CAPSA Working Paper No. 93

Pathways out of Poverty through Cassava, Maize and Soybean in Thailand

Nareenat Roonnaphai

United Nations
ESCAP

ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

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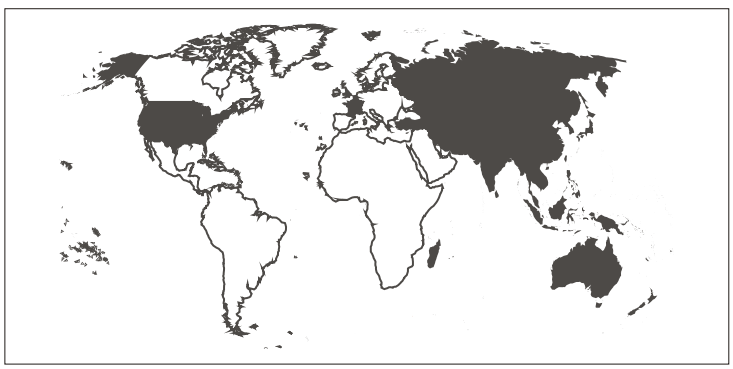

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The Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific (CAPSA) is a subsidiary body of UNESCAP. It was established as the Regional Co-ordination Centre for Research and Development of Coarse Grains, Pulses, Roots and Tuber Crops in the Humid Tropics of Asia and the Pacific (CGPRT Centre) in 1981 and was renamed CAPSA in 2004.

Objectives

CAPSA promotes a more supportive policy environment in member countries to enhance the living conditions of rural poor populations in disadvantaged areas, particularly those who rely on secondary crop agriculture for their livelihood, and to promote research and development related to agriculture to alleviate poverty in the Asian and Pacific region.

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United Nations
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ECONOMIC AND SOCIAL COMMISSION FOR ASIA AND THE PACIFIC

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List of Abbreviations

AFTA	ASEAN Free Trade Area
BAAC	Bank for Agriculture and Agricultural Cooperatives
CAP Reform	Common Agricultural Policy Reform
CGPRT	Coarse Grains, Pulses, Roots and Tubers
EU	European Union
GAP	Good Agricultural Practices
GPP	Gross Provincial Product
HYV	High Yielding Variety
MOAC	Ministry of Agriculture and Cooperatives
MOF	Market Organization for Farmers
MTBE	Methyl Tertiary Butyl Ether
OTOP	One Tambon One Product
R&D	Research and Development
SME	Small and Medium Enterprises
WTO	World Trade Organization

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 "**Pathways out of Poverty through Cassava, Maize and Soybean in Thailand**" as a result of the second phase of the Thailand 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.

I thank Ms. Nareenat Roonnaphai and other team members in the country study team for their efforts. Continuous support from the Office of Agricultural Economics (OAE) is highly appreciated. Prof. Hitoshi Yonekura, Graduate School of Agricultural Science, Tohoku University, Mr. Tomohide Sugino and Dr. Parulian Hutagaol provided useful guidance at every stage of the study as Regional Advisor, Project Leader and Associate Project Leader respectively. I extend thanks to Mr. Matthew Burrows for his English editing.

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Taco Bottema
Director
UNESCAP-CAPSA

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Executive Summary

Phase II covers the case study survey and interviews with farmers growing cassava, soybean and maize in the major producing areas, namely cassava farmers in Nakhonratchasima, soybean farmers in Sukhothai and maize farmers in Nakhonsawan, with the major objectives of studying the returns of diverse farming involving three CGPRT and other crops. Opportunities and constraints for the farm families are analysed together with the related industries and marketing systems in the survey areas. Furthermore, analysis of related institutional support and policy suggestions to promote and expand sustainable diverse farming are also conducted.

Smallholders were selected and their income and net profit from CGPRT mono-cropping and diversified farming in irrigated and rainfed areas are compared.

Findings concerning cassava farming, processing and marketing in Nakhonratchasima are summarized as follows. The average family size of the surveyed farms is 4.7 members per household, of which 44.3 per cent are engaged in farming. Most of them operate a farm holding of 1.76 to more than 4.8 hectares with 61.2 per cent of the farmland being owned by farmers and 19.5 per cent rented. Some farmers rent land in addition to their own, however, some do not own land or rent at all. Cassava is cultivated under rainfed conditions and takes 10-12 months to harvest. As a result, very few farmers spare farmland for other crops. Those growing chilli irrigate the crop from deep wells or waterways. Those practicing diverse farming hold several farm plots planted with many crops in the rainy season, namely major rice, maize, chilli and mung bean. Farmers are aware of the need to improve the soils and most of them acknowledge the need to use improved varieties. The farmers under survey achieve a cassava yield per hectare of 21,575 kilograms, greater than the national average of 20,275 kilograms. As prices of farm goods have been good in the last few years, farmers growing cassava and the other crops mentioned previously can realize profits. In some maize areas drought causes damage but the farmers are spared due to diversified cropping and lucrative profit gains from chilli grown throughout the year. A number of very small smallholders have no choice but to grow cassava only and their net cash income is less than those practising diverse cropping. The former group of farmers generate value-added through the production of clean chips and

therefore receive a 20 per cent higher price. Cassava monoculture has potential through the use of improved varieties suitable to the agro-climatic conditions but faces the expense of chemical fertilizers and labour shortages. On the other hand, farm diversification has proved to have the potential to raise income and mitigate risks through a wider crop choice, however, farmers face difficulties due to insufficient investment capital.

With regard to the marketing channels of cassava products in Nakhonratchasima, 61 per cent of farm products are sold to drying yards and the remaining 38 per cent to the flour mills, which are concentrated around the cassava producing areas, providing more choices of where to sell. Demand continues to grow but the peak harvests are always concentrated, thus prices depressed and freight becomes expensive to the farmers.

Aside from processing cassava into chips, flour, pellets and ethanol, the simple farm processing activities of the farmwife groups involving the use of cassava flour have the potential to expand the business further. They are located close to the supply sources and the activities have the potential to produce food with the use of natural colours to satisfy rising demand. Unfortunately, there are a lack of production techniques and no development funding.

The demand for cassava products, namely chips and flour, continues to rise. Raw material supply is often irregular, forcing the processing plants to run below capacity.

The findings of the survey regarding diverse soybean farming, processing and marketing in Sukhothai can be explained as follows. The average family size of surveyed farmers is 4.2 members per household, of which 59.3 per cent are economically active. In terms of farm size, 61.5 per cent of surveyed farmers hold land between 1.61-4.8 hectares per family. The majority of the farmers (77.5 per cent) own their farmland and 22.5 per cent rent.

In a given year, soybean can be grown three times: the early rainy season crop, late rainy season crop and the dry season crop which is irrigated. The study area covers both irrigated and rainfed areas. In the study area, comparison is made between income from soybean monoculture and soybean plus other crops. It is found that most farmers hold many farm plots, the same as the cassava farmers in Nakhonratchasima. The difference lies in the low-lying irrigated zone, where paddy is grown during the rainy months while soybean in the dry season and, at times, followed by mung bean. Farmers with several plots grow soybean in the rainy months followed by morning glory and chilli. Outside the irrigated zone, in the lowland, rice is sown followed by soybean as soil moisture is adequate. The upland areas

are planted with maize, sugar cane and cassava. Farmers growing solely soybean cultivate three crops per year with great expertise. In the rainfed area, only one sample soybean monocrop farmer is found. The reasons for such soybean monoculture are due to the smallness of the holding, the suitability of the soil, sufficient buyers and the family's major income source is a family member working abroad.

Net family cash income from soybean and other crops grown in the irrigated zone is larger than multiple cropping in rainfed areas and also higher than farmers who practice soybean mono-cropping in both irrigated and rainfed areas. Soybean rotated with other crops or grown in the same season enriches the soil and therefore, there is no need to use fertilizers for crops grown after soybean, reducing farm costs. However, farmers face the same constraints as the cassava planters in Nakhonratchasima, namely, a lack of a capital and drought damage attributable to the location in the rainfed area.

Regarding the marketing channels of soybean in Sukhothai, most farmers sell their produce without any grading immediately after harvest to repay outstanding loans for farm inputs and household consumables. After the value of the loan is deducted, farmers receive relatively little cash due to the prevailing low farm prices. Another type of buyer is the local crusher. Locally produced soybean is suitable for making soy milk for its freshness and high protein content. Demand from the crusher for locally produced soybean is rising. Farmers sell soybean without grading and some farmers are forced to sell their products to their lenders to repay debt. Prevalent low prices do not motivate production expansion, particularly when coupled with less competitiveness and fewer local buyers.

The case study of local soybean processing was conducted with the co-operation of the one crushing mill in the province. Most supply comes from imports. The company is currently building one more crushing mill and an oil silo. Constraints are in the form of the quality of the local soybean, which is contaminated with foreign materials and, in a year of a high buying price, the price for soy oil cannot be raised due to government control.

Potentials exist for simple processing of traditionally fermented Chinese soybean by farm housewife groups to increase processed production as well as marketing. Production techniques, product standardization and packaging development are all required.

In terms of maize farmers in Nakhonsawan, the average farm family size of the surveyed farmers is four with 53.6 per cent of the family members engaged in farming. Eighty-point-four per cent of the farmland is owned by farmers and 19.6 per cent is rented. Maize is grown twice annually. In some areas, maize is planted to replace minor rice. Rainy

season maize constitutes the farmers crop preference (77-88 per cent). The cropping system entails no maize monoculture. Farmers who have only one plot of farmland diversify crops on the same plot, for example, sorghum is grown after maize. Farmers with several plots cultivate several crops simultaneously. After harvesting some farmers grow either the same crop again or switch to another in line with market demand. For example, mung bean/soybean follow major rice on plot A and a second maize crop follows the first crop on plot B. In the case of limited water availability, sorghum is sown due to its more resistant nature. On bean rotated plots, the yields of maize are higher than that of maize mono-cropping plots. Family net cash income from maize plus other crops is higher in the irrigated zone than the rainfed area.

As for the marketing channels of maize, the crop is mostly sold at the farm to local assemblers/regional traders who, in turn, forward the maize to the mills. There are plenty of buyers ready to purchase from the farmers. Unfortunately, there are no maize farmer groups to negotiate prices and most maize is harvested during the rainy season which exposes it to fungi depressing prices.

In terms of processing, most maize is used as feed. Although there are no feed mills in Nakhonsawan, the maize is supplied to mills in provinces nearby. Feed production in neighbouring Lopburi targets integrated poultry farming.

The government has often implemented market intervention schemes in a year of depressed prices and a production credit service is provided by BAAC. In the area of trade, Free Trade Area agreements have been settled with a number of countries boosting exports of cassava products.

Thailand has the potential for sustainable farm diversification development as most farm producers are diligent and have accumulated substantial farm experience. The potential is highest when there is an on-farm irrigation pond. In terms of infrastructure, roads reach all the villages. Conversely, the constraints are numerous too, for example, landlessness and the small size of landholdings. Tenancy issues do not bode well for farm improvements due to the lack of collateral for credit allocation and the lack of incentives for farmers to produce. Harvesting is usually concentrated around the main harvesting periods and as a result, prices are often depressed since there is no market arrangement.

An appropriate strategy for the further development of diversified agriculture and policy intervention is required. Farm pond development and efficient water resource management are needed. The existing Village Fund programme should be amended to

extend the payment period for farm loans. Community centres to transfer technology, involving farmer training and discussion with state agents, farm visits and information updates are also required as well as co-ordinate production and consumption planning. The production and use of cheaper organic fertilizers should be encouraged and the degraded forest areas should be reallocated for farming with land rights assured for use as loan guarantees and to provide incentives for the rural youth to have more interest in farming.

In terms of policy recommendations to alleviate poverty through agricultural diversification, a farm diversification programme should be implemented as part of the government support programme. Recommendations of cropping patterns and the appropriate choice of crops in accordance with particular physical circumstances should be formulated. Suggestions of planting time/crop calendar and farm investment have to be suitable for farmers' economic conditions. Group planning for farm decision-making would lead to production that is well distributed. Of course, variety is crucial in processed products. The existing farmland distribution programme requires review to pick up the pace. Furthermore, leasing periods should be extended and product R&D has to become more active. Local brand names associated with quality and grade standardization require promotion, including a distribution network and supply management. Food safety implementation is a must and the processing of wastewater should be encouraged to produce biogas to limit environmental degradation and reduce manufacturing costs.

1. Introduction

Among the variety of food crops produced in Thailand, there are several types of CGPRT crops. The cereals grown consist of maize, sorghum and Job's tear. The tubers include cassava, potato, taro and yam, among others. The pulses comprise of soybean, mung bean, peanuts and others. Among these CGPRT crops, cassava and maize are the most common grown in Thailand. Demand is greater than supply is the case of soybean, despite it being more widely grown than other pulses.

Both monoculture and multi-cropping co-exist in Thailand. Cropping practices depend very much on several supporting factors, namely the size of farm holdings, agro-climatic conditions and water sources, among others.

During the past several decades, CGPRT crops have often encountered depressed prices, due to poor harvests as well as global demand and supply changes which impact farm income. The farm productivity of many CGPRT crops is still low, principally caused by crop repetition on the same plot, and fewer soil improvements than the combined effects of deterioration and erosion.

One possibility to overcome the outstanding obstacles is to diversify the number of crops in a particular growing season or to diversify with second crop during a second growing period. Processing also creates demand and as a result, CGPRT cropping could become sustainable and help mitigate poverty.

1.1 The first phase study's main findings

Three crops, namely cassava, maize and soybean were studied and the findings are summarized as follows:

1.1.1 Production trends

The areas planted with cassava, maize and soybean shrank during the last decade due to competition from sugar cane. However, production has increased due to the government's promotion programme stressing the use of high yield varieties (HYV). In spite of an increase in yield, soybean planted area and production have declined due to the poor price incentive to produce.

Quantitative analysis found that the current degree of diversification in Thailand using the Simpson Index of 10 crops grown in upland areas, namely cassava, maize, soybean, sugar cane, sorghum, mung bean, peanuts, sesame, cotton and kenaf, was 0.79 in 1993 and 0.77 in 2002 implying little diversification among these 10 crops.

1.1.2 Local consumption and exports

With little local consumption, 80 per cent of cassava products are exported as pellets, chips and starch. The chips and starch have increasing export trends but pellet exports are declining.

In terms of maize, 98 per cent is consumed locally, mostly as feed, with little exports. Soybean production satisfies 13 per cent of total demand and is primarily used to produce soy milk and a variety of foods. Imports are usually used for crushing purposes.

1.1.3 Effect of trade liberalization

Trade liberalization through WTO and AFTA has done little to enhance Thai maize exports. However, demand from Thailand's neighbouring countries has risen and production potentials exist. Cassava exports, flour and starch in particular, have risen in both the European Union (EU) and ASEAN markets, boosting processing.

Reductions in tariffs increased soybean imports and consequently, locally produced soybean has been affected. Cultivation dropped off as the costs of locally produced soybean are higher than the prices of imported soybean. Having a higher protein content and better freshness, locally produced soybean is usually used for direct consumption.

1.1.4 Constraints to agricultural diversification

Agricultural diversification has various benefits such as ameliorating food supply for poor farm families, improving the quality of food intake, mitigating risks emanating from price fluctuations and drought, and creating more local employment, among others.

Constraints to farm diversification include the smallness of landholdings; the agro-climatic conditions, which do not favour multiple cropping and the fact that diversified agriculture on the same plot usually does not favour mechanization. Moreover, family labour availability for multiple cropping also needs to be considered.

1.1.5 Driving forces for agricultural diversification

Driving forces include the nature of farmers in Thailand who are always industrious, persistent and willing to work step-by-step to improve their farming systems.

Soil deterioration, as a result of repetitive cropping, forces farmers to improve soil fertility by diversifying to other crops. Suitability of the soil and the topography are also driving forces of diversification.

1.1.6 Steps to promote major secondary crops

Maize

- Develop the dry season maize crop (second maize) in low-lying paddy fields. Maize requires less water, commands a higher price and is not affected by alflatoxins; and
- Supplement household income by exploiting farm residuals, for example produce charcoal from maize cobs and make handicrafts.

Cassava

- Improve the soils with green manure or chicken manure;
- Transfer appropriate farm technology;
- R&D and field test technology suitable for certain soil groups. Conduct farm trials of chemical fertilizers applied in conjunction with organic fertilizers to enhance cassava yields in various soil groups;
- Promote clean chip production extending technology to the farmers/co-operatives; and
- Encourage swine, cattle and dairy farmers to add more cassava slices to the feed.

Soybean

- Conduct farm trials of appropriate technology in each producing area and extend the proven technology to the farmers located in the area;
- Encourage soybean cultivation before and after the first rice crop in potential areas; and
- Conduct R&D activities for the high yielding cultivars with shorter duration and resistance to the hot and humid climate.

1.1.7 Diversified use of crops

Demand for maize, cassava and soybean for both domestic consumption and exports have continued to increase. Thailand has the potential to produce more maize and cassava, having already distributed the improved seeds and saplings to 80 per cent - 90 per cent of the producing areas. The WTO Agreement on Agriculture offers more export

opportunities and the soaring fuel prices act as a driving force for seeking alternative power from organic sources. In addition, the three mentioned crops are, hitherto, not processed leaving high potential for processing.

To this end, local processing should be promoted and included in the OTOP Project designed to sustainably develop local communities with more job opportunities utilizing the local resources to produce unique, standardized products. To promote local processing, the following measures should be applied:

1. Provision of new processing technologies, package design and training for the co-operatives;
2. Support the farmer groups to operate their own processing enterprises and create brand names for their top products and farmer groups; and
3. Continue to promote marketing activities such as merchandising, and arrange exhibitions both locally and abroad.

1.1.8 Guidelines for the future development of sustainable agriculture

1. Promote the introduction of various methods of sustainable agriculture as part of the agricultural restructuring programme and in the degraded land rehabilitation scheme. The method of promotion includes extension of the information, training, support and technology for adequate farm earnings.
2. Construction of farm ponds and improving irrigation should be prioritized. Provision of marketing services and farm inputs are also necessary for sustainable farm restructuring.
3. Readjustment of the farm extension programme, primarily to change the role of the extension organizations from technology transfer to a co-ordination role between the various stakeholders;
4. Bolster the role of the private sector and NGO's in the market and improve their management skills;
5. Support the farmer processing groups to use their own products for added value and increase their income through training on the processing technology, including investment in processing infrastructure;
6. Improving raw material supply for processing activities in the private sector through farmer participation in the corporate network;
7. Support the use of the organic fertilizers to improve the soils;
8. Support the reduction of soil erosion from repetitive cropping;

9. Support new crops which have the market potential to be cultivated with CGPRT crops;
10. Support processing, value added and the other income generating activities, such as the use of cassava leaves for feed; and
11. Support the processing of diverse products, for example ethanol from cassava.

1.2 Research issues

The first issue involves the analysis of production costs, income and profit of secondary crop farm households. The cropping patterns under survey include mono-cropping and multiple cropping of cassava, rice, maize and soybean. Multiple cropping means that farmers cultivate CGPRT crops in combination with other crops during the same growing season or that they cultivate additional crops in the second season. The potentials and constraints of these crops are also investigated.

Analysis is made on processing costs, revenue and profit of the related industries together with their potentials and constraints.

1.3 Study objectives

- Analyse constraints and opportunities faced by farm growers to diversify production;
- Analyse constraints and opportunities facing households and small-scale farmers to enhance diversification of production and consumption of CGPRT products;
- Investigate the industrial importance of CGPRT crops and products in the market and diversified ways of consuming them;
- Quantitatively analyse the impact of diversified agricultural systems on the rural economy, welfare and the environment;
- Analyse government policies, institutional arrangements and local factors that determine the use of local CGPRT crops for agricultural processing; and
- Formulate strategic proposals and measures to counter the inhibiting factors of CGPRT crops in production expansion and their industrial absorption at the national and local levels.

1.4 Scope of the study

Surveys of farmers growing cassava, maize and soybean were conducted in the producing regions: cassava in Nakhonratchasima, maize in Nakonsawan and soybean in Sukhothai. In the surveys, data for 2004 regarding production costs, earnings and expenditure were collected.

Traders and processors of farm products under study in the four provinces were surveyed. The industries surveyed include cassava flour, modified starch, clean chip drying yards, and farmer groups processing cassava and soybean. Data pertaining to processing costs and income in 2004 was also collected.

1.5 Formation of the study teams

1.	Mrs. Nareenat Roonnaphai	Team leader
2.	Miss Grittiga Akanittapichat	Member
3.	Mrs. Patchara Krittaphol	Member
4.	Miss Chalawjit Ruangwises	Member
5.	Miss Panee Pattamawipak	Member

2. Conceptual Framework and Methodology

2.1 Conceptual framework

2.1.1 Mechanics of agricultural diversification

The concept of agricultural diversification involves cropping patterns that stress aversion of farm risks from natural disasters and price volatility. As a result, farmers are empowered to earn and secure a stable living with household food security. To achieve these ends, farmers have to allocate their farm resources to diverse agriculture, forward their farm products directly to the processors or process part of the produce individually, initially with simple processing methods, with the purpose of direct family consumption and conservation or toward value-added commercialization. The farmer's decisions are resource-based and determined by their preparedness. After all, diversification will effect the community's ecological system and actually buttress economic activities too.

2.1.2 Theory of cost

A producer has to determine a level of input that will maximize profit, by which the decision is based on basic information leading to a profit equation that correlates income, expenditure and production costs.

Explicit and implicit costs

In the cost studies, classification of farm resources and outsourcing was made. Paid inputs constitute explicit costs while expenditure arising from the use of farm resources may be categorized as implicit.

Fixed costs and variable costs

Aside from explicit and implicit costs, classification of production costs is divided into fixed and variable costs.

Fixed costs. Fixed costs do not vary according to production. One unit or more than one unit of production has the same amount of fixed costs, which have to be expended irrespective of the production level. Fixed costs include depreciation, interest, taxes and building insurance.

Variable costs. This includes all other costs, which are not fixed, for example the input cost of fertilizer, labour, pesticides and others.

Total cost. Is the total of variable costs plus fixed costs.

Average fixed costs. Are obtained by averaging the fixed cost per unit production. The formula is:

AFC = TFC/TP

Where; AFC = Average Fixed Costs
TFC = Total Fixed Costs
TP = Total Production

Average variable costs. Are the input costs in relation to one unit of production and play an important role in production decisions. It can be calculated using the following formula:

AVC = TVC/TP

Where; AVC = Average Variable Cost
TVC = Total Variable Cost
TP = Total Production

Average total cost. Is the total cost of every item averaged per one unit of production. It may be estimated using two formulae as follows:

ATC = AVC + AFC

ATC = TC/TP

ATC = Average Total Cost

Where; AVC = Average Variable Cost
AFC = Average Fixed Cost
TC = Total Cost
TP = Total Production

When AFC and AVC decline, ATC follows. At the lowest point of ATC, the optimum rate of output is obtained.

2.1.3 Farm return analysis

The analysis requires an indicator of production performance. The concept is to analyse the farm costs and income, which are sub-divided as follows:

Farm cost and return

The farm cost and return analysis is an attempt to estimate the farm income generated from the annual production cycle, which can be formulated as follows:

Net cash farm income = Gross farm income – Cash farm expenses

Family income and expenditure

In the analysis, non-farm income and expenditure are accounted. The analysis is used to visualize net cash farm income added to non-farm income to give the total cash used for household spending. It can be estimated as follows:

Net cash household income = Net cash farm income + Non-farm income

2.2 Research methodology

2.2.1 Selection of crops

Cassava, maize and soybean are the three crops selected for study.

2.2.2 Selection of research sites

The survey site for cassava is in Nakhonratchasima; for soybean is in Sukhothai, which represents the highest soybean production concentration; and for maize in Nakhonsawan, the major producing area.

2.2.3 Selection of respondents

The sample farmers were purposely selected and the size of farm holdings were between 0.8 and 4.8 hectares. In a production area, irrigated and non-irrigated farms growing the same CGPRT crops were surveyed as well as diversified farms growing several CGPRT crops both concurrently and consecutively.

Traders, processors and processing farmer groups were selected based on the following criteria:

- Traders of CGPRT crops in the localities were selected;
- The flour and modified starch industries and the clean chip drying yards in Nakhonratchasima, the crushing mills in Sukhothai and feed mills in Lopburi were selected;

- A farmer group in Nakhonratchasima processing dried lodchong made of cassava and the group processing Chinese soy grain sauce in Sukhothai were selected; and
- Staff of the concerned government agencies.

2.2.4 Time frame of the study

Data related to cost, profit, income and expenditure in 2004 was collected.

2.2.5 Method of analysis

Collection of the data

Primary data concerning farm production and processing costs were gathered through interviews with the farmers, traders, processors and processing farmer groups.

Secondary data was collected from field staff of the relevant agencies.

Method of analysis

Both descriptive and quantitative analyses are applied. Descriptive analysis is applied to profiles of the study sites and profiles of the respondents and their households as well as analysis of the farming system, marketing system and processing businesses of the three products.

Quantitative analysis utilizes statistical analyses of cost, returns and net profit of the farms under study. The formulae used in the analyses are as follows:

- Cost analysis

  Total Cost (TC) = Variable Cost (VC) + Fixed Cost (FC)

  Costs are estimated on a per hectare basis for each crop of all farms, which are then averaged by the number of farms in the sample.

$$TC = \frac{\Sigma Ci}{N}$$

Where; TC = Total cost of a crop
Ci = Cost of a crop on farm i
N = Number of farms

- Farm return analysis

  Farm return analysis involves estimation of household income and expenditure as follows:

  Farm household income = Farm income + Non-farm income

  Net cash farm income = Cash farm income – Cash farm expenses

  Net cash household income = Net cash farm income + Non-farm income

3. Profiles of the Study Sites, the Respondents and Their Households

3.1 Profiles of the study sites

3.1.1 Nakhonratchasima province

Geographic and administrative setting

Geographic

Nakhonratchasima is located in the Northeast of the country on the Korat Plateau. The provincial area is the largest with an area of 2,049,396 hectares, which constitutes, 12.12 per cent of the region. It's adjoining provinces are:

To the north Chaibhume and Khonkaen

To the south Prajinburi, Nakhonnayok and Srakeow

To the east Buriram and Khonkaen

To the west Saraburi, Chaiyabhume and Lopburi

Administrative setting

Nakhonratchasima is locally administered into 26 *amphoe*, 6 *subamphoe*, 287 *tambon* and 3,645 *muban*.

Demographic profile

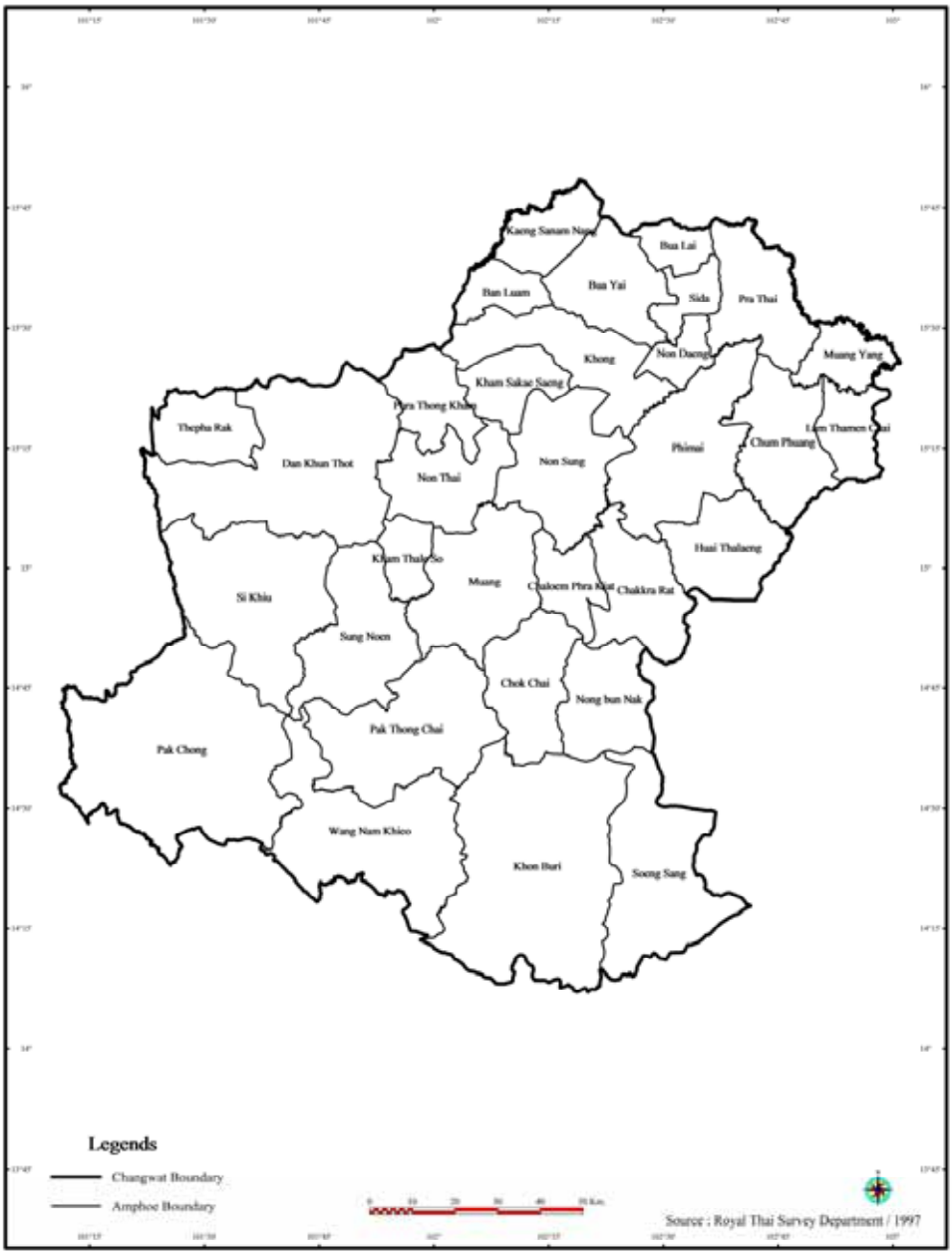
Population

In 2003, the provincial population was second highest in the country and highest in the Northeast. The population of 2,590,950 was comprised of 1,284,898 males; or 49.59 per cent and 1,306,152 females; 50.41 per cent. Under 15 year olds accounted for 557,733; 15-60 year olds represented 1,689,983 and the over 60s totalled 343,234 or 21.5 per cent, 65.2 per cent and 13.3 per cent of the total population respectively. The population is most dense in *amphoe* Muang, the city seat and most sparse in *amphoe* Banleum.

Population density

The population density in 2003 was 126/sq km. In *amphoe* Muang it was 579/sq km followed by 355/sq km in *amphoe* Kaengsanamnang. Conversely, population density was lowest, at 16/sq km, in *amphoe* Chakraraj.

Figure 3.1 Nakhonratchasima map



Source: Royal Thai Survey Department, 1997.

Economic profile

Gross provincial product. Nakhonratchasima's economy continues to grow both in terms of farm production and higher prices received. Moreover, industry is steadily expanding too and the two sub-sectors which enjoyed the most investment and absorbed the most employment were the electronics and auto parts sub-sectors. GPP in 1999 was US$ 2,354.73 million growing to US$ 2,776.57 million in 2003, with 3.83 per cent of the growth attributable to agriculture and non-agriculture. In 1999, the agricultural sector reported GPP at US$ 360.60 million which grew to US$ 451.89 million in 2003 or 5.98 per cent, while non-agricultural GPP was US$ 1,994.13 million in 1999 and US$ 2,324.68 million in 2003, representing 3.44 per cent growth (Table 3.1).

Table 3.1 Gross Provincial Product (GPP) at current market prices in Nakhonratchasima, 1999-2003 (million US$)

Year	Agricultural	Non-agricultural	Total
1999	360.60	1 994.13	2 354.73
2000	325.37	1 959.59	2 284.96
2001	319.02	1 817.29	2 136.31
2002	370.35	2 021.88	2 392.23
2003	451.89	2 324.68	2 776.57
Annual growth rate (%)	**5.980**	**3.438**	**3.826**

Source: The National Economics and Social Development Board, 2004.

Consumer spending. Farmer expenditure on consumption increased following the higher prices received for the province's major crops, namely rice and cassava, in addition to prevailing industrial growth. Consequently, both the business operators' and the general public's spending also grew.

Agricultural profile

Agriculture. Of the provincial population of 2.59 million in 2003, 75 per cent were engaged in farming on 1.43 million hectares of farmland. In 2003/2004 alone, the planted area accounted for 69.99 per cent of total provincial area, with 0.68 million hectares (47.64 per cent) assigned to paddy field crops, vegetables and ornamentals. The major crops produced are rice, cassava and sugar cane (Table 3.2).

The harvested area of cassava in 2004 was 0.22 million hectares, or 36.03 per cent of the total provincial area planted with upland crops or 22 per cent of the national planted area.

Over the last decade, 1995/1996-2004/2005, the province's cassava harvested area has shrunk from 0.269 million hectares to 0.221 million hectares (2.5 per cent) attributable to the CAP reform in the pellet importing EU. However, the introduction of HYV raised

cassava yields from 14.83 tons/ha in 1995/1996 to 19.90 tons/ha in 2004/2005 or annual growth of 3.83 per cent, driving total production from 3.99 million tons in 1995/1996 to 4.39 million tons in 2004/2005; 1.23 per cent growth (Table 3.3).

Table 3.2 Planted area in Nakhonratchasima, 2003/2004

Description	Area (ha)	Percentage of farmland
Provincial area	2 049 396	-
Farmland	1 434 360	100
Paddy	683 266	47.64
Field crops	620 842	43.28
Fruit crops and tree crops	70 437	4.91
Vegetables	9 256	0.65
Flowers and ornamentals	1 757	0.12
Other	48 802	3.40

Source: Nakhonratchasima Provincial Agricultural Office, 2004.

Table 3.3 Cassava: Area, production and yield in Nakhonratchasima, 1995/1996-2004/2005

Year	Harvested area (hectare)	Production (tons)	Yield per hectare (tons) Per harvested area
1995/1996	269 254	3 994 860	14.837
1996/1997	265 526	4 092 413	15.412
1997/1998	239 396	3 647 789	15.237
1998/1999	244 655	3 841 089	15.700
1999/2000	253 463	4 220 157	16.650
2000/2001	218 177	4 088 100	18.738
2001/2002	210 547	3 796 432	18.031
2002/2003	215 826	4 130 378	19.138
2003/2004	221 583	4 470 428	20.175
2004/2005	220 599	4 389 914	19.900
Annual growth rate (%)	**-2.501**	**1.233**	**3.829**

Source: Agricultural Statistics of Thailand 1998-2005.

Livestock. The province had a livestock population of 20,166,615 heads in 2003 sliding 3.54 per cent from 2002. However, the value was US$ 99.66 million in 2003, an increase of US$ 4.40 million over 2002. The four largest livestock populations include chicken, duck, cattle and swine, accounting for 93.50 per cent, 2.93 per cent, 1.69 per cent and 1.53 per cent of the total livestock population respectively (Table 3.4).

Table 3.4 Provincial livestock population, 2002-2003

Type	Heads, birds	
	2002	2003
Chicken	19 836 842	18 854 021
Duck	404 929	590 043
Cattle	329 811	340 828
Hog	267 040	308 412
Buffalo	63 304	66 778
Horse	1 649	1 882
Sheep	1 610	1 540
Goat	328	164
Goose	2 442	2 947
Total	**20 907 955**	**20 166 615**

Source: Nakhonratchasima Provincial Livestock Office, 2004.

Fisheries. Inland fisheries involve the culture of snake-head fish, catfish, tilapias, gourami, soft turtles, frogs and crocodiles. In 2003 the number of fisheries operators was 24,128 on 3,351 hectares of pond area and achieving total catches of 2,480 tons. In addition, the capture from natural water sources amounted to 5,579 tons.

Extent of unemployment and poverty

Unemployment. The employed population (1.369 million in 2001) rose by 3.11 per cent to 1.514 million in 2004 as a result of increases in the population and the rising number of economically active people (Table 3.5).

Unemployment, which represented 21,164 in 2001, rose to 26,622 in 2004 at an annual rate of 12.31 per cent. Regarding gender, while the majority of the population is male, unemployment growth during 2001-2004 consisted of more females than males. Female unemployment grew by 22.17 per cent, but unemployment male grew by only 7.73 per cent (Table 3.6).

Extent of poverty

Poverty line. Rural poverty is measured based on the poverty line as the indicator formulated from minimum requirement standards concerning the necessary food and goods to sustain a living person. The unit of measurement is US dollar per head per month.

Therefore, poor refers to a person existing below the poverty line or a person earning inadequately to satisfy the minimum food and goods requirement.

For the past five years (1998-2002) Thailand's poverty line has been set at US$ 21.14-22.20 per month and the number of poor has declined by 6.45 per cent from 7.90 million in 1998 to 6.22 million in 2002. The region inhabited by most of the poor people is the Northeast, followed by the North, the South, the Central and Bangkok and its perimeter respectively (Table 3.7).

Of the 19 provinces making up the northeast region, Nakhonratchasima represents 9.5-12.5 per cent of the poor population among the provinces of the region earning below US$ 21.14-22.20 per month. The provincial poor population declined by 8.7 per cent from 0.565 million in 2000 to 0.47 million in 2002 due to a number of public projects launched to increase farm productivity, income and access to capital sources (Table 3.8).

Table 3.5 Population by labour force status in Nakhonratchasima, 2001-2004 (person)

Labour force status	2001		2002		2003		2004		Growth rate (%)
	Population	(%)	Population	(%)	Population	(%)	Population	(%)	
Total population	**2 678 752**	**100**	**2 698 309**	**100**	**2 717 824**	**100**	**2 720 065**	**100**	**0.53**
1. Over 15 years old	1 956 950	73.05	1 982 132	73.46	2 006 877	73.84	2 016 222	74.12	1.02
1.1 Total labour force	1 391 435	51.94	1 469 653	54.47	1 494 306	54.98	1 555 753	57.20	3.53
a. Current labour force	1 390 121	51.89	1 469 653	54.47	1 484 397	54.62	1 540 971	56.65	3.30
- Employed	1 368 957	51.10	1 454 227	53.89	1 459 640	53.71	1 514 349	55.67	3.11
- Unemployed	21 164	0.79	15 427	0.58	24 757	0.91	26 622	0.98	12.31
b. Seasonally employed	1 314	0.05	-	-	9 909	0.36	14 782	0.55	418.73
1.2 Economically inactive	565 515	21.11	512 478	18.995	12 571	18.86	460 469	16.92	-5.98
2. Persons under 15 years	721 802	26.95	716 177	26.54	710 947	26.16	703 843	25.88	-0.83

Source: National Statistical Office, 2005.

Table 3.6 Unemployed people by sex in Nakhonratchasima, 2001-2004 (person)

Description	2001		2002		2003		2004		Growth rate 2001-2004 (%)
	Population	(%)	Population	(%)	Population	(%)	Population	(%)	
Total unemployment	21 164	100	15 427	100	24 757	100	26 622	100	12.31
Male	14 032	66.30	12 079	78.30	13 411	54.17	17 366	65.23	7.73
Female	7 132	33.70	3 348	21.70	11 346	45.83	9 256	34.77	22.17

Source: National Statistical Office, 2005.

Table 3.7 The poverty line and the poor population by region in Nakhonratchasima, 1998-2002

Year	National poverty line ($/month)	Number of poor people (millions)	The poor population by region in millions				
			The North	The Central	The Northeast	The South	Bangkok and its perimeter
1998	21.14	7.90	1.01	0.80	4.91	1.18	0.01
1999	21.33	9.90	1.18	0.75	6.55	1.35	-
2000	21.24	8.90	1.37	0.63	5.93	0.92	0.02
2001	22.06	8.20	1.20	0.54	5.19	1.14	0.02
2002	22.20	6.22	1.11	0.52	3.77	0.74	0.04
Annual growth (%)	**1.32**	**-6.45**	**2.08**	**-11.22**	**-7.33**	**-10.44**	**51.57**

Source: The National Economics and Social Development Board, 2004.

Table 3.8 Comparison of the poor population of the Northeast and Nakhonratchasima, 2000-2002

Year	The Northeast (million people)	Nakhonratchasima (million people)	Percentage of the region
2000	5.93	0.565	9.53
2001	5.19	0.585	11.27
2002	3.77	0.471	12.49
Annual growth (%)	**-20.27**	**-8.70**	

Source: The National Economics and Social Development Board, 2004.

Extent of environmental problems

- Garbage disposal. Nakhonratchasima has the second largest provincial population. The province acts as a passage of travel to other provinces in the region and large crowds of tourists, foreign and local, visit the province bringing with them substantial amounts of garbage. In the case of inactive disposal, the environment is affected detrimentally.
- Water pollution. Since the province accommodates various industries, some of which, for example the flour mills, consume a lot of water. Consequently, large volumes of water become spoiled and the lack of adequate drainage systems causes concern.
- Population concentrations have lead to the rise of many slums with no infrastructure or management.
- Vast areas of deforested land cause flooding on the farmlands and in rural villages.

Condition of public infrastructure relevant to CGPRT farming and related industries

Infrastructure

Cassava tubers, when harvested, must be transported and processed as expeditiously as possible due to their perishable nature. Therefore, the major public

infrastructure are the feeder roads leading to drying yards and flour mills which are readily available. The only obstacle is a shortage of trucks at times of peak cassava supply.

Industrial infrastructure

The cassava industry in Thailand includes the following:

- 88 chip drying yards
- 16 pellet plants
- 12 flour mills
- 4 modified starch plants
- 2 ethanol plants

All of the facilities listed belong to the private sector. While the drying yards are scattered around in the cassava producing areas, most of the remaining plants are located in the seat of the *amphoe* and in the provincial city. During periods of large cassava supply flow, specifically December through February, the industries' absorption capacity is inadequate for the volume of daily farm sales. However, in the low season; May to August, marketed root supply is less than industrial demand.

3.1.2 Sukhothai province

Geographic and administrative setting

Geographic

Situated in the lower north of the country, Sukhothai represents an area of 659,609 hectares, of which 60.7 per cent is low-lying, suitable for farming and the remaining 39 per cent is mountainous and highland. Sukhothai shares its borders with the following provinces:

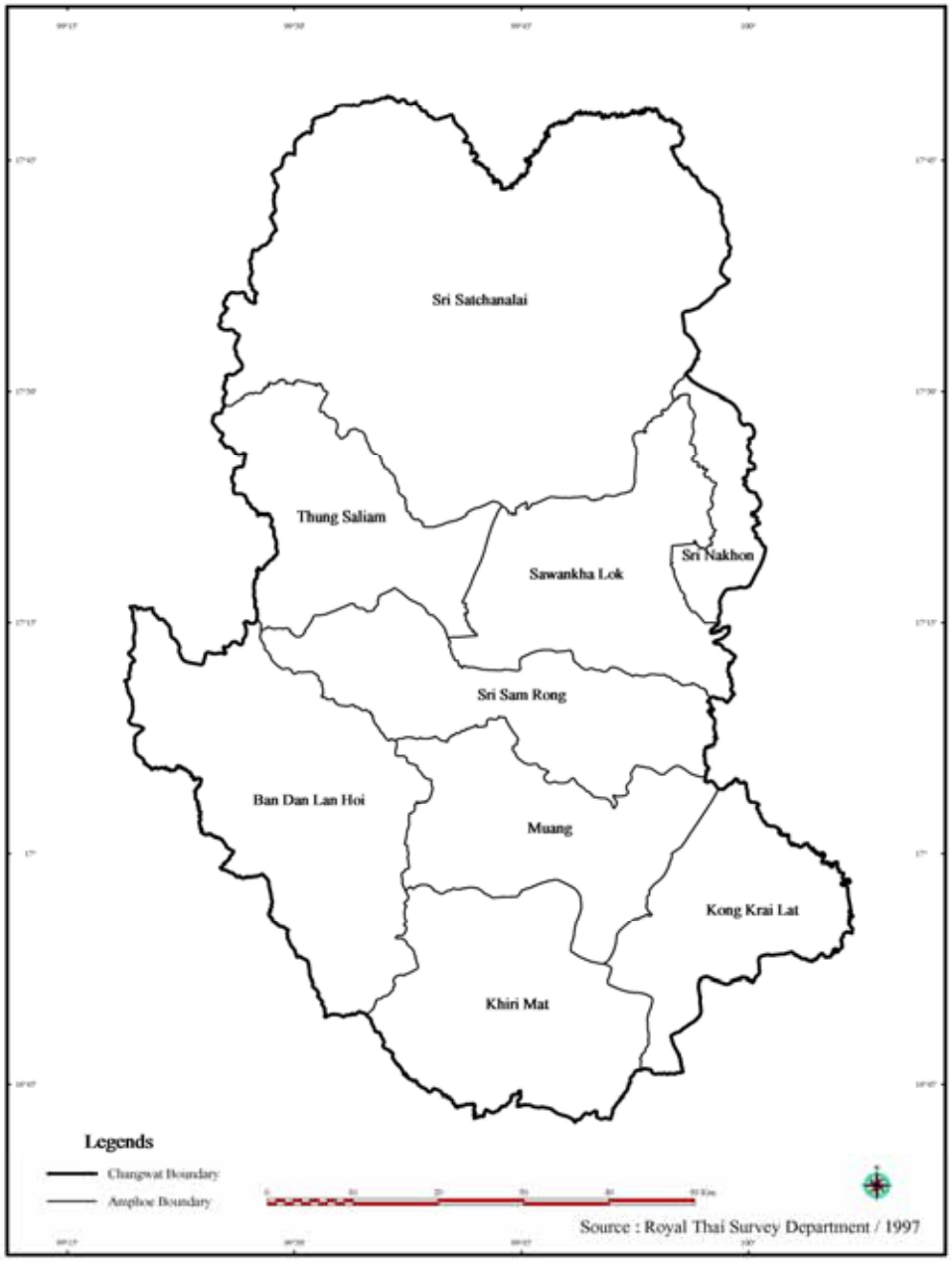
To the north Utaradit and Prae

To the south Kampaengpet and Pitsanulok

To the east Pitsanulok and Utaradit

To the west Tak and Lampang

Figure 3.2 Sukhothai map



Source: Royal Thai Survey Department, 1997.

Administrative setting

The Sukhothai administrative jurisdiction covers 9 *amphoe*, 84 *tambon* and 825 *muban* totalling 168,331 families.

Demographic profile

Population

The population of Sukhothai was 595,971 in 2003, with 292,641 males (49 per cent) and 303,330 females (50.9 per cent). People over 15 years old totalled 461,165, (77.4 per cent) while those under 15 totalled 134,806 (Table 3.9).

Table 3.9 Population by sex and age in Sukhothai, 2003 (person)

Item	2003		
	Total	Male	Female
Total population	595 971	292 641	303 330
Persons over 15 years of age	461 165	224 268	236 897
Persons under 15 years of age	134 806	68 373	66 433

Source: National Statistical Office, Office of the Prime Minister, 2004.

Population density. Population density in the province is 95/sq km. The population is most concentrated in *amphoe* Muang (190/sq km), and least dense in *amphoe* Danlanhoy (45/sq km).

Economic profile

The gross provincial product (GPP) was 488.6 million baht (US$ 12.91 million) in 1999, with 123.9 million baht (US$ 3.28 million) contributed by agriculture and 364.7 million baht (US$ 9.64 million) by non-agriculture. The GPP rose to 515.84 million baht (US$ 12.42 million) in 2003, with 136.4 million baht (US$ 3.28 million) from agriculture, and 379.5 million baht (US$ 9.41 million) from the non-farm sector. The rate of economic growth was 0.7 per cent per annum during 1999-2003 with more farm growth (1.41 per cent) than non-farm growth (0.45 per cent).

In terms of US dollars, economic growth declined at a rate of 1.8 per cent. (Table 3.10)

Table 3.10 Gross Provincial Product (GPP) at current market prices in Sukhothai, 1999-2003 (million baht)

Year	Agriculture		Non-Agriculture		Total	
1999	123.94	(US$ 3.28)	364.72	(US$ 9.64)	488.66	(US$ 12.91)
2000	115.24	(US$ 2.87)	356.35	(US$ 8.87)	471.59	(US$ 11.74)
2001	116.86	(US$ 2.63)	330.33	(US$ 7.43)	447.19	(US$ 10.05)
2002	109.49	(US$ 2.55)	344.30	(US$ 8.01)	453.79	(US$ 10.55)
2003	136.38	(US$ 3.28)	379.46	(US$ 9.14)	515.84	(US$ 12.42)
Growth (%)	**1.411**	**(-1.175)**	**0.449**	**(-2.063)**	**0.700**	**(-1.826)**

Source: The National Economics and Social Development Board, 2004.

Agricultural profile

The provincial area of 0.66 million hectares consists of 0.33 million hectares of farmland; or 50 per cent of the total area, mostly (63.2 per cent) devoted to rice, followed by field crops (24.9 per cent) (Table 3.11).

Table 3.11 Planted area in Sukhothai, 2003/2004

Description	Area (hectares)	Percentage of farm area
Provincial area	659 609	
Farm holdings	330 479	100
Major rice	208 733	63.16
Field crops	82 558	24.98
Fruit and tree crops	36 582	11.07
Vegetables	2 014	0.61
Flowers and Ornamentals	141	0.04
Other	451	0.14

Source: Sukhothai Provincial Agricultural Office, 2004.

The major crops include rice, sugar cane, maize, soybean, tobacco and hot chilli. Over the past 10 years, the area planted to soybean shrank annually by 12.5 per cent from 77,759 hectares to 12,316 hectares because of low yields and higher production costs compared with competitive sugar cane, maize and chilli (Table 3.12). One of the farm problems regarding soybean is the high moisture content in the grains causing fungi at the time of harvest after growing initially in the rainy months.

Table 3.12 Soybean: Area, production and yield in Sukhothai province, 1994/1995-2003/2004

Year	Planted area (hectares)	Harvested area (hectares)	Production (tons)	Yield per hectare (tons) of planted area	Yield per hectare (tons) of harvested area
1994/1995	77 759	61 224	75 324	0.969	1.230
1995/1996	33 405	30 416	38 648	1.157	1.271
1996/1997	30 555	27 161	32 632	1.068	1.201
1997/1998	32 658	30 601	37 624	1.152	1.229
1998/1999	27 808	23 412	28 808	1.036	1.230
1999/2000	26 960	26 129	30 634	1.136	1.172
2000/2001	24 360	23 487	30 204	1.240	1.286
2001/2002	22 157	17 525	23 715	1.070	1.353
2002/2003	21 904	21 212	26 193	1.196	1.235
2003/2004	12 316	11 500	17 984	1.460	1.564
Annual growth (%)	**-12.513**	**-11.655**	**-10.23**	**2.605**	**1.631**

Source: Office of Agricultural Economics, 2004.

Extent of unemployment and poverty

Unemployment

The population of Sukhothai increased to 595,971 in 2003 at an annual rate of 0.24 per cent. Employment rose by 2.8 per cent to 330,266 in 2003 and unemployment fell 29.6 per cent from 7,468 in 2001 to 3,696 in 2003 (Table 3.13). Unemployment was higher among males than females (Table 3.14).

Table 3.13 Population by labour force status in Sukhothai, 2001-2003 (person)

Labour force status	2001		2002		2003		Annual growth (%)
	Quantity	(%)	Quantity	(%)	Quantity	(%)	
Total population	**593 164**	**100**	**593 270**	**100**	**595 971**	**100**	**0.236**
1. Persons over 15 years	454 144	76.56	456 623	76.97	461 165	77.38	0.770
1.1 Total labour force	325 754		316 625		336 318		1.609
a. Current labour force	319 481		316 625		333 962		2.241
- Employed	312 014		308 200		330 266		2.883
- Unemployed	7 467		8 425		3 696		-29.650
b. Waiting for seasonal employment	6 273		-		2 356		-62.436
1.2 Economically active persons	128 390		139 998		124 847		-1.389
2. Persons under 15 years	139 020	23.44	136 647	23.03	134 806	22.62	-1.527

Source: National Statistical Office, 2004.

Table 3.14 Unemployment by sex in Sukhothai, 2001-2003 (person)

Description	2001		2002		2003		Annual growth rate 2001-2003 (%)
	Quantity	(%)	Quantity	(%)	Quantity	(%)	
Total unemployment	7 468	100	8 425	100	3 696	100	-29.650
Male	3 016	40.39	5 069	60.17	3 000	81.17	-0.266
Female	4 452	59.61	3 356	39.83	696	18.83	-60.461

Source: National Statistical Office, 2004.

Extent of poverty

Using the poverty line as an indicator there were 1.11 million poor people in 2002, falling by 9.9 per cent from 1.37 million in 2001 in the North. In Sukhothai alone there were 0.49 million poor people in 2002; 4.4 per cent of the northern region. In 2000, the poor population fell to 0.049 million from 0.107 million; 32.3 per cent annual rate of reduction (Table 3.15).

In a major effort to mitigate poverty through income distribution in the regions, the government allocated US$ 7,000 to each village inhabited by poor families earning less than US$ 500 annually for career development. During 1993-2001 the project was launched in nine *amphoe*, totalling 400 villages with funds totalling US$ 300,000.

Table 3.15 Poverty comparison; the North versus Sukhothai, 2000-2002

Year	The North (million persons)	Sukhothai (million persons)	Percentage of the region
2000	1.37	0.107	7.81
2001	1.20	0.082	6.83
2002	1.11	0.049	4.41
Annual growth (%)	-9.988	-32.328	

Source: The National Economics and Social Development Board, 2004.

Extent of environmental problems

The province is affluent in terms of money and a variety of natural resources. However, the residents remain unaware of the detrimental effects and the subsequent environmental problems that emerge, for example:

- Degradation of the soil resources from the over-use of agro-chemicals.
- Water pollution caused by urban communities lacking proper treatment. The improper disposal of garbage and waste spoils rivers making them shallow.
- Poor garbage disposal is compounded by the growing population and the expansion of urban communities greatly affects the province's environment and sanitation.

Condition of public infrastructure relevant to CGPRT farming and the related industries

Rural infrastructure

Post harvest, soybean growers sell the product to traders who forward the produce to the crushers in the province or elsewhere, namely to Bangkok or Nakhon Pathum, mostly using trucks and public infrastructure, more specifically the roads. In Sukhothai all villages have feeder roads, which is an indication that the province has good infrastructure for soybean marketing.

Infrastructure of the industries

As most of the population are engaged in farming, the agro-industries of the province are dominated by small-scale industries which absorb the local farm produce, namely rice mills and grain storage, followed by transportation services, machinery and food industries. There is one oil crusher located in Sawankaloke which forwards its oil to crushers in Bangkok and the fish canning industry and soybean cakes to livestock farms and feed mills.

3.1.3 Nakhonsawan province

Geographic and administrative setting

Geographic

With a provincial area of 959.967 hectares, Nakhonsawan is located in the lower North of Thailand is bordered by:

To the north Pichit Kampaengpet

To the south Lopburi Uthaithani Chinat

To the east Petchabun

To the west Tak

Administrative setting

The local administration of the province comprises of 13 *amphoe*, 2 sub-*amphoe*, and 1,363 *muban*.

Demographic profile

Population

In 2003, the population totalled 1,126,739 with 554,317 males (49.2 per cent) and 572,482 females (50.8 per cent). The population under 15 years old was 214,983, between 15-60 years 717,499 and over 60 was 194,257 or 19.01 per cent, 73.7 per cent and 7.2 per cent of the total population respectively.

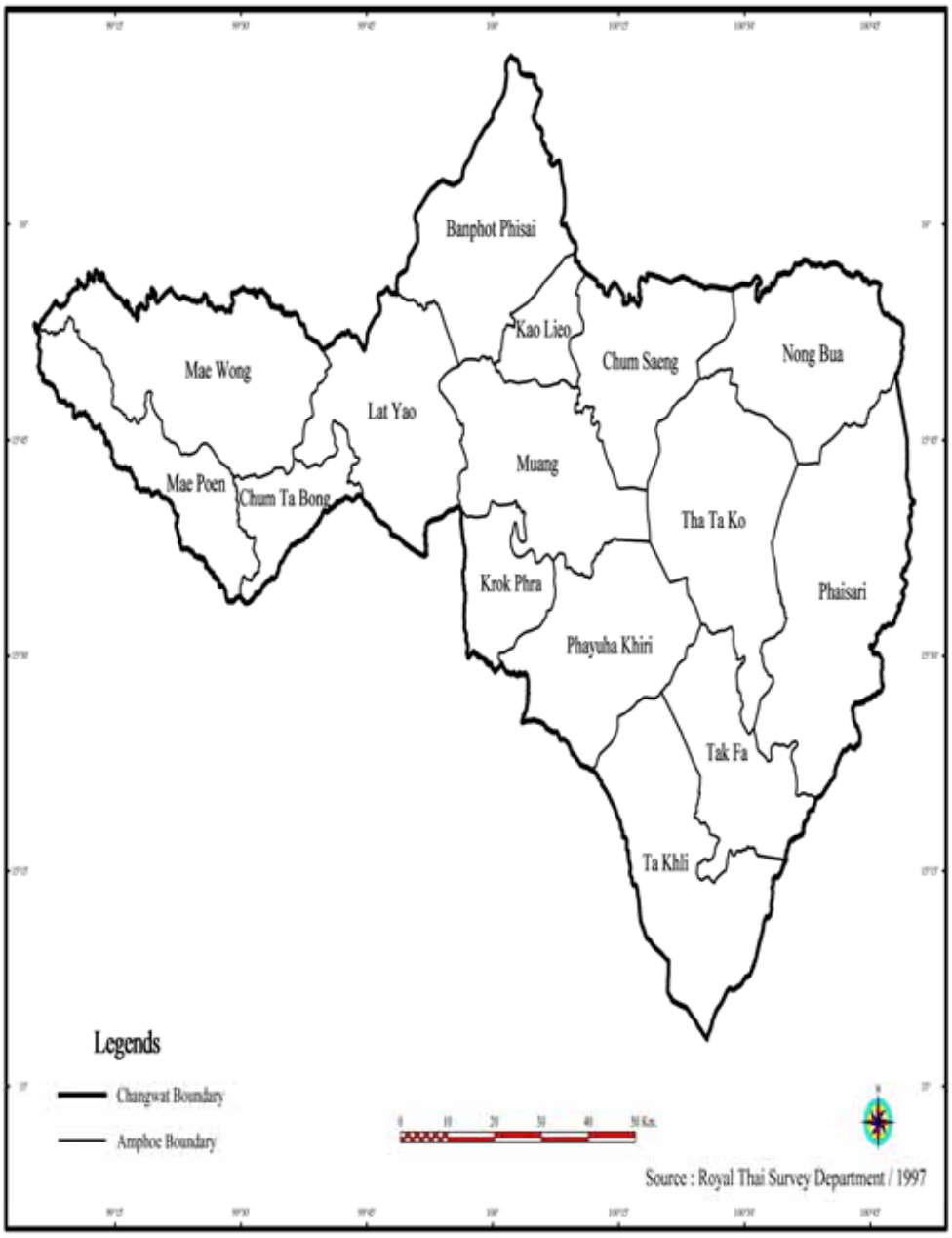
Population density

Population density averaged 117 people/sq km while it was 307 in *amphoe* Mueng.

Economic profile

GPP analysis shows that the population has an annual per capita income of US$ 1,063.88. In this respect, the province ranks 44th in the country and 6th in the North. GPP is US$ 1,319.48 million. The major source of income originates from the industrial sector enjoying highest investment and employment, especially the motor vehicle industry, wholesaling and retailing, followed by the agro-industry, specifically rice mills and feed mills. The non-farm sector grew by 6.15 per cent during 1999-2003 and the farm sector grew by 7.6 per cent in the same period due to the expansion of planted area of rice and field crops, namely sugar cane, cassava and maize (Table 3.16).

Figure 3.3 Nakhonsawan map



Source: Royal Thai Survey Department, 1997.

Table 3.16 Gross Provincial Product (GPP) at current market prices in Nakhonsawan, 1999-2003 (millions of US$)

Year	Agriculture	Non-agriculture	Total
1999	212	834.12	1 046.42
2000	226.10	783.48	1 009.58
2001	245	802.21	1 047.22
2002	253.26	934.43	1 187.70
2003	289.89	1 029.59	1 319.48
Annual growth rate (%)	**7.642**	**6.155**	**6.462**

Source: The National Economics and Social Development Board, 2004.

Agricultural profile

Crop. The province in 2004 had a planted area of 0.570 million hectares; 59.4 per cent of the total area. The area planted with rice totalled 0.3 million hectares; 63 per cent of the farmland. Rice contributes the largest share of income to the province and the region, followed by field crops (Table 3.17).

Maize, a major crop, has seen its planted area shrink from 0.094 million hectares in 1995 to 0.087 million hectares in 2004 due to competition from sugar cane and cassava. However, the maize yield increased from 3.07 tons/ha in 1995 to 3.8 tons/ha in 2004 due to the adoption of HYV (Table 3.17).

Table 3.17 Maize: Area, production and yield in Nakhonsawan, 1995-2004

Year	Planted area (hectare)	Harvested area (hectare)	Production (tons)	Yield per hectare (tons)	
				Per planted area	Per harvested area
1995	94 012	90 203	289 045	3.075	3.204
1996	93 243	90 688	308 199	3.305	3.398
1997	98 772	79 105	267 614	2.709	3.383
1998	108 635	106 795	384 964	3.544	3.605
1999	90 959	89 553	328 559	3.613	3.670
2000	91 364	90 971	355 559	3.892	3.908
2001	89 550	86 070	332 512	3.713	3.863
2002	88 176	87 824	330 370	3.747	3.762
2003	86 615	86 113	330 727	3.818	3.841
2004	87 129	86 710	335 872	3.855	3.873
Annual growth (%)	**-1.410**	**0.423**	**1.550**	**2.997**	**2.027**

Source: Agricultural Statistics of Thailand 2001-2004.

Table 3.18 Planted area in Nakhonsawan, 2004

Description	Area (hectare)	Percentage of farm Area
Provincial area	959 967	-
Farm holdings	570 035	100
Major rice	359 329	63.03
Field crops	169 733	29.77
Fruit and tree crops	15 250	2.67
Vegetable and ornamentals	5 650	1.01
Other	20 073	3.52

Source: Nakhonsawan Provincial Agricultural Office, 2004.

Livestock. Cattle, poultry and swine are raised in all *amphoe*. The poultry farms are mostly operated under contract farming and the industry continues to grow. The number of livestock farmers is 21,759.

Fisheries. The topography of the province illustrates the large wetlands and ponds. The province also enjoys a large water reservoir totalling 21,238 hectares in area containing 148 inland fish types surveyed, many of which are major fish species.

Extent of unemployment and poverty

Unemployment

Employment increased from 0.64 million in 2001 to 0.68 million in 2004 (2.4 per cent) as a result of a larger population and more economically active people (Table 3.19).

Unemployed fell from 6,124 in 2001 to 3,454 in 2004 (14.9 per cent) (Table 3.20).

Poverty

Poor people in the province, those earning less than US$ 21.14-22.20 per month represent 7.7 per cent - 15.4 per cent of the population in the North. The number of poor fell from 0.21 million in 2000 to 0.08 million in 2002 (36 per cent) (Table 3.21).

Extent of environmental problems

Polluted water. Many industries are located in the province close to the material supply and Bangkok's terminal market, 57 of which have poor drainage systems causing the pollution.

Air pollution and dust. Though to be caused by 363 plants, namely rice mills, grain dryers, silos, saw mills, noodle mills, cassava slicing mills, bean processing mills and sugar mills, among others.

Odor problems. Ninety manufacturing plants are causing bad odors, including car body rebuilding and painting, bean and starch noodle plants, meat producers, and sugar mills.

Deforestation. The province is concentrated with business operations due to its abundance of resources and transportation centre. Consequently, urbanization and expanded farming is actively encroaching more and more on the forests.

Soil degradation. Over-use of farm chemicals is taking its toll on the soils resulting in toxic residual build up and poorer soil quality.

Water shortages. Household and industrial water requirements and irrigation for farming compete with each other in the country.

Table 3.19 Population by labour force status in Nakhonsawan, 2001-2003 (person)

Labour force status	2001		2002		2003		2004		Growth
	Quantity	(%)	Quantity	(%)	Quantity	(%)	Quantity	(%)	(%)
Total population	**1 118 612**	**100**	**1 118 933**	**100**	**1 125 266**	**100**	**1 128 351**	**100**	**0.32**
1. Persons over 15 years	868 396	77.63	869 366	77.69	878 945	78.10	884 574	78.39	0.66
1.1 Total labour force	646 858	57.82	651 914	58.26	681 808	60.59	687 466	60.93	2.30
a. Current labour force	646 858	57.82	651 616	58.23	679 749	60.40	687 466	60.62	2.27
- Employed	640 734	57.27	647 402	57.85	675 073	59.99	684 012	60.62	2.41
- Unemployed	6 124	0.54	4 214	0.37	4 676	0.41	3 454	0.30	-14.90
b. Waiting for seasonal employment	-	-	298	0.02	2 059	0.18			590.94
1.2 Economically active person	221 538	19.80	217 452	19.43	197 137	17.52	197 108	17.47	-4.38
2. Persons under 15 years	250 216	22.36	249 567	22.30	246 321	21.89	243 777	21.60	-0.91

Source: National Statistical Office, 2004.

Table 3.20 Unemployed people by sex in Nakhonsawan, 2001-2004 (person)

Description	2001		2002		2003		2004		Growth
	Quantity	(%)	Quantity	(%)	Quantity	(%)	Quantity	(%)	2001-2004 (%)
Total unemployment	6 124	100	4 214	100	4 676	100	3 454	100	-14.90
Male	5 212	85.10	1 911	45.34	3 772	80.66	2 333	67.54	-15.89
Female	912	14.90	2 303	54.66	904	19.34	1 121	32.46	-3.11

Source: National Statistical Office, 2005.

Table 3.21 Poverty comparison; the North versus Nakhonsawan, 2000-2002

Year	The North (million/person)	Nakhonsawan (million/person)	Percentage of the region
2000	1.37	0.211	15.40
2001	1.20	0.119	9.91
2002	1.11	0.086	7.74
Annual growth (%)	-9.98	-36.16	

Source: The National Economics and Social Development Board, 2004.

Condition of infrastructure relevant to CGPRT farming and industries

Public farm infrastructure. Post harvesting, maize is transported to related vendors located in the districts and some vendors procure at the farms incorporating a threshing service. The available infrastructure is the feeder roads, however, during times of peak demand the number of trucks is insufficient.

Industrial infrastructure. The basic industries in the province are:

- 553 rice mills
- 116 chip drying yards
- 10 pelletizing plants
- 36 grain dryers
- 13 grain grinding mills
- 3 grain silos

Being a regional hub for farm produce distribution in the North and Central plains, most infrastructure in the province belongs to the private sector. The drying yard operators acquire the raw material supply in and around the adjacent provinces. The grain dryers and silos store and distribute grains to the various feed mills nationwide.

3.2 Profiles of the respondents and their households

3.2.1 Case study of cassava growers in Nakhonratchasima

The respondents' profile

Sex, age, education, major and minor occupations

A status survey of 13 cassava farmers found that more growers are male (69 per cent) than female (31 per cent). Ninety-two per cent of them are economically active (15-64 years old) and the remaining 8 per cent are elderly (over 65). With regard to education, primary school up to grade six is mandatory. It was found that the majority of farmers (61 per cent) did not complete the obligatory level, 23 per cent did complete primary education and the remaining 16 per cent exceeded the minimum requirement. All of the farmers surveyed were engaged in growing cassava, rice, maize and chilli, among others; only 23 per cent of which undertook supplementary work in the form of hired farm labourers (Table 3.22).

Table 3.22 Status of respondents, the case of Nakhonratchasima, 2004

Description	Persons	Percentage
Respondents	**13**	**100**
Gender		
Male	9	69
Female	4	31
Age		
Below 15 years old	-	-
Economically active (15-64 years old)	12	92
Elderly (65 and above)	1	8
Education		
Less than elementary	8	61
Elementary	3	23
Secondary	2	16
Major and minor occupations		
Major occupation		
- Farming	13	100
Minor		
- Farm labour	3	23
- Unemployed	10	77

Source: Field survey, 2005.

Household profile

Available labour force

The gender mix of the 13 cassava farm households surveyed was 52.46 per cent male and 47.54 per cent female. Most of them (77.05 per cent) are economically active (15-64 years old), followed by adolescents (less than 15 years old) and the elderly (over 65 years old) totalling 16.39 per cent and 6.56 per cent respectively. Their educational background is mostly (45.90 per cent) up to the compulsory level (grade 6), 39.35 per cent attained a higher than compulsory level education and 14.75 per cent below (Table 3.23).

Size of household

Generally, each household is made up of between three and five members; an average of 4.69 heads per household. Within the family unit unpaid farm labour amounts to 44.26 per cent with the rest working off farm. Most family labour (66.67 per cent) are 41-64 years old. Those below 40 plus those over 64 years old total 20 per cent, and 13.33 per cent respectively (Table 3.23).

Landholding by tenurial status

The survey found that most farm households own less than 1.61 hectares of farm holding. In terms of landholding status, ownership is dominant (61.18 per cent), followed by 19.52 per cent rented from landlords (US$ 7.22-12.04/year) and 19.30 per cent is ‘others’. Some own land but also rent some additional land, while others have to rent their entire plot (Table 3.24).

Table 3.23 Status of farm household members, the case of Nakhonratchasima, 2004

Description	Persons	Percentage
Total family members	**61**	
Gender		
Male	32	52.46
Female	29	47.54
Age	**61**	**100**
Less than 15 years old	10	16.39
Economically active (15-64 years)	47	77.05
Elderly (over 64)	4	6.56
Education background (from 6 years old)	**61**	**100**
Less than elementary	9	14.75
Elementary	28	45.90
Secondary	24	39.35
Main and minor occupations		
Main	61	100
- Farming	27	44.26
- Employee of a factory/company/hired labour	18	29.51
- In civil service	1	1.64
- Furthering study	8	13.11
- Other	7	11.48
Minor	4	
- Farm worker	1	25
- Unemployed	3	75
Family labour	**30**	**100**
15-40 years old	6	20.00
41-64 years old	20	66.67
Younger than 15 years and older than 64 years	4	13.33
Farm size	**13**	**100**
0.16-1.60 ha/household	1	7.70
1.61-4.80 ha/household	6	46.15
More than 4.80 ha/family	6	46.15

Source: Field survey, 2005.

Table 3.24 Holding size and ownership in Nakhonratchasima, 2004

Description	Number	Percentage
Farm size of the families	**13**	
0.16-1.60 ha	1	7.69
1.61-4.80 ha	6	46.15
More than 4.80 ha	6	46.15
Tenure of land	**72.96**	**100**
Owned	44.64	61.18
Leased	14.24	19.52
Other	14.08	19.30

Source: Field survey, 2005.

Annual income per capita and source of family income

The field study in Nakhonratchasima primarily covered rainfed areas where rice, cassava, maize and chilli are grown. Included are both farmers who grow cassava solely and those who cultivate cassava with other crops. Chilli is grown and irrigated using either deepwell water or from a waterway. Family labour is principally used. Some farmers also work off-farm or own large plots with limited family labour. Such farmers hire labour to supplement their own family labour during the growing season.

Income per cassava farm household

The field survey found that farmers wish to diversify their cropping patterns to mitigate price risks. However, it is difficult to diversify the cropping pattern due to the unsuitability of the soils to other crops. Only cassava can withstand drought and grows well in degraded soils. Consequently, cassava monoculture is widely practised. Therefore, the cassava farm income is generated from cassava sales and leasing farmland. On average, the annual net cash income from cassava sales is US$ 828/household and annual net farm cash income is US$ 866/household. Annual off-farm income generated from company employment averages US$ 3,178/household. Family net cash income (farm net cash income + off-farm income), which is the net cash balance after the spending of the family practicing unirrigated cassava monoculture is US$ 4,044 on average. For a family of four, income per capita is, therefore, US$ 1,011. However, annual cassava income per head is US$ 207 (Table 3.25).

Table 3.25 Farm household income and expenditure, the case of Nakhonratchasima, 2004 (US$/family)

Description	Unirrigated area			
	Cassava	Share (%)	Cassava + other crop	Share (%)
1. Farm cash income	2 185		3 061	
a. Crop sales	2 135		2 922	
b. Others, e.g. land rent	50		139	
2. Farm expenses	1 319		1 639	
c. Crop expenses	1 307		1 590	
d. Other: land tax, rent charge	12		49	
3. Net farm cash income (a-c)	828		1 332	
4. Annual income per capita from crops	207		272	
5. Net farm income (1-2)	866	21.42	1 422	51.88
6. Off-farm income	3 178	78.58	1 319	48.12
7. Net family cash income (5+6)	4 044	100	2 741	100
8. Family member/household (person)	4.0		4.90	
9 Annual income per capita	1 011		559	

Source: Field survey, 2005.

Note: “Cassava” means cassava mono-cropping and the number of sample farmers is three. “Cassava + Other” means farmers growing cassava and some other crops and the number of sample farmers is 10.

Growing cassava and other crops

The survey also found that a farmer holding several land plots grew several crops during the rainy season. For example, one farmer may grow paddy on a low-lying plot; and cassava, maize and mung bean on the upland plot. Other farmers arrange their land to plant cassava and other crops, for example maize and chilli in different seasons. They may grow two crops of maize, the first in the rainy season and the second late in the season, then other crops in the dry season. Therefore, family income from farm sources includes the

sales of cassava, rice, maize, mung bean and chilli plus the household members who work as farm labourers. The average net cash income from crop sales is US$ 1,332/household and the net cash farm income is US$ 1,422; or 51.9 per cent of the total income. Off-farm income consists of sales of goods and off-farm employment, earning an annual salary of approximately US$ 1,319/family; or 48.1 per cent of total income. The net cash income of a family growing cassava and other crops is US$ 2,741/household per year. With an average family size of 4.9, income per head is US$ 559 while the component of farm income per head totals US$ 272 (Table 3.25).

Comparing net farm cash income among the families practicing cassava monoculture and those growing cassava with other crops reveals that the latter earn more than the former and the crop income per head is also higher.

In summary, cassava-based farmers generates more family income than those growing cassava alone.

3.2.2 Case study of soybean growers in Sukhothai

The respondents profile

Sex, age, education, major and minor employment

The survey of the 13 soybean growers in the province found that eight of them are male and five female; or 61.5 per cent and 38.5 per cent respectively. All are economically active with 76.9 per cent of them completing compulsory education and 23.1 per cent higher education. All operate farms as their principle employment, growing soybean as a major crop, supplemented with cassava, maize, rice, sugar cane and chilli. A number of the farmers are engaged in government services, trade as well as industrial and farm labouring (Table 3.26).

Table 3.26 Status of the respondent in Sukhothai, 2004

Description	Persons	Percentage
Respondent	**13**	
Gender		
Male	8	61.54
Female	5	38.46
Age	**13**	**100**
Less than 15 years old	-	-
Economically active (15-64 years)	13	100
Elderly (over 64)	-	-
Education background (from 6 years old)		
Less than elementary		
Elementary	10	76.92
Secondary	3	23.08
Main and minor occupations		
Main		
- Farming	13	100
Minor		
- Farm worker	1	7.69
- Self-employed/businessman	2	15.38
- Employee of a factory/company/hired labour	1	7.69
- In civil service	4	30.77
- Unemployed	5	38.46

Source: Field survey, 2005.

The households' profile

Size of household

The 13 soybean growing farm households under survey total 54 persons, of which 68.5 per cent are female and 31.5 per cent are male. Altogether, 81.5 per cent of the respondents are economically active, followed by the children and the elderly of 16.7 per cent and 1.8 per cent respectively. In terms of education, 44.4 per cent completed compulsory schooling.

Available labour force

The sample households have an average family size of 4.15 and 59.3 per cent of them make up the family farm labour. The remaining 40.7 per cent are occupied in general services, factory work, vending and government services. Economically active family labour has the greatest share of 96.9 per cent, followed by the elderly group with 3.1 per cent (Table 3.27).

Landholding by tenurial status

The survey found that 61.5 per cent of the farm households have a farm holding of 1.61-4.8 hectares, and the remaining 23.1 per cent and 15.4 per cent are in the range of 0.16-1.60 hectares and more than 4.8 hectares respectively. Land ownership accounts for 77.5 per cent and tenancy 22.5 per cent (Table 3.28).

Table 3.27 Status of farm household members, the case of Sukhothai, 2004

Description	Persons	Percentage
Total family members	**54**	**100**
Gender		
Male	17	31.48
Female	37	68.52
Age	**54**	**100**
Less than 15 years old	9	16.67
Economically active (15-64 years)	44	81.48
Elderly (over 65)	1	1.85
Education background (from 6 years old)	**54**	**100**
Less than elementary	9	16.67
Elementary	24	44.44
Secondary	21	38.89
Main and minor occupations		
Main	54	100
Farming	30	55.55
Employee of a factory/company/hired labour	5	9.26
Civil service	4	7.41
Other	15	27.78
Minor	54	100
Farming	2	3.70
Farm worker	2	3.70
Self-employed/businessman	2	3.70
Employee of a factory/company/hired labour	4	7.41
Unemployed	44	81.48
Family labour	**32**	
15-40 years old	-	-
41-64 years old	31	96.88
Younger than 15 years and older than 64 years	1	3.12

Source: Field survey, 2005.

Table 3.28 Farm holding and ownership, the case of Sukhothai, 2004

Description	Persons	Percentage
Farm size/family		
0.16-1.60 ha	3	23.08
1.61-4.8 ha	8	61.54
More than 4.8 ha	2	15.38
Tenurial status	**43.36 ha**	**100**
Owned	33.60 ha	77.49
Tenant	9.76 ha	22.51

Source: Field survey, 2005.

Annual income per capita and source of family income

In Sukhothai, both irrigated and rainfed areas have been studied for soybean mono-cropping and soybean-based multiple cropping.

Irrigated zone

(1) Soybean mono-cropping assisted by irrigation and a lifetime of experience often generates good income. Farmers cultivate 2-3 soybean crops per year: early rainy season crop, late rainy season crop and the dry season crop. Income from soybean averages US$ 1,363/household; 92.2 per cent of net household cash income. Non-farm income

derived from off-farm work and the money sent home by their children averages US$ 116/family annually; 7.8 per cent of their net family cash income. Therefore, total family net cash income is US$ 1,479. A family of four on average receives net farm cash income of US$ 231/head and net family cash income of US$ 370/head.

(2) Family income from multiple cropping. Working several farm plots, farmers grow soybean and other crops due in part to area suitability. For example, on low-lying plots, rice is grown in rainy months followed by soybean, convolvulus and chilli in the dry months earning the farmer US$ 1,325/household net cash income from crop cultivation alone and US$ 1,529/household net farm cash income; 83.7 per cent of net family cash income. Annual non-farm income is US$ 298/household; 16.3 per cent of net family cash income. Therefore, family net cash income is US$ 1,827/household. For a family of four, income per capita from crops totals US$ 331 and family net cash income per head is US$ 457.

Rainfed areas

(1) The *survey found that only smallholders grow a single, rainy season soybean crop in the large soybean producing area using limited unpaid family labour.* The net soybean cash income of such farmers is US$ 219 and net farm cash income is US$ 199, which is 3.2 per cent of the household cash income. The non-farm source of income is overseas work representing US$ 5,960 a year; 96.8 per cent of family net cash income. Therefore, the net family cash income is US$ 6,159 for five family members, crop income averages US$ 44/head and the farm and non-farm income per head is US$ 1,232.

(2) The earning per household of those who diversify soybean with other crops. It is evident from the survey that the farmers who practise diverse farming hold several farm plots, both upland and lowland. Consequently, rice, soybean and mung bean are grown in the lowland areas, and maize, sugar cane and cassava in the upland areas. Net crop revenue is US$ 955/household and net farm cash income is US$ 729/household; 55.9 per cent of net family cash income. While non-farm income is US$ 576/household; 44.1 per cent of net family cash income. Net family cash income amounts to US$ 1,305/household. For an average family of four, crop earnings per head average US$ 239 and farm and non-farm income is US$ 326/head (Table 3.29).

Comparison of the net cash income from soybean mono-cropping and from diversified soybean farming in irrigated and rainfed zones shows that net household cash income from diversified soybean farming is greater than monocultured soybean sales in both types of zone. Diversified farming enables several crop sales per year and chilli can be stored throughout the year commanding a high price. However, the earnings and net profit

from diversified soybean farming in the rainfed areas are nearly two times lower than that in irrigated areas. Two of the sample farmers faced floods and therefore received a loss from the soybean crop. However, profit is made on other crops.

Table 3.29 Farm household income and expenses in Sukhothai, 2004

(US$/household)

Description	Irrigated areas				Rainfed areas			
	Soybean	Share (%)	Soybean + other crops	Share (%)	Soybean	Share (%)	Soybean + other crops	Share (%)
1. Farm cash income	2 259		3 053		487		2 308	
a. Crop sales	1 773		2 760		457		2 050	
b. Other, e.g., land rent	486		293		30		258	
2. Farm expense	896		1 524		288		1 579	
c. Crop expense	848		1 435		238		1 095	
d. Other: land tax, rent charge	48		89		50		484	
3. Net farm cash income (a-c)	925		1 325		219		955	
4. Annual income per capita from crop	231		331		44		239	
5. Net farm income (1-2)	1 363	92.16	1 529	83.69	199	3.23	729	55.86
6. Off-farm income	116	7.84	298	16.31	5 960	96.77	576	44.14
7. Net family cash income (5+6)	1 479	100	1 827	100	6 159	100	1 305	100
8. Family member/household (person)	4		4		5		4	
9 Annual income per capita	370		457		1 232		326	

Source: Field survey, 2005.

Note: "Soybean" means soybean mono-cropping. "Soybean + other crops" means farmers cropping soybean with other crops. The number of sample farms is two (Soybean mono-cropping, irrigated), five (diversified, irrigated), one (Soybean, rainfed) and five (diversified, rainfed).

3.2.3 Case study of maize growers in Nakhonsawan

The respondent profile

Interviews with seven maize growers found that 57 per cent of the respondents are male and all are economically active. In terms of education, 43 per cent of interviewees completed secondary level schooling and 29 per cent completed primary education but 29 per cent did not complete compulsory schooling. Farming is the main occupation of all of them (Table 3.30).

Table 3.30 Status of the respondents in Nakhonsawan, 2004

Description	Persons	Percentage
Respondent	**7**	**100**
Gender	**7**	**100**
Male	4	57
Female	3	43
Age	**7**	**100**
Economically active (15-64 years)	7	-100
Elderly (over 64)	-	0
Education background (from 6 years old)	**7**	**-100**
Less than elementary	2	-29
Elementary	2	29
Secondary	3	43
Main and minor occupations	**7**	**-4**
Main	7	100
- Farming	7	100
Minor	7	100
- Farm worker	4	57
- Unemployed	3	43

Source: Field survey, 2005.

Household profile

Available labour force

The seven farm families total 28 people, 71 per cent of which are economically active, followed by children and the elderly; 18 per cent and 11 per cent respectively. Regarding their schooling, 39 per cent completed secondary school, 32 per cent the compulsory level and 25 per cent below (Table 3.31).

Size of household

With 3-5 members per household, the average family size is four with 53.6 per cent of the family engaged in farming and the remainder working in private businesses. Economically active members represent 47 per cent of the family (Table 3.31).

Land tenurial status

Most commonly farm size is more than 4.8 hectares/household representing 42 per cent of the respondents, and 29 per cent own 0.16-1.60 hectares. Ownership makes up 80.54 per cent, followed by leasing (19.6 per cent) costing US$ 12.42-19.87/year (Table 3.32).

Table 3.31 Status of farm household members, the case of Nakhonsawan, 2004

Description	Persons	Percentage
Total family members	**28**	**100**
Gender	28	100
Male	11	39
Female	17	61
Age	**28**	**100**
Less than 15 years old	5	18
Economically active (15-64 years)	20	71
Elderly (over 65)	3	11
Education background (from 6 years old and above)	**28**	**100**
Illiterate	1	4
Less than elementary	7	25
Elementary	9	32
Secondary	11	39
Main and minor occupations		
Main	**28**	**100**
- Farming	15	53.57
- Employee of a factory/company/hired labour	5	17.85
- Attending school	8	28.58
- Other	-	-
Minor	**28**	**100**
- Farm worker	4	14.28
- Employee of a factory/company/hired labour	16	57.14
- Unemployed	8	28.58
Family labour	**15**	**100**
15-40 years old	7	47
41-64 years old	6	40
Below 15 years and above 64 years	2	13
Farm size/family	**7**	**100**
0.16-1.60 ha	2	29
1.61-4.8 ha	2	29
More than 4.8 ha	3	42

Source: Field survey, 2005.

Table 3.32 Farm holding and ownership, the case of Nakhonsawan, 2004

Description	Number	Percentage
Farm size/family	7	100
0.16-1.60 ha	2	29
1.61-4.8 ha	2	29
More than 4.8 ha	3	42
Tenurial status (ha)	37.6	100
Owned	30.2	80.42
Tenant	7.4	19.58

Source: Field survey, 2005.

Annual income per capita and source

Farmers operate their farming systems in both irrigated and non-irrigated areas. The crops grown include rice, sugar cane, maize, sorghum and mung bean, among others. In terms of the cropping systems, again, farmers holding many plots diversify cropping either concomitantly during the same period or consecutively. Repeating the same crop is often

practised. A farmer holding only one plot attempts to reduce risks by diversifying crops successively.

Income per maize farm household which also grows supplementary crops. In the survey area no farmer only grows maize. They practise multiple cropping. On average, net cash income in the irrigated areas is US$ 2,298 and the net cash farm income is US$ 146 (6.4 per cent) and non-farm income is US$ 2,152 (93.6 per cent). In rainfed areas, net family cash income is US$ 1,503/household annually and net farm cash income is US$ 852 (56.7 per cent) and non-farm income US$ 652 (43.4 per cent). More farm income is clearly earned in the irrigated zones (Table 3.33).

To lease farmland in the irrigated areas is often much more expensive than rainfed areas.

Table 3.33 Farm household income and expenses in Nakhonsawan, 2004

(US$/household)

Description	Irrigated areas		Rainfed areas	
	Maize + other crops	Share (%)	Maize + other crops	Share (%)
1. Farm cash income	1 566		1 357	
a. Crop sales	1 454		706	
b. Other, e.g., land rent	112		652	
2. Farm expense	1 420		506	
c. Crop expense	676		492	
d. Other: land tax, rent charge	744		13	
3. Net farm cash income (a-c)	778		213	
4. Annual Income per capita from crop	173		61	
5. Net farm income (1-2)	146	6.36	852	56,66
6. Off-farm income	2 152	93.64	652	43.34
7. Net family cash income (5+6)	2 298	100	1 503	100
8. Family member/household (person)	4.5		3.5	
9 Annual income per capita	511		429	

Source: Field survey, 2005

Note: The number of sample farms is four (Irrigated) and three (Rainfed).

3.3 Concluding summary

Nakhonratchasima province

Seventy-five per cent of the provincial population were engaged in agriculture in 2003, which indicates that agriculture is the primary industry in the province. Major crops in the province include rice, cassava, maize and sugar cane.

The province is a production centre for cassava, which accounts for 22 per cent of the national harvested area. However, a shrinking harvested area has been observed over the past decade (1995/1996-2004/2005), which is attributable to the reduction of pellets

imported by the EU due to EU's CAP reform. However, production has risen annually by 1.23 per cent and the yield per hectare by 3.83 per cent.

The farm household survey of cassava farmers showed that the total income of families practising a cassava-based diversified cropping system was US$ 272/family member, while that of cassava mono-cropping was US$ 207, which indicates that agricultural diversification of cassava-based cropping systems generates more income than cassava mono-cropping.

Sukhothai province

The major CGPRT crop in the province is soybean. However, over the last 10 years (1994/1995-2003/1904) the planted and harvested areas have declined by 12.5 and 11.7 per cent respectively due to lower farm returns compared to other competitive crops and the more intensive care requirement from seeding to harvesting.

The farm household survey of soybean farmers showed that soybean mono-cropping in the irrigated area earned an average net farm cash income of US$ 925/household, while farmers growing soybean and other crops in the irrigated area generated an average net cash income of US$ 1,325/household.

In rainfed areas, soybean mono-cropping farmers earned US$ 219/household, while farmers utilizing diversified cropping patterns earned US$ 955/household.

It is concluded that diversifying soybean with other crops generates more net cash income than soybean mono-cropping alone.

Nakhonsawan province

The province's major crops are rice, maize, soybean, mung bean and sugar cane.

The area planted with maize amounts to 7.8 per cent of the national total. Over the past 10 years (1995/1996-2004/1905), the harvested area declined by 1.4 per cent as a result of the expanding areas of competitive crops such as cassava and sugar cane. However, maize production grew by 1.5 per cent due to a 2.9 per cent rise in yield.

All the surveyed farmers practise maize-based diversified cropping and no maize mono-cropping farmers were observed. The comparison of net farm cash income showed that farmers in irrigated areas earn more net farm cash income than farmers in rainfed areas. It is concluded that farm diversification of maize with other crops yields more income in irrigated areas than in non-irrigated areas.

4. Analysis of CGPRT Farming System

4.1 Nakhonratchasima

4.1.1 Average size of farm operation

Nationwide, cassava planted area per farm is 0.32 hectares at the smallest and 22.4 hectares at the largest. However, the most common planted area is in the range of 1.6-3.2 hectares, comprising 30 per cent of the total planted area. The national average cassava planted area is 2.08-2.40 hectares. In the province, the average planted area of 2.88-3.20 hectares is larger than the national average because the province is the largest cassava producing area and the production is readily absorbed by the abundance of drying yards, and pellet and flour mills, which provide alternatives for farm sales. The farms under study range from 1.0-7.2 hectares with 3.2-4.8 hectares of cassava planting area in a year, 2.4-6.4 hectares of maize, 2.4-3.2 hectares of mung bean and 0.32-0.48 hectares of chilli.

4.1.2 Pattern of cultivation

Most cassava in Thailand (65-70 per cent) is harvested in December to February. Nakhonratchasima farmers grow two cassava crops; 80 per cent of which is planted in the early rainy months of April to May and 20 per cent during the late rainy season in October. In general, 8-10 months are required before harvest. Harvesting can be done year round as cassava may be harvested for six months, two years after being planted. However, the most suitable period to yield more starch is 10-12 months. Nevertheless, there is a price incentive to harvest early.

Some farms practise cassava mono-cropping, while other farmers, who own several plots or rent additional plots practise diverse farming. Some farmers arrange several plots of chilli, maize and mung bean. Chilli is grown throughout the year, harvestable after four months. The first maize crop is grown July-August and harvested in October-December. The second crop is planted in March and harvested in July. Mung bean is sown in February and picked in April.

4.1.3 Labour use

On average, 4-5 unpaid labourers are found per family in the province. Two-three members take care of cassava on the surveyed farms, which is inadequate for cultivation to

harvesting. Therefore, ploughing and preparing rows is mechanized to save labour. Seeding is still manual. In terms of cultivation, weeding is mostly manual and in some areas, herbicides are sprayed to save labour input for weeding. In some areas, manual harvesting is not possible due to hard soils and hence mechanized picking using a backhoe is employed but labour is required to cut rhizome and load crops onto the trucks, which is usually not mechanized.

The wage rate for planting and rooting is US$ 2.48-2.98 per day on the surveyed farms. In some other areas exchange of labour among cassava growers is seen in planting and harvesting to save on input costs. With regard to maize, mung bean and chilli, additional labour is hired for cultivation and picking, while land preparation is mechanized.

4.1.4 Farm productivity

To raise farm productivity by increasing cassava yield per hectare it is necessary to use improved cultivars, chemical fertilizers, green manure and compost. HYV refers to the formally recommended high yielding and high starch content varieties, namely Rayong 5, Rayong 90, Kasetsart 50 and Huaybong 60. At present, these HYVs are used on as much as 90 per cent of the national planted area, with both the government and private sectors taking part. In Nakhonratchasima there is a cost reduction centre for cassava production known as the Foundation on Cassava Development Institute. Its major aim is to develop the production of cassava to serve as a good raw material with reduced costs. Activities of the cost reduction centre include selection and distribution of good cultivars to the farmers, arrangement of training courses and know-how extension. The province has become nearly entirely planted with cassava HYV's. The recommended dose of chemical fertilizer, manure and compost on a national basis are 156,219 and 6 kg/ha respectively, while 175, 419 and 19 kg are used per hectare in Nakhonratchasima. As such the Nakhonratchasima farmers apply more fertilizers than the rest of the country. Weeding is manual complimented with herbicides both nationwide and in Nakhonratchasima.

The use of better farm inputs has affected national cassava production efficiency. The yield per hectare was 16,856 kg in 2000, rising to 20,275 kg in 2004. Cassava yield per hectare in Nahkonratchasima itself was 16.65 tons/ha in 2000, jumping to 20.17 tons/ha in 2004. The average yield of farmers under survey was 21,575 kg/ha for cassava, 4,681 for maize, 519 for mung bean and 1,031 kg/ha for chilli (Table 4.1).

Table 4.1 Yield per hectare of CGPRT crops, nationwide and in Nakhonratchasima for comparison, 2004 (kg/ha)

Crop	Nationwide	Nakhonratchasima[a/]	Farmer respondents in Nakhonratchasima[b/]
Major rice	2 025	1 206	2 119
Cassava	20 275	20 175	21 575
Maize	3 763	3 125	4 681
Mung bean	706	563	519
Chilli	n.a.	n.a.	1 031

Source: [a/] Office of Agricultural Economics, 2005.
[b/] Field survey, 2005.

4.1.5 Cost-revenue structure and farm profitability

Cost, revenue and profit

The production costs consist of variable and fixed costs. The variable costs are brought about by the use of farm inputs including labour for cultivation and harvesting, both paid and unpaid, input purchases, as well as repairs of equipment and tools, among others. Fixed costs do not vary with the amount of production and include land rent and farm equipment depreciation.

Crop sales are calculated by multiplying yield per hectare by farm price received.

Profit refers to the margin of total revenue and total cost. The field survey found the cassava cost of production to total US$ 404.55/ha with variable costs of US$ 360.13/ha or 89.02 per cent of total cost and fixed costs of US$ 44.42/ha (10.98 per cent of total cost).

Regarding the revenue of cassava growers, as farm yield per hectare is 21,577.44 kg and farm price is US$ 0.027, therefore, cassava sales per hectare are US$ 584.04. Deducting production costs per hectare of US$ 404.55, farm profit totals US$ 179.49/ha (Table 4.2).

Table 4.2 Costs and revenue of cassava in Nakhonratchasima, 2004
(US$/ha)

Description	US$
Total cost	404.55
• Variable cost	360.13
• Fixed cost	44.42
Revenue	584.04
• Yield kg/ha	21 577.44
• Farm price US$/kg	0.027
Net profit	179.49

Source: Field survey, 2005.

Maize production costs, sales and profit

Nakhonratchasima maize growers incur production costs per hectare of US$ 379.43 with variable costs per hectare of US$ 338.42 or 89.19 per cent of the total cost. Fixed costs per hectare total US$ 41.01.

Since the yield per hectare is 4,680.13 kg and farm price is US$ 0.107/kg, therefore sales per hectare are US$ 499.74. Deducting the costs the profit per hectare is US$ 120.31 (Table 4.3).

Table 4.3 Costs and revenue of maize in Nakhonratchasima, 2004

(US$/ha)

Description	US$
Total cost	379.43
• Variable cost	338.42
• Fixed cost	41.01
Revenue	499.74
• Yield kg/ha	4 680.13
• Farm price, US$/kg	0.107
Net profit	120.31

Source: Field survey, 2005.

Production costs, income and profit of major rice

In the region where Nakhonratchasima is located, rice farming is mostly rainfed and the major rice harvest is initially kept both for household consumption and seeds. If there is excess it is for sale. Production costs per hectare are US$ 262.08 and the sale per hectare total US$ 368.02. Therefore, net profit is US$ 105.95 (Table 4.4).

Table 4.4 Costs and revenue of major non-irrigated rice in Nakhonratchasima, 2004

(US$/ha)

Description	US$
Total cost	262.08
• Variable cost	215.57
• Fixed cost	46.51
Revenue	368.02
• Yield kg/ha	2 117.19
• Farm price, US$/kg	0.174
Net profit	105.95

Source: Field survey, 2005.

Cost, income and profit of chilli production

A survey of chilli growers in the province found that chilli production costs per hectare amount to US$ 858.06, with variable costs per hectare at US$ 802.89 or 93.57 per cent of the total and fixed costs per hectare at US$ 55.17 (6.43 per cent of the total).

Given that the chilli yield per hectare is 1,031.25 kg and the dried chilli farm price is US$1.583/kg, income per hectare is US$ 1,632.54. When production costs are deducted, profit per hectare is US$ 774.47 (Table 4.5).

Table 4.5 Costs and revenue of dry chilli in Nakhonratchasima, 2004 (US$/ha)

Description	US$
Total cost	858.06
• Variable cost	802.89
• Fixed cost	55.17
Revenue	1 632.54
• Yield kg/ha	1 031.25
• Farm price, US$/kg	1.583
Net profit	774.47

Source: Field survey, 2005.

Costs, revenue and profit of producing mung bean

From the survey, the production costs of mung bean per hectare are US$ 154.23, with variable costs of US$ 107.67 and fixed costs of US$ 46.56, more specifically 30.19 per cent of total costs.

With respect to farm revenue, mung bean yield per hectare is 520.81 kg and farm price is US$ 0.373/kg. Therefore, the income per hectare is US$ 188.11 and profit US$ 39.77/ha (Table 4.6).

Table 4.6 Costs and revenue of mung bean in Nakhonratchasima, 2004 (US$/ha)

Description	US$
Total cost	154.23
• Variable cost	107.67
• Fixed cost	46.56
Revenue	194.00
• Yield kg/ha	520.81
• Farm price, US$/kg	0.373
Net profit	39.77

Source: Field survey, 2005.

4.1.6 The role of diversified farming in risk mitigation

Rainfed agriculture does not ensure steady farm production. Drought, rain intermission, floods and the previous year's farm prices all affect production. Although upland areas can be planted with several field crops, such as maize, soybean, peanuts, cotton and cassava, the more profitable crops, more specifically, maize, soybean and chilli are more commonly chosen. However, in many producing areas soil fertility is poor and organic matter is required but the farmers generally lack investment funds. Consequently,

cassava is chosen as the main crop. Since it is not a sufficiently large income earner and the long duration of 10-12 months, many farmers often diversify or attempt to generate added value to their farm products to reduce natural disaster risks and price volatility

Arranging several farm plots for diverse cropping

Based on the survey, in some areas, cassava is mono-cropped on poor soils which do not allow other cropping. Supplementary job opportunities are then sought off-farm. In other areas, field plots are arranged for cassava and other crops, namely maize and mung bean. Some farmers own several farm plots and grow major rice in the low-lying fields leaving them fallow in the late growing season due to water shortages. On other plots of land, a field crop may be chosen to suit market demand in spite of being rainfed. Some crops, for example maize, are grown twice; the first crop in the early rainy season and the second crop late in the season. Access to a deepwell provides the opportunity for some farmers to grow chilli throughout the year. As a cash crop, chilli provides income several times a year. Farm decisions have to assess price risk reduction as farm products tend to suffer abrupt seasonal price swings. If crops face great price depressions farm income is greatly affected.

Cassava value-added

Aside from selling fresh tubers some farmers, in an attempt to add value to their farm products, produce clean chips. Each builds a drying yard at an average cost of US$ 422.15 using family labour. Some neighbours are then hired to produce chips from the cassava roots for drying. A worker can make 500 kilograms of chips in three hours and is paid US$ 1.24. Drying takes 2-3 days to achieve 15-16 per cent moisture.

While the price received for a kilogram of fresh tubers is US$ 0.025, the clean chips are sold at US$ 0.067/kg.

4.1.7 Impacts on employment, income and the environment

Impacts on employment

In the case of diverse agriculture, cassava mono-cropping requires little hired labour due to minimal weeding or fertilizer application. Cassava is also resistant to pests and disease. When fertilizer becomes available the cropping pattern becomes more diverse, specifically cassava is coupled with maize, chilli and mung bean. More labour is required, especially for chilli, to raise yield. Consequently, family labour and hired labour is in greater demand and hence, unemployment slides and farmers do not need to seek work in the cities.

In the case of cassava value-added, making clean chips requires household labour as well as neighbours' labour to slice the tubers.

Impacts on income

Comparisons have been made on cost, income and profit of monoculture and diversified agriculture. Farmers tilling several plots and operating diverse farming were surveyed. Most cassava fields are mono-cropped because cassava requires 10-12 months before harvesting. The maize plot, in addition to growing maize in the rainy season, is used for a second cropping, often chilli.

Upon analysis, farm returns from agricultural diversification amount to US$ 1,623.73/ha with net profit of US$ 572.39, whereas the return from cassava monoculture is US$ 504.41/ha with a net profit of US$ 128.66 (Table 4.7).

Table 4.7 Cost, revenue and profit of cassava monoculture compared with diverse farming in Nakhonratchasima, 2004 (US$/ha)

Item	Cassava	Cassava + other crops
Revenue	504.41	1 623.73
Production costs	375.74	1 051.34
Net profit	128.66	572.39

Source: Field survey, 2005.

In conclusion, diversified farm operators who plant cassava and other crops receive greater net income than those growing a single cassava crop because maize, mung bean and chilli command higher farm prices, chilli in particular.

Mono-cassava growers earn US$ 535.76/ha while farmers who can produce clean chips from their cassava roots earn US$ 624.85/ha. Therefore, the value-added activities earn US$ 107.09/ha more which translates into additional income from clean slices of US$ 0.005/kg (Table 4.8).

Impacts on the environment

The case of farm diversification shows that in irrigated zones cassava is rotated with maize because repeated cropping can encourage pests/disease. Based on the survey, crop rotation is widely practised. Repeated cassava planting causes impoverished soils reducing cassava yields. Conversely, repeating maize farming induces a hard subsoil caused by redundant tractor ploughing which impedes the water absorption capacity of the soil itself.

Drought seriously affects maize production. Cassava is rotated with maize and after harvesting the maize stalks are ploughed to improve the soil and improve cassava yield. On

cassava-grown plots, the use of mechanical root-pickers helps make the hard soils suitable for maize growing and augments ecological conditions.

Cassava value-adding activities hastens the formation of farmer groups in producing clean slices. Production of the clean chips requires a drying yard and processing equipment, both of which constitute a large investment. After the production line, the farmer group assembles its output for marketing and the environmental and social situation is seen to be improved.

Table 4.8 Comparison of revenues from cassava monoculture and clean chip production

Description	Revenues from		
	Cassava	Clean chip	Additional income
Yield/ha, kgs			
- Fresh cassava tubers	21 575		
- Clean chips		9 587.50	
Farm prices, US$/kg			
- Fresh roots	0.025		
- Clean chips		0.067	
Farm income, US$/kg	535.76	642.69	107.09

Source: Field survey, 2005

4.1.8 Potentials and constraints in farming operations

Cassava mono-cropping system

Based on the survey, the farmers' potentials and constraints are seen as follows:

Potentials

- HYV's use is widespread and the yield per hectare has been raised.
- Cultivation expertise has accumulated over time.
- Cassava grows well, being resistant to drought and disease attack.
- There are many related processing industries, namely drying yards and flour mills, providing alternatives for farmers to sell their products.

Constraints

- Production costs tend to rise because of the burden of increasing land rent, wages and more expensive chemical fertilizers.
- Lack of investment funds to purchase farm inputs cause inappropriate rates of application which further affects farm yield.
- Family labour shortages often forces farmers to hire labour which raises costs.
- Price depression triggers farm businesses to operate at a loss.
- Risk of pest and disease attack after repeated mono-cropping.

Agricultural diversification

Potentials

- Better farm income with less risk. Sufficient funding for farm diversification offers better potential.
- Better farm decisions on several crops at a time having market potentials.
- Farmers see the diversification value of a better ecological system.

Constraints

- In rainfed farming, drought often affects the second maize crop.
- Lack of funds force low application rates of certain inputs, such as fertilizers and pesticides which result in low farm yields.
- Shortages of household labour force farmers to hire labour at a cost.

4.2 Sukhothai

4.2.1 Average size of farm operation

The national average size of farm was 0.96-1.6 ha/household in 2003/2004, both irrigated and rainfed. Sukhothai is the largest soybean producing area in the country, supplying the crushers. The growers interviewed in 2003 own farm holdings of 1.6-4.8 ha/household. In the irrigated zone the soybean planted area was 1.6-2.4 ha/household and, in rainfed areas, it was 3.2-4.8 ha/household.

4.2.2 Pattern of cultivation

Nationwide, two soybean crops are grown; the first crop in the rainy season from May to October, and the second crop in the dry season from November to March.

In the case of Sukhothai, two soybean crops are also grown. In the rainy months, the first crop is grown between May-July and harvested in August-September. The second growing period starts from August-October and is harvested in November to December.

In the dry months, soybean is grown from November to February and harvested from March to April.

Smallholders grow soybean providing they possess cultivation skills, experience and the soils are suitable. Some farmers have several farm plots and grow soybean with other crops. In low-lying areas, rice is grown in the rainy season and soybean and chilli in the dry months. In upland areas, maize, sugar cane and cassava are selectively cultivated.

4.2.3 Labour use

The surveyed farmers have 4-5 members in their households and set aside 2-3 farm plots to cultivate soybean. In addition, outside labour is hired for the following activities:

- Land preparation. Farmers usually use a custom tractor service. In some areas, hill rows are raised.
- Planting. Some farmers hire labour for hilling, seeding in rows and sowing. Both mechanical seeders and manual seeding are used.
- Tending. Fertilizer application, weeding and watering are both mechanized and manual. Family labour takes care of applying fertilizers with hired labour. Weeding and pesticide control is mechanical work. Watering is mechanized but family labour is also used with hired labour.
- Harvesting is automated and also manual using a sickle. The harvested produce is air-dried for a few days and then made into bundles and left in the field house for a while. Subsequently, threshing begins, both automated and manual. Finally, cleansing and grading follow.

4.2.4 Farm productivity

Farmers have tried to raise soybean productivity in the following ways:

- Selection of high yielding seeds, which are pest and disease resistant and area and season specific.
- Weeding is recommended using a hoe and tilling instead of burning grasses to save plant nutrients in the soils and for mulching.

As a result, soybean production efficiency at the national level was raised from 1,419 kg in 2000 to 1,513 kg in 2003/2004. In Sukhothai, the yield per hectare of 1,175 kg in 1999/2000 was raised to 1,550 kg in 2003/2004. On the sample farms, the average soybean yield was 1,413 kg/ha and maize yield was 3,363 kg/ha (Table 4.9).

Table 4.9 Yield per hectare of CGPRT and other crops, nationwide and in Sukhothai, 2003/2004

(kg/ha)

Crop	Nationwide	Sukhothai [a/]	Farmer respondents in Sukhothai [b/]
Soybean	1 513	1 550	1 413
Maize	3 856	3 144	3 363
Cassava	19 294	14 156	18 750
Major rice	2 369	2 456	3 581
Sugar cane	65 181	62 125	51 250
Mung bean	806	1 175	931
Chilli	n.a.	n.a.	3 375
Morning glory seed	n.a.	n.a.	1 225

Source: [a/] Office of Agricultural Economics, 2005.
[b/] Field Survey, 2005.

4.2.5 Cost-revenue structure and farm profitability

Soybean

Farm profit refers to the margin between the total cost and revenue. The sample soybean farms incur production costs per hectare of US$ 324.22, broken down into variable costs per hectare of US$ 284.33 (87.7 per cent) and fixed costs of US$ 39.89 (12.3 per cent).

As the average yield per hectare is 1,412.50 kg and the farm price is US$ 0.295/kg, therefore revenue is US$ 417.75. Deducting production costs of US$ 324.22, the profit is US$ 93.53/kg (Table 4.10).

Table 4.10 Costs and revenue of soybean in Sukhothai, 2003/2004

(US$/ha)

Description	US$
Total	324.22
• Variable cost	284.33
• Fixed cost	39.89
Revenue	417.75
• Yield kg/ha	1 412.50
• Farm price US$/kg	0.295
Net profit	93.53

Source: Field survey, 2005.

More specifically, producing soybean in irrigated areas earns US$ 436.60/ha and the profit is US$ 115.80/ha. The figures are larger than growing soybean in rainfed areas, namely US$ 347.70/ha of revenue and US$ 10.13/ha of profit (4.11).

Table 4.11 Costs and revenue of soybean in Sukhothai, 2003/2004 (Comparison between irrigated/rainfed areas) (US$/ha)

Description	Irrigated	Rainfed
Total cost	320.80	337.57
Revenue	436.60	347.70
Yield kg/ha	1 475.00	1 343.75
Farm price US$/kg	0.30	0.26
Net profit	115.80	10.13

Source: Field survey, 2005.

Cost, revenue and profit of growing maize

Growing upland maize in monsoon months is found to incur total production costs of US$ 263.53/ha, comprising of variable costs amounting to US$ 215.11/ha; 81.6 per cent of the total cost and fixed costs of US$ 48.42/ha; 18.4 per cent of the total cost.

Maize growers generate revenues of US$ 349.03/ha. Deducting production costs the profit per hectare is US$ 85.50 (Table 4.12).

Table 4.12 Costs and revenue of maize in Sukhothai, 2003/2004 (US$/ha)

Description	US$
Total	263.53
• Variable cost	215.11
• Fixed cost	48.42
Revenue	349.03
• Yield kg/ha	3 362.50
• Farm price US$/kg	0.104
Net profit	85.50

Source: Field survey, 2005.

Cost, revenue and profit of cassava production

Planting cassava for 12-18 months in the province incurs production costs of US$ 328.10/ha. The variable costs per hectare total US$ 281.54 (85.8 per cent) and the fixed cost per hectare US$ 46.56 (14.2 per cent).

Cassava revenue per hectare is US$ 465.61 and therefore, when the total cost is deducted the profit is US$ 137.51/ha (Table 4.13).

Table 4.13 Costs and revenue of cassava in Sukhothai, 2003/2004

(US$/ha)

Description	US$
Total	328.10
• Variable cost	281.54
• Fixed cost	46.56
Revenue	465.61
• Yield kg/ha	18 750.00
• Farm price US$/kg	0.025
Net profit	137.51

Source: Field survey, 2005.

Cost, revenue and profit of rice production

The production costs of major and minor rice total US$ 355.72/ha, comprising of variable costs (86.3 per cent) and fixed costs (13.7 per cent).

The revenue of rice, derived from the yield per hectare multiplied by the farm price, is US$ 456.22/ha. Deducting production costs the profit is US$ 100.50/ha (Table 4.14).

Table 4.14 Costs and revenue of rice in Sukhothai, 2003/2004

(US$/ha)

Description	US$
Total	355.72
• Variable cost	306.99
• Fixed cost	48.73
Revenue	456.22
• Yield kg/ha	3 581.25
• Farm price US$/kg	0.127
Net profit	100.50

Source: Field survey, 2005.

A second rice crop grown in the irrigated zone generates US$ 521.03/ha with a profit of US$ 157.08/ha, which is higher than the US$ 359.45 revenue generated from growing major rice outside of the irrigated area.

Table 4.15 Costs and revenue of major rice and second rice in Sukhothai, 2003/2004 (Comparison between irrigated and rainfed areas)

Description	Irrigated zone	Rainfed zone
Total	363.95	343.15
Revenue	521.03	359.45
Yield kg/ha	3 900.00	3 106.25
Farm price US$/kg	0.13	0.12
Net profit	157.08	16.30

Source: Field survey, 2005.

Cost, income and profit of sugar cane

The cost of sugar cane production is US$ 362.56/ha, of which the variable costs account for 90 per cent and fixed costs 10 per cent.

The revenue per hectare of sugar cane generated from the yield and farm price is US$ 610.88/ha with a profit of US$ 248.32 ha (Table 4.16).

Table 4.16 Costs and revenue of sugar cane in Sukhothai, 2003/2004 (US$/ha)

Description	US$
Total	362.56
• Variable cost	326.24
• Fixed cost	36.32
Revenue	610.88
• Yield kg/ha	51 250.00
• Farm price US$/kg	0.012
Net profit	248.32

Source: Field survey, 2005.

Cost, revenue and profit of mung bean production

After soybean in the rainy season, mung bean forms a second crop grown in the dry months. Its average production cost is US$ 264.31, of which the variable costs are 81.8 per cent and the fixed costs 18.2 per cent.

The gross income earned from growing mung bean is US$ 254.84/ha. When the production costs are deducted, the growers are at a loss of US$ 9.47/ha since the second soybean crop often encounters drought (Table 4.17).

Table 4.17 Costs and revenue of mung bean in Sukhothai, 2003/2004 (US$/ha)

Description	US$
Total	264.31
• Variable cost	216.20
• Fixed cost	48.11
Revenue	254.84
• Yield kg/ha	931.25
• Farm price US$/kg	0.273
Loss	-9.47

Source: Field survey, 2005.

Cost, revenue and profit of chilli production

Chilli is grown throughout the year round with a production cost of US$ 780.51/ha, of which the variable cost is 93.5 per cent and the fixed cost 6.5 per cent.

With a yield per hectare of 3,375 kilograms and a farm price of US$ 0.372/kg, revenue totals US$ 1,257.14. After production costs are deducted, profit is US$ 476.63/ha (Table 4.18).

Table 4.18 Costs and revenue of chilli in Sukhothai, 2003/2004
(US$/ha)

Description	US$
Total	780.51
• Variable cost	729.76
• Fixed cost	50.75
Revenue	1 257.14
• Yield kg/ha	3 375.00
• Farm price US$/kg	0.372
Net profit	476.63

Source: Field survey, 2005.

Cost, revenue and profit of growing convolvulus

In irrigated areas, a number of farmers grow convolvulus vegetables after the rainy season soybean. Following the vegetable, a second soybean crop is again sown. The convolvulus (Morning Glory) production costs total US$ 217.13/ha, with variable costs of US$ 167.46/ha and fixed costs of US$ 49.66/ha.

Revenue from convolvulus sales per hectare amounts to US$ 792.74, which translates into US$ 575.61 of profit per hectare (Table 4.19).

Table 4.19 Costs and revenue of morning glory seed production in Sukhothai, 2003/2004 (US$/ha)

Description	US$
Total	217.13
• Variable cost	167.46
• Fixed cost	49.66
Revenue	792.74
• Yield kg/ha	1 225.00
• Farm price US$/kg	0.647
Net profit	575.61

Source: Field survey, 2005.

4.2.6 The role diversified farming systems play in risk mitigation

Soybean monoculture, both in the irrigated and rainfed areas yields variable production, especially in rainfed farming. Consequently, most farmers grow supplementary crops according to the area and soil suitability to mitigate risks on their investment.

Scattering farm holdings to diversify crops is common practice for farmers holding several farm plots, both owned and rented. The topography and soil characteristics are

different among the fragmented plots, so they grow soybean, rice and chilli in the low-lying fields and maize, cassava and chilli in upland areas.

4.2.7 Impacts on employment, income and the environment

Impacts on employment

In soybean mono-cropping, most labour is hired for seeding, maintenance and harvesting due to inadequate family labour and the wage is US$ 2.48-2.98 per day. Diversification with maize, cassava, sugar cane and chilli requires more family and hired labour which reduces local unemployment.

Impacts on income

Irrigated zone

Farmers growing only soybean produce 2-3 crops a year. Those growing soybean and other crops rotate with paddy, chilli or morning glory.

On average, farmers who diversify their cropping system earn US$ 574.87/ha and net profit of US$ 196.64/ha, while farmers concentrating on only soybean generate US$ 387.85/ha and a net profit of US$ 97.93/ha. The better income from diversification is attributable to the higher prices of the other crops.

Rainfed areas

The soybean mono-croppers grow both rainy season and dry season soybean. With regard to the farmers growing soybean with other crops, soybean and rice are grown on low-lying fields and soybean rotated with maize and mung bean or soybean coupled with cassava and sugar cane concomitantly in upland fields.

The economic analysis of costs and returns from farm diversification finds that soybean-based farm diversification earns US$ 364.73/ha with net profit of US$ 54.79/ha whereas, mono-cropped soybean generates US$ 356.97/ha and a profit of US$ 10.09/ha. The two groups have a similar income level because the supplementary crops of the sample farmers, namely paddy and mung bean were partially damaged by drought, resulting in a poor grade of the remaining products, and thus, a lower price received.

However, soybean-based cropping systems, both irrigated and rainfed, yield more net income than soybean mono-cropping, as the profits from sugar cane, paddy, maize, mung bean and chilli are all higher. In particular, sugar cane and chilli generate the highest returns (Table 4.20).

Table 4.20 Cost, revenue and profit of soybean monoculture compared with diverse farming in Sukhothai, 2003/2004 (US$/ha)

Description	Irrigated area		Rainfed area	
	Soybean	Soybean + Other crop	Soybean	Soybean + Other crop
Revenue	387.85	574.87	356.97	364.73
Production costs	289.92	378.23	346.88	309.94
Net profit	97.93	196.64	10.09	54.79

Source: Field survey, 2005.

Impacts on the environment

As for the case of diversified planted areas, in some irrigated areas soybean is rotated with other crops, for example rice, to avoid pest and disease risks from repeated cropping and soybean adds to soil fertility. Outside the irrigated zone, soybean is rotated with field crops, for example cultivating sugar cane for three years then rotating with soybean to improve soil texture and farm resources.

4.2.8 Potentials and constraints in farming operations

Soybean mono-cropping

Potentials

- Farmers use improved varieties under favourable agro-climatic conditions. In the irrigated area, three crops of soybean can be grown per year and the yield per hectare is better than elsewhere in the country.
- The farmers have management skills and long experience.
- Buyers are numerous including village assemblers and regional traders who often travel to the farms to make purchases. Also, there are agro-processing industries, namely the crushing mills and the farmwife processing group.

Constraints

- Production costs tend to rise in line with mounting land rent, farm wages and chemical fertilizers while the farm yields remain rather low.
- Lack of investment means that the use of inputs, such as fertilizers, is inappropriate resulting in low yields.
- Shortages of family labour make the farmers to depend more on hired farm workers at a cost.
- During periods of depreciated prices, losses may emerge. This is particularly true for smallholders.

Agricultural diversification

Potentials

- Those who have access to several farm plots diversify their cropping to cover risk. Such farmers are in a position to select a crop with market potential.
- Paddy is grown in the rainy season, both to sell and for household needs, followed by soybean requiring less water. Sukhothai is a major soybean producing area with a ready market.
- Farmers see the benefit of ecology and environment.

Constraints

- Rainfed farming is risky.
- Lack of funds triggers the poor use of farm inputs and hence, poor yields.
- Farms who grow several crops on their many farm plots but have small families require more hired labour and cash for wages.
- Producing too many crops requires different management skills and poor management can result.

4.3 Nakhonsawan

4.3.1 Average size of farm operation

Farms under study are smallholdings of 0.8-4.8 hectares growing maize on 0.80-4.16 hectares, mung bean on 2.08-2.40 hectares, soybean on 2.4-3.2 hectares, paddy on 1.6-3.2 hectares, sorghum on 0.8-3.2 hectares and sugar cane on 1.28-1.60 hectares.

4.3.2 Pattern of cultivation

Since most maize is cultivated rainfed with 120 days to harvest, farmers grow two crops. The early rainy season crop is in April-July and the late rainy season crop between July-October. In some cases, a small area usually grown to second rice is rotated with late rainy season maize. However, in Nakhonsawan, 77-88 per cent of the maize farmers prefer early rainy maize and the remainder grow maize late in the rainy season.

The cropping system for a single smallholding is diversified, namely sorghum after maize. Those having several separate plots practise multiple cropping concomitantly. After harvesting, a second crop or the same crop follows. For example, rice is grown in the first field and maize in the second. After harvesting, a second rice crop, mung bean or soybean follow. On the maize plot, a second maize crop follows the first.

4.3.3 Labour use

The surveyed farmers have four family members on average and 2-3 are available for farming. As such, a farmer holding a relatively large farm is forced to hire landless farmers or farm workers, especially for harvesting, threshing and packaging.

4.3.4 Farm productivity

There is a field crop research centre which conducts research, trials and development of maize varieties and farm technologies in the province. The *tambon* extension agents are responsible for transferring the technologies. The maize yield of the sample farmers in 2004 was found to be 4,469 kg/ha, above the provincial average of 3,844 kg/ha. The rice yield was 4,562 kg/ha; mung bean 862 kg/ha; soybean 1,406 kg/ha; and sugar cane 71,875 tons/ha (Table 4.21).

Table 4.21 Yield per hectare of CGPRT crops, nationwide and Nakhonsawan comparison, 2004

(kg/ha)

Description	National [a/]	Provincial [a/]	Sample farms [b/]
Major rice	2 025	2 537	4 563
Mung bean	806	769	863
Maize	3 856	3 844	4 469
Soybean	1 512	1 575	1 406
Sugar cane	57 937	57 956	71 875

Source: [a/] Office of Agricultural Economics 2005.
[b/] Field Survey, 2005.

4.3.5 Cost-revenue structure and farm profitability

Maize

The maize produced both in and out of the irrigated areas has an average production cost of US$ 358/ha. The variable cost totals US$ 305/ha; 85.39 per cent, and the fixed cost 14.61 per cent. The income from maize sales is US$ 461/ha with an average farm price of US$ 0.10/kg and profit is US$ 103/ha (Table 4.22).

Table 4.22 Costs and revenue of maize in Nakhonsawan, 2004

(US$/ha)

Description	Amounts
Total	358
• Variable cost	305
• Fixed cost	52
Revenue	460
• Yield kg/ha	4469
• Farm price US$/kg	0.10
Net profit	103

Source: Field survey, 2005.

The dry season (second crop) maize generates revenue totalling US$ 473/ha, and hence, profit of US$ 103/ha, which is higher than the rainfed crop which generates US$ 421/ha revenue and US$ 87/ha profit. The dry season maize yield is US$ 4,419 kg/ha, lower than the rainy season crop yield of US$ 4,581 kg/ha. In some rainfed areas, the rainfall is inadequate (Table 4.23).

Table 4.23 Costs and profit of maize production in irrigated (second crop) and rainfed (first crop) areas in Nakhonsawan, 2004 (US$/ha)

Description	Irrigated (second crop)	Rainfed (first crop)
Total cost	370	334
Revenue	473	421
• Yield kg/ha	4 419	4 581
• Farm price US$/kg	0.10	0.09
Net profit	103	87

Source: Field survey, 2005.

Costs and return of rice farming

The major and second rice crops grown in irrigated areas have an average cost of US$ 421/ha: variable cost of US$ 362/ha; 85.9 per cent and fixed cost of US$ 59/ha; 14 per cent of total cost.

Since the rice yield per hectare is US$ 4,563/ha and the farm price is US$ 0.12/ha, gross income is US$ 564/ha and therefore profit is US$ 143/ha (Table 4.24).

Table 4.24 Costs and revenue of rice in Nakhonsawan, 2004

(US$/ha)

Description	Total
Total	421
• Variable cost	362
• Fixed cost	59
Revenue	564
• Yield kg/ha	4 563
• Farm price US$/kg	0.12
Net profit	143

Source: Field survey, 2005.

Costs and return of major rice farming

In the low-lying fields, paddy is transplanted. Conversely, on upland fields, having no water storage facility available, sowing seeds is preferred. The cost of major rice farming is US$ 242/ha while its yield is 4,806 kg/ha and the price is US$ 0.12/ha. Therefore, gross income is US$ 609/ha and profit totals US$ 367/ha (Table 4.25).

Table 4.25 Costs and revenue of major rice in Nakhonsawan, 2004 (US$/ha)

Description	Amount
Total	242
• Variable cost	190
• Fixed cost	51
Revenue	609
• Yield kg/ha	4 806
• Farm price US$/kg	0.12
Net profit	367

Source: Field survey, 2005.

Cost, revenue and profit of sorghum production

Surveys of sorghum farming found that the crop is grown unirrigated in the dry months. The production cost is US$ 128/ha, of which the variable cost is US$ 64 (50.3 per cent) and the fixed cost is US$ 64 (40.7 per cent) (Table 4.26).

Table 4.26 Costs and revenue of sorghum in Nakhonsawan, 2004 (US$/ha)

Description	Amount
Total	128
• Variable cost	64
• Fixed cost	64
Revenue	178
• Yield kg/ha	1 788
• Farm price US$/kg	0.09
Net profit	49

Source: Field survey, 2005.

Cost and profit of mung bean production

Mung bean is sown in the irrigated zone after rice. The production cost is US$ 152/ha: 76 per cent is the variable cost and the remaining 24 per cent represents the fixed cost. Gross income is US$ 301/ha at a farm price of US$ 0.35/kg. Profit is US$ 149 (Table 4.27).

Table 4.27 Costs and revenue of mung bean in Nakhonsawan, 2004 (US$/ha)

Description	Amount
Total	152
• Variable cost	115
• Fixed cost	36
Revenue	301
• Yield kg/ha	863
• Farm price US$/kg	0.34
Net profit	149

Source: Field survey, 2005.

Cost, income and profit of soybean farming

Some of the surveyed farmers grow soybean after rice. The cost per hectare is US$ 261, of which the variable cost is US$ 179 (68.4 per cent) and the fixed cost is US$ 82 (31.6 per cent). Gross income is US$ 419/ha at a farm gate price of US$ 0.29/kg turning a profit per hectare of US$ 157 (Table 4.28).

Table 4.28 Costs and revenue of soybean in Nakhonsawan, 2004 (US$/ha)

Description	Amount
Total	261
• Variable cost	179
• Fixed cost	82
Revenue	419
• Yield kg/ha	1 406
• Farm price US$/kg	0.29
Net profit	157

Source: Field survey, 2005.

Cost, income and profit of sugar cane production

Sugar cane has been grown as the sole crop in the irrigated zone for years. The cost per hectare is US$ 791 of which the variable cost is US$ 666 (84.2 per cent), and the fixed cost is US$ 125 (15.8 per cent). The revenue per hectare is US$ 1,106 at US$ 0.01/kg and the profit is US$ 316 (Table 4.29).

Table 4.29 Costs and revenue of sugar cane in Nakhonsawan, 2004 (US$/ha)

Description	Amount
Total	791
• Variable cost	666
• Fixed cost	125
Revenue	1 106
• Yield kg/ha	71 875
• Farm price US$/kg	0.01
Net profit	315

Source: Field survey, 2005.

4.3.6 The role of diversified farming systems in risk mitigation

In times of drought, rain intermission or floods, farm production, even in the irrigated zone which depends on both irrigation and rainfall, is affected. Crops expected to command good prices are selected and a management system adopted to diversify with higher value products to dampen risks and maintain sustainable farming.

Diversified farm plots

A farmer holding several farm plots generally grows rice, maize, soybean and mung bean on the irrigated lowlands and sugar cane in upland areas not only according to topography but also to mitigate price volatility.

4.3.7 Impacts on employment, income and the environment

Impacts on employment

With diversified farm plots a farmer has to allocate labour for the cultivation of several crops, at times, contesting for farm workers.

Impacts on income

The income and profit of growing maize in the irrigated areas are higher than in rainfed areas as shown in Table 4.30.

Table 4.30 Revenue, costs and profit of maize in Nakhonsawan, 2004

(US$/ha)

Description	Maize irrigated zone	Maize rainfed zone
Gross income	473	421
Cost	370	334
Net Profit	103	87

Source: Field survey, 2005.

Impacts on the environment

Diversified farming

In areas of the irrigated zone irrigation is available in the dry season but farming is rainfed in the rainy months. Maize, soybean, mung bean, rice and sorghum are rotated to improve farm performance. Maize rotated with soybean or mung bean provides higher maize yields attributable to the nitrogen fixation of the beans in the soil.

4.3.8 Potentials and constraints of agricultural diversification

Potentials

- Greater farm income with much reduced risks. Consequently, there are more savings for farm investment and more experience is gained in diverse farming practices.
- More production alternatives to meet market potential.
- Advantages of better ecology and environment are realized by the farmers.

Constraints

- The second maize crop is likely to be vulnerable to drought in the rainfed areas.
- Lack of investment funds for farm inputs.
- Shortages of family labour induce higher cash costs for labour.

4.4 Concluding summary

4.4.1 Nakhonratchasima

The farms under survey were 1.0-7.2 hectares and the major crops include cassava, maize, mung bean and chilli.

The cassava yields of surveyed farmers are slightly better than national and provincial average yields, which indicates the area has good potential for cassava production in the country. The maize yield shows the same tendency, while the yield of mung bean of surveyed farmers is bellow the national average.

Among the five major crops in the study area, chilli has the highest profitability with a profit of US$ 774.47 per hectare, followed by cassava. The profit of major rice is lowest which indicates that CGPRT crops have better profitability in the study areas.

The survey found that diversified farming in the area has positive impacts on employment, income and the environment through increasing labour input, promoting agro-processing and fostering farmer organizations.

The major potential of agricultural diversification and farming in the area is the wide range of crop choice in the area, while the constraints are a lack of capital and the risk of drought.

4.4.2 Sukhothai

The farmers under survey have 1.60-2.40 hectares of farmland in the irrigated areas and 3.20-4.80 hectares in the rainfed areas. The major crops are soybean, maize, cassava, rice, sugar cane, mung bean, chilli and morning glory.

The yields of soybean, maize, cassava and sugar cane in the study area are less than the national average, while the yield of rice and mung bean is above than national average. Among the major crops in the study area, morning glory has the highest profitability (US$ 75.61 per hectare), followed by chilli. The profit of soybean is less than rice in both the irrigated and rainfed areas, which implies soybean has low potential in the study area.

The survey found that diversified farming has positive impacts on employment, income and the environment through increasing labour input, stronger commodity prices and improved soil fertility.

The major potentials of agricultural diversification and farming in the area are the farmers' management skills, the use of improved cultivars and good market opportunities. The constraints include fund and labour shortages.

4.4.3 Nakhonsawan

The surveyed farmers have an average holding size of 1.6-4.8 hectares per household. They primarily plant maize, rice, mung bean, sorghum, soybean and sugar cane. The yields of rice, maize, mung bean and sugar cane are above the national averages, while the yield of soybean is below. Among the major crops in the area, major rice commands the highest profit followed by sugar cane. The profit of maize is less than rice which implies maize has less potential in the study area.

The survey found that diversified farming in the area has positive impacts on employment, income and the environment through raising the labour requirement and improving soil fertility.

The major constraints of agricultural diversification in the area are fund and labour shortages and the risk of drought.

5. Analysis of the Marketing System of CGPRT Products

5.1 Cassava

5.1.1 Forms of products traded and channels of distribution

In Nakhonratchasima, after the tubers have been harvested they are sold as fresh roots for processing into dry slices to drying yards and flour mills. Selling to the flour mills is preferred as the flour mills' buying prices are based on starch content. The buying price is adjusted downward by US$ 0.005 per kilogram per 1 per cent of starch decrease. At the same time, most drying yards procure fresh roots but the growers usually obtain a lower price than from the flour mills. In fact, there are farms located far away from the flour mills, which are concentrated in *amphoe* cities and provincial seats. The drying yards are scattered around the producing areas, which makes it easier for the cassava growers to haul the roots for sales. Furthermore, some drying yard operators act as debtors for the growers to allow the procurement of their inputs and family expenditure. These growers are consequently forced to sell their products to the drying yards in order to be eligible for farm credit the subsequent year. The channel of distribution in the province is as follows:

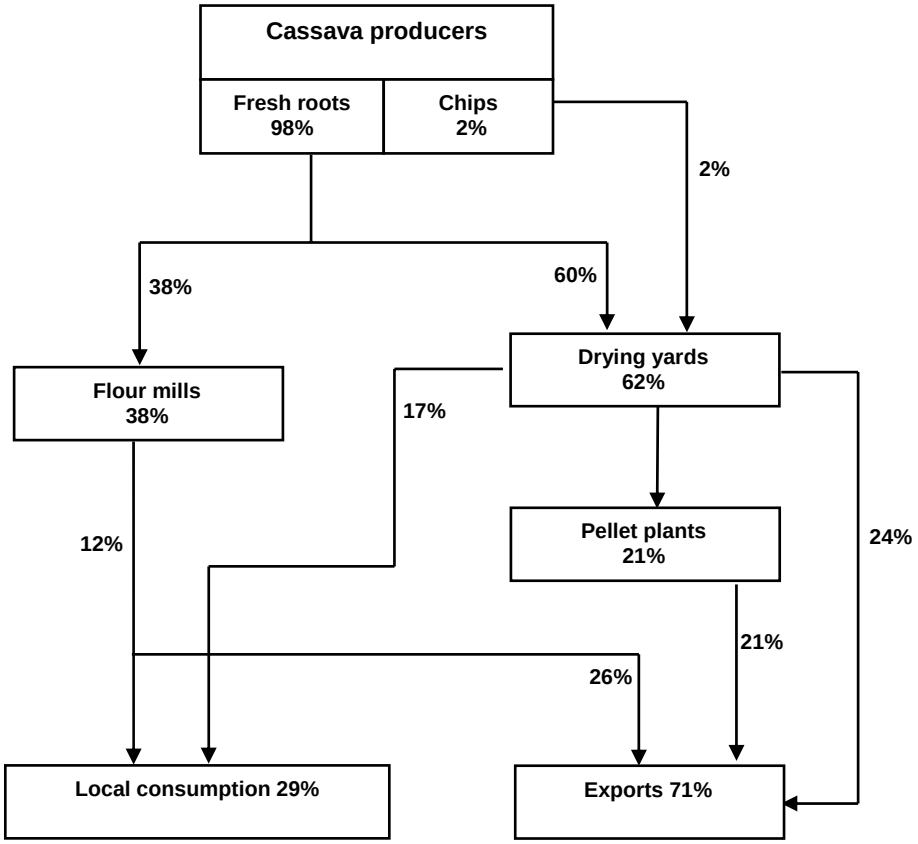
The farmers. Almost all cassava production (98 per cent) is sold fresh in Nakhonratchasima with the remaining 2 per cent sliced. Sixty per cent of the fresh tubers are sold to drying yards, 38 per cent to the flour mills and the final 2 per cent, in the form of chips, to the drying yards.

The drying yards buy the fresh tubers and slice them, with as much as 24 per cent of the sliced product sold to exporters, 21 per cent to pellet plants and 17 per cent to local livestock farms, namely the dairy co-operatives.

Pellet plants buy the chips from the cassava drying yards and process them into pellets. The entire 21 per cent of the chips made into pellets are exported.

Flour mills (the native starch mills) process the fresh tuber procurement into starch. The modified starch mills process both the fresh roots and the native starch into modified starch. Twelve per cent of both products are used locally and 26 per cent are exported (Figure 5.1).

Figure 5.1 Distribution channel of cassava in Nakhonratchasima



Source: Field survey, 2005.

5.1.2 Farm gate price and margin distribution

To study margin distribution, the distribution channel from the cassava producers to the drying yards and the starch mills was probed.

Farm gate prices and marketing margin of the chips

The price received in 2004 from the drying yard operators of US$ 73.25/ton of chips is set at 100. The marketing margin consists of the marketing cost and profit of US$ 12.42 or 16.95 per cent. After deductions, the cassava producers receive US$ 60.84/ton (83.05 per cent) at the fresh roots' farm gate price of US$ 0.03/kg.

The marketing margin of the drying yard is US$ 12.42/ton; 16.95 per cent of the chips' price. It is clear that the largest expense is the transportation cost (5.09 per cent) due to the bulkiness of the cassava chips, followed by water bills, electricity, telephone bills,

repairs and depreciation of 2.85 per cent, labour costs of 2.10 per cent and fuel costs of processing of 1.49 per cent.

Therefore, the profit of the drying yard is US$ 3.97/ton; 32 per cent of the marketing margin (Table 5.1).

Farm gate price and marketing margin of flour mills

The price received by the flour mill is US$ 193.69/ton and set at 100. The marketing margin includes the marketing cost and profit of the factory at US$ 72.38/ton or 37.37 per cent. Deducting the margin, cassava producers receive US$ 121.31 at the fresh tuber price of US$ 0.03/kg, which is higher than the price received by the drying yards because the flour mills purchase the roots by starch content.

The flour mills' marketing costs total US$ 54.63/ton; 75.47 per cent of the margin. The fuel, electricity and water bills are the greatest; 10.86 per cent followed by telephone bills, repairs, depreciation and packaging of 8.75 per cent, labour costs of 5.38 per cent and transportation costs of 3.21 per cent.

Therefore the profit of the flour factory is US$ 17.75/ton; 24.52 per cent of the marketing margin (Table 5.2).

Table 5.1 Marketing margin of chips in Nakhonratchasima, 2004

(US$/ton of chips)

Description	Total	Percentage
Average farm price at office	60.84	83.05
Labour	1.54	2.10
Fuel (in processing)	1.09	1.49
Transportation	3.72	5.09
Other	2.08	2.85
Profit of drying yard	3.97	5.42
Margin	12.42	16.95
Average price received by drying yard	73.25	100.00

Source: Field survey, 2005.

Table 5.2 Marketing margin of the flour mills in Nakhonratchasima, 2004

(US$/ton of flour)

Description	Total	Percentage
Average farm price at office	121.31	62.63
Labour	10.42	5.38
Fuel + electricity + water (in processing)	21.03	10.86
Transportation	6.21	3.21
Other	16.96	8.75
Profit of flour mill	17.75	9.17
Margin	72.38	37.37
Average price received by flour mill	193.69	100.00

Source: Field survey, 2005.

5.1.3 Market structure and competition

There are three major sources which buy tubers, more specifically 88 drying yards, 16 pellet plants and 16 flour mills scattered in the tuber producing areas contesting for the supply of roots, which provides alternatives to the farmers. The tuber market structure has perfect competition in which both the buyers and sellers are numerous and the goods are not differentiated. The exception is that some cassava chip producers are forced to sell their product to the modified starch mills which provide credit in cash or in the form of farm inputs early in the growing season. Consequently, the product is sold back to the mill to offset the credit. The credit service of the starch mills forms a farmer network and ensures the mill's supply security too.

5.1.4 Potentials and constraints in the marketing system

Marketing potentials of cassava

- Many alternative sales channels exist for the farmers.
- The domestic market for cassava products continues to grow. The market for cassava slices grows annually at a rate of 3.27 per cent as it is promoted for feed use in the livestock industry. In addition, the demand for flour and starch grows annually at a rate of 5.88 per cent following the expansion of the starch forward industries for sweeteners, seasoning, textiles and ethanol.
- The export market for cassava products displays a growing trend. In 2004, the demand for exports increased by 18.82 per cent over the previous year. Furthermore, China requires more chips and demand increased by 5.41 per cent over 2003 for alcohol production.

The increasing demand for cassava products in both the domestic and export markets tends to raise Nakhonratchasima farm prices for the roots.

Constraints in the cassava marketing system

- Cassava producers generally hold low bargaining power due to the lack of organized farm groups in the province.
- Market supply has narrow concentrations over the year. The cassava harvest peaks in December to February, at which time the daily supply to the processors is always in excess, thus farm prices are often depressed.
- Transportation:
  - **High cost of the transport.** Ten-wheeled trucks are in common use to haul the tubers, however, unfortunately the harvest period coincides with paddy

and sugar cane. Competition for the trucks usually raises the hauling cost by US$ 0.008-0.001 per kilogram above the normal.

- **Freight load.** There is an upper limit for the load of the crops and therefore freight costs become higher.

5.2 Soybean

5.2.1 Forms of products traded and channels of distribution

After the harvest, soybean is sun-dried for a few days and then threshed for the grain. Most soybean is sold mixed to local assemblers to repay outstanding debt from earlier in the growing season. The credit was used to purchase farm inputs and for daily household spending. The prices received are generally lower than prevailing market prices. Any remaining produce is sold to local crushers. Soybean and its products are traded to intermediaries as follows:

Local assemblers. The local assemblers sell their purchased and graded beans to processors producing soybean grain sauce, curd and Chinese sauce, among others. Second grade beans are sold to local and national crushers and crushers in Bangkok.

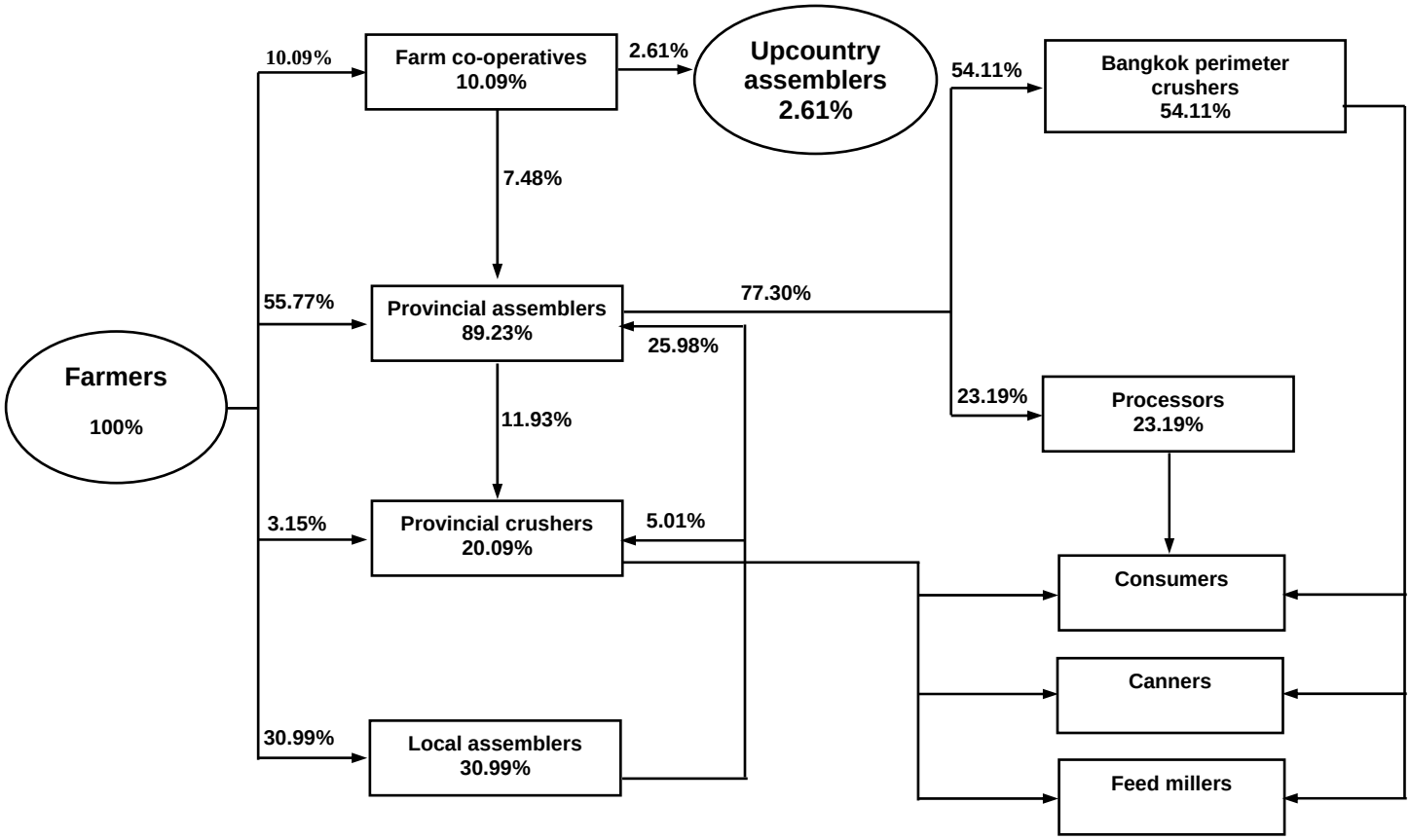
Farm co-operatives sell their produce to local and Bangkok crushers, local assemblers and processors.

Sukhothai crushers. Soybean oil is sold to vendors and linkage industries, for example canning plants and paint industries, among others.

Bangkok and national crushers. Part of the soy oil is bulk packed and sold to other crushers and canners. Another part is bottle packed and wholesaled. Soy cakes are sold to livestock farms and feed mills.

Processors. Their products, which include, among others fermented beans, sauces, and soy milk, are sold to consumers, some of which through brokers (Figure 5.2).

Figure 5.2 Distribution channel of soybean in Sukhothai, 2004/2005



5.2.2 Market structure and competition

The Sukhothai buyers of soybean are few in number. Crushers add to the number of the assembler buyers. Many soybean farmers are forced to sell to the local assemblers cum money lenders for debt repayment.

5.2.3 Potentials and constraints in the marketing system

Potentials

- Sukhothai-produced soybean certainly contains more protein and is fresher than imported soybean. The vendors even grade the soybean for soy milk production which is in high demand from the national vendors.
- Sukhothai has better production and market potential.
- Demand for soybean continues to rise. In this context, the crushing industry is expanding to meet increasing domestic demand.

Constraints

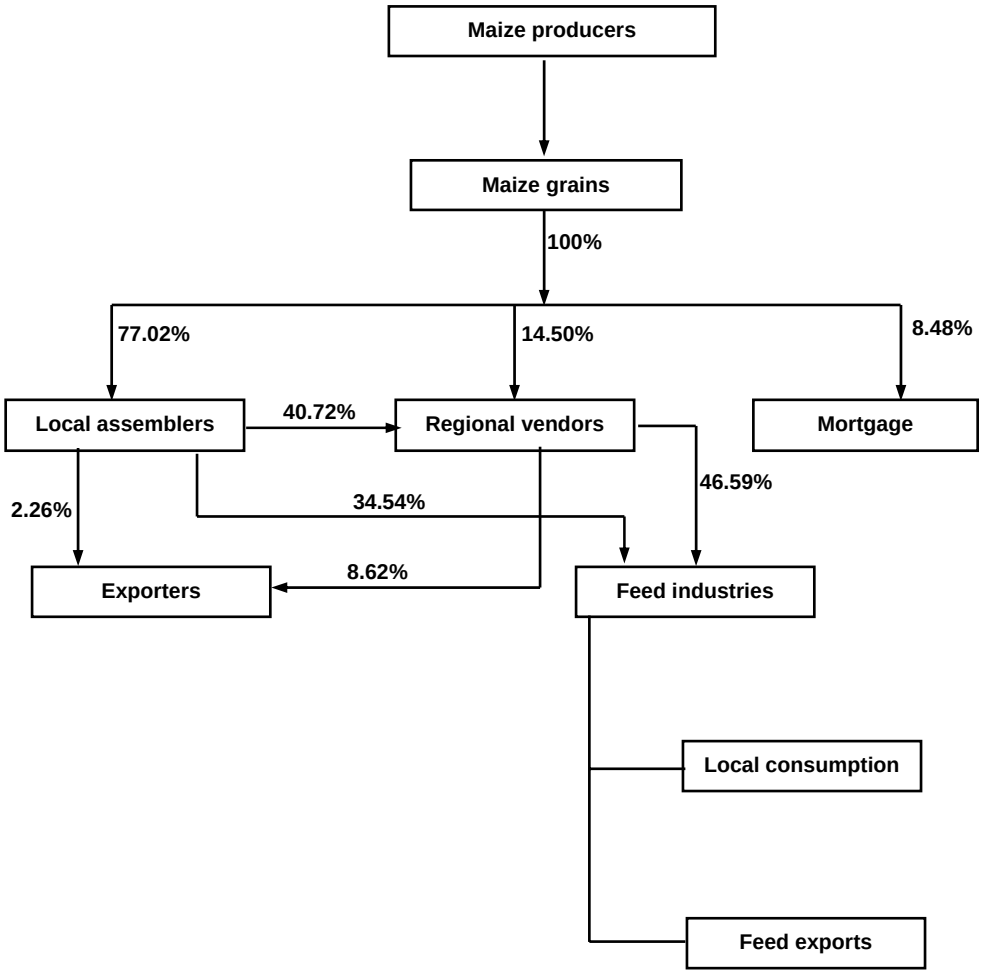
- The low farm price received due to its common, mixed grade selling nature.
- The farmers have no bargaining position as they are tied to debts owed to the vendors and no farmer groups exist.
- Rainy season soybean has a high moisture content while the growers have no drying yards or storage facilities. Consequently, the soybean is usually sold immediately after harvest at a low price. Moreover, the traders have no interest in investing in dryers, which are expensive when the trade margins are small.
- Market news is not well disseminated.
- Local soybean traders have declined in number, attributable to less soybean production, lower margins due to keen competition from imports, and no trade successors as it is mostly a family business and nowadays the children often seek jobs elsewhere. Moreover, some vendors are forced out of business due to lost lending.
- Some traders lack revolving trade funds for large concentrations of soybean harvests over a short period of 1-2 months.

5.3 Maize

5.3.1 Forms of products traded and the channels of distribution

Almost all domestic maize production is used as feed. In Nakhonsawan, most farmers sell their maize crop at the farm gate price or send to local assemblers who provide mechanical threshing and hauling services to the market. While the threshing charges are paid by the farmers, the hauling charges from the farms to market are paid by the assemblers. Those who trade with the regional traders have to pay the threshing and delivery fees to the traders' offices. Local assemblers usually sell 40.72 per cent and 34.54 per cent of their supply to the regional vendors and feed mills respectively. The regional vendors are usually in favour of selling their maize to the feed industries; according to price quotations, 46.59 per cent to the large maize market and 8.62 per cent to the exporters. Bulk loading on trucks is currently preferred to the expensive bagging. The maize price offered is largely determined by the feed industries, without seller participation. The transactions are usually made through brokers between local assemblers and feed industries, whereas there is no involvement of intermediaries between the regional traders and the industries. The moisture content is the main measurement of quality at the farms while the moisture, perishable broken grains and additives are the criteria for the price offered (Figure 5.3).

Figure 5.3 Distribution channel of maize in Nakhonsawan



Source: Field survey, 2005.

5.3.2 Farm gate price and margin distribution

Farm gate price and marketing margin of maize

The farm price received in 2004 was US$ 0.11/kg which represents 90.32 per cent of the local assemblers' price received from the factories. The profit of the farm producers is US$ 0.02/kg, namely 21.99 per cent of the assemblers' price received. The prices received by the assemblers and the regional traders in 2004 for maize were US$ 0.10 and US$ 0.11 per kilogram respectively, representing 93.84 per cent and 100 per cent of the regional vendors' price received from factories. Freight represents the largest share of the marketing

cost; 5.43 per cent of the regional vendor's price received from factories. The profits of the farmers, assemblers and regional traders are 32.18 per cent, 1.11 per cent, and 0.42 per cent respectively.

5.3.3 Market structure and competition

There are a large number of maize buyers locally and regionally scattered in all maize producing *tambon* and *amphoe*. In some areas traders have direct purchases with maize producers to reduce marketing costs.

5.3.4 Potentials and constraints in the marketing system

Potentials

- Farmers have choices in their marketing. In Nakhonsawan and its neighbouring provinces there are many maize assemblers and the producers are able to sell their product locally.
- The animal industry continues to grow and the feed industry's maize demand follows accordingly.

Constraints

- Maize producers have no bargaining power in Nakhonsawan. Many have to repay loans from the vendors with their produce.
- Maize is supplied in the rainy season leading to more moisture and aflotoxins in the maize. Consequently, farm prices are depressed.
- Transportation:
  - Usually freight is expensive with the use of large trucks.
  - There is an upper limit for the truck load and therefore freight costs become higher. It is accounted in the raw material cost in the linkage industries.

5.4 Concluding summary

The marketing systems of three target crops were surveyed in the respective study areas. A summary of the findings is as follows:

5.4.1 Cassava

The major players in terms of cassava marketing in Nakhonratchasima are farmers, drying yards, pellet plants and flour mills. The farmers sell most of their produce fresh from harvest.

Regarding the price received by the cassava farmers from the drying yards and flour mills, farmers enjoy better prices from the flour mills, since the flour mills determine prices according to starch content. The nature of the cassava market in the province is perfect since there are a sufficient number of drying yards and flour plants in the area, no product differentiation exists and information on the tuber prices is perfect. Some farmers have to sell their produce to certain processors who provide loans prior to the growing season, which contributes to securing the supply of material to the processors.

The major potentials of marketing are the competitive market conditions and growing domestic cassava demand, while the major constraints include the poor bargaining power of the farmers and high transportation costs.

5.4.2 Soybean

The major players of soybean marketing in Sukhothai are farmers, local assemblers, farm co-operatives, Sukhothai crushers, Bangkok and upcountry crushers and processors. Farmers sell soybean after sundry and threshing. The product is sold to local assemblers without grading.

The major marketing potentials are the good quality of the soybean and rising demand, while the constraints are low farm price, no farmer bargaining power, high moisture content of the rainy season crop and the lack of funds and market information for farmers.

5.4.3 Maize

The major players in the maize market in Nakhonsawan are farmers, local assemblers and regional vendors.

There are many local assemblers and regional vendors in the province and many of them buy on-farm. Potentials in the marketing system of maize include expansion of the feed industry seeking more maize, while constraints are the low bargaining position of the farmers, low grain quality in the rainy season and high transportation costs.

6. Analysis of the Industrial Processing Business of CGPRT Products

6.1 Cassava processing

6.1.1 Types of processed products and annual production

Due to the high hydrocyanic acid content and the bitter taste, cassava roots grown in Thailand are inedible. Consequently, the fresh roots have to be processed into various products according to their end use. One such product is targeted for human consumption. In the linkage industries; flour and various forms of starch are produced. For feed and ethanol manufacturing pellets and cassava slices are initially produced.

The production of cassava products are grouped as follows:

Cassava chips

The chips are the primary products obtainable from the fresh roots as illustrated in Figure 6.1.

Cassava pellets

The pellets are processed from the cassava chips to reduce bulk and transport costs as illustrated in Figure 6.1. Annually, 45-48 per cent of total root production in Thailand is used as raw materials for the production of chip/hard pellets and the remaining 52-58 per cent for starch production. The proportion of chips/hard pellets to starch is 45-48 per cent and 52-55 per cent.

Cassava starch

The processing of fresh cassava roots to starch is shown in Figure 6.2, which is divided into:

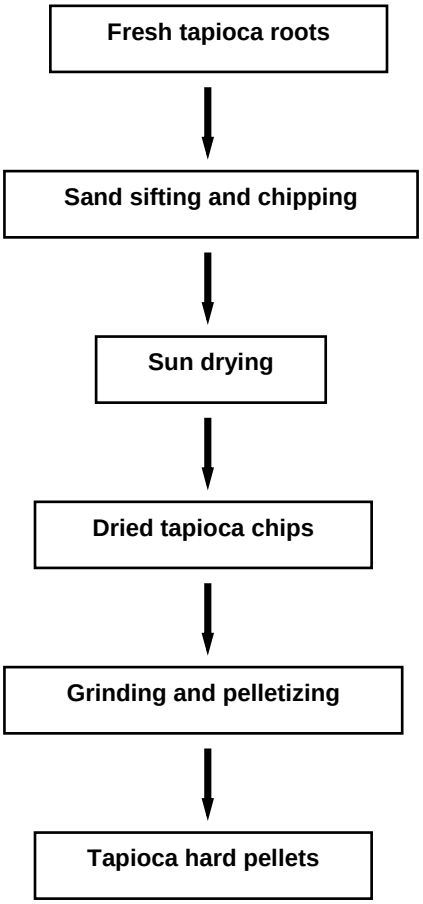
Cassava native starch is obtained when the fresh cassava roots are processed. An amount of 4.2-4.5 kilograms of tapioca roots is required to produce 1 kilogram of tapioca native starch. Tapioca roots are crushed and the liquid starch is extracted; the latter is subsequently heated and oven dried. Native starch also has a wide range of applications but the most value added application is to produce modified starch.

Cassava modified starch is manufactured directly from native starch. There are three methods of production: Chemical, Physical and Biotechnology. There are hundreds of varieties of modified starch through customization in line with demand from various industries (Figure 6.3).

Ethanol

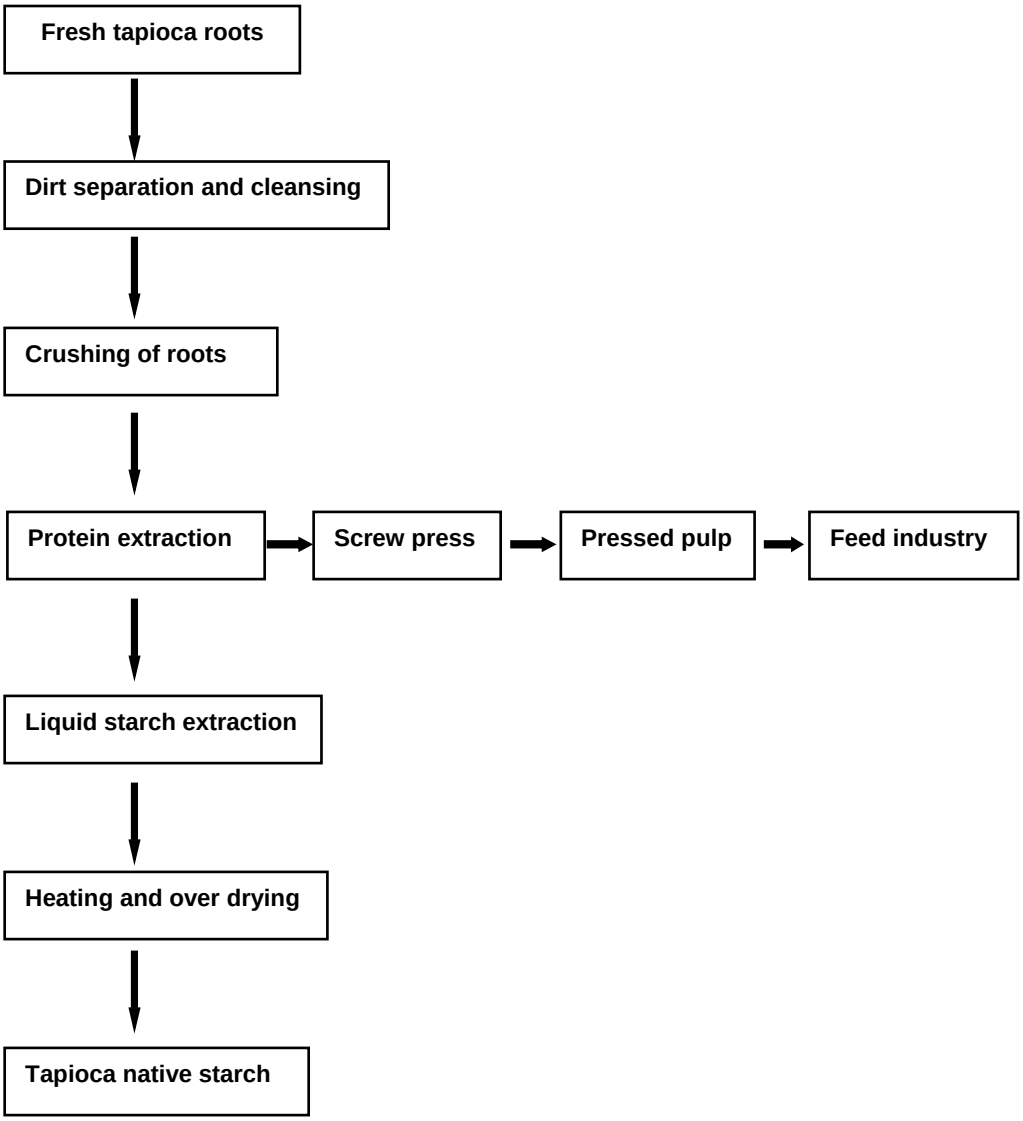
Ethanol is a form of alcohol produced from carbohydrates. The raw material may be fresh cassava roots or cassava chips.

Figure 6.1 Production process of tapioca chips and hard pellets



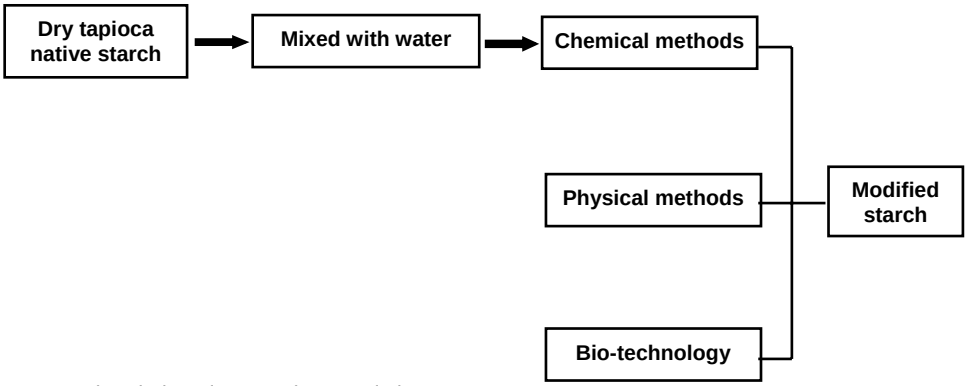
Source: The Thai Tapioca Trade Association, 2005.

Figure 6.2 Production process of tapioca native starch



Source: The Thai Tapioca Trade Association, 2005.

Figure 6.3 Production process of tapioca modified starch

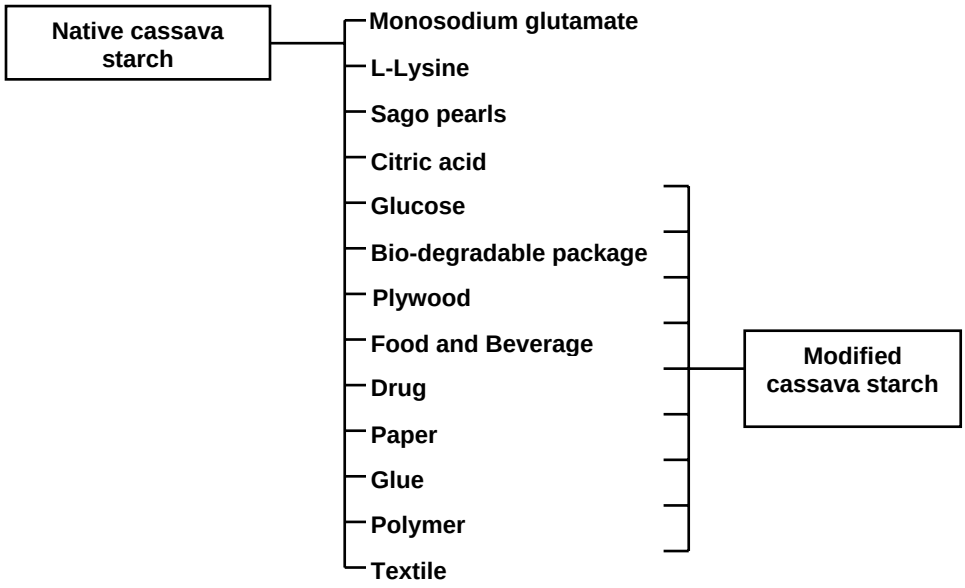


Source: The Thai Tapioca Trade Association, 2005.

Linkage industries of cassava starch

Cassava starch and modified starch can be used in various linkage industries to produce, among others, seasoning, lactic acid, food and beverages. Since the cassava starch has an array of properties, such as viscosity, hardening, adhesiveness and water balancing, to name a few, there is a large range of uses: industrial, consumption and disposition (Figure 6.4).

Figure 6.4 Linkage industries of native cassava starch and modified cassava starch



Source: The Thai Tapioca Trade Association, 2005.

6.1.2 Cassava processing in Nakhonratchasima province

In Nakhonratchasima province, there are several enterprises operating in the production of cassava chips, pellets, flour including native starch and modified starch, ethanol and industries requiring cassava flour, for example Lodchong dessert.

Chips

Production of cassava chips

In the past, the chips were primarily made from fresh roots and forwarded to produce the hard pellets which served as the major cassava product. Before 1993 the country produced chips representing 65-75 per cent of total cassava production; or about 12-13 million tons of fresh roots. After the CAP Reform launched by the EU in 1993/1994, the EU has increasingly turned to its domestic cereals to substitute cassava products. While the market for starch began to expand, starch production followed a similar pattern. However, since 2001, China began to place large orders for Thai cassava chips but this could not offset the falling demand for the pellets. As a result, Thailand currently processes about 45-50 per cent of national production (9-10 million tons of the fresh tubers) for chip production.

Production capacity and its use

At the national level, there are 870 chip drying yards scattered in the cassava tuber producing areas. In Nakhonratchasima alone, there are 88 chip drying yards, the largest number of all provinces. The production capacity of a chip drying yard depends very much on the size of the yard. On average, one hectare of drying yard can accomodate about 93.75-125 tons of fresh tubers. The average yard size is 1.6-2.4 hectares. The peak supply months are from November to March, at which time all yards are at full capacity. However, from April to May, production declines as the tuber supply recedes and yards operate once every 3-4 days. From June on, the monsoon restricts chip drying due to the rainfall. Activities resume with a small tuber quantity in September.

Cost-revenue structure and business profitability of the chips

The chip processing cost may be divided into two parts, namely; the variable and fixed costs. The variable costs include the cost of raw materials (cassava tubers), labour, fuel, lubrication and repairs to the machinery. Fixed costs include machine depreciation for example chipping machine, chip sprinkler, chip flipper, chip collector, and shovelor in addition to the drying floor. The cost structure indicates that the highest chip processing cost item is the cost of the raw material supply (83.05 per cent of the processing cost). The processing cost reduction effect can occur, increasing the processing volume. Increased

performance reduces the depreciation cost per unit of production, as well as the cost of labour, fuel and lubrication for full use of the machinery.

The cost of producing one ton of cassava chips is around US$ 65.56, comprising of US$ 64.27 variable cost (98.03 per cent).

Income

The drying yard operators sell their chips to the pellet plants for about US$ 73.25 per ton. Therefore, the revenue from the chips is US$ 69.53 per ton.

Profit

The profit is the margin of the revenue and the total of processing cost and selling expenses (transportation cost of chips). A drying yard operator generates US$ 3.97 of profit per ton (Table 6.1).

Table 6.1 Cost, revenue and profit of chips in 2004 (US$/ton)

Description	Total
Total cost	65.56
• Variable cost	64.27
- Cassava root	60.84
- Processing cost [a/]	3.43
• Fixed cost	1.29
Revenue	73.25
Selling expenses	3.72
Earning from the chip	69.53
Profit	3.97

Source: Field survey, 2005.
Note: [a/] Processing costs included electricity and fuel, labour, etc.

Potentials and constraints in the processing business of the chips

Potentials

- Sufficient supply of the raw material exists to absorb chip processing. Current national annual cassava production is 18-20 million tons of fresh tubers, of which 9-10 million tons are processed into chips. Nakhonratchasima province alone produces 4-4.5 million tons of fresh roots.
- The knock-on effect of relatively low root prices forces chip prices lower than other farm products. Furthermore, the chip industry is growing.
- There are a large number of chip drying yards scattered around the cassava producing areas. Nakhonratchasima province has as many as 88 drying yards. In the case of growing demand for cassava chips, the number of the drying yards can simultaneously expand raising production capacity.
- Better hygiene and an improved environment can be expected from the use of the

cassava chips. Chip use in animal feeding sets a good example in keeping livestock healthier than using maize with its aflatoxin hazards. Another example is the production of alcohol from the chips which reduces greenhouse effects. China has turned to import cassava chips for alcohol production instead of using molass.

- The FTA bilateral agreements such as that between Thailand and China increase demand for the chips.

Constraints

- Competition in the purchase of raw materials. As there are numerous chip drying yards in Nakhonratchasima scattered around the producing areas, they often compete with price offers among the drying yard operators and the flour millers too.
- Underemployment of the infrastructure and input. The demand for pellets has fallen dramatically whereas the chip drying yards are many. As a result, underemployment raised the cost of production. Worse still, some drying yard operators in Nakhonratchasima were forced out of business and turned to other unrelated occupations, for example trading building materials.
- Unsteady raw material supply during the growing season. Harvesting the tubers is usually concentrated in November to March. After this period shortages occur and consequently there is no adequate daily supply which spurs further high production costs.

Pellets

Pellet production

Before 1993, Thailand produced the chips with 65-75 per cent of total tuber production (12-13 million tons) used for chip production. Of the total chip supply 85-90 per cent (10-11 million tons of cassava roots) were pelletized, to satisfy EU demand for feed production. However, the EU's CAP Reform resulted in a reduction of the pellets imported despite demand for the chips from China growing. Consequently, pellet plants were forced to reduce production. The current situation is such that pellet manufacturing has come close to about 50 per cent of total chip supply (4-5 million tons the fresh tubers).

Production capacity and its use

The number of pellet plants is currently 63 nationwide, of which 16 are located in Nakhonratchasima, the largest concentration. The production capacity of pellet plants is commonly expressed in terms of the number and size of the dies (pressurized metallic molds) and the energy taken to pressurize them. Each plant has a production rate of 11-12

tons of pellets. In fact the plants are only operating at 20 per cent of annual total capacity, only 4-5 months of operation, reflecting the much lower export demand. Tuber production during April to August is usually insufficient to switch on the production line.

Cost-revenue structure and business profitability of pellets

Total cost in pelletizing the cassava chips may be divided into two groups of variable and fixed costs. The variable costs include the chips as raw material, labour, fuel and lubrication, electricity and weight loss. The fixed costs comprise of machine depreciation, namely pelletor, steam boiler, grinding machine, shovel and scale. Based on the total cost structure, the main variable cost of pelletizing, the same as for chip processing, is the raw material which accounts for 91.16 per cent of the total cost.

The total cost of pelletizing is US$ 74.22 per ton, including variable costs of US$ 73.82 (99.46 per cent) and fixed costs of US$ 0.40 (0.54 per cent) (Table 6.2).

Revenue. Pellet plant operators sell the pellets to exporters for US$ 80.36 per ton. Cost incurred in selling involve US$ 3.73 for transportation. As a result, the sales of 1 ton of pellets generates US$ 76.63.

Profit. The margin of the revenue less the processing costs less the transportation costs is US$ 0.62 per ton.

Table 6.2 Cost, revenue and profit of pellets in 2004 (US$/ton)

Description	Total
Total cost	74.22
• Variable cost	73.82
- Chip	73.25
- Processing cost	0.57
• Fixed cost	0.40
Revenue	80.36
Selling expenses	3.73
Profit	2.41

Source: Field survey, 2005.

Potentials and constraints in industrial processing pellets

Potentials

- The chipped raw material supply is adequate. With annual cassava root production at around 18-20 million tons, only 4-5 million tons of the tuber are required to make the chips to be used for pelleting. In Nakhonratchasima alone, 4-4.5 million tons of the tubers are produced annually.
- There are numerous plants for pellet production. In the case of a larger market for the pellets, production capacity can meet the demand.
- Pellet prices are relatively low compared to EU cereal prices. The EU imports Thai pellets due to their cheaper price compared to EU domestic cereal prices.

Constraints

- Pellet machinery and regular plant workers are under utilized as a result of lower EU demand for the product.
- Great price risks exist for the pellets as the plants have to maintain a stockpile of chips before forwarding the pellets. If the prices of pellets depreciate while chip prices are high, the pellet plant would run at a loss.
- The numerous pellet plants foster tight competition for the purchase of raw materials. A large number of flour mills also exacerbates the situation so that the pellet plants have to pay higher prices for the chips.

Tapioca starch

Native starch mill

Production capacity. There are 68 starch mills nationwide, each with a production capacity of 200-300 tons. Twelve starch mills are located in Nakhonratchasima. December to March are the peak months of market supply when all mills operate at full capacity. The plants work in three, 8-hour shifts. When the supply of roots subsides, during the low season, beginning April, some mills reduce their capacity to two shifts attempting to evade the period of 16.00-22.00 p.m. as the electricity charge per unit is very high. In a very low season of root supply, most mills operate once in 2-3 days. The mills close during July to August due to the very little supply of tubers and for maintenance and repairs. There is an exception that some mills operate all year round, working one to two shifts a day in the low season.

Cost-revenue structure and business profitability of cassava native starch. The processing cost of native starch is divided into variable and fixed costs. The variable costs include tuber supply procurement, processing labour, power and fuel, chemicals, water, packaging and interest. The fixed costs include depreciation and repairs to machinery. Based on the cost structure, the processing cost for native starch, the same as for the chips and pellets, includes the main item of raw material, accounting for 62.63 per cent of total cost.

Native starch production costs total US$ 169.73 per ton, the breakdown of which shows variable costs of US$ 164.52 (96.93 per cent) and fixed costs of US$ 5.21, (3.07 per cent of the total cost).

Revenue. Native starch mills usually sell their products to linkage industries, such as for seasoning and sweeteners, or for export. In this study, sales to exporters are emphasized, with a price of US$ 193.69, involving the expense of transportation at

US$ 6.21 per ton. Therefore, the revenue of native starch excluding sales expenses is US$ 187.48 per ton.

Profit. The margin of the sales and the sum of processing cost and selling expenses is US$ 17.75 per ton (Table 6.3).

Table 6.3 Costs, revenue and profit of cassava native starch (US$/ton)

Description	Amount of money
Processing cost	169.73
• Variable cost	164.52
- Cassava root	121.31
- Processing cost	43.21
• Fixed cost	5.21
Revenue	193.69
Selling expenses	6.21
Profit	17.75

Source: Field survey, 2005.

Modified starch mills

The processing cost and return of modified starch are as follows:

Production capacity

There are 18 modified starch mills across the country and the daily capacity of each mill is about 300-400 tons. Four mills are located in Nakhonratchasima. As modified starch has many properties, the mills producing the more common types operate at full capacity to reach economies of scale. Those producing starch with special properties operate to order. Most of them, however, operate all year round having a steady supply of native starch. At times, they work below full capacity depending on the type of modified starch being produced. Moreover, some mills produce both the native and modified starch.

Cost-revenue structure and profitability of modified starch

Modified starch can be locally produced in a variety of more than 100 types and each type carries a different processing cost and, therefore, a different return to the entrepreneur. Since availability of the export cost, forward price to the linkage industries and the f.o.b. price are very restricted, the study focuses on the cost and revenue structure of modified starch production qualitatively.

Total cost. The major cost item of modified starch is the native starch at US$ 0.19 (one kilogram of native starch makes 0.95 kilogram of modified starch), followed by the chemical cost which varies and subsequently alters the processing cost. Chemicals are required in the processing to ensure a proper chemical reaction to obtain starch with suitable molecular arrangements for use in a particular forward industry. The cost of the chemicals in a kilogram of modified starch is US$ 0.02-0.19. The cost of labour, power,

water, etc. together total US$ 0.05 per kilogram of modified starch. Therefore, the processing cost of the various types of modified starch is US$ 0.26-0.43 per kilogram.

Revenue depends very much on the price fixed by the operators. Since the market for modified starch has few sellers, modified starch requiring advanced production technology can have a high price. As a result, the operator can generate large revenues. Modified starch with standard/general properties is priced in consideration with its competitors and substitutionability.

Profit in the modified starch trade is lucrative with little or no competition as advanced technology is required to produce a particular type of modified starch.

Potentials and constraints in the processing of modified starch

Potentials

- Adequacy of raw material supply throughout the year.

  Out of the 18-20 million tons of total tuber production harvested all year round, provided good farm management is used, 9-10 million tons of the tubers are used in starch processing. Nakhonrachasima alone annually produces 4-4.5 million tons of cassava roots which represent 22 per cent of national production. The province also accepts deliveries of tubers from the neighbouring provinces of Chaiyabhume and Khonkaen.

- Low-cost starch production.

  Comparing the production of cassava starch and other starch products, the cost and price of cassava starch are lower. Consequently, consumers turn more to this starch in the forward industries.

- Foreign entrepreneurs and technology development.

  In Nakhonratchasima there are 3-4 starch processing plants involved in joint investment ventures with foreign sources.

  Also in the plants run by the Thai operators, technological development for processing continues to substitute maize, wheat and potato starch.

- Demand expansion.

  There exists vast absorption capacity of a large number of the linkage industries and high added value can be achieved. They are sweetening products, paper, textiles, plywood, adhesives, seasonings, and many more.

Constraints

- Unsteady supply and volatile prices of the tuber.

  In a year shortages of the tubers often occur and therefore, prices soar which

further raises the production costs of starch. In times of scarcity native starch is used which further adds to the cost.

- Underutilization of the machinery.
  Usually the tuber supply flows heavily to the market from November to March and production lines operate at full capacity. Subsequently, however, supply falls short forcing some plants to temporarily cease work or underemploy, which affects the production cost per unit. The exception is modified starch, which, upon using the native starch, can be produced throughout the year, however, it is also underemployed.
- Competition of material provision.
  A larger number and concentrations of starch producing plants coupled with the establishment of the ethanol industry. For example, Nakhonratchasima has 14 starch plants with two more plants being established. Competition for raw material supply is tightening with the drying yards pushing up raw material prices. Two ethanol plants are now located in the province exacerbating the problem.

Ethanol

Alcohol is a product of fermentation of either carbohydrate or sugar. Currently the potential crops in Thailand include cassava and industrial sugar cane as they are abundant and can have their planted areas expanded rapidly upon greater incentives to produce. Moreover, the two crops are strategically planned.

Production capacity and its uses

In line with policy on ethanol production to substitute petroleum imports, 24 potential ethanol operators have been approved, of which eight will be supplied with cassava at an annual production capacity of 2.2 million litres. Two of the plants, located in Nakhonratchasima, will produce 1 million litres daily. They will begin operation in 2006.

Cost of ethanol from cassava

The cost of producing ethanol can be divided into two groups; raw material and for processing. At the current price of US$ 29.80 per ton of tubers, a litre of ethanol costs US$ 0.33. At 54.55 per cent of the cost of the raw material, the processing cost per litre is US$ 0.15 or 45.45 per cent. Therefore, ethanol production costs vary primarily according to the cost of raw materials (Table 6.4).

Table 6.4 Cost of ethanol from cassava, 2005 (US$/litre)

Description	Cost	Percentage
Raw material	0.18	54.55
Processing cost	0.15	45.45
Total cost	0.33	100.00

Source: Field survey, 2005.

Potentials and constraints in the processing industry of ethanol

Potentials

- The production and use of gasohol (fuel added with ethanol) is included in the promotional public policy. The 2005 target of use expects 1 million litres of ethanol to be substituted for Methyl Tertiary Butyl Ether (MTBE) in gasoline 95. From 2002-2010, the daily use of 3 million litres of ethanol is expected to replace, in part, gasoline 91 in addition to gasoline 95.
  - Support for ethanol production by waiving excise duty and reducing the payment to the fuel fund and the fund for the promotion of energy conservation, US$ 0.02 a litre.
  - Establishment of the 24 ethanol production plants, of which six use cassava.
  - Under the cassava strategy, 2005-2008, there is a plan to secure raw materials for ethanol production and hence, cassava production will have to be expanded accordingly.

Constraints

- Unstable and seasonal volatility in the cassava root price affects the cost of ethanol.
- High-cost ethanol processing affects the ethanol selling price.
- Lack of knowledge and limited confidence in ethanol on the part of consumers obstructs the rapid adoption of gasohol.

The linkage industries of the cassava starch

Lodchong processing is a food enterprise. The Lodchong processing group at Banbuakam is taken as the case under study.

Production and its costs

- **Formation of the group.** The group was formed in 2003 with a membership of 30 farmwives. Partly free from farm activities, the group's management consists of a chairman, secretary, cashier, marketing agent and advisor. Its office is located at 69 Mu 11 Banbuakam, sub-district and district of Soengsarng, Nakhonratchasima.
- **Source of funds.** Members invest through the purchase of shares at US$ 2.49. At

the time of reporting the group had accumulated US$ 2,495.65.

- **Government support.** The MOAC through the Department of Agricultural Extension and Ministry of Social Development and Human Security supports the group with an investment fund of US$ 2,400 to purchase necessary equipment, including a baking oven, starch thresher and mixer.
- **The processed products** include Lodchong dessert, crispy flake donuts and cakes. Lodchong's main ingredient is starch. The other products are made from wheat and rice flour.
- **Benefit sharing within the group.** After sales, group labour is paid totalling 70 per cent of the profit. Twenty per cent is saved for benefit payments at the end of the year and 10 per cent is kept for funding.
- **Lodchong processing.** The cassava starch is purchased from the processing plant in the district of Soengsarng. Lodchong dessert is coloured and added with coconut milk, syrup and ice cubes. The colours in use come from flowers and herbs, sun-cured or oven dried and packaged for particular sales too.
- **Costs, revenue and profit of Lodchong processing**
  - **Costs.** The variable costs include native starch as the raw material, supplies and equipment, labour, plastic bags, power, etc. The fixed costs refer to the depreciation of the equipment.

    Processing one kilogram of Lodchong costs US$ 0.33 with a variable cost of US$ 0.31 and a fixed cost of US$ 0.01(Table 6.5).
  - **Revenue.** The processor group sells Lodchong directly to consumers, hospitals and schools at US$ 0.37 per kilogram.
  - **Profit**. The margin between earnings and processing expenditure including transportation costs is US$ 0.05 per kilogram.
  - **The Lodchong production.** Production totals 5,640 kilograms annually.

Table 6.5 Costs, revenue and profit of Lodchong processing farmer group at Banbuakam, Nakhonratchasima province (US$/kg)

Description	Total
Total cost	0.33
• Variable cost	0.31
- Cassava flour	0.11
- Processing cost	0.20
• Fixed cost	0.01
Revenues	0.37
Profit	0.05

Source: Field survey 2005.

Potentials and constraints

Potentials

- The group members all contribute industriously and deposit their earnings, aside from their shares to the group to invest more for growth.
- Advertisements. At the annual provincial fairs, exhibits of Lodchong products are arranged. The products are also advertised on television.
- The use of natural colours brings uniqueness to the products as health-conscious people turn more to herbal foods.

Constraints

- Lack of investment. Currently, Lodchong being sun-cured, rainy or overcast days obstruct the process and, therefore, it cannot be produced throughout the year. Upon availability of funds, a hot-air oven will regulate production.
- Lack of proper production techniques, in mixing the colours in particular, causes inconsistent product colour and size.
- Packaging is not attractive.

6.2 Soybean processing

6.2.1 Types of processed products and annual production

The following products can be obtained from soybean processing (Figure 6.5):

- Soy oil is used for cooking and in food, paint and non-food industries. The soy cake by-product is used in the production of feed, seasoning, non-fat soy flour, soy protein extract and soy protein concentrates (Figure 6.6).
- Feed. Full-fat ground soybean is fed to swine.
- Food is made through two main processes.
  - Through fermentation, Chinese sauce, Chinese fermented beans and soybean grain sauce fermented square soy curd are produced.
  - Non-fermentation includes full-fat soy flour, soybean milk, traditional soy milk, curd, soy film and sprouts.

6.2.2 Soybean processing in Sukhothai province

The study focuses on crushing and soybean grain sauce.

Crushing mills

Soy oil

Out of the eight crushing mills, six are located in the central region in Ayudhya and on the Bangkok perimeter. The other two mills are located in the North in Sukhothai and Lampoon. Nationally, 0.5-0.6 million tons of soy oil are crushed annually.

Main processes

Three stages of processing are involved. The preparation of material includes cleaning, flaking, steaming and drying. In stage II, raw oil is extracted with solvents and soy meal is mixed with the raw oil. Stage III consists of refining.

Production capacity and its use

The total annual capacity is 1 million tons of soybean, but actual production is 0.5-0.6 million tons or 50-60 per cent of total capacity due primarily to the inadequacy of the raw material. Secondly, full capacity production may induce excess market supply since there are several substitutes in the form of vegetable and animal sources.

Interviews with P.A.S. Produce Export and Silo, Co., Ltd. the crusher of Sorn Tong brand soybean oil found that it has a production of 100-150 tons of soybean daily. Eighty per cent of the soybean is imported from Argentina because the freight is cheaper than from the US and the remaining 20 per cent is procured locally from direct farm purchases and from the assemblers.

Cost-revenue structure and business profitability of soy oil

The interview also revealed that locally produced soybean contains more oil than imported soybean as well as more residues with higher protein content. A ton of soybean, when crushed, produces as much as 790 kilograms of residue, 188 kilograms of oil and 3 kilograms of by-products, namely crude fatty acid, distilled fatty acid, lecithin, sterol and acid oil in minute amounts, and a loss of 19 kilograms.

Figure 6.5 Diagram of soybean uses

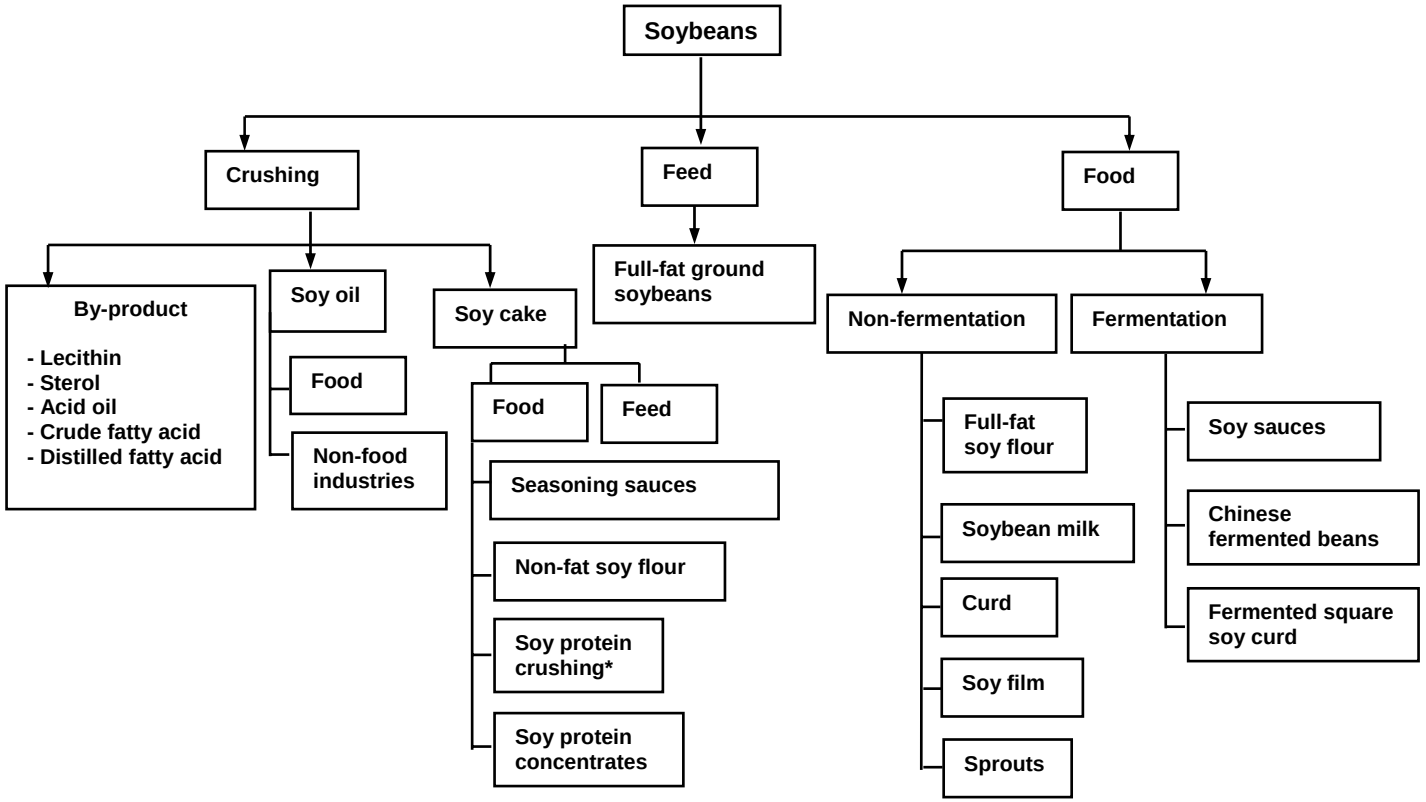
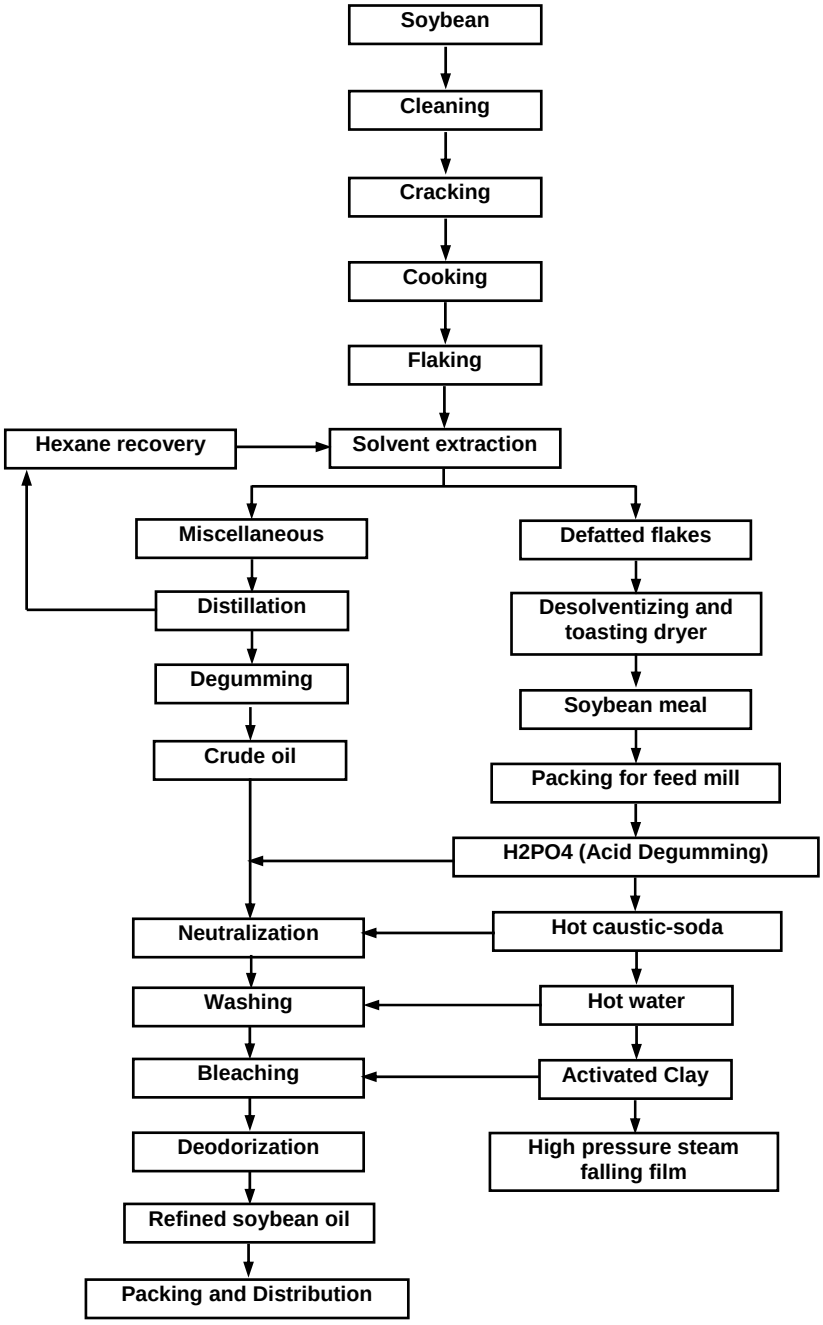


Figure 6.6 Production process of soy oil



The total cost of processing soy oil is US$ 0.74 per litre, of which 80 per cent is the raw material cost and the remainder is packaging, power, labour and administrative costs. The oil selling price is US$ 0.77 per litre. With the delivery cost of US$ 0.01 per litre, the profit is US$ 0.02 per litre.

Potentials and constraints

Potentials

- In line with greater market demand, the company is adding capacity by building a new crushing plant and oil storage silo.
- It is located near to the major soybean producing area. Being stored for a few months, the soybean is still good for crushing.

Constraints

- Farmers sell their produce mixed, containing much soil. During the rainy months produce is often of low quality and subsequently the crushed oil quality is poor.
- Price undercutting among the seven crushers tends to force some of them sell at a lower price.
- The price is often fixed by the large crushers leaving the smaller ones at a disadvantage.
- During some years, the raw material price is expensive, however, the price of soy oil cannot be raised due to government price controls.

The Bueng phra-yod community group for processing soybean grain sauce

An interview was conducted with the group on production, costs and income as follows:

Production and cost

- **Group formation.** The group was established in 1993. The 30 members comprise of farmwives and ladies who co-operatively manage and process the product, having a president and deputy, secretary, cashier as well as marketers. It has an advisory group of village headman, farm household economics workers, a local administrative body and village committee. The group's office is at 111/1 mu 4, Buengpra-yod village, *tambon* Klongmaplub, *amphoe* Srinakhon, Sukhothai. Funding is from members' shareholdings at US$ 2.50 per share. Currently the shares are worth US$ 750.
- **Private and government support**
  - **Processing house.** The village headman grants the right to use 0.04 hectares

of land. The local administrative body supports the housing worth US$ 2,300.

- **Processing equipment.** The Department of Community Development granted US$ 2,500 for the necessary equipment.
- **Revolving fund.** The group is allocated interest-free credit amounting to US$ 4,000 for the revolving fund.
- **Processing technology transfers.** The off-school learning centre and *tambon* home economics workers technically assist the group.

- **Benefit sharing.** Seventy per cent of the profit of each sale is immediately paid as wages. Another 20 per cent is saved for benefit sharing every six months and again, 10 per cent is saved for further investment.
- **Cost, revenue and profit.** The variable costs include soybean, flour, salt, sugar, Koji agent, seasoning, wages and supplies, such as stickers and bottling pieces. The fixed cost is wear and tear.

  A 300 c.c. bottle of soybean grain sauce costs US$ 0.23 with a variable cost of US$ 0.21 and fixed cost of US$ 0.02.

  - Income. The group retails 60 per cent in Sukhothai and 40 per cent in neighbouring provinces.
  - Profit is US$ 0.07 per bottle (Table 6.6).
  - Production total 8,640 bottles a year. Total revenue is US$ 2,575 per year and profit US$ 617.90.

Table 6.6 The production costs, income and profit of Ruamjai farmer group, soybean grain sauce in Sukhothai province (US$/bottle)

Description	Total
Total cost	0.23
• Variable cost	0.20
- Raw material	0.05
- Processing cost	0.16
• Fixed cost	0.02
Revenues	0.30
Profit	0.07

Source: Filed survey, 2005.

Potentials and constraints

Potentials

- Strong co-operative work prevails with strong marketing activities bolstering the group's earnings and growth.
- Technology transfers are continuous with study tours to other farm processing groups to acquire knowledge.

- Good co-ordination is seen with the local administrative body and the village committee in product development.

Constraints

- Shortages of production techniques, especially the use of colours and fermenting fungi.
- The product is not yet certified by the Food and Drug Department and group activities pose housing and sanitary concerns which are being addressed.
- Packaging is not modern and remains unattractive.
- Market expansion is limited with the product being produced just once a month.

6.3 Maize processing

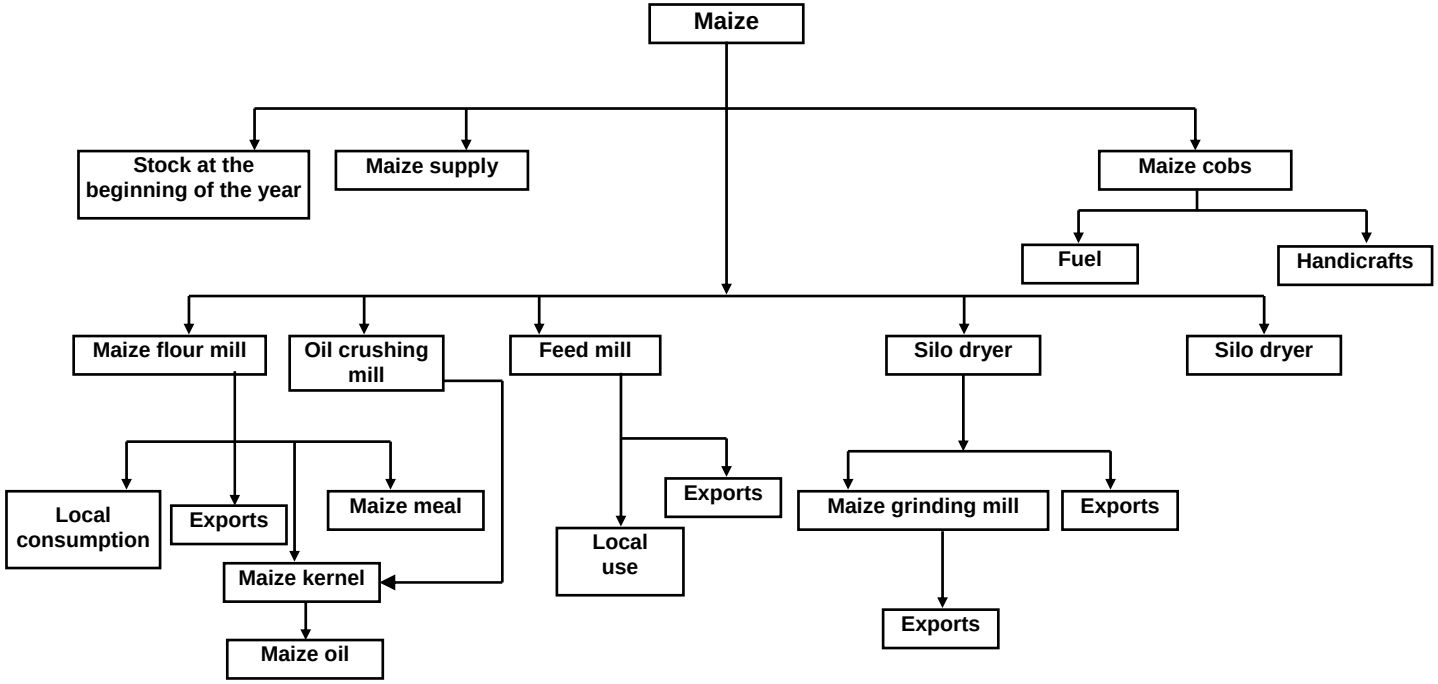
6.3.1 Types of processed products and annual production

Types of processed products

Maize is nutritious containing 72 per cent starch, 10 per cent protein, 4.8 per cent fat and 8.5 per cent fiber with the rest consisting of sugar, minerals and vitamins. As such, it has a significant role in feed manufacturing providing a large share of carbohydrates in the feed mix, especially in the mix for poultry and swine. Besides, maize can be used to make flour and can be crushed for oil. The processed products of maize are classified into three types.

- **Feed.** The product comprises of maize as its main carbohydrate ingredient in a combination of bran, broken rice and soybean cake.
- **Maize flour.** Grinding the maize grain, coarse and fine maize flour are obtained.
- **Maize oil.** The oil is obtained from crushing 4-5 per cent by weight (Figure 6.7).

Figure 6.7 Production process of maize



Source: Field Survey, 2005.

Production capacity

Although most maize production is used as feed, there is no feed industry in Nakhonsawan. However, in the province's maize marketing system, a number of maize traders deliver the produce to the feed mills in the adjoining Lopburi and some is forwarded to Bangkok and Ayudhaya, where export silos are located.

In Lopburi, the production capacity of the feed mills is 55 tons per hour, working 24 hours 6 days a week. In 2004 feed production was 1 million tons. Construction of another feed mill will be completed in 2005, raising provincial annual feed production to 1.5 million tons. The major part of maize supply is directed at the company's poultry farms in the form of feed mixed with sorghum, bran and broken rice. The additional maize supply comes from the neighbouring provinces within a 300-400 kilometres radius, including Petchburi, Nakhonsawan, Nakhonratchasima and Sakeow.

The procedures of feed manufacture and operation are as follows:

- Inspect the raw materials, (maize, soy cake, bran) for conformation to the company's standards.
- Place each of them into the silo, godown or barn.
- The production control room draws the raw materials into a tank before grinding.
- Grind and forward the output for weighing according to a feed formula and have the minerals and vitamins in palm oil added.
- Cook with steam, disinfect and pelletize.
- Weigh the product and have it packed in small bags for small farms and larger bags for large farms for delivery to order.

Ordinarily, the feed formula and combination requires not less than 45 per cent maize with relative prices and substitutionability of the feed materials taken into consideration, having similar nutritional value.

The selling price of the feed is US$ 0.22-0.24 per kilogram with costs of 90-93 per cent and profit of 7-10 per cent.

6.3.2 Potentials and constraints in the maize processing business

Potentials

- Maize prices are ordinarily cheaper than broken rice, bran and soy cake. Therefore, the feed processing business essentially needs maize in combination.
- There is a ready market. Also, the company maintains poultry farms for sale purposes.

Constraints

- To produce feed, both fungi and alflatoxins in the ingredients have to be kept constantly free. As part of the food industry, animal sanitary and hygiene is strict. Therefore, maize quality is also constrained and under tight control.

6.4 Concluding summary

The processing businesses of three target crops in the study areas were surveyed. The summary of study results is as follows:

6.4.1 Cassava processing

The major products of cassava processing are chips, pellets, native starch and modified starch. In addition to these major products, ethanol production is growing rapidly.

In Nakhonratchasima province, there are 88 chip drying yards, 16 pellet plants, 12 native starch plants, 4 modified starch plants and 2 ethanol plants.

The cost and profit of the processing businesses vary depending on the product. The revenue and cost ratio of the processing business is relatively low at around 1.1 (chips, pellets and native starch).

The major potentials of cassava processing are adequate raw material supply and its low price due to extensive production in the province, accumulation of the processing industry which enables flexibility in production, FTA agreements which will expand exports of cassava products and environmental concerns, which are a driving force to use cassava alcohol as a substitute of petroleum fuel. The constraints include competition for raw material supply between industries in the high season, the low working rate of production capacity and volatility in product prices.

The farmer group for Lodchong processing was surveyed as a case of small-scale processing. The group consists of 30 farmwives, producing 5,640 kilograms of Lodchong every year and earns an annual profit of US$ 266.10 with government support. The potentials include the industrious nature of the group, effective advertisements and the use of natural materials which attracts the interest of health conscious consumers. The constraints include a lack of investment, lack of processing technologies and poor product packaging.

6.4.2 Soybean processing

The major products of soybean processing are soy oil, feed, and various kinds of

food. The study focused on soy oil and Chinese fermented beans. The total cost of processing soy oil is US$ 0.74, while the selling price of the oil is US$ 0.77 per litre.

The major potentials of soy oil processing are greater market demand, and the location of the plant which is near to the soybean production area. Constraints include the low quality of soybean in the rainy season, depreciated prices of soybean oil due to severe competition and volatile soybean prices.

The farmer group involved in soybean grain sauce processing was surveyed as an example of small-scale processing. The group consists of 30 farmwives and ladies, produces 8,640 bottles every year and earns an annual profit of US$ 617.90 with government support. The potentials include strong co-operative work within the group, technology transfers to improve product quality and good co-ordination with the local administrative body. The constraints are a lack of colouring and fungi technologies, poor packaging and a limited market.

6.4.3 Maize processing

Maize is usually processed as feed, flour and maize oil. Since there is no feed industry in the province, the one in the adjoining Lopburi brings in feed materials from Nakhonsawan for this purpose. With an annual production capacity of 100,000 tons of feed, 45 per cent of the maize supply is used. At a selling price of US$ 0.22-0.24 per kilogram, the profit margin is 7-10 per cent.

7. Analysis of Institutional Support

7.1 Economic policies

7.1.1 Price support programme

In a year of expected excess farm production and/or the supply is largely concentrated in the early harvesting season and the farmers are likely to receive depressed farm prices and, thus, income problems, the government institutes a support programme to raise farm prices through market intervention in the form of a mortgage programme to absorb excess market supply.

The CGPRT crops included in the market intervention programme include cassava and maize. Cassava has been under the mortgage programme since 1998/1999, and maize since 1994/1995. However, in a year free of market problems, both crops are left to normal market forces.

The farm price subsidy formalized under the cassava and maize market intervention programmes is calculated specifying the eligible quantity, the mortgage price and the mortgage period. The participating farmers are expected to be endorsed by the Bank for Agriculture and Agricultural Cooperatives (BAAC) if they are the bank's client. If not they are required to be certified by the provincial agricultural committee.

Performance of the intervention programme is evaluated to raise the farm price to a certain level.

7.1.2 Credit support programme for farming, processing and marketing activities

Credit programme for farming

Most of the smallholders are poor and require an investment fund for labour hire, fertilizers, and seeds among others. To this end the government arranges farm credit sources as follows:

The farm credit service provided by the BAAC

BAAC is a parastatal, a farm lending agency for crop cultivation, livestock raising, and fisheries, among others. The credit is used as revolving and investment funds in preparing the land and for seeds, labour and farm equipment with a loan period of 18 months to 20 years. The interest charges depend on the annual classifications of the clients.

For ordinary clients, the rates are 7-10 per cent per annum. The loan guarantee requires either 2-5 loan clients, property pledges or a bank deposit.

In addition to lending to individual farmers, the BAAC provides loans to farm institutions, for example farm co-operatives for their members to borrow over short and intermediate terms for production purposes.

Credit provision from the national village and urban community funds

This fund was established based on government policy to buttress the self-reliance process of the village and urban communities. The objective of the fund is to provide revolving loan funds within the village and urban communities for investment in careers. The loan ceiling is US$ 481.58 per person. Any loan above the ceiling has to be considered by the fund members for approval of not more than US$ 1,204 and the repayment period must be within one year.

Most of the sample farmers in the three provinces under survey seek loans from the BAAC and the village fund for investment in the production of cassava, maize and soybean.

Credit provision for purchases of chemical and organic fertilizers

As a crucial input for raising farm productivity, the Ministry of Agriculture and Agricultural Cooperatives (MOAC) in a major effort to allow fertilizer provisions, provided an investment support programme for fertilizer grades, chemical and organic. The responsible agencies include the Cooperative Promotion Department to the farm co-operatives and farm groups, and the Market Organization for Farmers (MOF) to the smallholders. They prepare annual projects on farm support of fertilizer procurement. The conditions for the projects are as follows:

- The MOF submits a request for loans from the programme to its farmer members in acquisition of organic fertilizer, biological fertilizer, green manure and chemical fertilizer at 90 per cent of the purchase value. It follows that the farmers pay their counterpart fund of 10 per cent of the value.
- The MOF has to repay the loan as follows:
  - Repayment within nine months at no interest.
  - Repayment over 12 months involves interest charges of 6 per cent per annum for the period after the nine months.
  - A repayment period of more than 12 months incurrs interest charges of 9 per cent per year for the extended period.

The project annually helps 300,000-350,000 farmers acquire fertilizers according to their requirement, in addition to producing the organic and biological fertilizers themselves. They also save farm expenses at no interest. Therefore, their fertilizer procurement prices are reduced by US$ 12.04-13.24 per ton upon repayment within nine months.

Credit support programme for processing and marketing activities

Aside from lending to individual farmers and farm institutions, the BAAC provides credit services for processing and marketing activities as follows:

- Lending to individual farmers for the development of supplementary careers related to their farming occupation bringing own farm produce or produce from outside to process finished/semi-finished products for sale. It is a short-term loan versus loans for investment in equipment and tools which are long-term.
- Providing credit services for farm institutions, the BAAC sets their annual loan funds following their repayment ability and requirements. Subsequently, in addition to lending to their members, farm co-operatives seek BAAC credit for their revolving fund to sell farm products. The credit is used to process and sell the members' farm products and in other co-operatives' investment activities.

7.1.3 Food diversification policies

Discussions were presented in phase I on national policies regarding food security and the economy of Thai farmers. In this regard, the New Agriculture Theory was allocated high importance. With stresses on secure food acquisition and stable income, farm water resources are managed to allow sufficient farm production, and diverse production that provides stable incomes for the household. Simultaneously, poverty and limited farm resources are to be mitigated and the farmers become self-reliant. According to the New Theory, farm fields are divided into paddy plots, upland plots, horticultural plots, farm ponds, farmsteads, livestock areas and others. Due to the scale of the smallholdings of the farmers in most of the country, the farmers are less likely to grow CGPRT crops but prefer livestock production.

Launched in 1998, the project is participated by more than 10,000 farmers who produce crops, namely paddy, fruit-crops, vegetables, field crops; and livestock, such as fish, poultry, cattle and buffalo. From the rise in income, their savings tend to be more accordingly, and food is secured as seen by 49 per cent of the food on the farm families' tables coming from their own farms.

7.1.4 International trade policies

- Arrange free trade agreements as dictated by national interests, strengthening the competitive capabilities of Thai business operators, and aggressive implementation of marketing policies for extensive acceptance of Thai products.

  The Thailand-China FTA on cassava products heightened Chinese cassava chip demand.
- More active foreign economic policies are implemented in concordance with internal economic policies in terms of economic restructuring emphasizing the economic co-operation to develop personal potential.
- Ayeyawady-Chao Phya-Mekong Economic Cooperation strategy and other sub-regional frameworks are supported in terms of trade, investment in agriculture and industry. To be more specific, Thailand has recently begun promoting production of soybean, maize and others in neighbouring countries. In the near future, private sector trade on contract-farming will be facilitated.
- Participation of private businesses with the government is sought to exchange trade and investment information and analyse impacts that may arise from foreign trade and investment rules for national directives, strategies and trade negotiations.

7.1.5 Investment policies

- Promote new entrepreneurs under the investment support programme of the Board of Investment with soft loans for factory building, a grace period and tax exemption for machinery imports so that new industries of cassava flour and oil crushing may emerge.
- Reduce taxes on necessary raw material imports to increase the competitiveness of Thai industries. Since 1999 the cabinet has ruled in favour of reducing tariffs on capital goods and raw materials effecting cheaper chemicals for use in making modified starch so to increase its competitiveness.
- Facilitate the development of basic industries in terms of the linkage industries. In the case of the flour industries, support exists for expansion and new emergence while the linked paper, food, and sweetener industries continue to grow using more flour.
- Development of SME farm processing to play a larger role in the industrial sector includes the production/conservation of food or additives involving modern technologies, grading and storing horticultural crops and flowers. Private

investment in these enterprises is exempt machinery tariffs and corporate income tax.

7.2 Infrastructure provision

7.2.1 Irrigation

The irrigation systems built for the province include.

- Large-scale irrigation projects.
- Medium-scale irrigation projects.
- Small-scale reservoirs.
- Restoration of natural ponds and waterways.

In spite of the seemingly large number of irrigation systems, they are too sparse and largely inadequate. Consequently, rainfed agriculture is dominant.

7.2.2 Transportation

As a transportation centre and the gate to the region, the province has a good transportation network. Almost all farm products are freighted by 10-wheeled trucks.

7.2.3 Marketing

As for marketing infrastructure, Nakhonratchasima province has major agricultural markets and marketing centres as follows:

- **Paddy.** The paddy trade centre is in *amphoe* Muang where large mills are scattered.
- **Cassava.** The trade centres surround the cassava producing *amphoe*, six of them in particular, where the drying yards are prevalent. For the cassava product markets, the trade centres are predominantly in *amphoe* Muang.
- **Maize.** The major maize trade centres are located in *amphoe* Muang.
- **Vegetables and fruits.** There is no official central market for vegetables and fruits in the provinces. Therefore, the trade of the products is scattered in several private markets.

7.2.4 Potentials and constraints of infrastructure provision

Potential

The overall infrastructure for transport and marketing in the province favours the flow of farm products. A regional hub and near to the terminal market, the province takes advantage of freight and the receiving market.

Constraints

- **Irrigation. I**n spite of the large number of natural water sources as well as irrigation systems, most farm areas do not have access to irrigation, especially cassava farms are not able to operate integrated farming.
- **Transport.** Immediately following the harvesting periods of the various crops the trucks and the traffic to the terminal market are often very busy raising the freight costs.

7.3 Research and development

Farm R&D is one of the major MOAC strategies in raising productivity and securing income for farming sustainability and the betterment of life. In addition, public agencies including the Ministry of Science and Technology and universities as well as the private institutes such as the Foundation for Cassava Development and private companies, conduct R&D on the production, processing and marketing of the products. With regard to the MOAC, its limited financial appropriations year by year force it to only be financially able to pursue a research priority line, followed with the completion of continuing research activities.

7.3.1 Development of farm technology

Development of farm, processing and marketing technology

R&D on cultivars

Farm products have different aspects of R&D as follows:

- **Cassava.** A local-specific variety is sought together with higher starch content.
- **Maize.** HYV and grain quality is targeted by the R&D.
- **Soybean.** Rust, fungi and downy mildew disease resistant varieties are sought coupled with low input cultivars.

R&D on farm inputs

- **Cassava.** The research is focused on mixed fertilizer applications and yield responses to plant nutrients.
- **Maize.** R&D on soil, water and fertilizer management.
- **Soybean.** R&D on technology for soil, water and fertilizers; chemical, organic and biological.

R&D on plant pests and disease

- **Cassava.** R&D on elimination of pests and disease.
- **Maize.** R&D on pest management.
- **Soybean.** Technological research on pest control.

R&D on mechanization

- **Cassava.** The research concerns developing a harvester.
- **Soybean.** R&D on sequential laying of the harvests.

Development of processing technology

The processing R&D on CGPRT crops is devoted mainly to cassava.

- Research on the use of cassava leaves as feed ingredients.
- Research for the use of cassava waste for production in linkage industries, for example, organic acid, alcohol and bio-decomposable containers.
- Research on the production of ethanol from cassava.
- Research on the chemical and physical composition of flour.
- Research on the use of flour for higher value-added products.
- R&D for technology of producing bio-decomposable matters.

Development of marketing technology

R&D for marketing technology also concentrates on cassava.

- Research on marketing factors influencing the use of cassava as feed which will affect local chip demand.

Marketing technology is further advanced by:

- A website of clean chip makers for information regarding potential buyers.
- The forward market of cassava flour, which will be a technological marketing initiative towards international standards of efficiency, speed and safety with transactions via the internet and mobile phones, allowing farmers to access more information for improved bargaining and farmer organization. Furthermore,

information dissemination from the forward market, implemented in 2005, will be useful in farm production and marketing planning.

In conclusion, the public and private sectors are well aware of the current focuses of R&D and they are working together to achieve the ultimate objective, namely improving income in the agricultural sector in the country.

7.3.2 Development of an extension service network

The MOAC by the Agricultural Extension Department has organized an extension network as follows:

1. Promote farm recommendations on Good Agricultural Practices on the three CGPRT crops by which part of the farm input, namely cultivars and fertilizers, are supported. Let the farmers manage in the form of revolving loan funds for operations over successive years.
2. Farmer participatory research and technology transfers for the three crops with community forums, study tours and demonstration plots.
3. Integrated and mixed farming are promoted in accordance with the concept of a self-sufficient economy, with extension plots for community learning.
4. Promote farming in line with the New Agriculture Theory by organizing learning plots with farming resource persons coupled with a learning forum through the farm learning centre.
5. Promote farmer development through a Royal Farming School using the farmers at the learning centre to analyse the farm environment to assist national farm decisions.

7.4 Concluding summary

Regarding CGPRT crops and diversified agriculture, economic policies, infrastructure provision, technology development policies are described as follows:

7.4.1 Economic policies

Of the CGPRT or secondary crops, cassava and maize benefit from a price subsidy to absorb excess supply. Credit is provided to farmers and farm co-operatives through several schemes.

The MOAC has a credit support programme for farmers to acquire fertilizers with 30,000-350,000 farmers benefiting from the programme each year. The fertilizer cost is reduced to US$ 12.04-13.24 per ton.

The BAAC also provides loans for enterprises relating to farming. Food diversification policies are implemented which encourage smallholders to diversify their farming to achieve self-sufficiency.

Thailand actively participates in bilateral FTAs, which are likely to positively effect the expansion of cassava exports to China.

To promote investment, newcomers to the industrial investment programme receive tariff reductions on their raw materials.

7.4.2 Infrastructure provision

In Nakhonratchasima province, the road and marketing infrastructure is well developed, while irrigation facilities are not sufficient.

The major potential of infrastructure provision is its geographical condition, being the regional centre and not far from the terminal markets. The constraints are poor irrigation systems and shortages of transportation capacity in the peak season of crop harvests.

7.4.3 Research and development

The major R&D issues are the development of improved varieties, impact of cassava use in feed, the development of a processor website and a forward market for the flour.

8. Prospect of Enhancing Sustainable Development of Diverse Agriculture

8.1 Overall assessment of potential

The potential of farm diversification includes the ability of the farmers, the type of crop, basic structure of the resource base (terrain, soils and water sources) and the demand. The study on diverse farming in terms of cassava-based, maize-based and soybean-based in the three provinces seems to have both similar and differing issues as follows:

- Stable farm income and experience in growing multiple crops with choices for crops with market potential and the farmers see the advantages of crop rotation.
- In the low-lying soybean producing areas, paddy is grown in the rainy season and soybean in the dry season due to the lower water requirement. Sukhothai has a ready market of many channels to absorb soybean.
- The smallholders and large-scale farmers alike, who have many land parcels prefer to grow diverse crops to avert price risks. Those owning one land parcel rent more land for more crops. Some grow more than one crop on their single plot; for example, maize and chilli.
- In a season, some farmers grow several crops in the rainy season and switch to other crops in the dry season due to water shortages and market demand.
- In the irrigated zone, many crops are grown to serve the market.
- The farmers, having production know-how, grow crops that suit the agro-climatic conditions.
- Farmers wish to improve soil fertility and be more self-reliant. Therefore, they rotate crops, for example, in the repeated cassava planted areas. The yield per hectare is raised by covered ploughing of corn stalks or by growing soybean after rice. This reduces the chemical fertilizer use on the rice due to the increase of organic soil matter from soybean cropping.
- In the three provinces, the transport systems are good and all villages are served with feeder roads. Local culture is conducive for group formation that may work as a model.

- The survey areas in Sukhothai and Nakhonsawan are rather fertile. In particular, the irrigated areas are ready for diverse farming development.
- Nakhonsawan has an abundant resource base, especially water and land resources with good irrigation systems that require little public infrastructure development spending. Therefore, the crop production potential is brighter than in other regions.
- In Nakhonratchasima, the diversification of farming has great potential to mitigate the prevalent poverty in the region with more stable farm income and the restoration of natural resources.
- Nakhonsawan is the centre of trade, communication and tourism which will serve to develop marketing channels for crops.
- Cassava products have great market potentials in low-cost ethanol production. In addition, the chips and flour continue to receive great foreign demand.

8.2 Overall assessment of constraints

- Although the farmers are engaged in diverse farming; most of it is rainfed. In Nakhonratchasima, which is more prone to drought, cassava is selected to suit the terrain. However, rain intermission and drought often take their toll and induce smaller tubers and lower yields. Some crops, can be completely destroyed. Other factors affecting production efficiency are poor soil fertility and sandy soils.
- As the economy grows with better communication facilities and media, the demand for consuming items other than food constantly emerges. Therefore, post-harvest sales and debt repayment, household expenditure and other spending increase limiting savings for farm investment. The farmer approach BAAC and the Village Fund to purchase farm inputs and pay farm wages are, in most cases, not adequate since part of the loans are used for family needs.
- The smallholders with one farm plot cannot afford to operate diverse farming systems involving long duration crops, such as cassava.
- Regarding those having more than one plot but small family size, diverse farming is likely to require hired workers resulting in higher costs and poor farm management.
- Landless farmers and smallholders have no intent to improve the soil or acquire basic infrastructure, like farm ponds and therefore, productivity is not enhanced. In
-

addition, a farm tenant usually has no collateral for adequate borrowing. This is a major obstacle to farm diversification.

- Diverse farming requires different know-how and experience. Low management skills give rise to poor performance.
- In the harvesting season, the harvests are concentrated and prices are depressed. The trucks are inadequate too.
- Farmers generally lack aspirations for a heavy workload resulting in poor earnings relative to the non-farm jobs.
- There is no sustainable shift from monoculture to diverse farming. The educated youth prefer non-farm jobs. The parents who remain in the farm sector have to seek more cash to pay more wages.
- No emergence of a marketing system to absorb farm produce of very diverse farming and the organization of a processing group usually does not perform satisfactorily.
- Local soybean production does not satisfy demand. While the locally processed products are for direct consumption, the produce receives favourable prices relative to its substitutes and less soybean is used to make local products.
- The processing development of maize faces similar problems as soybean as most of the supply is for feeding purposes. The prices for maize are also favourable relative to substitutive crops and local processing is not urged.

8.3 Search for strategies and policies to enhance the sustainable development of diverse agriculture

- Water resource supply poses a serious limitation to diverse farming. Even though farmers try to switch to a crop with a low water requirement that suits the terrain, water is still needed, especially for a second crop. Only in a year of normal rainfall is the production good. The second maize crop in Nakhonratchasima, when the corn ears bloom, is much affected by drought in some areas. Similarly, the findings of the second mung bean crop survey in Sukhothai disclosed production damage and farm loss in 2004 due to serious drought (Table 4.17). However, the second maize crop in irrigated areas commands a better farm price than maize grown in the monsoon months and the price effect on income is remarkable (Table 4.23). The provision of irrigation is, therefore, crucial for a second crop while currently, the irrigation infrastructure exists mainly in the rice producing areas. The addition

of a large-scale irrigation system has budget limitations and often faces NGO challenges. Building a smaller scale irrigation facility would save budget and incite no foreseeable conflict with the public. Also, building farm ponds has to be encouraged with water management and crop selection.

- Amend the Village Fund's rules to extend farm loans over more than one year terms. A refinancing programme should be adopted to allow farmers to reborrow to repay farm debt over a longer term loan period for new investment. In this respect, the village committee/farm group members should work as credit supervisors having government agents attached.
- Bloster the existing community centres for technology transfers and services extending farm know-how with community media, farmer training and monitoring, brainstorming, consultation and study tours, using the government as co-ordinator.
- Organize the farm groups and have the community set its production and consumption plans. Moreover, in times of concentrated harvests, supply is much greater than demand and price depression often occurs. The production plan should level this out and the promotional plan for community consumption will help the production plan.
- Develop farmer organizations to understand and carry on farm diversification leading to sustainable development.
- Arrange study tours for the farmers to visit diverse farms of different types having the same government agency co-ordinate and support the tours.
- Promote group procurement of farm inputs. Arrange for the production of organic fertilizers, compost and bio-extracts having a community fertilizer plant to be managed by the farm groups.
- Allot farmland to the farmers from the degraded forests with non-transferable ownership rights for use as loan collateral for farm investment. The non-transferability aims to prevent sales of the land.
- Encourage the farm youth to be interested in arranging training on diverse farming lessons in co-ordination with village schools.
- The local public bodies and farm groups seek production, processing and market news for farmers through the farm groups and support the marketing arrangements.
- Research on soybean and maize that are resistant to drought and produce oil-rich maize, etc.

- Provision of product standardization and food safety will potentially give competitive advantage and enlarge the export market.
- Promote more use of food and non-food prepared from CGPRT crops to raise value-added.

9. Conclusions and Policy Recommendations

9.1 Conclusions

9.1.1 Cassava survey in Nakhonratchasima

General information regarding the study area

The province has the largest area and second greatest population in the Northeast. The overall economy is growing at a rate of 6.5 per cent, while agricultural GPP and non-farm GPP are growing at 8.7 per cent and 6.1 per cent respectively. In 2003, 75 per cent of the population were engaged in farming. Seventy per cent of provincial areas are used for cultivation and the major crops are paddy, cassava, maize, industrial sugar cane and chilli.

A survey of cassava producers finds that 92 per cent of them are of economically active age and the remaining 8 per cent are elderly. Farming is their major occupation. The cassava producing area is rainfed and the crop takes 8-10 months until harvest. The single cassava fields are scarcely set aside for other crops. Those having several plots grow different crops of rice, maize, chilli and mung bean and earn more income than from cassava culture alone. However, non-farm income added to the farm income of the families growing only cassava is larger than from diverse farming. Therefore, non-farm income is the determining factor making the total income of cassava only growers larger.

Cassava-based cropping system

The survey findings show that a farm size of 0.96-7.2 hectares is grown with cassava, maize, chilli and mung bean. The cassava harvesting period largely extends all year round while the harvest concentrations are in December and February. The first crop of maize is usually picked in October-December while the second maize crop in July. The second mung bean crop is picked in April and chilli after four months of growth.

While farm households in Nakhonratchasima have an average of 4.7 members/household, only 2-3 work on farms. Consequently, outside labourers are hired. The production cost, income and profit analyses show that profits are generated from all crops because over the last few years farm prices have been favourable. While chilli earned the highest profit per hectare, cassava came second.

Existing farm management systems have already been diversified. The farmers practicing farm diversification earned more than cassava only farmers. Besides, value-added is enhanced making clean chips which positively effects employment, income and the environment. Slicing is carried out by hired workers to make the chips. Chilli is harvested all year round. The environmental impact is a better ecological system and the group organization for clean chip activity helps augment both the environment and society.

Although the smallholders prefer to grow cassava alone, most of the farmers hold several farm plots and thus practice multiple cropping concomitantly.

Cassava marketing system

The farmers sell all fresh cassava tubers to the drying yards as well as the flour mills. Subsequently, the flour mills sell flour/starch to the wholesalers and exporters. The fresh roots bought from the growers are usually cheaper than those purchased from the drying yards for starch content considerations. The marketing system for cassava products thrives well due to a variety of product processing.

Cassava processing business

- The tubers are processed into chips, pellets, flour, modified starch and ethanol. The flour and modified starch are used to produce seasoning, L-lysine, sago, lactic acid, sweetener, food containers, wood boards, food and beverages, drugs, paper, glue, polymers and textiles.
- Drying yards. There are 88 drying yards in the area, the largest number countrywise, having a processing cost of US$ 66.55 per ton and revenue of US$ 73.25 per ton. When the freight rate of US$ 3.72 per ton is deducted, the drying yards generate a profit of US$ 3.97 per ton.
- Pellet plants. Having the largest number of pellet plants in the province (16), the processing cost per ton is US$ 49.39 per ton and sales are US$ 80.36 per ton. With freight at US$ 3.72 per ton, the pellet plants make a profit of US$ 0.62 per ton.
- Flour and starch mills. The province has 12 flour mills and 4 modified starch mills. The flour production cost is US$ 169.73 per ton and it is sold at US$ 193.70 per ton. With a freight rate of US$ 6.21 per ton, US$ 10.68 per ton is made as profit.
- Starch can be modified into over 100 types with different processing costs and returns. However, the revenue and profit depends much on the price quotations and technological advancement involved.

- Ethanol. With the promotional policy to expand the production of ethanol, two of the ethanol plants in the province have a production capacity of 1 million litres per day to be in operation in 2006. The production costs depend on the cost of raw materials. Markets for flour products and ethanol have bright prospects.
- Cassava Lodchong processing. This community processing enterprise is operated by the Ban Buakam farmers group. Now a small business, it has the potential to process more to enable market expansion on the basis of a clear-cut marketing plan.

9.1.2 Soybean survey in Sukhothai

General information concerning the study area

The province has a population of 0.59 million, and a planted area comprising of 50.1 per cent of total area. Its economy grew at a rate of 0.7 per cent per annum during 1999-2003. It is notable that the farm sector shows a better growth trend than the non-farm sector. Among the major crops of rice, sugar cane, maize and soybean, the significant CGPRT crop is soybean. However, the planted area declined for lower returns compared with competing crops.

The unemployed population and poor income group in Sukhothai continue to decline. With regard to the environment, the soils generally deteriorate due to the over-use of chemicals, polluted water and huge piles of garbage.

Soybean-based cropping system

In both irrigated and rainfed areas, farms producing soybean plus other crops generate more net cash income than farms grown to soybean alone. However, the latter group of farmers is more experienced and mainly use family labour. Those who grow soybean and other crops have a number of farm plots and soybean is rotated or grown along with other crops to suit the agro-climatic conditions. The farmers employ both household and outside labour.

The net profit per unit of planted area for farms producing several crops is higher than soybean monoculture in both irrigated as well as rainfed areas. In diverse cropping, market potentials are taken into account.

Soybean marketing system

Soybean farmers sell most of their products mixed to local assemblers and co-operatives to repay for the farm inputs they borrowed in kind. The remaining part is sold to provincial crushers. In terms of freshness, the locally produced crop has great production potential and the crushers can expand their capacity to satisfy consumption demand. The setbacks include high moisture content due to a lack of drying yards and storage on the farmers' part. Post-harvest the crop is sold at low prices. As the planted areas and harvests decline, the number of local traders also slides. Moreover, imports constitute tight competition.

Soybean processing business

Soybean is crushed for oil and the cakes are made into feed. The domestically produced crop contains more oil than the imports and more residues too.

The processing business has potential for great demand and the mills are located in the producing area.

The drawbacks include low crop quality in the rainy months, and price cutting among the crushers. In a year of higher costs, the oil prices cannot be raised due to the price control measures adopted by the state.

A local Chinese traditional fermented beans processing group run by farmwives and supported by private-public concerns was surveyed. The group members are paid for work and profit sharing. The group has operational potential for both market and processing expansion and product development continues but with limited production techniques and packaging.

9.1.3 Maize survey in Nakhonsawan

General information about the study area

Located in the lower north, the province has a population of 1.12 million, of which 32.4 per cent are engaged in farming. The farmland accounts for 59.4 per cent of the total. The major crops include rice, soybean, mung bean, sugar cane and maize.

The surveyed families have 3-5 members/family, four per household, 47 per cent of which are economically active.

Maize-based cropping system

Having a rather better irrigation system and soils, the cropping system involves both irrigated and non-irrigated areas. Most farmers have more than one holding and, thus, grow many crops in the same season. The survey did not reveal any farmers growing only maize both in the rainy and dry seasons. However, there are those who grow maize and other crops. The survey findings show the net cash income per family of those farming in the irrigated zone is more than the cropping system outside the irrigated zone. The major constraint of maize production is the lack of bargaining power of the maize producers.

Diverse cropping systems on several farm plots often cause family labour shortages and farming begins to mechanize. However, diverse farming growing maize followed by beans helps improve maize yields due to Nitrogen fixation.

Diversified cropping systems can raise income but the serious obstacles regularly faced are drought, lack of funds and expensive chemical fertilizers.

Maize processing

Most maize supply goes to feed mills while a part is exported. The maize traders involve local assemblers and regional vendors who collect the crop for the feed mills. As the feed industry expands, maize demand follows.

9.1.4 Institutional support

Economic policy

Market intervention of CGPRT crops is often implemented with mortgage programmes. BAAC provides a farm credit programme to the farmers and farm institutions as well. The services are also provided by the Village and Urban Community Fund. BAAC also provides credit to individual farmers to operate businesses related to farming.

Regarding food diversification, the government implements policy on food security and the economy to reduce off-farm dependence. For the smallholders, New Agriculture Theory is urged dividing the farm area into rice, field crops, horticultural crops, farm pond and livestock. There is no major involvement in CGPRT crops.

On foreign trade, FTA arrangements have been penned. The Thailand-China FTA boosts the cassava chip trade. Besides, there are foreign economic policies, trade and investment co-operation with Thailand’s neighbours and the private sector is encouraged to co-operate in exchanging trade and investment information.

Public investment policies include investment promotion for emerging entrepreneurs, reduction of raw material imports, strengthening the development of basic industries and the development of MSMEs in commodity production and processing.

R&D

In addition to the R&D role of MOAC, other agencies and bodies are involved including the Science Technology Ministry, universities and the private sector with co-operative R&D efforts in production, processing and marketing. For example, the development of farm technologies through R&D of cultivars, inputs, pests and diseases and machinery; in processing technology development, e.g. research on the use of cassava leaves as feed ingredients, use of cassava waste in linkage industries, ethanol production research, R&D for the production of bio-degradable materials. Marketing technology development, includes setting up a forward cassava market.

The development of extension service includes GAP, farm production efficiency technology transfers using a participatory approach, promotion of mixed farming and integrated farming and New Agriculture Theory.

9.2 Policy recommendations

In addition to the efforts for developing on-farm irrigation, more production support measures should be implemented with a better combination of farm resources, soft loans and financial support for farm investment. The sustainability of diverse farming should be improved through these policies. Furthermore, the MOAC should save a portion of the farm aid fund to prepare for possible droughts.

Extension officers and other related institutes should work together with farmers to promote sustainable farm diversification by choosing a cropping pattern and type of crop that will augment farm productivity.

Farmers whose funds are not readily available should adjust the time and method of investing more in infrastructure and farm activities to be consistent with their economic conditions as follows:

- Invest initially for a short-term return and in activities that help reduce household expenditure. Afterwards, invest for longer-term returns.
- Stress full employment of family labour and seek activities supplementing the income, namely grouping for simple farm processing or allow some family members to seek off-farm jobs for capital accumulation.

Prepare the resource base and monitor information on market conditions to ease farm decisions from state agencies and sub-district technology transfer centres. The state and local bodies must update the information services in real time.

Most farmers in the same production area harvest the same crops at the same time. To avoid excess supply of crops, co-ordination would be useful such as the grouping of farmers and joint farm planning. Promoting processing is useful to absorb excess supply. These activities should be assisted by the state.

Improve the soils and reduce chemical fertilizer use which also reduces pollution problems. There should be a promotion programme for greater use of organic matter and bio-ferment solutions.

Implement a tariff measure for smallholders to pay less tax and have longer tenancy contracts instead of a year-to-year basis. Therefore, the farmers will be secure in investing and improving their infrastructure.

Farm holdings should be secured with stipulations for environmentally friendly farming. Farmers should be obliged to participate in resource restoration and educated against forest poaching.

The farm co-operatives or local organization should be encouraged to organize youth groups in the community to practise farm activities, to be provided with agriculture study grants and interest-free credit for the purpose of purchasing farmland for the agricultural graduates.

Major factors of the sustainability of farm diversification are the rise and stabilization of income coupled with strong community organization. Grouping boosts the incentives to produce, exchange of ideas, bargaining power and good leadership. Technical assistance provision by the state would consequently be facilitated. Furthermore, the state needs to change its concept of providing farm recommendations to individual farmers and farm institutions.

The farmers and their institutions must be buttressed by promoting farm plans that have a bearing on market potentials, processing technology, harvesting and quality control. Arrangement of marketing know-how and revolving funds for farm production should be worked on.

Local leaders and farm groups are recommended to jointly build a brand name for local goods utilizing local wisdom. A goods distribution plan should be drawn up to level out the supply in times of concentrated harvesting. The state’s R&D results are to be well-extended.

Standardize farm goods. A process needs to be established to control and monitor food safety from farm to table.

State agencies and technical colleges should take a role in improving goods' quality, higher value-added processing, storage and packaging.

The state should arrange community welfare activities, namely the formation of a savings group to enable the farmers to set aside part of their income for investment and health care.

Regarding ethanol production from cassava, two plants have been approved to be constructed in Nakhonratchasima and to be in operation in 2006. They should be protected from stiff competition for the cassava supply. In this connection, the processing industries are urged to set up a network and contract farming with the farm producers to acquire quality raw materials with accountability. For maize and soybean processing, the inadequacy of supply persists and more R&D is required that includes area-specific and drought resistant varieties.

As most maize production is rainfed and it often faces drought, one of the farm recommendations is to shift the planting time to suit the climatic conditions in the area.

Farmers are suggested to harvest maize in times of good prices. Therefore, maize is recommended after rice, the major crop.

Standardizing and grading of the crop is urged to be tied with marketing rules that refer to grade. This provides incentives for the farmers to improve the quality and, consequently, generate more revenue.

The cassava processing industry should be encouraged to produce bio-gas to supplement power use in the plants, lessening the impact on the environment and reducing industrial costs.

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