seed damage by rats	8		
Inadequate availability of information on new technology at village level	4		4
High cost of production (fertilizer, machinery, labour)		4	
Damage by pests and disease	11	2	5
Damage by wild animals	3	5	7
Lack of capital and credit facilities			9
Limited availability of fertile highland	10		
Low yield and inadequate income from small holdings	6		3
Low quality of produce			10
Unavailability of threshing floor material	9		12
Low price due to inadequate marketing facilities at village level	5		6
Lack of field storage facilities	7		
Labour shortage during harvesting period			11

Source: Field survey data, 2005.

Maize and other secondary crops are grown mostly under rainfed conditions and therefore the risks and uncertainties involved in obtaining high yields and profits are comparatively higher. Development of drought tolerant varieties is important to overcome such a situation. Therefore, the development and dissemination of appropriate technology packages adaptable under rainfed as well as irrigated conditions are vital to increase the extent and improve the productivity of these crops.

4.6 Concluding summary

The use of hybrid varieties and application of fertilizers have enhanced the productivity and income from maize as a commercial crop in the study area. Similar trends are observed in the production of soybean. The productivity of other secondary crops could also be increased through promoting the cultivation of improved varieties and management practices which take into account soil nutrition. Some of the uncultivated rice land with well drained soil could be cultivated using these crops during *yala* by adopting appropriate water management practices.

Farmers in the major producing areas could be organized into small groups to cover different *Yaya* (tracts) so that they would benefit from collective action at the village level.

Management of irrigation systems, supply of inputs, marketing, processing activities and training programmes could be systematically organized through such farmer organizations.

Research and development programmes should also be focused and pay attention to technology packages that would bridge the yield gap and reduce the cost of production, hence raising the profitability of crops grown on smallholdings under rainfed as well as irrigated farming conditions.

5. Analysis of the Marketing System of Secondary Crops

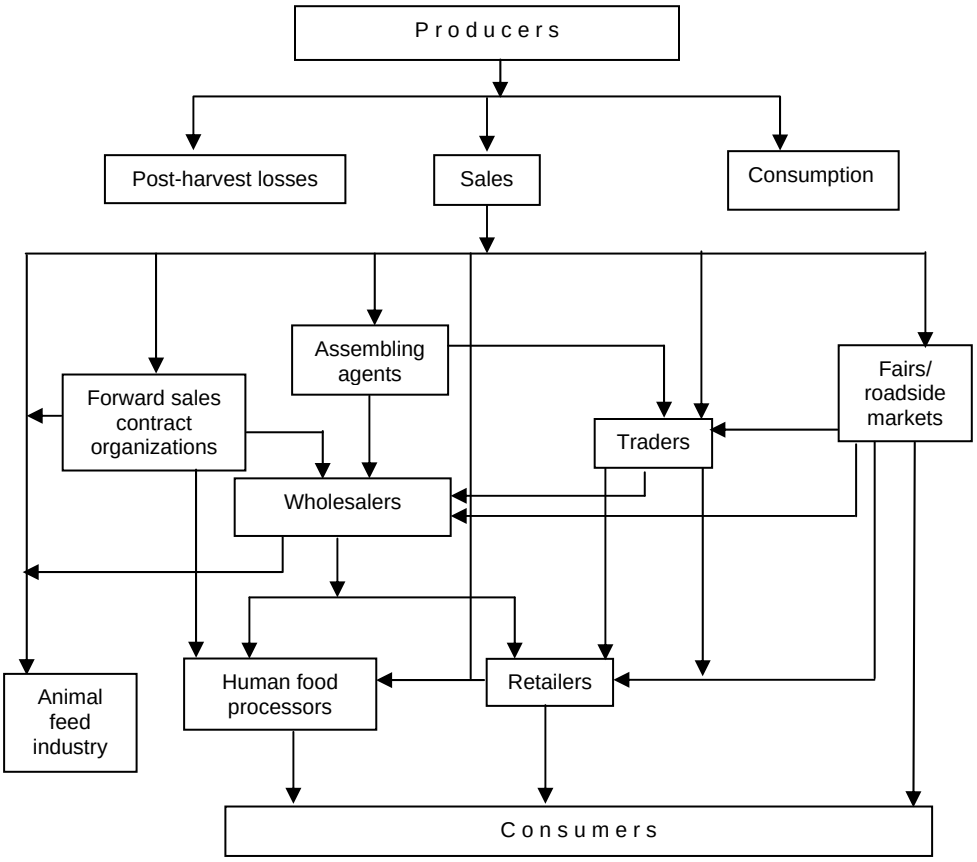
5.1 The products and the marketing channels

The marketing of maize take place mainly in the form of green cobs and grain. A few organizations are engaged in purchasing dried cobs. The consumption of maize in terms of green cobs is popular in all parts of Sri Lanka. The dried cobs and grains are utilized mainly for animal feed and human food. About 90 per cent of the produce is sold in the form of dried cobs and grain and the balance is sold as green cobs in the study area. This is different from other maize producing areas where about 20-30 per cent of the produce is sold as green cobs. The cultivation of maize has emerged to become a commercial venture in the study area and farmers prefer to store and sell their produce in dried form in order to obtain better prices and a higher income.

Four significant methods of marketing are identified in the study area (Figure 4). They are:

1. Farmers selling to collecting agents visiting the farm;
2. Farmers taking their produce to local traders and collectors;
3. Farmers selling at local fairs; and
4. Farmers selling their products to private companies through a Forward Sales Contract Agreement.

Figure 5.1 Marketing channels of maize in the study area



Source: Field survey data, 2005.

About 80-85 per cent of the green cobs are sold to collectors who visit the farms and the balance is sold to traders or at village fairs. The majority of commercial farmers sell their produce to collectors and traders in grain form. The grain purchased by the collectors is resold to wholesale traders and animal feed manufacturers on a commission basis. Some of the animal feed manufacturers purchase the grains directly from farmers. A small percentage of grain is sold at local fairs.

Forward sales contracts (FSC) were introduced by the central bank in 1999. Since then, the FSC system has become popular and the expansion of this system has turned out to be the key factor for the commercial nature of maize cultivation in the study area.

The Central Bank of Sri Lanka introduced the FSC system of marketing for selected food crops with a view of popularizing the concept of contractual marketing among producers and buyers. The FSC is an agreement made between a buyer and a farmer to sell their produce to the buyer on a certain future date at a reasonable pre-determined price. As a result of this contract, whilst the farmer is provided with a stable market to sell his produce at a reasonable price, the buyer will also get the opportunity to procure the required quantity of raw material at the required quality, desired time and pre-determined price (Central Bank of Sri Lanka, 2003).

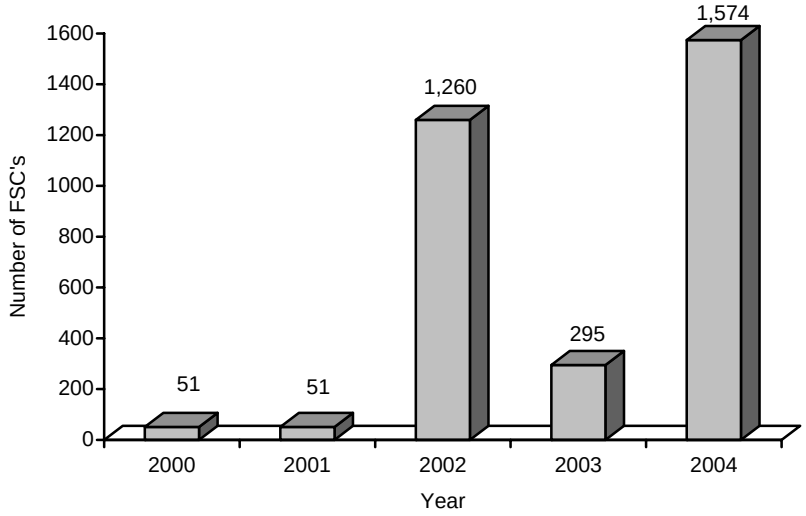
Prior to entering into an FSC, both parties, namely farmer and buyer, will discuss and agree on the forward price, quantity to be supplied, quality of the produce, manner of the packing, transport and delivery, duration of supply, payment methods and provisions to reduce or increase the agreed price in unexpected situations.

The managers of banks operating in production areas act as facilitators by conducting preliminary discussions with farmers and buyers, and help both parties to reach an agreement. In other parts of the country, Regional Development Officers of Mahaweli Authority, Agrarian Services Department, Agriculture Department and several NGOs act as facilitators. The forward price is generally calculated considering the cost of production, quality, profit margins of the buyers and import costs.

Contract agreements are signed between the sellers and buyers on the basis of consensus between both parties, which is certified by the facilitator. Thereafter, if the farmer requires credit for cultivation he can take out a loan by presenting the FSC agreement to the bank. After the harvest, the farmer hands over the specified commodities in accordance with the specified quality and quantity standards to the buyer who issues a receipt. By presenting this receipt to the bank, the farmer is paid to the value of the crop subject to the deduction of any loan taken by them. The bank charges a certain percentage as commission for providing the above services.

Although the FSC system was introduced for maize in Anuradhapura district during the 1999/2000 *maha* season little progress was observed during the first two years. Since, however, there has been a considerable increase in the FSCs signed by maize growers with the assistance of the central bank in 2002 and 2004 (Figure 5). The number of contracts signed was lower in 2003 due to drought.

Figure 5.2 Number of FSC's signed for maize in Anuradhapura district facilitated by the central bank



Source: Central Bank Regional Office, Anuradhapura.

Two processors, namely KST Evergreen (Pvt.) Ltd. and Plenty Food (Pvt.) Ltd. actively implement the FSC programme in Anuradhapura district. The World Vision, Grain Elevators Ltd. and Huruluwewa Farmer Company are among the other major agencies involved in forward sales contracts in the area.

KST Evergreen (Pvt.) Ltd., which is basically engaged in purchasing dried cobs, purchased and processed about 2,000 tons during 2003/04 *maha* and 4,000 tons of seeds through FSC. About 835 farmers in 2004 and 1,100 farmers in 2005 were involved in their FSC programme. The company also purchased maize from farmers outside FSC. The details of the FSC programme implemented by both organizations during the 2003/04 *maha* season are presented in Table 5.1.

Credit facilities were arranged through Seylan Bank (Pvt.) Ltd. and an insurance scheme was facilitated through Ceylinco Insurance Ltd. The bank provided a loan of about Rs 7,500-8,000 per acre to meet the expenses involved in land preparation, seed purchases and fertilizers. The company made arrangements to supply the required hybrid seed, fertilizers and packing materials. Evergreen has its own field staff and transport facilities to collect the harvest from the field.

Table 5.1 Forward sales contracts signed for maize-locations, price, targeted production and income in 2004

Name of the purchasing organization	Locations of 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
	Mawathawewa	54	16.00	150 000	2 400 000
	Himbutugolla	66	16.00	160 000	2 560 000
	Marathangalla	48	16.00	140 000	2 240 000
	Siwalakulama	19	16.00	42 000	672 000
	Hidogama	48	16.00	112 500	1 800 000
	Thammennawa	73	16.00	370 500	5 928 000
	Nachchaduwa	49	16.00	114 750	1 836 000
	Upuldeniya	56	16.00	192 750	3 084 000
	Mawathawewa	80	16.00	363 750	5 820 000
	Seewalakulama	101	16.00	304 500	4 872 000
KST Evergreen (Pvt.) Ltd.	Thaththirimale	95	13.00	353 250	4 592 250
	Galenbindunuwewa	92	13.00	249 000	3 237 000
	Wilachchiya	188	13.00	556 500	7 234 500
	Nachchaduwa	41	13.00	118 500	1 540 500
	Gambirigaswewa	20	13.00	132 750	1 725 750
	Medyagama Nuwara Platha	48	13.00	138 000	1 794 000
	Mihinthale	193	13.00	566 250	7 361 250
	Kohatagasdigiliya	97	13.00	225 750	2 934 750
	Rambewa	61		148 500	1 930 500
		1 574		**4 889 250**	**70 762 500**

Source: Central Bank Regional Office, Anuradhapura, 2004.

The purchasing price agreed upon by Evergreen was Rs 16.50/kg for seed and Rs 13.00/kg for cobs in the 2004/05 *maha* season. The processed seeds are stored and sold to manufacturers of animal feed and *Thriposha* human food at higher prices. The company purchases seeds that are completely filled, void of impurities (dust, sand, coloured seeds), free of aflatoxine and with a moisture content of less than 14 per cent. The company has established automatic dehulling, drying and cleaning facilities at Mihinthale in Anuradhapura district and prefers to purchase the harvest in cob form. The payments made for cobs vary according to the moisture content of the produce. The conversion rates applied by the company in fixing the price are presented in Table 5.2. Although selling in the form of cobs ease the difficulties of drying, dehulling, cleaning and storing by the farmers, they expressed dissatisfaction about the conversion rates applied by the company in fixing value to their produce.

Table 5.2 Conversion rates on payable weight of maize cobs by KST Evergreen (Pvt.) Ltd.

Moisture content	Weight deduction
30-35%	40%
25-29%	33%
20-24%	27%
15-19%	23%

Source: KST Evergreen (Pvt.) Ltd.

Plenty Foods (Pvt.) Ltd., which produces mainly human nutritional food, namely *Samaposha* using high quality maize, signed FSC agreements with 474 farmers and purchased 1,525 tons during the 2004/05 *maha* season. The company offered a price of Rs 17.50/kg for high quality maize. Plenty Foods purchases only limited quantities to meet its requirement for processed human food production.

Farmers were able to obtain higher prices of Rs 16.50/kg to Rs 17.50/kg for their maize through FSC agreements with Evergreen and Plenty Foods respectively during the 2004/05 *maha* season (Table 5.3). The average producer price received by the farmers in nominal terms had increased by about 87 per cent in *maha* 2004/05 compared to the 1997/98 maha season. The nominal producer price obtained by farmers was about Rs 8.00/kg in 1997/98. The real producer prices obtained by farmers in 1997/98 and 2004/05 were Rs 6.79/kg and Rs 8.93/kg respectively showing an increase of about 32 per cent during the period.

Table 5.3 Market share and prices paid for maize by different agencies

Marketing agency	Percentage of farmers selling	Average producer price (Rs/kg)
KST Evergreen (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.

The price offered by these companies raised the market price of maize in the area and other marketing agencies were also compelled to pay higher prices. As a result, maize farmers who were not engaged in any FSC programme also benefited by way of having access to different marketing channels and received better prices of Rs 15.00/kg to Rs 15.50/kg for their produce (Table 5.3).

Data indicates that about 30 per cent of the surveyed farmers distribute their maize produce through an FSC. An FSC programme is also implemented in the district by Plenty Foods in Huruluwewa for soybean, where 491 farmers participated during *maha* 2004/05 and 1,421 in *yala* 2004. The company purchased about 336 tons of seed during *maha*

2004/05 and 963 tons in *yala* 2005. The entire procurement is used for the human food industry.

About 70 per cent of the finger millet produced is used by the farmers for self-consumption and the balance is sold to collectors and traders. About 80 per cent of the black gram and mung bean produced is sold to collectors and traders while the remainder is used for consumption. Although FSCs are not available in the study area for these crops, Plenty Foods and a few other selected companies operate FSCs on a limited scale in other major producing districts.

5.2 Farm gate prices and margin distribution

The producers' share of the consumer price is high for maize and soybean due to better marketing arrangements like the forward sales contract system (Table 5.4). The share drops to less than 70 per cent for other crops for which the marketing system is not yet organized.

Table 5.4 Marketing margins of selected secondary crops

Crop	Producer price (Rs/kg)	Wholesale price (Rs/kg)	Retail Price (Rs/kg)	Producer margin (%)	Wholesale margin (%)	Retail margin (%)
Maize	14.8	17.5	19.5	76	14	10
Finger millet	30.85	35	45	68	12	22
Soybean	39.51	45	50	79	11	10
Mung bean	45.19	57	72	62	18	20
Black gram	36.91	42	52	70	11	19

Source: Field survey, 2005.

5.3 Potentials and constraints in the marketing system

Farmers expressed various constraints in the marketing of their produce (Table 5.5). Maize and soybean growers who marketed their produce through forward sales contract agreements received better prices compared to other farmers and encountered less problems in marketing their produce. But they also reported various difficulties in selling their produce through the FSC system. The refusal of private sector companies to pay more than the prices agreed on precedently, purchasing only limited quantities during surplus production and delays in receiving payments are some of the concerns of the farmers in the FSC system. Lack of proper storage facilities is an important constraint encountered by secondary crop growers in the area.

Table 5.5 Marketing constraints in the cultivation of maize, soybean and other secondary crops

Marketing constraint	Ranking of the constraint by respondents		
	Maize	Soybean	Other secondary crops
Delays in receiving payments	3	3	6
Low price	2		1
No market facilities	6		2
No storage facilities	1	1	3
Competition from imports	4	2	4
Transport difficulties	5	4	5

Source: Field survey data, 2005.

5.4 Concluding summary

Unavailability of organized marketing and storage facilities are major constraints inhibiting the cultivation of secondary crops. The establishment of these facilities at the village level is important to ensure better prices and income to farmers and to develop sustainable diverse agriculture in the country. More private sector investment is vital in the marketing and development of agro-based industries in order to improve employment opportunities and increase income levels of farmers involved in the cultivation of secondary crops. The forward sales contract system is gaining popularity among the farmers. However, government intervention is necessary to ensure the effective functioning of the FSC system, without any adverse affects on the farmers or processors.

6. Analysis of the Industrial Processing of Secondary Crops

6.1 Types of processed products and annual production

Maize and other secondary crops produced in the country have the potential to be used for both animal feed and human food. Maize is used as a key ingredient in the industrial processing of animal feed and several human food stuffs. Soybean is mainly used for human food. Finger millet, black gram and mung bean are processed in cottage level industries as human food.

6.1.1 Processed maize products

Poultry feed is the main compound feed (90 per cent of the total) produced in Sri Lanka utilizing locally produced maize and other imported ingredients (Ranawana, 1999). At present only about 20 per cent of locally produced maize is used in the feed industry and the rest is imported. Almost all the feed manufacturers use about 40 per cent and 33 per cent maize in their broiler and layer rations respectively. This is attributed to the high cost of other energy substitutes. The quantities of compound feed produced during 1991-2004 are presented in Table 6.1.

Table 6.1 Compound feed production in Sri Lanka, 1991-2004

(thousands of metric tons)

Year	Registered manufacturers	Self-mixing	Total
1998	319.5	61	380
1999	326.95	62.4	389.3
2000	339	64.6	403
2001	372.4	71	443.4
2002	384	72	456
2003	399.05	76.5	475
2004	405.55	76.5	482

Source: Department of Animal Production and Health.

In 2000, compound feed production for dairy and piggery were 12,000 and 8,000 metric tons respectively. Since only about 20 per cent of maize is used, the total maize requirement for compound feed for dairy and piggery totalled only about 4,000 metric tons. The demand for animal feed in Sri Lanka is a derived demand that depends mainly on the growth rate of the poultry industry. The Department of Animal Production and Health has

predicted that the broiler and layer industries are expected to develop at 10 per cent and 1 per cent respectively.

The state controlled *Thriposha* (a high nutrient food) project, which provides a high nutrient food for pregnant women and children use about 8,000 metric tons of maize annually. Two private sector medium-scale organizations, namely Plenty Foods (Pvt.) Ltd., and Cereal Product (Pvt.) Ltd. are also engaged in the production of *Samaposha* and *Ranposha* using maize as their main ingredient. There are some other cottage industries that produce flour and various other mixtures for human consumption. Large-scale biscuit manufacturers use maize in the production of cookies. All these organizations utilize aflatoxine free quality maize. It is estimated that the present maize requirement in the human food industry, excluding *Thriposha* be about 5,000 metric tons per annum.

6.1.2 Processed soybean products

At present, almost all locally produced soybean is used in the human food industry. Various food products are developed by cottage level and medium-scale entrepreneurs. *Thriposha*, *Samaposha*, *Ranposha*, *tempe*, soy meat, soy snacks and soy ice cream are some of the major food products manufactured locally. The annual production of soybean foods is presented in Table 6.2.

Table 6.2 Annual production of soybean products, 2004

Product	Manufacturer	Annual Production (tons)
Thriposha	Ceylon Tobacco Company	4 800
Samaposha	Plenty Foods (Pvt.) Ltd.	4 200
Ranposha	Cereal Product (Pvt.) Ltd.	100-120
Soy meat	Raigam	60 000
	Lanka Soy	
	General Soy	

Source: Soybean Food Manufactures.

The *Thriposha* project, managed by Ceylon Tobacco Company Ltd. and implemented by the Ministry of Health consumes 3,600 metric tons of soybean annually. *Thriposha* is a high nutrient food issued free of charge to pregnant women, mothers and children.

Plenty Foods produces various cereal foods items under their trade name *Samaposha*. Cereal Product (Pvt.) Ltd. produces another set of snacks under their trade name *Ranposha* using soybean and other ingredients. Both these organizations consume about 2,000 metric tons of soybean per annum and have arranged a forward sales contract programme with selected farmer groups in identified areas to satisfy their soybean and

maize requirements. Apart from these two companies there are a large number of cottage level entrepreneurs who produce various soy products.

Textured Vegetable Protein (TVP) is also imported to prepare soy meat as human food. TVP imports are utilized by a few local companies namely Raigam, Lanka Soy and General Soy to produce soy meat. Soy meat is a popular, daily food item (curry) in the diet of vegetarians. Demand for soy meat may rise with price hikes in animal protein sources such as chicken, beef, mutton, etc. as well as due to the growing number of vegetarians. In the future, once TVP is produced locally, demand for soybean will increase, creating demand for locally produced soybean.

The animal feed industry is the major soybean consumer in the country today. However, it only utilizes defatted soybean meal. The total requirement of soybean meal is imported. The local availability of defatted soybean meal is very low due to the non-availability of industrial facilities to extract the oil and insufficient local production even to meet the requirements for human food. According to the compound feed producers, only soy meal is used as the protein source in their rations. Presently, soy meal usage is 20-30 per cent in broiler feed and 15-20 per cent in layer feed (Ranawana, 1999). A few private sector companies have recently started producing prawn feed that utilizes 98 per cent soybean. About 9,123 tons of prawn feed was imported in 2003.

6.1.3 Finger millet processing

Finger millet is processed as flour at the cottage level and used in the preparation of traditional Sri Lankan foods. In the preparation of flour for home consumption, the grain is initially cleaned using a hand winnower, de-hulled through hand pounding in a mortar using a pestle and then ground into flour using a hand grinding stone or pestle and mortar.

Grinding the grain at the household level is usually performed by women and is a tedious and time-consuming process. Hence, grain is mostly taken to the village mills for processing by the women. A few traders also collect the grain from production areas and process and pack them before marketing. The cottage industry is prevalent in villages where finger millet is milled, packed and sold to traders who sell roadside.

6.1.4 Black gram and mung bean processing

In Sri Lanka, black gram and mung bean are consumed in large quantities in processed form in various food preparations. Processing applies traditional methods, namely hand pounding followed by winnowing. This process is tedious and time consuming. Processing involves de-hulling, or removing the seed coat from the kernels, which splits the

grain in to two halves. De-hulling makes the grain more acceptable to consumers, reduces cooking time and gets rid of the seed coat, which contains anti nutritional factors. The de-hulled grain is sometimes further milled into flour using a grinding stone before making various food preparations. At present, only a small percentage of black gram and mung bean are processed as the grain splits due to lack of suitable processing equipment.

The difficult nature of processing these crops has impeded their development. To overcome this problem, a motor driven de-huller has been developed by the Institute of Post-Harvest Technology (IPHT), Sri Lanka, which is currently being introduced to rural farmers.

6.2 Production capacity and its uses

At present, the animal feed industry is entirely controlled by the private sector from a few co-operative societies which carry out some feed mixing mostly to cater to the their own farmers. The industry's total output is about 415,000 tons per annum. A few large companies dominate the industry and three of them account for 70 per cent of annual production. The rest of the production is covered by the medium and small-scale manufacturers and self-mixing poultry feed producers. Animal feed processing facilities are located mainly in three districts namely Colombo, Gampaha and Kurunegala, which are dominated by the poultry industry. There are only 17 registered feed millers and their capacities are presented in Table 6.3. Most of these manufacturers are operating at between 80-90 per cent capacity.

Table 6.3 Number and capacity of registered animal feed manufacturers (2004)

Scale	No. of mills [a]	Capacity (mt/year)
Large- scale	03	>40 000
Medium-scale	02	10 000-40 000
Small-scale	12	< 10 000
Total	17	--

Source: Department of Animal Production and Health.
Note: [a] Number of self-milling industries not included.

In addition to these registered feed millers, a few thousand small-scale poultry farmers are engaged in self-mixing poultry feed production. No official data is available about their capacities etc. In 2000, it was estimated these millers produced about 80,000 metric tons. of poultry feed for their own use and for selling purposes. It is also reported that about 75,000 families are involved in small-scale poultry production in the country.

The human food processors have the capacity to utilize about 8,000 tons of soybean annually. Finger millet is processed in small mills located in the villages. The machine used

to mill flour consists mainly of two shelling cast iron discs coated with emery and carborundum mounted on a vertical shaft. The machine is operated by a 27-30 HP diesel engine.

The grain de-huller introduced by IPHT to de-hull black gram and mung bean is a low cost, small-scale machine and it consists of a set of rotating abrasive discs (made out of cutting discs) mounted on a horizontal shaft within the de-hulling chamber. The machine can be driven by a three-horsepower single-phase motor or engine (if electricity is not available) as per requirement. The machine has a holding capacity of 5-6 kg per batch and it takes 1.5 minutes to de-hull a batch. The hull particles that emerge as a by-product constitute a valuable animal feed, rich in nutrients. The recovery rate of the processed grain is 76 per cent.

6.3 Cost-revenue structure and business profitability

According to the information collected from small-scale poultry feed producers, the cost of production of layer mash is Rs 18.9/kg and for broiler pellet is Rs 26.19/kg in 2004. Total cost of production includes capital, labour, maintenance and packing costs. A detailed cost break down of producing layer mash is presented in Table 6.4.

Table 6.4 Cost and returns of layer mash produced by small-scale poultry feed manufacturers

Item	Rs/kg
Cost of raw material	17.53
Labour cost	0.76
Capital cost	0.11
Operational cost	0.1
Packing cost	0.4
Total cost	18.90
Sale price	23.4
Net income	4.5

Source: Field Survey Data, 2005.

Maize, wheat, rice polish, rice bran, coconut poonac (the residue after obtaining oils from coconut), soy meal, fish meal, meat and bone meal, shell grit and milk powder are the major raw materials used in poultry feed production. Maize is the major ingredient in poultry feed. The wholesale price of imported maize (Rs 19.25/kg) is higher than locally produced maize (Rs 18.50/kg) due to taxes imposed on imports and is attributable to the higher costs of production of animal feeds.

A farmer who process 500 kilogram of finger millet per month earns about Rs 5,000 additional income. The details are presented in Table 6.5. Promoting cottage level processing is therefore beneficial in the fight against poverty in rural areas.

Table 6.5 Cost and returns of finger millet flour production

Item	Rs
Cost of raw material per kg	30.00
Cost of raw material to obtain 1 kg of processed grain (at a recovery level of 90 per cent)	33.00
Milling cost per kg (including labour cost)	1.00
Packaging cost per kg (including labour cost)	1.00
Total production cost per kg of milled flour	35.00
Sale price per kg of milled flour	45.00
Net income per kg of milled flour	10.00
Net income per month (assuming that 500 kg of grain flour are produced/month)	5 000.00

Source: Field Survey Data, 2004.

A farmer who processes about 1 ton of black gram or mung bean would receive an additional income of Rs 5,000 per month (Table 6.6). Processing these crops generates employment opportunities, mainly for women, in rural areas.

Table 6.6 Cost and returns of legume processing

Item	Rs
Cost of raw material per kg	40.00
Cost of raw material to obtain 1 kg of processed grain (at a recovery level of 76 per cent)	52.00
Processing cost per kg (including labour cost)	2.00
Packaging cost per kg (including labour cost)	1.00
Total production cost per kg	55.00
Selling price of processed legume per kg	60.00
Net income per kg	5.00
Net income per month (assuming that 1 metric ton of grain legume is produced/month)	5 000.00

Source: Field Survey Data, 2005.

6.4 Potentials and constraints in industrial processing

The industrial demand for maize and soybean from the compound feed industry is expected to rise with the rapid growth in the poultry industry. Domestic production is inadequate to meet the industrial demand for these crops. Hence there is a need to boost local production of these crops. At the same time, tariff on imports on maize and soy meal should be maintained at an appropriate level to ensure sustainable growth in the animal feed industry. According to the estimates, a 1 per cent increase in broiler and egg production would raise demand for maize by 0.5 and 0.35 per cent respectively. Given such estimates, derived demand for maize from the animal feed industry will be 344,920 metric

tons in 2010, which amounts to about a three-fold increase over 2001. Total estimated demand for maize is presented in Table 6.7.

Table 6.7 Supply and demand projections for maize, 2005-2010 (thousands of metric tons)

Year	Estimated production	Estimated feed consumption	Estimated food consumption	Estimated demand
2005	32.65	187.21	101.81	289.02
2006	33.00	211.55	112.57	324.12
2007	33.36	239.05	124.47	363.52
2008	33.72	270.12	137.64	407.76
2009	34.09	305.24	152.19	457.43
2010	34.45	344.92	168.28	513.20

Source: Karunatilake, 2003.

About 80 per cent of the maize requirement is imported and a few large-scale feed manufacturing companies, which produce over 70 per cent of the total animal feed, use imported maize due to its good quality and year round supply. However, imported maize is costly due to taxes imposed on imports. As a result, the cost of production is relatively higher compared to medium and small-scale producers who use locally produced maize. The study revealed that the cost of production of layer feed users was about 19 per cent less than the price of layer type commercial products (Jayaweera *et al*., 2003). But the quality of the products is not satisfactory in terms of nutrient content and hygienic standards. Many medium and large-scale poultry feed manufacturers (self-mixers) require training and credit facilities to enhance the use of locally produced maize and other raw materials. The quality of locally produced maize must be improved if is to be utilized in animal feed production. The produce should be free of aflatoxin and fulfill other quality requirements. Recently, a few private sector companies established collection centres in major producing areas with modern facilities to produce quality grains. KST Evergreen (Pvt.) Ltd. has established such a facility in Mihintale area in Anuradhapura district.

The demand for soybean is also projected to increase both for human food and animal feed. Processed soy-based food items are becoming popular among both vegetarian and non-vegetarian consumers. The involvement of non-governmental organizations and private sector organizations in human food production has revitalized the soy industry, which is evidenced by greater demand for these products. Total seed demand from the food industry is estimated to be around 8,000 metric tons. The soy meal requirement for the feed industry is projected to increase up to 146,869 metric tons due to growth in the poultry industry. The projected soybean meal demand for 2005-2010 is presented in Table 6.8.

Table 6.8 Soybean meal requirement for animal feed

Year	Requirement (mt)
2005	106 651
2006	113 597
2007	121 051
2008	129 051
2009	137 643
2010	146 869

Source: Department of Animal Production and Health.

Recently, due to an increase in the cost of agricultural inputs, the returns on cultivation of finger millet, black gram and mung bean have become marginal. An effective way of overcoming this problem of low income from farming is to initiate small, medium and large-scale agro/food processing enterprises in rural areas.

In a normal season, nearly 40 per cent of the finger millet and 80 per cent of the black gram and mung bean produced by farmers is sold and the rest is retained for home consumption and seed purposes. At present, farmers sell their grain in unprocessed form and during the harvest the prices slump to very low levels. On the other hand, if the farmers could sell their grain in the form of high-quality flour in convenient package sizes, they could add value to their produce and thereby substantially increase their income.

Since most farmers growing these crops are engaged in subsistence farming and belong to the low- income category, any technology that is introduced should be affordable and manageable by the rural sector, especially by rural women, and at the same time, should bring about a significant increase to income. Hence, the selection of appropriate technology would ease the drudgery of rural woman.

Cottage level processing of finger millet, black gram and mung bean has the potential to generate employment, particularly for women, and provide additional income to farm families. The introduction of appropriate processing equipment and credit training facilities are essential to develop cottage level industries.

6.5 Concluding summary

Integrating secondary crop farms with cottage level as well as large-scale agro-based industries by way of providing incentives and concessions to stakeholders will generate employment and provide additional income to farm families.

7. Analysis of Institutional Support

7.1 Economic policies

Self-sufficiency in rice production has been the major strategy of agricultural policies during the last five decades to ensure food security, generate employment and eliminate poverty, mainly in rural areas. In 2003, the country almost achieved self-sufficiency in the production of rice, which is the staple food of the nation.

Consequent to the above strategy, emphasis on the production of maize and other secondary crops received low priority compared to rice. The cultivation of these crops was promoted through the 'Food Drive' programme of the government, implemented in the 1960s. Agricultural diversification through the cultivation of non-rice crops was encouraged during 1970-1977 by imposing a ban on their imports in 1971. The said ban on imports of other food crops resulted in their short supply and an unprecedented price hike. Farmers responded by increasing the area cultivated with these crops and thus production of most of them doubled.

With the introduction of open economic policies in 1977, the trade of maize and other secondary crops were liberalized in the late 1990s. The government also intermittently introduced tariff changes to protect domestic production as well as support the animal feed industry. Therefore, liberalized trade policies had varied impacts on the production, marketing and trade of secondary crops.

As maize and soy meal are imported in large quantities for animal feed, where the total soybean requirement and 80 per cent of the maize requirement are met through imports, trade liberalization has assured expansion and the sustainability of the animal feed industry through continuous supply of raw materials at affordable prices. Trade liberalization also assisted in the importation of hybrid seeds of maize, which raised productivity and farmer income.

The government recently introduced a Cess duty[1] on the importation of maize to protect local production. These unpredictable changes, which occur frequently, create a considerable amount of uncertainty, exacerbating price risks for processors and farmers,

[1] Cess duty is the duty imposed on the value of imports, or exports, that will be used for the development of a particular sector. At present, a 20 per cent Cess duty is imposed on the CIF value of maize imported to the country.

consumers and local entrepreneurs. They no doubt tend to adversely affect the demand and supply of these crops.

The government operates a subsidy programme for urea fertilizer, which is mainly used in rice cultivation. The current subsidy provided for maize of 18,000 rupees per metric ton has been in effect from January 2005. The maize and soybean growers who apply urea in the cultivation of these crops also benefited through this subsidy scheme.

The government also provide loan facilities to cultivate maize and other secondary crops through state banks and rural development banks. However, since rainfed cultivation involves high risks, and high risked prices are not insured, only a few farmers are accepted for bank loans. On the other hand, all the farmers, who grow these crops under 'Forward Sales Contract System', are provided with loan facilities through the commercial banks.

7.2 Infrastructure provisions

Inadequate availability of water in small-minor tanks is a major constraint to the expansion of rice cultivation and other food crops in Sri Lanka, mainly during the *yala* season. The Government of Sri Lanka, realizing the importance of improving the tank irrigation facilities, launched s special project 'Renovation and Rehabilitation' of 10,000 Minor and Medium Irrigation Systems. Under this project 50,000 acres of land are expected to be cultivated with irrigated water and as a result the average cropping intensity in rehabilitated small and medium irrigation systems will be raised from the current level of 75 per cent to 125 per cent. About 64,000 families will directly benefit by being able to cultivate paddy as well as other food crops, thus raising their food consumption and income levels. Above and beyond the economic significance of this project, the project will contribute towards mobilizing farming communities, and strengthen cultural and social cohesiveness as an integral part of their life.

7.3 Research and development

7.3.1 Development of production, processing and marketing technology

The Field Crop Research and Development Institute (FCRDI) of the Department of Agriculture (DOA) bears the mandate of developing new production technologies relevant to coarse grains and pulses in the country. In spite of the number of new varieties and other new technologies developed and introduced by the institute in the last two to three decades, a marked decline has been observed in the production of most crops. This is partly due to the inadequate development and dissemination of appropriate production technology to

achieve higher yields. As these crops are grown under moisture stress conditions in the dry zone of the country, attention should mainly be given to develop technologies to obtain higher yields under such conditions. The five-year work plan of the Department of Agriculture (2006-2008) focuses on the following research programmes for developing new technologies for these crops:

1. Crop improvement - Develop and introduce high-yielding varieties with quality protein and resistance to stress conditions as well as pest and disease.
2. Improve crop production technology – Development and introduction of new agronomic packages, micro-irrigation methods, suitable for small and commercial farming.
3. Sustainable use of natural resources – Improve small-tank based farming systems and soil fertility management practices in rainfed and irrigated areas.
4. Develop demand-based nutrient packages – Recommendations for different, yield levels (3, 4, 5, 6 tons per hectare).
5. Appropriate farm mechanization to reduce labour costs and attract youths to farming – Develop machinery and equipment for seeding, weeding, fertilizer application, irrigation, processing for both small-scale and commercial farms.
6. Develop crop protection practices - Introduce new technology to identify pest damage, low cost eco-friendly crop protection measures and promote biological pest management including bio pesticides.
7. Develop post-harvest and processing technologies to produce aflatoxin free maize and other value-added products.

The Department of Agriculture has developed several verities of maize and other secondary crops during the last two decades. A hybrid maize variety named *Sampath* bears similar characteristics of the imported variety Pacific which is popular among farmers. The low availability of locally produced hybrid seed is one of the major constraints that limits productivity increases. The Department of Agriculture produces about 40,000-50,000 kilograms of OPV maize seed and 2,000 kilograms of finger millet seed annually. This caters for only 5-8 per cent of maize and 10 per cent of finger millet area planted annually. These levels must be increased considerably to introduce the improved varieties to farmers.

The Institute of Post-harvest Technology has numerous processing equipment, namely pulse processing machines, sand-removing machines for finger millet and low cost dryers to assist the processing of secondary crops by small farmers. Popularization of these machines is important.

7.3.2 Development of the extension service network

Agricultural extension services have been decentralized to the provinces through the Provincial Agricultural System. Although a sound extension system has been developed in respect of paddy, steps are yet to be taken to strengthen the extension process in respect of secondary crops. This could be achieved through mobilization of adequate staff and providing them with appropriate training on secondary crops.

Since 2004, the government has promoted the formation of Farmer Production Societies (FPS) nationwide to function as an extension arm to provide agricultural knowledge and marketing services required by the farmers. These societies will undertake responsibility to supply all agricultural inputs such as seeds and planting materials, fertilizers, agrochemicals, machinery and other inputs required for the cultivation of food crops.

7.3.3 Potentials and constraints in developing technology and the extension service network

A significant number of farm families depend on the cultivation of maize and other secondary crops. These crops are grown mostly under rainfed conditions and therefore the risk and uncertainty involved are comparatively higher. In order to overcome the main agronomic constraints and to improve the productivity of the crops, research should be directed to explore opportunities and create avenues to expand production capacity through the development and introduction of improved crop production and crop protection technologies.

Maize that was once grown mainly in the dry and intermediate zones of Sri Lanka with the onset of the North East Monsoon has now turned out to become a more important commercial crop in contemporary agriculture. Therefore, a well-planned extension programme should be implemented in order to increase local production of maize and other secondary crops.

7.4 Concluding summary

Appropriate reforms have to be introduced to the technology development systems towards secondary crop production, which is suitable for rainfed as well as irrigated conditions, with emphasis on the development of hybrid varieties, improved soil fertility and water management practices, tank-based farming systems, post-harvest and processing technologies and appropriate farm mechanization for small and commercial farms. More

investment is needed for research and development programmes concerning secondary crops.

Collective farmer group participatory activities, including female and youth farmers should be implemented for effective technology transfer, input supply, marketing and processing. Regional specialization of crops needs to be promoted for sustainable agricultural diversification through the cultivation of secondary crops. A system has to be developed to encourage all stakeholders engaged in the production of seeds of secondary crops to ensure adequate availability of quality seeds to the farmers at the village level.

8. General Conclusion and Policy Recommendations

8.1 General conclusion

At present, domestic production of maize and other secondary food crops is inadequate to meet the local demand for human consumption and from the animal feed industry. The demand for most of these commodities is expected to increase further in line with population growth and the expansion of the poultry industry. Therefore, future policies on sustainable secondary crop production should be of an integrated approach towards: (i) enhancing production; (ii) developing the marketing system; and (iii) promoting agro-based industries at industrial and commercial levels, to ensure household food and nutritional security, employment, to enhance income, alleviate poverty and improve the living standards of resource poor farmers. These objectives can be achieved through the integration of appropriate technologies, development of infrastructure and appropriate government policies.

8.2 Policy recommendations

A national pro-poor policy has to be formulated and implemented to ensure food security and employment for the rural population through production and processing of secondary food crops. Some of the policy options recommended for the sustainable development of secondary crops based farming systems and their integration to processing towards poverty alleviation are summarized as follows:

1. Technology Development
    - Develop technologies directed towards poverty alleviation and output oriented through:
        - Suitable varieties (including hybrids);
        - Improve soil fertility and water management practices for both rainfed and irrigated systems;
        - Minor-tank/Agro-well based farming systems;
        - Farm mechanization for small and commercial farms;
        - Crop-livestock integrated farming; and
        - Improved post-harvest handling and processing.

- Farmer participatory research; and
- Increase investment on research programmes pertaining to secondary crops.

2. Technology Dissemination
   - Regional specialization of crops (crop prioritization – crop zoning);
   - Expand cultivation on uncultivated rice lands/marginal lands;
   - Improve access to information technology; and
   - Awareness programmes on nutrition to promote food diversification.

3. Input Supply
   - Encourage all stakeholders engaged in the production of seeds and planting materials of secondary crops to ensure adequate availability of quality seeds at village level through:
     - Self seed production;
     - Production/imports by state and private sector; and
     - Contract seed production.

4. Credits/Insurance
   - Credit/Insurance scheme for secondary crops; and
   - Promote micro-financing schemes (Revolving fund).

5. Marketing
   - Expand Forward Sales Contract (FSC) System;
   - Improve storage facilities at the village level;
   - Value chain development; and
   - Development of market information system for secondary crops

6. Value Addition and Processing
   - Introduce improved post-harvest, processing and packaging technologies and branding;
   - Promote cottage level processing with the active participation of women;
   - Incentives to private sector for development of large-scale agro-based industries;
   - Improve access to processing machinery and equipment; and
   - Quality standards for processed products.

7. Price and Trade Policies
    - Tariff structure to regulate imports/prices at appropriate levels to sustain growth in the animal feed industry as well as protect domestic production.

8. Empower farmers
    - Establish and strengthen of farmer organizations/commodity based producer societies/farmer companies.

9. Regional Co-operation
    - Collaborate programmes with regional countries in development, processing and trade of secondary crops.

10. Government Intervention
    - Priority for promoting agricultural diversification in national level programmes; and
    - Consistent and continuous commitment from the government to promote the production of secondary crops.

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Annexes

Annex 1

Annex 1.1 Area planted, production and average yield of maize (1995-2004)

Year	*Maha* season			*Yala* season			Annual		
	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)
1995	34 455	33 340	0.97	1 483	1 496	1.01	35 938	34 836	0.97
1996	29 391	31 430	1.07	1 504	1 533	1.02	30 895	32 963	1.07
1997	23 824	23 630	0.99	1 972	2 059	1.04	25 796	25 689	1.00
1998	27 531	31 451	1.14	2 259	2 423	1.07	29 790	33 874	1.14
1999	26 822	29 284	1.09	2 082	2 187	1.05	28 904	31 471	1.09
2000	26 344	28 540	1.08	2 302	2 512	1.09	28 646	31 052	1.08
2001	23 734	26 661	1.12	1 978	2 094	1.06	25 712	28 755	1.12
2002	20 329	23 244	1.14	3 084	3 173	1.03	23 413	26 417	1.13
2003	23 448	25 745	1.10	3 611	3 900	1.08	27 059	29 645	1.10
2004	20 275	31 449	1.55	3 146	3 752	1.19	23 421	35 201	1.50

Source: Department of Census and Statistics.

Annex 1.2 Area planted, production and average yield of finger millet (1995-2004)

Year	*Maha* season			*Yala* season			Annual		
	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)
1995	6 208	4 088	0.66	1 231	788	0.64	7 439	4 876	0.66
1996	5 306	3 401	0.64	8 23	505	0.61	6 129	3 906	0.64
1997	4 734	2 994	0.63	8 28	506	0.61	5 562	3 500	0.63
1998	5 091	3 797	0.75	9 51	588	0.62	6 042	4 385	0.73
1999	5 566	4 220	0.76	9 17	587	0.64	6 483	4 807	0.74
2000	5 667	4 285	0.76	8 77	564	0.64	6 544	4 849	0.74
2001	4 986	3 774	0.76	6 50	422	0.65	5 636	4 196	0.74
2002	4 830	3 663	0.76	6 47	408	0.63	5 477	4 071	0.74
2003	6 233	4 542	0.73	1 123	725	0.65	7 356	5 267	0.72
2004	4 226	4 026	0.95	887	643	0.72	5 113	4 669	0.91

Source: Department of Census and Statistics.

Annex 1.3 Area planted, production and average yield of soybean (1995-2004)

Year	*Maha* season			*Yala* season			Annual		
	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)
1995	1 270	988	0.78	1 089	1 379	1.27	2 359	2 367	1.00
1996	665	540	0.81	184	186	1.01	849	724	0.86
1997	298	229	0.77	199	189	0.95	497	418	0.84
1998	261	193	0.74	380	406	1.07	641	599	0.93
1999	352	277	0.79	470	520	1.11	822	797	0.97
2000	310	234	0.75	384	414	1.08	694	648	0.93
2001	285	224	0.79	362	398	1.10	647	622	0.96
2002	179	146	0.82	1 078	1 010	0.94	1 257	1 156	0.92
2003	355	291	0.82	2 192	2 666	1.22	2 547	2 957	1.16
2004	178	236	1.33	1 116	1 654	1.48	1 294	1 890	1.46

Source: Department of Census and Statistics.

Annex 1.4 Area planted, production and average yield of black gram (1995-2004)

Year	*Maha* season			*Yala* season			Annual		
	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)
1995	10 997	7 541	0.69	456	401	0.88	11 453	7 942	0.69
1996	7 602	5 442	0.72	1 463	1 921	1.31	9 065	7 363	0.81
1997	7 034	4 718	0.67	1 748	2 126	1.22	8 782	6 844	0.78
1998	9 323	790	0.78	848	759	0.90	10 171	8 049	0.79
1999	7 738	5 872	0.76	920	858	0.93	8 658	6 730	0.78
2000	6 013	4 807	0.80	690	613	0.89	6 703	5 420	0.81
2001	5 642	4 476	0.79	719	651	0.91	6 361	5 127	0.81
2002	5 492	4 185	0.76	992	909	0.92	6 484	5 094	0.79
2003	6 245	4 959	0.79	935	982	1.05	7 180	5 941	0.83
2004	4 303	4 448	1.03	437	511	1.17	4 740	4 959	1.05

Source: Department of Census and Statistics.

Annex 1.5 Area planted, production and average yield of mung bean (1995-2004)

Year	*Maha* season			*Yala* season			Annual		
	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)	Area (ha)	Production (mt)	Yield (mt/ha)
1995	12 405	11 353	0.92	5 692	4 660	0.82	18 097	16 013	0.88
1996	12 934	12 112	0.94	5 327	4 473	0.84	18 261	16 585	0.91
1997	11 680	10 960	0.94	4 956	4 040	0.82	16 636	15 000	0.90
1998	13 487	12 240	0.91	4 022	3 406	0.85	17 509	15 646	0.89
1999	11 705	10 671	0.91	3 657	3 154	0.86	15 362	13 825	0.90
2000	9 716	8 904	0.92	3 253	2 791	0.86	12 969	11 695	0.90
2001	8 438	7 589	0.90	2 627	2 127	0.81	11 065	9 716	0.88
2002	8 501	7 881	0.93	2 747	2 443	0.89	11 248	10 324	0.92
2003	9 603	8 560	0.89	2 413	2 045	0.85	12 016	10 605	0.88
2004	6 438	5 881	0.91	2 169	1 927	0.89	8 607	7 808	0.91

Source: Department of Census and Statistics.

Annex 2

Annex 2.1 Imports of coarse grains

Year	Maize seeds		Maize (other)		Finger millet	
	Quantity (mt)	Value ('000 SLRs)	Quantity (mt)	Value ('000 SLRs)	Quantity (mt)	Value ('000 SLRs)
1995	3 504	32 099	76 554	602 636	-	-
1996	35 502	425 568	56 076	665 419	499	4 332
1997	19 859	212 439	70 382	675 036	1254	13 613
1998	38 358	359 128	68 179	580 574	695	8 881
1999	66 669	620 514	58 956	494 738	277	3 968
2000	7 864	75 348	115 248	1 088 006	551	8 932
2001	69	1 466	157 334	1 794 638	816	12 740
2002	7	1 456	945 883	12 046 754	1 134	17 367
2003	8 247	129 937	128 450	1 797 794	610	9 555
2004	84	12 137	148 782	2 506 647	1 829	25 587

Source: Sri Lanka Customs.

Annex 2.2 Exports of coarse grains

Year	Maize		Finger millet	
	Quantity (mt)	Value ('000 SLRs)	Quantity (mt)	Value ('000 SLRs)
1995	0.0	0.7	0.2	18.4
1996	0.2	70.1	0.3	21.6
1997	-	-	9.9	344.6
1998	-	-	0.2	6.0
1999	0.2	36.7	0.1	7.9
2000	0.2	34.5	3.2	321.1
2001	0.5	53.0	1.2	138.9
2002	0.1	24.7	1.0	59.9
2003	0.2	55.0	1.6	145.0
2004	0.7	84.0	1.4	473.0

Source: Sri Lanka Customs.

Annex 2.3 Imports of pulses

Year	Soybean seeds		Mung bean		Black gram	
	Quantity (mt)	Value ('000 SLRs)	Quantity (mt)	Value ('000 SLRs)	Quantity (mt)	Value ('000 SLRs)
1995	2 669	32 356	1 761	28 628	3 979	62 267
1996	285	4 854	22	377	4 034	77 297
1997	200	5 119	2 091	39 938	1 659	29 564
1998	179	3 617	5 132	113 278	677	13 275
1999	1 830	37 179	7 528	183 330	4 928	99 524
2000	2 972	61 828	6 767	172 548	7 332	170 082
2001	3 166	80 393	8 717	271 434	7 891	225 054
2002	3 512	98 612	7 121	223 083	6 939	223 850
2003	1 451	40 439	8 181	241 893	7 597	220 751
2004	1 607	47 104	12 672	402 412	-	-

Source: Sri Lanka Customs.

Annex 2.4 Exports of pulses

Year	Soybean seeds		Mung bean		Black gram	
	Quantity (mt)	Value ('000 SLRs)	Quantity (mt)	Value ('000 SLRs)	Quantity (mt)	Value ('000 SLRs)
1995		-	1.8	160.1	-	-
1996	-	-	1.6	154.9	0.2	22.1
1997	-	4.8	3.3	310.5	0.5	36.3
1998	0.1	-	2.9	365.9	0.2	20.7
1999	-	75.2	3.7	475.6	5.6	326.9
2000	0.4	0.6	7.8	970.1	0.0	2.0
2001	0.0	49.5	11.0	1 598.5	0.6	59.0
2002	0.2	161.1	7.2	1 144.5	2.6	237.8
2003	0.6	32.0	8.4	1 143.0	1.7	237.0
2004	1.1	47.0	9.6	1 470.0	-	-
	0.2					

Source: Sri Lanka Customs.

Annex 3

Annex 3.1 Projected extent, production and average yield of other field crops (2006-2010)

Crop	2006			2007			2008			2009			2010	
	Extent (ha)	Prod. (mt)	Av. yield (mt/ha)	Extent (ha)	Prod. (mt)	Av. yield (mt/ha)	Extent (ha)	Prod. (mt)	Av. yield (mt/ha)	Extent (ha)	Prod. (mt)	Av. yield (mt/ha)	Extent (ha)	Prod. (mt)
Coarse grains														
Maize	34 170	49 991	1.46	36 103	58 100	1.61	38 132	67 502	1.77	40 282	78 438	1.95	42 487	91 007
Kurakkan	7 435	5 699	0.77	7 515	6 048	0.80	7 593	6 417	0.85	7 672	6 808	0.89	7 741	7 212
Sorghum	278	213	0.77	282	220	0.78	285	226	0.80	288	234	0.81	290	240
Condiments														
Red onion	5 340	43 430	8.13	5 376	45 472	8.46	5 411	47 597	8.80	5 447	49 832	9.15	5 476	52 097
Big onion	3 782	44 714	11.82	3 939	47 501	12.06	4 101	50 439	12.30	4 270	53 564	12.50	4 438	56 789
Chilli	17 126	14 386	0.84	17 327	15 282	0.88	17 523	16 228	0.93	17 722	17 233	0.97	17 894	18 271
Pulses														
Black gram	9 781	9 551	0.98	10 354	10 616	1.03	10 957	11 797	1.08	11 597	13 110	1.13	12 255	14 546
Green gram	13 069	13 755	1.05	13 708	15 148	1.11	14 373	16 677	1.16	15 072	18 363	1.22	15 781	20 187
Soybean	3 535	4 640	1.31	3 740	5 154	1.38	3 955	5 723	1.45	4 183	6 356	1.52	4 418	7 048
Cowpea	14 725	14 129	0.96	14 746	14 290	0.97	14 761	14 448	0.98	14 776	14 608	0.99	14 768	14 746
Oil crops														
Gingelly	8 459	5 694	0.67	8 556	5 875	0.69	8 651	6 059	0.7	8 747	6 249	0.71	8 831	6 435
Groundnut	14 425	8 534	0.59	14 981	9 040	0.6	15 553	9 573	0.62	16 148	10 138	0.63	16 740	10 719

Source: Department of Agriculture.

Annex 4

Annex 4.1 Cost and returns of maize production, 2004/05 *maha* District: Anuradhapura (rainfed)

A. Cost of production

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	0.00	0.00	6 100.90
1st plough with 4wT	0.00	6 598.09	0.00	6 598.09
Seeding	4 848.10	0.00	3 519.35	8 367.45
Fertilizer application	3 847.35	0.00	6 834.31	10 681.66
Weeding and earthing up	7 109.07	0.00	0.00	7 109.07
Harvesting and drawing	7 804.48		0.00	7 804.48
Threshing with thresher	1 912.55	2 258.12	0.00	4 170.68
Transport produce to stores	0.00	1 314.92	0.00	1 314.92
Total including imputed cost	31 622.45	8 856.21	10 353.66	50 150.67
Total excluding imputed cost	5 827.88	8 856.21	10 353.66	25 037.75

B. Yield and returns

Average yield (kg/ha)	5 233.58
Price of produce (Rs/kg)	14.80
Gross income (Rs/ac)	77 456.95
Profit including imputed cost (Rs/ha)	27 306.29
Profit excluding imputed cost (Rs/ha)	52 419.21

Source: Field survey data, 2005.

Annex 4.2 Cost and returns of finger millet production, 2004/05 *maha* District: Anuradhapura (rainfed)

A. Cost of production

Operation	Labour cost Rs/ha	Machinery and equipment cost Rs/ha	Material cost Rs/ha	Total cost Rs/ha
General land preparation	7 930.06		0.00	7 930.06
Seeding	5 286.70		477.40	5 764.10
Harvesting and drawing	9 662.85		0.00	9 662.85
Threshing and processing manually	4 151.90		0.00	4 151.90
Total including imputed cost	27 031.50		477.40	27 508.90
Total excluding imputed cost	5 809.94		477.40	6 287.34

B. Yield and returns

Average yield (kg/ha)	1 339.28
Price of produce (Rs/kg)	24.80
Gross income (Rs/ha)	33 214.19
Profit including imputed cost (Rs/ha)	5 705.29
Profit excluding imputed cost (Rs/ha)	26 926.86

Source: Field survey data, 2005.

Annex 4.3 Cost and returns of soybean production, 2004/05 *maha* District: Anuradhapura (irrigated)

A. Cost of production

Operation	Labour cost Rs/ha	Machinery and equipment cost Rs/ha	Material cost Rs/ha	Total cost Rs/ha
1st plough with 4wt	0.00	7 330.64	0.00	7 330.64
Preparation of beds and ridges	4 447.80	0.00	0.00	4 447.80
Seeding	4 610.89	0.00	3 070.78	7 681.66
Fertilizer application	911.80	0.00	1 276.99	2 188.78
Weeding and earthing up	7 028.64	0.00	0.00	7 028.64
Pest and disease control	979.91	0.00	3 224.11	4 204.02
Irrigation	3 484.11	0.00	0.00	3 484.11
Harvesting and drawing	5 475.88	0.00	0.00	5 475.88
Threshing with 4wt	2 898.48	1 439.63	0.00	4 338.11
Winnowing with fan	1 578.97	741.30	0.00	2 320.27
Transport produce to stores	0.00	494.20	0.00	494.20
Total including imputed cost	31 416.47	9 511.57	7 571.88	48 994.12
Total excluding imputed cost	12 028.42	6 909.90	6 904.32	25 842.63

B. Yield and returns

Average yield (kg/ac)	1 853.25
Price of produce (Rs/kg)	39.51
Gross income (Rs/ac)	73 221.91
Profit including imputed cost (Rs/ac)	24 227.79
Profit excluding imputed cost (Rs/ac)	47 379.28

Source: Field survey data, 2005.

Annex 4.4 Cost and returns of black gram production, 2004/05 *maha* District: Anuradhapura (rainfed)

A. Cost of production

Operation	Labour cost Rs/ha	Machinery and equipment cost Rs/ha	Material cost Rs/ha	Total cost Rs/ha
General land preparation	4 290.7717	0	0	4 290.7717
1st plough with 4wt	0	6 268.72932	0	6 268.7293
Broadcasting	3 139.0037	0	1 411.8296	4 550.8333
Weeding and earthing up	5 570.8087	0	0	5 570.8087
Pest and disease control	511.497	0	8 67.27158	1 378.7686
Harvesting and drawing	7 598.9477	0	0	7 598.9477
Threshing with 4wt	1 830.7011	2 115.25013	0	3 945.9513
Winnowing with fan	285.4005	499.90801	0	7 85.30851
Total including imputed cost	23 227.13	8 883.88746	2 279.1012	3 4390.119
Total excluding imputed cost	1 4112.336	79 15.104391	1 828.7015	2 3856.142

B. Yield and returns

Average yield (kg/ha)	1 225.62
Price of produce (Rs/kg)	36.91
Gross income (Rs/ha)	45 237.49
Profit including imputed cost (Rs/ha)	10 847.37
Profit excluding imputed cost (Rs/ha)	21 381.34

Source: Field survey data, 2005.

Annex 4.5 Cost and returns of mung bean production, 2004/05 *maha* District: Anuradhapura (rainfed)

A. Cost of production

Operation	Labour cost Rs/ha	Machinery and equipment cost Rs/ha	Material cost Rs/ha	Total cost Rs/ha
General land preparation	1 927.38			1 927.38
1st plough with 4wT		6 963.72		6 963.72
Seeding	3 471.76		1 931.81	5 403.57
Weeding and earthing up	6 128.08			6 128.08
Pest and disease control	1 356.58		1 622.63	2 979.21
Harvesting and drawing	8 256.23			8 256.23
Threshing manually	1 827.92			1 827.92
Winnowing manually	1 093.42			1 093.42
Total including imputed cost	24 061.36	6 963.72	3 554.44	34 579.53
Total excluding imputed cost	1 640.84	6 428.05	3 405.84	11 474.74

B. Yield and returns

Average yield (kg/ha)	996
Price of produce (Rs/kg)	45.19
Gross income (Rs/ha)	45 000.79
Profit including imputed cost (Rs/ha)	10 421.26
Profit excluding imputed cost (Rs/ha)	33 526.05

Source: Field survey data, 2005.