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Dry season rice production based on irrigation from man-made reservoir (Tomnub) of floodwater
(Siem Reap,Cambodia/Photo by K.Yasunobu)

In This Issue

JIRCAS
JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

The Role of Development Economics

Development economics is an applied field of macro and micro economics. Macro development economics used to be the mainstream. It analyzed the interdependency of savings, investments and population growth rates, and estimated the necessary aid for the targeted economic growth under a certain market mechanism. However, empirical evidences of the correlation were difficult to find between investments, aids, and economic performances, and it became clear that macro development economics alone could not solve practical issues in developing countries. There might be a problem in the assumption that a certain market mechanism works in every country.

Accordingly this time, roles of land and credit institutions, human capital, education, and health were studied from micro economic viewpoints that analyzed how market mechanism works under certain conditions. This "under certain conditions" is tricky. If the conditions were very diversified, the frequency of the individual cases that can be tackled from the entire cases and to what extent the solution of each case contributes to the improvement of the overall performance become obscure.

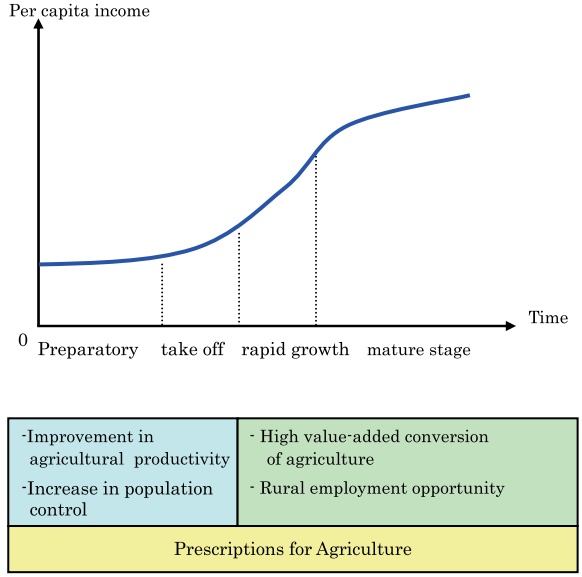
It is an extreme simplification to assume that a single stable rule applies across all cases of a social issue. On the contrary, even a large number of researchers can tackle only a small part of the entire cases if the solution is dependent on the unique condition of each of the innumerable cases. Therefore, such approach that classifies the overall phenomena and provides a solution for each of the classification is necessary. It is said that even the intuition of a chess wizard fails by 30%, and there is a reason for developing an economic expert system that compiles a standard solution for each classification. This approach is named "clinical economics" by Jeffery Sacks who wrote "The End of Poverty: Economic Possibilities for Our Time," in which he compares this approach to that of a medical doctor who prescribes probable remedies based on a chart of diagnostic checklist for patients.

In analyzing agriculture in developing countries, the "clinical economics" approach is equal to thinking of prescriptions for ensuring agricultural sustainability and alleviating poverty, which are dependent on some conditions such as present economic development stages and existing geographic conditions. This approach is being tried under the JIRCAS' "East Asian Economic Integration Project." East Asia is composed of countries with very diversified economic and geographic conditions under a similar monsoon climatic condition, and is therefore considered an appropriate region in which to apply the approach.

Let me start a story in line with the time axis of economic development (Fig. 1). Economic development stages are generally classified as preparatory, take off (early stage of development), rapid growth and mature periods. In the preparatory and take off periods, agriculture plays an important role in capital accumulation and acquiring foreign currencies. During that time, the relationship of agricultural productivity with population growth is very crucial. However, urban-rural income gap and increasing rural poverty become serious issues in the next stages. As prescriptions against these issues, the diversification of agricultural production, high value-added agriculture through high quality production and advanced processing technologies, farmers' horizontal integration activities such as forming cooperatives and expansion in rural employment opportunities,etc., could be listed down. Which suitable option out of this menu of prescriptions is more effective might depend on existing geographic conditions.

As is seen above, the parallel relationship of agricultural prescriptions with development stages might be clearer than that with geographic conditions. However, the rapid "catching up" of the Chinese economic development with the ASEAN has presented the possibility of providing a countercheck against the long observed "flying geese pattern" in Asian development, in which Newly Industrializing Economies (NIEs) and ASEAN countries have been following in Japan's pattern of industrial development. In addition, the Indian economic growth provides a new development model in which a country's economy is jumping from preparatory stage to high-tech and service industry stages such as IT, medicine, and movie industries, in the process by-passing the light and heavy industrial stages. In the meantime, whether we can find a stable relationship between agricultural prescriptions and development stages within the unique development paths of China and India is a big challenge for development economics which aims at using the approach of "clinical economics."

Fig. 1. Economic Development Stages and Prescriptions for Agriculture



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Farm Management Research in Southeast Asia: Technology Adoption and Dissemination

"Developing technology assessment methods to determine factors that influence technology diffusion in Southeast Asia (2006-2010)" is one of the researches under the project, *"Elucidation of the direction of technology development in developing regions and analysis of socioeconomic conditions to improve the status of farming and fishing villages,"* within the JIRCAS Mid-term Plan. In the Plan, there are two projects which consist of social science components. While another project focuses on macroeconomics, international/regional trade and policy research, this project deals mainly with micro and/or community-level problems, especially farm-household economy, farm management and technology issues.

The overall goal of this project is to provide socioeconomic information and characteristics about the specific regions in Southeast Asia in order to contribute to technology dissemination. Specifically, there are two main objectives: 1) To assess the farmers' current irrigation practices for rice cultivation and compare the relative economic efficiency and social acceptability for different modes of irrigation, and 2) To understand the linkage between farm management decision-making in terms of water irrigation control and the social relationships within the irrigation group. These issues will be carried out in selected research sites in the Philippines, Cambodia and Thailand.

We also took into consideration other topics which are not directly related water management issues. In Laos, Vietnam and Myanmar, we are interested in using the participatory method to understand local farmers' technology needs. In those areas, we are also focusing on group farming and resource management through participatory technology selection.

In the beginning stages of the project, we limited the study sites to unfavorable rice production areas in the Philippines, Cambodia and Thailand. These basic farm management researches will provide relevant information regarding possible obstacles and problems which will be encountered whenever new technologies will be disseminated in each area, since the relationship, community and ecosystem are quite unique in each area. The reason why we focused primarily on water irrigation management is because water is an important resource in high-risk rice farming under unfavorable conditions, which include unpredictable climatic conditions leading to unstable production due to damages brought about by both droughts and floods, and poor cultivation in lingering drought-prone fields in rainfed agriculture areas.

Prior to the start of this project in FY 2006, we have already started collaborative research with the International Rice Research Institute (IRRI), Philippines and the Cambodian Agricultural Research and Development Institute (CARDI) as early as the beginning of 2005. Through these collaborations, we conducted several activities, such as the selection of survey sites, the collection of communities' baseline information and so on. In July and November, 2006, we visited Thailand to selecte a possible research site with the cooperation of the National Agriculture Research Organization (NARO), a JSPS fellow, Khon Kaen University and the Ubon Ratchatani Rice Research Center. In Laos, we are going to start the research with the collaboration of the National Agriculture and Forestry Research Institute (NAFRI), while in Vietnam, the Cuu Long Delta Rice Research Institute (CLRRI) will work jointly with us.

Though every research site has a unique ecosystem and a different irrigation system, the same concept of "social capital" will be applied as the key concept in this study. Social capital is the fundamental concept which can describe any human relationship and interaction by using structural and cognitive measures, and widely known by the fact that the World Bank adopted this concept as a new theory of development in the 1990s. This is because the idea, that invisible characteristics such as trust and norm in the society can collectively be an important capital for development, is widely accepted. It focuses on non-economic factors, such as networking, communication among human beings, etc., which actually influence people's actions and play an important role for people's decision-making processes.

To measure the structure social capital, the community and/or organizational profiles will be used as bases while the cognitive social capital will be measured by the degree of shared trust (norms, values, attitudes and beliefs) among members in the community/organizations. Since irrigation water is the common resource which can be managed for sharing with others, social capital will be a useful concept to be adopted for the analysis on the utilization of irrigation water. Saving farming water is the most important issue because the unfavorable rice cultivation ecosystems suffer water-scarce condition or deteriorated / non-functioning irrigation facilities. The project outcome will help to improve the farming situation in those areas.

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Development Research Division, JIRCAS

Field survey in Cambodia: Interview with the association members of the Farmers' Water Users Community (FWUC) in Siem Reap

Field survey in Northeast Thailand: Interview about community activities by women farmers

Development of a Water-Saving Vegetable Cultivation Method through Farmer Participatory Approach in a Rainfed Agriculture Area in Indochina

In this vegetable-growing area in Thailand, the burden of watering can seem enormous. The farmer drags a hose, and shuttles from one corner to another in the field, taking a few hours in the mornings and evenings to perform this routine task. The volume of water habitually used is also quite large. The rainfed agriculture project is carrying out developmental research on water-saving vegetable cultivation technologies that can effectively utilize the valuable water resource in the rainfed region through the use of some techniques, such as the small-scale catchment pond in farms, mulching, etc.

In Khon Kaen Province, where the project site in Nong Saeng Village is located, the average annual precipitation in the last two years was only 700 mm or less. On the other hand, the average evaporation potential was 1,400 mm or more. In this environment, water-saving cultivation seems almost impossible; however, sugarcane has been grown locally without being watered, feeding only on soil-stored water.

A type of sandy soil widely covers most of Northeast Thailand. In this sandy soil, the capillary movement of water becomes interrupted when the surface dries, and evaporation at the ground surface is almost lost. On the other hand, rainwater infiltrates into the deeper layers of the sandy soil because of excessive rainwater at certain times, which exceeds its water-holding capacity.

Soil moisture content at down to 1 m deep was discovered at 76 points in two watersheds at the project site during the last dry season. There was 155 mm moisture as average precipitation in the soil within 1 m deep at the beginning of December, two months after the beginning of the dry season. As a result of the analysis, the influence of vegetation on the differences in the amount of moisture was found to be larger than that of the geographical features. The soil moisture content was at its lowest in the forest, followed by abandoned fallow lands, sugarcane or cassava fields, and finally rice fields. It is very important to recognize that if there are weeds, for example, in abandoned fallow lands, moisture is lost even without crops.

The water-saving cultivation method was developed through the farmer-participatory technology development approach, which was based on the principle that a farm technology can become adaptable only when it is modified by the farmer himself/herself in such a way to become suitable to his/her unique farming conditions. Then, an appropriate model technology that can be easily modified was developed. The message "Vegetables can be grown without watering in the morning and evening" was shared with the farmers, then the model technology was offered to them for experimentation, and they subsequently modified it to suit their own situation.

The farmers who participated in developing the water-saving tomato cultivation method are shown above.

As a result, 44 methods were invented from the two models. The existing standard level of watering was more than 500 mm, whereas that of the new method requires at most only 200 mm, the majority at 30 mm maximum and at 5 mm minimum. Moreover, the new tomato yield exceeded the provincial average in more than half of the fields. At the same time, the farmers achieved the extra result of chemical-free cultivation. The beneficial result that the participating farmers had also been emphasizing the most was the opportunity to be able to use the previous watering time for other activities. In addition, they said that the water-saving cultured tomatoes were more delicious than the previously produced tomatoes.

Some of these good practices have now spread to other villages by the scaling up of the project through technology exchange from farmer to farmer. Moreover, a JBIC (Japan Bank for International Cooperation) project has started to extend the use of water-saving technology in dry season. The project's water-saving cultivation technology development has likewise been registered in the Good Practices Database of the Food and Agriculture Organization or FAO's SARD (Sustainable Agriculture and Rural Development) website (http://www.fao.org/sard/en/init/1574/1846/index.html).

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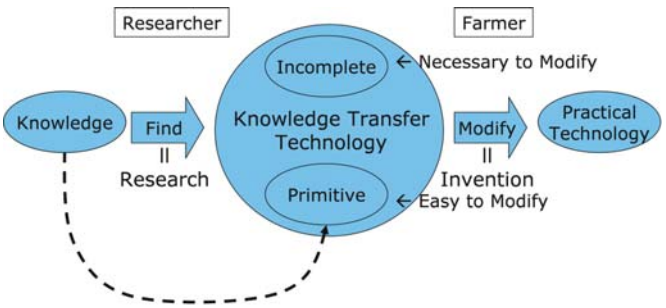

Fig. 1. Participatory technology development using Knowledge Transfer Technology

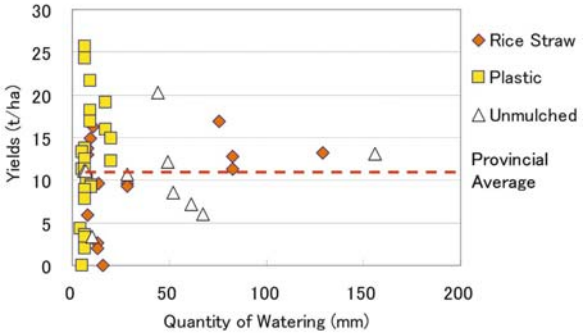

Fig. 2. The amount of irrigated water and yields of water-saving tomato

Development of a Sustainable Agro-Pastoral System in Northeast Asia

Drylands account for 47% of the world's total land area and are mainly distributed in Africa, Middle East and Central Asia. Most of these lands are found in developing countries, where potential annual evaporation plus transpiration exceed annual precipitation and are thus unsuitable for cultivating crops. In these areas, people traditionally make their living from livestock by producing meat, dairy products, etc. Recently, desertification and degradation of dryland pastures have emerged where overgrazing is reported to be one of the main causes.

However, it is difficult for herders to tell if their pastures are already overgrazed or not. In addition, herders usually tend to increase their cattle in order to sustain or improve their livelihoods. Thus, grazing pastures could sometimes be severely damaged and hard to restore. This irreversible phenomenon was mentioned by many experts and scientists present during the symposium held at the United Nations University in Tokyo to commemorate 2006 as the International Year of Deserts and Desertification (IYDD). In the same venue, the need for proactive research to combat desertification was also stressed. Although the expansion of desertification in the Sahel region is well known, the desertified lands in Northeast Asia have also increased and recently, even Japan has been affected by yellow dust from these desertified regions.

Therefore, we started in 2006 this research project targeting Northeast Asia, specifically China and Mongolia, in order to clarify the optimum conditions for feeding livestock by using pastures sustainably without causing pastoral land degradation. The sustainable use of pastures and the stable livelihood of livestock producers must reach or strike a balance at the same time. As vegetation in dry areas can easily be affected by climate change, it might be an ideal way to share the common use of a broad expanse of pasture under some mutual agreement, in terms of risk management, among the herders. It is sometimes pointed out that on the contrary, natural resources under common use are apt to be consumed without the users taking into account their sustainability, often referred to by socio-economists as the "tragedy of the commons."

In our research project, a survey on policies for agriculture, livestock industries and countermeasures against desertification in each country will be carried out. The actual nomadic herders' life, animal feeding operations and livestock-related markets for meat, dairy products and forage will also be comparatively surveyed in China and Mongolia, which exhibit contrasting land use systems. Estimation of vegetation changes by satellite remote sensing will also be carried out to know the relationship between the vegetation trend and the historical or chronological record of the herders' livestock grazing operations. In terms of experimental science, we will then develop a new approach to grazing and livestock feeding that can preserve pastures/grasslands by carrying out grazing experiments in Mongolia to find the optimum conditions that sustain vegetation under different animal species and grazing pressures, with or without supplemental feeding. Finally, researchers from both natural sciences and socio-economic disciplines will collaborate to find the optimal conditions which will enable a sustainable agro-pastoral system by simulating a model which describes the relationship between livestock household economy and pastoral vegetation based on the above-mentioned household survey, market survey and grazing and feeding experiments. We hope that this project will be able to successfully integrate the natural science approach and the social science approach, enabling us to find new ways to develop dry areas in Northeast Asia without causing or aggravating the encroaching desertification.

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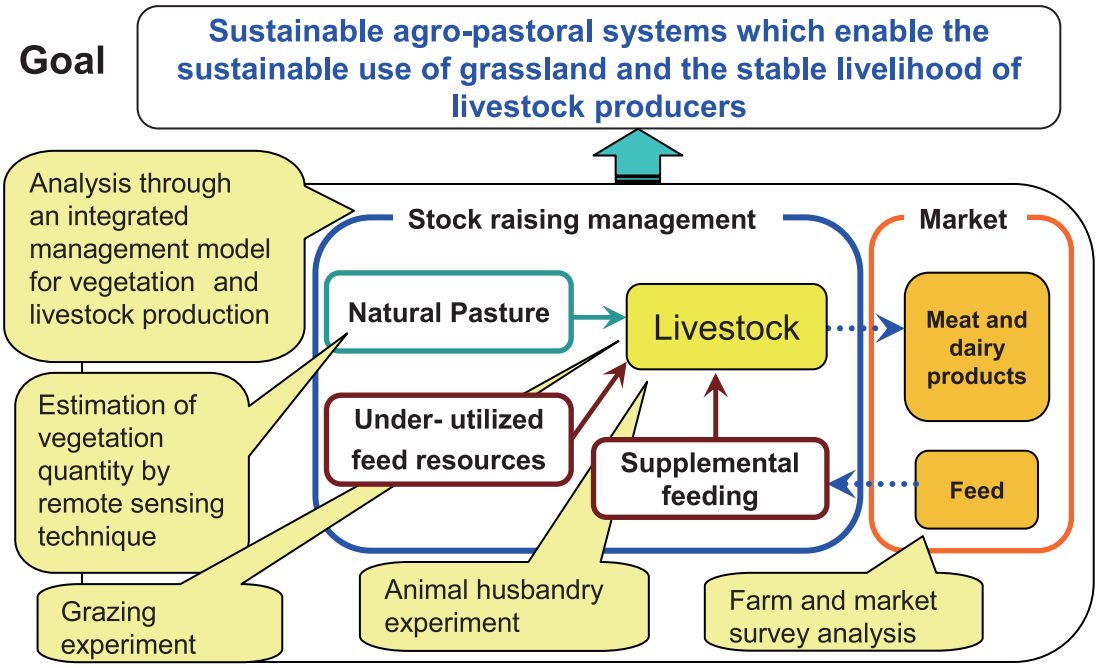
Animal Production and Grassland Division, JIRCAS

PROJECT OUTLINE



Improvement Effects of the Agro-Pastoral System on Soybean Production and Soil Properties

The opening up of some 12 million hectares of savanna area in South America has been carried out over the last 40 years. And soybean has been cultivated in most of the cleared areas. However, under continuous cropping for a long period of time, the soil productivity declines due to soil loss, soil compaction, loss of organic matters and increase in pests, diseases and weeds. Therefore, the productivity of the soybean as a crop is also decreasing/falling.

So, although the no-tillage system was introduced and gramineous crops such as corn and wheat have been cultivated during the winter season, these have not yet resulted in an effective solution. Then, in recent years, it was thought that the introduction of an agro-pastoral system which is a rotation-type system of crops and pasture is effective for the removal of the injury or damages caused by continuous cropping and for recovery of the productivity of the soybean crop. In an agro-pastoral system, there is a difficulty in simultaneously managing crops and cattle but the farm management is actually stabilized by adding animal husbandry to soybean cropping.

Therefore, in order to verify the improvement effect of the system, we conducted joint research with CETAPAR-JICA in Paraguay. We set up agro-pastoral plots wherein guineagrass had been grown for seven years after continuous cultivation of soybean for three years and separate continuous crop-cultivation plots where soybean has been continuously cultivated for 10 years, aimed at evaluating the soybean production between the agro-pastoral system and continuous cropping system (Photo 1). We collected soil samples from the soil surface down to a depth of 60 cm to investigate the effects of the agro-pastoral system on the chemical and physical properties of the soil.

Soybean production in agro-pastoral plots were twice as high as that in continuous crop-cultivation plots (Fig. 1). Soybean production of agro-pastoral plots in the 2003-2004 and 2004-2005 cropping seasons were 1.48 ton/ha and 3.56 ton/ha, respectively. On the other hand, production in the continuous crop-cultivation plots were 0.63 ton/ha and 1.91 ton/ha, respectively. The average soybean productivity in the Yguazu area with CETAPAR-JICA is a little less than 3.0 ton/ha, but soybean productivity in this area fell off greatly because of the severe drought during both growing seasons. For the same reason, the production of soybean was low in continuous crop-cultivation plots. Furthermore, local agro-pastoral system farmers said that “this system is strong even through drought”; our data likewise confirmed the same trends.

The percentages of organic matters at each depth as measured in the soils of the agro-pastoral plots were significantly higher than in the continuous crop-cultivation plots. The agro-pastoral system appears to be effective in the accumulation of organic matters by supplying more litter and effecting deeper rooting characteristic of the roots of guineagrass. Moreover, since fertilizer nutrients usually accumulate in the soil surface if soybean cultivation is by the no-tillage technique, then the growth of soybean is also inhibited. But, our data shows that the accumulations clearly improved on the soil surfaces of the agro-pastoral plots, because the concentration of phosphorus, potassium and magnesium in the agro-pastoral plots were 1/3, 1/2 and 2/3 of continuous crop-cultivation plots, respectively.

The percentage of large aggregates of soil in the agro-pastoral plots was higher than in the continuous crop-cultivation plots at each depth. This high percentage of large aggregates which promotes the inflow of air to the underground, then, likewise improves nitrogen fixation in soybeans. And then, soil compaction at the depths of 10 to 20 cm disappeared in the agro-pastoral system. Therefore, it appears that the improvements in the physical properties of the soil contributed to the recovery of soybean productivity.

Thus, we think that as the physical and chemical properties of soil are improved by the introduction of an agro-pastoral system, the productivity of the soybean crop also consequently recovers. Joint research is still continuing until now for the further evaluation of these improvement effects.

Katsuhisa Shimoda
Animal Production and Grassland Division, JIRCAS

Photo 1. Experimental site of the agro-pastoral system in Paraguay

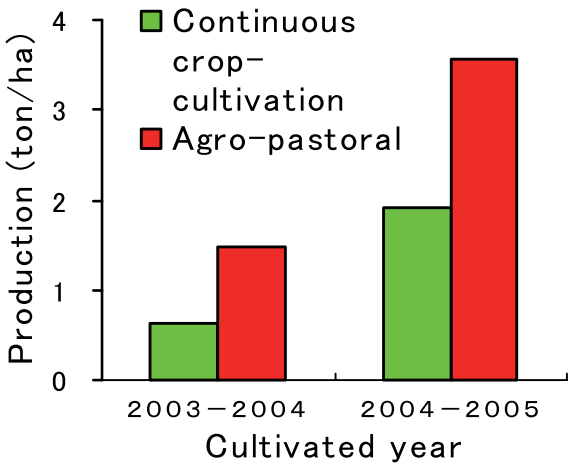


Fig. 1. Comparison of the soybean production in the agro-pastoral plots and continuous crop-cultivation plots

Development of Aquaculture Technologies Suited to Southeast Asia

Aquaculture is one of the best food-producing technologies that can contribute to a constant supply of proteins to the people and increase their incomes especially in developing areas. However, in intensive culture in particular, fish or shellfish are reared densely in a limited area and fed large amount of feeds to obtain high productivity. Accordingly, nutrient salts derived from the left-over feeds and excretion of the animals cause water pollution around the area. Moreover, in the culture of exotic species, these species have the potential of escaping into and establishing in natural waters, with the possibility of some adverse effects on biodiversity. The development of aquaculture technology which minimizes the environmental load is required to realize, not only efficient production, but also sustainable use of waters.

In this project, we are tackling the development of eco-friendly aquaculture technology which enables sustainable use of waters and which are applicable by the local people. The project includes 2 research subjects, as indicated below, concerning brackish water and freshwater aquaculture:

1. Study for appropriate aquaculture environment and development of aquaculture technologies in brackish water

Intensive prawn culture in mangrove areas has increased rapidly in Southeast Asia since the 1980s. It has not only deprived coastal ecosystems of the functions provided by mangroves but has also caused severe water pollution in these coastal areas.

We are currently developing eco-friendly prawn culture systems which enable stable and sustainable production, in collaboration with Kasetsart University in Thailand. More specifically, we are studying the utilization of mangroves, seaweeds, benthos and planktons for water purification and natural feed in prawn culture pond.

2. Study for development of eco-friendly aquaculture technologies in freshwater

In the inland of Southeast Asia, agriculture and aquaculture are closely related to each other. Local farmers have cultured fish in rice fields, reservoirs or ponds and the harvests have been important protein resources for them. However, there is still room for improvement in aquaculture techniques, including seed production and brood stock management. In addition, fish species for aquaculture have been mostly limited to exotic species such as tilapias or carps including Chinese carps. There is concern about the effect on the ecosystem in natural waters around the farms in case of these exotic species escaping into the natural habitat.

Photo 1. Indigenous fish species sold at a local market in Lao PDR

In this study, we are to conduct research for the development of eco-friendly freshwater aquaculture technologies suitable to the local condition in an inland country, Laos. In the Mekong Basin, there are some 1,300 fish species, some of which supposedly have potential for aquaculture. We will likewise select some indigenous species suitable for aquaculture from biological and socioeconomic points of view and develop technologies of breeding, polyculture and rice-fish culture systems.

This study started in November, 2006, in collaboration with the Living Aquatic Resources Research Center (LARReC) in Vientiane, Laos.

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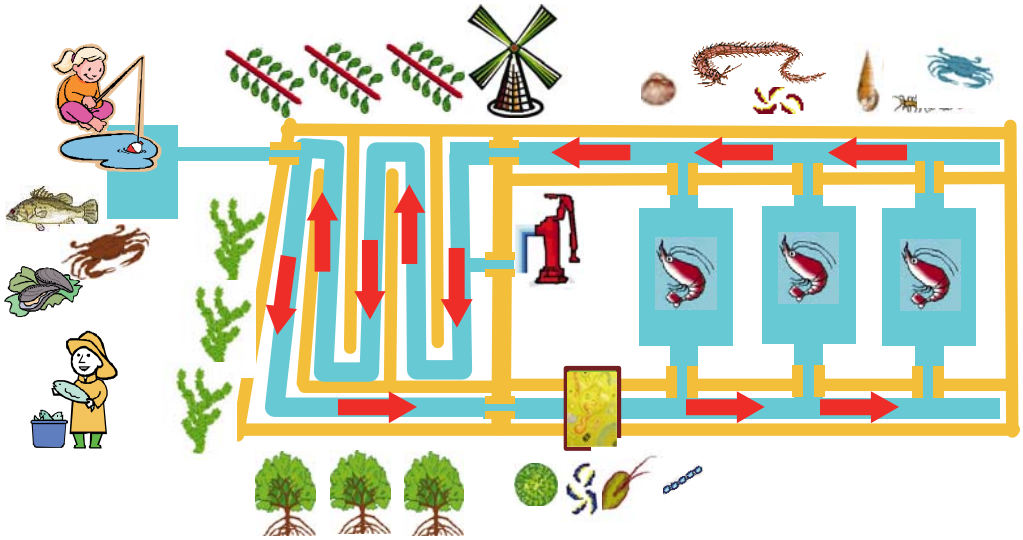

Fig. 1. Environment-friendly, recycling-oriented prawn aquaculture system utilizing the natural ecological functions of benthic and planktonic organisms, mangrove stands and seaweeds

Target of the "Low Tree Height-Cultivation of Tropical Fruits" Project

In the research project on fruit trees in temperate zones, as a solution to the aging of growers and labor shortages, these trees were trained to provide compact tree canopies and make low tree height-cultivation possible by utilizing dwarfing rootstocks. In the case of 'Satsuma' mandarin, dwarfing rootstocks of Trifoliate orange and 'Flying Dragon' were utilized and it was made possible to produce fruits with high sugar content and compact tree canopies. Previously, apples were harvested with tall stepladders but a dense planting technique, utilizing the dwarfing rootstocks of M-9 and M-26, made it possible to harvest higher yield far easily due to lower tree heights. In the case of the 'Fuyu' persimmon trees, fruits at the top of canopies were only previously accessible to crows because of their elevated canopy heights. Now, they are being cutback pruned for lower tree height-cultivation.

On the other hand, current tropical fruits' cultivation practices are careless and rough, no training and pruning are performed and activities are focused mainly on harvesting fallen fruits. One of the reasons why more advanced cultivation techniques did not progress was that even if the growers grew high quality fruits with care, the harvested fruits were sold more or less at the same price as the fallen fruits with insect bites or damages.

In progressively developing countries like China, Vietnam, Thailand, etc., wealthy people are starting to purchase fruits with great taste and appearance at premium prices which made possible the establishment of new markets in which fruits growers can expect higher income. Meanwhile, the demand for high quality fruits increased both in domestic and overseas markets. Exporting to overseas markets like Japan can fetch higher prices but so far no fruits with sufficient quality that can meet the Japanese consumers' taste and demand have yet been locally produced. The ideal economic condition that will enable the fruits growers to earn more profits will be established if they can sell high quality fruits which meet the market demand.

Hence, our research group started the project, 'Low tree height-cultivation of tropical fruits' to contribute to the incomes of tropical fruit growers by utilizing appropriate cultivation techniques. These techniques for tropical fruit trees include low tree-height training and pruning, mulching cultivation, regulating the flower-induction mechanism of specific tropical fruits such as durian, mangosteen, etc., and developing a year-round production technology for high-value fruits. Starting from the establishment of training and pruning techniques to be able to maintain within 5 m the maximum tree height of durian and mangosteen, which usually grow over 20 m in height, other techniques of artificial flower induction, pollination by utilizing pollinators, etc. will likewise be developed for consistent production.

Anyway, the outcomes of this project and the cost effectiveness of its developed technologies are required to be evaluated through interim review, which will be 3 years from now. Even though there is a disadvantage in using tree crops as experimental materials since they require several years (10-years in case of mangosteen) in order to be able to produce a first crop, the possibility of low tree height-cultivation for mangoes by utilizing a dwarf rootstock or interstock (Fig. 1) was already confirmed through past research. In addition it was also proven that there is the possibility of artificially inducing the flowering cycle of durian by giving water stress to the tree. Likewise, a decrease of yellow gumming symptom, which lowers quality (Fig. 2) in mangosteen fruits, was observed when they were harvested during the dry season.

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Fig. 1. Differences in tree growth affected by using dwarf interstock in mango
Left: Regular grafting
Center: With dwarf interstock
Right: Dwarf cultivar

Fig. 2. Appearance of mangosteen fruits
Left: Normal fruit flesh
Right: Fruit flesh with yellow gumming symptom

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