Minutes of the International Forum on Development Strategy of Agricultural Equipment and Mechanization in Less Developed Regions

(15 October 2004, Beijing, P.R. China)

At the 10th Session of the Standing Committee of the National People’s Congress of China, a “Law on Promotion of Agricultural Mechanization” was adopted and effective as of November 1, 2004. In favor of the implementation of the new Law, the Chinese Academy of Engineering (CAE) and the United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM) in Beijing have jointly initiated an International Forum on Development Strategy of Agricultural Equipment and Mechanization in Less Developed Regions on October 15, 2004 in Beijing. Following the great event of the 2004 CIGR International Agricultural Engineering Conference, which attracted over 900 participants in Beijing, 11-14 October, 54 overseas and domestic experts on agricultural equipment and mechanization were specifically invited to participate this event. The forum is subject to discuss issues on the development strategy for agricultural equipment and mechanization in less developed regions. Prof. Xu Kuangdi, President of Chinese Academy of Engineering, Prof. Liu Yanhua, Vice-Minister of the Ministry of Science and Technology, P.R. China, Prof. Xue Liang, General Economist of the Ministry of Agriculture, P.R. China addressed the opening ceremony on the importance of strategies for vitalization of the agricultural equipment manufacturing industry and promotion of mechanization in the future Chinese agricultural development and advances of R & D. Topics covered in this forum included the following areas:

1) Vision on the trends of technology innovation on agricultural equipment and mechanization in the less developed regions.

2) Impact of economic globalization on agricultural equipment and mechanization; the role of government in technology promotion and policy development.

3) Activities and roles of UNAPCAEM in promoting technology transfer, information and experience exchange, and regional cooperation.

After extensive discussion, the participants brought up some critical issues for developing a strategy for promoting innovative equipment and management technologies, and provided many constructive suggestions for solving these problems.

1. Vision on the trend of technology innovation

The discussion on this subject was leaded by four keynote presentations by Prof. Bill Stout (Texas A&M University, USA), Dr. John Reid (John Deere Company, USA), Prof. Yuan’en Gao (China Association of Agricultural Machinery Manufacturers), Prof. Hermann Auerhammer (Technical University Munich, Germany).

Prof. Bill Stout discussed the concept of “selective mechanization”, an approach to mechanization that uses technology appropriate for the local conditions and level of agricultural development of the country / region and meets the social / cultural needs of the
people. He also discussed the need for a national mechanization policy (strategy) that ensures the necessary requisite infrastructure such as rural roads, dealer services, training programs at all levels, credit, etc. He defined five levels of agricultural equipment technology as originally conceived by co-author Prof. Karl Renius. He discussed the trend to de-emphasize the agricultural mechanization component in agricultural engineering education in the US and said, “Don’t let it happen in China”. He ended with a discussion of the need for a systems approach both for the engineering development and also for inclusion of the social and economic factors.

Dr. John Reid presented the technology trends on modern agricultural equipment and their impact on agricultural mechanization. According to Dr. Reid, agricultural production is characterized by a range of highly intensity production to hobby farming in the US: while 1% of the farmers produce 42% of the agricultural output, a large number of farmers have a second job in addition to farming. It means that the farmers in developed countries require advanced technologies, such automated functions and information management capability on the agricultural equipment for achieving higher productivity with fewer skills required. In developing countries, the need of advanced technologies for agricultural equipment has also increased. Increased demands on more efficient and safer machinery will require the adoption of x-by-wire technologies on equipment designed for LDC’s.

Prof. Yuan’en Gao proposed some infrastructure modifications to meet new challenges in agricultural production in China, including the use of larger, more efficient, and cleaner special machinery, instead of small and general-purpose machinery, for more intensive agro-production. New technologies, such as mechatronics, are necessary to accomplish such modifications.

Prof. H. Auernhammer highlighted the role of information technologies in mechanized crop production. There is a strong need for standardizing data communication systems (ISO 11783, called ISOBUS) for farm management, data management, machinery management, and labour management for effective and efficient crop production. He showed three impressive examples: data acquisition to document tasks on specific fields used by contractors or cooperatives for proof and for invoice; data acquisition in a “Trans-border Farming System” (virtual land consolidation) for documentation of the field inputs and outputs; and data acquisition for on-farm research purposes to establish standardized work sequences and standardized planning figures for farm use, extension and research.

Many participants provided their viewpoints on the technology innovation on agricultural equipment: Note-speakers refer to “mechanization”, but in most cases they mean “tractorization” or advanced machines such as tractors and combines, not hand tools or animal draft implements.

Sarig-
- Mechanization can contribute to the safety of workers, e.g. sprayer operation barefoot can be avoided
- Warning Less Developed Countries (LDC’s) should not blindly accept American/European model. The gap between researchers and farmers is not so great in
developed countries. In China, the rural areas are far behind researches; also the infrastructure to support tractorization is lacking.

- Some developed countries may not want to help LDC’s, but prefer to sell their products to them.

**Reid-**
- Excellent keynote presentations covered almost all the technologies, but one point is missing. Successful mechanization programs require other technologies, e.g. irrigation, plastic covered agriculture as a water saving technique, farm ponds as a source of water, etc.
- In order to keep farmers in the rural areas the rural standard of living must be improved. Such items as TV, educational programs, cell phones, etc will help avoid migration to the cities.

**Sigrimis-**
- Agrees with need for infrastructure development, e.g. rural electrification, roads, etc
- Need to develop markets for agricultural products
- Certification of production is needed, e.g. organically grown foods

**Tian-**
- How can technology transfer be facilitated?
- NE China is quite undeveloped, lacks infrastructure such as roads and electricity

**De Baerdemaeker-**
- Looking back at the US situation, mechanization was needed to release labor for work in industry. The situation is very different in LDC’s.
- If mechanization is adopted, are industries able to absorb the released labor?
- What do farmers want (in terms of machinery)?
- Perhaps China has a high technological industry to absorb released rural labor, but what about Africa?

**Wall-**
- The need to emphasize a system approach, consider a continuum from the farmers to the consumer. What are the bottlenecks? How can mechanization help solve the problem?
- PEOPLE that’s what it is all about, what is the effect of mechanization on people?
- Is adoption of mechanization the result of some bottleneck or need? Or is it a catalyst to make life better for rural people and to help increase their productivity and income?

**Kitani-**
- Referred to energy issues.
- The Kyoto protocol will be implemented soon (Russia recently approved); Carbon credits may help promote bioenergy, but must not interfere with food production.
- R & D takes time; need to accelerate R & D programs to have answers in time.
Marchenko-
- Need improved dry land / desert land technology for vast areas of the world where the
  Natural agro-resources are not still used. e.g. – Wild forage plants that can be cultivated
  with no use of fertilizers at low level of rainfall.

Salokhe-
- Stout in his keynote address pointed out that mechanization programs in US agricultural
  engineering departments are disappearing. In contrast, mechanical and agricultural
  engineering in general are increasing in India.
- Salinity problems are serious in many areas of the world
- ICAR is promoting improved varieties, pest control technology, etc,
- India has governmental subsidies to promote new agricultural technology.

Kishida-
- Too much research in universities/institutes which is not useful by industry.
- Japan has agricultural mechanization promoting law which provides subsides for farmers
  to buy machines, but sometimes it was not effective.
- Need a strategy for developing small scale manufacturers of machines, e.g. in Italy, there
  are some 4000 manufacturers.

Sarig-
- Proposed a site specific approach
- Mechanization is not a goal in itself.
- In China, the number one priority is to produce more food. Other countries have rural
  labor shortages

Umeda-
- Two requirements of mechanization programs
  - Must improve farmer income
  - Must have a labor shortage
  - Pointed out the relation between the automotive industry and farm equipment industry.
    The automotive industry provides technology that can be used by the farm equipment
    industry. Many countries do not have an automotive industry and therefore will have
    difficult developing a farm equipment industry.

Kishida-
- Does mechanization create rural unemployment?
- Not necessarily. Consider the peak season when rural labor shortages occur even though
  there may be plenty of labor the rest of the year.
- Adequate power increases yield /ha.

Sigrimis-
- Go back to the Italian example, i.e. small manufacturers (4000).
- Joint ventures with international companies are needed for large machines (tractors,
combines, etc), but small implements can be produced locally. Greece doesn’t have an automotive industry, but there are many small scale implement producers.
- Don’t overlook greenhouse technology and mechanization. Very important source of food and income
- Balanced mechanization is needed.
- Infrastructure needs, e.g. roads from farm to market

Kishida-
- Don’t forget the part time farmers, i.e. one who lives on a farm but has a job in industry. This can increase farmer income.

Umeda-
- Prof. Luo mentioned the China/Japan cooperation in farm equipment manufacturing
- Discussed direct seeding vs. transplanting.

Sigrimis-
- Prof. Luo gave an example of combination of research and training under government direction to solve regional problems.

Wall-
- What are the benefits of investment of 700 million yuan (from Luo)?

Kishida-
- Japanese farmers prefer transplanting of rice as opposed to direct seeding. Transport of seedlings from the nursery to the field is a bottleneck. Requires 100-250 trays of seedlings per ha.

Kang-
- Kishida says that LDC’s need machines suitable for their operations. Can Japan transfer technology to China to build inexpensive tractors and Machinery?

Stout-
- The coauthor of my keynote presentation Prof. Karl Renius, feels manufacturers in India can provide a model for China and other LDC’s to follow. He feels that the Tempo OX tractor is very modern, is indigenous to India and has many advanced features. Is China following developments in the Indian tractor industry with possible adaptation to China?

Zhang-
- China should not depending only on transferring technologies developed in other countries, Most foreign technologies were developed to meet some special farming needs in their own countries, may not best suit Chinese agriculture. Therefore, China should develop some core technologies or modify transferred foreign technologies to fulfill the special needs of its agriculture.
Munack-
- Prof Luo presented a real success story, i.e. regional approach with more homogeneous conditions than the national level. The new national Chinese mechanization promotion law can be adapted to the various regions.

Jiang-
- Prof Stout in his keynote presentation said “Don’t let practical mechanization training disappear from the agricultural engineering programs in China”. This is a good warning.

Kishida-
- The Indian tractors are becoming popular in the US.

Reid-
- Agricultural Engineering specialties (core areas)
  - Environment
  - Processing
  - Production
- Young researchers have no funding in some core-areas (e.g. production) so they chase funds in other areas (e.g. robotics, remote sensing, etc) and thus compete with mechanical engineers and other scientists. China should preserve funding for core areas, including production and mechanization.

Sigrimis-
- How to provide low cost machines to farmers while maintaining high quality?

Kang-
- The domestic market (even in China) will eventually be saturated. We must emphasize export of Chinese manufactured machines to other LDC’s.

Umeda-
- Labor shortage is the main driver for introducing mechanization.

2. Impact on agricultural equipment and mechanization

The discussion on this subject was leaded by four keynote presentations by Dr. Yoshisuke Kishida (Shin-Norrisha Co., Japan), Mr. Tianzuo Zhang (Ministry of Agriculture, China), Prof. Xiwen Luo (South China Agricultural university, China), and Prof. Oleg Marchenko (All Russian Research Institute of Agricultural Mechanization, Russia).

Dr. Yoshisuke Kishida, pointed out that to make any agricultural equipment or devices practical, it is essential that such equipment or devices are profitable to the farmers and profitable for the manufacturers and dealers. According to Dr. Kishida, the globalization of agricultural equipment industry reduces the costs of farm machinery and provides better quality spare parts.
Mr. Tianzuo Zhang pointed out that the Chinese Government has introduced a law (Law of the People’s Republic of China on Promoting Agriculture Mechanization) to solve policy issues for promoting agricultural mechanization. One very effective method for implementing agricultural mechanization in China is the commercialization on machinery services. Similar to many LDC’s, it is economically unbearable for most Chinese farmers to purchase their own machinery to implement mechanized production. The commercial mechanized production service removes the obstacle and makes mechanized production affordable to Chinese farmers.

According to Prof. Xiwen Luo, even in LDC’s, the development status in rural areas is uneven. For example, in Guangdong Province, the mechanization level is lower than many of the other provinces in China because of geographic features and other reasons. In this region, the applicability of the machinery is very important. To support this effort, the provincial government approved a proposal for enhancing agricultural mechanization by means of commercial services and establishing an extension network to transfer mechanized production “know-how” to farmers.

Prof. Oleg Marchenko pointed out that it is very important to introduce a new concept of using an integrated disengaged power unit of a comparatively low mass, equipped with front and rear mounted systems and power take off in order to be used with various machines and adapters for different operations and crops. The main point of using an integrated power unit is to increase significantly annual usage of this power unit with different complexes of mounted machines on it. It is widely known that one of the obstacles preventing effectively utilization of equipment is incompatibility of implement with the tractor of big mass. But in a case of the integrated disengaged power unit, for example, it is possible to equip it with different mounted and trailed harvesting modules and the unit would be able to perform various harvest tasks, such as for forages, wheat, sugar beets, potatoes etc. It is possible to extend the power unit usage period from spring to winter including using of it with combined aggregates, for example, to fulfill for one pass several operations like: tillage, fertilizing, rolling and seeds sowing of different crops that making it more economical for farmers to own and utilize the machinery. Much more efficient is using of these complexes of machines on the base of integrated power unit in a frame of “contractors”. Prof. Marchenko also recommended paying more attention to use of natural agro-resources in Asia countries such as arid pastures and other low rainfall technologies. It will allow to raise up significantly (5-7 folds) of forage production in arid regions of Asian countries for increasing the numbers of cattle and sheep. One of the possibilities is to transfer the technology and experience of using of new type of special combined aggregates for arid pasture improvement by way of row tillage and seeding of wild forage plants. First of all it is improvement of dry land pastures with solonetz soils by way of differential soil tillage and sowing of local salinity stable plants and grasses. Also the improvement of semi-desert and desert pastures with new technology is recommended: row subsoil tillage with row sowing of wild plants seeds like “cohia prostrate” etc. No use of fertilizer at low precipitations for growing the wild forage plants.

Issues discussed in the forum included, but were not limited to the following aspects: it is important for the Chinese institutes and industrial companies to develop technologies suitable for Chinese agriculture. Technology import is important to enhance equipment performance.
and quality in a short period, but such enhancement is normally unsustainable because the market for any particular product will be saturated. Also, the imported technology might not be the most suitable technology due to the fact that it is often developed to meet the special needs for the country for which the technology being developed. Also, research, extension, demonstration, and training, along with good policy, are very important.

3. Activities and roles of UNAPCAEM

Prof. Ping Chang of UNAPCAEM introduced the activities and the role of his organization. Being a regional institution of UNESCAP in the field of agricultural engineering and machinery, the mission of UNAPCAEM is to provide assistance to its member countries in capacity building, technology transfer and information networking through human resource development, policy analysis, promotion of cost-effective agricultural machinery and engineering projects and practices, technical co-operation and agro-based enterprise development to reduce poverty of the region.

4. Conclusions and Recommendations

1). Agri-food systems exist in a socio-economic and natural resource context. Any initiative to mechanize agriculture must be based on an analysis of this contextual framework. There is no ‘one size fits all’ formula for agricultural mechanization; rather the approach adopted will be location specific. Effective demand for mechanization must be created or nurtured. Linkages within the food chain must be enhanced. The focus here is on fostering more remunerative and reliable linkages within the food chain for all participants from input suppliers, farmers (particularly smaller commercial farmers), small agro-enterprises, to traders and retailers. In so doing, the entire system will be able to benefit from market opportunities in the agri-food system. Market forces alone will not ensure such integration for two reasons. Firstly, in the absence of effective linkages throughout the chain, it is very difficult to conceive of how market forces will ‘kick-start’ the creation of these linkages. Secondly, the transaction costs faced by commercial entities both upstream and downstream of small rural farms will be high. The range of possible measures could include: strengthening producer and industry associations, facilitating development of rural infrastructure, strengthening market information systems, development of training on quality and process standards, R&D and technical support on production process, post-harvest and processing technologies and facilitating contract co-ordination.

The topic of mechanization in less developed countries should be treated as a site-specific issue. Solutions which are suitable to China with its high level technology, are not the same as those needed for African countries, for example, differences in location, climatic conditions, education level and even mentality, require specific attention.

Always keep in mind the need for sustainability of all agricultural technology including mechanization. The concept of selection mechanization requires balanced development that
include optimum input such as improved seeds, irrigation, post-harvest technology, etc. and horticulture, forestry and animal husbandry as well.

To promote agricultural mechanization in developing countries, it is inevitable to have functional designs fitting to local situation and to have production designs that make local production possible. The machine should be designed so that it can bring profit to all three sectors, farmers, machine distributors and manufacturers. The tractor is very important, but it is just a power source. It is important to develop the implements meeting local demands. To promote mechanization of agriculture effectively, it is necessary to strengthen the communication among major components, i.e. government, financial institutions, research and development, education and extension, manufacturing, distributing and related organizations. The linkage and cooperative work among agricultural engineering experts in advanced countries as well as developing countries are essential to the progress of mechanization of agriculture in developing countries.

2). Input supply chains for machinery and equipment must be created. Input supply chains for mechanization will be made up of privately owned enterprises that will have linkages to major manufacturers as well as local suppliers. The supply chain will have to deliver items of new equipment, spare parts for this equipment, fuel and lubricants, and provide a market for used equipment. In addition, it will be important to ensure that appropriate legislation exists to protect consumers (farmers and users) in terms of occupational safety and health and to ensure inter-operability of the items of equipment. A broad range of interventions will be required to achieve such an outcome; it will include: A suite of actions to identify suitable business models and to support the creation of viable private sector enterprises; Standards for equipment and legal frameworks to support occupational health and safety; Provision of effective R&D and extension services that provide machinery users with increased choice; An emphasis on technologies that conserve natural resources and increase financial margins; Transport and communication infrastructure to support the timely provision of equipment, fuel, and servicing.

For farmers and entrepreneurs to purchase agricultural machinery and equipment there must be a business case that they find convincing. This business case will be built on the profit margins available to the farmer (which is in turn driven by the price received for the farm outputs), opportunities to generate income from non-farm sources, and the financial package available to support the investment. Systems approach is needed linking every step from the farmer to the consumer.

3). Infrastructure development must go hand in hand with mechanization. The farmers see the benefits for mechanization and have the ability to pay or have credit available when there is a market for their products. Even if it is in part obligatory selling to government agencies, then still there should be a good infrastructure for this market and sufficient rewards for a farmer to increase his productivity. In case it is about products with a completely free market, then increased productivity implies that the farmer can get his products to the consumer. Cooperative marketing organizations can help here. They can also help in purchasing goods like fertilizers, equipment and services. This has proven very successful in European horticulture. Of course it also means that roads or other transportation means provide a direct
link between production areas and major population centers. Here again we see the
development of horticulture using modern equipment in a large number of European regions
that have benefited from the European structural funds for connecting the production areas
with the markets (consumers). This has also created a local industrial activity for
manufacturing and supplying technology to farmers. A stimulation of such local entrepreneurs
is a means of improving mechanization and technology implementation.

4). On the farm level dealer will be of great importance. There is a need for an educated
dealer network which can be extended to small manufacturers. This gives a practical as well
as a social impact to the rural areas. Financial credits and extension are needed from the
government. The introduction of machinery needs new organizational ways of machinery
usage. Machinery rings work fine if they have a well educated and trained leader (e.g. in
Germany the government paid 75% of their salary during the time of establishment).

5). The subject of subsidies was mentioned. It would be prefer to see this subject approached
from the perspective of risk sharing. In order to achieve the outcomes described above,
individuals and enterprises must try something new, this inevitably involves risk. If a
government wants to encourage a particular action by, say a farmer, it is legitimate for the
government to be prepared to share in the risk. Thus a grant may be made towards the
purchase of a machine. The concept of risk sharing does imply continuity in the way that
subsidies do.

6). It is needed to take attention to the role of information technology in promotion of
agricultural mechanization and technological innovation of agricultural equipment. The
driving forces of mechanization are “documentation” and improved work efficiency.
Manufacture of agricultural equipment should be promoted to establish standardized
electronic communication interfaces to the tractors (and implements). The signal connector
by ISO 11786 would be a good, simple and powerful entrance into this technology. Later on
the ISOBUS (ISO 11783) should be followed.

7). Relevant skills and talents must be nurtured. A well educated and skilled and adaptable
workforce is an essential ingredient in agricultural growth. There is a need for broad-based
skills including hands-on mechanical maintenance and repair, efficient operation of
machinery, and logistics management for spare parts. Skill shortages can be a major barrier to
growth and paucity any one area can create a major bottleneck. Although so far none of
agricultural engineering department in China is trying to remove it from the name, a warning
is still of realistic significance for some developed countries. Many Power and Machinery
like programs in A.E. department have added many new courses at the cost of crippling the
mechanical engineering training. And the students complain that some replacing courses are
quite superficial and lack of substantial technique. It is quite evident that China lags a lot
behind the developed countries in agricultural mechanization. Because of disparity in some
natural and economical conditions the agricultural machinery and equipment needed in China
can’t all rely on the import or copying from the foreign. The mechanical engineering
graduates from A.E. department should possess the fundamental knowledge and ability of
designing and construction of new machine based on local conditions. Even in the developed
countries the well performed now machines will need further improvement or renovation in its principle or construction as the time requires.

8). To establish a think-tank group is required to promote agricultural mechanization development in less developed regions. It is recommended to meet periodically to discuss current status, suggest modes of actions, recruit experts and maintain contacts with policy makers, both in developed and less developed countries. This group, which could be named: "The Beijing Forum for Mechanization in Agriculture in Less Developed Countries" could be associated with APCAEM, for example, get financial assistance from large agricultural machinery companies, countries, UN agencies and other organizations. The proposed group could have an impact and assisting in the prudent introduction of mechanization to less developed regions. CAE and UNAPCAEM could continuously to organize the periodical International Forum or Conference for technical exchange of agricultural machinery innovation and mechanization development mainly for less developed regions. The existing International Conference or Symposium of such kind in the world mainly targeted on the agricultural modernization for developed countries. Attending these meetings usually are financially unaffordable for professionals from less developed countries. Because of the disparate level in agricultural machinery development from the developed, the less developed countries nowadays urgently need mostly the appropriate technologies rather than the sophisticated, aiming at the automation and comfort in operation. The problem of mechanization of the field and post-harvest operations for rice production may be the common interests for less developed countries in Asia-Pacific region. This problem might be taken as one of the main themes of the forum or conference. The conference should be purposely invited to attend the experts from developed countries who are relevant to and interested in the promotion of agricultural mechanization and business development in less developed regions.

9). Need a system to promote mechanization; evaluation not by government but by third party. Agricultural mechanization is a system, which is composed of policy, research, demonstration, training and extension. Every segment of the system co-exists and interacts each other. The system mainly relies on government policy in less developed regions if it is to become dynamic and energetic. In rural areas where food safety is the primary need of the poor farmers, market-driven effects appear less crucial to agricultural mechanization. Preferential policy becomes a key element, which should create an environment suitable for research and application of appropriate and advanced technology. Policy making is important and its implementation is equally important in less developed regions. To keep the policy sustainable and the implementation stable, the establishment of an evaluation mechanism is necessary. The evaluation should be done by a third party or a non-governmental organization (NGO) such as the Chinese Academy of Engineering in China. Both should be addressed with every kind of promotion from government, state or county. Need a financial instrument to promote mechanization; avoid use of the word “subsidy”; consider sustainability.

10). To set up a permanent group for long range planning for promotion of agricultural mechanization is needed for each country. Establishment of a long term mechanization policy committee in China was strongly recommended. A better name for this important committee may be Agricultural Mechanization Development Strategy Committee (AMDSC).
Acknowledgments

The Forum was initiated by the Chinese Academy of Engineering and United Nations Asia-Pacific Centre for Agricultural Engineering and Machinery in Beijing and organized by China Agricultural University. The faculty and staffs of the Key Laboratory of Modern Precision Agriculture System Integration Research of Ministry of Education, P.R. China in CAU headed by Academician of CAE, Professor Wang Maohua in corporation with CAE departments’ leaders have contributed to all the organizing process and services for the event. Prof. Han Lujia (CAU), Prof. Qing Zhang (UIUC), Prof. Ou Yinggang (SCAU) and Assistant secretary, Ms. Zhang Miao (CAU) have made a great effort to record and edit the draft of the minutes. Based on the wide response and comments to the draft, Prof. Bill Stout and Wang Maohua have contributed to formulating the minutes and final conclusions and recommendations.

Attached: Name List of invited participants
Name List of invited participants to the International Forum of Development Strategy on Agricultural Equipment and Mechanization in Less Developed Regions (October 15, 2004 Beijing)

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<th>Institution</th>
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