東南アジアにおける
農業機械設計概念の特質に関する調査研究

15255019

平成15年度～平成17年度科学研究費補助金
（基盤研究（A））研究成果報告書

平成18年３月

研究代表者　小池正之
筑波大学大学院生命環境科学研究科教授

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第１章　はしがき

東南アジアの農業現場における農業機械化は，モザイク的かつダイナミックに進行している。そこでは，相互に関連する多くの影響要因，即ち民族，民俗，歴史，社会・経済的要因が複合的に絡み合い，さらにその状況へは人間の精神的要因が色濃く投影しているため，そのことが機械化関連技術の移転を読み解くという作業を複雑にしているのではないかと考えられる。一方，農業現場での機械化水準は，着実に前進しているが，その質，量及び方向性は地域的な独自性を帯びながら進化を遂げていると考えられる。

本研究は，フィリピンとタイの農村集落を調査地と定め，これら特定の集落で採り行われている農法を観察して資料収集を行い，農業機械設計概念の枠組みにおいて，当該技術体系に内在する固有の民俗学的・工学的特性等につき学際的観点から分析を進めている。現地調査により，技術受容構造の形態，受容技術の改良・継承，技術と農村社会との係りについて考察しているが，同時にこのことが，限られた調査期間内に所期の目的を達成するための調査分析能力を鍛える場ともなった。

研究成果は所収論文及び梗概に述べているとおりであるが，今回は個々の研究者の専門に照して，分析内容の説明と結論の報告に力点を置いており，これら知的流れを束ねて新たな学際的展開を指向する統合化への試みは、今後の課題としていることをお断りしておきたい。本成果に対する大方のご批判をいただければ幸いである。

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平成　15　年度	4,300,000	1,290,000	5,590,000
平成　16　年度	4,700,000	1,410,000	6,110,000
平成　17　年度	5,000,000	1,500,000	6,500,000
総　計	14,000,000	4,200,000	18,200,000

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(3) 出版物

該当なし

研究成果による工業所有権の出願・取得状況

該当なし

Workshop on Efficient Use of Machines and Related Technology Dissemination in Southeast Asia
Bangkok, Thailand, November 25, 2005

Current Status and Future Prospects of Thai Agriculture

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Current Scenarios of Thai Agriculture

- Production based more on natural resources and labor
- Cultivated area ~40% of total land area (~50 Mha)
- 65% cultivated land owned by private, 35% government
- 25% agricultural land can be irrigated in some forms
- Multiple cropping index ≈110

- ~40% of the population (26 M) are farmers
- 75% age 15-65 years
- Total agricultural household ~5.5 M
- More emphasis on efficient use of inputs
  - improved varieties
  - farm management
  - farm machineries
  - post harvest handling
- Improved packaging

- Production structure rather constant during the past 20 years
  - field crops (rice, pararubber, cassava, sugarcane, corn, grain legumes, pineapple)
  - fishery (marine and inland)
  - livestock (bird flu is a big problem)
  - farm machinery service (tractors and equipment for hire)
    : combined rice harvester
    : soybean and mungbean threshers

- Production Efficiency is still low in major crops

- Rice

Country	Yield (t/ha)	Cost of production (t/USD)
Thailand	2.3	113
Vietnam	4.0	74
USA	7.2	254

- Pararubber

Country	Yield (t/ha)	Cost of production (t/USD)
Thailand	1.54	550
Malaysia	0.85	560
Indonesia	0.72	440

- Sugarcane

Country	Yield (t/ha)	Cost of production (t/USD)
Thailand	59	11.5
Australia	75	11.0
Brazil	63	Na

Agriculture-based SMEs

One Tambol (a group of villages) one products (OTOP)

Western OTOP

Agave products

Eastern OTOP

Bamboo ceramic

Fried durian

Lemongrass products

Central OTOP

Banana products

Fish product

Rice crackers

Preserved fruits

Fruit drinks

Cotton clothings

Herbal tea

Bamboo bags

Spices

Northern OTOP

Dried longan

Hand woven cotton clothings

Painted cloth

Household products

Banana products

Northeastern OTOP

Fragrant rice

Silk clothings

Natural dye cotton clothings

Sedge products

Herb drinks

Hot chili delicacies

Mulberry tea

Coconut shell products

Southern OTOP


Banana sheath products


Bamboo products


Sedge products


Hot chili delicacies


Pandanus products


Instant ginger powder


Fruit wines


Preserved eggs

Future Prospects

- Emphasize on the consumers (demand driven)
  - GAP
  - Organic farming
- More collaboration with other countries
  - bilateral agreement with China is affecting some agricultural products
  - investment and contract farming in naboring countries (soybean, corn, mungbean, oil palm, sugarcane)
- Infrastructure for agricultural products
  - millers of rice and cane
  - silos for grain; cold storage for vegetables and fruits
  - availability of farm machineries

- More knowledge based production
  - organic farming (research and quality control)
  - crops for energy
    : cassava and cane for alcohol
    : oil crops, especially physic nut (purging nut or jetropha) for biodiesel
  - switching from crops to fishery and livestock
- Increase production efficiency/mechanization
- Improve quality of the products "From Farm to Table"
  - technology transfer
  - quality control measures to support branding (DNA fingerprinting to certify jasmin rice)

- "Kitchen of the World" policy
  - through Thai restaurants abroad
  - building up brand names and certifying process
  - market development
- Production infrastructure
  - improved logistics system
  - water resource management
  - management of pollution from agricultural waste

- Promotion of product champions
  - Plants
    : rice production in Chaophraya and Maeklong basins
    : fragrant rice production in Northeastern provinces and branding
    : tropical fruits, flowers and herbs
    : energy related crops
  - Fishery
    : culture of shrimps, fancy fish, fancy aquatic plants
  - Livestock
    : local chicken breeding
    : production of beef cattle (1 million head project)
    : cattle production around the border

- Expanding the use of product champions
  - Rice
    : development of new products
    : more use of by-products (rice husk, bran)
    : rice drinks
    : rice shampoo, soap
  - Rubber
    : used in megaprojects (road construction, dam construction, rubber sheet for reservoir)
  - Shrimps
    : domestication of parental stocks
    : utilization of product waste

Constraints

- More research needed
  - Organic farming
  - Crop for biodiesel : physic nut, oil palm
  - Machineries for farms and SMEs
  - Value-added crop cultivars : higher in nutritional values and anti-oxidants
- Short –term agricultural policy
- Farm debts

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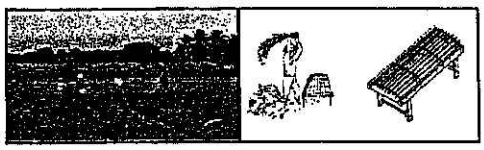
Workshop on Efficient Use of Machines and Related Technology Dissemination in Southeast Asia
Bangkok, Thailand, November 25, 2005

Thavachai Thivavarnvongs
President of the Thai Society of Agricultural Engineering

Development and Suggested Strategies for Agricultural Machinery in Thailand

Context

- Background
- SWOT consideration
- Strategies for Development



Background of Agricultural Machinery (AM) in Thailand

Thailand 's conditions:

- Important exporter of agric. prod.
- 25% irrigated area (out of totally cultivated area)
- Significant reduction in labour force due to econ. & indust. expansion

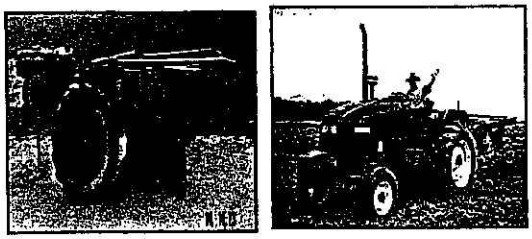
Use of AM helps in the following aspects

- Time saving
- Labour saving
- Prod. loss reduction
- Cost reduction
- Quantity / Quality increase
- Prod. value increase

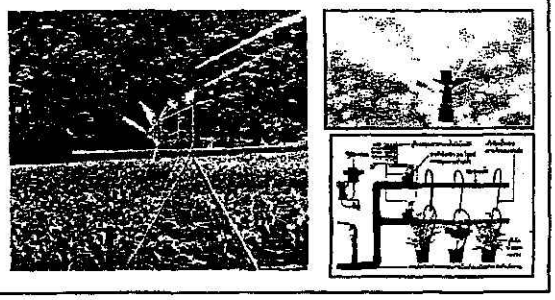
Types of machinery (m/c) in use

- Prime mover
- Irrigation m/c or equipment
- Land preparation m/c or implement
- Planting / Seeding m/c
- Weeding / Fertilizing m/c
- Harvesting m/c
- Postharvest m/c
- Agro-Industry m/c

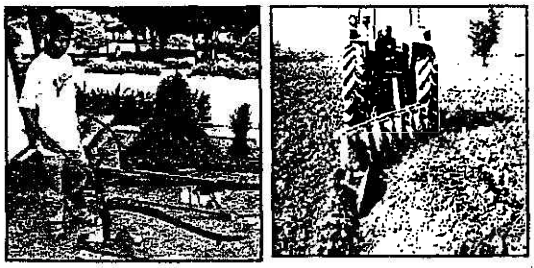
Prime mover



Irrigation m/c & equipment



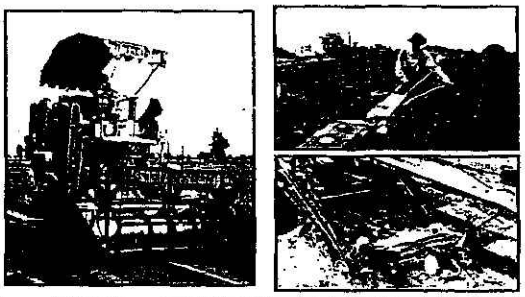
Land preparation m/c or implement



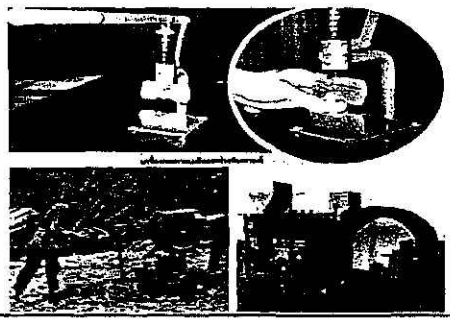
Planting / Seeding m/c

Weeding / Fertilizing m/c

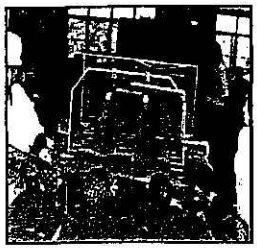
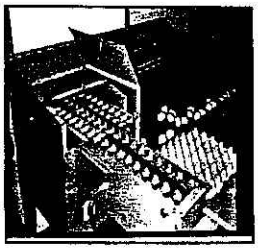
Harvesting m/c



Postharvest m/c

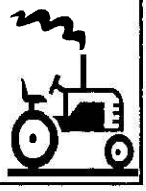


Agro-Industry m/c

Status of AM produced in Thailand

- Suitable for Thailand 's conditions
- Simple design & low cost
- Appropriate technology
- Various manufacturers
  - Varied quality
  - High competition (price)
  - Limited exporting



Status of AM (continued)

- Most m/c are for rice, field crops & horticulture
- Few m/c are for fishery & livestock
- Farmers lack investing money
- ASEAN countries import more than export AM; good potential for exporting

SWOT consideration

for Thailand's conditions

Strength:

- Suitable topography and climate for year round agricultural production ; AM greatly helps to increase productivity and efficiency.
- Appropriate technology application

SWOT - Strength (continued)

- Great potential to expand activities to ASEAN countries
- Various AM manufacturers and relevant supporting industries
- Locally available servicing centers
- Skilled and efficient personnel / labour force in both the manufacture and utilization of AM

Weakness

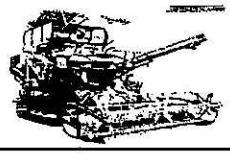
- Limited irrigated area ; AM is not fully utilized throughout the year
- Small plots of cultivated land ; certain AM can not operate effectively
- Some AM manufacturing practices are not up to standard
- Low technology in certain cases

SWOT - Weakness (continued)

- Dependence on importing parts from overseas
- Government 's direct supports are not high and do not help sustainability
- R&D works are still insufficient and so are extension works

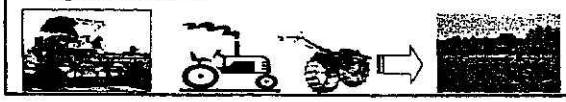
Opportunity

- There are always increasing needs for AM
- Available markets both within and outside Thailand
- Good potential to export to ASEAN countries



SWOT - Opportunity (continued)

- Appropriateness of AM utilization and post production management existing for local and regional conditions
- Joint production & investment with developed countries for market expansion
- National policy of emphasizing competition in the agricultural sector



Threat

- ⇨ Lack of investment fund ; custom farming is still not widespread
- ⇨ The FTA Agreement leads to severe competition & may lead to reduction in quality and efficiency of AM
- ⇨ Options in manufacture & utilization of AM are limited
- ⇨ Assistance/support are still lacking for manufacturers and users of AM

Strategies for Development

Concept

National policies of :

- competitive & business-minded agricultural production
- Thailand as the World Kitchen
- strong support for the manufacture, utilization & management of AM in Thailand

Strategies (continued)

Vision

Thailand to be ASEAN center for manufacture, utilization and management of Agricultural Machinery & Post Production

Strategies (continued)

Mission :

- Develop sufficient skill and capability for AM users
- Support / promote AM utilization and good management scheme for post production
- Support & assist in the development and improvement of AM leading to good standard and their versatility

Strategies - *Mission* (continued)

- Develop optimum land size & layout for farmers enabling them to fully utilize AM and have adequate transportation for agric. prod.
- Provide good framework & utilization scheme of AM and suitable post production management system in order to integrate them to the full benefit.

Strategies (continued)

Objectives & Methodology

To be expected on a national scale covering a 1st stage period of 5 years (eg. 2006 - 2010)

- Training of AM users, targeted at 5,000 minimum
- Assistance in AM investment according to farmers' needs, targeted for 20,000 - 30,000 farmers.

Strategies (continued)

Objectives & Methodology (continued)

- Reduction of loss(es) by 20 %
  Reduction of cost(s) by 10 %
  & Increase of prod. value by 10 %
- Achievement in developing AM & post production management system(s) suiting the need of users, targeted for 10 items minimum.

Strategies (continued)

Objectives & Methodology (continued)

- Support for R&D works in AM (10 patents minimum) & improvement of AM manufacturing procedures in Thailand (10 cases minimum)
- Development of optimum land size & layout to suit full utilization of AM, with targeted area of 2 - 3 million rais.

Strategies (continued)

Objectives & Methodology (continued)

- Establishment of a ' National Council / Committee of Agricultural Machinery Policy (NCAMP)' to help both the government and private sector to achieve all the mentioned goals for Agricultural Machinery status in Thailand.

Workshop on Efficient Use of Machines and Related Technology Dissemination in Southeast Asia
Bangkok, Thailand, November 25, 2005

General Description of the Two Study Sites —History, Land and People—

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Abstract

In the past two decades, farmer's needs and socio-economic circumstances in rural community have positively been advocated the necessity of implementation in the context of development programs in Southeast Asia. Undoubtedly, physical and spiritual dynamism in terms of technology acceptance seems to play important roles to assess the validity of the program and prepare the proposal for further constructive improvement. Inherent characteristics of farm machine use also disclose such nature that necessitated coordination in any form with demand of the people. This article deals with technology acceptance aspects made in the rural communities of the Philippines and Thailand.

To cope with various intricate matters involved, some professional fields including agricultural history, folklore science, geography, farm mechanization were provided to discuss common targets from different academic interests.

Keywords: farm machine, technology acceptance, folklore science, agricultural history, Philippines, Thailand

1. INTRODUCTION

This field study aims to identify the framework of technology acceptance in relation to the mechanized farming by means of data collection through interview or other appropriate procedures. For the implementation of this study, two study sites were selected in the Philippines and Thailand. In different settings and locales with different history of agricultural developments, the particular educational methods of introducing knowledge and technology while improving farmer's curiosity and creativity did produce an enrichment of schemes in growing rice and other crops as well.

It is not to dismiss the reality though any national programs are also based on the "scientific agricultural domain." The gradual change that follow reveal that once the farmers learn new elements – that fill in the missing slots in farmer's understandings of their rice ecology – together with adopting new ways of learning, an enhancement of various combinations of elements lead to an ongoing process of knowledge accumulation. The return of farmer's dignity and the enhancement of their creativity play a significant part in this process. However, this is only one contributing path for a gradual change in individuals' knowledge to occur. The extent to which knowledge is put into action – that is affected by various intra- and extra-personal structures that are locality contribute to a heterogeneous nature of crop farming to develop. Only with the provision of diverse features of growing crops does a natural selection occur, not only on the "best" practices in its new meanings, but also on the nature of farmer's expertise. These are the assumptive significant paths for evolutionary processes of technology acceptance in rice-based farming[1)].

A comparative perspective in examining those phenomena in different countries proves useful in understanding and elucidating processes that lead to the formation of new meaning and interpretation in its similar or diverse ways.

In this paper, the components which influence to the ways and manners of efficient farm use have been studied in interdisciplinary approaches applying engineering and social science expertise.

2. STUDY SITE IN THE PHILLIPINES

2.1 Cauplasan, Santa Maria, Pangasinan, Philippines

In the past, Pangasinan province was composed of only a few towns which boundaries stretched as far as the farthest barangagy[2]. In the course of time, prominent people found the place surrounded by marshes, and therefore beyond their capability to improve it, transferred the townsite from Namagbagan (currently a barangay of Santa Maria) to the present site of the place. The townsite is near a clay promontory which formed an impregnable defense against the early erosion of the Agno River, 1km from the site.

Santa Maria was formerly a barrio of the municipality of Tayug. It was founded on January 10, 1858 and became a town under a rule of Captain up to 1863, but was fused to Tayug later because of its inability to maintain financial stability. In 1877, however, upon the application and granting of the inhabitants for separation from the mother town, Santa Maria became again a separate town under the rule of different Captains. Again in 1903, Santa Maria was fused to the town of Tayug until 1906 for the same reason. But in 1907, special election was held for the purpose of turning municipalities fused with bigger towns. Thus the municipality of Santa Maria became a current administrative body.

Santa Maria is located 189km far from Manila. The study site, Cauplasan, is one of 23 barangays. As a primary source of agricultural income in the municipality, rice occupies 5,060ha whereas tobacco 700ha, corn 100ha, legumes 130ha and fruit 10ha respectively.

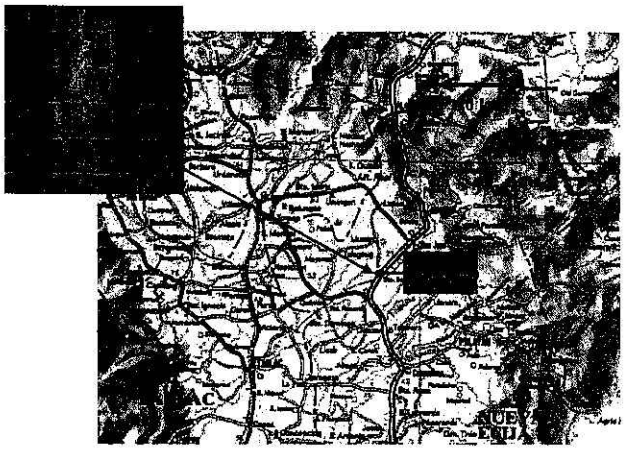

Fig.1 Study site in the Philippines

2.2 Interview to a Barangay Captain

Our first preparatory observation trip to Cauplasan brought us strong impression that we describe it as the place something different with neighboring communities as far as superficial survey is concerned. According to the senior official of PhilRice, Cauplasan never categorized as an exceptional case, but it provides good example in terms of the implementation of mixed farming.

On June 28, 2005, we have paid a visit to barangai Captain, Mr. Fortunato Pasion who is 54 years old, for interview. This barangay became independent in 1958 without establishing a chapel due to local politics.

In this barangay, overall households are 185 and population is 831. Occupation of all household is a farmer except 10 households that include school teachers and so on. Since then, only one household has moved to the other community. Either husband or wife of almost all households is a native of this barangay. It is of interest to note that one family has moved to Cauplasan from neighboring barangay in 1960 and has resulted in a settled inhabitant as it was for the sake of less tax and possible privatization of the surplus of agricultural commodities.

Barangay Captain owns altogether 50ha farm land. In wet season, he allocates 30ha for rice and 20ha for upland crops including corn, eggplant, chilli and okra, while 50ha used to be provided for vegetables in dry season. Under such a rain-fed condition, the cropping pattern is subject to restrain the decision-making by the amount of rainfall. 80% of rice is selling through middleman, and remaining 20% is for family use. Most of the vegetables are provided for the market.

Farm mechanization is steadily progressing but the status of mechanized farming is mixed in terms of different type of machine provision.

Since this community has started to enjoy the power supply service since 1998, they maintained their life-style as old as the conventional level of animal-dependent power system until very recent years. We were stunned by the unfamiliar scene when we visited a farmer's house. Farmers were watching TV in the living room of rather shabby house. Our immediate question is why farmers do not make action to better off current life standard. Perhaps their attitude seems to come from the specific sentiment of safety first philosophy that is stemmed from their experiences. In short, due to the shortage of available budget, it is difficult to launch the action plan even if they plan to accept innovative technology or to expand the scale of farming practices. Under such circumstances, we can not help to respect the philosophy described above so that they are seriously tackle to the new undertakings.

2.3 Direction of technology dissemination

To encourage the technology dissemination and vitalization of local industry and agricultural practices, improvement of institutional development program, action plan provided by farmers or entrepreneur and foreign assistance or technical exchange are to be implemented. But these ideas seem to be commonplace. However when it comes to institutional development program, more realistic program is to be proposed. For example, any national program is to include the local industry effectively in implementing the increase of job opportunity, income increase, dissolution of regional economic difference, acquisition of foreign currency by export. The gap between big-scale industry and small-scale one had better not fix any longer and try to pave way to minimize the gap inviting the sub-contractor for the built-up of desirable technology linkage among them. Concurrently, technical linkage with the primary industry including agriculture and fishery is to promote the possible collaboration. The taxation system which leads to the fair income distribution is considered as another means of the encouragement for local industry.

3. STUDY SITE IN THAILAND

3.1 Nohn Jalern, Wang Yaw, Ko Sum Pi Sai, Mahasarakham, Thailand

The study site, Mooban Non Jalern lies SSE of Khon Kaen and about 30km by highway and then paved road from Khon Kaen. The land is undulating as the slopy land, but few canals, dried fields, and house mound sharpen its contours.

Nohn Jalern's population lived as 60 households, of which less than 10% derived a living mainly worked as storekeepers and teachers etc.

Mooban Khon Kwang, one km far from Nohn Jalern, played as a mother administration and the move from Khon Kwang to Nong Jalern has started in the late of 1980s and finally splitted each other in 1992. Acreage of cultivating land can be estimated as 1800rai (288ha), of which one-third is for paddy field and two-third for upland crops. Most of the farmers are act as full-time workers. One-fourth of farmers own power tillers, and remaining farmers rely on the contract-hire-system in conducting cultivation and leveling operation. Farm land composed of sandy soil, and hence it prones to cause erosion.

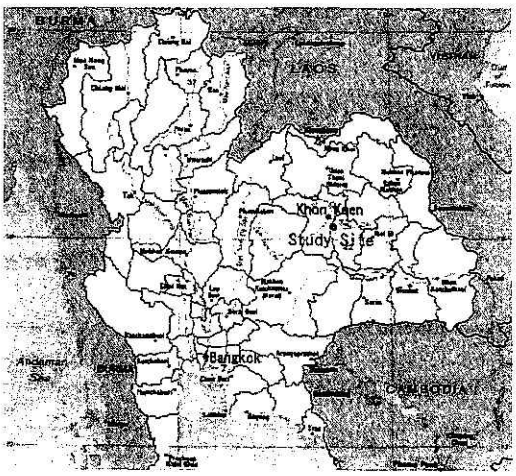

Fig.2 Study site in Thailand

3.2 Brief description of agriculture in Northeast Thailand

For rice-growing farmers, family workforces are directed to engage with domestic farm practices. Occasionally they may work at the other farmer's field upon request that bring about the creation of labor opportunity for sugarcane production. Educational level for parents remains as low as elementary school in most cases. As for mechanization level, big-scale farmers possess four-wheel tractors, trucks and others, but small-scale farmer's outfits of machines still stay minimal.

Most of the rice production includes sticky rice species, but its yield is unstable and low. As a specific feature for rice, joint works sharing labor forces among relatives can be widely observed premising commonly sharing consumption of rice.

On the other hand, sugarcane cultivation faces particular issues to be solved. Normally, first harvesting shows good profitability, but the required production cost is high. To achieve higher income, it implies some prerequisites; i.e. selling with higher unit price, improvement of labor productivity and yield increase per unit area. A customary practice in conjunction with yield increase is to increase the amount of fertilizer and filter cake application. Unfortunately, this practice is not effective for the improvement of physical characteristics for soil.

3.3 Direction of technology dissemination

For rice production, the debt status of farm household is imminent. One realistic prescription can be suggested that the implementation of efforts for the cost reduction per unit area will be the one to be achieved. In general, this approach is feasible by the fixed cost curtailment by land expansion. However, if current farm operation system is henceforward adopted as a prerequisite, the land expansion is automatically accompanied with proportional increase of variable cost inclusive of the hired labor cost or fertilizer cost, and then it never attain the cost curtailment per unit area.

Therefore, the provision of reasonable priced machine is requested to develop in the market. On the other hand, they also expected to activate the local industry through versatile technology enhancement. Although small-scale local industry is surely contributing to support the regional economy and providing the job opportunity, their social status is between acceptable and poor. An assumption is proposed that this metal-working business becomes useful if current skill level improves up to the level being capable to cover the general metal industry domestically. Such a reinforcement of skill level brings about the revitalization of the domestic production of machine parts and capital goods. And hence, it leads to cancel to regional economic gap and fulfillment of national industrialization.

CONCLUSIONS AND RECCOMMENDATIONS

1) At the study site in the Philippines, following items have been identified as the issues to be improved for small-scale metal-working improved industry; i.e. instability of the seeply of raw materials, dependency to the import capital goods, incomplete mechanization of manufacturing process which leads to the high dependency to muscle work labor force, and quality and shortage of capitals. To cope with these issues, following proposals can be described; i.e. start-up of manufacturers' organization, joint sale in the form of the organization, joint purchase of raw materials, and so on.
2) In Thailand, it can be pointed out that the management of mechanization is of importance to meet the local demand of machine performance. In 1970s, Hanks[3] stated that "if plowing can be done at leisure over many days, as in broadcasting, the greater speed of a tractor has no justification. Its use resembles flying a jet plane to visit a neighbor who lives only a few miles away. Moreover, the energy expenditure of a tractor must fit the local patterns of labor, lest it become a burden to the owner having to travel miles in search of scarce fuel or a mechanic to make repairs. The more powerful and efficient burst of energy must not interfere with subsequent tasks. In some communities, driving a tractor spoils a worker for the fields, since tractor drivers become too proud to help with transplanting. Like a poor peasant trying to maintain a costly chateau, a simple fisherman operating a battleship or a crop duster paying the bills for a bomber, the rice grower must avoid being submerged by a machine."

   At the time of machine design process, this statement is also suggestive to boost the target-fitted scheme. Appropriate management of machine in adapting local conditions might provide us a new spectrum of mechanization. In the process of such a study, the voice of farmers becomes more important.

ACKNOWLEDGEMENTS

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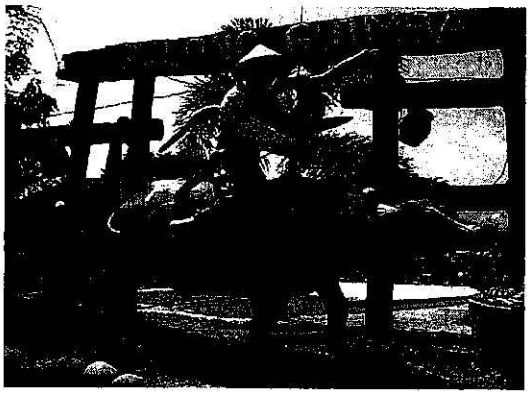

Fig.3 Monument for animal and man

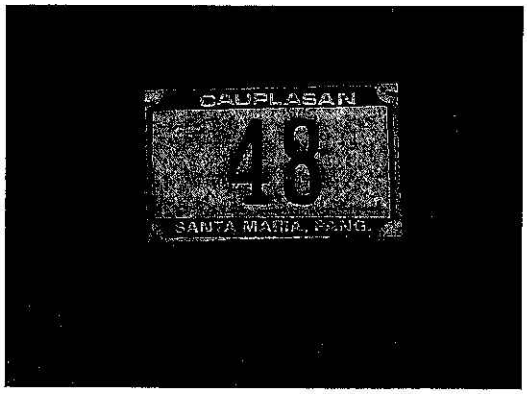

Fig.4 ID number for each household

Fig.5 Local food, Cauplasan

Fig.6 Repairing the field ridge

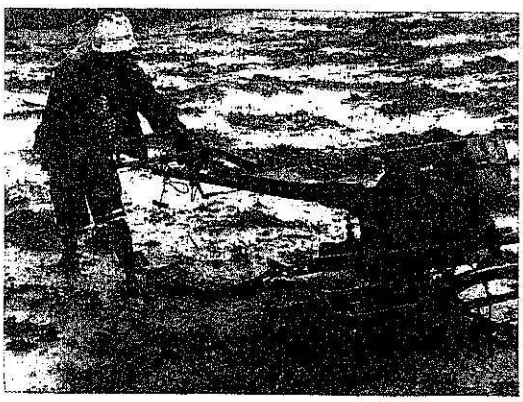

Fig.7 Paddling operation

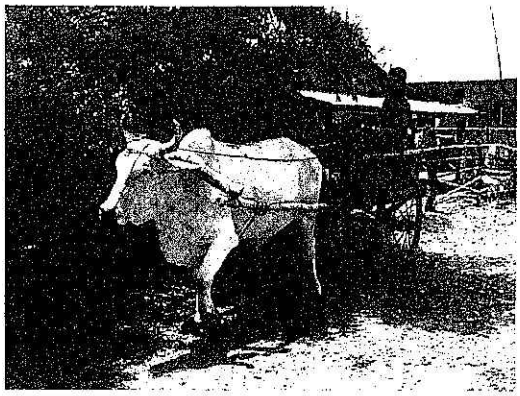

Fig.8 Animal-drawn cart

Fig.9 Sleigh

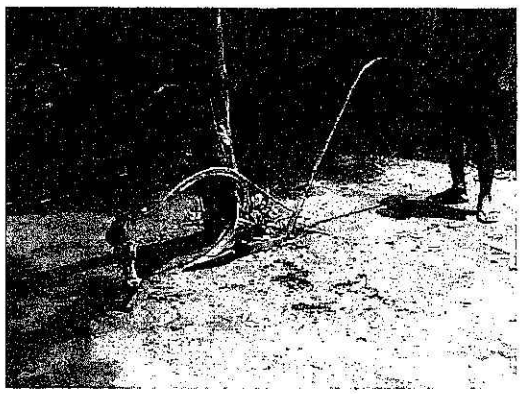

Fig.10 Traditional animal-drawn plow

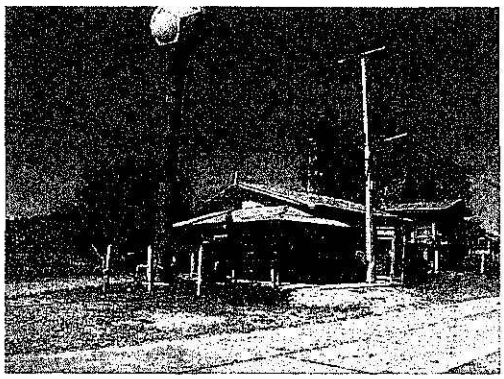

Fig.11 Central area of the study site, Nohn Jalern

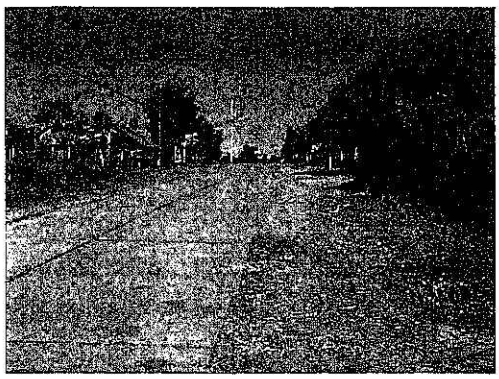

Fig.12 Trunk road

Fig.13 Custom service for threshing

Fig.14 Original design prepared by a local artisan

Fig.15 Inter-cultivating operation using a modified local plow

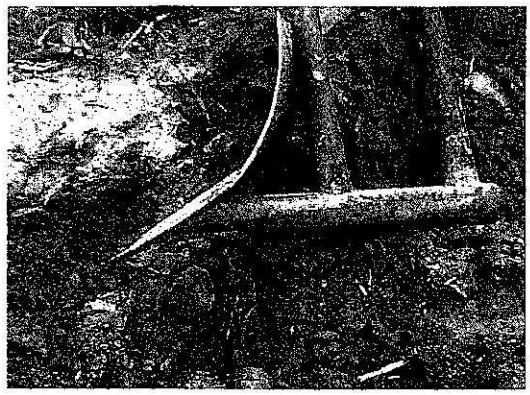

Fig.16 Close-up view of a modified local plow

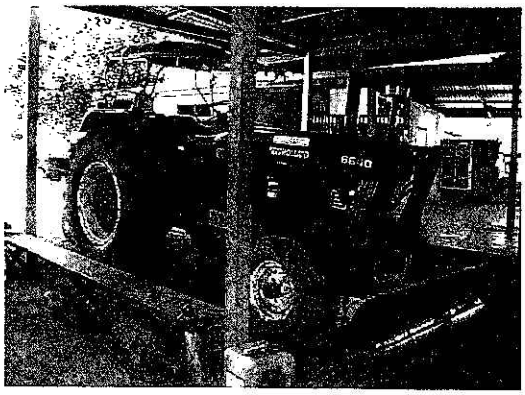

Fig.17 Tractor being ready for operation by contract-hire-system

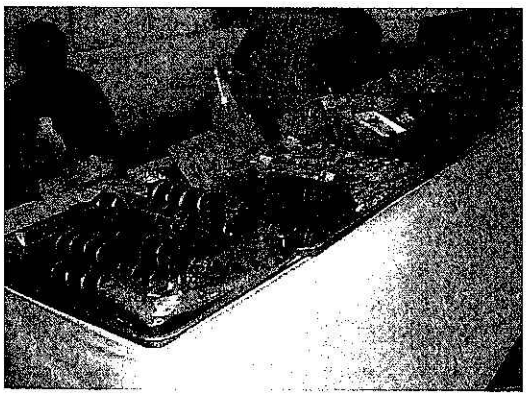

Fig.18 One-Tambon-one-product campaign

Workshop on Efficient Use of Machines and Related Technology Dissemination in Southeast Asia
Bangkok, Thailand, November 25, 2005

Relations between rural community transformation and specific farming practices influenced by the rolling hilly land of Northeast Thailand

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Abstract

We uncovered relations among agricultural landscape changes, rural community transformation, and soil erosion problems. The former agricultural landscape of the study site, which was composed of forest-covered uplands and lowlands occupied by paddy fields, was prevalent until the early 1970s. The introduction of cash crops in the upland starting in the 1970s caused a drastic change to the landscape because the upland forests were completely cleared to introduce cash crops. In the beginning, cassava was the main crop, but production has shifted to sugarcane since 1990. The income obtained from cash crops has increased with the expansion in crop fields since the mid 1970s. The increased income resulted in a population growth in Khon Khwang village. Such growth led to migration to the outside in the mid 1980s and caused the subsequent establishment of Non Jalern village in 1993. Following the establishment of Non Jalern village, the number of households in Khon Khwang slightly increased in 2002, whereas that of Non Jalern in 2002 rapidly increased to nearly twice as many as in 1993. To support this population growth, paddy fields in the study site were somewhat expanded in 1993. However, the paddy fields considerably decreased in 2002 and were distributed only at valley floors because the village people chose to obtain additional rice from the outside. Two types of soil erosion were found in the study site. Soil erosion of crop fields was caused by the change in site hydrology due to a decrease in the infiltration capacity, coupled with strong intensity of rainfall and sandy soil. Soil erosion of paddy fields resulted from culverts in the road that crossed the valley of rolling hilly land. This special erosion depends not only on the culvert construction of the road but also on topographical features. The current level of road standards is closely related to the development of the rural community due to the increase in agricultural production controlled by the farmers' behavior. In conclusion, the soil erosion problem of paddy fields is caused by underlying factors such as rural community development, agricultural production, and farmers' behavior, as well as by direct factors such as road culverts.

Keywords: rural community, farming practice, rolling hill, rain-fed paddy, crop field, soil erosion

1. INTRODUCTION

The agricultural landscape of Northeast Thailand is influenced by its rolling, hilly topography that alternates between upland (hills) and lowland (valleys). Once, forests typically covered the upland and rain-fed paddy fields stretched into the lowland. However, that landscape has rapidly changed since a wave of agricultural development reached this region at the end of the 1960s (Japan Agricultural Development and Extension Association, 1996). Now, expanses of crop fields have generally replaced the forests in the upland, while stretches of rain-fed paddy fields still occupy the lowland. Such landscape changes could be caused by the influence of specific topography, productivity and sustainability in the cultivated land on farming practices and the effect of socio-economic conditions on farmers' behavior. Accordingly, there could be a close relation between landscape changes and transformation of the rural community.

This paper aims to clarify relations among agricultural landscape changes and rural community transformation and soil erosion problems by analyzing interrelations among farming practices, specific topography, soil erosion in connection with productivity and sustainability in the cultivated land, and farmers' behavior. For this purpose, we conducted a case study in the Khon Khwang and Non Jalern villages of Maha Sarakham Province.

2. STUDY SITE

The Khon Khwang and Non Jalern villages of the study site near Khon Kaen City belong to the Kosum Phisai district of Maha Sarakham Province (Fig.1). The geology of the study site and its neighboring area consists of Mesozoic sedimentary rocks overlaid by Quaternary deposits composed of sandy loam in the surface layer (Imaizumi *et al.*, 2002). The topography is classified as rolling hills, which undulate with a relative height of about 10 m in the study site and neighboring area. Elevations range from 170 m to 200 m above sea level. The region has a tropical monsoon climate characterized by a rainy season from May to October and a dry season from November to April. The mean annual rainfall in Kosum Phisai near the study site is 1150 mm: 1005 mm (87%) falls during the rainy season, and 45 mm (13%) falls during the dry season. The present land usage in the study site is as follows: lowland, which is formed by the first order stream of the Chi River, is mainly used for paddy fields, whereas upland, which was covered by forests in the early 1970s (Fig.2), is occupied by sugarcane and cassava crops.

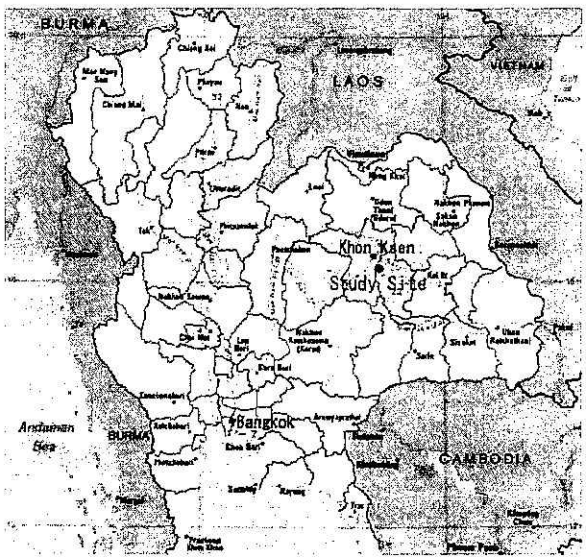

Fig. 1. Map showing study site (Khon Khwang and Non Jalern villages near Khon Kaen City)

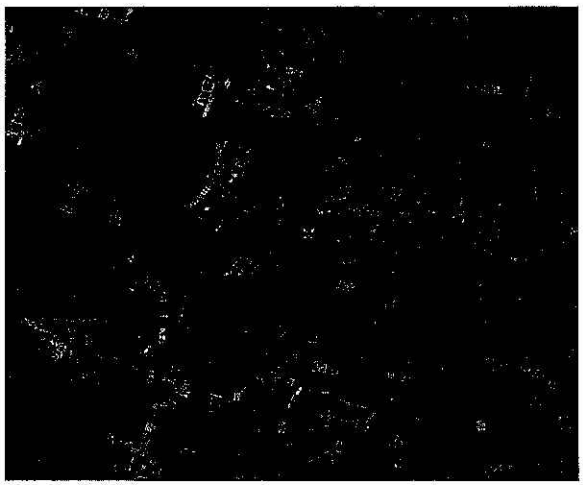

Fig. 2. Aerial photo showing the landscape in 1973 that consisted of forest-covered upland (hills) and rain-fed paddy fields stretching into the lowland (valleys) in the study site and neighboring areas

3. DATA AND METHODS

We interviewed farmers in the Non Jalern village and collected farming data from the agricultural office of Kosum Phisai to obtain information about the village history, population, farming system, and land use. We also gathered rainfall and sediment data from the Khon Kaen office of the Royal Irrigation Department. In addition, we performed photo interpretation using aerial photos taken in 1968, 1973, 1993, 1996, and 2002 as well as a map analysis using a topographical map of 1/50,000 published in 1969 and the revised map in 1992 by satellite imagery to comprehend the community transformation and land use changes.

4. RESULTS AND DISCUSSION

4.1 Farming practice changes in the study site and neighboring area during the recent three decades

4.1.1 Map analysis

By comparing the 1969 map showing neighboring areas (6.1×5.4 km) of the study site (Fig. 3) with the map of 1992 (Fig. 4), we can see drastic changes during the recent three decades, with crop fields replacing forests in the upland and shrinkage of the rain-fed paddy fields that stretched into valleys. The map of 1969 shows that the forest area including villages was 22.1 km^2 (67%) and the paddy area was 10.9 km^2 (33%). In contrast, the map of 1992 shows that the crop field area, including villages, was 27.6 km^2 (84%), of which 22.1 km^2 (67%) had been converted from forests and 5.5 km^2 (17%) converted from the paddy. Likewise, the paddy area decreased by 5.4 Km^2 (16%) in 1992 due to the invasion of crop cultivation to the paddy. It should be noted that such aggressive expansion of crop cultivation in order to

increase cash revenues occurred in the study site and its neighboring areas during the recent three decades.

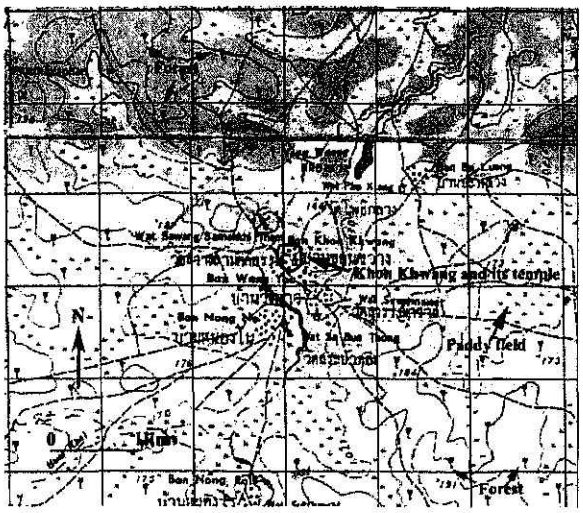

Fig. 3. Topographical map of 1/50,000 published in 1969

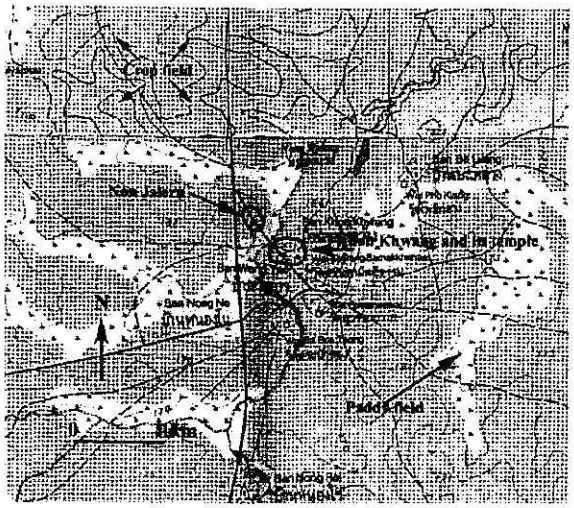

Fig. 4. Topographical map of 1/50,000 revised by satellite imagery in 1992

4.1.2 Aerial photo interpretation in the study site

We analyzed aerial photos from a typical agricultural landscape consisting of a set of upland and valley areas adjacent to the Khon Khwang and Non Jalern villages (6 km^2 in area). We found that forests covered most of the upland area in 1973, and rain-fed paddy fields stretched not only into the main valleys, but even into the tributary valleys as well (Fig. 5). This suggests that rice was a main farming product for subsistence and that rice farming was practiced wherever possible in the early 1970s. A comparison with the 1993 aerial photos (Fig. 6) shows that all the existing forests in1973 had been completely cleared and changed into crop fields by 1993. Such forest reductions occurred throughout the whole country with the most rapid decline between the 1960s and the 1970s (Fig. 8). Forests in the study site must also have rapidly diminished in the mid 1970s because, according to an interview with farmers, cash crops such as cassava and sugarcane were introduced to the study site and its neighboring area in the 1970s. At first cassava was the main crop to be introduced to the land converted from forests, but the emphasis shifted to sugarcane after 1990, reflecting the country's changing tendency in the cultivation of cassava and sugarcane (Fig. 9). In contrast with the drastic changes in the upland from 1973 to 1993, there was very little change to the paddy fields in the valleys in those days. If anything, these paddy fields increased somewhat (Fig.12), although paddy fields in other neighboring areas generally decreased because of the invasion of crop cultivation from the upland. However, the 1996 photo shows that these paddy fields had begun to decrease slightly because the valley head of the first order was invaded by the crop cultivation. Moreover, the 2002 photo shows that the paddy fields had decreased considerably by then and were distributed only along the main valley floors because crop fields occupied almost all first order valleys and side slopes where crops can grow (Fig. 7). Thus, the expansion of paddy fields shown in the 1993 photo might be due to a special situation of the community in the study site. Why did this tendency for rice farming occur? The details will be discussed later.

4.2 Rural community transformation in the study site during the recent three decades

According to the interview with farmers, Khon Khwang villagers established the new Non Jalern village in 1993 about 1 km northwest of Khon Khwang. Such village community transformation can be found in four aerial photos taken in 1973, 1993, 1996, and 2002 (Fig. 10). Based on the aerial photos , the estimated number of households in Khon Khwang village was 55 in 1973 and increased to 111 households in 1993 (Fig. 11). This rapid population growth resulted in the birth of Non Jalern village in 1993. At that time, there were 35 households in Non Jalern. This suggests that the migration to Non Jalern had begun in the 1980s. By 2002, the number of Khon Khwang households had increased slightly to 137, whereas Non Jalern's households rapidly increased to 64, which was almost twice as many as in 1993.

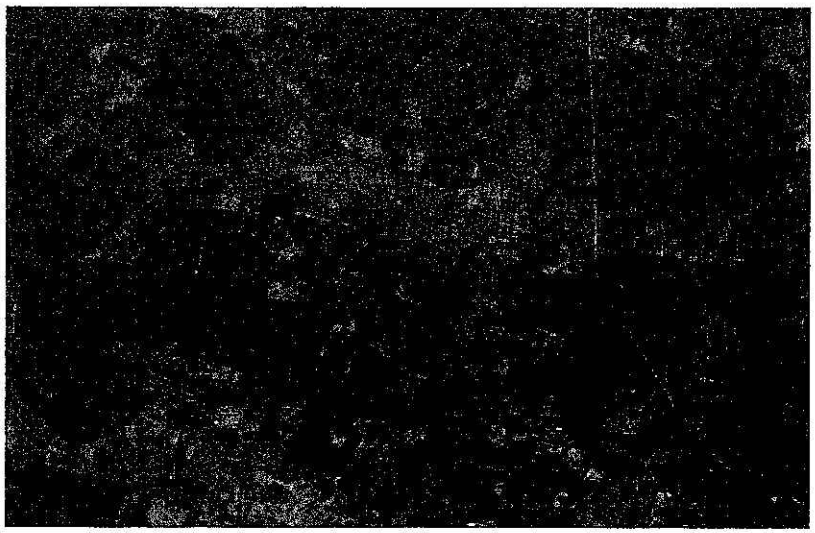

Fig. 5. Aerial photo showing the landscape of the study site that consisted of upland covered by forests and lowland occupied by rain-fed paddy fields in 1973

Fig. 6. Aerial photo showing the landscape of the study site that consisted of upland occupied by crop fields and lowland occupied by rain-fed paddy fields in 1993

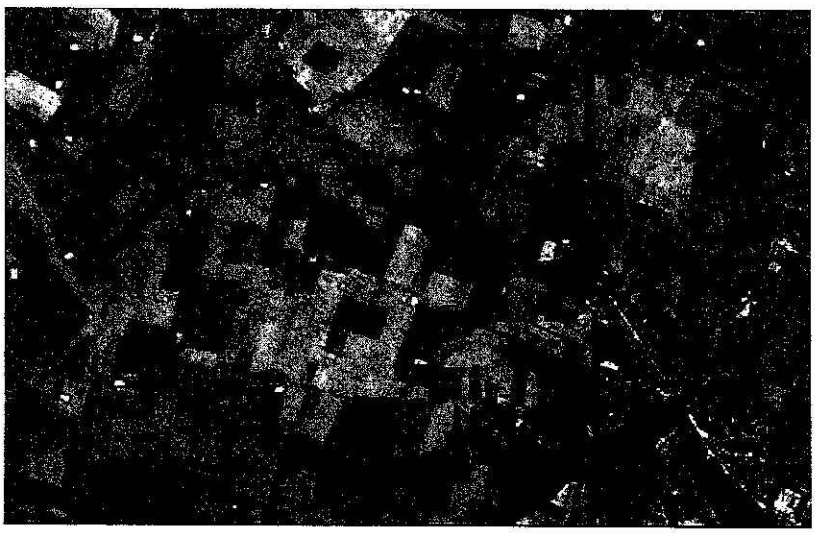

Fig. 7. Aerial photo showing the landscape of the study site that consisted of upland occupied by crop fields and lowland occupied by rain-fed paddy fields in 2002

The year when the Sawang Samkkhitham temple (Figs.3 and 10) was constructed in the village can be used to estimate the birth of the original Khon Khwang village community. A temple is a symbol of unification in a rural community, and the temple must have been built when the rural community was actually unified. According to an interview with a monk of Sawang Samkkhitham temple, it was built in 1940. Therefore, Khon Khwang village was established sometime before 1940.

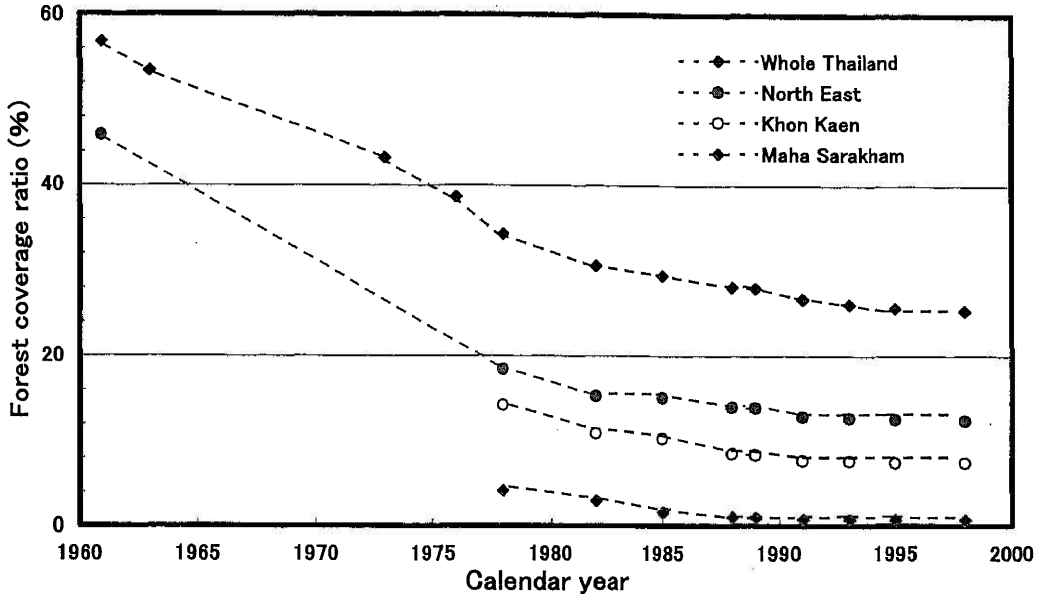

Fig. 8. Changes in forest coverage ratio of the whole Thailand, Northeast region, Khon Kaen and Maha Sarakham Provinces (source: Forestry Statistics, Royal Forestry Department)

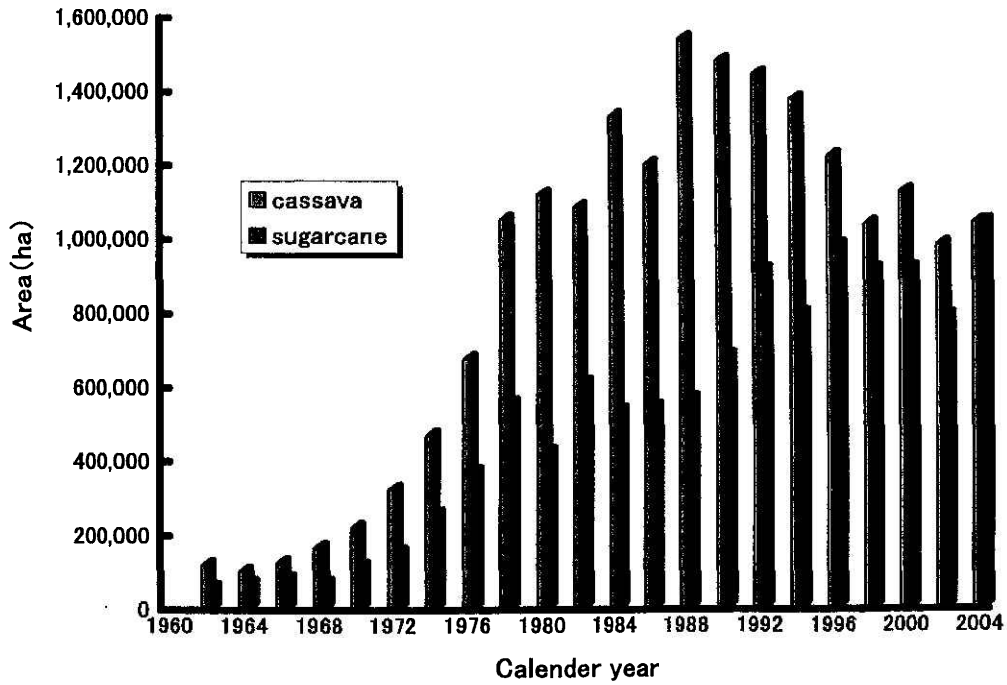

Fig. 9. Changes in the cultivation area of cassava and sugarcane in the whole Thailand (source: FAO Statistical Databases, http://faostat.fao.org/faostat/)

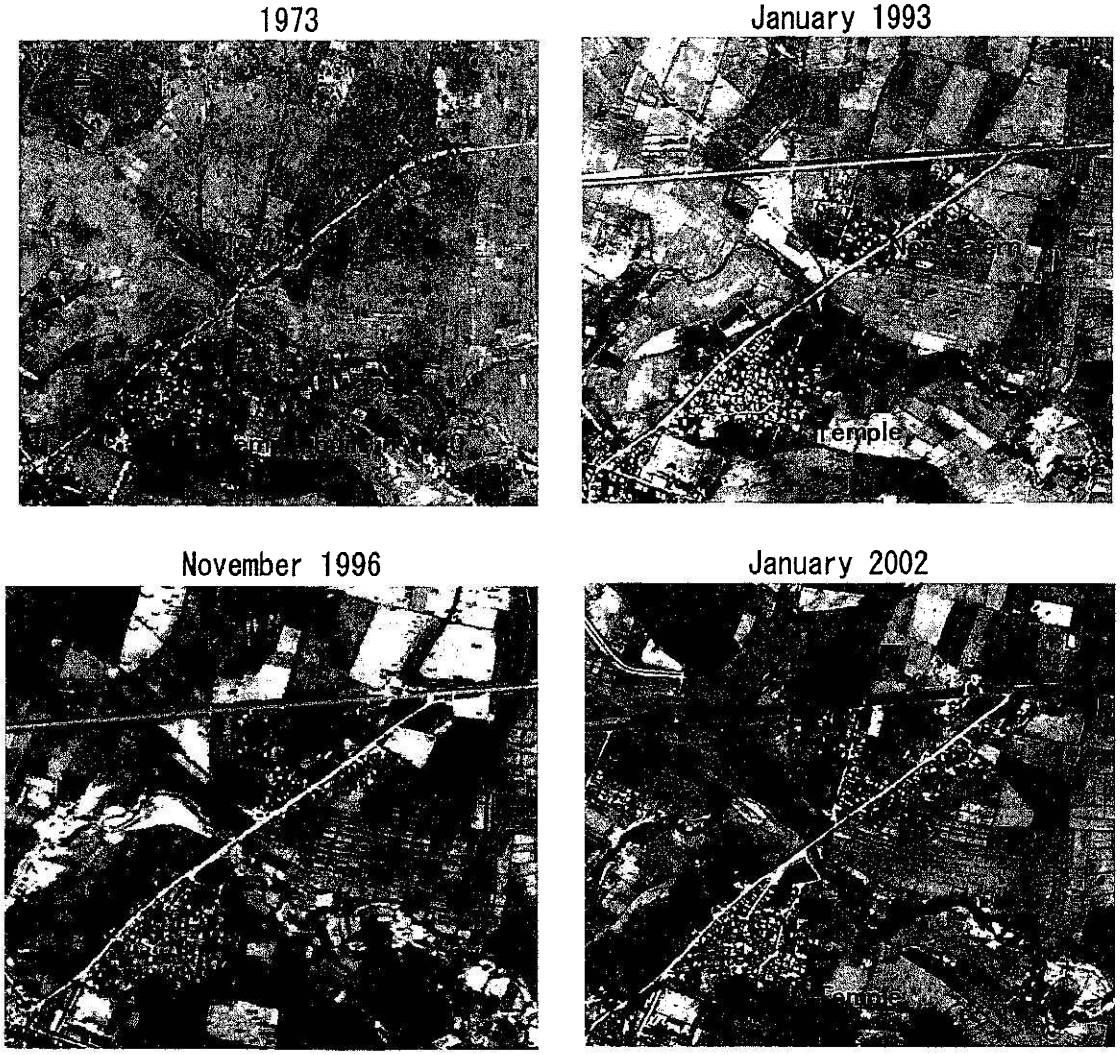

Fig. 10. Aerial photo showing the birth of a new village (Non Jalern) from a mother village (Khon Khwang)

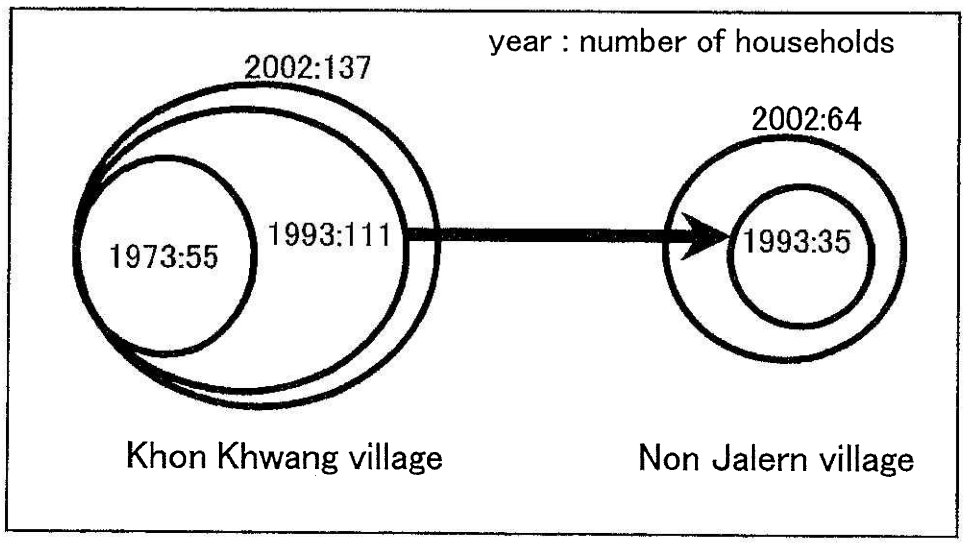

Fig. 11. Changes in the number of households in Khon Khwang and Non Jalern estimated using aerial photos

Average area of a plot of paddy field → 1973: 840m² 2004: 1,730m²

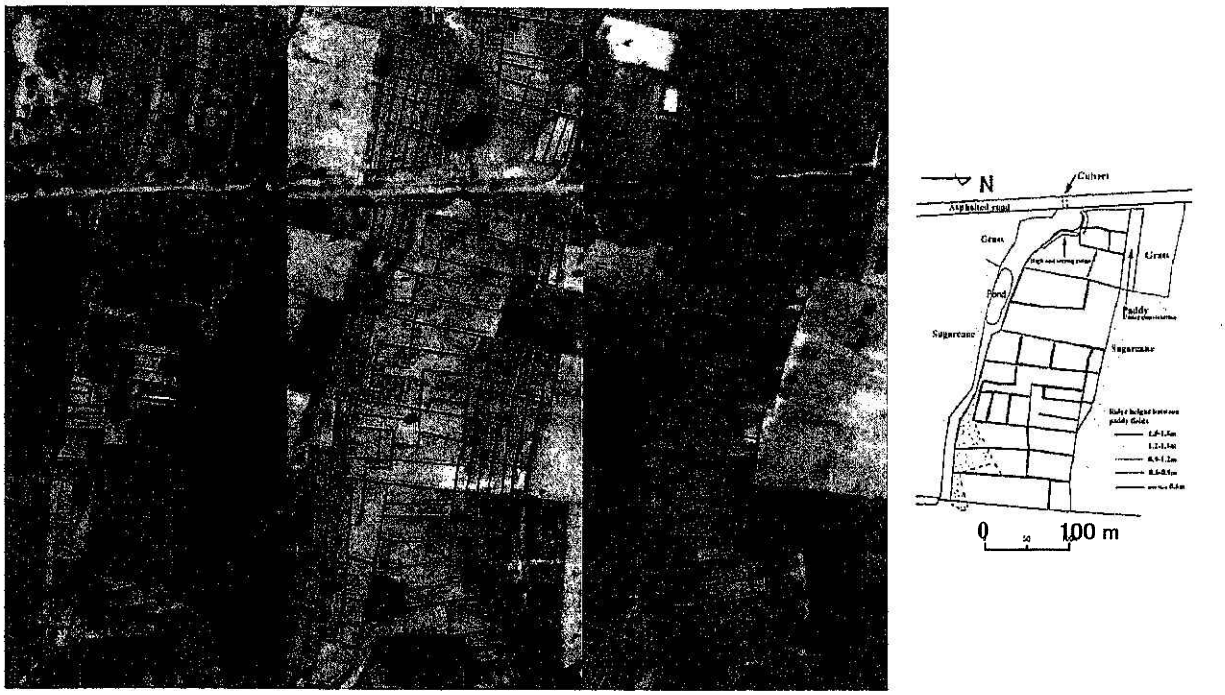

Fig. 12. Changes in the area and plot size of paddy fields in Non Jalern village

4.3 Relations between farming practices and rural community transformation in the study site

In the old days, when the upland was covered by forests and rain-fed paddy fields occupied the lowland (Fig. 5), rice farming was practiced almost anywhere rice could possibly be cultivated in order to maximize its production. Forests in the upland remained stable because paddy rice could not grow in the upland; the uplands were non-productive rice areas. Therefore, the population of the village in those days was controlled by the production of subsistence rice in the lowland. Thus, the population in the study site must have remained at almost the same level from around 1940 until 1973, and the site's upland forests remained stable until the early 1970s. However, the introduction of cash crops into the upland in the mid 1970s changed the forests into crop fields and effected the evolution of a new landscape where crop fields covered the upland, while rain-fed paddy fields still occupied the lowland. At the same time, the increased income obtained from the cash crops made the village people wealthy and resulted in the population increase in Khon Khwang village. The growth in Khon Khwang village led to the establishment of the new Non Jalern village in 1993. To support the population growth, paddy fields in the study site were expanded as shown in Figs.6 and 12. However, because of topographical constraints, there is a limit to the size of the population that can be fed by the production obtained from its own paddy fields. If the population exceeds the limitation, additional rice must be introduced from the outside. Judging from the aerial photos, the village people must have abandoned their dependence on their own fields to provide all their subsistence rice since 1996. Once such behavoir starts, cash crop cultivation is further stimulated and continues to invade wherever possible. This is why the paddy fields of the study site decreased considerably in 2002 and were distributed only at the valley floors (Figs. 7 and 12, Table 1). Recently upland rice cultivation introduced by pioneer farmers has begun to replace that of sugarcane and cassava in some parts of the upland. We are very interested in the movement of upland rice because it is closely related to farmers' behavior in selecting crops including rice, and in farming practices, socio-economic status, productivity of the cultivated land and so on. However, this is a topic for future studies.

Table 1 Area of paddy field, sugarcane and cassava of Non Jalern and Khon Khwang villages in 2002

Village	Padddy field	Sugarcane	Cassava
Non Jalern	425 (43.1%)	545 (55.3%)	16 (1.6%)
Khon Khwang	1,345 (48.9%)	1,278 (46.4%)	130 (4.7%)

unit: rai

4.4 Influences of farming practices on soil erosion

The replacement of forests with crop fields introduces a high potential for erosion of the uplands because crop fields modify site hydrology by decreasing the infiltration capacity provided by forestlands. Moreover, strong rainfall intensity in the region easily exceeds the infiltration capacity of crop fields. Consequently, the Horton type overland flow, which results from accumulated water that run downs the soil surface, coupled with soil texture (sandy soil, sandy loam soil) that is susceptible to erosion, causes soil erosion in the upland crop fields. This potential has become a reality in the study site and its neighboring area because of the drastic change from forests to crop fields that occurred in the upland in the 1970s. In the study site, cassava was first introduced as the main crop to the land converted from forests, but production has shifted to sugarcane since 1990. Cassava cultivation has a higher erosion potential than sugarcane because cassava is a lower cover for soil surface than sugarcane, so some of the soil erosion shown in Fig. 13 must have occurred when cassava was planted as the main crop in the upland. Even though sugarcane cultivation is less susceptible to erosion than cassava, it, too, sometimes caused soil erosion, because the field was laid bare just after harvesting at the end of a three-year (sometimes two-year) crop cycle and was not sufficiently covered when young plant of sugarcane was planted. For example, Fig. 14 shows that rainfall at the end of the rainy season in November 2004 caused soil erosion at the temporal bare field just after harvesting sugarcane. Also, rainfall at the end of the rainy season in 2001, just one cycle before, caused erosion at almost the same field after harvesting (Fig. 14).

Fig. 13 Severe soil erosion in the cassava field of Khon Kaen Province (taken in October 1999)

A flood in the late rainy season in 2003 caused soil erosion in the paddy fields of the study site, although paddy fields are not usually susceptible to soil erosion. The eroded soil was deposited in the downward paddy fields (Fig. 15). This unusual erosion was caused by concentrated water flow when the floodwaters ran down through culverts in the road that crossed the valley of rolling hilly land. Therefore, this erosion depends not only on the culvert construction based on current road standards, but also on the topographical characteristics of the rolling hilly land. The current level of road standards is closely related to the rural community's development because of the increased agricultural production controlled by the farmers' behavior. In conclusion, the soil erosion problem of paddy fields is caused not only by direct factors, such as road culverts but also by underlying factors, such as rural community development, agricultural production, and the farmers' behavior.

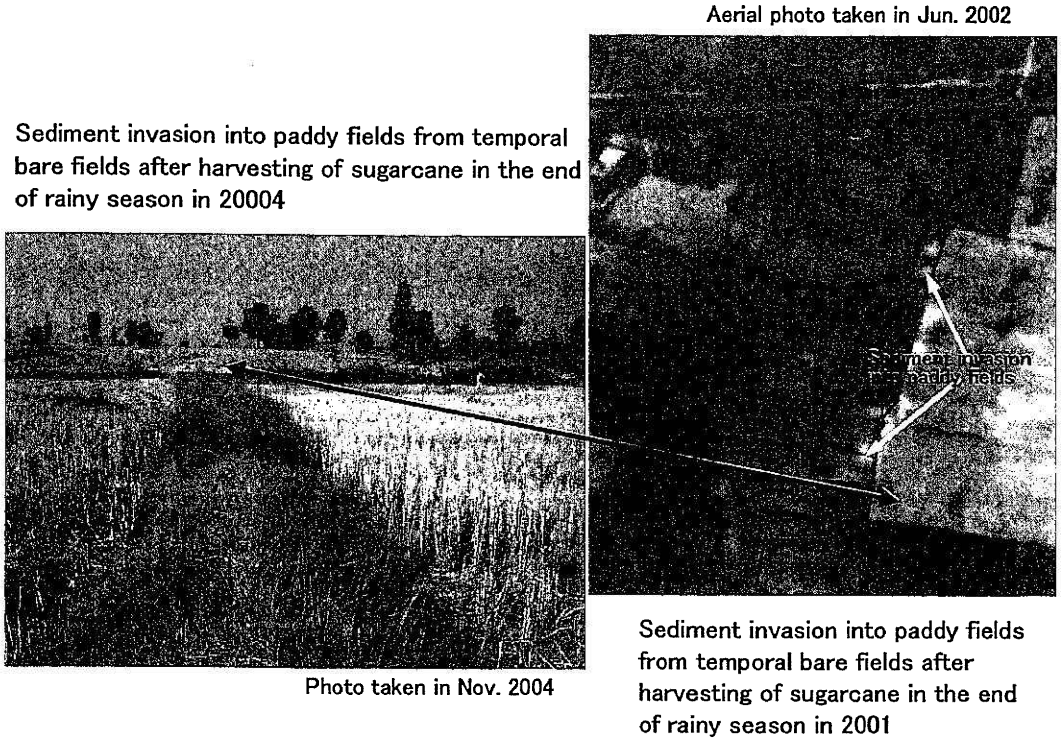

Fig.14. Soil erosion at the temporal bare field just after harvesting sugarcane and the invasion of eroded soil into paddy fields

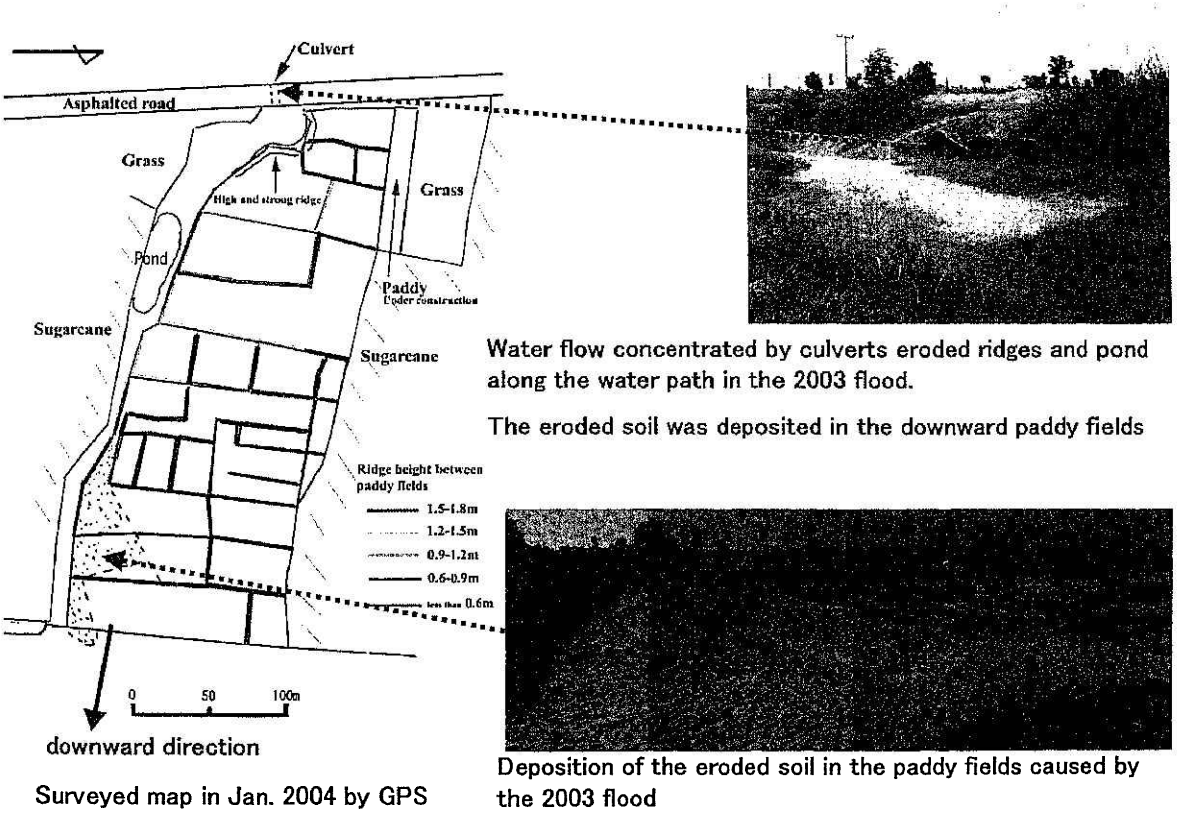

Fig. 15. Soil erosion of paddy fields caused by concentrated water flow due to culverts in the road and the deposit of eroded soil in downward paddy fields

5. CONCLUSIONS

At one time, the agricultural landscape of the study site consisted of a forest-covered upland and a lowland occupied by paddy fields. This continued more than at least 30 years until the early 1970s. During this period, the community of Khon Khan village was supported by the production of subsistence rice obtained from its own paddy fields within constraints of valley topography. It must have remained stable at the level of approximately 55 households until the early 1970s. A drastic change to the landscape started in the 1970's when the upland forests were completely cleared to introduce cash crops, such as cassava and sugarcane. Cassava was first introduced as a main crop to be grown on the land converted from forests, but production has shifted to sugarcane since 1990. The income obtained from cash crops has increased with the expansion in crop fields since the mid 1970s. The increased income resulted in a population growth in Khon Khwang village (111 households in 1993), which led to the establishment of the new Non Jalern village in 1993 (35 households). However, migration to the new community of Non Jalern must have already begun in the 1980s. Following the establishment of Non Jalern village, the number of households in Khon Khwang slightly increased to 137 in 2002, while households in Non Jalern rapidly increased to 64, almost twice as many as in 1993. To support the population growth, paddy fields in the study site were somewhat expanded in 1993. However, because of topographical constraints, there is a limit to the size of the population that can be fed by the production obtained from its own paddy fields. If the population exceeds the limitation, additional rice must be introduced from the outside. The village people chose to obtain additional rice from the outside and must have abandoned their dependence on their own fields to provide all their subsistence rice since 1996. As a result, the paddy fields in the study site considerably decreased in 2002 and were distributed only along main the valley floors. Recently, cultivation of upland rice has begun to replace that of sugarcane and cassava in some parts of the upland.

Two types of soil erosion were found in the study site. One is a typical erosion of crop fields in the upland. The other is a unique soil erosion of rain-fed paddy fields in the lowland. Soil erosion of crop fields converted from forests in order to sustain an increase in the rural population was caused by the modification of site hydrology by decreasing the infiltration capacity, coupled with a strong intensity of rainfall in the rainy season and sandy soil. Soil erosion of paddy fields in the study site resulted from culverts in the road that crossed the valley of rolling hilly land, although paddy fields do not usually cause soil erosion problems. This unusual erosion depends not only on culvert construction based on the current level of road standards, but also on the topographical characteristics of the rolling hilly land. The current level of road standards is closely related to the rural community's development because of the agricultural production controlled by farmers' behavior. In conclusion, the soil erosion problem of paddy fields is caused by underlying factors such as rural community development, agricultural production, and farmers' behavior as well as by direct factors such as road culverts.

ACKNOWLEDGEMENT

Appreciation is extended to the three-year KU-PhilRice-UT joint research project entitled "Inherent Features concerning Design Concept of Agricultural Machinery in Southeast Asia" which is granted by JSPS Grant-in-Aid for Scientific Research (No. 15255019).

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Workshop on Efficient Use of Machines and Related Technology Dissemination in Southeast Asia
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Innovation Consciousness of a Farmer
— Proposal of New Concept —

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Abstract

The mental situation lacking intention of the adoption of innovation is usually explained by using the word *resistance*. The purpose of resistance is refusing the acceptance and explaining the opposite intention. However, all parsons concerning the adoption of innovation don't think any time how to refuse. Certain portions of them think they have to adopt innovation, but it may accompany any troublesome procedure. The word *resistance* is logically corresponding to such mental situation?

The adopters of innovation were categorized for adoption time by E. M. Roggers; the first 16% as innovator and/or early adopter, the next 33% as early majority, the following 33% as late majority and last 16% as laggards. The word resistance is conceptually corresponding to the laggards and late majority (or it's almost portion). The early majority understands the necessity of adoption, but feel some differences. They should be marked by the different concept, not resistance!

The author proposes the new conceptual term, *mental impedance*. The word impedance is not excluding the intention to proceed. *Mental impedance* is conceptually corresponding to psychological situation in the early majority. And also, it well explains their emotion and intention.

The author defined its adaptability through the on-cite survey in a village of Northeast Thailand.

Keywords: adoption of new technology, social scientific case study, *mental impedance* proposed

1. INTRODUCTION -- What does the term *resistance* mean in the diffusion of innovation?

Almost all of the idea discussed in this presentation is technological innovation. Technology has usually two components of hardware and software aspects, and also two phases of element technology and system technology. An innovation is the definite idea for the introduction of new technology including the software change and also the replacement of basic system technology.

The diffusion of innovation usually does not go on in its technological rationalism. The stagnation and undesirable less development of introduction may irritate the management engaging the introduction of new technology system. They may think the labourer do not like to accept the new technology system or refuse it. Usually the introduction of new technology accompanies the certain replacement of basic system and requires the software change in the labour. Not a few labourers look the behaviour to be felt disinclined. The management explains it by the term, resistance, and researchers also. 'The biggest cost is the resistance of the labour for the introduction of a new technology system' is one sentence shown in "Technostress" (Brod, 1984)

The term *resistance* is always appropriate to be used for defining the consciousness of new technology adoption?

The purpose of resistance is refusing the acceptance and explaining the opposite intention. However, all parsons concerning the adoption of new technology don't think any time how to refuse. Certain portions of them think they have to adopt new technology, but it may accompany any troublesome procedure. The term *resistance* is logically corresponding to such mental situation?

2. EARLY ADOPTER AND LATE ADOPTER

E. M. Roggers presented interesting categorisation and characteristics on adopters of new technology as

shown in Fig.1 (Roggers, 1962). The number of adopters for each time span from the initial time was plotted on histogram. The distribution curve of the histogram shows the Gaussian (normal frequency) distribution. By using two statistics, mean *m* and standard deviation *sd*, the adoption distribution was divided into four categories; the category is at the left of (*m* – *sd*), 16%, the second is between (*m* – *sd*) and *m*, 33%, the third is between *m* and (*m* + *sd*), 33%, and the fourth is at the right of (*m* + *sd*). The first 16% is more divided into two; innovator as earlier 2.5% and early adopter as later 13.5%. The early 33% (following this 13.5%) is called as early majority, the later 33% is late majority and the last 16%, laggards.*

E. M. Roggers remarked the mental characteristics for those categories, but it seams a stereotype as recognized by him. The categories interested in this discussion are the early and late majorities, which are respectively remarked as deliberate and sceptical. The early adopters are deliberate (slow, careful, and unhurried) to decide the adoption. The late adopters are sceptical (having or showing caution, with uncertainly). The late adopters cannot usually decide the matter by their own thinking way. They don't adopt until most others in their social system have done so.

The term *resistance* is conceptually corresponding to the late majority and the laggards. It may be appropriate to explaining the situation of the late majority. However, we should be deliberate to use this term for the early majority.

* Roggers' model may be so simplified. From our observation and/or experience, category 4 will be smaller and category 5 will be less (or nearly zero) as shown in Fig.2. At least in East and Southeast Asia, the modified model may be supportable.

3. FARM MANAGED UNDER INDIVIUAL DECISION

The work on the adoption distribution by Roggers was derived though his surveys on the diffusion of 2,4-D weed spray carried out in Iowa, during the 1950s and 1960s. He focussed the research target on the mental situation of farmer, as the final decision for introducing new technology is done by the individual decision on the management of farm, beside his speciality was a rural socio-economist. The decision done by the individual reflects the personal condition of farmer's mentality and/or psychological characteristics.

The diffusion of 24-D was not only its introduction to agricultural sector as element technology but also the revolution-like change of farm management and also basic change of growing system technology. On the change concerning management system and system technology, did Roggers discuss not enough? The discussion on the diffusion of innovation is to be focussed on matters concerning to the change accompanied with basic replacement of system.

We have another same example of the diffusion of innovation; the diffusion of rice transplanting machine in Japan during the latter half of 1960s and the first half of 1970s.

4. MECHANISATION OF RICE TRANSPLANTING IN JAPAN

The mechanisation of rice transplanting was remained as the most important subject after the mechanisations of other major operations of rice cultivation. It was solved by the revolution of idea, not adopting a mechanism to a rice plant, but seedlings of rice plant to a machine. The seedlings are uniformly grown in a nursery box under the controlled climate, and each seedling is bounded by root-mat. The mat of seedlings of two or three leaves set on tray of a machine is continuously fed to transplanting mechanism, and every two or three seedlings are picked and transferred by a linkage onto the surface of paddy field.

The seedlings of 7 to 8 leaves employed to manual transplanting are not so suitable for stable handling and available for continuous feeding by its less uniformity of size and state.

The introduction of transplanting machine required the fundamental replacement of rice growing system technology; technique for growing seedling, paddling operation of paddy field for adjusting mechanical transplanting, fertilizing planning designed for young seedlings of two to three leaves, how to change fertilizing planning and water control before and after transplanting (Horio, 2005).

The adoptions by farmers showed various responses in their mentality and psychological behaviour. Some kinds of farmers' messages corrected though the author's investigation on the state of rice transplanting machines on farm carried out in 1978 are cited as follow.

> "I understood I had to introduce the machine because of the shortage of temporary labour for transplanting. I couldn't decide immediately its introduction, and looked after the results of expert farmers."

"I deliberately challenged the cultivation of rice transplanted by machine, and controlled water and others every day by my whole attention at the first year, and succeeded. But in next year, I was off the guard (released from the first year's stress), and missed."

"I didn't want to introduce the machine. But I was forced to introduce it by myself after more than half others in our village used the machine."

The adoption distribution was defined approximately same to that of 24-D. The major two categories were same in their portions and corresponded to their mental behaviour. Many farmers belonging to the late majority showed the reason of their introduction; more introduced near them. The farmers belonging to the early majority understood the necessity of the machine, and mastered the troublesome replacement of growing system under the supervision of expert farmer.

They should be marked by the different concept, not by the term *resistance*.

4. PROPOSAL OF NEW CONCEPT, *MENTAL IMPEDANCE*

Unfortunately we have no appropriate term for this concept. We are commonly using the impedance in engineering fields, e.g. as the equivalent resistance of alternative circuit or mechanical impedance as the mechanical resistance of dynamic system. Let us survey the varieties of adopters in their conscious characteristics. The word *resistance* is conceptually corresponding to the laggards and late majority (or it's almost portion). The early majority understands the necessity of adoption, but feel some differences. They should be marked by the different concept, not resistance!

The author proposed the new conceptual term, *mental impedance* (Horio, 1994). The Random House Dictionary shows 'We were impeded by muddy road.' as an example. The word impedance is not exclusing the intention to proceed. Mental impedance is conceptually corresponding to psychological situation in the early majority of adopters in the diffusion, dynamic process, of innovation. And also, it well explains their emotion and intention.

5. DEFINITION BY SURVEY IN A THAI VILLAGE

The cultivation diversion from cassava to sugarcane has been occurred in Northeast Thailand. Sugarcane requires sometimes weeding and the higher technique of fertilisation and growing control. The introduction of sugarcane cultivation means learning new system technology and also put farmers under a stress. The survey on the farmer's consciousness of sugarcane introduction was carried out in Northeast Thai village, Ban Nohn Ja Ruan in Mahasarakham Province. The survey program was designed though preliminary investigation in Aug. 2003, and carried out in Nov. 2004 by using the questionnaire as presented in Appendix. The village of survey-cite locates and at about 30 km distance from Kohn Kaen its southeast south . The villagers moved from mother village, neighbouring Ban Kon Kwan Village, in 1980, and established new village in 1992. It is consisted from 60 farmhouses, which are almost full time farmers, and some portion has income from out of farming. The estimated cultivated land was 1,800 *rai* (288 ha), which one third of land is rice paddy field and the other is upland field. The soil texture is sandy silt and heavy erosion was observed. The one forth has 2-wheeled tractor and the other of no own entrusts tillage and land preparation to contractor.

The cultivation diversion to sugarcane started at beginning of 1990s was triggered by the lower price of cassava. At this village it was started in 1991, and reached 30% 4 years later. The farmers of its 30% always want to introduce any new matter and visit the office of agricultural cooperative for obtaining up-date information. They are corresponding to the category of innovator or early adopter. The farmers of the next 50% in following 5 years had thought that they had to decide the diversion though watching the compliment of innovators. They are categorised to early majority. All of them mentioned that they had troubles for keeping the labour and its wages for transplanting, maintenance of field soil and weeding at the early stage of 2 to 3 years. Some of them, even at present, deplore the trouble of weeding or their situation of not foreseen expense of weeding chemicals and soil erosion. On contrary, the innovator and the early adopter boasted of conquest of weeding and soil erosion. Some one developed the 3 years cropping system of 2-years sugarcane and 1-year rice paddy for weed control and soil maintenance. Another was thinking to put sugarcane back rice paddy.

6. CONCLUDING REMARKS

The survey in the village was carried out halfway of diffusion process not to define the later half of late majority and laggards. However, the later half is out of discussion on the applicability of adaptor categorisation of innovativeness and proposed concept. The results show enough agreement with the categorisation, and the concept well matches their consciousness to adoption of diversion.

The further problem is how to apply the proposed concept on the extension program of innovation. One of application is the program designing to decrease the pain and trouble for adopting new system and also after care.

ACKNOWLEDGEMENT

Appreciation is extended to the three-year KU-PhilRice-UT joint research project entitled "Inherent Features concerning Design Concept of Agricultural Machinery in Southeast Asia" which is granted by JSPS Grant-in-Aid for Scientific Research (No. 15255019). And also, I like to extend my sincere thanks for the support and assistance of Prof. Tabachai Thivavarnvong and his students, Kohn Kaen University.

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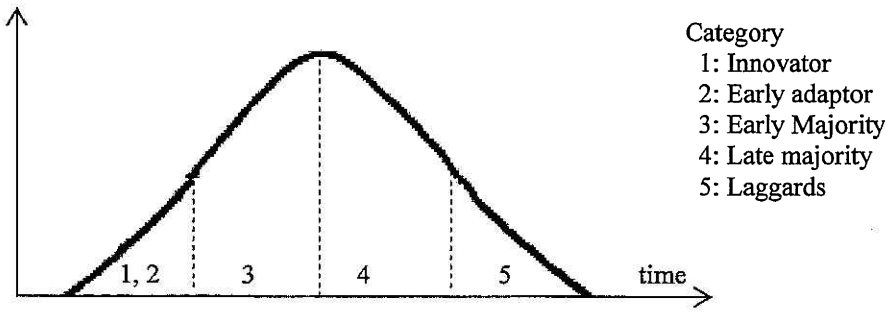

Fig.1 Histogram of new Technology Adopters for Adoption Time (Roggers, 1962)

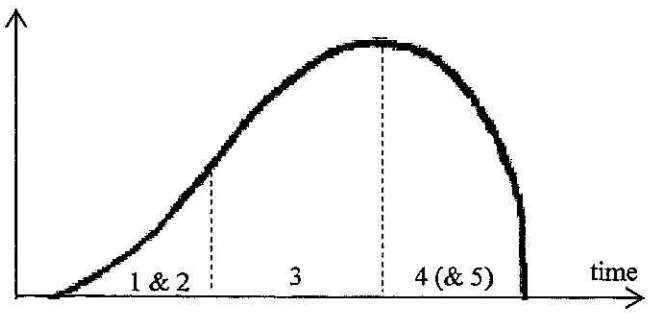

Fig.2 Modified Histogram of new Technology Adopters for Adoption Time

Appendix: QESTIONAIRE

No. ..... Date ..... , Dec. C/P .....

Location, general condition & others for remember

---

1. Cropping & other cultivation (kind & cultivated area (*rai*))
   Rice: .....
   Cassava: ..... Sugarcane: .....
   Others: .....
2. Soil and/or geographical condition .....
3. Farm tools & machines .....
4. Cattle & livestock .....
5. Acreage & period of immigration .....
6. Full or part time ...F / P.....

A. What was the most troublesome to introduce and become proficient?

1. Technology , cultivation or others / its period?

2. Early or late in this village?

.....

B. How to decide its introduction?

.....

C. What emotion or feeling at that time?

.....

D. How about the result?

.....

Workshop on Efficient Use of Machines and Related Technology Dissemination in Southeast Asia
Bangkok, Thailand, November 25, 2005

What are the Requirements of Design Concepts for Farm Machines Anticipated by the Traditional Rural Community?

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Abstract

We have investigated the rural village in Thailand and the Philippines for three years, 2003-2005. This investigation brought about the facts that the new problems related to the declining tendency of the village society in relation to a successor's shortage were occurring. These new problems in the 21st century will cause common difficulty which is likely advanced regardless of the success or failure of a governmental local development policy in the present world. Shortage of a successor and the delay of local development might arise specific issues in relation to popularity and development of a farm machine.

For continuous development, the middle class farmers must also be formed and strengthened in a community accompanying with minimization of a regional gap and income difference. A local development project must be launched in a future from such a viewpoint. The idea of the design criteria for an agricultural machine will offer an effective development plan only when being in collaboration with the rural society, economy, history, and culture.

Keywords: machine design, economic status of farm household, rural community, technical stagnation, Southeast Asia

1. THE ACTUAL FARMING CONDITIONS OF THE STUDY SITES

We investigated two typical villages at Northeast Thailand and central plain of Luzon island, Philippines (Figs. 1and 2). Management scale of a farmer of the Northeast Thailand is 1-4ha whereas Luzon island includes a tenant land covering of 0.3-2ha which occupies nearly 40% of cultivating land. The family management cultivated by two to five workers for every household is a case of majority in these two villages.

Most of rice are for private use, but there exist even the farmer in Northeast Thailand buying rice from neighbors. A main income source of Northeast Thailand is coming out of sugarcane, but Luzon island is out of vegetables and raising of cows. The Thai farmer switched from kenaf and cassava to sugarcane cultivation (Fig. 3). The sugarcane is processed in a factory of a town at the distance of 2-30km apart. In the Philippines, a corn cultivation that is for private use is popularly undertaken.

However, in both two communities, the expansion of economic gap for poor and wealthy-class among farmers and an increasing tendency of a debt which are seemingly direct causes of pursuing large-scale monoculture management were not recognized remarkably.

At the study site in Thailand, sugarcane cultivation is tended to reduce its producing volume last two years, and is switched to grow rice in a dry field for private use. A reason of this remarkable tendency is due to the necessity of reduction of the transportation costs to a sugarcane factory, and fertilizer charges and rice purchasing cost as well.

The villege of Luzon island takes approximately 4h drive on a highway from Manila. Therefore, in dry season, a broker comes to purchase vegetables from nearby town or Manila one or two times a week. A water buffalo for farming is kept only as little as 10 out of 185 households of villages (Fig. 4). This decreasing rate of farming animal is more rapid in Northeast Thailand these years.

Instead, the number of fattening cattle increases up to around 2 heads for each household .They fatten up the cattle buying by 25000 pesos in the market located at a nearby town by one-year- or a half-year-age and sell it with a gain of 20-100% increase. In these few years, fattening of beef cattle

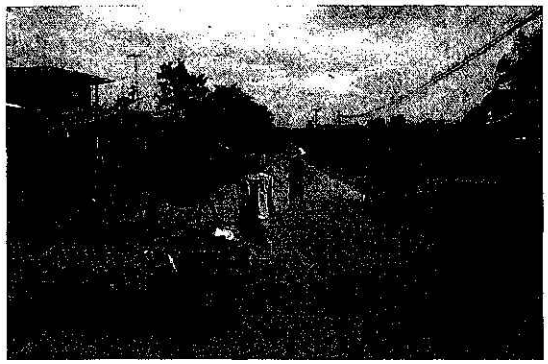

Fig.1 Scenery in the vicinity of central village, Northeast Thailand

Fig.2 Rice-growing field at Luzon, Philippines

Fig.3 Cassava-growing field in Northeast Thailand

Fig.4 Inter-cultivation by cattle at Luzon, Philippines

thrived in Northeast Thailand. At both villages, this was confirmed to be an important income source.

Electricity was introduced in two villages in 90's, and consecutively TV and propane gas for cooking began to use in each household. As for the irrigation water of a rice field, rain-fed system is often adopted in Northeast Thailand. However, it is common to pump up subsurface water in Luzon (Fig. 5). As for introduction of a machine power, hand tractors got popularity in each household in both villages. And they share a riding-tractor with the help of government grant (29kW) in Luzon. It has happened to recognize a farmhouse that hired 44kW tractor by own expense from a nearby village is operated on request basis.

They must pay a wage to workers for field cultivation, transplanting rice, and operation of a riding-tractor. A burden of the purchasing costs of a hand tractor can not neglect. But expenditure for custom-hire service for a hand tractor is not extremely expensive for a farmer. Other necessary expenditures include chemical fertilizer and fuel of hand tractor. And, of daily commodities, the clothing or fuel of a motorcycle or school expenses of children are also of necessity. The former is indispensable for production, and the latter is of course essential for life.

Cash is gained as a selling income of vegetables, sugarcane or a wage obtained from external job. Furthermore, they got this wage in business such as small-scale transportation service, tour management company, restaurant in a nearby town. In addition, more wages can be expected for some farmers to work at a rice milling factory in Northeast Thailand (Fig. 6). In any case, it is impossible to maintain the current standard of living or consumption life only depending to an agriculture income. Another issue whether farmers can find their successor at present or not - in fact, it does not reach at the level of 20% of them- is seemingly common to both villages. They faced particular rural problems, and the similar cases have been observed in Japan few decades ago in the process of industrialization.

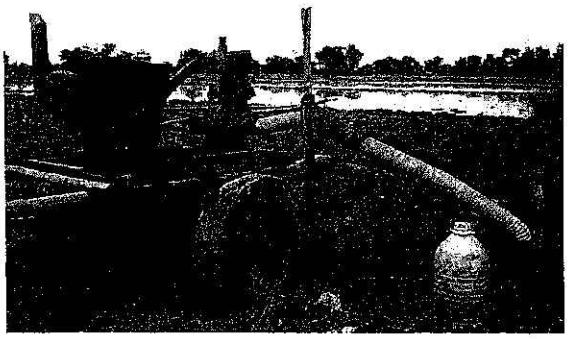

Fig.5 Pump irrigation using underground water in Luzon,Philippines

Fig.6 Cottage industry in Northeast Thailand

2. STABILITY FACTOR OF RURAL COMMUNITY

In 1965, Dr. Koichi Mizuno, agrarian sociologist, pointed out the fact of the following circulation law about a long-term change of family constitution of a farmhouse in the suburbs of Khon Kaen-city in Northeast Thailand (Mizuno, 1965). About a quarter household did not have farmland in the village. And he insisted that its understanding as the issue of poverty was not enough for the interpretation of actual condition.

To live with a parent of a wife is believed as a general custom for the Thai traditional marriage. This custom remains as the one that the youngest daughter supports the aged parent. It is not unusual for the third generation family to live in a house together. A daughter and her husband offers workforce to her parents even if they prepare an outbuilding in the same compound and shares the family budget in many aspects.

Mizuno called a household of the young couple who did not have fields as "A relative-community agriculture engaged household." They constitute a nuclear family after becoming independent by the land inheritance with the death of parents. However, he insists that birth of a nuclear family by such inheritance and independence is the starting point of a switchover to the third generation that lives together with family at the same time. Therefore, Mizuno pointed out the periodic circulation law inside the relative community is in effective for of inheritance of land.

Such a tradition seems to be still remain in the village. However, it is not very unusual throughout the world in the rural society having a similar family behavior and circulation law, as far as we ignores a difference whether new couple lives with a wife's parents or a husband's parents.

Furthermore, some evidences are demonstrated concerning a social condition to prescribe a standard of appropriate technology. For more understanding, an example of customary movement of worker keeping track of single boy will be described. This custom is not different from local traditional ones to which a newly married couple resides in a wife's parent's resident.

At first, some evidences about boy's move and the life-style as a worker were proposed for discussion. 13 interviewing data were successfully provided. Many of farmer's children go on to a high school today. However, when their father was young, at the age of 16-17 years old, they came out of the house and became a temporal laborer. And when they reached around 20 years old, they got married with the girls at a place of move in most cases. Inheritance of farm land and forest is done after parents passed away, and there is no discrimination in terms of brotherhood and ages under belief of equal inheritance.

However, it was affected by the situation of household economies depending on the number of members and status of families who should be responsible for parents, children, and some of a spouse's inherited goods etc. Moreover, each brothers and sisters' residential status, category of work, etc. are discussed. Sometime cash may be prepared instead of inheriting land. Therefore, real estate like a farm lands and forests are not always equally distributed into all children. Therefore, a youngest daughter inherits most of the estate which remains to live in a parents' home and looks after her old parents in many cases.

The range which an unmarried boy's moves was likely widespreading. Usually the provincial boundary was surpassed and they moved exceeding 100km.The boy usually moved as an agricultural laborer for 5 years or so. Although the period became short due to the intention to go to a high

school now, the life-style of youth for the move does not sound to be strange. The life-style of a newlywed youth who has moved and the daughter of a village are economically dependent on their parents' property. Parents are dependent on daughter and her husband expecting to some extent their income as a worker. There is also an example in which couple's properties are combined and an independent household is formed from the beginning of new life.

Since the equal principle of inheritance has been changed affected by some of husband and wife's bringing goods as mentioned above, the cultivation scale of a newlywed household has fallen within the range of ten to 30rai(1.6-4.8ha). This equal principle is flexibly changed when children finally inherit after parents passed away. This is a readjustment taking into account the actual condition of each household economy. Such reliability of an inheritance custom secures a farmland area to be determined to keep sound agricultural management in the Northeast Thailand

The custom of an unmarried boy's move bring about inflow while the labor force caused the outflow in the community. The village society of a Northeast Thailand is considered to have kept social stability by this custom, and the equal principle of inheritance with flexible change as well.

3. TECHNICAL STAGNATION FACTOR

As items of farmers' expenditures, the wages to the temporal laborers mentioned above are to be discussed. Next, payment for the operator of a riding tractor was confirmed to be worthwhile for further investigation. Although some of a hand tractors were privately owned, less economic emphasis was placed to this machine because of little loan for farmer.

And, in the study village, the large-scale monoculture management has not seen at all. In fact, the small-scale management of 10-30rai (1.6-4.8ha) was almost prevailed in this area. Commercial crops had changed to the sugarcane from kenaf or cassava due to availability of processing plant at nearby town (Fig. 7). The increasing amount of the debt by monoculture-oriented expansion management, and the gap between the rich and the poor were not observed clearly. Small-scale agriculture management was observed as a stable system for further continuation.

The farmers grown rice for private use. Sugarcane, vegetables and other processing crops were grown as commercial crops. Moreover, women were engaging a mulberry and sericulture business in and around house as a source of cash earnings. On the other hand, youth's job is not always as a temporal laborer. Even now, the small-scale farmhouse industry is keeping its place for continuing development.

An agricultural successor's downward tendency existed and recognized in all aspects. However, this tendency also produced a chance for scale expansion of the farmland which helped secure the successors. This downward tendency did not necessarily link with a decline or collapse of traditional village society which are constituted mostly by a small-scale management system.

A requirement in implementing reduction of expenditure and increase of income is discussed from the viewpoint of agricultural engineering.

First, two repair factories were operated in a study village. It was a family management employing one to three workers, and also technically remained at the level of adjustment and repair of a disk plow. Tools are also in a minimum including a welding machine, a boring machine and a lathe (Fig. 8). Since such repair and maintenance service are contracted by the factory of neighboring town, money and employment flow out of a village. It might lose employment opportunity of a community that is primary beneficial to a traditional community in keeping economic resources.

Therefore, the local policy of the skill training inclusive of the repair and maintenance technology addressed to dissemination and penetration to a village factory is to be implemented. And hence, related marketing policy is to be made for implementation.

About the animal farming, fields are scattered widely in about 3-5km apart each other. When hand tractors used extensively, the role of buffalos became less emphasized for use. Instead, some farmer has begun to breed the racehorse and beef cattle to gain the excellent level skill in Northeast Thailand, and this could be expected remarkable increase of income. Therefore, development of technical instruction and the local policy of breeding were also encouraged. In addition, Northeast Thailand has traditionally special technology about the breeding skill and meat processing culture of cow. And hence, related marketing policy is to be developed toward implementation.

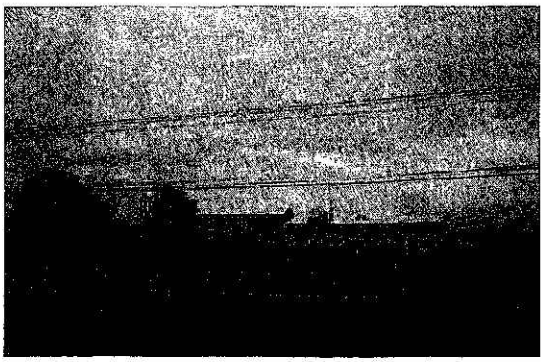

Fig.7 Sugar processing facility in Northeast Thailand

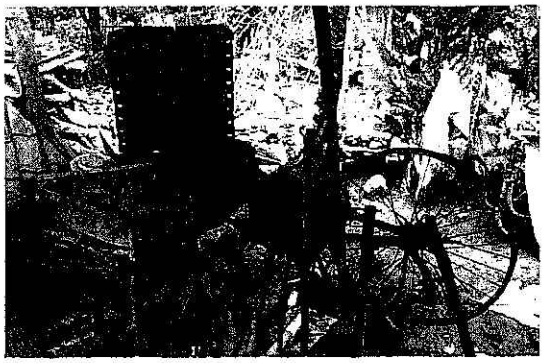

Fig.8 Manufacturing site of small farm tools in the Luzon Philippines

Fig.9 Harvesting work by hired workers in Northeast Thailand

Two recommendations in relation to technology advancement can be described as below.

1) The current status of popularity of a small farm machine including hand tractor etc. and the technical supporting system of the repair and parts supply etc. is in balance. If this balance obstructs the leap of mechanization to the next stage, technical stagnation is likely took place. Similarly, the number of landless labor forces composed of youths were found to increase year by year, that driving factors be provided to young people. If those balances lack the employment opportunity and the skill training in scheme, it might cause another socio-economic stagnation factors.
2) The joint use systems of agricultural machines, such as a farm truck, storage pump, riding tractor, and thresher, have unfortunately been developed inadequately. Moreover, the infrastructure improvement with respect to the technology of agricultural production is also lagging. Therefore, farmers have to temporarily employ an agrarian laborer and the operator of a riding tractor etc. Those who are employed are also the small scale farmers of the same community or inhabitants of a neighboring area in many cases (Fig. 9). It is possible that the stability of community is strengthened by circulation of such extraordinary wages in a sense. However, this circulation does not minimize the shortage tendency of the successor of a farmer. What is more, the middle and upper class farmers may be deprived of the opportunity to purchase an agricultural machine. And what is worse, the factor of technical and socio-economic stagnation which was already pointed out may be accelerated in some cases.

4. IMPLICATIONS ON A MACHINE DESIGN ASPECT

Such socio-economic stagnation factor requires the technical approach and the technical policy for improvement and then able to contribute to the reinforcement of mechanization technology or a design concept.

4.1 Technical approach:

1) Transport work requires a certain level of horsepower to haul in agricultural work. In this case, the

hand tractor can be used for most transport processes. And the locations of fields for each farmers are sporadically scattered. Therefore, it is difficult to increase the quantity and the speed of transport, and improve efficiency. It is also difficult to reduce costs in the process of those improvements. The ridge of fields is normally prepared for a water-holding, not for the passage of a hand tractor (Fig. 10). Therefore, maneuverability of a hand tractor is required to overcome this ridge when moving to neighboring field. So, the hand tractor of the Northeast Thailand must equip a wheel as big as about 80cm diameter.

2) The hand tractor in the Northeast Thailand has a large diameter wheel to secure the motility in the devastated fields, and the smooth running on a public road (Fig. 11). This suggests that the potential demand of the small lightweight riding tractor which is easy to fix is high. And, it is required to pay special care in achieving weight reduction in the Philippines particularly when used frequently at the inclined ground (Fig. 12).

4.2 Technical policy:

1) To reinforce reliability of machine parts, the supply system must fully meet to the demand of end-users (Fig. 13). For that purpose, the personnel training programs are required at the distributing stage to enhance the capability of repair and maintenance. And also technical simplification and unification of parts and machine are matters to be discussed. Also improvement of processing accuracy and reliability will produce strong, lightweight and durable machines. This issue could be attained by collaboration in the regional scale of Southeast Asia which is capable to accumulate technical skills like automobile industry (Fig. 14).

2) It is required to solve two issues such as a technical simplification, unification, and qualitative improvement of parts. These two issues are inseparable from a subject in developing small rural industry. Their solution will rationalize agricultural production which suspends an agricultural successor's shortage. And the superfluous problem on the youth labor force in a rural area will also be solved. Thus, the new economical relationship of the local combination between agricultural production and rural industry should be assessed (Fig. 15). The technical and socio-economical stagnation factors are hopefully faded away in due course.

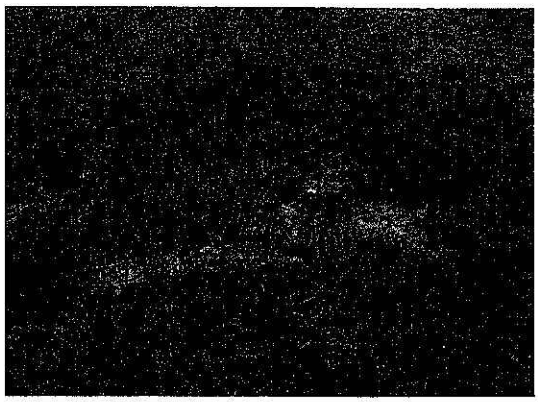

Fig.10 Field ridge which permits downflow of water

Fig.11 Hand tractor in use in Northeast Thailand

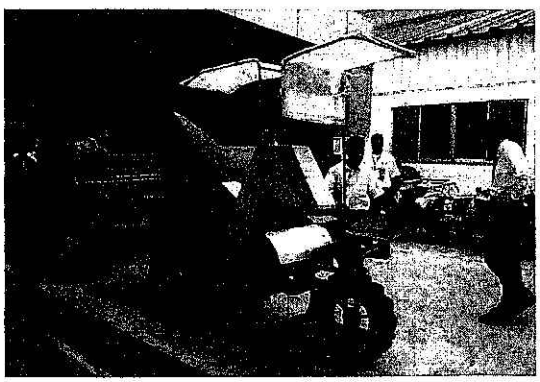

Fig.12 R&D of farm machines at the PhilRice

Fig.13 Manufacturing workshop in The nearby city, Luzon Philippins

Fig.14 Skill training class at the vocational school in Bangkok

Fig.15 Local plow manufacturer in the Philippines

CONCLUSIONS

Progress of the commerce and industry of the Northeast Thailand which has smoothly made for the past 20 years is to be evaluated as a result of a National District Development Project. However, another aspect of rural development that engaging in agricultural practices includes successors' shortage in number, and the society itself begins to decline. These somewhat new phenomena are also able to observe in the Philippines. Continuous development of both countries is dependent on the robustness of an agricultural sector. This is surely demonstrated a reliable backbone endorsed by specific potential power in terms of political and economic supporting systems. An agricultural sector is often referred to as the core of development policy, but this is sometimes becomes weak point of the scheme. But, concurrently, greater emphasis can be placed to agricultural sector in contributing acquisition of the foreign currency by export of agricultural commodities to serve as a source of funds of development.

And so, as the development which never aggravates rural society is required, establishment of the stable family-management system becomes a pressing issue. A farmer's main expenditure is directed to the consumption goods. Therefore, a farmer's expenditure should preferably be compensated by the wage income getting from local industry. And hence, an agricultural income can be stabilized and increased simultaneously.

Therefore, what can be more concretely proposed towards rural development for two countries?

First, there are two or three repair shops in the study village. The number of workers of the small workshop operated by family members is hiring at almost three persons, and people is capable to repair and place maintenance for major parts of implements including disk plow. Accordingly, the importance to stabilize the mobility of workforce is perhaps explained in conjunction with cash flow logically rural community.

It can also be suggested that institutional support for the efforts paid by local workforces is of essence to have smooth way for successful implementation of skill development programs due to possible spontaneous motivations of workers involved.

The viewpoint of the design concept of an agricultural machine will offer an effective development plan when connected with the viewpoint of rural society, economy, history, and culture.

ACKNOWLEDGEMENT

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Issues and Challenges in Mechanizing Philippine Agriculture

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Abstract

Agricultural mechanization in the Philippines lags behind other agricultural production technologies as there is no coherent plan in current implementation. The machinery industry is characterized by importation of large machines and prime movers, and local assembly and fabrication of simple tools. Research and development activities are heavily focused on downstream and midstream research like design, development and improvement of tools, implements and machines for production and post-production of various crops like rice and corn. Research gaps exist in other potential commodities such as coconut and fruit crops, and, in many critical fields such as precision agriculture, material science, waste utilization and energy resources.

Keywords: agricultural mechanization, Philippines, agricultural engineering, farm machinery

1. INTRODUCTION

As the Philippines seeks ways to modernize its agriculture to be able to supply the required food, feed and fiber of its growing economy, its mechanization arm still lags behind other agricultural technology inputs. While it has imported large agricultural machines in the past, it has now attained some level of expertise and skill in the local manufacture of some small, simple but appropriate tools and equipment. Still, aggressive efforts in research and development are necessary to keep pace with the demands of modernization and to satisfy the need to intensify and diversify the agricultural production systems of the growing population. Various support systems must also be established to enhance mechanization which can help increase agricultural productivity while preventing any untoward economic dislocations.

2. AGRICULTURAL MECHANIZATION IN THE PHILIPPINES

2.1 Brief history

The mechanization of Philippine agriculture started during the late era of the Spanish colonization in the 1890s when agricultural machines from Spain and later from the United States were introduced into the country. The imported machines found application in large estates such as the sugar plantations while the traditional animal draft technology persisted in the small landholdings. The very limited sizes of most farms precluded the adoption of the imported and capital-intensive machines.

Efforts to foster mechanization were exerted by the government in the later half of the 1940s but they were still heavily biased to large scale farming. Machines for stationary operations included rice threshers, rice mills, sugar cane mills and water pumps. For motive operations, large four-wheel tractors were employed for land preparation in sugar plantations and in opening up additional areas for cultivation.

The drive to mechanize Philippine agriculture received a big boost with the introduction of the Central Bank-International Bank for Reconstruction and Development

(CB-IBRD) loan program in 1966-1980. While the initial phase of the program was heavily geared towards the promotion of four-wheel tractors for sugar, rice, and corn, the demand for small power tillers also grew as these smaller and low-cost machines were more preferred by rice farmers. The decade of the 70s saw the growth of the local agricultural machinery manufacturing industry along with the other developments that resulted from the Green Revolution. Local designs especially those developed by the International Rice Research Institute or IRRI were produced at the machine shops of village craftsmen around the country.

As the Philippines had earlier followed the American and European models of mechanization using large machines in the farms, a shift to the Japanese example is much apparent during the decade. The small area of landholdings and the characteristic culture of puddled soil for rice in Japan are much similar to the conditions in the Philippines. Also, with the world suffering the oil crisis, the search for the 'appropriate', 'alternative', 'selective', and 'intermediate' mechanization technology became the rallying call of planners and activists especially in the developing world. These imported large machines were referred to as 'modern day Trojan horses' sent by developed countries in disguise as aids to developing countries while 'small' machines which can be locally manufactured were found to be 'beautiful' to the economic setting of a third world country (Schumacher, 1973).

The 1970s were considered the golden age of farm mechanization in the Philippines as it was in this period that there was a coherent program to increase grain production which included massive financing of the acquisition of farm machineries and postharvest equipment (Sanvictores, 1998). During the decade, PCARRD or the Philippine Council for Agriculture, Forestry and Natural Resources Research and Development, a government body that monitors agricultural and forestry research has included agricultural engineering as a commodity of investigation. In the national legislature, a bill has been proposed to create a body to coordinate agricultural mechanization activities (Lantin, 1978).

During the turbulent decades of the 80s and 90s, the mechanization of the country slowed down due to political, social and financial constraints (Sanvictores, 1998). No substantive increase in the level of mechanization occurred in the 80s but several agencies and programs were established or launched to promote it. These include the (a) Agricultural Mechanization Development Program based at the University of the Philippines Los Banos which is the country's commitment to the RNAM or Regional Network of Agricultural Machinery (now APCAEM or Asia and Pacific Centre for Agricultural Engineering and Machinery), (2) the AMIC or Agricultural Inter-Agency Committee, a multi-agency body which serves as the technical adviser of the Department of Agriculture regarding mechanization policies and strategies, (3) the NAPHIRE or National Postharvest Institute for Research and Extension (now BPRE or Bureau of Postharvest Research and Extension), (4) the AMTEC or Agricultural Machinery Testing and Evaluation Center which was envisioned to provide testing, evaluation and quality control services of agricultural machines (AMDP, 1990), and (5) the PhilRice or Philippine Rice Research Institute which virtually took charge of the work of IRRI in the design and development of machines for rice.

Mechanical power, hp/ha	0.023 (12%)	0.186 (36%)
Total available power, hp/ha	0.198 (100%)	0.52 (100%)

Table 1. Philippine agricultural mechanization statistics (PCARRD, 2002).

Item	1968	1990
Arable land (million ha)	7.934	13.4
Agricultural workers/ha	0.71	2.62
Human power, hp/ha	0.071 (36%)	0.262 (50%)
Animal power, hp/ha	0.104 (52%)	0.072 (14%)

Another mechanization plan was initiated in the national legislature as early as 1990 but it reached only the proposal stage. As mechanization proceeded without a coherent national plan, it never reached the small farm holders that constitute the vast majority of

farmers. A later study revealed that the impact of mechanization has minimally permeated the grassroots level (Rodulfo et al., 1998).

Table 1 shows that during the period from 1968 to 1990, the increase in mechanization level is mostly due to increase in number of farm workers which has more than tripled per unit area of arable land. The table also shows that there was an increase of mechanical power and decrease of animal power per area of arable land. In real numbers, however, there was an increase of the total animal population from about 0.83 M to about a 0.96 M heads during the period.

2.2 Current status of mechanization

The current overall level of agricultural mechanization in the Philippines is low as human and animal power sources still dominate most operations. While rice and corn are relatively more mechanized than other crops, only land preparation, threshing, shelling and milling are highly mechanized and other operations like planting, crop care, harvesting and drying are low (Bautista, 2003; Rodulfo et al., 1998; Franco et al., 2003a). Overall mechanization level of vegetable farming and small scale livestock and poultry raising is low (De Asis et al., 2003; Franco et al., 2003b). The fishery sector is in the intermediate level of mechanization mainly due to the use of engine-powered boats for accessing fishing sites and transport of harvests to coastal markets (Franco et al., 2002). The level of mechanization of other crops is insignificant except in sugarcane along with two fruit crops, banana and pineapple, where imported equipment and machines are widely used (AMDP, 1990; PCARRD, 2002).

The low level of mechanization in the country partly reflects various socio-economic and technical constraints. Among these are low farmer's incomes, high machinery and energy cost, low level of support for research and development, lack of local manufacturing capability for prime movers and inadequate institution and infrastructural support services and facilities (AMDP, 1990).

2.3 The agricultural machinery industry

The agricultural machinery industry in the Philippines is characterized by the importation of heavy machines and prime movers and local assembly and fabrication of small equipment. With these prime movers and important component parts, locally manufactured machines have high import content sometimes constituting more than half of the total machinery cost.

Since the 1970s, the Agricultural Machinery Manufacturers and Distributors Association, Inc. (AMMDA) has emerged as a highly credible spokesman of the industry (Sanvictores, 1998). There are now about 400 registered manufacturers and dealers of agricultural machinery of various sizes, services and after sales capabilities in the country. In a survey made by the AMTEC as cited by PCARRD(2002), more than half of these agricultural machinery enterprises are found in the island of Luzon, about a third in Mindanao and the rest in the Visayas islands.

2.4 Relevant programs and policies

Early government efforts that support mechanization include the preferential custom duties to farm machinery in the 1940s and the CB-IBRD load program in 1966-1980. Currently, the most significant is the passing of the law known as Agriculture and Fisheries Modernization Act (AFMA) of 1997 to modernize the agriculture and fishery sector. Under the leadership of the Department of Agriculture, it provides for the coordination of an integrated national mechanization plan. Since start, however, its implementation is hampered by financial constraints.

Other programs that directly or indirectly affect mechanization are the following: a) AMTEC which has conducted tests of agricultural machines since its creation has also initiated the development of agricultural engineering standards. b) The Agricultural Engineering Act which promotes and upgrades the practice of the agricultural engineering profession in the country was enacted in 1998. c) The country joined the World Trade Organization and committed itself to globalization and trade liberalization. Along with this, the country enacted in 1998 a new intellectual property law which is in conformity with international standards. d) BPRE, through a loan from China, spearheaded a postharvest facilities dispersal program.

3. RESEARCH AND DEVELOPMENT EFFORTS

3.1 Status of research and development efforts

Various institutions are conducting research and development work on agricultural machinery engineering. Among the government agencies include the Department of Agriculture through its bureaus and attached agencies such as the Bureau of Agricultural Research (BAR), the Bureau of Plant Industry (BPI), the Bureau of Postharvest Research and Extension (BPRE) and Philippine Rice Research Institute (PhilRice). The state colleges and universities include the University of the Philippines Los Baños through the Agricultural Mechanization Development Program and the Agricultural Machinery Testing and Evaluation Center (both based at the College of Engineering and Agro-Industrial Technology), the Central Luzon State University, the Leyte State University and many others located around the country. The non-government sector includes the International Rice Research Institute (IRRI), the various private agricultural machinery manufacturers and distributors and some local craftsmen. The Philippine Council for Agriculture, Forestry and Natural Resources Research and Development (PCARRD) of the Department of Science and Technology (DOST) among its many activities and functions such as monitoring and evaluating research in agricultural engineering, currently spearheads the development of an integrated agricultural machinery information system.

Significant products of local research and development efforts in agricultural machinery engineering include the power tillers and hydrotillers, irrigation pumps, rice transplanters, drum seeders, weeders, rice reapers, rice strippers, corn and peanut shellers, village rice mills, grain moisture meters, coconut husk decorticators and grain and copra dryers.

Table 2. Major completed research and development projects, 1990-2004 (PCARRD, 2002; PCARRD, 2005a).

Areas of concern	No. of projects
Agricultural machinery and power	32 (13%)
Agricultural buildings and structures	3 (1%)
Postharvest/agricultural processing and food engineering	124 (51%)
Irrigation and agricultural drainage system	30 (12%)
Agricultural waste utilization and environmental management	5 (2%)
Agricultural instrumentation and control	4 (2%)
Technical standards for agricultural machinery, materials and procedures	5 (2%)
Agricultural electrification and energy	19 (8%)
Benchmark survey and information system for agricultural engineering	4 (2%)
Impact assessment and policy studies in support of agricultural engineering	17 (7%)

The output of research and development efforts during the fifteen-year period from 1990 to 2004 is shown in Table 2. A great percentage constitutes the design and development of machinery and postproduction processing (64%, 156 research projects). A detailed breakdown of the two would reveal that 21% (52 research projects) is on rice and 11% (26 research projects), on fruits. This bias on rice shows its importance to the Filipino diet while that for fruits is attributable to the consideration of the product as an export commodity. The focus on irrigation (12%) is a rightful recognition of this important production input that can help intensify and sustain cropping systems. The research on electrification and energy (8%) addresses the need of alternative power and energy source as fossil fuel costs continue to escalate. Noticeably, the outputs on agricultural structures, instrumentation and control and waste utilization and environment are ranked among the lowest in numbers.

Total	243(100%)

3.1 Challenges in research and development

Inadequate research and development work is one of the many interrelated factors and reasons for the poor quality of local products and slow growth of the agricultural machinery manufacturing industry and the slow pace of agricultural mechanization. PCARRD (2002) has identified the various major research and development gaps in agricultural engineering and mechanization. The following are included in the various technologies that need attention:

1.Structures and controlled-environment agriculture. Protected agriculture is a highly potential technology for raising ornamentals and other high value crops. Research and development efforts in this field is very limited in the country. While there are a few success stories of commercial operation, they mostly use imported units that include all the structural components and auxiliary systems. Hydroponics, soilless agriculture and other similar techniques of crop production will find their niches both as large scale commercial enterprises that require a separate land area or as small scale operations in urban and sub-urban communities.

2. Machinery requirements for specific commodities such as:

a) Rice. As a staple crop, adequate supply is always every season's target as the government aims for self-sufficiency (NEDA, 2005). Intensification of production can only be possible if the complete array of machines to fully mechanize its production is made available. Missing links in its complete mechanization are machines for planting or transplanting, crop care, harvesting and drying. The engineering arm of PhilRice is actively pursuing both research and development work and training and extension of rice mechanization technology.

The manual pull-type transplanter developed as early as the 1980s never found much success among farmers while the engine-powered design is yet far from being acceptable in performance. On the other hand, the current improvement on the construction and material components of the drum seeder has considerably reduced its total weight and drastically lessened the burden of operation.

The favorable performance of the new combine harvester of PhilRice shows some promise while the rice stripper has yet to be improved to decrease grain loss to within tolerable limits.

Many designs of mechanical driers are already available and they were reported to produce higher milling recovery (AMMDA, 2005). However, affordability of the technology is still the issue when the farmer has to choose between free solar energy and costly machine.

b. Corn, vegetables and other upland crops. Mechanization of corn is being given emphasis in the current agricultural development program of the government (PNA, 2005). A BPRE's study recommends the use of currently available machines to increase yield and improve productivity. It further recommends the development of more appropriate and efficient machine models, one example of which is the smaller version of the combine harvester.

As earlier reported by De Asis et al. (2003), vegetable farming is at a very low level of mechanization and only irrigation, washing/sorting/packing operations and .

transport are somewhat mechanized in certain limited areas of the country. There are many available machines for upland farming which can do well to perform the farm operations for vegetables especially land preparation. The main reason for the low adoption of mechanization technology is still affordability. The study recommended various support systems through government efforts.

One high impact area for research and development includes machines for village-level processing of farm products and by-products. Such technologies can generate employment and livelihood, increase land productivity as well as diversify and increase the value added to farm products. This is line with the government policy of poverty alleviation and pro poor agenda. Standards for equipment and processed products have to be formulated and enforced (AMDP, 2005).

c. Coconut. Some commercial machines for coconut product processing are reportedly working inefficiently like decorticators and oil mills. The possible increase in demand for coconut coir products (e.g. 'coconet' for control of soil erosion) may require the improvement of design or rehabilitation of old machines. As there is currently no small scale technology for coconut processing (PCARRD, 2005b), other machines may have to be developed. The 'virgin oil' phenomenon opens up new challenges to machine designers and developers. Also, another very important research area is the use of coconut oil as diesel engine fuel (NEDA, 2005).

d. Fruit crops. Low level of mechanization exists particularly in the production stage of fruits. There are imported and locally manufactured processing equipment though they are generally found in large scale plants. Similar to the vegetable sector, research and development on new products and processes for small scale and/or village level processing can help in increasing level of current technical knowledge in canning, bottling, preservation, repacking and many other operations.

e. Livestock, poultry and aquaculture. These commodities have been identified as 'sunshine industries' which will help in the country's poverty alleviation program. High level of technology is already in use in large scale farms. Backyard farmers need technologies that fit their scale of operation.

3. Instrumentation and control

The fields of electronics and micro-computer technology provide a broad range of applications in agricultural machinery engineering. The application of mechatronic devices and/or GPS-guided machine assemblies for remote-controlled operations can evolve to be practical and economical in some respects. Also, the need for precision and accuracy in many farm operations from land preparation and planting stages up to product sorting and classification now warrants the research and development work in machine components interfaced with electronics and computer technology such as machine vision, artificial intelligence and automatic controls.

4. Energy resources, generation and utilization

The country imports a large amount of its fuel requirement. Although the energy share of the agriculture and fishery sector is very small, ramifications of any oil price increase can definitely affect the use of mechanical technologies for agricultural production. For research and development work, it is still much preferable to improve design of machines rather than focus on low input farming technologies that cut down energy consumption at the expense of crop production. The design and development of energy efficient machines is always an ideal approach to conserve energy input for agricultural operations (AMDP, 1990).

Also, alternative sources of energy must be given importance such as development of windmills, solar power utilization system, gasifier technology and other biomass energy resource utilization schemes like coconut oil for diesel engines and ethanol for gasoline engines.

5. Agricultural waste utilization and environmental management

Biogas production from biomass wastes is already an old technology as the country had seen success stories in the past. Currently however, its adoption is poor and its popularity is seemingly waning. As pollution problems come along with intensification of agricultural production especially in the sectors of livestock and poultry, training and

extension as well as research on new utilization and management systems must be pursued to renew or sustain interest in the adoption of environment-friendly practices and processes.

6. Materials science and manufacturing processes

The capability of the local mechanization industry to produce quality products has to be enhanced. This implies emphasis on research and development on materials and manufacturing processes and setting of standards for agricultural machinery (AMDP, 2005). As an example, optimization of shapes and parts by computer aided design and computer aided manufacturing (CAD/CAM) can greatly help in reducing size and weight of machines. Also, the development of standards initiated by AMTEC has to be pursued on a continuous basis.

Many other issues directly relate to agricultural machinery engineering in the Philippines. These include the following:

1. Information generation and dissemination

One important concern is the weak generation and dissemination of information on agricultural engineering technologies. Survey work conducted on the mechanization needs had only established limited data on the mechanization status of a few commodities and community areas. And even as a general assessment that the country's mechanization is low prevails, the current available information is not adequate to project a national or even regional conditions. Many data gathered several years or decades back are not yet updated. For example, the common yardstick of mechanization status, hp/ha, is virtually unknown and can never be established with currently available data. Government offices in various local government units are poor if not unreliable sources of information.

With regards to information dissemination, PCARRD had initiated the establishment of an internet-based information network on agricultural machinery. It is expected to provide the necessary linkages among agencies regarding information on agricultural machinery technologies and other related matters.

2. Local manufacture of prime movers and other machines and components

Local manufacturing capability is limited to small agricultural machines and simple tools. The prime movers like engines and motors which constitute major portion of machine cost, are all imported. Local manufacture of these components can help save the country's dollar reserves and the industry can also provide additional employment opportunities. The news about the establishment of a manufacturing plant of a popular engine brand can be an indication of this growth of capability of local manufacturing industry.

Research and development efforts should also be extended to the methodology of manufacturing and fabrication even as training and extension are necessary to continuously upgrade the skills of local manufacturers and fabricators. Also, standardization of components is expected to greatly facilitate design and interchangeability of parts.

3. Appropriate or high-tech?

Scarce resources for research and development are easily allocated to activities in the applied field, the midstream and the downstream kinds of research. Through adaptive research, foreign technologies are modified to come up with appropriate local versions of foreign designs. There are also commodities that are unique in the Philippines and they do receive attention among local investigators and machine designers. Notable products have been developed and found wide application while others are in various stages of development process. In general, however, although the country had advanced through local efforts, it is still far behind when the technologies are evaluated in terms of the current state of the art. If the country has to keep pace with international standards of product design, local scientists have to aim their eyes in the upstream field of investigation, the basic research. Various schools of agricultural mechanical engineering can be tasked to take this course of research but just the same, the problem of resources, laboratory and equipment facilities for high technology scientific work, may not be available.

4. Intellectual property rights

Lack of capital and inadequate access to information hinder the adoption of modern agricultural technologies. The recent growth of awareness on *ipr* issues among research institutions can possibly aggravate these problems and negate the purpose of enacting the intellectual property laws of the country which has just taken effect in 1998. Intellectual property laws are made to encourage inventions. However, if the cost of royalties can severely mark up the prices of new machines, or if additional paperwork can delay or even discourage small farmers and manufacturers in getting the know-how in the adoption of new machines and technologies, then, the current drive of the government to get Filipinos into the bandwagon of creative invention and patenting may not at all be beneficial to the farmers and to the whole agricultural sector.

4. PROBLEMS AND POLICY RECOMMENDATIONS

Major problems encountered by farmers which directly and indirectly relate to mechanization have been identified in a recent research activity supported by the Bureau of Agricultural Research and the University of the Philippines Los Baños (De Asis et al., 2002; Franco et al., 2002; Franco et al., 2003a and Franco et al., 2003b). The study which was aimed to establish baseline information on mechanization levels of selected commodities was conducted in relation to the implementation of the Agriculture and Fisheries Modernization Act (AFMA) of 1997.

One major problem is marketing which involves low farm gate prices and lack of alternative market outlets even as prices are dictated by wealthy middlemen. Other problems are the increasing costs of farm inputs, incidence of pests and diseases, environmental problems like floods and drought, lack of financial capacity, lack or inadequacy of support infrastructures like farm-to-market roads and lack of access to current farming technology.

The reports suggested the following policy recommendations:

1. Non-interference by government in dictating the price levels of some commodities such that the prices should be allowed to move upwards under conditions of rising market demand. This will enable farmer-producers to derive more income from their products.
2. Increased availability of credit facilities and less stringent requirement for loan processing and amortization.
3. Establishment of more cooperative buying stations in villages such that farmers would not have to sell harvests to middlemen. These stations must be equipped with storage and marketing facilities to lengthen shelf life and maintain quality of harvest.
4. Establishment of machinery centers that provide custom hiring and repair services to farmers. These centers can be alternative business enterprises in the countryside.
5. Intensification of support to both small and large-scale machinery manufacturers such that affordable farm tools and machines can be more available to farmers.
6. Establishment of more support infrastructures such as irrigation systems and farm-to-market roads.
7. Discouragement of further division of land.

5. CONCLUSION

The government aims develop 2 M ha of new land for agribusiness and generate 2 M jobs by the year 2010 of which about 0.4 M are in the agriculture sector. The action plan includes multicropping, cultivation of idle and marginal lands, expansion of fishery in offshore and inland waters and expansion of product mix (NEDA, 2005). Manpower and financial resources can only be effective as 'fuels' if there are machines for performing the tasks of agricultural production.

There were insufficient support to agricultural mechanization and fragmented efforts in the research and development work in the past. Through the efforts of various agencies and non-government groups, strides have been made to attempt to catch up.

with the requirements of the growing economy. A coherent mechanization plan along with research and development components has to be prepared both for short term and long term goals. The needed financial and technological inputs are as necessary as the political will of the government. This political will can only be manifested in the implementation of various policies which have direct impact on the productivity and efficiency of Philippines farms.

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Workshop on Efficient Use of Machines and Related Technology Dissemination in Southeast Asia
Bangkok, Thailand, November 25, 2005

Evolution of Rice Mechanization in the Philippines in the Past 100 Years[1]

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Abstract

The rice mechanization in the Philippines started with hand tools and animal-drawn implements in the 1900s. In order that big farmers (hacienderos) could control their land, big four wheel tractors and large McCormick threshers were imported and introduced after the Spanish-American war and the Filipino-American conflict. This only changed with the Green Revolution of 1960s to 1980s that introduced the modern rice technology that brought increased rice production during the period. This period was dominated by small farm equipment in the rice fields that were developed and introduced to allow two consecutive rice crops as a result of short-duration high-yielding varieties (HYVs), irrigation, and land reform. These equipment, notably the hand tractor, the rice thresher and the rice mill, in addition to a few others, have basically remain unchanged since introduction.

Mechanization is now highly adopted in land preparation, rice threshing and rice milling using the locally- developed and locally-manufactured designs. Crop establishment is shifting from the laborious manual transplanting to direct seeding, with the plastic drum seeder getting a boost lately. Fertilizer rates are becoming low while chemicals to control pests and diseases are becoming minimal or seldom used in order to reduce costs. Postproduction operations at the miller's level are greatly dependent on imported dryers and big ricemills; at the farmer's level, drying on pavements under the sun is heavily practiced while rolling rubber roll ricemills are increasingly patronized.

At present, the level of mechanization in the Philippines seems to be still insufficient to bring about a significant reduction in the cost of production and to attain a high level of competitiveness with its neighboring rice-producing countries that have started to shift from small to large-scale equipment. Selective mechanization, particularly in harvesting with the combine, village drying at the farmer and trader's levels, can still significantly reduce cost and increase production efficiency even in the face of the decreasing quality of the rice environment, the ever increasing population growth, and the looming threat of global competition.

Introduction

Rice is the major staple food crop in the Philippines. Rice farming is a way of life for most of the Filipinos, 70% of the total population of which is greatly dependent on its production, processing, distribution and marketing. About 3 million farmers distributed along the many islands of the country are actually involved in rice farming. Of the total value for agricultural produce, 14.9% comes from rice.

Despite the success of Green Revolution in the Philippines, the conduct of farm operations in rice production and postharvest is still heavily reliant on manual labor, with just a few operations using farm machinery. These operations (land preparation,

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threshing, milling) are power-intensive tasks that relied on engine power for their accomplishments. Most of what farmers employ are the relatively small, affordable machinery that are produced locally by small village shops with less dependence on imported parts except the engine and some power transmission elements like chains and bearings. These technologies did not evolve right away as small from the start; rather, rice farmers experienced both large and small equipment before finally settling on the cheaper, smaller machines that would also require few maintenance problems and low cost of operation. The next decade is expected to bring about further changes as the need to increase yields, reduce cost, increase efficiency, and generate income becomes of utmost concern in the dynamic rice farming system. This paper traces the evolution of these technologies and aims to analyze and recommend the next steps for Philippine rice mechanization based on this historical study.

Evolution of Rice Mechanization

Land preparation (Fig. 1).

In order to better establish rice plants, it is necessary to prepare the field by plowing and puddling for softer soil surface to ease planting and to develop a hard pan. In the old days, the rice field was mainly prepared using a carabao with moldboard plow and harrow implements. In some remote areas, a team of carabaos trampling through a flooded field without the use of implements is practiced. During this period, farmers are genially attached to the carabao, considered as family member and even provided with nicknames such as *Kalakian* (male animal), *Pogi* (handsome) and the like. In some provinces, especially-cared carabaos are still featured in fiestas (in Bulacan with kneeling carabaos, in Nueva Ecija with carabao races, and on female beauty contests).

In the late 18th century, a Spanish priest introduced the moldboard plow from European designs pulled by a steam engine. Plowing tests have been tried in La Granja and in Laguna but the European plows would break due to the hard soil conditions. Reports by Teodoro (1925) indicated that the carabao-drawn plow, made of a combination of steel (moldboard was fashioned from discarded rails and scrap iron) and wood from hard forest trees, was already locally produced by Filipino blacksmiths while parts were already available with Chinese dealers. However, using carabao is tiring as the farmer has to walk an equivalent of 60 km for 77 hours to plow and another 9-13 passes to harrow a hectare (Casem, 1967). During these times, however, it is common for neighboring farmers to help plow a neighbor's field in return for a similar service, *bayanihan* style.

From 1896 to 1902, as a result of the Philippine Revolution against Spain and that of the Spanish-American War and the Filipino-American conflict, most work animals were killed or slaughtered so that fields were neglected or abandoned. The need for power machinery for land preparation was felt keenly. The Bureau of Agriculture designed a V-shaped disk plow of very heavy construction material (Cruz, 1950) that proved satisfactory in both fairly moist and dry soil. The first tractor, which was kerosene-fueled, was tested in the Philippines in 1908 but the roughness of the terrain

caused many parts of the tractor to fail. In 1912, a more powerful tractor was imported and became a sensation. At about this time, power plowing was popular and this stimulated much interest in mechanized land preparation in large rice estates (*haciendas*) owned by big farmers (*hacienderos*). Thus, as early as the 1920s, at rice areas near sugarcane haciendas, four-wheel tractor with rotavating attachment were used on wet rice fields with the development of steel lug extension on big rubber wheels by the Bureau of Agriculture working with machinery dealers. The tractor's popularity increased after the war and after a serious outbreak of foot and mouth disease in the 1960s, when carabao population was again diminished.

Towards the late 1960s, prompted by the introduction of short-duration high-yielding varieties (HYVs), the development of large irrigation systems, and land reform that allowed former tenants to own small tracts of land subdivided from haciendas, immediate preparation of the field prior to planting the second crop became necessary. Small walking-type hand tractors with attachments that can plow, harrow, and transport were developed and introduced by the Los Banos-based International Rice Research Institute (IRRI) starting in the 1970s. The hand tractor, now known as *kuliglig* (Tagalog word for cricket), is common in the rice communities, also serving as farmer's family "car" similar to the carabao-drawn cart of the older years. In some communities, kuligligs fitted with removable sheds and padded seats are also passenger vehicles plying through villages and muddy dirt roads.

Nowadays. most hand tractors are made and maintained by backyard village shops. These are equipped with either a diesel or gasoline engine, depending on the farmer's preferences although engines are becoming bigger in size, from 5 hp in the 1970s to 16 hp at present. In the 1980s, some manufacturers innovated a similar tractor for soft, deep fields in Southern Philippines called turtle tiller. A recent innovation on its attachment allows the operator to ride while plowing, harrowing and leveling. Although reconditioned mini-four wheel tractors from Japan are becoming available for more efficient preparation of rice fields with less water, farmers still prefer the small, light weight and cheap hand tractor, either for their own fields or as custom service units. Despite many efforts to introduce other alternatives, the kuligligs will still serve the rice farmers for a long time just as the carabao, which symbolizes the Filipino farmer's hard work under the sun, continues to get use for plowing plot edges and for hauling.

Rice harvesting and threshing (Fig. 2)

Harvesting rice entails cutting of rice stalks or individual panicles and gathering these for bundling and stacking. Harvesting of individual panicles is done in the uplands using a hand-held piece of hard wood with a short blade fastened across called *ani-ani* or *yatab*. In the lowlands, the lodged-prone traditional rice requires that the person bends low into the ground to pick up stalks through a wooden tool called *lingcao,* having a hook at the end to pick up bundles and a serrated blade at its back for cutting. Present-day harvesting is done mostly using the sickle (*lilik* or *karet*), which is a modern version of lingcao without its hook for picking. These methods have withstood the

introduction of short-statured, practically non-lodging and high-yielding rice varieties despite efforts to modernize with faster harvesting machinery.

The more successful of the mechanical harvesters introduced so far is the reaper-windrower mounted in front of a small walking tiller operated by a small engine. Standing plants are cut slightly above the ground by a series of serrated triangular blades and released at one side in neat windrows. This design, introduced first by IRRI (Stickney et al., 1985), was later replaced by an imported model with better features and durability. However, because of its high cost and labor-displacement effect, it is only used in areas where labor is deficient and costly.

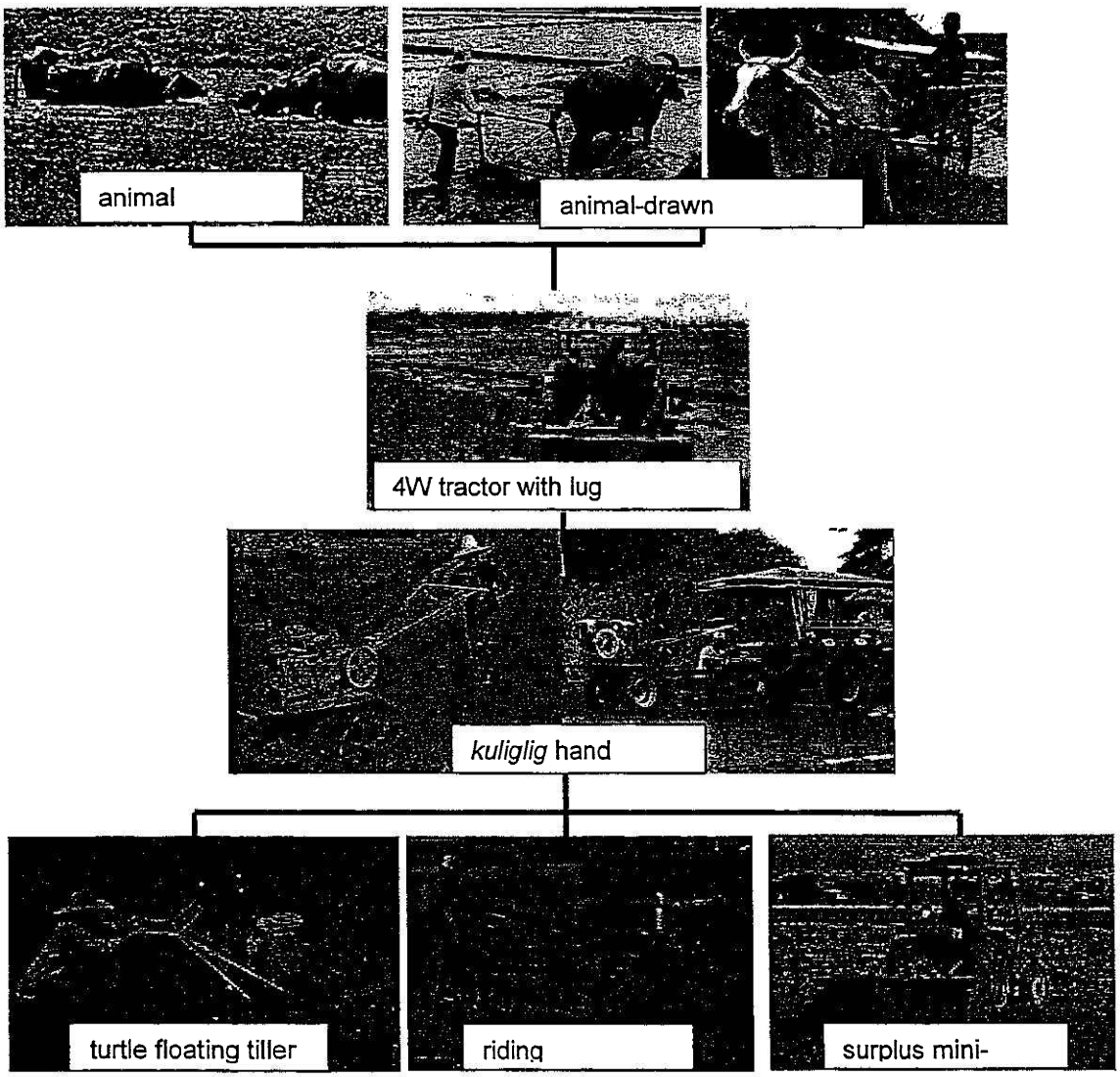


Fig. 1. The evolution of land preparation practices and equipment in the Philippines.

On one hand, rice threshing before the 1900s was normally done by trampling rice stalks laid on a hardened ground by a team of four or five carabaos. Small amount of rice stalks were also threshed by foot on mats laid on the ground or, in some places, on elevated bamboo flooring. Later, manual beating rice stalks into anything hard, such as stones or standing bamboo slats (*hampasan*), became common among small farmers.

One of the early research on the rice thresher was made by the University of the Philippines College of Agriculture by changing the clearance between the teeth of the concaves of a bean thresher for threshing rice. In 1929, UPLB successfully modified the bean thresher into a small rice threshing machine using a 1.5hp engine as source of power (Bondoc, 1931).

Later, foot-operated pedal rice threshers were introduced by the Chinese and the Japanese before World War II (Barker et al, 1985). Formerly made of wood with some metal parts, it is now produced out of steel frame and canvass to reduce weight and cost. The use of powered pedal threshers was also attempted shortly after World War II; however, these threshers never became widespread in the Philippines since it offered no significant time and energy savings over hand threshing. However, in the Ilocos region where the rice straw is valued as mulch material on vegetables after rice, locally made pedal threshers are common.

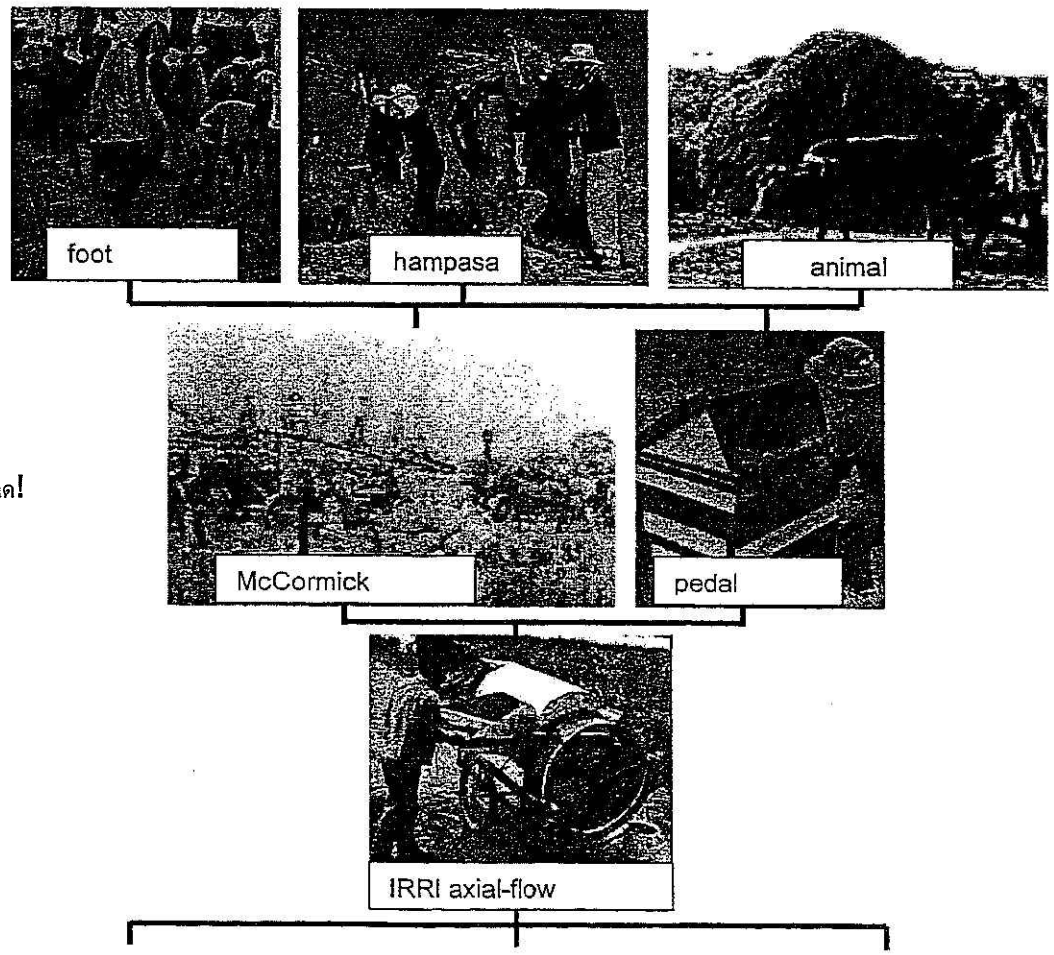
Because of too much labor and time spent with manual methods, Central Luzon *hacienderos* started in 1920 to shift to big imported McCormick threshers (locally known as *tilyadora* and costing $5,000 per unit in the 1920s) to thresh bundles of rice stalks openly stored in big *mandalas* of large conical stacks. In the 1960s, local copies of the tilyadora started to become available. However, this bulky thresher had high grain losses and was difficult to transfer from field to field. IRRI started developing a small, portable thresher in 1967 (Khan 1985). A throw-in-design, which rotates in axial-flow manner the rice stalks from the feed end to the opposite end through a rotating drum housed in a chamber and equipped with peg teeth, was developed. Upon entry into the chamber at the feed end, the stalks are hit by pegs against regularly-spaced lateral bars enclosing the rotating drum to separate the grains from the straw. The straw spirals a few times from the inlet to the outlet and is thrown out of the machine. A fan underneath blows air to winnow the grain as it falls from the chamber. The grains are further cleaned by a rotary screen before it finally gets out of the machine. The thresher was mounted on small, narrow wheels for mobility and powered by a small gasoline engine.

Finally released in 1973, local manufacturers immediately modified the thresher by using pneumatic car tires to allow the thresher to be pulled by a carabao or hand tractor, spring-supported chassis, and a flat oscillating screen beneath the threshing chamber prior to fan winnowing (Khan, 1985). Smaller models that can be carried manually by a group of men were also developed for Southern Luzon and Central Philippines. These small threshers enable farmers to complete field postharvest activities within a short period to allow a second rice crop (Duff and Toquero, 1975). The axial flow threshers has plays a major role in the rice field since it also allows farmer-owners to generate income with custom threshing.

Because of increasing wage and labor unavailability during peak seasons, farmers keenly feel the need for cheaper, faster and more efficient methods like a combine harvester that allows simultaneous harvesting, threshing, cleaning and bagging. Large combine harvesters from other countries had been introduced but were found to be incompatible with the small wet fields in the country (Palis, 1949; Nover, 1951; Raymundo, 1953). Until a combine as simple and inexpensive as the thresher is introduced and locally manufactured, the thresher, together with the kuliglig hand tractors, will continue to dominate the rice fields because these are easily accessible to farmers and manufactured or serviced locally by backyard shops.

Other operations

Rice planting. Planting rice was done in many ways: through *caingin* (by clearing the underbrush and trees on the mountain slopes before the onset of rains and making holes where rice seeds are placed), *secano* (by drilling or broadcasting seeds on dry furrowed or unfurrowed



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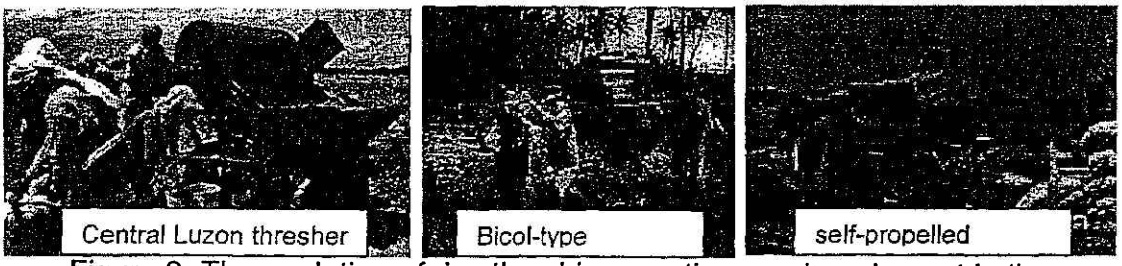

Figure 2. The evolution of rice threshing practices and equipment in the Philippines

fields on upland or rolling fields), *sabog* (hand broadcast of seeds on puddled irrigated fields), or *tubigan* (transplanting 25 to 40 days old seedlings on paddies with dikes to maintain rainwater throughout the growing season). The seedlings for tubigan are grown in the wet field (*punlaan* or wetbed system), pulled by women from the beds, washed of soil sticking on the roots, and then bundled for transport and distribution. Later, carpet-like 12 to 15 days old *dapog*-type seedlings, which are raised on top of banana leaves laid on a select portion of a puddled field, are also used. Around 10 to 12 transplanters are hired at 40-60 centavos a day (1920s) with one meal and afternoon snack. To speed up the job, a guitarist is often hired to provide music and to lighten the job (Camus, 1921).

At present, manual rice transplanting of seedlings is common during the wet season, providing livelihood and extra income for women and children in the community. It is a back-breaking task, done rain or shine, as the traditional folk song immortalizes:

"Planting rice is never fun
Bent from morn till the set of sun
Cannot stand and cannot sit
Cannot rest for a little bit".

Despite its drudgery, however, transplanting remains as one of the two most important economic activity among the landless labor providing custom services in the community. In some provinces, transplanters are bound by social arrangements to harvest the same crop, further providing table food and income.

In the 1980s, attempts to develop and introduce machines for transplanting were not successful due to the local social system and technical constraints that included difficulty in preparing seedlings, poor land preparation, low capacity for the manually operated transplanter, the high drudgery in operation, and poor precision in local manufacturing (Salazar et al., 1985).

In areas where water is scarce, an increasing number of farmers practice direct seeding or *sabog tanim* on wet puddled fields to reduce cost. The resurgence of direct seeding started in the 1970s with introduction of short-duration high yielding varieties like IR-36 and the availability of herbicides for inexpensive control of weeds. Many farmers now combine *sabog* (during the dry season when water is controlled for better seedling establishment) and transplanting (during the wet season). Manually-pulled drum seeders (has metal or plastic cylinders with end holes where seeds drop in rows

on soil surface when pulled through its groundwheel) are now introduced to allow row direct seeding and better crop management (Bautista et al, 1986). Direct seeding is still the most convenient and cheapest method of establishing rice so that, even during the rainy season, an increasing number of farmers risk broadcasting pre-germinated seeds that establish poorly if the rain falls before the seeds are properly established.

Palay drying. Palay drying was not a normal practice before the 1970s. Since traditional rice is planted only during the rainy season, stalks are harvested after the rainy season, dried under the sun for days or weeks, before stacking these into *mandalas* to shield the grains from any rain, ready for threshing. Because of two crops made possible by short-duration high yielding varieties, farmers had to immediately thresh and dry their wet rice since harvesting now coincides with the rainy season. Suddenly caught by high yields and the absence of drying equipment, any cemented pavement was used to dry farmers' paddy under the sun. A simple box-type flatbed dryer heated by a kerosene burner and driven by a small engine was introduced (Catambay et al., 1960) but was not adopted because of farmers' belief that the rice grains would over dry and burn, the dried grains smelled of kerosene, and its capacity was too small to cope up with the farmers' big harvests from the HYVs (Cardino, 1985)

Until now, most farmers and traders dry their paddy on interior roads or pavements when good weather makes this possible. Because the wet season harvest always coincides with monsoon rains; many grains are damaged. Big millers resort to using imported dryers but the very wet nature of the rice grains during wet season and high cost of dryer and its operation make mechanical drying impractical. A bright side of this situation is growing adoption of the flatbed dryer adapted from a Vietnamese innovation of the flatbed dryer, with its 120 cavans/batch capacity using rice hull to heat the drying air (Gagelonia et al., 1995).

Rice milling (Fig. 3). The rice grain is covered by a hard rough coating called hull or husk that must be removed by milling. Farmers and villagers traditionally mill their paddy for household consumption with two or three people pounding rice, one at a time in a harmonious fashion, with a hard wood on a stone or wooden mortar called *lusong*. The output would be skillfully winnowed to separate the bran and hull using *bilao*, a flat and rounded bamboo tray. This method of rice pounding is often a social occasion before and after the war, in which young villagers would normally gather and compete in fun.

Before the war, kiskisans (from the Tagalog word *kiskis* meaning rubbing off) powered by water mills and big engines, were introduced along railroads. This is actually a coffee grinder of European origin modified to mill rice and corn (Van Ruiten, 1979). Paddy is fed into a wooden hopper overhead before it is milled by a stone dehuller, which mills the grains with husks in the same chamber. Because of this one-step milling process, the kiskisan's milled rice recovery is low with a lot of brokens. Although very popular among villagers because of high bran output feed to backyard animals, the government discouraged its use in the 1970s.

Rubber roll rice mills, at first originating from Japan but later on produced locally, replaced the kiskisans due to its high milling recovery (Andales et al., 1977). In this mill, paddy is dehusked between two rubber-lined rollers rotating at different speeds and directions while whitening, or removal of rice bran from dehulled grains, is done separately by a whitener cylinder. These mills could now be found mounted behind jeepneys for custom milling in villages in exchange of a milling fee or the bran output. Commercial mills, on one hand, employ bigger components are linked together by conveyors. In addition to the rubber rolls and whiteners, extra components could be a paddy pre-cleaner, a polisher to give the grain a glossy appearance, and a destoner to take out stones picked up during sun drying on the pavement.

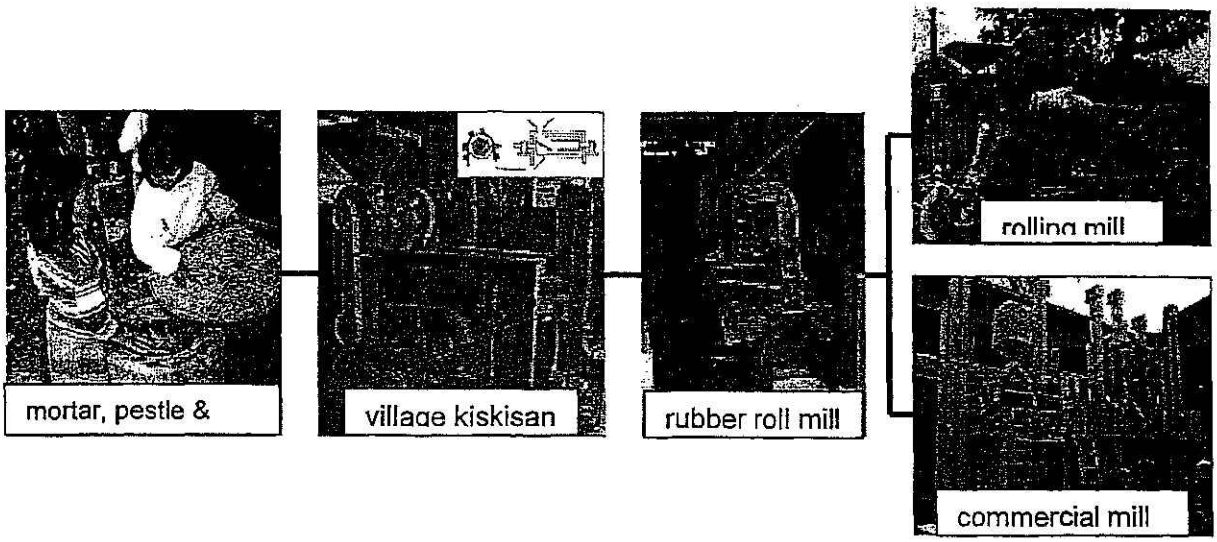

Figure 3. The evolution of rice milling practices and technology in the Philippines.

Discussion

The evolution of rice mechanization in the Philippines was a result of the needs of the times. Before the 1900s, farmers heavily relied on human- or animal-powered tools and implements as there was no need for time-efficient methods. Small farmers at the time also relied on animal-drawn implements for land preparation, manual beating or animal treading for threshing and manual ponding to mill their rice. The hacienderos, on one hand, bought big four-wheel tractors and expensive tilyadoras, their use of which later expanded to small farmers who would hire them to thresh their mandalas in groups. There was no need for other equipment at this time since rice was only planted once a year while harvesting coincided with the start of the dry season, allowing field drying before threshing. Labor, often exchanged among neighbors, was mainly provided by the family and neighbors such that the conduct of tasks primarily became more of a social activity rather than as an opportunity to generate income.

The introduction of HYVs coupled with irrigation and land reform in the late 1960s to 70s allowed small farmers control of the rice land and greater income opportunities as a result of higher yields and double cropping. Field operations became time-bound,

efficiency became important, and technology became significant. Mechanization started to shift to small, affordable equipment that sought to reduce the time and effort to end the first crop and immediately start the second crop. The big tractors and threshers were replaced with smaller hand tractors and portable axial flow threshers. Until now, these equipment are continuously patronized with little changes from their original designs.

The need to further increase yields, profitability as well as sustainability in the rice farms prompt farmers to look for better, more efficient, less costly and more reliable methods. There is a continuous trend towards the adoption of direct seeding even during the rainy season. To further reduce cost, farmers use low fertilizer rates and seldom apply chemicals for pest and diseases. Sun drying is common on any concrete pavement. Village milling is done with rolling rice mills, in some cases putting the stationary village mills out of business. Attachments to the hand tractor are being redesigned by innovative manufacturers in order to attain high capacity at less drudgery. The rice thresher is continually used although the introduction of a small rice combine is looked into to minimize cost, handling, losses and time.

Because farmers are increasingly shifting to cost-effective technologies, new and expensive technologies will take time to get adopted and only be afforded by big farmers and farmer-entrepreneurs who could capitalize on the more sophisticated models through custom service system, thereby indirectly benefiting smaller farmers. Custom hiring is expected to result to bigger, high-capacity equipment as in the case of neighboring Thailand and Malaysia. The need to increase yields, reduce cost, increase efficiency, and generate additional income from machines will affect the decision of Filipino farmers to continue to use what are used presently, adapt from these to bring about better results and output or simply adopt big imported equipment similar to its neighbors. There is much to be desired as the present mechanization level remains low and insufficient in most areas contributing to the yearly insufficiency of rice in the country.

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Basic Survey for Scheduling of Sugarcane Harvest in Northeast Thailand

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Abstract

Multiple inefficiencies cause excessive cost in harvesting and transportation system in Thailand. It is of importance to clarify shortcomings in sugarcane harvesting and transportation system of Thailand. As a result of preliminary study, it has been revealed that economical, field, and technical factors tend to restrict mechanization in sugarcane production in Thailand. Since cost in sugarcane harvesting occupies a large portion of total sugarcane production cost. It can be anticipated that improvement in sugarcane production can be achieved through more efficient harvesting and transportation systems, for competition in world trade. It is essential to stress that sugarcane are being produced in many small fields in Thailand. It is exceptional characteristics of sugarcane production in Thailand when compared with other sugarcane exporting countries; Brazil, South Africa, Australia, where very large sized fields are cultivating. Therefore, cost effective management of sugarcane harvesting and transport planning in many small fields is requisite. To realize efficient harvest planning, development of optimization in sugarcane harvesting system is required. This paper presents results of basic study conducted for this purpose in Udon Thani province. In addition, reflecting the fact that important information for optimization has not been assembled, the database design of Sugarcane Management Information System (SMIS) is proposed to bridge the information gap. The SMIS was designed to collect and summarize important data relevant to sugarcane harvesting and purchasing system. Finally, some results obtained in optimization using simple sugarcane harvesting and transport simulator are reported.

Keywords: Sugarcane; Harvesting; Scheduling; Optimization; Management Information System; Thailand

1. INTRODUCTION

Sugarcane is very crucial economic crop for Thailand. It is a perennial crop grown mainly as a source of sugar. The sugarcane is shredded and then juice extracted by crushing at a sugar factory. Raw sugar produced from these juices are later refined into white sugar. Thailand produces sugar as export commodity that is a source of foreign currency and supports industrial development. Thailand is one of the largest sugar exporters in the world. In 2004, total export of white and raw sugar was 4.45 million tons, and total value of sugar export was 31.39 billion baht (Office of Agricultural Economics, 2004).

In 2004/2005-crop year, sugarcane grown area in Thailand is 1,014,940 ha. The average yield of sugarcane production in Thailand was 47.11 tons per ha. There were 46

sugar factories in Thailand. Number of sugarcane families is 212,505 households (Office of the cane and sugar board, 2005).

Cost of harvesting accounts for 66.04% of total labor cost, and 35% of the total cost. Transportation cost was 106.14 baht/ton. These facts show importance of harvesting and transportation in sugarcane production. Quick and proper harvesting and transportation will be beneficial both for farmers and factories. The farmer's income is determined by weighing delivered sugarcane, together with the quality and sweetness of it. Commercial cane sugar (CCS), a measure of how much pure sucrose can be extracted from the sugarcane, is reckoned and use to determine returns of farmers. The sugarcane with higher CCS will obtain higher price. Fresh harvested sugarcane has higher purity and produces more sugar than older sugarcane. Consequently, it is crucial problem that deterioration in sugarcane occurs during improper harvesting and transportation.

2. DESCRIPTION OF THE STUDY SITE AND METHODOLOGY

2.1 Study site

The basic survey was conducted in Udon Thani province of Northeast Thailand. In this part of Thailand, topography is hilly with steep slopes. Rainfall totals 1200 mm/year. The temperature ranges from 20 to 38 degrees Celsius all year round.

The total sugarcane planting area in this region, during the crop-year 2004-2005, was 435,822 ha, representing 42.94 per cent of the country's total production. Udon Thani province produced 5.62 million tons of sugarcane. Due to abundance of sugarcane, there are 13 sugar factories in northeast region, and 3 sugar factories in Udon Thani.

The survey focused on operation of a sugar cane factory in the province. The study area locates in the area within 102°50'36.0''E-102°56'4.2''E and 16°59'57.6''N-17°5'24.5''N, which corresponds to an area of 10 km by 10 km (Fig. 1).

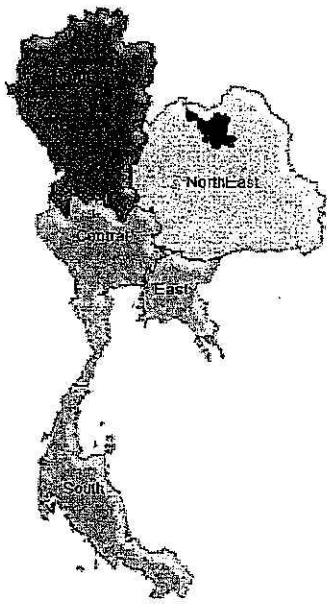

Fig. 1 Location of the study area in Thailand

2.2 Methodology

The information was in a sugar factory in Udon Thani province, Northeast Thailand. Interview has been made twice in March and July 2005 from sugarcane specialists, workers and farmers. Field investigation was performed in August through November 2005, and still on going. Two topographic map sheets on a 1:50000 and twelve aerial photos on a 1:25,000 scale were used to locate fields in surveyed region. In addition, GPS device and laser distance meters were also utilized to aid a digital map of the area, which provides the geographical information of the locations and the routes for each plot.

3. SUGARCANE HARVESTING AND TRANSPORTATION IN THAILAND

In Thailand, there are 2 common types of sugarcane harvesting system currently being used: (1) Manual harvesting and (2) Mechanical harvesting.

Traditional manual harvesting of sugarcane is whole-stalk cutting. Before the harvesting operation, the sugarcane is burned to remove leaves and other extraneous matter. The capacity of manual harvesting depends on field conditions before the operation such as burned, and the percentage of lodging cane. While capacity of manual harvesting in burnt fields is 2.5 ton per one-man per day, it will be 1 ton per one-man per day in a green harvested field. When workers are requested to cut only the bottom of the stalk, manual capacity will increase up to 4 or 5 ton per one-man per day. For the manual harvesting system, a loader needs to load the harvested sugarcane stalks into trucks or wagons pulled by tractors.

Mechanical harvester can be divided into two types: whole-stalk harvester and chopper harvester. The chopper harvester is more widespread in Thailand, because the whole-stalk harvester has to work with a loader. A truck or a wagon pulled by a tractor should run keeping its orientation parallel with a harvester. The chopper cuts one row of cane per swath at a rate of about 45 tons per hour. Sugarcane stalks are cut into 12–14-inch billets and loaded into the truck or wagon by using a loading elevator, mounted on the chopper An extraction fan system on a harvester strips and removes leaf and other extraneous matter from the sugarcane prior to loading into trucks or wagons. When sufficient number of trucks and/or wagons is available, a chopper harvester can carry out continuous harvest operation. However, if sufficient number of hauling units is not available, optimized schedule is needed. The structure of sugarcane delivery system in Thailand can be illustrated in Fig. 2

Although mechanical harvesting system can recover a higher percentage of sugarcane in the field than the traditional manual cutting, it also has higher investment and operating costs. Thus, manual cutting is still mainly employed in Thailand. However, the mechanical harvester should be introduced to solve the problems such as labor scarcity and environmental pollution. Burning of sugarcane prior to harvest also results in losses in sugarcane quality such as sucrose content. In addition, the presence of green sugarcane harvesting is likely to result in agronomic benefits as it reduces weed growth, favors moisture preservation and enhances the soil's nutrient balance.

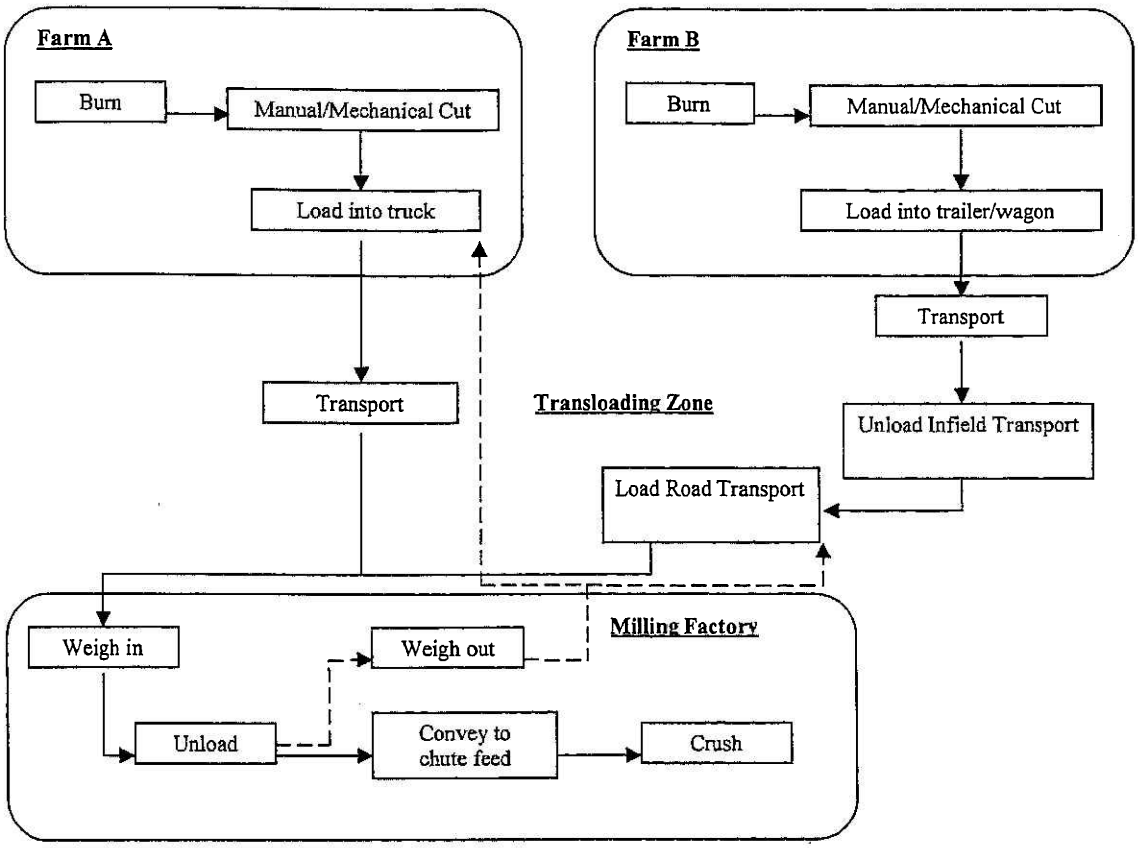

Fig. 2 Structure of the sugarcane delivery system in Thailand

4. RESULTS AND DISCUSSION

4.1 General aspects of the sugarcane harvesting and transportation

In Thailand, transportation cost is also one of the major costs in sugar industry in Thailand. It occupies a large portion of sugar production cost.

Sugarcane farmers in the study site are small family farmers. Most of them have to pay transportation cost of sugarcane from their farm to the sugar factory, because they do not own a truck. Both small and large farmers usually deliver sugarcane to a sugar factory by 10 or 6 wheeled trucks that have legal loading limits of 21 tons and 10 tons respectively. However, trucks tend to be overload to keep down transportation cost and to maintain the quality of fresh harvested sugar. In general, truck owners operate middleman business. The transportation cost will be varied dynamically depend on the fluctuation of the fuel price. During the middle of harvesting season, supply is peak and higher than the milling capacity, hundreds of trucks have to wait long hours in front of a sugar factory.

4.2 The confinement of mechanical sugarcane harvesting

According to the obtained information, there are several factors that affect mechanization in sugarcane harvesting in Thailand. These factors comprise the economical factors, field characteristic factors, and technical factors..

Economical factor: High cost of imported mechanical harvesters. Availability of credit at a reasonable rate. The investment capacity of Thai sugarcane farmer is limited.

Field characteristic factor: Common size of sugarcane fields in Thailand is small and scattered (Table 2). The percentage of field size from 1 to 2 ha is the most. 59.83% of plots are smaller than 5 ha. Most of imported harvesters is designed for relative large farms. Then, operational efficiency in smaller fields is usually low.

Table 2 Amount of plot at various field size in a study area.

Field size (ha)	Number of plot		Area (ha)
	Plot(s)	%	
≤1	3	2.56	2.56
1<ha≤2	22	18.80	38.08
2<ha≤3	14	11.97	32.32
3<ha≤4	20	17.09	69.28
4<ha≤5	11	9.40	49.92
5<ha≤6	1	0.85	5.60
6<ha≤7	6	5.13	37.92
7<ha≤8	5	4.27	40.00
8<ha≤9	3	2.56	25.92
9<ha≤10	6	5.13	57.76
10<ha≤15	5	4.27	58.88
15<ha≤20	7	5.98	125.76
20<ha≤25	5	4.27	108.80
25<ha≤30	0	0	0
30<ha≤40	1	0.85	32.00
40<ha≤50	2	1.71	96.00
50<ha≤70	3	2.56	172.80
70<ha≤100	0	0	0
100<ha≤200	2	1.71	288.00
200<ha≤300	1	0.85	240.00
Total	117	100	1,481.60

Source: Investigated data

Technical factor. One of the principal problems of mechanical harvesting is the low efficiency in its use due to inadequate training of operators and mechanics; lack of maintenance and repair facilities; and very often unavailability of spare parts.

4.3 The prospects for optimization in sugarcane harvesting system

An important management decision in sugarcane production is to determination of time to harvest crop having different history over the long harvesting period (Muchow et al., 1998). It is important to harvest priority by taking crop types, planted, first ratoon, and second ratoon, into account. Without this kind of consideration, optimized planning of this operation might be impossible in Thailand.

Hence, development of mathematical models is in needs for the determination of the optimal harvesting date when CCS is highest. Such model can be used to determine the appropriate harvesting scheduling keeping CCS maximum value at the operational.

Moreover, an aspect frequently overlooked is the factors beyond the control of the farmer, such as unfavorable climatic conditions. It causes increases in following costs both in general and also in mechanization. Therefore, the concept of timeliness and soil workability should be integrated to describe which conditions are suitable for mechanical sugarcane harvester in a field.

4.4 Development of Sugarcane Management Information System (SMIS)

Sugarcane Management Information System (SMIS) was proposed to collect the important data relevant to sugarcane harvesting and purchasing. It is intended to bridge the information gap and provide a tool for foresight in raw material management for sugar production. This approach is not only to enable farmers and sugar factories to make use of the data for cultivation management and operating planning, but it also take an advantage of information technology (IT) to corporate with optimization concept for agricultural system too.

The database was designed as a relational database system consisting of several related tables. The relationship of this database is shown in Fig. 3. SMIS was necessary initially developed for optimization in sugarcane harvesting and transportation. It is an information management tool, which enables the multi-users to access for their operational and management desire. By continuing this approach, the sugar factory, researchers and extension agents will be benefited numerously. Because of the interested model can be developed by using the realistic and technical information from the factory. The new data will be collected continuity.

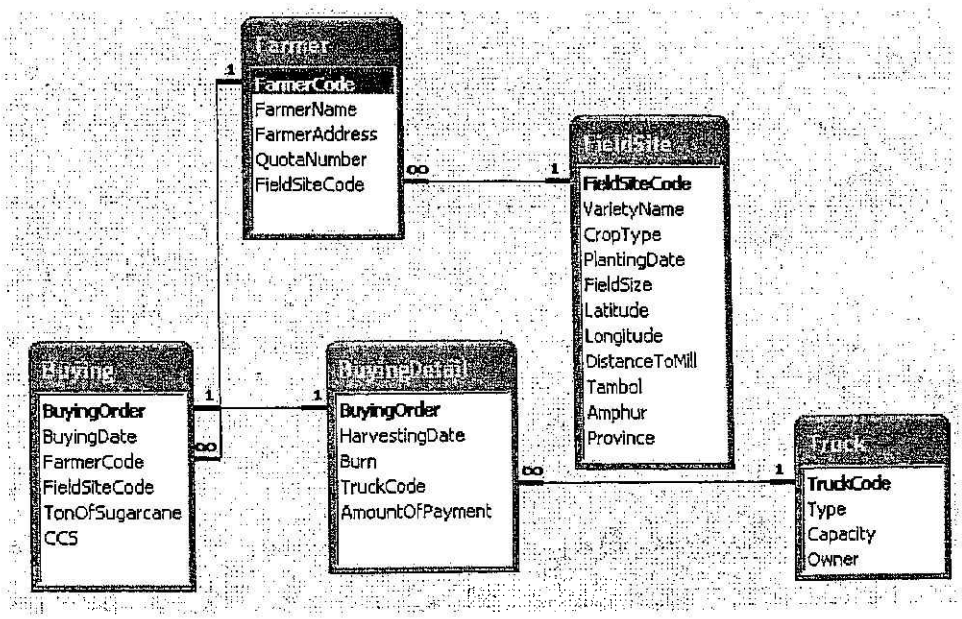

Fig. 3 The relationship of the database

5. CONCLUSIONS

As a result of basic survey, it has been confirmed that sugarcane harvesting and transportation in Thailand is key issue for reduction of sugarcane production cost. Introduction of mechanical harvesters is expected to improve productivity and profitability of sugarcane production in Thailand. However, since management of many relatively small sugarcane fields is required in Thailand, in actual usage of such harvesters, daily schedule of harvest and transportation should be properly planned in order to reduce production cost effectively. Therefore, planning of harvest and transportation has to involve optimization of selection fields to be harvested on the day, allocation of harvesters, trucks, and labor force, and selection of transportation route, and so forth. To achieve the optimization in sugarcane harvesting, management data should be accumulated as a basic database for optimization. For this purpose, the design of Sugarcane Management Information System (SMIS) was proposed to collect the important data relevant to sugarcane harvesting and purchasing. It was intended to bridge the information gap for CCS model development in further study. However, this approach can also use as an appropriate tool for planning and extension..

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Present situation of processing technology of rice for the home consumption use

- Case studies in Khon Kaen area of Thailand and Nueva Ecija area of the Philippines -

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Abstract

We studied present situation of processing technology of rice for the home consumption use in Khon Kaen area of Thailand and Nueva Ecija area of the Philippines.

Especially, the community-level rice mill in each area has comprehensively been investigated. As a result, it has been understood that there are differences in the rice milling method and the way to recover of the rice milling cost in both areas. In the rice mill in Thailand, the grinding type rice milling machine was used whereas the friction type milling machine was used in the rice mill of the Philippines. Moreover, the owner received a part of milled rice, the rice bran and the broken rice as milling charge in Khon Kaen area, while the farmer was paying cash as milling charge in Nueva Ecija area.

Keywords: village rice mill, home consumption rice, method of use milling, Thailand, Philippines

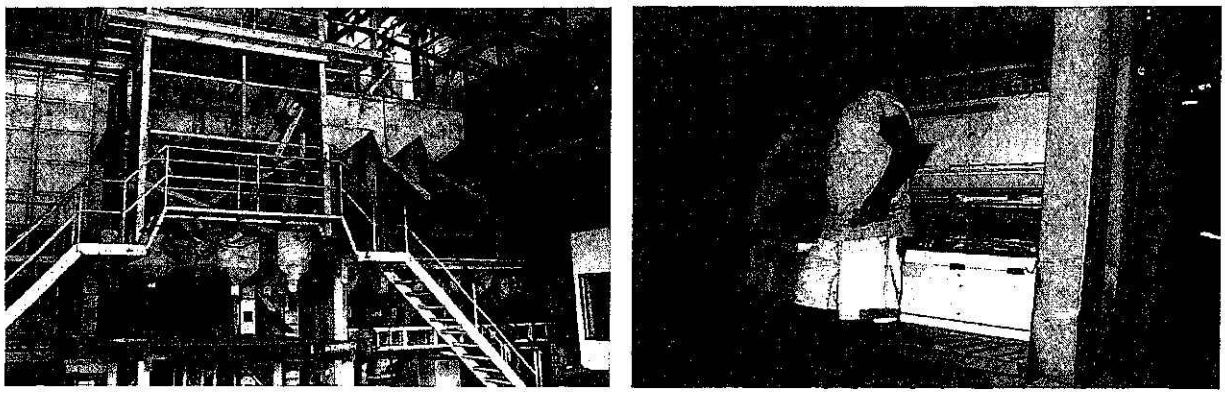
1. INTRODUCTION

The present situation of processing technology of rice for the home consumption use of Khon Kaen area of Thailand and Nueva Ecija area of the Philippines has been studied.

In each commercial use rice mill, the grinding type rice milling machine and the indent separator were operated as shown in Figure 1. The rice mill in the Philippines also included the specific model in which the color sorter was installed.

However, the types of the rice mill were different to meet the demand for the home consumption use

in the community though the grinding type rice milling machine was generally used for the indica type (Sakaguchi et al., 1995). The grinding type rice milling machine was used in the study area in Thailand. To the contrary, the friction type milling machine was used in the one of the Philippines. In addition, differences in the ways of the burdens of the user about the rice milling cost were saliently recognized. We compared the difference of processing technology of rice for the home consumption use in both areas although the number of study samples were little.



(a) (b)

Figure 1 Commercial use rice mill in Thailand (a) and the Philippines (b)

2. OBSERVATIONAL DESCRIPTION

2.1 Khon Kaen area of Thailand

In November 2004 and July 2005, the rice mill in Non Jalern village that has begun its services about 40 years ago has been studied.

In the village, there found a rice mill for the home consumption use as shown in Figure 2. This facility was built ten years ago, and its installation cost was about 180,000 baht. Power is generated by an engine. The paddy passes the pre-cleaner, and then turns on to the rice husker as shown in Figure 3. After the passage through the rice husker, it is separated into the paddy and the brown rice with the sorter respectively. Next, the paddy is conveyed to the rice husker again while the brown rice is send to the rice mill machine. Two units of the vertical grinding type rice milling machine are set up, and the brown rice passes the first rice milling machine, and is to sent into the second rice milling machine. Afterwards, rice grain is returned to the sorter at the center again. The rice grain is separated to the white rice and the broken rice each with this sorter.

The paddy was carried in from not only this village but also a surrounding one. There existed a similar rice mill also in a neighboring village, and the farmers nearby were behaved as customers for such a service.

The charge of rice milling is free-of-charge, and the owner receives milled rice, rice bran and the broken rice produced at the rice milling. The milled rice at about 30 L was recovered out of about 36 L paddy. The owner receives the milled rice of 0.5-1 L, the recovered rice bran of about 18 L and the broken rice of about one L.

Figure 2 Village rice mill in Khon

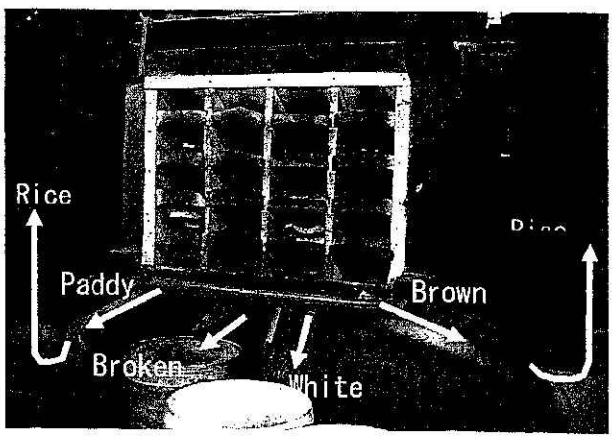


Figure 3 Sorter

The owner customarily sells the rice bran as a livestock feed and the broken rice as a processing. Considerable amount of paddy will be brought into the rice mill so as to make no dead space throughout whole season.

The machine of the rice mill had been extensively improved. Figure 4 showed one sample improved to do the magnetic separation by putting the magnet to the sorter. Even more, the farmer did not bring the paddy but the owner occasionally gives the paddy and the milled rice to the farmer. Owners aim at the differentiation with other owners to keep better relations with customers.

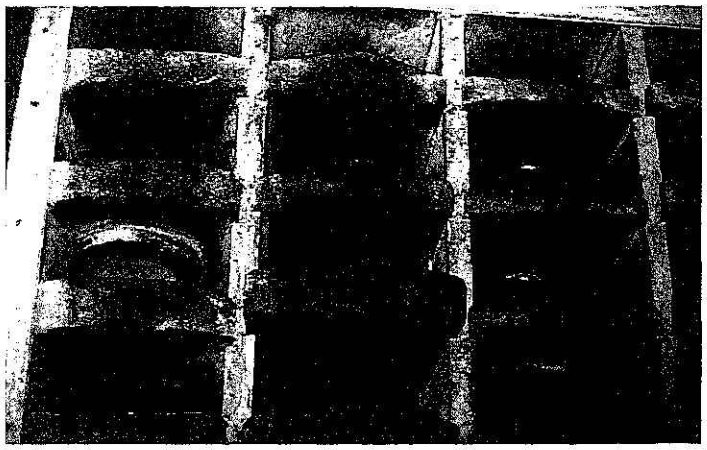


Figure 4 Example of an improved sorter

The managerial features of these rice mills includes its milled rice without receiving cash. A big rice mill plant is conducting milling operation in charge. However, it seems that a occurrence pate of broken rice is few but efficiency is good. However, the rice milling efficiency not always acceptable, village rice mill is extremely important existence for the farmer due to free-of-charge system. If the amount of the broken rice can be decreased, processing free of charge becomes impossible. We think an efficient rice milling technology alone not to be necessarily hoped.

2.2 Nueva Ecija area of the Philippines

In July 2005, the community-level rice mill in Nueva Ecija area of the Philippines has been investigated.

Both the rubber roll type husker and the friction type milling machine were customarily operated in this area as shown in Figure 5. One of reason to use the friction type rice milling machine includes rather easy maintenance due partly to the presence of broken rices.

Moreover, for rice milling of 2-3bag (1bag≒50kg), a farmer should pay 80 pesos per bag.The farmer brings the recovered rice bran at home, and can use it for livestock animal's feed.

The number of customers has decreased when the mobile rice mill shown in Figure 6 were appeared getting good popularity in the 1980's. The mobile rice milling provided the rubber roll type husker and the friction type rice milling.

It is pity not to confirm the amount of the broken rice in the milling operation. The evaluation of milling quality of the indica type by the friction type machine will be feasible by measuring the incidence of broken rices in the future.

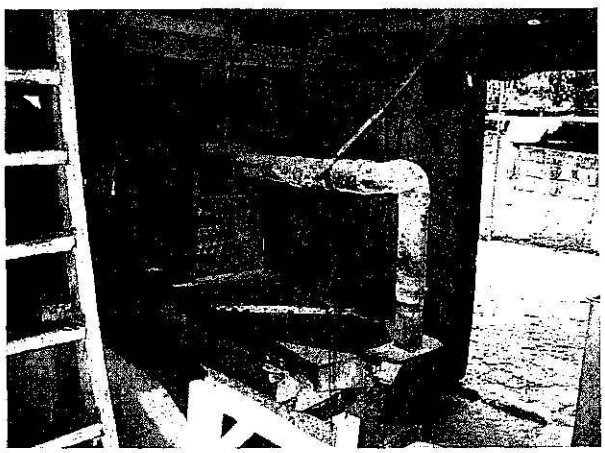


Figure 5 Village rice mill in Nueva Ecija

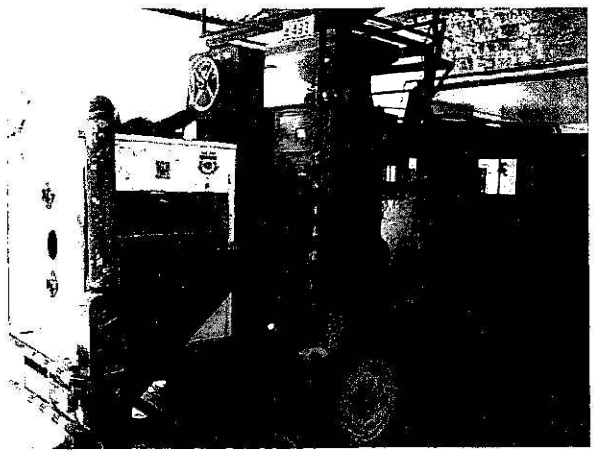


Figure 6 The mobile rice mill in Nueva Ecija

3. SUMMARY

Table 1 summarized the main differences in both area in Thailand and the Philippines.

It can be noticeable that the differences among milling machines were saliently characterized by the machine types; i.e. the friction type in the Philippines though was a grinding type in Thailand.

In Thailand, popular rice variety might affect to the adoption of this particular milling machines. In-depth discussion can be remained as future works.

Table 1 Comparative features of two areas in Thailand and the Philippines

	Thailand	The Philippines
Rice variety	Indica type	Indica type
Type of machine	Grinding type rice mill	Friction type rice mill
	Free-of-charge Milled rice Broken rice Rice bran	Charge in cash P80/1bag(50kgf)

Another discussion should be directed to the intrinsic charging system for the milling service. It was 80 pesos per 50kgf of the paddy in the Philippines while the owner received a part of the white rice, rice bran and broken rice in Thailand. In Thailand, people seemingly enjoys the free-of-charge system which allows the fringe benefits to the owner.

Following aspects of milling operations may suggest possible technical pointers to be considered. To implement effective maintenance services, the friction type machine keeps stronghold for stable good reputation because of simple structure or easier repairability. Availability of skilled personnel normally raises another problems to be tackled. Speaking of utilization of broken rice, local people tends to create a new cooking method or propose something different dining manner which naturally lead to the promotion of its daily consumption.

In addition to it, milling charge is to be adjusted internally in the community under the economic principles in relation to the demand and supply systems.

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Technology Dissemination at the Local Blacksmith in the Philippines and Thailand

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Abstract

Small-scale blacksmiths have been surveyed placing technical emphasis to elucidate their business structure and technology dissemination. Two study sites plus several manufacturing workshops have been selected and conducted interview investigations in the Philippines and Thailand. Through the survey, it was confirmed that manufacturing skill level is kept as it was at business scene among local artisans in adapting to the demand of end-users. However pertinent issues have been remained as the pending themes to be improved.

Keywords: blacksmith, technology dissemination, farm implement, repair shop, sense of value

1. INTRODUCTION

The small-scale local industry is often esteemed as the mirror which is able to reflect the technological wisdom and potentiality related to the community. The objectives of this study are to investigate the present situation of the blacksmiths in the Philippines and Thailand in brief and discuss about the possibility of forthcoming development toward highly competitive and challenging industry. In the Philippines, GDP is still in the level of 2000US$ or more. As the concept of "Alternative development" suggests, the role of local industry is now likely reappraised because such a small-scale enterprise can start with a little investment, and use the regional or at most domestic resources, and provide the employments in related industry, and bring about the proud to the people. Therefore, attention in reference to such issues becomes more or less necessary to implement the alternative development. In Thailand, demand made by external pressures from outside country seemingly accelerates to furnish fundamental structures for small-scale local industry. But the success for both reinforcement of manufacturing competency and economic status is not attained so easily. Such sort of dilemma is perhaps the matters to be discussed in this study.

2. STATUS QUO OF THE BLACKSMITH BUSINESS

2.1 In the case of the Philippines

Throughout the country, the products of blacksmith are manufactured by direct order from

wholesaler, owner of the drugstore and customer. Without any orders from customer, the manufacturers who have enough producing capacity used to continue their operation as a stock of products. In general, any customers prepaid a certain amount of money for an owner for the sake of procurement of raw materials, and then an owner starts to prepare iron, fuel and charcoal for producing items. For example, manufacturing process of a sickle for rice harvesting use is as follows: ① forge→ ② shaping→ ③ sharpening→ ④ serration→ ⑤ trademark stamping→ ⑥ heat treatment→ ⑦ final finishing and polishing. A respondent for interview is listed below.

Founded in 1960 by grandfather
1995 father passed away
Owner 37 years old
Wife 35 years old
Two boys and one daughter
Owner is a BS holder majoring in electronics and communication engineering
Product item: moldboard plow (for four-wheel tractor and hand tractor use)
harrow hand tools including hoe
Price: moldboard plow for hand tractor 2000 peso
Production volume: 30 units/month
Sales volume: 15 units/month
Number of employees: three persons
Manufacturing equipment: one electric blower, welding machine

In the Philippines, farm implements are produced for domestic use only, not for export. Imported high-class farm implements are displayed at the department stores, but cannot find out them at the public market and hardware dealer due to relatively expensive price. Domestic farm implements including sickle, scythe, and moldboard plow are dominating over public market or street stall.

Nationwide demand of sickle is to be estimated from rice production. Sickle cannot use any longer by the abrasion of share when it is used in average one ha or 2.5t cereal harvesting. For example, if rice yield is premised to be 8.9 million and divided it by 2.5 and then necessary production volume of sickle attains 3.6 million. So market share of specific manufacturer's becomes 34.8% provided that its annual production volume is approximately 1.3 million.

However, hacksaw, axe, plane, kitchen knife, paring knife, medical instrument are occupied by import items with high market share. And then it can be pointed out that the carpenter's tools are from United State, stainless items are from Japan. Therefore, the idea of import alternative attracts people's attention for implementation. People has so far attempted to organize the craft union, but failed to promote it due to the difference of expectation among the people concerned. As a sense of value, people place the family welfare as one of most important element in their life. Although manufacturers has an action plan, they were not so fortunate to obtain the conditions of achievement.

2.2 In the case of Thailand

In and around the study site, more than ten blacksmiths have been operated their business. The scale of business is like self-sustaining level but showing modestly confirmed determination to get success. The outline of one blacksmith can be described as below.

[Case 1]
Owner: 46 years old
Wife and two sons
When he was 17 years old, he started to work in Bangkok at automotive workshop, then returned home at the age of 34.
Cultivating land: total 11rai (1.8ha)
(Cassava 1rai, rice 5rai, no cultivation for remaining field due to water shortage)
Workload proportion between agriculture and repair shop: 50:50
One major reason of business includes earning for school expense.
Amount of income: 6000 bath/month
No idea about his successor.
The goal of central government is to encourage the consciousness reform of the inhabitants.

[Case 2]
Owner: 36 years old
Wife and two daughters

Main business: repair of transmission shaft 250 baht/pc
Net income: 3000 baht/month
Institutional skill development program was not implemented.
Private sector including Kubota Ltd. offered the skill training course.

2.3 Features of industrialization in Thailand

Firstly, Thailand has initiated its industrialization just 35 to 45 years ago. As an exporting country of rice, rubber, corn, tapioca, tin and so on, Thailand has so far advanced its economic stride.

Secondary, foreign capitals have continuously supported its policy under tough guidance of Thai Government. Tertiary, the locally settled overseas Chinese demanded their presence in the local enterprises. Although their experience as an entrepreneur was not in adequate level, their entrepreneurship gained high evaluation.

Rural society in Thailand is considered to function as a buffer for urban workers. And so, that population absorbing capacity of rural community was believed to be capable to adjust the excess of laborforce of manufacturing industry which might be caused by business fluctuation, and hence it acts as a stabilizing device of labor market.

Under the frame work of this business environment, small-scale local industry is destined to survive in developing and enhancing their capability of manufacturing skills.

CONCLUSIONS

1) In the Philippines, a manufacturer of blacksmith is guaranteed a certain amount of income by middleman, but heavily dependent to the wholesale dealer at the critical aspect of price decision. In fact, a middleman makes a decision of retail price, and hence a manufacturer never involved in the process of price determination. This relation acts favorably to the wholesale dealer who is comparatively rich, rather than a manufacturer who stays in small-scale business.
2) As the behavior of action, so-called "safety-first" principle or maintenance of the status quo is widely adopted by owner of local industry. This is partly rational to cope with the possible risk.
3) Organizing the manufacturer's union seems to be effective to reinforce technical information exchange and formulation of various proposal submitted to the Government.
4) Development to be a metal-working industry is seemingly desirable for a blacksmith to enhance social and economic status.

ACKNOWLEDGEMENT

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Fig.1 Rural path to cottage blacksmith

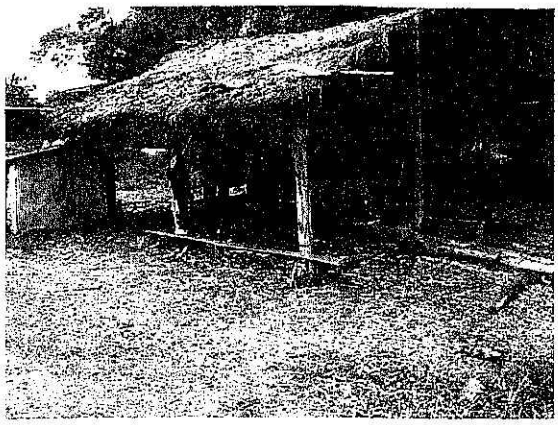

Fig.2 Cottage blacksmith with thatched roof

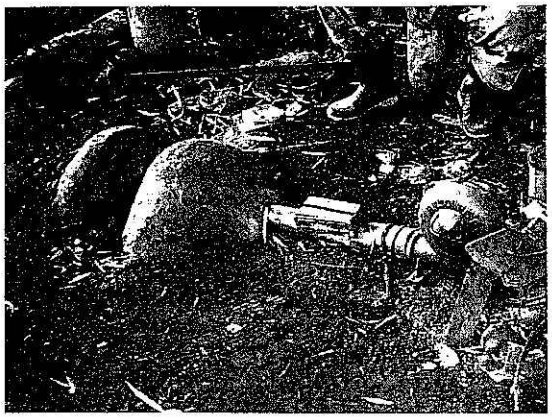

Fig.3 Furnace in operation

Fig.4 Furnace at the blacksmith

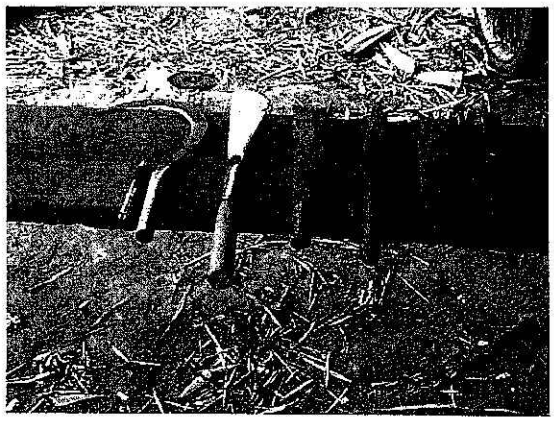

Fig.5 Products of the blacksmith

Fig.6 Metal tube bending device

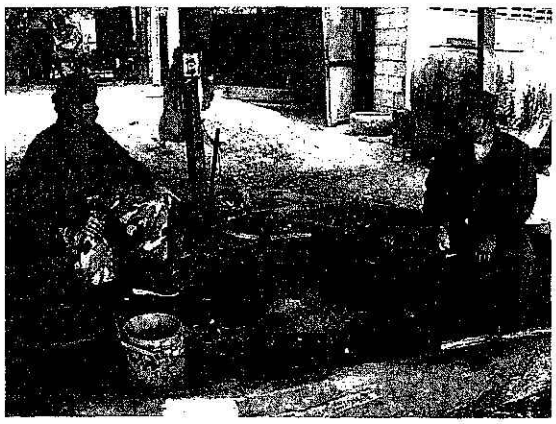

Fig.7 Pleasant talks

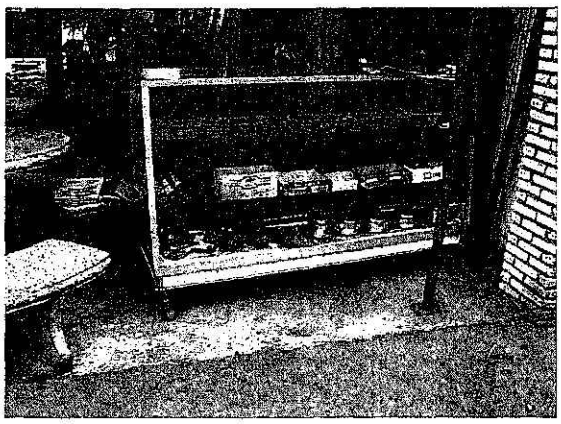

Fig.8 Repair shop in the town

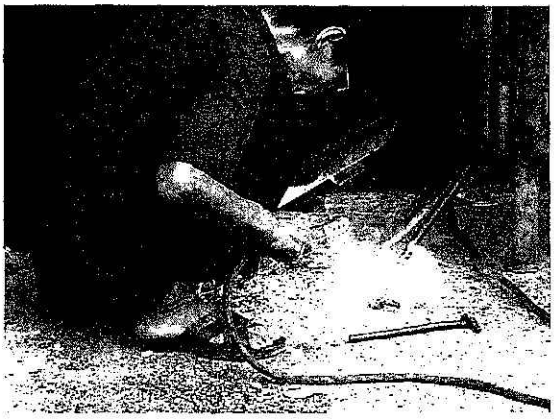

Fig.9 Welding operation

Fig.10 Locally-made sickle

Fig.11 Repairing of the component of disk plow

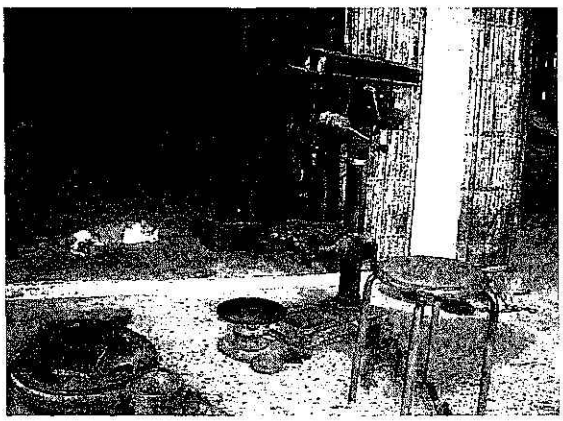

Fig.12 Metal-working rural industry

OS16-1

東南アジアの農業機械化にみる技術論的展開とその地平

小池正之(筑波大生命環境研)

1．はじめに

地域によって異なる農業機械化の様相は、移転されてきた技術の水準と種類、社会経済的条件、農法、風土、農耕上の物理的要因等に左右される。東南アジアは民族的にはモザイク模様に分散しているといわれるが、農業機械化の進行過程にはどのような規制要因が存在して、現在の多様な技術水準を呈することになったのか、その視点からの分析は必ずしも十分ではない。ここでは、機械化に対する技術的要因の影響について考察し、今後の技術移転の姿について概観してみたい。

2．農業機械化の技術論的特質

2.1 機械化の役割とは何か

経済的に低水準にある農村では、人力作業が主流である。その農村で、機械化は必要とされる政策理念となりうるかと問われれば、即答は困難であることに気づく。農家経済の向上に寄与しつつ、ユーザーに過剰な物理的・経済的負担を求めない機械化モデルの提案は、ユーザーの精神構造の探索なくしては現実味を帯びることはないからである。当該農村が真に求めている機械化の姿の具備条件とその持続的派及効果について、ラオス東部の集落で調査したので、その結果を口頭発表時に説明する。

2.2 「求められる技術」と「置き去りされる技術」

技術の定着を促す要因としては、苦役からの解放、経済的利点、収量増大への貢献、望ましい土壌環境の準備、社会的状態（ステータス）の確保等が挙げられる。しかしながらそこには消費者からの視点に対する配慮が欠落しているため、技術革新に結びつく動きがもたらされることは極めて少ない。つまり、「求められる技術」と「置き去りされる技術」の間には、農村社会の内と外で情報の相互交流を誘導する仕組みに乏しく、それ故に技術及び事業の革新が起こりにくい構造となっている。フィリピン・ボホール島では畜力耕うんが行われているが、その主な理由は圃場規模に見合った利用可能エネルギー投入量と経済的利点が技術要件と合致しており、その技術体系をして「求められる技術」として維持され続けていると考えられた。カンボジアでも畜力が広範に用いられているが、この場合は作業賃が安く、堆肥の生産と肉生産にも貢献することが普及理由とされている。ユーザーは同時に生活者でもあり、両者の要求を満足する方向へと技術の改良、馴致が行われた結果が眼前に繰り広げられる在来技術の姿であると思われる。

2.3 技術の進化の将来展望

農業機械は乗用トラクタ、耕うん機、各種作業機において、いずれも技術革新の歩みは遅々としている。有能な技術者の輩出例が少なく、かつ地場産業も周辺技術における素材や加工技術の進化と移転の速度が遅いこともあって、技術水準の停滞が顕在化している。移転してきた技術が根付くためには、ひとつに地場産業がもつ製造技術の質的底上げを図るため若年技術者の育成を具体化すること、そして受容するに足る社会経済的要因が必然的に存在し、当該技術が個人のステータスを止揚するように作用することが必要条件となると考えられる。

タイでは、コントラクタ農業方式が広く普及している。ここでの農家の機械装備はわずかな小農具程度にとどまっており、重作業である耕うんと収穫作業は請負業者に依託する。時には、防除・除草作業も依託する場合がある。このような農法における機械の設計概念は、一体どのような与件を必要としているのであろうか。当然ながら、機械の稼働時間は極めて長く、稼働条件は厳しい。そのため故障の発生頻度も高い。ここでの設計要件としては耐久性（耐衝撃性を含む）、座乗性、軽量化、低価格に配慮することが求められ、今までに例を見ないゼロから出発した設計概念の創出が、ユーザーのニーズに対処する有効な技術的方策のひとつになるであろう。

3．まとめ

一部の日系企業で「アジアトラクタ」の研究開発が手掛けられ、またアセアン（東南アジア諸国連合）では、人々の間に東南アジア意識が醸成され始め、部品共通化といった技術的側面を広域圏で考える傾向が強まっている。いわば資金と技術の坩堝（るつぼ）にあって、機械化の方向性に過誤なきを期すには、ユーザーの精神構造に配慮したものづくり体制を構築することが重要な視点になると思われる。

OS16-2

新技術の受容と意識の構造

○堀尾尚志（神戸大学農学部）、小池正之（筑波大学院生命環境科学研）、瀞川具弘（筑波大学院生命環境科学研）、眞板秀二（筑波大学院生命環境科学研）、牛島紀彦（九州女子大学）、川上昭太郎（東京農業大学）

問題の所在　E. Roggersは24-Dの普及過程を分析し、それを導入した農家の時系列的分布がガウス分布で与えられるとした。そして、初期から分布関数の変曲点までの16%を早い順に①innovators及び②early adopters、中心値まで34%を③early majority、次の変曲点までの34%を④late majority、それ以降を⑤laggardsと類型化した。①は革新者あるいは先駆者で、冒険心に富みリスクを好んで取り入れる。比較的若い層であるが、相当資力もあり、専門的に優れ技術的情報にも近いところにいる。それだけに同調者を得にくく地域のリーダーとはなりにくい。②は先導的受容者で、堅実な判断による導入・受容が、いまだ判断を下しかねている多数者に影響を与える。地域での地位も高く経営規模も大きい。③と④は早期導入と晩期導入の多数派である。Roggersは、前者を「考え抜いた上で計画的に（deliberate）」と、後者を「懐疑心を抱きながら（skeptical）」と形容している。③は②を見ならって論理的に新技術を受け入れるのに対し、④は周りの変化に遅れてはと言う不安から受容してしまうのである。⑤はさらにその後から遅れてついていく者である*。

著者はかつて、このモデルを援用して田植機の導入に関わる導入側の意識について分析した。田植機の普及過程についても、このモデルは十分適合した。Roggersは普及過程のモデル化と集団の類型化に留まっていて、各集団の意識構造を分析するところまでは至ってなかった。③以外の集団についてことさら分析する必要はないが、普及過程において③の集団の意識構造、あるいは②の段階から③の段階への過程を明確にすることが重要である。従来②と③を分けることなく、これら68%を一括し②の段階から先に進まないことの要因を、この68%が持っている「抵抗」として扱ってきた**。しかし、②には③と違い明確な意識がある。新技術を受け入れる必要性を論理的に認識していながら、そこへ進めないという意識構造を「メンタル・インピーダンス」なる概念を提唱し分析した***。

提唱した概念をタイの農村で検証し、本プロジェクトに資することが本研究の目的である。

* E. M. Roggers, "Diffusion of Innovations", Coller-Macmillian, 1962

** 例えばC. Brood, "Technostress", Addlison-Wesley, 1984

*** 堀尾尚志、新技術の受容と意識の構造、『テクノロジーの思想』、岩波書店、1994、所収

調査地の概要と調査方法　マハサラカン県ノンジャルン村、東北タイの中心都市コンケーンの南南東、直線距離で約30km、車で1時間半のところにある。約3km離れた比較的古くからあるコンクワン村から1980年代後半に移住が始まり1992年に分村した。寺院はなく元の村に出かけている。戸数60戸、耕地面積は推定1800ライ（288ha）、その1/3が水田、2/3が畑地である。ほとんどが専業で、行商などで一部が農外収入を得ている。1/4の農家が2輪トラクタを所有しているが、他の農家では耕うん・整地をコントラクタに頼っている。ほとんどの耕地が砂土で土壌流亡が激しい。

調査は2003年8月に予備調査、2004年11月に本調査を実施した。予め用意した質問紙により、コンケーン大学の学生を介して質問した。対象者は、村長の紹介によった初日以外は村落内を歩き、できるだけ無作為に対象者を選び、調査の同意を得て行つた。

キャッサバからサトウキビへの転換　キャッサバは、土性を選ばず乾燥に強い。挿し木するだけで約1年待てば収穫できる。それに比べサトウキビは苗の移植から複数回の除草と手間がかかるうえ、肥培管理に技術を要する。

キャッサバの価格は90年代に入り下落を始めたため、サトウキビへの転換が始まった。調査村でも1991年から転換が始まったが、4年間で30%に達していなかった。彼らは、①あるいは②に該当するが、新しいことをするのを好むとか、農協や農業事務所によく顔を出している等、この類型の特性を持っている。それに続く5年間の間に転換したものが50%強で、キャッサバ価格の下落に対処するには転換するしかないと思っていたが、先駆者の成功を見て決心した。まさに、③に該当する。

かれらは転換して2、3年の間は、移植の労力集めや労賃の捻出あるいは除草作業に苦労したことを、おしなべて述べている。また、いまだに除草の苦労を嘆く者、除草剤の出費や土壌流亡が予想外とする者もいた。一方、①あるいは②に該当する者は、除草や土壌流亡の問題を述べながらも、それを克服したことを自慢する。そして問題はあっても収益性のゆえにサトウキビの栽培を続けていく対応を考えている。例えば、サトウキビ2作・イネ1作の3年ローテーションを考え障害を緩和したとか、サトウキビを一部水田に戻すことを検討している等である。

以上のように、提唱した概念をタイの農村においても検証できた。今後は、その概念の実用、例えば新技術の受容に伴う苦労や苦痛を軽減するプログラムつくりの可能性と意味を検討する必要があろう。

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OS16-3

東北タイの波丘地形と耕作形態による土壌侵食問題
－ノンジャルン村を事例として農村集落の拡大という視点から－

○眞板秀二(筑波大生命環境研)・コシット・ロルシリラット(タイ国・王室潅漑局)

1．はじめに

東北タイのコンケン県にあるノンジャルン村は、約1km離れたコンカン村から10数年前に分村した新しい村である。これらの村は、東北タイ特有の波丘状の地形（コラート高原）の上に成立しており、現在は、波丘上部にはサトウキビ畑が、波丘低地部には天水田が谷津状に広がっている。

東北タイはタイの中でも森林の減少および土壌侵食が著しい地域の一つであるが、ノンジャルン村では水田の土壌侵食という、これまで余り例のない侵食が見られた。これは農村集落の発展による道路整備の進展などが波丘地形という条件と相まって出現した新たな土壌侵食問題と考えられた。そこで、過去30数年間の土地利用変化、農家戸数の動態、道路状況の変化を把握するとともに波丘地形の分析を行うことによって、農村集落社会の拡大と土壌侵食問題との関連について検討した。

2．土地利用の変化と農村集落の拡大

1961年にはタイ国全土の57%を被覆していた森林は1998年には25%に減少している。特に東北タイでは12%、ノンジャルン村のあるコンケン県では7%の森林面積率となっており、タイ国の中でも最も森林消失の大きい地域となっている。ノンジャルン村周辺でも1973年に波丘上部を被覆していた森林はほぼすべて伐採され、畑作地に転換している（図1）。これに対して波丘低地部の天水田の面積にはほとんど変化は見られない（図1）。

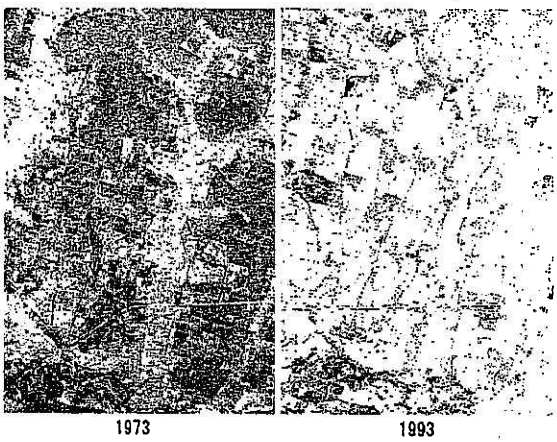

図1　ノンジャルン、コンカン村周辺の土地利用変化

航空写真の判読により家屋数から農家戸数を推定したところ、1973年には55戸だったコンカン村の農家戸数は1993年には111戸と倍増した。聞き取り調査によれば10数年前にノンジャルン村が誕生したとのことだが、航空写真でも1993年に35戸の農家を確認することができた。その後も農家戸数は拡大し、2002年にはコンカン村は137戸、ノンジャルン村は64戸となっている（図2）。

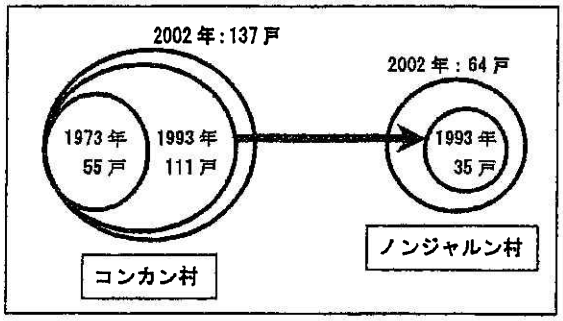

図2　コンカン村の拡大によるノンジャルン村の誕生

3．農村集落の拡大を支えた畑作物

この30数年間、波丘低地部の天水田面積にほとんど変化がみられなかったということは、農村集落の拡大を可能にしたのが、波丘上部の畑地開発であったことを示唆している。タイ国全土でみると、畑作物としてはキャッサバが1970年代から急増し1988年をピークに減少傾向をたどっている。一方、サトウキビは着実に増加し2004年にはキャッサバとほぼ同面積になっている。聞き取り調査から、ノンジャルン村周辺でも波丘上部の畑作物栽培についてはほぼ同じような経過をたどったと判断されたが、現在はサトウキビが90%を占め、サトウキビに特化している。

4．農村集落の発展による新たな土壌侵食問題

波丘上部でのキャッサバ栽培は、キャッサバが地表被覆の少ない作物であること、また、波丘地の土壌が砂質であることから深刻な土壌侵食を引き起こしてきた。サトウキビはキャッサバに比べれば、地表被覆が大きくキャッサバより土壌侵食の問題は小さい。しかし、2年・3年ごとの植え替え時期には広い裸地がひろがり、その時期に雨季が重なれば、やはり侵食の問題は大きい。これら従来型の土壌侵食問題に加えて、谷津状の天水田を横切る道路に起因する水田の土壌侵食が起こっている。30数年前なら雨季の洪水時には、洪水は道路を越流したが、農村集落の発展によるインフラ整備によって、道路は暗渠を持つ高規格なものになり、洪水は暗渠に集中するようになった。しかし、暗渠下流の流末処理が行われていないため、暗渠に集中した流れは下流水田を侵食するという新しいタイプの土壌侵食問題を引き起こしている。このように、場所によっては道路を守るために下流水田が一部犠牲になるという状況がみられており、この新たな侵食問題への対応が必要になっている。

OS16-4

タイ国・コンケン郡ノンジャルン村でのサトウキビ栽培について

瀧川具弘（筑波大生命環境研）・小池正之（筑波大生命環境研）・Banshaw Bahalayodhin（カセサート大学工学部）・ Pratuang Usaborisut（カセサート大学工学部）

研究の背景と目的

タイ国はブラジル、インド、中国などに次ぐ主要なサトウキビ生産国であり、2003年度の生産実績は6000万トン（サトウキビ）である。サトウキビ生産はタイ国にとって農業全体の生産額の7%占めており、タイにとって重要な作目となっている。歴史的にプランテーション生産を受け継いでいる国々では、サトウキビ収穫機を用いた大規模で計画的な生産が行われているのに対し、タイでは、多くの小規模農家を含む、経営規模の異なる農家がサトウキビ栽培を行っている。よって、工場のイニシアティブによってほ場を直接管理できないため、生産の効率化を図りにくいことが知られている。本報告ではタイ東北部コンケン郡ノンジャルン村及び製糖工場3社で行った調査結果を報告する。本研究の最終目的は、ほ場の位置的、規模的分散をGISデータベースにより把握して、従来から蓄積されたデータを活用して、効率的な管理手法を提案する。また、タイの条件に適合する収穫機に求められる諸要件を明らかにすることである。

研究の方法と結果

ウドンタニ及びコンケンにおいて3カ所の製糖工場と、コンケンのノンジャルン村のサトウキビ農家の聞き取り調査を行い、以下の結果を得た。

1）製糖工場は、工場から最長100kmに及ぶ範囲の農家からサトウキビを収集する。栽培開始時にサトウキビの搬入を契約する農家は5000戸以上にもなる。

2）工場は収穫時期の管理を「Cue」「Quota」の発行によって行っている。この場合、工場に数十名いる栽培技術の普及担当者が、収穫Cueを農家に連絡する。

3）ごく小規模の農家は直接工場に搬入せずに、仲介者（Middleman）に売却することが多い。この場合、収穫及び工場への搬送は仲介者が行うことが多い。

4）収穫は手作業で行われており、大型ハーベスタによる収穫面積は全体の1割に達していない。収穫物の運搬には、10～20トンのトラック及びトレーラが使用されていた。タイでの単収は60 Ton/ha程度であるので、トラックの容量及び刈り取り作業能率の制限から、一日の収穫可能面積は1/6～1/3ha程度である。よって、10ha程度のほ場で収穫するには数ヶ月を要することになる。また、収穫機導入の障害の一つほ場に切り株などが存在することもあげられた。

5）耕耘はコントラクタの提供する大型トラクタによるサービスで行われ、工場が機械のレンタルなどのサービスを提供することは少ない。

6）多くの工場がサトウキビの確保のために競争している現状があり、発行したCueが厳密に守られないことも多い。

7）一方、大規模農家も存在し、大型機械を利用した効率的管理を行っている。こうした農家では、アメリカ製やオーストラリア製の大型収穫機が使用されていた。

8）東北タイの気候、土壌条件から持続的生産を目的として、有機分の涵養を含めた土壌管理技術が必要である。

今後の計画

航空写真、GPSを利用した計測を利用して、収穫実績と地図情報とを組み合わせたウドンタニにおけるGISデータベースを作成する。これを利用した収穫管理法を、シミュレーションを通じて検討する。さらに、ほ場条件から見た収穫機の具備すべき設計要件を明らかにし、今後の機械化計画の指標を確定していく予定である。

OS16-5

Sugarcane Production in Thailand: Perspective in Mechanization and Optimization

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1. Introduction

Sugarcane is very crucial economic crop of Thailand. It produces sugar as export commodity that is a source of foreign currency and supports industrial development. It enables national economic growth of Thailand to take place on a wide front. The production of sugarcane involves farm mechanization and management. There were many implements and machineries at various farming operations. Unfortunately, several factors tend to restrict mechanization and its benefits for sugarcane production in Thailand. Therefore, this study is intended to comprehend the system of sugarcane production in Thailand for further development

2. Data Collection and Analysis

The information was provided by the collaboration with the Kasetphol Sugar Factory, the sugarcane-milling factory in Udonthani province, Northeast Thailand. The interview was made in March 2005 with sugarcane specialists, workers and farmers to get specific data related to academic targets both at the factory and in the field. Additionally, apart from this survey, essential information was collected from Ministry of Agriculture and Co-operatives and Ministry of Industry in Thailand.

3. Results and Discussion

There were numerous factors contributed to make mechanization costs excessive for sugarcane production in Thailand. These factors comprise the economical factor, field characteristic factor, and technical factor. Further detail of each factor is described below.

Economical factor. For instance, the high cost of imported machinery and fuel, the availability of credit at a reasonable rate for the purchase of implement.

Field characteristic factor. Although almost implements have developed in western countries, designed for relatively large farms, the commonly size of sugarcane field in Thailand was small and scattered, low efficiency operational in their use occurred to be low.

Technical factor. One of the principal reasons of operating problems is the low efficiency in its use due to inadequate training of operators and mechanics; lack of maintenance and repair facilities; and very often unavailability of spare parts.

From the detail of the cost associated with each operation of sugarcane production in Thailand (MOI and OAE, 2000), it was analyzed that the labor cost of harvesting is the highest. It was around 63.46% of total labor cost or around 27.21% of the total cost. In addition, sugarcane harvesting and transportation is complex. Because it includes daily planning of area to harvest and allocation of labor and machinery for burning, cutting, loading and delivering the sugarcane from the field to the sugarcane-milling factory.

4. Conclusions and Recommendations

Limitations in amount of mechanical sugarcane harvester and sugarcane transport capacity in Thailand dictate that the harvesting of sugarcane is carried out over a harvest season of several months. Hence, the further study is needed to develop the mathematical model for determination of the optimal harvesting date when the percentage of extractable sugar from cane ('Commercial Cane Sugar', or CCS) is highest. And also the other model to determine the appropriate harvesting scheduling of fields keeping the maximize CCS value at the operational and the strategic decision level. Moreover, an aspect frequently overlooked is the factors beyond the control of the farmer, such as unfavorable climatic conditions. It causes increases in following costs both in general and also in mechanization. Therefore, the concept of timeliness and soil workability should be integrated to describe which conditions are suitable for mechanical sugarcane harvester in a field. These approaches improve risk management, decision making and enhance benefit of the sugar industry in Thailand.

Acknowledgement

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OS16-6

東北タイ・コンケン地域における米の調製加工の現状

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Ⅰ　はじめに

東南アジアにおける農業機械設計概念の特質に関する調査として東北タイ・コンケン地域を調査対象地域として米の調製加工の現状の調査を実施した。この地域では、籾摺り機４台(１台あたり120t/day)，精米機６台を備える比較的規模の大きな調製加工施設もあったが、40年ほど前から発展し始めたノンジャルン村にある自家米用の調製加工施設について2004年11月に調査を実施し、その結果を報告する。

Ⅱ　施設の概要

村内に図１に示す自家米用の調製加工施設があり、稼動していたのでその概要を調査した。この施設は村民の個人経営で10年以上前に作られたもので、当時18万バーツかけて作られたとのことであった。エンジンが動力となり、持ち込まれた籾は粗選別機をとおり籾摺り機に投入され図２に示す中央の選別機で籾と玄米に分離され、籾は再び籾摺り機へ玄米は精米機へと送られる。精米機は縦型ロール式が２台設置され、第１精米機を通過後更に第２精米機へと送られ再び中央の選別機に戻される。この選別機で精米と砕米に分離される。

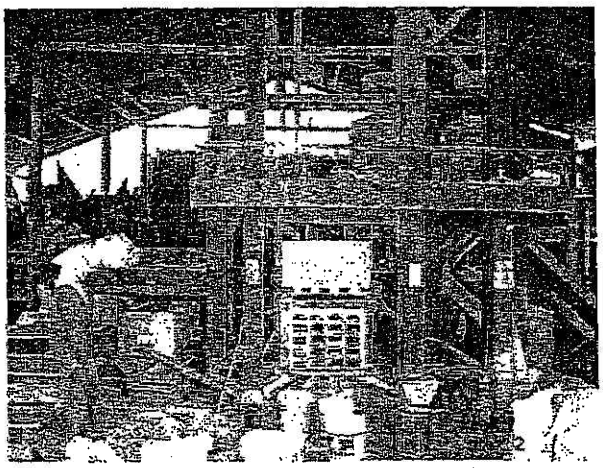


図１　調製加工施設内の様子

籾は、村内だけでなく周辺の村からも持ち込まれるということであった。周辺の村にも同様の調製加工施設はあるが、ノンジャルン村の施設は周辺の村の施設よりも効率がよいということで村外からの持ち込みも多いということであった。他の村の施設では、砕米の発生量が多く精米の量が少なくなってしまうということが原因といわれている。精米するための費用は、無料となっており、精米時に発生する糠と砕米を調製加工施設が受け取り、糠は牛，豚等の家畜の飼料として、また、砕米は加工用としてそれぞれ業者に販売しており、その売り上げを施設の経営者が収入として得ているとの事であった。最盛期には、施設に保管できないくらいの籾が持ち込まれるということであった。周辺の村にあった同様の施設では、同時期にまったく稼動していない施設があった。

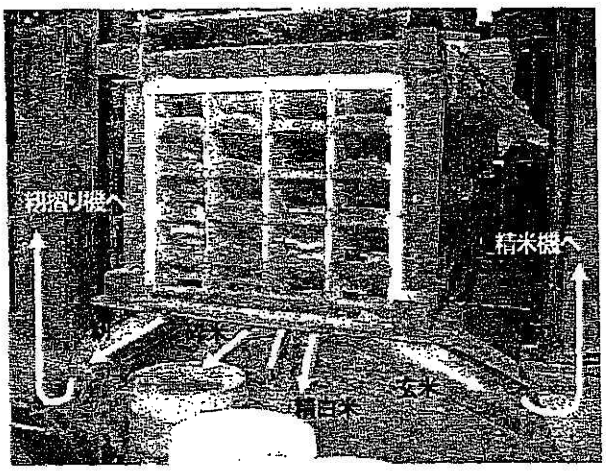


図２　選別機の様子

この調製加工施設の特徴は、持ち込まれた籾を無料で処理するということにある。大型の調製加工施設では、当然処理は有料となるが砕米も少なく効率よく精米すると思われるが、この施設では、精米の効率は必ずしもよくないが同様の他の施設よりは精米の量が多く、地域住民の自家米の無料処理を可能にし、周辺住民にとってきわめて重要な存在になっていると思われる。砕米の量を減らせば、無料での処理は不可能となる。適当な量の砕米を発生させているとは考えられないが、必ずしも効率のよい精米技術だけが望まれているわけではないことを知った。

OS16-7

フィリピンにおける農業機械開発の技術協力－PhilRice での例－

○猪之奥康治（生研センター）

フィリピンの Nueva Ecija 州にある国立稲研究所（PhilRice）に、1999 年と 2000 年に、当時の国際協力事業団（JICA）から１ヶ月半、短期専門家として派遣された。目的は、水稲のリーパ用収集機の開発であった。以下、この研究及び他のプロジェクト（ドラムシーダ）を通して、フィリピンにおける技術協力の状況の一端を報告させていただく。

１．リーパ及びイネ収集機の開発（1993～98、1999～2004）

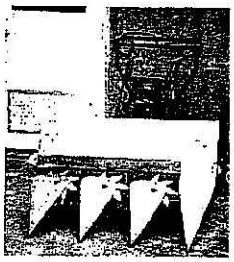
フィリピンでは、米は重要な主食であるものの、自給率は 100%に満たない状態で、生産力の向上が求められている。水稲の作業の内収穫や脱穀作業には特に多くの労働力を要しており、全投下労働力の約 60%、経費も総生産額の約６～８%を要している。収穫作業は、手刈りが一般的であり、10～16 人･日/ha もの労働力を要している。そこで、収穫作業の省力化・生産安定化を図るため、PhilRice は JICA とプロジェクトを組み、フィリピンの技術力に適した安価なリーパの開発を行った。本機の特徴は、円周上を４分割した位置に刈取刃を取り付けたロータリカッタを有しており、当時既に IRRI が開発していたリーパのコンセプトを大いに取り入れた、フィリピン国内で調達可能な部品等を用いたところにあった（図１）。私に課せられた課題は、リーパで刈り倒された稲を収集する機械の開発であり、私はリーパと一体化した装置の開発を行った（図２）。結果は、機構の検討が不十分のため良好な結果を売ることが出来なかった。しかし、後日カウンターパート等の努力により、リーパとは切り離した収集機を開発することで所期の目的は達成できたと聞いた。

２．ドラムシーダの開発（1992～1998）

フィリピンでは、年２作が一般的であるものの収量は低いのが現状である。農業人口も都市への流出のため、乾期は省力的な湛水直播を多く行っているが、手播きのため均一に播くことが難しく生育管理が困難な状態であった。そこで、歩行型トラクタに装着したドラムシーダの開発を行った。日本からは短期の専門家が適宜派遣され、スプリングサスペンションや接地輪の改良等を行い、播種量を設定量の±10%以内の精度まで高めることが出来た（図３）。この結果、研究期間終了後には十数台のドラムシーダを農家に貸し出すことが出来た。

３．技術協力について

どちらの研究及び技術協力についても成功した事例と言える。それは、現状のフィリピンの技術力に適した作業機の開発を目指し、フィリピン国内での生産を可能にした点であり、普及までさせたことである。一方、今後の技術協力の方向を考えた場合、国内では比較的高度な技術力を持つ PhilRice の試作工場での工作技術をさらに高度ものとしていただきたい。それは高い技術力こそ、より高度な機械の開発を可能にするからであり、製作手法の高度化とともにより高い工作技術の移転を日本側に望みたい。



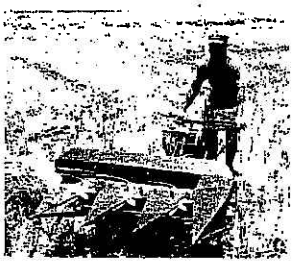


図１　開発されたリーパ（左プロトタイプ、右市販機）

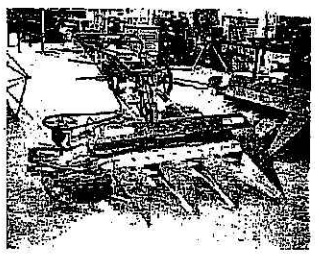
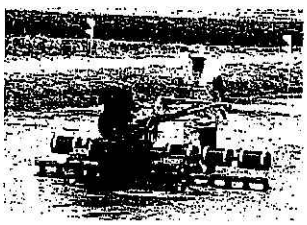


図２　収集装置を取り付けたリーパ



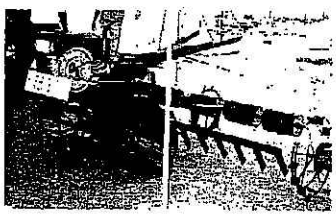


図３　ドラムシーダ（左試験機、右市販機）

第３章　あとがき及び参考資料

平成 18 年 1 月 1 日の朝刊紙面では，インドを中心とする周辺７箇国が結集して新たな経済的共同体「南アジア自由貿易圏（SAFTA)」が発足したとの記事が衆目を集めた。そこでは，緩やかな貿易協力体制を推進することがその目的であると唱われている。このニュースが象徴するように，アジアという広大な一つの地域の中での東南アジアという地理的括りは，これまでとは異なる形で周縁部との政治的，経済的，社会的関係を新たな思考で構築していかなければならない状況に変貌しつつあると言えよう。その状況は，人々の暮しに有形無形に影響を及ぼすこととなり，今後，そのような外圧に押しつぶされることのない対応策の構築作業が我われを待ち構えることになると考えられる。

このような社会的動向は，一昔前のグローバライゼーションに代る地域的な規模での動きと把えることができるであろうが，土着的要因を付与した動きであることから，その対応に要するエネルギーは一筋縄ではいかないことが予想される。

農村社会での技術の係りにおいて，新規に発明した技術について検討することに加えて，農村の変化態様と技術受容の関係についての調査は，技術の在りよう，改良，継承の観点からして，重要な示唆を与えてくれるものと考えられる。

脱稿するに当たり本研究の遂行において，さまざまな便宜供与をしていただき現地調査を可能としてくださったフィリピン稲研究所，フィリピン大学ロスバニョス校，カセサート大学，タイ王位かんがい局の方々，並びに神戸大学，九州女子大学，東京農業大学の各位に記して謝意を申し上げる次第である。

なお，次頁以降に参考資料３件を示す。

2005年（平成17年）11月7日

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タイで研究を公開

筑波大 小池教授ら 農機設計の調査

筑波大学の小池正之教授を研究代表とするプロジェクト「東南アジアにおける農業機械設計概念の特質に関する調査研究」チームは、15年度からのフィリピンとタイの国際共同研究の成果を公開するワークショップを11月25日、タイ・バンコックのミラクルホテルで開催する。

この研究は、フィリピンとタイで3年間にわたり聞き取り調査等を行い、技術受容の概念と形態、農業機械技術の民俗学的特質、風土・地形構造と機械導入形態の関係などについて、今日的意味づけをする作業を、学際的見地から行っているもの。

ワークショップでは、タイ・カセサート大学副学長のS・ピーラサック氏、タイ農業工学会長のT・タバチャイ氏が基調講演する予定。

葉たばこ耕作協
新年情報交換会

最近の情勢を報告

筑波大学小池氏が講演 東南アジアの農業機械


森会長

葉たばこ耕作機械協議会（森洋三会長）は1月27日、都内の全国たばこビルで新年情報交換会を開催し、最近の葉たばこをめぐる情勢についてJT、たばこ耕作組合関係者らから説明を受けたほか、筑波大学生命環境科学研究科・小池正之教授の講演「東南アジアにおける農業機械技術の受容構造と将来展開」を聞いた。

はじめにあいさつした森会長は、厳しい状況ながら環境対応やIT化などの時代ニーズに適う技術を取り込んで葉たばこ生産現場に新しい提案を進めていきたい旨抱負を述べた。

情報提供では、17年産葉たばこの販売に関して、バーレー種でまだ7割程度の進捗率とし（1月16日現在）、10a当たり代金は黄色種で平年対比97%の45万4493円、バーレー種で同89%の41万2036円になっていること、とくに鹿児島、沖縄県の第2黄色種が前年水準を大きく下回っていることなどが報告された。

今年産のたばこ耕作面積（公告面積、実際の耕作面積はこれを下回ることが多い）は1万8737ヘクタールで、前年の契約面積より2・2%ばかり減少した。昨年産は、廃作募集のため減少率が大きかったが、今年は平年並みの状況に戻った。

JTがまとめたたばこ作専用機械の普及台数は次の通り（単位・台、カッコ内は前年比）。

▽堆肥散布機＝2909（225台減）▽高架型作業機＝6410（71台増）▽接触剤散布装置（高架型作業機）＝1123（77台増）▽幹刈機＝4498（97台減）▽葉もぎ機＝13台（前年同数）▽施肥機＝6834（85台減）▽定速散布装置＝72台（17年産から新たにカウント）

日本葉たばこ技術開発協会が説明したたばこ耕作資材試験について、17年度は試験機がゼロだったが、18年度は▽たばこ運搬車＝井関農機（岩手県で実施）▽キセキたばこ伐根機＝同（同・沖縄県）の2課題を計画。

書面で18年度に使用可能となった機械は、▽クボタセル成型苗たばこ全自動移植機SKP-100T（クボタ）▽管理作業車用移植装置（バーレー種）AP-PBF（文明農機）▽高床マルチ回収機W-5（みのる産業）。仕様変更などの申請が承認されたのは▽サンダーロジュニアLS-JM-1、同LS-JM-2（三州産業）▽ヘルパー幹運搬車KYU-S-3TRC（関東農機）▽フルタゲートリフタGL1-3AD・3段吊用、同GL1-2AD・2段吊用（フルタ電機）▽ヘルパー集穫車KS-3C-5（関東農機）。

食農総合

■「第386回海外農機事情報告会」

平成18年2月28日（火）午後2時より(株)新農林社会議室

国際農業機械化研究会は(株)新農林社と共催で、第386回海外農機事情報告会を、平成18年2月28日（火）午後2時より(株)新農林社会議室において開催いたします。奮って出席くださいますよう案内申し上げます。

- **日　時**　平成18年2月28日（火）午後2時より
- **場　所**　(株)新農林社会議室（東京都千代田区神田錦町2－7）
- **テーマと講師**　「東南アジア農業と鍛冶産業」＝小池正之氏（筑波大学生命環境科学研究科・教授）
- **注**　社会情勢の変化に伴ってさまざまに変貌する東南アジアの農村、後継者不足に悩む鍛冶産業―そこには社会の波と人間の叡智との闘いのドラマがある。ここでは、平成15年から3年間にわたって実施した科学研究費海外学術調査の成果を報告する。今回は、特定の集落での農業生産、農村生活と機械化の状況について述べる。

- **会　費**　維持会員1,000円、大学・団体2,000円、産業界3,000円
- **申し込み先**　国際農業機械化研究会＝東京都千代田区神田錦町2－7・電話03(3291)5718・FAX03(3291)5717
  Eメールはこちらまで。
- **お願い**　出席者は、会場・資料作成等の関係がありますので、必ず所属・氏名をFAXしてください。