

*Improving small-farm productivity through appropriate machineries*

## Small farm mechanization systems development, adoption and utilization

**IN MANY PARTS** of Asia, small farms remain at the center of agriculture and rural development. However, one of the main causes for the low agricultural productivity in most developing countries in the region is the lack of appropriate machineries that cater to and suit the requirements of small-scale farms. For this reason, many small farms are deemed as unproductive and inefficient.

Farm mechanization plays a significant role in every nation's economy. However, it is often misconstrued to mean modernization, beneficial only to industrialized countries with highly mechanized agriculture. Developing countries often have to rely on a variety of imported farm machines, which are seldom appropriate for small farms.

In many parts of the Asian region, the most pressing need is to feed a growing human population. This requires sustaining food production, which can be realized by increasing land and labor efficiency in agriculture through farm mechanization.

This international workshop challenged conventional notions by addressing issues concerning the development and utilization of small farm mechanization systems and technologies for the greater benefit of small-scale farmers. The activity provided a venue for the sharing of practical application of existing systems and technologies, as well as of strategies that will be most effective in tackling the very complex socioeconomic and environmental factors influencing the adoption and utilization of small farm machineries. Topics included: status and directions of small farm mechanization in the Asian and Pacific region; factors influencing the successful development, adoption, and utilization of small farm mechanization systems and technologies; problems, issues, and constraints in developing and introducing small farm mechanization systems and technologies to the end users; and recommendations to enhance small farm mechanization development and adoption, particularly in less-developed countries. Lessons from the more developed countries in the region were shared, particularly in terms of their experiences in corporate farming and land consolidation, which make the joint use of land physically easier, including the communal use of large farm machineries and other modern farm facilities.

### Status of small farm mechanization in Asia

The world agricultural scenario indicates that food security is the paramount concern of every nation. All technological advances in both developed and developing countries must gear towards increasing food production. Both the large-scale, specialized commercial agriculture, and small-scale mixed semi-subsistence types of agriculture play vital roles to attain this objective.

The average operational farm size in Asia ranges from 1.0 to 3.7 hectares, with Thailand topping the list. Research expenditures for agriculture are 0.4 percent for low-income countries; 2 percent for middle-income countries; and almost 2.5 percent for high-income countries. The share of the Asian and Pacific region in the global agriculture machinery consumption is only 10 percent compared with Europe, which has the highest share of 80 percent. As of 2002, Japan had the highest number (1,042,000 units) of harvesters-threshers in use, followed by China (197,000 units), while Sri Lanka had the lowest number of only 10 units of harvester-threshers.

Asian agriculture is rapidly increasing with the rise in farm mechanization support. Most developing countries in the region are now in transition from labor intensive to control intensive agriculture. Precision agriculture and automation is the current trend in agricultural mechanization. Irrigation system machines, planting machines, powered sprayers, combine harvesters, dryers using biomass fuel, silo and storage handling, and advanced and high quality rice mill machines are likely to be adopted by Asian farmers in the the near future.

### **Case studies on small farm mechanization: strategies and approaches**

Land consolidation is a successful approach in Japan to mechanize the previously small farm landholdings. The government's strong political will and commitment coupled with the farmers' cooperation contributed to the success of land consolidation. The consolidated fields allowed for the entry and travel of tractors and other implements, provision of efficient field irrigation and drainage, road access systems, and the establishment of on-farm post harvest facilities and other infrastructures.

The experience in Korea proves the appropriateness of mechanizing the production and post-harvest operations of horticultural crops planted mostly in the uplands with 7 percent slope and above. These sloping lands comprise 61.6 percent of the country's total cultivated area. The country's integrated mechanization system employs the use of appropriate farm machinery and implements, from the seedling nursery to production to post-harvest. Focus is on competitive crops like ginseng, carrot, garlic, Chinese cabbage, Chinese leek, red pepper, and onions.

The key to the successful implementation of the village-based cashew nut processing in the Philippines lies on several factors such as appropriateness of small-scale machine, skill-building and market-linkaging activities, networking with other government agencies, full support of the local government unit, initial funding assistance from outside source, and positive and active collaboration of the cooperator.

Rice mechanization in Vietnam has achieved significant developments in terms of acquisition and utilization. Most machineries are imported and utilized in operations like tillage, sowing, transplanting, and harvesting. Also, the country has developed and improved axial flow threshers, rice combines, and dryers. R&D activities on rice mechanization have gained continuous progress through the endless efforts of administrators, researchers, machine designers, and farmers.

### **Technology trends and directions**

Japan, Taiwan, and Korea are among the countries with highly mechanized farming operations. Common among these countries is the prevalence of strong political support and farmers' cooperation, paving the way for advancements in agricultural mechanization technologies and systems.

Japan developed mechanized production systems for lettuce and citrus. The semi-automatic transplanter for lettuce, which were tested in a small prefecture in Japan with an average area of arable land per farm household of only 0.62 ha, saved on time and labor for transplanting. The sitting cart, on the other hand, helped improve the work posture and is suitable for farmers cultivating less than 0.5 ha of farm area.

The construction of monorail system and contour narrow path made possible citrus



***"...Sustaining food production can only be realized by increasing land and labor efficiency in agriculture through farm mechanization."***

*Farmer-scientist dialogue*  
**Learning appropriate  
 small-farm mechanization  
 from the farmers**

The field study tour for the workshop on small farm mechanization provided participants with the rare opportunity to interact and consult with the farmers. Farmer-cooperators demonstrated hands-on operation of some small-farm machineries commonly used in the field. The activity also provided a venue for scientists and farmers to interact and exchange ideas and opinions on mechanization technologies appropriate for small farm operations.



production in the sloping lands of south-west Japan. These structures reduced the number of working hours and work load for fertilizer and chemical herbicide application, harvesting, and transporting.

Taiwan's agriculture is 98 percent mechanized. Manufacturers of dryers in this country are able to produce competitive products. Products using biomass as fuel are also becoming popular. Mini-power tillers have the highest market share in both domestic and international market. Protected crop culture or greenhouse cultivation is expected to attract youths to engage in farm production because of its profitability as an enterprise.

Another recent development in Taiwan is the automation and computerization in agriculture, fisheries, and animal husbandry. Precision farming system for rice crop has been the focus of major projects in agriculture. This technology uses satellite position system and geographic information system on farming management as bases of decisions in the farm.

Government support significantly contributed to the advancement of farm mechanization in Korea. This involves institution of policies on financing for farm machinery and projects as well as subsidies by supplying farmers with machines at half the price. Trends in mechanizing upland crops in Korea involve integrated systems for mechanizing

production of Chinese cabbage, garlic, Chinese leek, carrot, ginseng, etc. Machines and equipment have been developed for specific farm operations from land preparation to planting, to harvesting, to post harvest and transport.

Indonesia, Thailand, Malaysia, Vietnam, and the Philippines have been receiving similar support from the government for its special projects and programs on farm mechanization. However, level of mechanization is medium to low due to such factors as: lack of resources, infrastructure, and institutional arrangements; prevalence of manual labor/operations; and lack of policies that support the general economic welfare of the different stakeholders in the agricultural machinery industry;

### **Problems, issues and constraints**

The barriers that impede the growth and sustainability of farm mechanization industry and programs in the region can be classified into technological constraints, socio-cultural and behavioral barriers, financial and economic problems, and environmental issues.

In some Asian countries, local manufacturers are still in the "cut and weld" level of manufacturing technology. Low or substandard machines continue to be peddled in the market, while some machines are not suitable to the farming conditions of the

users. Farm machines are likewise beyond the reach of most farmers owing to high acquisition and maintenance costs.

Small-size farm is a big issue when it comes to mechanization because it is against the "economies of scale." Mechanizing small, non-contiguous parcels of lands may prove to be inefficient especially in operations like land preparation and harvesting. Poor rural infrastructures such as roads, bridges, canals, and power network also pose as a major obstacle to farm mechanization. Also, in developing countries, farm labor is abundant, hence, the need for machinery is seldom recognized. However, the income of farmers has remained very low and the value of working day very cheap.

In terms of environmental issues, high energy-consuming large machines with emissions pollutive to the environment have become an important concern. Human being, as a component of the environment, is also now being considered in machine development. "Machines with a human face" is the byword in some developed countries, which put great consideration on the plight of ageing and women farmers, and on safety issues.

### **Recommendations and directions**

Due to the nature of small landholdings in many countries in the Asian region, the following criteria for designing and developing machines have been identified during the workshop:

#### **Technology and systems development**

- Machines should be compact, light, low-powered, and multi-purpose. Locally-available materials must be incorporated in fabricating machines to reduce the manufacturing costs. Manufacturing and designing parts must also be precise.
- Small-size tractors, mini-power tillers, and small farm equipment must meet the needs of small farmers. Operator's safety and comfort must also be considered.
- The high cost of fossil fuel in some countries emphasizes the need to develop energy-efficient machines by harnessing non-conventional sources of energy.

#### **Adoption and utilization**

- Information dissemination activities through multi-media, fairs and exhibits, and similar modes should be actively pursued in strategic locations where machines are actually needed.
- Training local craftsmen in manufacturing

technology, operation, repair and maintenance would promote local manufacture of agricultural machinery.

- Farmers' organizations or cooperatives can also be tapped, particularly in setting up joint use of farm machineries and other modern farm facilities.
- Government-private sector complementation is vital in promoting farm mechanization. Service centers could be established in rural and remote areas; and financial assistance, loans, and subsidies must continue to provide machinery owners and users of continued farm production operations.

### **Conclusion**

The level and appropriate choice of agricultural mechanization has direct effects on land and labor productivity, farm income, environment, and the quality of life of small-scale farmers in Asia. Hence, basic farm mechanization requirements to cater to small-farm needs must be met, such as: suitability to small farms; simple design and technology; versatility for use in different farm operations; affordability in terms of cost to farmers; and most importantly, the provision of support services from the government and the private sectors/manufacturers.

Cases of highly mechanized countries point to a common factor leading to successful farm mechanization programs, that is, strong political will. Hence, each country's effort on small-farm mechanization must be anchored on a coherent strategy based on the actual needs and priorities of the small-scale farmers.

## **International Workshop on Small Farm Mechanization Systems Development, Adoption and Utilization**

Held at the Oasis Hotel, Los Baños, Laguna, Philippines on June 13-17

No. of countries participating: 8 (Indonesia, Japan, Korea, Malaysia, Philippines, Taiwan ROC, Thailand, Vietnam)

No. of papers presented: 16

No. of participants: 70

Co-sponsors: Philippine Council for Agriculture, Forestry and Natural Resources Research and Development- Department of Science and Technology (PCARRD-DOST); Bureau of Agricultural Research-Department of Agriculture (DA-BAR); Asian Institute of Technology (AIT)

### **List of papers**

#### *Keynote paper*

1. Development and utilization of small-farm mechanization systems in Asia: status and challenges
  - Vilas M. Salokhe, Asian Institute of Technology (AIT), Thailand

#### *Resource papers*

2. Technology development process and experiences on small-farm mechanization
  - Din-Sue Fon, NTU, Taiwan ROC
3. Private sector investments on small-farm equipment in the Philippines
  - Rodolfo H. Tamayo, AMMDA, Philippines

#### *Case studies*

4. Experiences in land consolidation and farm mechanization: Lessons for sustainable agriculture in Asia
  - Toshihiro Uetani, JIRCAS, Japan
5. Small-scale farm mechanization for rice in Vietnam
  - Nguyen Hay, NongLam University, Vietnam
6. Small-scale farm mechanization for horticultural crops in Korea
  - Chai-Shik Lee, NIAE, RDA, Korea
7. Small-scale postharvest mechanization system: The case of the cashew nut processing in the Philippines
  - Renita SM. Dela Cruz, BPRE, Philippines
8. Technology transfer strategies and experiences for small-farm mechanization technologies in the Philippines
  - Fernando O. Paras, Jr., UPLB, Philippines

#### *Country papers*

9. The problem and present condition of small farm mechanization systems in Japan
  - Masamichi Daikoku, NARC for Western Region, Japan
10. Agricultural mechanization in Korea
  - Young-Hun Park, NACF Research Institute, Korea
11. Development and challenges of small farm mechanization in Taiwan
  - Fu-Ming Lu, NTU, Taiwan ROC
12. Small farm mechanization system development, adoption and utilization in Indonesia
  - Handaka, IAARD, Indonesia
13. Rice farm mechanization in the central plain of Thailand
  - Sakda Intaravichai, Kasetsart University, Thailand
14. Research & development and adoption of farm mechanization in Malaysia
  - Ibni Hajar bin Haji Rukunudin, MARDI, Malaysia
15. Status and prospect of agricultural mechanization in the Philippines
  - Romeo B. Gavino, PhilSCAT, Philippines
16. Small farm mechanization system development, adoption and utilization in Vietnam
  - Ngo Ngoc Anh, Vietnam Institute of Agricultural Engineering, Vietnam

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