

**Integrated Systems and Processes towards Sustainable Agriculturally
based Livelihoods in Northern Thailand**

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Abstract

Under the current economic crisis, sustainable agriculture is seen by many as the solution to regenerate rural economy and to achieve self-reliance livelihood systems for smallholders in northern Thailand. The paper adopted the working definition of sustainable agriculture from the IIED literature to identify a number of "successful" cases. The cases were the exploitation of highland rice ecosystem to achieve food security by the Karen ethnic community; the practice of conservation farming emphasizing agroforestry system on the hillslopes; the integration of production and marketing arrangement in the intensified rice-potato systems in the irrigated lowlands; the increasing contribution of small scale agro-food processing cottage industries to generate rural employment and to improve household economy; and the significant roles of local organization in overall agricultural development.

A number of key interacting components that would attribute to the achievement of sustainable agriculturally based rural livelihood systems (SARLs) had emerged from the case studies: agrobiodiversity, sustainable intensification, small and medium scale agro-food processing enterprises, household and community capability building, and policies that work for SARLs. The study also identified the enabling context that would accelerate the process of implementation and expansion of SARLs such as the inclusion of sustainable agriculture in the 8th National Social and Economic Development Plan, the proclamation of new National Constitution and decentralization policy, the state adoption and promotion of "New Theory" approach to achieve self-reliance economy as proposed by His Majesty the King since December 1997. The participatory and action oriented approach was used in the research process. The on-farm research with varying degrees of farmer participation was used for technology generation and transfer at the farm and the community levels. The open forum was staged to include key actors to review the on-going activities and to formulate the future plan. The dialogue between farmers and state representatives under well prepared information and facilitation helped improve communication and conflict resolution.

With the current economic recession and its continued chaotic consequences for the coming years, integrated landuse, either rice based or non-rice based systems and rural employment generating activities will continue to be the most viable production practice to achieve food security and self-reliance economy for smallholders.

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1. Background

The study area covered the main agricultural landscapes of the Upper North of northern Thailand with Chiang Mai Province ($17^{\circ}10'$ and 20° north latitude, and $98^{\circ}30'$ and $99^{\circ}30'$ east longitude) being used for case studies to represent and highlight characteristics of sustainable agriculture in the region. Three main physiographic features were selected. The highlands which constituted 72 percent of land forms and inhabited with hilltribe ethnic groups are facing with many development dilemma: striking for food security, possessing comparative advantage of production of temperate fruit crops for the market economy, and depriving access to land and forest resources for sustainable livelihoods. The hillslope and rainfed uplands constituting 17 percent and occupying mainly by the ethnic northern Thai are seen as future prospects for developing sustainable landuse and agricultural production. At present the areas are considered underutilized due to mismanagement of land resources in the early settlement period. The lowland rice base ecosystem occupying about 10 percent and representing the most intensive and diversified landuse system is regarded as advanced agricultural zone with market-oriented production system. Integration of production and marketing arrangement is seen as one approach to achieve agricultural sustainability.

Across the ecosystems, different farmer groups with different resource endowment, skills, goals and objectives were observed. The highland Karen one of the ethnic group is more conservative and thriving for self-reliance agricultural systems. The hillslope farmers are able to manipulate and exploit species-environment interaction to achieve sustainable landuse through developing marketing niche for the farm products. The lowland farmers are able to deal with private sectors for almost equal basis of sharing benefits and risks in production-marketing arrangement.

The paper will describe and analyse the sustainable agriculture profile from the field case studies in the lowland, upland hillslope and highland ecosystems. The participatory approach has been adopted involving various stakeholders along the research process from field activities to policy recommendation.

2. Methods

Several methods of client-and developmental-oriented research were employed. The on-farm experimentation was carried out with different levels of researcher farmer partnership, ranging from less farmers managed to fully farmer managed. The on-farm adaptive research was used to generate and disseminate sustainable agricultural practices to the target farmer groups. It was an effective entry point when farmers' goals and objectives were considered in the design of landuse technology, for instance sustainable rice production for the Karen's goal of food security, conservation farming with tree crop based systems for the hillslope farmers to achieve both ecological and economic benefit, etc. The periodic monitor by the researchers and farmer group meeting to review the production process, problems and potential solutions, expected outputs and next season production plan had helped motivated farmers to continue to participate in the research process.

The results of on-farm experimentation were presented in different forum with and without farmer participation. The on-farm adaptive research was able to link the on-station studies mainly of disciplinary scientists to the local village-based NGO workers, for instance the case of rice biodiversity, where detailed characterization was conducted on station, and testing was done both on station and on-farm.

The participatory rural appraisal (PRA) with effective facilitation had helped generate farmer response and make relevant and workable proposals for the community. During the PRA process among clients of different social status, appreciation of individual experience and knowledge, positive interaction within and among groups were enabled to gain individual or group commitment to perform certain tasks. The PRA was found very successful in the technology generation and transfer process when individual farmers were able to present their views among others and receive response. It is now commonly used by the development projects as ways to empower local groups and to strengthen local organization.

Several short case studies through farmer or entrepreneur interviews either informal or formal were found to be effective tool to policy formulation process when lessons of success and failure could be highlighted.

3. Definition of sustainable agriculture and rural livelihood systems (SARLs)

The IIED's working definition of sustainable agriculture and rural livelihood system was adopted, because it has a strong dynamic links from field, farm, community and community-external sectors. The definition thus encompasses various stakeholders. The success of sustainable agriculture should then reflect what has happened at the field, farm household, community and the community-external sector partnership.

The working definition thus consists of

I Field level

1. The practice of sustainable agriculture incorporates agroecological principles and processes such as enhancing agrobiodiversity, nutrient cycling, pest-predator relationship, etc.

II Farm level

2. the farm household optimizes the use of external and non-renewable resources,
3. make full use of local knowledge as well as incorporate the introduced information and technology for full benefit.
4. diversifies the production system to increase food and income generating capacity over time.
5. the practice would allow households and community increase self-reliance capacity,

III community and beyond community level

6. the SARLs has strong link to local rural economy,
7. ensure more equitable access to entitlements,
8. encourages full participation of producers and consumers in problem solving and innovation.

The definition is found to be similar to the principle of self-reliance economy as proposed by His Majesty the King's "New Theory" for overcoming the economic crisis in the country since July 1997. The key features of the "New Theory" are first emphasizing on self-reliance production system i.e. sustainable intensification through integrated farming system to stabilize food production and to enhance income generating capacity of production surpluses. The second stage concerns more on capability building at the community level to be independent through self-help civic programs such as rural health care, education, rural enterprise, saving fund etc. The stage advocates strong link among rural households. The final stage is for the community to provide incentives for the external private sectors to joint and form partnership in trading activities, delivery systems for the farm products and help expand the market, so that both parties become more interdependent.

The "New Theory" approach to self-reliance economy has now been adopted and implemented by various governmental agencies. The activities are still in the first stage of promotion sustainable agriculture with emphasis on integrated farming systems. The joint venture of private-farming communities has been established by a few private institution, Such as Bang Chak petrol company to promote "green products" under the franchise of "Lemon Farm" at Bang Chak petrol stations, to help distribute and sell safe farm products.

4. Process of research: the move from field research to policy recommendation

The case studies that highlighted the key features of sustainable agriculture cover wide spectrum of landuse patterns, production systems, and production-marketing arrangements. Each case represents specific target groups which possess their own unique problems and potentials.

The outcomes of case studies were used in several ways with the aim of presenting their strength and policy implications. First the on-farm case studies were presented to farmer community to get the feedback and the proposed action plan. The forum was mainly participated by the local groups, such as farmers, farmer leaders, and tambol (subdistrict) administrative officials (TAOs). The finding was then presented in the local seminars and workshops organized jointly by the NGOs and the Regional

Agricultural Research and Development Office. Since 1995, the local and regional networks on sustainable agriculture, spearheaded by NGOs with collaboration of governmental research institutions and universities are increasingly active in trying to draw conclusions from various cases and formulate into policies.

The process from field research to policy recommendation in the study involved case studies, farmer forum and seminars and workshops involving more stakeholders from public and private sectors, local NGOs and universities.

5. The Elements of “success”

The most important elements of the “success”

a) in term of SARLs would include:

- ❑ integrated landuse with diversified cropping systems that fit farmer’s circumstances, e.g. Karen adaptive strategies, to integrate farming and forest utilization to overcome food deficit. (Box 1)
- ❑ the ability of hillslope farmers to make use of ecological setting that provided specific niche for certain commodities with comparative advantage, e.g. *Miang* system on sloping hills. (Box 2)
- ❑ strong farmer organization and good managerial skill would speed up the process of success, e.g. contract potato farming system. (Box 3)

b) in term of policies, policy instruments, and policy process the elements of success could be highlighted as follows:

- ❑ the integrated production-marketing arrangement, either established by private initiatives or government policy support, would help to achieve the government policy of promotion of export of high value added, high quality products, e.g. contract framing, group marketing etc.
- ❑ the successful adoption of conservation farming on the hillslope could be attributed to the understanding of local forest auf land transformation, and policy of landuse right for adoption of sustainable landuse practicesthority on the ;light of hillslope farmers, the initial rice aid program as an incentive o. The close collaboration between hillslope farmers and forest officials had helped promote the success of conservation farming.
- ❑ the “top down” policy which based on local needs can be successful when it is accepted and implemented by strong farmer groups with close collaboration of local authority, such as contract farming.

6. The "institutional practice" / "institutional dynamics" in supporting success stories

The institutional practices/dynamics are observed when community or farmer organization works towards the same goals. The Karen community copes with food security by protecting and utilizing forest resources with cultural rules and regulations, and by sharing food grains to those needed. The resource use conflicts within community will be first attended by the senior citizen or the respected individuals, and very few cases of the conflicts are handed over by the state authority. The culture of sharing and the attitude of maintaining the balance between man and nature help create environmentally concerned, low-input production systems of the community in the highland.

The potato contract growers have set up the Potato Grower Cooperative (PGC) to diversify potato production system. The PGC is the only organization that has been authorized by the government to import cooking potato tuber seeds. The local officials also helps regulate the contract arrangement between growers and the processing companies, in return, the companies could estimate the production capacity that each company could share in the area. This "Win-Win" situation or interdependent relation between the contract growers and companies helps stabilize the production and farmer income.

The case of potato exemplifies government policy on supply control of cooking potato, integrated-production-marketing system running from central governmental level to local practices. It also exemplifies process of conflict resolution (prices, grading, etc.) between farmers and processing companies.

7. Communication between people at different level

The government policy on decentralization and the process of local empowerment is materialized when the Tambon (sub-district) Administration Organization (TAO) has been established in 1994. The TAO is the lowest hierarchy in the local administration (Province-District – Subdistrict (Tambon) that legally and administratively makes decision on the utilization of local resources, conflict mitigation, community development, etc. Thailand has about 7000 subdistricts or Tambon, but not all tambons are eligible to set up TAO, for instance those villages in the remote areas on

the highlands. Each TAO will receive an annual budget of Baht 3. Million as operating funds for community development from the central government. The TAO also collects certain fees and taxes such as land tax, billboard tax, abattoir fee for tambon development fund. So the financial resources of each TAO will be different. The TAOs in the lowlands with high agricultural potential will be better off than those in the highland, and so will have more bargaining power when dealing with external private investors, as in the case of contract farming, or group marketing of high value commodities such as potato, longan etc.

The TAO can also deal directly with governmental institutions for support services, such as credit, information, inputs, and site for development projects. Since its inception, the TAO throughout the country are still concentrated their efforts on infrastructure build-up such as road construction, water supply, etc.

The TAO has great potential for agricultural development if the organization can formulate its own action plan on sustainable agriculture and seek support from the Ministry of Agriculture and Cooperatives (MOAC).

The members of TAO will be elected from the local community. The chairperson of TAO is generally politically active and influential community leader.

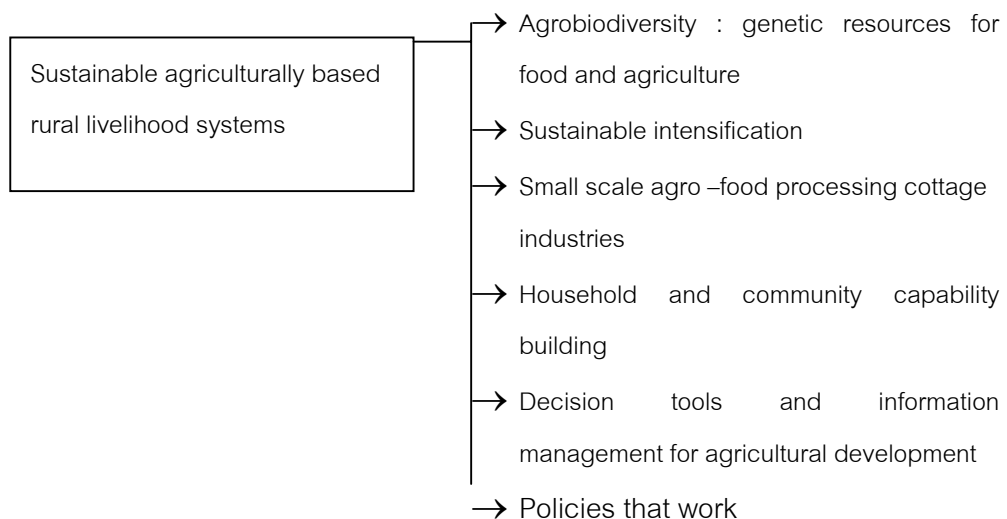
The production groups or marketing groups within tambon could have strong farmer organization. The potato grower group in the contract farming at San Sai, the longan grower group in Chiang Mai were very effective in dealing with government authority or local politicians. Since the commodities are major income earning types and price instability will have adverse effect on large numbers of farming communities, so their problems are normally being looked after by the authority.

On the other hand, the ethnic hilltribe communities who are less powerful, will always find difficulties to get their message across to the authority. These excluded and less privileged communities seek support from the local NGOs and the academics to voice their hardships such as depriving their landuse right, access to community forest, and citizenship. Several forums concerning sustainable resource management on the highlands were organized either by NGOs or jointly by NGOs and research institutions

and universities to allow the hilltribe ethnic groups to openly discuss with the representatives of government implementing agencies. Although the impact was not spectacular, the public has become aware of the issues and there are growing concerns about welfare of those highland ethnic communities.

8. Positive discoveries from the study

To achieve sustainable agriculturally based rural livelihood systems, there would be a combination of key system components interact together as depicted as follows



All these require external intervention but should be built upon the existing local knowledge and experiences. There would be changing roles of public sector to position oneself so that to provide right services to the rural poor. Information and management that help farmers' decision making should be designed for efficiency improvement. The post production food processing cottage industries have shown to be powerful means of social development in the rural community. The policy process that involve participation of various stakeholders will be more materialized than the conventional top down approach.

9. Changes in the policy process

The proclamation and implementation of new national constitution and the economic recession since July 1997 have forced the government and authority to be more opened, and responded to the excluded. Good governance, transparent administration, accountability etc. are a few social demands by the middle class and the representatives of the National Forum of the Poor.

To cope with risk and uncertainly and the degrading of water resources, the MOAC has also launched the Agricultural Restructuring Programme in 1994 to reduce the rice production in the unfavorable growing areas. Furthermore, the program was to reduce the production of certain crops that show declining export potential such as cassava, pepper, coffee, and rubber.

In northern Thailand, the rice farmers were encouraged to transform their monoculture of rice into integrated farming systems, where the MOAC had provided certain input assistance such as fruit tree seedlings, farm pond excavation service, and vegetable seed materials, etc. The result of Phase I was shown to be satisfactory (1994-99). The MOAC has decided to launch the Phase II by providing loan to farmers at Baht 300,000 per household with 3-year grace period, beginning the 2000 fiscal year.

The adoption and extension of the “New Theory” integrated rice based farming system in the lowland by the governmental ministries has helped promote the principle and practice of SARLs. With the collapse of financial institution and its chaotic consequence on industrial sector, agriculture is now regarded as the main strength for economic recovery. Food security and self-reliance economy, particularly for the excluded, have received high priority setting to cope with this economic crisis.

With these new changes, it is anticipated that policies that would enhance integrated landuse system, self-reliance economy oriented production system, small and medium scale rural enterprises, strengthening local organization will continue to be the main development programs.

For the first time, sustainable agriculture has been included in the 8th National Social and Economic Development Plan (1997-2001). With this economic recession and

its chaotic consequences, sustainable agriculture is expected to continue to be the major thrust of agricultural development policy in the following plans.

10. Policy options

The policies that work for SARLs should include the following frameworks as guideline:

- Develop safe production system
- Increase rural employment
- Enhance household food security
- Produce value added products or processed products
- Strengthen local organization

The case studies have indicated the above guidelines are achievable, although they are not happened in all cases. Given the Thai political (coalition government) and economic (long process to recovery) context, integrated landuse, either rice based on non-rice based systems will continue to be the most viable production practice for food security, self-reliance economy for small farmers.

The policy recommendations are:

1. The integrated production-marketing arrangement to develop production alternatives, and to produce high value, high quality products that are competitive in the export market, e.g, contract farming group marketing, etc. Local government offices that oversee such arrangement should be equipped with information and technology-based management skill that could help farmers making decision. The emphasis is on developing decision tools and management of information systems. The training of local officials such as agricultural extension agents, community development workers and NGOs should be incorporated.
2. Promotion of post-production, small and medium scale agro-food processing cottage industries to create rural employment, and to increase value added food products. Most food processing cottage industries are operated and managed by housewife groups, from processing to marketing. The system could also enhance closed-link social structure and better household relationship. The food processing

and packaging technologies should be further emphasized. The roles of biotechnology on agro-food processing also offer potential for quality products and efficiency improvement.

3. Strengthening local organization through human capability building. A number of successful cases on contract farming and group marketing have shown that the top-down policy would be achievable when the action plan or program is suitable for farmers and farmer organization is strong to be able to commit and execute it effectively. More action plans should be directed towards empowering the excluded.
4. Environment-oriented production system would be the recommended land use practice for the highland ecosystem. The ethnic communities should be given land title and the right to control of and access to forest resources. The Karen case has shown that the community is capable of protecting forest resource, and integrating it with the household livelihood system.

Box 1 Exploitation of highland rice ecosystems to sustain food security by the Karen community

The Karen, whose population accounts for about 47 percent (over 350,000) of the ethnic hilltribe communities, is traditionally the wet rice cultivator. Production of rice for self-sufficiency is the main household objective. Three types of landscape are developed to produce staple food crop. These are the paddy fields which are the prime land, along the valley floor, the arable upland fields for permanent farming where upland rice is planted in rotation with two to three year of bush fallow; and the forest fallow patches where upland rice is cultivated with slash and burn practice for land preparation once every 7 years.

At the Wat Chan study site (elevation 1000 m), the Karen planned their annual rice production based on expected household food consumption demand, but cultivation of paddy rice was an absolute necessity. Use of bush fallow or forest fallow plots would depend on various factors: family labour, activities, which offered better opportunity, soil nutrient status (after several cycles of fallow), weeds infestation, etc. The community adopted low external input production system. Chemical fertilizer, if use, was applied at low rate, less than 20 kg N/ha. Use of pesticide was observed in 1998 rainy season when the paddy rice was heavily infested with white back

hopper. Weed control was always carried out by hand, either pulling or hoeing. Occasionally farmers sprayed low concentration of salt solution to control weed infestation.

The most important resources upon which the Karen's depended were rice genetic resource. Through continuing selection, the local rice varieties were adapted to low input production system and long growing season. The optimal planting time was found in June, which coincided with the early rainy season. Delay planting in July and August would result in yield decline. In 1997 and 1998 when the drought occurred during the early rainy season, causing farmers to adjourn rice cultivation to late July, rice yield was seriously affected and rice deficit was observed throughout the community.

Study on characterization of zymogram patterns of local paddy rice population revealed that the local varieties was heterogeneous population. The Karens, either intentionally or unintentionally, had incorporated population-buffering capacity in their local rice varieties. On the contrary, the upland rice varieties used by the Karen were found to be less diverse than the paddy rice.

To supplement rice consumption demand, the upland rice was cultivated in rotation with bush fallow system where land had been cleared and developed for permanent farming. Continuing cultivation of upland rice was not viable because of heavy infestation of *Imperata cylindrica*. The major input required in the system was family or exchange labour. Thus expansion of rice farming in the bush fallow fields would be restricted by availability of labour.

The Karen continued to adopt slash and burn practice in the forest fallow system. The common fallow period found in the study site was 7 years. Yield of upland rice could attain at 2.0 t/ha. The subsequent cropping on the forest fallow was found to result in low rice yield, because of depleting soil nutrient and colonizing of *Imperata cylindrica*.

To cope with annual household rice demand, the Karen would have to manage the three rice ecosystems that were available under labour constraint. The option was to cultivate either bush fallow or forest fallow, but seldomly not both in the same season. It was found that the production system, as traditionally practised, was compatible to farm resources, but the performance was vulnerable to climatic stress as found in 1997 and 1998. It was suggested that improving paddy rice yield and intensifying bush fallow fields with other non-rice crops would help reduce the slash and burn practice of forest fallow.

Box 2 Conserving farming with agroforestry system on the hillslopes

The upper terraces and hillslopes lying between 600-800 m above mean sea level have long been settled by the lowland landless farmers in northern Thailand. In Chiang Mai province. Two

crops are commonly planted by the hillslope settlers: upland rice as staple food crop, and banana as pioneer crop designating land occupancy. Most of these areas are now easily accessible with extended road network, thus making transportation of farm produce becomes convenient.

The Royal Forest Department (RFD) which oversees the forest land had managed to convince the hillslope farmers stop growing upland rice, and to change into integrated perennial tree crop based landuse system. To assist rice consumption demand, the RFD had set up rice bank to supplement household need. In certain area, the scheme operated for 10 years until the farm families could earn enough incomes from the new farming practice.

The environment has provided specific niche for cultivation of tea plant or “*Miang*” (*Camellia sinensis* L.). The crop was first incorporated into the hillslope where there was some remaining forest tree species, which provided shading for the tea plants. Subsequently several fruit tree species were carefully selected and introduced into the system, such as mango, Japanese apricot, peach, pomelo, jack fruit, banana, etc. But the most significant attribution to the success of landuse transformation was the successful commercialization of forest species, *Zanthoxylum rhetza*, to become economic cash crop. When the tree-crop succession reached the mature stage, *Zanthoxylum rhetza* would form the uppermost story, fruit tree species as the intermediate, and *Miang* plants as the understory. Thus the evolving agroforestry systems had provided conservation features such as continuing ground cover throughout the year, erosion control and synergistic tree-crop interaction.

The study site at Nan Phadeng, Pa Pae sub-district, Mae Taeng district, Chiang Mai province had shown that the *Miang*-based agroforestry system had evolved into more ecologically stable and economically viable landuse practice through a series of farmers’ coping strategies. However there were growing concerns about the future of *Miang* product, as the consumption of fermented of steamed tea was declining, causing farmers to search for other farming alternative on the hillslopes. The last decade had witnessed the following changes:

- ❑ Those farmers, who continued to *Miang* cultivation, had replanted good *Miang* stocks as hedgerows so that tree pruning and leaf picking and weeding could be carried out more efficiently.
- ❑ Farmers were more aware of product quality, and tealeaf picking and processing were better managed to produce high quality *Miang*.
- ❑ A few farmers had independently managed marketing arrangement with traders in the other northern provinces, in addition to Chiang Mai market.
- ❑ Farmers had incorporated *Zanthoxylum rhetza* into the *Miang* system together with other fruit tree species to increase income generating capacity of the landuse system.

Farmers had foreseen the prospects of market demand for high quality *Miang* product. The *Miang* production system generated over 8 months of employment from April to December. The harvest of *Zanthoxylum rhetza* from late September to early November provided annual lump sum of cash return. Both communities required no chemical fertilizer or pesticides. The selected fruit trees would provide income seasonally throughout the year. Thus the *Miang – Rhetza – fruit trees* agroforestry system had shown to generate better income distribution and employment opportunity for the rural community in the hillslopes.

Box 3 The integration of production and marketing arrangement in the intensified rice-potato system in the irrigated lowland

The rice-potato production system is considered to be one of the most intensive land-use, high input system in the Chiang Mai Valley. The system requires loamy sand soil with reliable irrigation water supply throughout the season. The potato is considered as new cash crop and was first introduced in Chiang Mai in the early Sixty, but was successfully established as commercial crop in San Sai district in the early Seventy, when it was adopted as an alternative to flue-cured tobacco.

For over 10 years since its first adoption as commercial crop, the farmers had acquired enough production skill through trial and error, as the crop was not considered important economic cash crop nationwide, so no research support or extension service was provided by the MOAC. The Potato Growers Cooperative (PGC) was later formed to act as only authorized agent for the importation of Spunta tuber seed from the Netherlands, and to help develop market or to seek government price support when the market price was too low. The Spunta variety is still being planted until now as the cooking potato with annual domestic consumption of about 8000 tons.

The development of agro-processing industries using potato as raw material in the late 80s had changed the potato industry in the Chiang Mai Valley. The new product development requires processing potato, having different quality and varieties. The contract farming is also introduced to secure supply of raw material with ensured quality.

New processing varieties were introduced for testing by the processing firms. The growers also were exposed to new production technology particularly fertilizer management and pest/disease control. The technology transfer was carried out by the field supervisors of the firms, with assistance from the experienced growers who are selected as the contract farmers.

The combined knowledge between the farmer past experience on cooking potato and the new management practice from the processing firm had helped speed up the production stability and quality assurance.

At present there are three main food processing companies actively establishing contract farming with the farmers in the San Sai district to produce processing potato. These are Frito Lay, Siam Snack and Unichamp. All provide the same processing variety, the Atlantic from the Scotland, to the farmers.

Three types of contract farming were found in the studied site

(i) The broker system. The processing company signed contract with the village broker who had long: experience in potato cultivation and had become respected influential figure. The company provided only the seed material to the broker at 30 baht/kg, and guaranteed price of potato tuber at 6.50 baht/kg. The broker will handled all the contract agreement with growers, provided credit services on inputs such as fertilizers and chemicals. Farmers paid the same seed price of 30 baht/kg as the broker and the guaranteed price of 6.50 baht/kg. The broker together with the company would provide some hand-on technical advices. The broker received the commission fee from the company one baht/kg of potato purchased from the farmers.

(ii) The contract farmer system. The company would approach the farmer leaders who had also good knowledge and experience in potato cultivation. The contact farmer selects the promising growers in the neighbouring fields and helped provide technical and management services to the growers. The company provided all inputs on credit to the growers. The contact farmers in return would receive the servicing fee from the company at 0.10 baht/kg (\$0.028/kg).

(iii) The direct contract whereby the company make direct contract with individual growers. The system is found to be only feasible with large farmers. In this case the company field supervisors monitored all the individual growers.

In conclusion, the rice-potato system is considered to be sustainable, base on the following observations:

1. The San Sai rice ecosystem with sandy loam soil and good irrigation facilities has provided a specific niche for cool season potato cultivation.
 2. The submerged condition of the proceeding rice ecosystem has control the incidence of nematode infection.
 3. Farmers' increasing management skill and technological adaptability help stabilize the production for the rice-potato system. For instance, nutrient management on potato (with high input of chemical fertilizer) also benefits the rice crops; potato tuber seed propagation technique to reduce seed cost, etc.
- The development of food processing companies using potato as raw material has led to constant demand of potato throughout the year.

- ❑ The market opportunities for fresh and processing potatoes have provided farmers to have flexible production options for stable and high incomes.
- ❑ The contract farming arrangement has shown to benefit both the growers and the companies.
- ❑ The credit support from the BAAC has enabled farmers to engage in the high input and capital intensive potato production system.
- ❑ Increasing capability building within the community is evidenced at individual and organizational level. For instance, the contract farmers with good practical knowledge and trustworthy help foster relationship between the growers and the processing companies; the increasing role of PGC in providing supply contract of fresh potato for domestic market.