ISSN 0919-8822

JIRCAS Newsletter

FOR INTERNATIONAL COLLABORATION

NO.5 Nov. 1995

Field drain in oil palm estate in coastal acid sulphate area, Peninsular Malaysia (Photo by Y. Kitamura)

CONTENTS

JIRCAS
JAPAN INTERNATIONAL RESEARCH CENTER FOR AGRICULTURAL SCIENCES

Research Activities of the Biological Resources Division

Dr. Shoji Miyazaki
Director, Biological Resources Division

It is estimated that the world human population will double in the middle of the next century, while biodiversity on this planet is threatened. Biological resources are the base of human existence, which include genetic resources or any biotic component of ecosystems with actual or potential use or value for humanity (Convention on Biological Diversity, June 1992). We are now confronted with two difficult issues of vital importance: 1) effective utilization of biological resources to feed the rapidly growing population especially in developing countries and also 2) systematic conservation of biological resources to promote sustainable agricultural development in the future.

Research activities of the Division are being carried out overseas as well as at Tsukuba. Overseas research activities focus mainly on the development of agricultural technologies applicable to the respective local environments, while home research is more basic and being carried out in close linkage with overseas research activities, to support them using sophisticated facilities which are not available at overseas research sites.

A total of eight overseas research projects are being implemented. Using genetic resources, rice breeding projects are being carried out in Yunnan, in the subtropical highlands of China, for the development of cold tolerance and blast resistance, and in Malaysia for the production of high-yielding hybrid rice. A vegetable breeding project is also implemented at Shanghai, subtropical China, with emphasis on disease resistance. Doubled haploid breeding method is being applied at CIMMYT in order to breed wheat varieties with tolerance to various environmental stresses. Soybean breeding project has been recently implemented at Jilin, northern China. New varieties developed through these breeding projects are widely grown and contribute to the increase and stabilization of crop production with lower input in developing countries.

As for genetic diversity, Asian *Vigna* species including mungbean and its wild relatives are being collected in Southeast Asia and their phylogenetic relationships are being studied. Andean root and tuber crops are examined at CIP-Quito in order to clarify their botanical as well as agronomical characteristics. These research activities should contribute to the development of conservation technologies for endangered plant species. In addition, genetic diversity of plant pathogens is being investigated at the DNA level in Thailand and a DNA-based method for indexing greening disease of citrus has been recently developed (Photos 1, 2).

Regarding the linkage between overseas and home research, studies on drought tolerance of cowpea, tropical grain legumes, can be a good example. Since 1990, eco-physiological studies on cowpea have been carried out at IITA Kano Station, Nigeria, to analyse varietal differences in drought tolerance and adaptability in mixed cropping systems with sorghum. On the other hand, the Biotechnology Unit of the Division has been recently established at Tsukuba, to analyse the mechanisms of drought tolerance at the molecular level in cowpea and other higher plants and to identify several genes controlling the tolerance to drought. After cloning of these genes, attempts are made to clarify their structure by DNA analysis and their function in transgenic plants. Research fellows and visiting scientists are welcomed to join the research activities of this unit.

In order to apply biotechnological findings to the development of agricultural technologies, plant physiology studies are considered to be a prerequisite. It is, therefore, necessary to promote further plant physiology studies at Tsukuba, although some physiological studies on allelopathy or crop rotation systems have already been carried out.

Finally, in addition to the development of new technologies, more attention should be paid to determine whether the products are safe for the environment or human consumption. In this regard, the toxicity to mammals of bruchid resistance factor(s) introduced from wild mungbean TC1966 is being examined, since Thai mungbean lines with this resistance will be developed in the near future.

Photo 1: Symptoms of greening disease of citrus plants
Chlorosis is a characteristic symptom of leaves resembling that induced by zinc deficiency

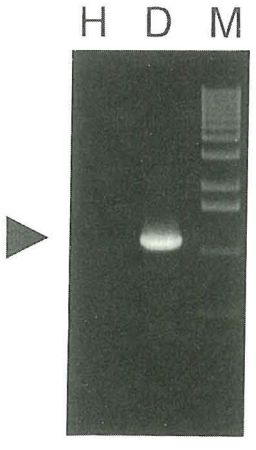


Photo 2: Electrophoresis analysis of DNA fragments amplified by the PCR using greening agent-specific primers
The DNA templates for PCR were derived from healthy citrus plants (lane H) and citrus plants with greening disease (lane D). Lane M shows 1 kb DNA marker. Arrowheads indicate the position of the amplified 16S rDNA fragments of the pathogen (about 1170 bp)

Changes in Earth Environment and Agriculture

Dr. Katsuyuki Minami
Director, Environmental Resources Division

It is undeniable that human activities are closely related to the changes in the earth environment. The cycling of all of the materials on a global scale has been transformed as a result of the clearing of forests for increasing the arable land area, expansion of the livestock industry, changes in the chemical composition of the atmosphere by the combustion of fossil fuels, discharge of wastes, cutting through mountains for mining deposits and distribution of mined heavy metals on the earth. Mankind is now modifying the original environment of the earth.

The biosphere of the earth seems to be suffering from environmental disruptions including global warming, depletion of the ozone layer, deforestation, sea pollution, air pollution, acid rain, deforestation, water pollution, soil erosion, pollution with metals, reduction of biological diversity, pollution with nuclear wastes, pollution with livestock wastes and depletion of underground water.

These trends are not new, because mankind has changed the earth environment for survival since coming into the world. The recent deterioration of the earth environment in the last five decades has been faster and larger than ever experienced. It may safely be said that a new material sphere called "human sphere" has been developed on the earth in addition to the biosphere, geosphere, atmosphere, etc. Mankind is actively analyzing the factors controlling the environmental disruptions caused by human activities and attempting to develop countermeasures.

Environmental limits have also been reached in the agriculture, forestry and fisheries industries. Productivity in a large number of existing farmlands has been reduced though new arable lands can not be expanded any more. The production of food from animals and plants has recently been reduced by deforestation, overgrazing, excessive fishing, salinization of soils and desertification. Water resources in many regions have been depleted and contaminated. Agricultural production and urban water resources will be strictly limited in the future.

The agricultural activities themselves through the increase of food production affect the environment. Nitrous oxide derived from the application of nitrogen fertilizers and from livestock wastes and methane produced from paddy fields and ruminant livestock affect the atmospheric composition and cause global warming. It has been demonstrated that the gases produced for the expansion of arable lands by the slash-and-burn method and combustion of biomass by forest clearing also cause global warming.

The State of the World Population published by the United Nations Population Fund indicates that the present world population of 5.7 billions will increase up to as much as approximately ten billions in 2050. The grain-yielding area in the world decreased from 695 million hectares to 693 million hectares in 1991, while the world population increased by 92 millions. The grain-yielding area per capita decreased, therefore, by 2.0%, showing a continuous downward trend since the middle of this century. This phenomenon is associated with the conversion of agricultural lands to non-agricultural lands, expansion of urban districts, soil erosion, conversion of irrigation water to city water and loss of farmlands by radioactive pollution. Chemical fertilizers had been able to compensate for the loss of farmlands until 1989. Even though more fertilizers may be applied than the present level, food production will not increase but only the environmental regulations will become stricter.

The world population has exceeded the population-supporting capacity of the earth due to environmental deterioration, population increase, increase of agricultural products, consumption pattern and selection of technologies. This trend is substantiated by the consumption of natural resources and environmental disruption.

Against this background a long-term strategy has to be worked out by JIRCAS.

It is most important and difficult to determine the upper limits of food production without exceeding the population-supporting capacity of the earth. Sustainable agricultural technologies have to be developed in various research fields using the limited resources in the limited environment.

To address the above problems, the following orientation of research could be adopted by agricultural scientists worldwide.

1. Emphasis should be placed on the development of technology involving the efficient material cycling of resources including elements, water, plant residues and animal wastes.
2. Efforts should be made to promote the development of detailed land use models for sustainable agriculture based on the projection of population increase and climatic changes in various agro-ecosystems.
3. Studies should be focused on the soil-plant relations to improve the adaptation of plants to adverse soil conditions and promote biological fixation for better utilization of nutrients through the use of biotechnological procedures.
4. Emphasis should be placed on studies on sustainable agriculture compatible with environmental conservation, including the prevention of soil erosion, water conservation, prevention of floods, water quality improvement, prevention of landslides, etc.

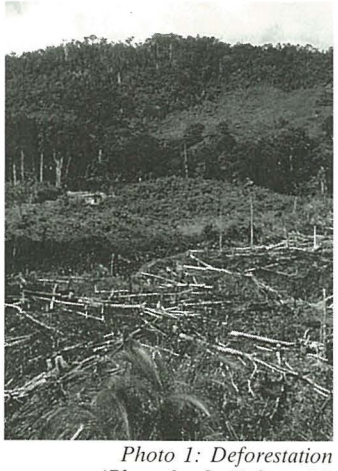


Photo 1: Deforestation
(Photo by S. Kobayashi)

Photo 2: Soil erosion
(Photo by S. Kobayashi)

Photo 3: Feedlots

JIRCAS RESEARCH HIGHLIGHTS

Anaerobic Direct Seeding of Wetland Rice in the Tropics

Minoru Yamauchi

Rice farmers in the tropics practice direct seeding by broadcasting germinated seeds on the puddled soil surface. Because the seeds are sown on the soil surface, they are often destroyed by birds and rodents, they may dry up due to direct exposure to sunlight, or may be splashed by heavy rain, resulting in erratic seedling establishment. In addition, plants are prone to lodging due to poor anchorage. Because the rice plants and weeds start to germinate at the same time, heavy weed infestation may occur. To address these problems, we developed a new seeding technology (called "anaerobic seeding") in which germinated seeds are broadcast or drill-sown anaerobically under the surface of flooded or water-saturated soil.

Germplasm accessions characterized by a high rate of seedling establishment from flooded soil were screened: elite accessions originating from Northeast India and Bangladesh due to their adaptation to deep water and early summer rainfed lowland culture. Since they elongate the coleoptile quickly under anaerobic conditions (Photo 1), O_2 can be efficiently transported to the germinating seeds in the anaerobic soil.

Seedling establishment varies even with identical cultivars if the source of seeds is different. We observed that seed aging (which reduces seed vigor) leads to poor seedling establishment in anaerobic soil. Cultivar ASD1 (origin: India) was found not only to display a high rate of seedling establishment in anaerobic soil but also to be tolerant to seed aging, thus being a suitable material for breeding rice cultivars for direct seeding.

Germinated seeds were successfully sown in the anaerobic soil layers by broadcasting soon after the field had been puddled or by drilling with a seeder especially designed for this practice. Collaboration with the Philippine Rice Research Institute (Photo 2), Cuu Long Delta Rice Research Institute, Vietnam Agricultural Science Institute, and Central Agriculture Research Institute of Myanmar demonstrated the superiority in seedling establishment.

Lodging was remarkably reduced by drill seeding compared with broadcast seeding. It was also found that the ability of the elite cultivars to withstand competition with weeds was higher than that of the ordinary cultivars. Thus, the improvement of seedling establishment through the integration of cultivar use and seeding method may enable to overcome major constraints on direct seeding culture of rice.

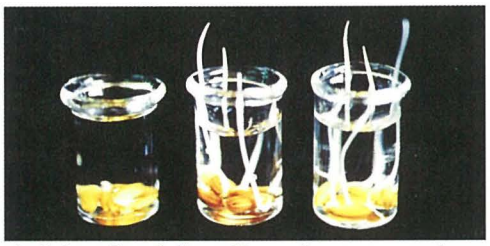


Photo 1: Coleoptiles of elite cultivars elongate more vigorously than those of the control (left) in the vials filled with water and subjected to the flow of N_2 gas

Photo 2: Rice crop establishment of elite (left) and control (right) cultivars. Germinated seeds were drill-sown under the puddled soil surface during the 1993 dry season in the experimental field of the Philippine Rice Research Institute

Survey on Characteristics of Agriculture in Central Asia and Priorities for Research Collaboration

Mitsunori Oka, Masaaki Suzuki, Shinobu Tanabe, Tetsuo Suyama** and Yoshinari Ohwaki*

Central Asia is one of the new research areas targeted for collaboration following the reorganization of TARC into JIRCAS. Central Asia stretches over four million km^2 on a vast steppe and desert with a wide range of temperatures, from the Tianshan and Pamir mountains to the east to the lower reaches of the Volga area and the Caspian Sea to the west. The area consists of five independent republics, Kazakhstan, Uzbekistan, Kirghizstan, Tajikistan and Turkmenistan formed immediately after the division of the Soviet Union in 1991. We visited twice the former three countries on the Silk Road to survey characteristics of agriculture and research constraints in 1994.

Traditional agriculture consisted originally of pastoralism in the steppe and oasis agriculture in the piedmont and desert areas. At present, agricultural activities are characterized by 1) settled cattle raising on grasslands, 2) rainfed upland crop production in the steppe of northern Kazakhstan and 3) agriculture based on large scale irrigation as well as oasis agriculture and 4) fisheries in river and lake basins.

Main constraints confronting agriculture include the deterioration of steppe and arable land, environmental problems in the basin of Aral Sea and erosion of genetic resources. Priorities for research are as follows: 1) development of sustainable grassland and animal production, 2) alleviation of environmental problems including soil salinization due to cotton cultivation with large scale irrigation and water pollution by agricultural chemicals and fertilizers in the Aral basin, 3) development of sustainable crop production (mainly wheat) in rainfed upland areas compatible with the preservation of soil fertility and 4) conservation and utilization of abundant agricultural resources, including fruits, vegetables, cereals and forage crops as well as animals (sheep cattle, horse, goat, etc.) and fishes in inland waters.

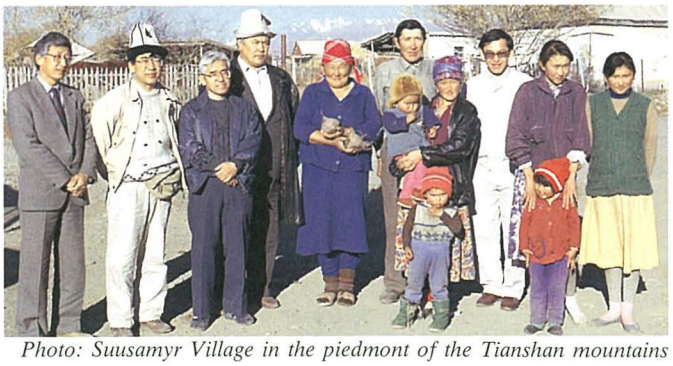


Photo: Suusamyr Village in the piedmont of the Tianshan mountains

Agricultural research organizations consist mainly of the Academy of Agricultural Sciences and its affiliated institutes in each country which have obtained significant results in their long research history, though the research activities are being stagnant under the current economic depression after the independence. It is essential to initiate international research collaboration in the major fields of agricultural environment and production described above in Central Asian Countries.

* Tohoku National Agricultural Experiment Station
** National Grassland Research Institute

A New Variety of Heat-Tolerant Snap Bean

Hiroshi Nakano

Nansei islands where JIRCAS Okinawa Subtropical Station is located are scattered in the southernmost region of Japan. In this area, during the summer vegetables are not cultivated due to the high temperature. Breeding of vegetables with heat tolerance has been one of the objectives of JIRCAS Okinawa Station for many years in order to compensate for the shortage of vegetables in this season and a new variety of heat-tolerant snap bean (*Phaseolus vulgaris* L.) was eventually developed.

Kidney bean is a heat-susceptible crop. Vegetable kidney beans (snap beans) are widely cultivated during the cool season in the Nansei islands but they are harvested when the air temperature rises in May.

JIRCAS Okinawa Station had organized one or two expeditions per year for the collection of plant germplasm abroad for the past twenty five years. Heat-tolerant snap bean germplasm was detected among the accessions collected in Malaysia and the Philippines in 1985. A new variety was bred through pure line selection from a heterogeneous seed population of the accession. The variety exhibited the highest heat tolerance and the highest yield performance among the varieties introduced from tropical countries and testing lines provided from CIAT (Centro Internacional de Agricultura Tropical, Colombia). The new variety, which had been called "Ishigaki No.1" in the breeding program, was named "Haibushi" (southern star, in the local dialect of Okinawa) by the Ministry of Agriculture, Forestry and Fisheries.

Haibushi is a variety of the vein type and medium maturing type that flowers about 50 days after sowing. Young pods of Haibushi are broad and light green. Mean pod length is about 13 cm. Haibushi shows a high pod setting ability at high temperatures unlike common varieties in which most of the flowers fall during hot spells. Critical temperature for pod setting in Haibushi ranges from 28.0°C to 29.5°C (mean day air temperature) for more than one month.

In the local adaptability tests carried out in various areas in the subtropical islands, Haibushi showed an adequate heat tolerance and high yield potential in open culture in summer. This new variety will be rapidly disseminated by the regional organizations concerned.

Photo: A young pod on Haibushi bean plant

Ecology and Control of the Albizzia Borer, *Xystrocera festiva*

*Kazuma Matsumoto and Ragil S. B. Irianto**

The albizzia borer, *Xystrocera festiva* (Coleoptera: Cerambycidae) is a serious pest of the leguminous forestry trees, albizzia, *Paraserianthes* (=*Albizia*) *falcataria*, and acacia, *Acacia mangium*, in Indonesia, but its ecology has not been fully documented and no effective control method has been developed. Under the first collaborative research program between JIRCAS and the Agency for Forestry Research and Development (Ministry of Forestry, Indonesia), we studied the life history, population dynamics and methods of control of the borer during the period 1991-94.

It took six to eight months for *X. festiva* to complete one generation. Adult longevity was short and females laid their clutch in just one or two clusters into cracks, nodes, traces of trimmings, etc. within a few days after emergence. Larvae gregariously fed under the bark, and finally bore into inner wood for pupation.

Population dynamics of the borer in an old albizzia plantation could be monitored along with the aging of albizzia: the borer invaded from surrounding older stands and began to attack 2 or 3 years old trees, and the population steadily increased throughout the two subsequent years. On trees from the age of 5 years until harvest cutting (usually 7 to 10 years old), the borer population remained comparatively stable. The population increase in young stands was promoted by artificial trimming; i.e., neighboring farmers regularly trimmed albizzia branches for fuel in young stands, providing many suitable oviposition sites for *X. festiva*. Therefore, trimming should be avoided during the four year period after planting. Selective removal of the attacked trees through thinning or salvage cutting every three months enabled to control the population, which is a practical method to protect albizzia and acacia plantations from the borer's attacks at a low cost in the small to medium scale forest areas on Java island.

X. festiva commonly occurred in villages, depending on several leguminous host trees useful for the farmers, such as *Pithecellobium jiringa, Parkia speciosa* and *Paraserianthes falcataria*. Once a man-made forest of albizzia or acacia was established nearby, the borer invaded the forest and its population increased. The borer dispersed rather slowly, due to the long life cycle and low adult dispersal capacity. Therefore, man-made forests of albizzia and acacia should be separated from already existing habitats of *X. festiva*, such as villages. Otherwise in the large scale plantations commonly observed in Sumatra and Kalimantan, control would be very difficult once the borer population became large.

* Forest and Nature Conservation Research and Development Center, Indonesia

Photo 1: A stem of Paraserianthes falcataria *heavily damaged by* Xystrocera festiva, *showing feeding larval galleries and bores made at pupation*

Photo 2: A colony of larvae of Xystrocera festiva *collected from one tree*

Photo 3: A newly eclosed adult of Xystrocera festiva *staying in pupal cell*

Nitrogen Management for Pigeonpea-Based Intercropping in the Semi-Arid Tropics

Osamu Ito, Katsuyuki Katayama, Joseph J. Adu-Gyamfi**, Theertham P. Rao** and Gayatri Devi***

Intercropping is a common practice in the semi-arid tropics to reduce the risk of crop failure due to the erratic rainfall. Combinations of cereals and legumes are recommended for extracting potential yield from the cereals and for maintaining soil fertility with nitrogen input by biological nitrogen fixation (BNF) of the legumes. Pigeonpea is considered to be best fitted as a component crop for intercropping in Alfisols as it is characterized by a rather long growing period and a deep root system, unlike other crops grown in the region. Among several options available at the farm level, fertilizer management would be most suitable to achieve an immediate increase in crop production in the area where most of the farmers have no access to irrigation facilities. Objectives of the project initiated in December 1989 for a period of five years in collaboration with ICRISAT were 1) to characterize rooting habit and nitrogen uptake efficiency of pigeonpea, 2) to analyse the nitrogen supplying capacity of soils during the cropping season and 3) to compare placement and timing of nitrogen fertilizer application in terms of land productivity and nitrogen use efficiency with a view to making appropriate recommendations for nitrogen management in the pigeonpea-based intercropping.

Using an exponential fitting of profile distribution of root length, it was found that the roots of pigeonpea spread less to the horizontal direction and more to the vertical direction than those of sorghum, pearl millet, groundnut and cowpea. A model based on weather and soil data predicted that the progress in the rooting front of pigeonpea was more rapid for the same physiological age. A kinetic study on nitrogen uptake showed that pigeonpea could utilize soil and fertilizer nitrogen as efficiently as other crops which lack an ability of BNF, suggesting that there is a considerable competition for nitrogen between the components crops when BNF of pigeonpea is suppressed. To reduce the competition for external nitrogen, it would be important to increase the dependence of pigeonpea on BNF.

Nitrate concentration in the soil solution which was found to be the highest at the beginning of the cropping season decreased rapidly thereafter. The values became very low within two months after sowing. The maximum amount of nitrogen present in the soil solution was calculated to be 100 to 150 kg ha^{-1} within 50 cm soil depth, suggesting that an appreciable amount of nitrogen would be available for the crops during the initial growth stage even in nutrient-limited Alfisols.

The application of urea to the sorghum row was superior to broadcasting and split application, and delayed application at one month after sowing was superior to the application before sowing in terms of nitrogen use efficiency of a component sorghum crop, without affecting land productivity. The delayed application would be also advantageous in saving valuable input when crop establishment fails due to insufficient rainfall.

For the improvement of resource utilization in intercropping, it was recommended to associate pigeonpea with the crop which has a shallower root system and a higher nitrogen uptake efficiency such as sorghum, and to apply nitrogen fertilizer to rows of the cereal crop before nitrogen disappears from the soil solution which normally occurs about one month after sowing.

* National Agriculture Research Center,
** International Crops Research Institute for the Semi-Arid Tropics

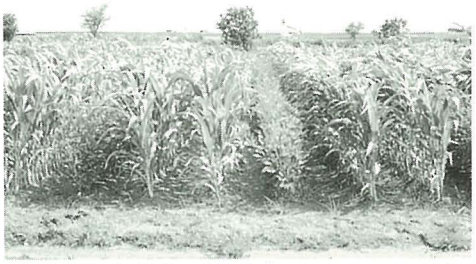


Photo 1: Sorghum/pigeonpea intercropping

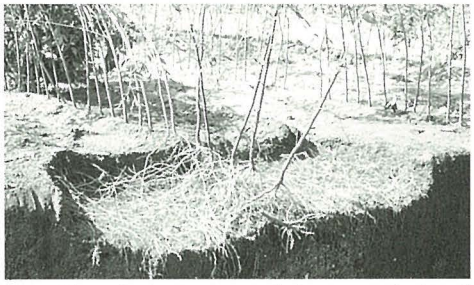


Photo 2: Root system of pigeonpea displayed in the field by trench wall method

≪New Research Field≫

Collapsible Soils

Yuji Kohgo

Soils which are subjected to compressive deformation due to wetting (saturation collapse) under natural conditions, are designated as "collapsible soils". One of these soils, Loess (in Chinese, loess is called "Kohdo") covers 11% of the world land area[1]. The collapse behavior can also be seen in soils compacted on the dry side of optimum water content. For the construction of irrigation facilities using soil materials, for example fill-type dams, it is therefore very important to investigate the possibility of saturation collapse of the soils which may lead to the damage of the facilities.

Fig. 1 shows the typical collapse behavior of a soil in a laboratory test[2]. If the soil is soaked under a constant load applied under unsaturated conditions, a large amount of compressive deformation may occur. The stress point after soaking lies on the loading line obtained under saturated conditions. Deformation of the soil may not be significant until the yield load is applied under unsaturated conditions.

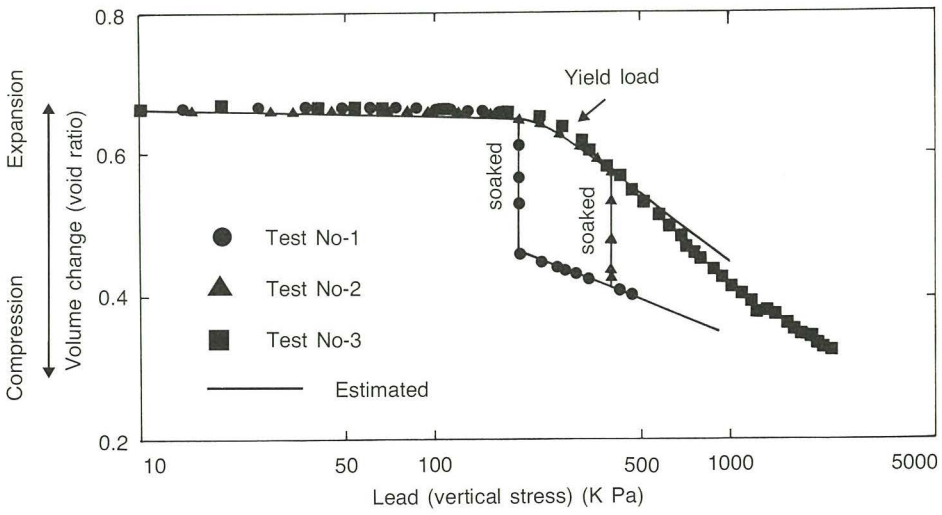


Fig. 1. Typical collapse behavior of a soil (Relationship between volume change and load)

Thus, the soil is considerably stiff under unsaturated conditions.

Photo 1 shows the damage of a building due to saturation collapse. The building with a raft foundation was built on a loess soil (Red Loess). The soil was saturated with wasted water which percolated into the ground and ground settlement then occurred. The gap between the building and the ground due to the ground settlement reached about 10 cm in maximum and many cracks ran in the walls, floors and ceilings. The mechanism regulating the ground settlement may be explained as follows.

Under dry conditions, the pore water in pores is retained in the meniscuses around contact points between soil particles. Due to the surface tension at the boundary between the water and the air, soil particles are drawn to each other with a force known as the capillary force. The capillary force increases with the reduction in the degree of saturation. As the capillary force generates shearing resistance between soil particles, the soil bearing capacity is sufficiently high to withstand plastic deformation and ground settlement under unsaturated conditions. However, once the collapsible soils are saturated, the capillary force disappears completely and compressive deformation occurs as shown in Fig.1. This phenomenon often results in destructive damage of structures built on collapsible soils.

Actually, the phenomenon of compressive deformation of the collapsible soils under saturated conditions is a natural process whereby the soil density and bearing capacity increase. However, this is an irreversible phenomenon which brings about large shrinkage in volume and causes considerable damage to the structures built on collapsible soils. It is very important to analyse the mechanism of saturation collapse quantitatively as well as to investigate the soil properties precisely under both saturated and unsaturated conditions in order to prevent such damage from occurring.

The saturation collapse behavior is one of the typical properties of unsaturated soils and has been one of the most difficult problems to analyse quantitatively in the field of soil mechanics for a long time. A few groups of researchers[3,4,5] have attempted to address the problem on the basis of elastoplastic theory since the end of the 1980s. We have developed elastoplastic models which may enable to estimate the saturation collapse[6,7]. An example of estimation of the saturation collapse using an elastoplastic model can also be seen in Fig.1. The estimation results are represented as solid lines. Both experimental and estimation results coincided well. It is thus important to promote research on the mechanism of saturation collapse of collapsible soils for the precise estimation of the physical behavior of such soils and application to the design of structures to prevent the damage.

Photo: Damage of structures built on collapsible soil

REFERENCES

1) Miki, G. (1978). Loess, Tsuchi to Kiso, Vol. 26, No. 5, 84-85, (in Japanese).
2) Maswoswe, J. (1985). Stress Paths for a Compacted Soil during Collapse due to Wetting, Ph. D. Thesis, University of London, 1-485.
3) Kohgo,Y. (1987). The Interpretations and Analyses of Mechanical Behavior of Partly Saturated Soils using Elastoplastic Models. Proc. Symp. On Unsaturated Soils, Osaka, Japan, JSSMFE, 69-78, (in Japanese).
4) Karube, D. and Kato, S. (1989). Yield Function of Unsaturated Soil. Proc. 12th ICSMFE, Rio de Janeiro, Vol. 1, 615-618.
5) Alonso, E. E., Gens, A. and Josa, A. (1990). A Constitutive Model for Partially Saturated Soils, Geotechnique 40, No.3, 405-430.
6) Kohgo, Y., Nakano, M. and Miyazaki, T. (1993). Theoretical Aspects of Constitutive Modeling for Unsaturated Soils. Soils and Foundations Vol. 33, No.4, 49-63.
7) Kohgo, Y., Nakano, M. and Miyazaki, T. (1993). Verification of the Generalized Elastoplastic Model for Unsaturated Soils. Soils and Foundations Vol. 33, No.4, 64-73.

≪Overseas Information≫

Changes in the Right to Use Land in Vietnam
— Situation in Red River Delta —

Sho Kosugi

The year of 1995 is a memorable year for Vietnam, as 20 years have passed since the end of the Vietnam War and Vietnam just became the seventh member of ASEAN. In addition, the diplomatic relations with the United States of America have been normalized. On the other hand, various laws are being promulgated for the transition from a centrally planned economy to a market-oriented system under the renovation policy called "Doi Moi". As a result, farmers who account for 80% of the total population which is estimated at 72 million may face major changes.

Vietnam agriculture and villages are experiencing remarkable changes as evidenced by the export of nearly two million tons of rice per year recently and the transfer of the right of farm land use from state ownership to smallholder farmers. Each farm household received 0.3 ha of land in the Red River Delta or 1.17 ha in the Mekong River Delta on average in 1991. The situation is similar to that of Japan just after the end of World War II.

1. Increase in the number of smallholder farmers

The renovation policy resulted in the promulgation of a new "Land Law" which became effective in July 1993 as follows: 1) one farm household can manage up to three ha of farm land, 2) farmers are allowed to use their farm land during a 20-year period for non-perennial crops and during a 50-year period for perennial crops and 3) the right of using farm land can be inherited, mortgaged, and leased. Smallholder farmers are now able to manage farm land by themselves.

As a result, smallholder farms coexist with state-owned farms, and cooperative farms whose roles were changed. A cooperative farm is organized by roughly all the farmers in one village for supporting services like lending machines and supplying fertilizer and for collecting a tax but not for managing the production. Almost all of the state-owned farms provide reclaimed land to farmers, introduce new seeds and ways of production, are in charge of processing and selling agricultural products, etc. The number of smallholder farm households who were allowed to manage their farm land increased and amounted to 10.28 million as of 1993 (Table).

2. Red River Delta area

Red River Delta area which is located in the northern part of Vietnam is also an important area for the nation as the population density is larger but the natural conditions are less favorable than in the Mekong River Delta. Mekong River Delta, which is located in the southern part of Vietnam, is very famous because farmers there produce large quantities of rice and most of the rice exports of the country come from this area. Though the Mekong River Delta area accounts for 38% of the national cultivated land and 38% of national food production, farm village population accounts for only 24% of the total population of Vietnam. On the other hand, the Red River Delta area which is the administrative center of the country accounts for 13% of the total farm land, 18 % of the total food production, and 22% of the total population in the country.

3. Example of agricultural activities in the Red River Delta

Vinh Phu Province is located 100 km apart from Hanoi, the capital of Vietnam, in the northern agricultural area of the Red River Delta. The right of managing farm land was transferred to farmers in April 1992. One family member, irrespective of age or sex, received the right to operate 0.1 ha in a flat area, 0.12 ha in a hilly area, and 0.15 ha in a mountainous area.

Smallholder farmers are allowed to manage the land but most of them do not seem to realize that the role of the cooperative farms has decreased in terms of extension services, provision of subsidies,

supply of inputs, etc. The expectations of many farmers, with a low technical level, small capital, and limited marketing channel that agricultural extension services provided by the government may help them may not be fully realized.

To alleviate these shortcomings, the authorities of Vinh Phu Province set up a Coordination Committee for Agricultural Extension to compensate for the role of cooperative farms. The Committee organized a systematic apparatus: 1) Agricultural extension committee in the Province, 2) Extension bureau in every District and 3) Extension groups at the village level. The system was estimated to be successful not only by the Province but also by the government.

Therefore a nationwide extension system was organized by the Ministry of Agriculture and Food Industry (MAFI) in March 1993. Since this system is very much appreciated by the farmers, MAFI plans to train and re-educate extension officers and workers who were transferred from other sections and offices. However, the administrative investment fund for the extension system is so limited that the budget for training personnel and for extension work is insufficient and it will be necessary to implement a more effective system in future.

4. Possibility of undertaking cooperative research in the Red River Delta

JIRCAS initiated an integrated research project entitled: "Evaluation and Improvement on Farming Systems Combining Agriculture, Animal Husbandry and Fisheries in the Mekong Delta" in cooperation with Cuu Long Delta Rice Research Institute and Can Tho University (refer to Newsletter Vol.2 No.1 June, 1994). Although there are differences in the rural structure between the northern and southern parts of Vietnam, as mentioned above, it may be possible to undertake a form of cooperation to develop appropriate technologies.

Table Some indicators relating to Vietnam agriculture

	Indicators	Unit	1985	1990	1993
1	Farmer households	thous. houses	8,315	9,357	10,281
2	Agricultural population	thous. persons	41,244	45,421	49,574
3	Labour for agriculture	thous. persons	18,808	21,863	23,700
4	(of which state labour)	thous. persons	408	343	260
5	State farms	number	1,376	793	651
6	Cooperatives	number	55,714	30,433	22,900
7	Tractors	units	31,620	25,086	37,000
8	Pump machines	units	188,631	168,145	225,500
9	Chemical fertilizers	thous. tons	1,819	2,644	3,250
10	(of which nitrogenous)	thous. tons	1,419	2,110	2,650
11	(of which phosphoric)	thous. tons	346	402	450
12	Insecticide production	thous. tons	18	9	10
13	Spring rice	thous. tons	6,191	7,846	9,032
14	Autumn rice	thous. tons	2,855	4,110	5,144
15	Winter rice	thous. tons	6,828	7,269	7,724
16	Coffee	thous. tons	36	321	390
17	Cattle	thous. head	2,598	3,121	3,265
18	GDP per capita in Vietnam	US Dollar	n/a	121	181

Source: 1-17 General Statistical Office, Statistical Data of Agriculture, Forestry and Fisheries, 1985-1993
18 EIU Country Report, 1st quarter 1995, Vietnam

Photo 1: (Bridge): Trucks and trains run on the same bridge in National Highway No. 1

Photo 2: Trainees in lecture room

≪Topics≫

The 2nd JIRCAS International Symposium
15th Asian-Pacific Weed Science Society Conference

Innovative Weed Management Strategy for Sustainable Agriculture

Minoru Takabayashi

The 2nd JIRCAS International Symposium on "Innovative Weed Management Strategy for Sustainable Agriculture", sponsored by Japan International Research Center for Agricultural Sciences (JIRCAS) in cooperation with Food and Fertilizer Technology Center for the Asian and Pacific Region (FFTC) and in conjunction with the 15th Asian-Pacific Weed Science Society Conference (APWSS) was held at Tsukuba Science City on July 26-28, 1995. The subject of the symposium covered the current situation and future prospects of weed management for sustainable agriculture. The subject was highly evaluated by related researchers, and a large number of participants (more than 500) attended the symposium.

The objective of the symposium was to discuss various aspects relating to weed control compatible with the preservation of the environment for the promotion of sustainable agriculture. The symposium consisted of a keynote address and two sessions (I, II). At the opening of the symposium, Dr. K. Kainuma, Director General of JIRCAS, gave the inaugural address, followed by the welcome addresses by Dr. T. Sato, Deputy Director of FFTC, and Mr. K. Kadowaki, Director, International Research Division, Agriculture, Forestry and Fisheries Research Council Secretariat, MAFF.

The symposium started with a keynote address delivered by Dr. K. Ishizuka, Chairperson of 15th APWSS. The subject of Session I was: "Present status of weed problems in sustainable agriculture". Presented papers were as follows:

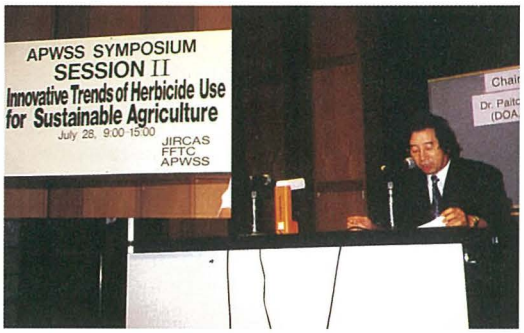
- Noxious weeds in Asian tropics and their control. U. Suwunnamek (Thailand)
- The succession of noxious weeds in tropical Asian rice fields with emphasis on Malaysian rice ecosystems. M. Azmi & B. B. Baki (Malaysia)
- Weedy rice problems in Southeast Asia and control strategy. H. Watanabe (Japan)
- Implementation of integrated weed management for sustainable rice production. P. Vongsaroj (Thailand)
- Sustainability in rice weed management. K. Moody (Philippines)
- The contribution of no-tillage crop production to sustainable agriculture. A. D. Worsham & G. G. Nagabhushana (USA)
- Weed management in rubber plantation with special reference to minimum tillage cultivation. S. Tjitrosemito (Indonesia)

The subject of Session II was : "Innovative trends of herbicide use for sustainable agriculture". Presented papers were as follows:

- Current status of rice herbicide use in the tropics. N. K. Ho (Malaysia)
- Longterm concepts of herbicide use in paddy fields in Korea. J. O. Guh (Korea)
- Technical innovation in herbicide use. M. Kamoi & K. Noritake (Japan)

- Effectiveness and behavior of soil-applied herbicides. Y. W. Kwon (Korea)
- Allelopathic compounds as naturally occurring herbicides. C. H. Chou (Taiwan)
- Herbicide safeners : Recent advances and biochemical aspects of their mode of action. K. Kreuz, S. Farago, S. Murakami & H. C. Steinruecken (CIBA-GEIGY Japan)
- Current status of herbicide-resistant weeds and their management strategies. J. C. Cotterman (USA)
- Current and future herbicide risk assessment in Europe and United States. W. L. Chen (USA)

Eight papers related to the symposium were presented in the concurrent session before the symposium. The proceedings of the symposium will be published as International Agricultural Research Series (IARS) in the near future by JIRCAS.



Photos 1, 2: Symposium on Weed Science

⁂⁂⁂⁂⁂⁂⁂ JIRCAS News ⁂⁂⁂⁂⁂⁂⁂

Dr. Keiji Kainuma, Director General of JIRCAS was nominated as member of the Technical Advisory Committee (TAC) of the Consultative Group on International Agricultural Research (CGIAR) at the Mid-Term Meeting of the CGIAR held in Nairobi during the period May 22-24, 1995.

≪Overseas Survey≫

Utilization of Freshwater Fishes in China

Kouji Nakamura

Pond aquaculture of freshwater fishes dates back to the 11th century B.C., in the latter part of the Yin-Sho dynasty and/or the Shu period. Around 500 B.C., Fan Li published a book on the breeding of fishes, in which it is stated that carp was the main fish for aquaculture. This shows how early Chinese aquaculture began.

According to the fishery statistics of FAO in 1993, the catches in the inland waters of China amounted to 7.5 million tons, a value four times as large as the value of 1.84 million tons recorded 10 years before. It is predicted that the catches may reach 10.0 million tons in the near future (in recent years, India was second next to China with catches amounting to about 1.5 million tons). Species suitable for aquaculture in China consist of approximately 50 species, suggesting that aquaculture in China surpasses that in other countries both in quality and quantity.

Along with the rapid increase of the population in many countries, the major problem is to secure a sufficient amount of protein in food. China is no exception and the Chinese Government is implementing policies to secure a stable food supply. Development of fishery products in inland waters is one of the priorities aiming at the diversification of the source of protein supply. For stable supply, the production should obviously increase. Furthermore, it is essential to alleviate the current ineffective use of fishes which are distributed only in the living state. To promote the distribution of fishery products effectively and extensively without deterioration, social infrastructure including the use of railways and roads, as well as distribution systems, such as cold chain, should be further developed. In addition, studies should be carried out on the characteristics of fishes to develop various processing methods for fishery products.

World total catches in inland waters had been relatively small (10% of the whole catches) up to recently. As a result, biochemical or food chemical investigations had hardly been carried out in freshwater fishes. The characteristics of myofibrillar protein, which accounts for 50～75% of the whole protein, have not been examined in as great detail for freshwater fishes as for saltwater fishes. Actomyosin (myosin) accounts for the greater part of myofibrillar protein and plays a leading role in muscle contraction. Recently, it has been reported that the amino acid sequence of actomyosin varied even in the same species. The changes were assumed to be induced by differences in the culture temperature. This phenomenon is referred to as "biological fluctuation". Furthermore, the changes appeared mainly in the S-1 fraction displaying ATPase activity in actomyosin. It is likely that there is a remarkable difference in the amino acid sequences of proteins and characteristics of proteins between freshwater and saltwater fishes. The investigations on the actomyosin structure and analysis of protein characteristics, which will be carried out under the collaborative project between Shanghai Fisheries University in China and JIRCAS in Japan, should lead to the development of new food processing methods for effective use of fresh-water biological resources. At the same time, basic biochemical data should be obtained.

From the viewpoint of the protection of the environment, fishing activities in the sea will be strictly regulated. On the other hand, aquaculture in inland waters can be regulated only by municipal laws. Furthermore, the control can be easily achieved scientifically or technically. The production can be controlled easily, and a large capital is not required. Due to these advantages, inland waters should become production areas in developing countries. However, due to the possible pollution of inland waters, such as rivers and lakes, aquaculture should be promoted cautiously.

Photo 1: Fishermen in Taifu Lake located in the center of Koso Prefecture, where aquaculture is extensively carried out

Photo 2: Dried fishes and some fish processing products sold at the fish market of Zhanjiang City

Drainage Situation in South and Southeast Asian Monsoon Region
— Collaborative Study with The World Bank —

Yoshinobu Kitamura, Kazuo Murashima, Yoshihiko Ogino** and L.Smedema****

The past and ongoing programs of international organizations concerned with agricultural development had concentrated their efforts mainly on irrigation development. Therefore, irrigation has played a significant role in increasing the productivity of agriculture in South and Southeast Asian countries. On the other hand, drainage has been given limited attention, being mostly confined to the irrigation-induced problems in the arid and semi-arid regions. The rainfall-induced drainage problems in the humid and semi-humid regions have not been given priority.

In the past, waterlogged condition of the land during the monsoon season was generally not a major constraint as rice was the main crop during this season and agricultural production levels were anyway restricted by many other factors. Rising yield levels, introduction of more sensitive varieties and growing demand for crop diversification have changed this situation. As a result, improvement of drainage control during the monsoon season has become a major issue.

Thus, the importance of drainage has increased to enhance agricultural productivity as well as to improve the living environment of rural inhabitants. This is especially true for the low-lying lands of South and Southeast Asia which experience inundation during the rainy season almost every year. There is an urgent need for improving the drainage conditions during the monsoon season in this region.

The World Bank (IBRD) attaches much importance to drainage and is trying to address this problem within the framework of the "International Program for Technology Research in Irrigation and Drainage (IPTRID)". As the first stage, IBRD carried out a study to analyse the current situation of rainfall-induced drainage problems for the identification of priority research and development (R&D) needs in five countries of South and Southeast Asia (India, Malaysia, Thailand, Vietnam and Philippines). The results of the study in the five countries are summarized as follows:

India: Emphasis has been placed on drainage improvement to overcome irrigation-induced drainage problems in arid and semi-arid regions. Flood control is now being implemented mainly in the Ganga River basin. The rainfall-induced drainage problems are mainly identified in the river plains and deltas of the East coast. Only gravity drainage is applied in those areas. The difficulty of drainage management stems from the large size of the unit drainage blocks. Rearrangement and downsizing of drainage systems with proper size of drainage blocks is needed. Since semi-arid regions also experience rainfall-induced drainage problems, proper drainage improvement is required to cope with both problems.

Malaysia: Emphasis has been placed on flood control and main drainage system for several decades. It can be stated that flood control has been achieved in many areas. The drainage problems in Malaysia can be classified into three types, i.e. 1) drainage problems in the reclaimed areas of acid sulphate and peat soils (Photo 1), 2) waterlogging in paddy areas caused by lack of ordinary drainage and 3) drainage problems in the underdeveloped areas in East Malaysia. Improved drainage is needed to promote crop diversification and to facilitate mechanization in labor-scarce areas.

Thailand: In Thailand, the main constraint on agricultural production is water shortage during the dry season and irrigation development is still given first priority. Agricultural drainage projects mainly focus on flood mitigation aspects, such as river improvement works. At present, much attention is given to flood protection of the Bangkok metropolitan area based on the polder system. This activity adversely affects the drainage of agricultural lands.

Vietnam: In the Red River Delta, infrastructures both for flood control and agricultural drainage are in reasonably good condition. Drainage improvement activities have been carried out by applying polder-based drainage systems with gravity drainage and additional pump drainage method. The systems are well maintained but aging facilities losing their original capacity and function are conspicuous. In the Mekong Delta, many problems must be solved including flooding (inundation), acidification, seawater intrusion and soil salinity as well as unsanitary conditions (Photo 2). Regional drainage improvement is essential for upgrading the living environment in the area.

Philippines: Drainage is not given the same priority as irrigation. Drainage projects focus mainly on flood mitigation aspects such as flood protection works in the Pampanga River basin. A large area of agricultural land experiences inundation and cannot be cultivated during the rainy season. Some areas are affected by water-borne diseases such as schistosomiasis which is a major social problem in the country. Drainage should contribute to the improvement of the sanitary environment and control of schistosomiasis and other water-borne diseases with epidemic proportion.

On the basis of the field surveys carried out in five countries, it was concluded that further R&D activities relating to drainage are essential in the region where many countries are being faced with various types of severe drainage problems. The nature and magnitude of the attention paid to drainage improvement differ depending on the countries mainly due to the difference in the natural environment and technical and socio-economic background. Complete information and full understanding of the present state of drainage problems is the starting point for further drainage improvement in each country/region. Based on the findings of the study, twenty-three (23) long-term R&D needs were identified (Table 1).

In order to develop a sound knowledge

Table 1 Research and development needs on a long-term basis

1. Study on Asian monsoon agriculture and standardization of Asian drainage works
   - (1) Study on hydro-meteorological conditions for Asian monsoon agriculture
   - (2) Study on paddy-based irrigation systems
   - (3) Standardization of drainage works
2. Main drainage and flood control
   - (4) Drainage improvement strategies based on global climate changes
     – Impact assessment of sea level rise on drainage –
   - (5) Data collection, information management and networking on drainage
   - (6) Guidelines for drainage planning and management in the semi-arid region with monsoon climate
   - (7) Guidelines for polder-based drainage improvement in the delta area
   - (8) Criteria for design of paddy field drainage for mechanization
3. Field drainage
   - (9) Construction of conceptual model for field drainage planning in paddy-based irrigation systems
   - (10) Development of subsurface drainage method for diversified cropping systems in paddy fields
   - (11) Guidelines and manuals for field drainage design for diversified cropping systems in paddy fields
   - (12) Guidelines for construction and maintenance of field drainage systems
   - (13) Pilot farms for research on field drainage systems
   - (14) Environmental improvement through field drainage
4. Land consolidation
   - (15) Guidelines for land consolidation projects
   - (16) Guidelines for reallocation of land rights
5. Socio-economic approach
   - (17) Farmers' associations as water users' association for drainage project promotion
   - (18) Assessment of opportunity losses incurred by inadequate drainage system
6. Problem soils
   - (19) Criteria for design of drainage in acid sulphate areas
   - (20) Criteria for design of drainage and water management in peatland
7. Environmental effect problems
   - (21) Study on drainage effects on environment
   - (22) Guidelines for design of drainage facilities based on ecological conservation
     – Design of coastal bund taking account of ecological conservation –
8. Rural development
   - (23) Guidelines for drainage for rural development and sanitation improvement

base and capabilities to contribute to the upgrading of drainage technology toward the next century, it is important to concentrate efforts on some priority research projects. Out of the 23 identified needs, the following five (5) key research project proposals which should be implemented on a short-term basis were selected. All of these research projects contain important elements of training and collaboration between researchers and professionals in South and Southeast Asian countries and with partners from outside of the region:

1. Field Drainage Development in Paddy-Based Irrigation Schemes
2. Main Drainage Development for River Plain and Delta Areas
3. Development of Suitable Land Consolidation Programs for Asian Lowlands
4. Drainage Guidelines for Acid Sulphate and Peat Soils
5. Drainage Guidelines for Semi-Arid Regions with Monsoon Climate

Photo 1: Private oil palm estate (acid sulphate soil area, Malaysia)

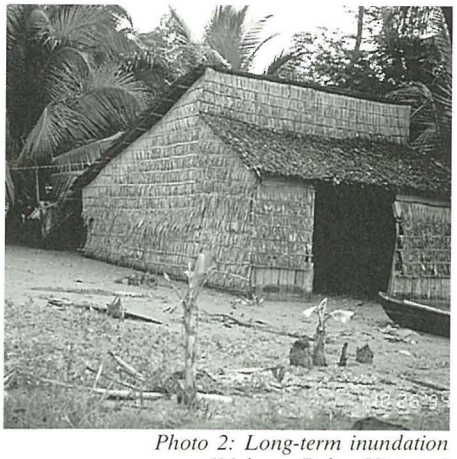


Photo 2: Long-term inundation (Mekong Delta, Vietnam)

* Ishikawa Agricultural College
** The University of Osaka Prefecture
*** The World Bank

≪New Research Area≫

Eastern European Countries

Osamu Koyama

The temperate-cool climate zone was added to the geographical area targeted for collaboration by JIRCAS in October 1993. Since then, JIRCAS has been considering the possibility of undertaking joint research projects with organizations from countries in these new areas, including Eastern European countries. Eastern Europe used to be referred to as the "Bread Basket of Europe" before World War II. After the region was included into the Former Soviet Union Economic zone, it played an important role in agricultural production within the group. However, since the collapse of the planned economy, the economy as a whole, including the agricultural sector, has been thrown into confusion.

In order to observe the current situation of agriculture, a mission was sent to Hungary in 1994 to visit agricultural research organizations. In every organization (Research and Information Institute for Agricultural Economics, Institute of Economics and Agricultural Research Institute of the Hungarian Academy of Sciences, Debrecen Agricultural University, Gödöllö University of Agricultural Sciences, Cereal Research Institute and the Department of Science and Education of the Ministry of Agriculture), the mission received a warm welcome, and obtained a great deal of information about research activities. So far, human exchanges in agricultural research areas had been organized through individual channels except for some training programs. The mission felt that the agricultural research institutes were very much interested in JIRCAS activities.

Agriculture in this area is characterized by large scale production of upland crops, e.g. wheat, maize, sugar beet, and the traditionally strong livestock production including pork and dairy products. Except for Poland, where family farms are dominant, collective farms, either state-owned or cooperatives, played a major role in the agricultural production in this area. The economic dislocation associated with the process of transition of the economic system exerted a considerable impact on agricultural production systems. New land ownership system was introduced. Relative prices of agricultural inputs and agricultural products completely changed. The old distribution system did not function any longer. Consequently the agricultural output decreased dramatically in this transitional period. The target of agricultural policies including research fields was directed toward the market economy.

The major tasks of the agricultural researchers in the region are as follows: 1) farm management in response to the new market economy, 2) development of low-input/low-cost production systems and conservation of the environment and 3) improvement of the quality of final products. These activities are carried out under tight budgetary and human resources. Several joint research programs have already started with other European countries.

It appears that one could learn a great deal from the agricultural activities of these countries, especially in the field of large scale upland crop production and multiplication of seeds of upland crops for low-temperature regions. On the other hand, collaborative research activities with Japanese organizations could cover fields such as postharvest technology, biotechnology and agricultural economics applied to the current policies and farm management. It is hoped that research collaboration under JIRCAS projects will be initiated in this region in future. At the same time, JIRCAS should continue to collect information in order to become more acquainted with this rapidly changing type of agriculture.

Photo 1: The great Hungarian plain (puszta)and sheep

Photo 2: Newly planted apple trees

Photo 3: A display of Hungarian agricultural products

≪Research Collaboration≫

Collaborative Project with CIAT: Upland Rice Research for Sustainable Development of Acid-soil Savanna in South America

Kensuke Okada

CIAT (Centro Internacional de Agricultura Tropical), based in Colombia, is one of the three international agriculture centers situated in Latin America. Due to its high scientific level CIAT has contributed significantly to agricultural development for more than a quarter of a century by concentrating its efforts on 4 programs: Bean, Cassava, Rice and Tropical Forages. However from 1992, CIAT initiated three new programs, Tropical Lowlands, Hillside and Land Use for natural resources management to promote research for sustainable agriculture development.

CIAT and TARC/JIRCAS have had a long history of collaboration in research on tropical pastures since 1977. JIRCAS has dispatched 7 pasture scientists to the Tropical Forage Program of CIAT. Throughout this project, the development of highly productive pastures consisting of both legumes and grasses has been pursued. The use of seed-coated pellet fertilizer is one of the research highlights of the project. An ecophysiologist from JIRCAS is now studying the mechanism of the persistence of legumes in pastures in order to develop suitable methods of management to maintain legumes.

On the other hand, the new collaborative project on upland rice was initiated in January 1992. This project is also aiming at achieving sustainable development of the vast expanse of savanna covered with strongly acid soils in some parts of Latin America. The productivity of native pastures could be substantially increased through the introduction of improved pastures together with appropriate fertilizer application and soil management. The problem is, however, that improved pastures undergo degradation with time, and it is very difficult to renovate them because of the initial cost incurred by the farmers.

The rice/pasture system has been, therefore, introduced and improved by CIAT since the late 1980s. In this system the pasture is sown with upland rice and fertilizer is applied at the beginning of the rainy season. After 4 months, rice is harvested, and earnings can cover the initial cost of establishment, while the pasture grows well with organic matter derived from rice roots and stems as well as residual fertilizers. This system was implemented by the release of a new variety of upland rice which is high-yielding, has a good grain quality, and is tolerant to acid soils. Breeding was initiated by CIAT in 1982, through crosses of indica rice (high-yielding variety with slender shape, good grain quality) with tropical japonica rice variety (tolerant to soil acidity). However, since the mechanism of tolerance of this variety had not been elucidated the development of effective screening techniques for further improvement of similar types of tolerant varieties could not be realized.

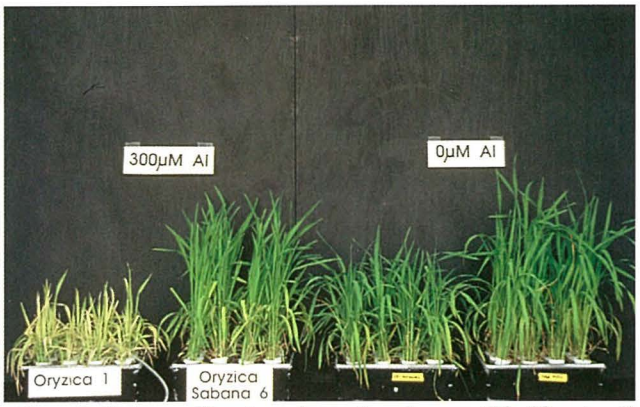


Photo 2: Tolerant (Oryzica sabana 6) and susceptible (Oryzica 1) rice varieties grown in solution culture with and without Al

JIRCAS started the collaborative project within the framework of the Rice Program of CIAT by sending a crop physiologist. The strategy is 1) to analyse the changes in the soil conditions in fields of upland rice on acid savanna soils in relation to the growth of roots of upland rice, 2) to expose the rice plants to soil-limiting factors prevailing in the area (high Al, or low pH, P, Ca, Mg) for revealing the genotypic differences between tolerant and susceptible varieties, 3) to identify physiological and/or biochemical mechanisms controlling the difference in tolerance (e.g. root exudates with a chelating ability with elements) and 4) to develop rapid and accurate screening methods based on these mechanisms. Varieties were found to differ in Al tolerance as well as tolerance to low Ca and Mg contents of soils. The analysis of root exudates is also being pursued. Simple screening method based on Al tolerance is already used in the selection of potential parents in the breeding program.

Savannas in Latin America cover a vast area which is under-populated and under-utilized. Although soils are acid with a low fertility level and must be used carefully, the topography is flat, precipitation is abundant and evenly distributed, the temperature is high and the soil physical properties are adequate. It is anticipated that this collaborative project will contribute to the improvement of the management and utilization of these valuable natural resources for sustainable use.

Photo 1: Sowing rice for experiment in a savanna field

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