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AGRICULTURAL EQUIPMENT AND MECHANIZATION
IN LESS DEVELOPED REGIONS

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CONTENTS

INVITED PAPERS AND PRESENTATIONS

The Agricultural Equipment Industry and its Promotion in Less Developed Countries………………………………………… Bill A. Stout (1)

Technology and its Impact on Agricultural Mechanization………………John Reid (29)

The Present Situation and Development Trend of Agricultural Machinery Industry in China …………………………………… Yuanen Gao (47)

Agricultural Mechanization in Developing Countries and World Agricultural Machinery Industry …………………………Yoshisuke Kishida (62)

Promoting the Development of Agricultural Mechanization in China According to Law ………………………………………Tianzuo Zhang (68)

Proposal Speeding Guangdong Agricultural Mechanization…………Xiwen Luo (78)

Asian and pacific Centre for Agricultural Engineering and Machinery………………………………………………Ping Chang (95)
The Agricultural Equipment Industry
and
Its Promotion in Less Developed Countries

by

Bill A. Stout
Biological and Agricultural Engineering Department
Texas A&M University
College Station, Texas, USA 77843-2117
stout@tamu.edu

Karl Th. Renius
Faculty of Mechanical Engineering
Technical University of Munich
Garching, Germany
renius@ltm.mw.tum.de

John K. Schueller
Mechanical Engineering Department
University of Florida
Gainesville, Florida, USA 32611-6300
schuejk@ufl.edu

Presented at the Forum Entitled
Vision on the Trends of Technological Innovations of the Modern Agricultural Equipment Industry
And Its Promotion in Less Developed Countries

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Abstract:

Agricultural mechanization is a reality! Hand tools, animal draft implements and tractors are used in every country. Agricultural/mechanical engineers are needed to design efficient equipment or to select the right size and type of machines for local conditions.

The global agricultural equipment industry is discussed along with its joint ventures and other collaborative efforts with Chinese manufacturers.

Some principles of global tractor development are presented. Five technology levels are defined in terms of engine power, type of transmission, hydraulic and electronic systems and so on.

A section on reduction of manufacturing costs is included with emphasis on the systems approach bringing together many types of expertise to accelerate engineering developments and reduce costs.

The critical need for well-educated practical agricultural/mechanical engineers is emphasized. This type of expertise is being lost in many universities in the USA and other parts of the world. Don’t let this happen in China!

Finally, the need for agricultural/mechanical engineers to work as key members of interdisciplinary teams is discussed. Too often we focus too much on micro-studies and fail to look at the big picture—i.e. key issues facing agriculture such as feeding a growing world population, improving income distribution so that all people will have the purchasing power to afford a balanced and nutritious diet, natural resource conservation and management, maintaining the environment including water and air quality, and so on. Agricultural mechanization must be considered in the context of these broader issues.

Keywords and phrases:

Agricultural equipment, Selective mechanization, Global tractor development, Reducing manufacturing costs, Systems, Agricultural mechanization policy, Agricultural Engineering education.
Introduction

Effective crop production requires machines—hand tools, animal-drawn implements and engine-powered equipment. In this paper the focus is on tractors and associated equipment. One might ask—why mechanize? Many less developed countries have abundant cheap labor or so it seems when looking at national statistics. But a closer look reveals labor shortages at key times such as during land preparation or harvesting. Timeliness is a key factor in agricultural production and mechanization may be necessary to prepare the land for seeding before the rains come or for rapid tillage in multiple cropping systems (for examples, see Stout and Downing, 1974). Selective mechanization is an old term used to describe an approach to mechanization that is compatible with the national goals of development while maintaining high levels of employment. If a higher level of living for all the people is sought, does this not require increased production per person? Is the goal to maintain employment for all people who are able to work? Even at a near starvation level? Or is there some optimum allocation of jobs allowing some unemployment where production and individual income and thus the level of living is maximized for the greatest number of people?

Stout and associates have been involved in these debates for over 40 years. In an article by Stout and Downing (1975) in the FAO magazine, CERES, we debated the above questions. We pointed out that the prerequisites for successful mechanization schemes were and are quite well known, but that too often one or more critical elements is overlooked or ignored, leading to a predictable failure. We concluded. “Mechanization is a reality. It is not just an academic theory or a vague concept. It is being used in every country of the world. Let’s resolve to use mechanization to its full advantage as one input to optimize agricultural production and food delivery systems.”

In another article (Stout and Downing, 1974A) published in Shin-Norinsha Publishing Company’s journal, Agricultural Mechanization in Asia, we argued that selective mechanization is a “hope” for farmers in less developed countries. Migration from rural areas to the cities in search of jobs is a well-known problem afflicting many if not most less developed countries. Motives for this migration (rural to urban) are a complex mixture of urban “pull”, the attraction of higher wages, social, cultural, and educational activities and the glamour of towns; and the rural “push”, the desire to escape from a stagnation that offers only heavy, unrewarding jobs in an atmosphere of little hope. We suggested that the lack of employment opportunities in rural areas, low pay for agricultural work, the seasonal nature and drudgery of agricultural employment, and the unattractiveness of rural living under existing conditions all contribute to this urban drift. We went on to say, “Selective mechanization of an appropriate type, used under carefully selected conditions, can provide hope for agricultural workers. Selective mechanization can thus provide a “counter-pull” to resist the attraction to the city.”
More recently, Clarke and Bishop (2002) wrote, “The availability of power is a prerequisite for any agricultural activity whether the source is human, animal or motorized. In developed country agriculture the general availability of virtually unlimited amounts of farm power in its different forms is almost taken for granted and comes almost exclusively from internal combustion engines or electric motors. The human is just the “brain” and control of the system. However, in most developing countries, the human is also a major source of farm power.” They went on to say, “In developing countries there is a great variation in the proportional use of the three primary sources of farm power. In some countries there is a dynamic situation in which human and animal power is being replaced by mechanical power, but in others, farmers are having to give up mechanical and animal power and revert back to human power.”

There is no question that uses of tractors increase the land area that can be cultivated, Figure 1. This study by Clarke and Bishop (2002) also shows that hand, animal draft and tractors supplied more or less equal amounts of power in developing countries (excluding China) in 1998, Figure 2. By 2030, Clarke and Bishop expect the proportion of power supplied by hand and animal draft will decrease and tractor use is expected to increase substantially, although some countries may be unable to follow this trend because of increasing fuel costs and insufficient government-based initiatives for introducing tractor power.
Figure 1  Area cultivated per person economically active in agriculture - Africa and Asia - 1996 (Clarke and Bishop, 2002)

Source of area data: FAO-Agriculture Towards 2015-2030; Source of population data: FAOSTAT
Figure 2  Land cultivated by different power sources
(Developing Countries excl. P.R. China)(Clarke and Bishop, 2002)

Figure 3. Agricultural mechanization in China, 1996 (Zhou, et al, 2003)

** it is about 21.38% of the total seedling area  *** it is about 12% of the total harvesting area
Other speakers will deal with the status of mechanization in China, but it seems to be increasing rapidly as shown in Figure 3 (Zhou, et al. 2003).

One of the purposes of today’s Forum is to discuss the conditions and prerequisites to make selective mechanization a success. We will also discuss the issues of selective mechanization from the manufacturers point of view. With this background, may I give you a preview of this paper. Some principles for global tractor development are outlined based largely on the work of coauthor Dr Karl Renius, a noted authority on tractor design and manufacturing (Renius, 2002; Firodia, Bacher, and Renius, 1989 and 1999). The view from North America draws heavily on the work of coauthor Dr. John Schueller (Schueller and Wall, 1986; Schueller and Stout, 1995; Krutz and Schueller, 2000), another noted authority on mechanical design and farm equipment applications. The section on reducing manufacturing costs is based on Club of Bologna presentations by Reid, Schueller, and Norris (2003) and also Harms(2003). The prerequisite infrastructure necessary for successful use of farm equipment comes from Stout and Downing (1976) work published 30 years ago that is still very relevant today. The recent article in Successful Farming (Mowitz, 2004) outlines the demise of practical mechanical programs in Agricultural Engineering departments in the US. Similar de-emphasis on mechanical specialties is taking place around the world (Technical University of Munich, Silsoe Research Institute, FAO, IRRI, etc.). The paper ends with a discussion of the need for interdisciplinary teams to solve complex problems facing agriculture and the crucial need for agricultural engineers to be part of those teams (Stout, 1997).

**Agricultural Equipment Industry in the USA**

The agricultural equipment industry in the USA has been rebounding from difficult times in which sales and profitability suffered and there were continued consolidations. In general, while there were introductions of new models, they tended to be technical evolutions rather than revolutions. But there are some areas in which innovations are driving significant commercial sales.

Light bars and other forms of guidance assistance have been a great bright spot in agricultural equipment sales, both in aftermarket and original equipment. They allow the equipment to follow very precise paths. Based upon the Global Positioning System (GPS), they reduce overlaps and skips, which can be very important in planting, fertilization, and pesticide applications. They also increase the productivity of other operations. Automatic guidance is on its way to be a requirement for new tractors and some self-propelled equipment, including fertilizer and pesticide applicators.
Equipment for precision agriculture also continues to sell, although the enthusiasm and sales are tempered by difficulties in using the technologies for effective management. The large amount of data manipulation and intervention required, and the uncertainties of what should be done, have caused some to be disappointed. Yield mapping technologies are becoming standard on grain harvesters and variable rate controls are achieving some penetration on fertilizer and pesticide application. The trend appears to be to make systems, which are both, easier to use and more open, so that they can be used with more software.

There appears to be a trend for continued adoption of the controller area network (CAN) bus on agricultural equipment. This standardized communications network allows the various controllers and other electronic devices to communicate with each other. It has reached the point of maturity where ISO 11783 is now viewed as the communications standard for this industry.

Continuously variable tractor hydromechanical transmissions were introduced later into the USA than into Western Europe. However, their recent introduction has drawn considerable interest. It is likely that they will increase their market share.

Perhaps the overriding concern of those attempting to sell powered agricultural equipment in the USA is the increasingly strict engine emission standards. This is requiring very major investments in technology development and will affect equipment prices. The Tier 3 emissions standards are being reached. However, the very substantial further reductions in NOx and particulate matter (PM) required in Tier 4 has the industry very concerned. These standards will start to be applied in 2008 and be completely enforced by 2014. The strict requirements will probably require advanced engine controls, comprehensive exhaust after-treatment, and good low-sulfur fuels. The current uncertainty of the available technologies and the overall costs of the after treatments raise great concerns. Controlling emissions in agricultural equipment and other off-road machinery can be difficult due to the more adverse and varied conditions of use. The many models and sizes, combined with the relatively low volumes of sales of those models and sizes, contribute to the difficulty in being able to devote the resources necessary to solve such a problem.

The agricultural equipment industry has long been globalized. This is not surprising, given the fact that agriculture of some type is practiced in all countries. This globalization takes many forms. In some cases it is simple importation of equipment from centralized factories in developed countries. In other cases, it is local manufacture of foreign designs. One rather unique situation for agricultural equipment is the global marketing of globally dispersed manufacturing to locate the manufacturers near their most natural markets. For example, large tractors could be made in North America,
medium tractors in Western Europe, and small tractors in Asia. All sizes might be sold worldwide, but manufactured where they dominate. Cost of production and achieving sufficient economies of scale may also drive the particular type of globalization. For example, they may be behind AGCO’s recent decision to cut combine manufacturing in Denmark to only high-specification models and make a long-term agreement to have entry-level and mid-level combines manufactured for them in Italy. Another globalization strategy is to produce the same equipment in multiple locations throughout the world. This provides the manufacturer with some protection against labor actions, currency fluctuations, and political situations.

There is much political discussion in the USA about “outsourcing”. There has been a long, and sometimes politically unpopular, trend for manufacturing to be moved to countries with lower labor costs and less regulations, such as countries in Latin America, Asia, and Eastern Europe. There was also some internal migration in the USA from the northern states to the southern states. But with the extension of globalization to service, technical, and managerial tasks, the level of political concern has increased even more. Although the change has been much less abrupt in the agricultural equipment industry, the trend to globalization continues. Leading engineering universities in the USA are now making much greater efforts to prepare students for such environments. For example, twenty percent of the engineering graduates at the University of Rhode Island also receive a college degree in German, French, or Spanish language.

The USA agricultural equipment market is the world’s largest in total value, although more units of certain machines are sold in other large countries, such as India, China, and Brazil. Due to its size, there are many participants in the market. They include the large multinationals and manufacturers from North America, Europe, and Asia. Success in the USA, as elsewhere, depends upon the usual factors of appropriate product, strong dealership organization, and good parts and service. Importers have been able to prosper especially where they fill needs which some USA farmers feel are neglected by a perceived concentration of multinationals on large equipment and equipment for high-area crops.

The globalization has also led to the “gray market” issue. These are machines, which are imported into countries through non-official channels. In the USA, the concern earlier was most with small tractors from Japan. Now self-propelled forage harvesters and telehandlers from Europe are also an issue. Companies claim that there are problems with warranty, parts and attachments, and legal liability issues with such imports. Consumers see it as a way to get unique or less expensive products.

There are many other trends or issues that have recently arisen in the contemporary
USA agricultural equipment industry. These include:

- being concerned with meeting the European Machinery Directive.
- remanufacturing. Will the agricultural equipment companies follow the lead of Caterpillar who has purchased engine and transmission remanufacturing companies?
- qualified service verification. John Deere is now matching sales delivery or rental receipts to the dealer’s training. To sell certain pieces of equipment someone from the dealer’s staff must have passed an exam on the relevant training. Will this apply to agricultural equipment?

The agricultural equipment industry in the USA appears to be recovering from the down cycle. This may be due to improved credit availability and lower interest rates, as well as pent-up demand for replacement equipment. The U.S. Ag Flash Reports (AEM, 2004) released in September 2004 report USA sales in the January through August sales periods, Table 1.

Table 1. Sales of tractors and combines in the USA.(AEM, 2004)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Jan - Aug 2003</th>
<th>Jan - Aug 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>2WD Tractors (&lt; 40 HP)*</td>
<td>92,123</td>
<td>99,297</td>
</tr>
<tr>
<td>2WD Tractors (40 - 100 HP)*</td>
<td>40,718</td>
<td>47,655</td>
</tr>
<tr>
<td>2WD Tractors (&gt; 100 HP)*</td>
<td>9,141</td>
<td>13,287</td>
</tr>
<tr>
<td>4WD Tractors**</td>
<td>1,703</td>
<td>2,199</td>
</tr>
<tr>
<td>Self-Propelled Combines</td>
<td>2,596</td>
<td>3,698</td>
</tr>
</tbody>
</table>

All the tractor categories and the combines show increases in sales. This optimism is reflected in the total predicted sales forecast for the full year, Table 2.

Table 2. Predicted sales of tractors and combines in the USA.(AEM, 2004)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>2004 Forecast</th>
<th>2005 Forecast</th>
</tr>
</thead>
<tbody>
<tr>
<td>2WD Tractors (&lt;40 HP)*</td>
<td>131,485</td>
<td>136,415</td>
</tr>
<tr>
<td>2WD Tractors (40 - 100 HP)*</td>
<td>63,761</td>
<td>66,039</td>
</tr>
<tr>
<td>2WD Tractors (&gt; 100 HP)*</td>
<td>16,700</td>
<td>16,962</td>
</tr>
<tr>
<td>4WD Tractors**</td>
<td>3,376</td>
<td>3,331</td>
</tr>
<tr>
<td>Self-Propelled Combines</td>
<td>5,808</td>
<td>6,077</td>
</tr>
</tbody>
</table>
*including tractors with front wheel drive with small wheels  
**large tractors with same size front and rear wheels

The situation in Canada has not improved yet, although the market for smaller tractors is expected to improve in 2005.

The improving USA situation has been reflected in improving profitability for the major manufacturers in that market. For example, Deere’s operating profits have gone from US$252 million to US$817 million to US$1212 million from 2001 to 2002 to 2003. The best projection for the future of the agricultural equipment industry is that it is a mature market with most of the sales being replacement equipment. No revolutionary products are being introduced which would create rapid technological obsolescence and radical changes in sales. The large markets will likely continue to be dominated by the large multinationals, principally Deere, CNH, and AGCO. Smaller companies and importers will continue to successfully service smaller markets and those farmers in large markets who demand the lowest cost equipment. Electronics will continue to increase in importance due to the increased functionality they provide. However, their contribution to equipment cost will not increase proportionately due to the electronics industry’s continued cost declines per unit of performance.

The North American Agricultural Equipment Industry and China

A recent article on the automobile industry and market in China begins with the statement “In some respects, China is defined more by what it was and might become than by what it is.” (Ponticel, 2004). Although only about two million passenger vehicles were produced last year, about the same as Italy for example, what has excited automobile makers and their suppliers is the 70% increase this represents over the previous year and the huge potential of a country with over a billion people.

There seems to be a similar excitement among the agricultural equipment industry. The Association of Equipment Manufacturers is the trade association for USA and Canadian off-highway equipment manufacturers, including those who make agricultural equipment. It’s first, and only, overseas branch was opened in Beijing in 1997. It is there to help companies “locate partners for manufacturing and distribution and uncover new sales opportunities”. (http://www.aem.org/Intl/Global/China/). For example, it sponsored exhibit pavilions at two expositions last month (September 2004). It even published a hydraulic excavator safety manual in a Chinese language.

Meanwhile, there have been substantial involvements of multinationals in China, examples of which are given elsewhere in this paper.
Similar sorts of involvement have occurred in the automobile industry, which may provide an example or model for the agricultural equipment industry. In many parts of the world, the two industries have followed similar paths because of similar technologies.

The joint ventures between multinationals and Chinese automakers have led to a dominance of the Chinese-made, but outside-designed, automobile. Mackey (2004) says: “There is some resentment mixed with disappointment among the Chinese public that so many vehicles and vehicle technologies are not of Chinese origin. ... FAW produced 140,000 Jetta sedans via its joint venture with Volkswagen, but only 20,000 of its Red Flag brand”. Although there may be some modifications for local conditions, such as vehicle stretching for passenger comfort, engine modifications to accommodate fuel quality, and chassis modifications for the poor road, there is not a lot of reengineering.

But, as in other industries (for example, Motorola’s cell phone network in China is state-of-the-art), the vehicles themselves are high-tech. Audi’s chairman says, “We are supplying China with ultra-modern technology.” (Mackey, 2004) The high-tech components for these automobiles can be made in China, but they are often imported, sometimes due to difficulty in maintaining quality. Zhang Xiaoya, director of SAE China, suggests combining introduction of advanced foreign technology, cooperation with foreign parts business, and expansion of China’s R & D capacity as a way to build component design and manufacturing capability.

What does this mean for the agricultural equipment industry in China? The great size and diversity of China and its agriculture will definitely affect the development of the agricultural equipment industry. It will be large and competitive, as we have seen in India. (Schueller and Wall, 1986). Appropriate equipment must be manufactured and the support infrastructure developed, as in any country. But China has advantages over many less developed countries in that the market is so big and that, at least in urban centers, there is substantial technical expertise. It is therefore likely that the equipment for use in China will be appropriate for the local situations and it may be relatively high-tech for a less-developed country.

In the absence of political interference or guidance, it seems likely that the Chinese agricultural equipment industry will develop through existing and new joint ventures with foreign firms. The dominant business model will be equipment of foreign design with local modifications to facilitate rural transportation and other needs. The equipment will generally be high tech by the standards of less developed countries. It will be Chinese-made, although certain high-tech components will be imported. As a
vice-president of Philips Semiconductors says, “China won’t be a dumping ground for older technology.” (Costlow, 2004)

The foreign partners might work with the Chinese firms to develop the training and management structure. This might even include the financial aspects. For example, Caterpillar has formed a wholly foreign-owned enterprise to lease its equipment in China.

The World Health Organization says that seven of the ten most polluted cities are in China. Although the rural problems are not as severe, and the requirements will not be as strict as Tier 3 and Tier 4, restriction of pollution will be an issue. India’s demonstration of a less-developed country successfully greatly reducing pollution in the Delhi area, in this case by the use of compressed natural gas (CNG), shows that the people in less-developed countries do not have to suffer terrible air pollution.

To also reduce pollution, China’s dependence on imported oil, and to leapfrog Western technology, China’s leaders are very interested in fuel cells. Since fuel cells may be very appropriate for tractors, as shown by Allis-Chalmers’s early innovative research. (Krutz and Schueller, 2000). Fuel cells for agricultural equipment could be an area of innovative Chinese research and development.

**Global Tractor Development**

Hundreds of excellent references have been written on engine power, single-axle and two-axle tractors. No attempt is made herein to cite all the relevant references, but one excellent overview is presented in the comprehensive CIGR Handbook, Volume III, entitled Plant Production Engineering (Stout and Cheze, Editors, 1999). This handbook deals not only with tractors, but also with tillage machinery, pest control equipment, harvesters and threshers, and most other types of farm equipment. It was authored by some 40 experts from around the world.

The focus in this paper is on a few principles of tractor development, based on the lifetime work of coauthor Dr. Karl Renius. He classifies the worldwide tractor technologies into five levels as described by the level of tractor functions and technical complexity, Table 3.
Table 3. Basic specifications of tractors by technology levels: worldwide view for two-axle tractors. ROPS means “Roll-Over Protective Structure”. (Renius, 2002)

<table>
<thead>
<tr>
<th>Technology level</th>
<th>Nominal engine power (40–80 kW)</th>
<th>Wheel drive</th>
<th>Diesel engine</th>
<th>Drive transmission</th>
<th>PTO</th>
<th>Hydraulics</th>
<th>Cab</th>
<th>Electronics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low (I)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>No cab</td>
<td>X</td>
</tr>
<tr>
<td>Medium (II)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>No cab</td>
<td>X (X)</td>
</tr>
<tr>
<td>High (III)</td>
<td>X (X)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X (X)</td>
<td>X</td>
<td>X (X)</td>
<td>X (X)</td>
</tr>
<tr>
<td>Low (IV)</td>
<td>X</td>
<td>X</td>
<td>(X)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X (X)</td>
<td>X (X)</td>
</tr>
<tr>
<td>High (V)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X (X)</td>
<td>X (X)</td>
</tr>
</tbody>
</table>

Technology level I is the lowest and V the highest. Reliability and durability are not included in this classification scheme because a tractor of a low technology level must offer outstanding durability when operated by an untrained driver, perhaps in a tropical climate, in heavy soils or paddy fields or with inadequate service.

The lowest technology level, I is characterized by a low power level, only rear wheel drive, low comfort (no cab), low overturning resistance (typically no ROPS) and very simple components. Level I represent the predominant tractor population in China (small two axle tractors) and similar regions. Level I may well meet the needs of many farmers in other less developed countries. Level I was also found in India in the past, but now India is moving towards Level II.

A new tractor line in India with some interesting principles of technology transfer and international cooperation was described by Firodia, Bacher, and Renius (1999). This tractor, called the Tempo OX, focused on the following customer expectations:

- improved power with high torque backup for operating in different agro-climatic conditions,
- efficient transmission and easy shifting of gears,
- higher capacity of hydraulics with sensitive response,
- good ergonomics,
- high reliability,
- reduced vibration and noise, and
• modern appearance.

The OX family of tractors is fully indigenous (in India) and therefore can be manufactured at very low cost. What has been created is truly a modern tractor, comparable in performance and characteristics to world market standards in its class.

Level IV describes the typical modern tractor in highly developed regions such as Mid-Europe, North America, Japan and others. But these markets are moving toward Level V, mainly characterized by infinitely variable transmissions and more sophisticated diesel engines---both with electronic control systems and common automatic control strategies, also called “drive line management”.

**Technology Levels for Tractor Components**

The principle of definition of technology levels can also be applied to tractor components. The transmission is considered the most important component in terms of first cost, mostly in terms of development costs.

The tractor transmission consists mainly of the speed change and reverse gearbox, the final drive with service brakes, the four-wheel drive mechanism and the PTO drive line often including auxiliary drives such as the main hydraulic pump. The most important differences regarding technology levels can be found in the speed change concept, Table 4.

Table 4. Technology levels for tractor transmissions (concentrated on the speed change and the reverser functions). SG: Sliding Gear shift, CS: Collar Shift, SS: Synchronised Shift, HiLo: 2-speed power shift, PPS: Partial Power Shift (3 or more speeds), FPS: Full Power Shift (all speeds), CVT: Continuously Variable Transmission, ( ) options. (Renius, 2002)
The simplest gearbox of Level I offers only 6 forward and 2 reverse speeds, and shifting is done by sliding gears or collar elements covering a relatively small speed range. This technology was typical for Western Europe and North America in the 1950s and later became important for several developing countries (India for example). At this time the Indian market requirements move towards Level II. For example, the transmission in the Indian Tempo XO tractor is synchronized with 4 basic speeds and a mixture of collar shift and sliding gear shift resulting in 8 forward and 4 reverse speeds. It has a large master clutch, 2 PTO speeds, high-performance lifetime wet disc brakes and an extra strong final drive.

<table>
<thead>
<tr>
<th>Technology level</th>
<th>Nominal speeds, km/h</th>
<th>No. of speeds forw. / rev.</th>
<th>Shift elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>2–20(25)</td>
<td>6/2 to 8/2</td>
<td>SG+CS</td>
</tr>
<tr>
<td>II</td>
<td>2–30</td>
<td>8/4 to 12/4</td>
<td>CS+SS</td>
</tr>
<tr>
<td>III</td>
<td>(0.5)2–30(40)</td>
<td>12/4 to 16/8</td>
<td>SS+HiLo</td>
</tr>
<tr>
<td>IV</td>
<td>(0.3)2–40(50)</td>
<td>16/12 to 36/36 (or more)</td>
<td>SS+PPS, FPS</td>
</tr>
<tr>
<td>V</td>
<td>0–50(65?)</td>
<td>infinite</td>
<td>CVT+SS</td>
</tr>
</tbody>
</table>

Level III has been typical for smaller tractors in the industrialized countries while the popular concept is toward Level IV in recent years. Level V represents an increase in technology with infinitely variable transmissions of a new-sophisticated generation. They offer considerably higher efficiencies and more automatic functions than is the past. Compared with, The energy loss of the new CVT units (without final drive) is only about half that of conventional hydrostatic units such as used on Japanese tractor transmissions due to the power split principle and optimized or completely new axial piston units.

Tractor manufacturers marketing their products in many counties must minimize the number of mechanical parts in each family of their complete tractor line. Such a manufacturer can use interchangeable parts at Levels IV and V, but it will be difficult to use the same parts for Levels I and II which are typical for countries such as China and India. Less developed countries should therefore look for technology transfer strategies based on proven tractor designs suitable for their level of technology.
Reduction Costs (Reid, Schueller, and Norris, 2003; Harms, 2003)

For agricultural equipment to be practical, it must be affordable to the users and profitable for the manufacturers. Therefore, manufacturing productivity and efficiency of agricultural equipment is an important part of the systems engineering necessary to improve our food production systems.

Figure 4 illustrates the processes the agricultural industries use in the development of new products. It shows the linkage between the new concepts for products that come from Product Planners or Advance Engineering groups and results in identification of a product development timeline including the influence of R&D, manufacturing, sales, service and finance. New concepts inputs to the process are heavily influenced by the ability of the manufacturer in providing the capabilities to be found in new products. The output of the process is products that meet customer needs. This leads to consideration of product families (e.g., tractor series), re-use of well-developed subsystems (e.g., transmission and engine components), and manufacturing capabilities of the organizations. Strong supplier relationships have been used to provide those components that do not differentiate the manufacturer from their competition (e.g., hydraulic components). Over the years, these processes have interacted to result in a highly efficient organization for the production of agricultural equipment.

But the efficiencies that have been accomplished over the last twenty years are being further stressed to become more efficient in the face of decreased sales and changing distribution of the agricultural workforce worldwide. User requirements for additional electronics, controls and corresponding software require a high level of manufacturing efficiency while adding an ever increasing level of complexity to the management and manufacturing processes. To meet these additional requirements and because project management is an outgrowth of systems management, traditional project management is migrating towards the use of system engineering tools. Through the application of these tools, the design, manufacture, and life cycle of products are considered early in the project development cycle. Early application of systems tools reduces cost, improves efficiency and minimizes risks associated with increased electrical content.
Figure 4. Example schedule of managing new projects (Reid, Schueller and Norris, 2003)

Electronics and Mechatronics Systems

Replacing mechanical functionality with electronic functionality might also reduce manufacturing costs. Just as electromechanical servomotors are computer-tuned to get responses based upon their industrial application, agricultural equipment components can be similarly adjusted.

In the markets of less-developed countries, it may make sense to have a slower adoption of electronic content in equipment since a critical issue is the serviceability of machines in the field. This is based on the presumption that less developed countries find it easier to support a mechanical-service infrastructure than an electrical-service based infrastructure.

Mechatronics is the synergistic combination of mechanical engineering, electronic engineering, control engineering, and information sciences (Figure 5). Mechatronics characterizes a general trend of increasing automation. Previous products have treated the mechanical and electronic design as separate entities. Fusion of these systems in design will lead to decreased costs in design and manufacturing and increased functionality. In effect mechatronics becomes the implementation of systems engineering principles resulting in the efficient design of electro-mechanical systems.
Figure 5. Mechatronics systems combine mechanical, electrical and computing technologies to create equivalent functionality (Zhang, 2003).

Systems Approach to Manufacturing

Due to current agricultural equipment complexity, some agricultural manufacturers are adopting systems engineering methods to reduce the costs of machinery and mitigate the risks involved in the design and manufacture of ever more complex machinery. The systems approach proceeds with design synthesis and system validation while considering the complete problem and product life cycle including disposal. In short, a systems approach considers both the business and the technical needs of all stakeholders with the goal of providing a quality product that meets the user needs.

The systems approach has three major components as shown in Figure 6:
“Requirements Management” consists of requirements capture and allocation. Requirements capture involves capturing and using stakeholder requirements to yield product specifications while requirements allocation involves developing systems architecture possibilities and systematic requirements traceability. The modular components of a system or sub-system are defined by form, fit, function and input/output definitions.

“Top Down Design and Simulation” and “Bottom Up Design and Simulation” used in the design process will improve product quality while eliminating prototypes, reduce product delivery cycle time, and optimize machine performance. “Bottom Up Simulation and Analysis” which involves simulation and analysis starting from the component level and working upward. Examples include the finite element analysis of wheels and three-dimensional dynamic simulation of a tractor. Rapid prototyping, virtual simulation, and design for assembly and manufacture are possible methods that may be involved. “Top Down Synthesis and Simulation” involves product development (synthesis) from upper level requirements. For example, fleet system simulation and optimization, synthesis of machine systems, to synthesis of kinematics. An additional aspect of this process is the design of modular system architectures.
Harms (2003) described the concept of simultaneous (or concurrent) engineering. Without early and simultaneous involvement of all departments, specialists, suppliers and potential external consultants, one can no longer develop ever more complex agricultural machines. In that case “simultaneous” means to be faster to the market, because all manufacturers can contribute their expertise earlier, and also have the opportunity to use the expertise of the various specialists as early as possible. Thus, the product quality and the market use is improved simultaneously. In former times and with small machines, one could afford to have machines designed and looked after by one specialist. Today this is no longer feasible due to the fact that machines have become too complex. For various conditions in different markets it is important to cooperate with a very high flexibility in the field of design, production, purchasing, controlling and marketing.

In all parts of the industry there is great pressure on the development departments, Table 5.

Table 5. Pressure on the development department. (Harms, 2003)

<table>
<thead>
<tr>
<th>Pressure on Time</th>
<th>Pressure on Costs</th>
<th>Pressure on Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>short product life time</td>
<td>increasing complexity</td>
<td>realization of customers request</td>
</tr>
<tr>
<td>quicker in the market</td>
<td>outsourcing</td>
<td>flexibility of development process</td>
</tr>
<tr>
<td>accelerate development process</td>
<td>overhead expenses</td>
<td>integration of special know-how</td>
</tr>
<tr>
<td>development process must be</td>
<td>production expenses</td>
<td>innovative concepts for new products</td>
</tr>
<tr>
<td>shorter than product life time</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

"Simultaneous (or Concurrent) Engineering", is a process wherein products and production equipment are developed simultaneously by interdisciplinary teams and sub-suppliers are involved as early as possible. The main advantages of the SE-method are a much shorter development period, lower development cost and earlier market presence.

**Agricultural Mechanization Policies**

Almost 30 years ago, Stout and Downing (1976) wrote about the need for a coherent mechanization policy. They pointed out that in most countries development plans provide basic policy guidelines for agricultural development; but the component of
these plans concerning mechanization policy is generally weak or non-existent. This is a serious failing, for it is increasingly recognized that mechanization profoundly influences factors such as the volume and quality of production; the productivity of both land and labor; the cost of production; the level of employment; migration of agricultural wage earners and farmers; land ownership patterns; the development of mechanical skills and of manufacturing and service-related industry; and foreign exchange. These are all very important factors for the national economy of any country and each requires careful and deliberate consideration.

All governments should therefore work out a coherent and consistent set of aims and approaches, which in aggregate constitute an agricultural mechanization policy, and should make sure that the role of mechanization is understood by all.

Adequate mechanization policy involves much more than production and employment considerations; in addition it includes objectives concerning consumer prices, land tenure, conservation and energy. Some of the basic questions concerning mechanization it will attempt to resolve are: Is tractor mechanization to be promoted? What operations should be further mechanized? Where (i.e. to what particular crops, areas or production bottlenecks) should mechanization be applied? What levels of mechanization (i.e. hand tools, animal-draft or tractorization) should be applied? What is the best way to promote the desired mechanization?

The major components of a mechanization policy may be broadly categorized as technical, on the one hand, and economic and social on the other. Before examining the various technical considerations that should guide a mechanization policy, it must be emphasized that a successful agricultural program, with or without mechanization, must include measures to ensure the availability and proper use of modern inputs such as high yielding varieties, fertilizers, improved water control systems and crop protection chemicals as well as labor, draft animals, hand tools, and engine powered machines.

Training And Education

One of the first priorities is to provide training and education for users of mechanical equipment, whether hand operated, animal drawn, or motorized. Training facilities are needed for mechanics, technicians and engineers, those who will design equipment, work as extension officers, conduct mechanization research and supervise mechanization programs.

Manufacturing, Distribution, Service and Repair
Development of a local farm equipment industry provides alternative employment, reduces dependence on imports, saves foreign exchange and facilitates the supply of spare parts and service. Adequate supplies of spare part are essential for the smooth and efficient operation of a mechanization program.

**Imports and Joint Ventures**

Equipment designed for use in Europe and North America often has to be modified and strengthened or even completely redesigned to ensure mechanical reliability and to fit in with local agricultural practices. Joint ventures where international companies collaborate with local manufacturers have become commonplace in recent years. Examples include Deere and company’s joining with China’s state owned Tianjin Tractor Manufacturing Company and CNH joining with the Shanghai Tractor and Internal Combustion Engine Corporation.

**Fuel supplies**

Engine powered equipment requires a steady, dependable supply of fuel, which is an essential task of a mechanization policy to ensure, especially in times of shortages and higher prices.

**Research**

Appropriate research on agricultural mechanization systems should be encouraged and funded at existing national and regional institutions. These may be universities, institutes for agricultural research, machinery testing centers or other agencies. Research can be strengthened by better financing, better qualified staff, better facilities, better communication between agencies and disciplines, and integration with general agricultural research.

**Credit**

Since most farmers in less developed countries have accumulated very little capital, any move to higher-level mechanization will require a supply of credit to small manufacturers and farmers.

**Storage, Transportation, Post-harvest Processing and Marketing**

The goal of increased production assumes the existence of a market. Storage, transportation and Post-harvest processing are important links between the farm and the market.
Mechanization Policy Committee

A special co-ordinating committee (or working group) should be appointed and made responsible for drawing up a detailed mechanization policy and program to accelerate the development and efficient application of equipment for agricultural production and post harvest handling and processing. It activities might include:

1. a broad program of research to define the role of agricultural mechanization in each country,
2. prioritizing mechanical research and development projects,
3. testing and functional evaluation as well as reliability and durability,
4. operating demonstration farms in cooperation with extension specialists,
5. collaborating with manufacturers,
6. provide extension services
7. economic and social considerations, effect on employment,
8. calculation of cost/benefit ratios

Agricultural/Mechanical Engineering Education

Education and research has been discussed in the previous section, but another aspect needs to be mentioned. In North America, Europe and other countries as well, the Power and Machinery (mechanization) programs in many agricultural engineering departments have been severely reduced almost to the point of elimination. Many agricultural engineering departments have added the word biological, or biosystems to the department name and some have removed the word—agriculture. The idea is that the machinery manufacturers can provide all the needed engineering expertise. But where will the machinery companies find that mechanical expertise? Certainly not in most of the agricultural engineering programs in US universities. The same is true in many European universities. And FAO has recently downgraded its mechanizations services. IRRI has nearly eliminated its once mighty mechanization research program.

A recent article in the widely read US magazine, Successful Farming, decries this move away from practical applications of agricultural engineering and mechanization. It cites the example of a well-known practical agricultural mechanization specialist, Dr. Graeme Quick, who was recently allowed to retire from Iowa State University and return to his home in Australia. The author of this article, Dave Mowitz, asks where will we find the practical engineers specializing in agricultural mechanization in the future? He writes, “Never mind that agriculture is still the number one occupation in many states (in the US and around the world) as well as the largest single industry in the
country (US). Yet it seems that university administrators are turning up their collective noses at production agriculture. At times they act embarrassed to deal with the day-to-day aspects of farming and ranching.” (Mowitz, 2004)

My message to you—don’t let this situation develop in China or in other countries where agriculture is so important to the national economy.

**Engineers---Part Of The Interdisciplinary Team**

Engineering has the potential to contribute to a wide variety of options to help increase production and productivity and thereby reduce poverty and increase food security and safety. All too often, however, we have missed opportunities by working on micro-studies in isolation and interpreting our role too narrowly. We haven’t communicated our achievements effectively in terms that the public, policy makers, and other disciplines can appreciate. We are very good at what we do, but too many of us are content to focus on micro-studies; that is, problems with well defined boundaries that lend themselves to quantitative analysis. Many of us are uncomfortable when faced with broad issues that may be poorly defined and often unbounded; problems such as poverty, illiteracy, unequal income distribution, and food security and safety. We prefer to withdraw to our labs and develop and validate mathematical models that have clearly defined, finite boundaries. We can then present our results with confidence based on mathematical principles, the laws of physics, thermodynamics and so on. And this type of work is important. We should be justifiably proud of our talents and accomplishments. But the technical and mathematical aspect is only part of the picture; sometimes the easy part. The fundamental objective of engineering should be to help people, so we must strive to be a part of interdisciplinary teams that include social, economic and even political dimensions.

So my challenge to you is to look at the big picture—think globally and multidisciplinary. Look for ways for industry and university/government engineers to work with other specialists to solve bigger problems. Ask—what are the major agricultural-related problems in the world today? And how can we contribute to solutions? We have already talked about a systems approach for solving mechanical design problems, but now we are thinking about working within a multidisciplinary environment. In this way engineering can have a direct impact through research and development as well as an indirect impact by being a catalyst for increasing the impact of other disciplines. By adopting a demand-led systems approach that considers all stakeholders involved in the production to consumption chain, intervention points can be better identified and targeted and R&D can be better focused to achieve outputs appropriate for each target group. Combined with a problem-solving orientation rather than a technology focus,
hardware development becomes a tool and not an end in itself. To capture the opportunities that a systems approach offers will require engineers to work more closely with target groups in a more multidisciplinary environment. As such, it may be necessary to develop or tap into a wider set of skills (such as economics, operations research, ergonomics, business management, agronomy, etc.). Problem solving, not technology generation, must be the focus.

Some big problems that agricultural engineers can address include feeding an expanding world population, improving income distribution so everyone will have the purchasing power to afford a balanced and nutritious diet (food security), natural resource conservation and efficient management (soil, water, energy, etc.), maintaining the environment (preventing soil degradation, maintaining water and air quality, etc.), maintaining food safety, and creating a safer workplace. Mechanization must be considered in the context of this broader set of issues.

I also challenge you to become more involved with public policy issues and to let administrators and policy makers know about the benefits of your work to society and to ensure that agricultural engineering (mechanization) is on the national and local research priorities list. No one person can do these things alone—it is up to all of us to broaden our horizons, think and talk more about the impact of our work on humans; and thereby strengthen our profession and increase our service to humanity (Stout, 1997).

References


Firodia, A., R. Bacher, and K. Renius. 1999. Transfer of Technologies from Developed to Developing Countries: Experiences and Results in Asia and the Far East. The Case of
International Forum on Development Strategy of Agricultural Equipment and Mechanization in Less Developed Regions


Technology and Its Impact on Agricultural Mechanization

Dr. John Reid
Manager, Intelligent Machine Systems
John Deere Technology Center
Deere & Company
Moline, IL

This paper will provide a technology review for agriculture from the perspective of a Technology director associated in industry.

First, I think it is interesting to understand how John Deere fits into this as a company. I apologize if this seems like an advertisement of John Deere, but I think that the heritage of the company is interesting with respect to the impact of technology. Some of this information is borrowed from an overview of John Deere company.
It all started as a blacksmith shop 167 years ago.

John Deere’s amazing longevity and prosperity can be largely attributed to four core values … strong, basic values that were exhibited by our founder and have been long adopted by our company’s employees:

Quality  
Innovation  
Integrity  
Commitment

While business has expanded exponentially, these values have remained constant, and that’s why we remain successful today ... that is why we will be successful in the future.
What lies ahead for Agricultural Equipment?

Percentage of population engaged in agriculture

(NOTE: Percentages shown are based on 2000 data from the Food & Agricultural Organization of the United Nations)

150 years ago, 90% of U.S. population engaged in agriculture; now 2.2% due to mechanization; much of the rest of world hopes to follow this trend.

With the world population growing by over 8,700 every hour, and diets being extensively upgraded, demand for grain is expected to triple in the next 50 years. Reduced farm population due to industrial development is also increasing the demand for farm equipment ... so a tremendous worldwide growth in agricultural equipment is yet to be realized.

The world is only about half mechanized.
Production agriculture in both developed countries and developing countries have constraints that will be reviewed in some detail.

Additionally, there are unknown factors or influences that may change the evolution of agriculture. Sometimes we can estimate the trend of this change, but in other cases it is somewhat unpredictable.

I will review the issues from Developed countries in more detail and to a lesser extent (because of my expertise) Developing Countries.
1. Larger, More Powerful Customers

**Facts**
8% of farms produce 72% of the agricultural output in the US

**Implications**
Broader geographic support required
Integrated products and services desired

The US is an example of Developed Country agriculture. In the US, 8% of the farms produce 72% of output (1997). The source is the Ag census.

A related fact (for an unknown year) sourced from a conversation with the USDA is that 1% of the nation’s farmer produce 42% (almost half) of the nation’s agricultural output.
2. Demographics

- Rapid consolidation of businesses and individual operations
- Fewer skilled laborers
- Aging customer base (Agriculture)
- Increasing number of lifestyle farms

Farmers and producers are becoming more like businesses through consolidation of farms into larger operational units. Fewer people are involved in agriculture as a profession in developing societies. This has the impact that there are fewer skilled laborers for agricultural tasks and there is a general increase in the average age of the farmer given that fewer of the younger generation are adopting farming as a career.

Interestingly, many professionals are seeking farming as a hobby, so-called life-style farmers driven to the agricultural life-style but not requiring farming for sustenance or business income. Many people with a historical association with agriculture can only afford it as a part-time venture.
The consolidation of producers has also driven the industry into a smaller number of companies that manufacture equipment. There are few competitors and this brings the with it the complexity of large organizations.

And the companies that remain are driven into provided solutions for customers that go beyond the traditional role of “selling iron” or manufacturing the machine. Interestingly, these consolidations and process efficiencies have made it impractical for large companies to remain active in all aspects of production. There is a trend towards collaboration and outsourcing of low value products to maintain a complete product line.

This has opened the door smaller short-liner companies to have a healthy business for equipment not attractive to the major manufacturers.
4. Trends Impacting Agricultural Equipment

- Increased electrification as part of the standard product
  - Electronic Control Units
  - Operator interfaces (displays, joysticks)
- Natural "organic" transformation of machine electrification has been an enabler for intelligent mobile equipment.

Product evolution has led to more and more electronic content in agricultural machines. What were once exclusively mechanical systems have significant electronic content, including embedded controllers, displays, and joysticks, for machine operation.

These developments have been one enabler for potential evolution into intelligent machine concepts.
The evolution of electronics in agriculture has closely followed the trends of the automotive industry. Today, advanced vehicle systems have one or more distributed networked architectures (CAN-bus, etc.) with distributed control systems that link prime mover and implement functions.

These developments and the advent of precision agriculture have lead to the birth of intelligent mobile equipment.
Precision Agriculture and the associate technologies provide a strong springboard to accelerate the development of intelligent mobile equipment leading to opportunities for automation in agriculture.

Yield mapping was an early product introduced to farmers to understand the variability of the crops and to enable some management decisions.

Of greater significance have been the automated guidance technologies that enable productivity increases that can be used to recover the cost of the technology investment.

With Precision Agriculture and intelligent mobile equipment have come the need for communication, sensors, positioning as part of the machine.
Today we have realized the following automation technologies for navigation and automation:

- Parallel tracking systems based on GPS
- Non-contact navigation of combine harvesters (Claas)
- Precision guidance based on RTK GPS
- Turning assistance

Some additional developments will have to occur for these systems to develop:

- Area coverage path and point-to-point path planning based off of the current automatic guidance systems.
- GPS technologies will get better and will be augmented with posture sensing capabilities.
- Optimization of traversed pathway for vehicles based on field specific variables (e.g., contours, obstructions, etc.).
- Crop-referenced navigation using machine vision technologies to allow more flexible GPS positioning solutions.
- Leader-follower collaboration between machines, especially for combine harvesters and tractors with grain carts.
The farmer and producer is becoming associated with the market channel in new ways. There is increasing demand orientation of the agri-food chain is attributable to:

- The need of consumers for more and better agri-food products
- The need of food companies to further establish and protect their brands
- The need of processors to achieve additional improvements and efficiencies in their production processes.
There are four primary factors that drive demand. Compliance and Food Safety are related to cost avoidance or cost reduction. Performance improvement and brand management are related to value creation.
7. Biotechnology Impact

- GMO’s represent a biotechnology event.
  - Transgenic technology involves molecular transfer of a “foreign gene” into a species, i.e. a gene from bacteria or sunflower into corn.
- Future will bring transgenics with complex traits
  - Stress tolerance, yield enhanced, nutritional improved, disease resistance, vaccines, novel goods, energy, etc.
- Fast and major impact on equipment, technology, and businesses

Spraying systems displace mechanical cultivation

Transgenic technology or GMO’s are very controversial worldwide. The lead of this biotechnology-related field is ahead of the customer acceptance curve. But independent of ones position on GMO’s it is clear that the impact of transgenics has, and will continue to have, significant impact on agriculture.

From an equipment standpoint, these methods have the potential to completely make cultural practices that were once commonly accepted obsolete. Or perhaps become socially-driven enablers of new technology that was not considered reasonable previously.

Round-up ready corn and soybeans are an example.

- Cultivation as a method of weed control is reduced as a result of this GMO.
- Spraying systems increase.
- And social reaction to GMO’s provides a driver for mechanical weeding providing the opportunity for inter-row and intra-row technologies.
**Issues in Developing Countries**

Goals of growth, environmental sustainability, and poverty alleviation in developing countries will provide framework to develop equipment, technology, and services.

- Demographics
- Economic constraints
- Infrastructure
- Social issues
- Appropriateness of technology

Moving briefly to developing countries one would have to observe that technology needs are different that the developed countries. Demographics, economic constraints, infrastructure and other social issues are a much higher priority. These include:

- Water availability
- Environmental issues like erosion, salinity, desertification, pesticides, and nutrients
- Sustainability and acceptance of ‘Green Revolution’ (improved genetics, fertilizer, and irrigation)
- Seed issues

And technology appropriateness drives for needs that are quite different from developed countries in most cases. Technology needs include improved genetics, efficient use of water and inputs, improved seeding systems, and information and communication technology.

Appropriateness of technology does not limit developing countries to low technology. There are examples of systems in developing countries that adopt modern technology developments and skip over interim technology solutions that have been experienced by developed countries.

The computer, communications systems, Internet and information management seem likely to be technologies that will enable rapid development at the appropriate level of national, regional, or local adoption.
In both developed and developing countries, agriculture needs to be considered as a system with appropriate understanding of the constraints that need to be considered. With the advent of information technology, it is not a requirement for developing countries to model their agricultural practices as duplicates of systems used in developed countries.

In other cases, it may be possible to jump over steps in the evolution of systems that adopted or even improve upon the practices of developed countries using existing machines as the basis.

Alternative approaches have to be considered by knowledgeable practitioners of agriculture that have a broad knowledge of the constraints of the system (social, economical, climatic, etc.). This issues a challenge to the agricultural and biological engineering profession to take a view of the interrelationships between man, machine and environment as well as connections to the food chain.
Technologies of Common Interest

- Remote Sensing
- Communications
- Computer
- Biotechnology

Independent of developed or developing agriculture situation, some technologies have potential impact that can provide benefit to the society. A number of researchers at this forum represent knowledge experts on this technologies. A few worth mentioning include remote sensing, communications, computer technology and biotechnology.
Summary

- Agricultural Mechanization has been responsible for increasing efficiency, productivity, and safety in agriculture.
  - American Academy of Engineering cited Agricultural Mechanization as one of the top innovations of the 20th Century.
- Opportunities for increased efficiencies in agriculture through Technology
  - Developed Countries
    - Potential for increased automation as part of evolution involving sensors, controls, electronics and automation of parts of the machine system.
    - Lead to formation of an industrial-plant-agricultural system with the producer as part of the production channel.
    - Agricultural industries can develop new strategies based on intelligent systems applications development.
  - Developing Countries
    - Can benefit from key technologies (including remote sensing, computerization, information technology) when applied appropriately.
    - May also take evolutionary steps for some systems.
The Present Situation and Development Trend of Agricultural Machinery Industry in China

Mr. Gao Yuanen,
The Deputy President of China Machinery Industry Federation,
The Chairman of China Association of Agricultural Machinery Manufacturers

China is a big country and agriculture is the foundation of national economy. The central government has been paying great attention to the development of agriculture, and has taken the realization of agricultural modernization as a very important position. Agricultural machinery is the basic equipment of modernized agriculture, the agricultural machinery industry in China has obtained great achievements and China has become a big country of agricultural machinery production along with the agricultural development.

For over 50 years after the People’s Republic of China was founded in 1949, the agricultural machinery industry has supplied the agriculture with about 2 million big-mid-size tractors and 28 million small-size tractors, 25 million farm vehicles, 300,000 combine harvesters and a lot of gas engines, attachment farm implements, machinery of plant protection, agricultural products processing, animal husbandry, fishery, forestry, irrigation and drainage and so on over some 50 years. The agricultural machinery industry has played a great role in increasing the agricultural productivity, accelerating to increase production and income, developing the diversified economy, strengthening the anti-disaster capacity, and promoting the agricultural modernization. The country has seen a remarkable development in agricultural mechanization, the mechanization level of ploughing, sowing and harvesting had reached 46.8%, 26.7% and 19% of the total respectively in 2003. The mechanization has almost been realized in wheat field operation.

1. The Present Situation of Agricultural Machinery Industry in China

1.1 The whole system of agricultural machinery industry has been established.

The whole system of agricultural machinery industry has come into being from research, development, manufacture to sale and service, such as the research and development system among the three-joint-organization of scientific research departments, colleges and universities and enterprises, the production system consisted of 8,000 enterprises of whole machine and spare parts, the sale & service system conjoined between
enterprises and sale companies, the extension and demonstration system combined technology extension departments with enterprises.

1.2 The service object of agricultural machinery covers the whole agricultural field.
The service object of agricultural machinery includes agriculture, forestry, animal husbandry, sideline production and fishery. Owing to the vast territory and in China and various natural condition and economic situation in each region, the categories of agricultural machinery are also complicated with many types. At present, Chinese enterprises can manufacture 3,000 kinds of agricultural machinery under 95-small-type and 14-big-category. Because most farmers are working in a medium-small sized scale, the constraints of limited income and low operational level of machinery, Chinese agricultural machinery is featured by practicality, simplicity and low price. To meet the needs of big farm, large machinery is manufactured too. The output of main agricultural machinery in China in 2003 and in the half of 2004 are as following (see Table 1).

Table 1:

<table>
<thead>
<tr>
<th>Product Name</th>
<th>Unit</th>
<th>The output in 2003</th>
<th>The output in the half of 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big-mid-size tractor</td>
<td>set</td>
<td>48,544</td>
<td>48,822</td>
</tr>
<tr>
<td>Small-size tractor</td>
<td>set</td>
<td>1,864,540</td>
<td>867,878</td>
</tr>
<tr>
<td>Gas engine</td>
<td>10,000Kw</td>
<td>33,010.50</td>
<td>21,695.70</td>
</tr>
<tr>
<td>Harvesting machinery</td>
<td>set</td>
<td>193,265</td>
<td>119,091</td>
</tr>
<tr>
<td>Field operating machinery</td>
<td>set</td>
<td>137,955</td>
<td>63,162</td>
</tr>
<tr>
<td>Farm machinery</td>
<td>transportation set</td>
<td>2,581,952</td>
<td>1,117,246</td>
</tr>
<tr>
<td>Grain machinery</td>
<td>processing set</td>
<td>664,645</td>
<td>378,184</td>
</tr>
<tr>
<td>Feed machinery</td>
<td>processing set</td>
<td>130,873</td>
<td>60,736</td>
</tr>
<tr>
<td>Tobacco machinery</td>
<td>processing set</td>
<td>4,534</td>
<td>3,291</td>
</tr>
<tr>
<td>Cotton machinery</td>
<td>processing set</td>
<td>12,746</td>
<td>10,231</td>
</tr>
<tr>
<td>Pump</td>
<td>set</td>
<td>22,638,779</td>
<td>12,681,069</td>
</tr>
</tbody>
</table>

1.3 The number of the enterprises of agricultural machinery is large and the scale is small. Meanwhile the nongovernmental enterprises have grown up rapidly.
There are about 8,000 agricultural machinery manufacturers in China, which occupies a bigger portion in machinery industry. According to the statistics in 2003 by National Bureau of Statistics of China, there are 1,469 scale enterprises with the annual sale income of over 5 million RMB Yuan, excluding the enterprises of farm diesel engine and irrigation and drainage machinery, the total employees reach to 410,000 in these enterprises. There are only 4 enterprises with the annual sale income of over 2 billion RMB Yuan. There are 181 tractor manufacturers with the total sales of 16.4 billion RMB Yuan, the average sale income is 90 million RMB Yuan for each one.

Before the reform and opening up in China, the agricultural machinery manufacturers are all state-owned or collective-owned, with the stress on the former. However, along with the reform and opening up in China, the nongovernmental enterprises have developed rapidly and become a very important part in Chinese agricultural machinery industry. According to the statistics in 2003 by National Bureau of Statistics of China, among the 1469 scale enterprise, 920 of which is nongovernmental enterprises with the annual sale income of over 5 million RMB Yuan, covering 62.6% of the total, its assets 43.6% and sale income 63%. Sino-joint venture, cooperative business and exclusively foreign-owned enterprises are increasing gradually, like John Deere, New Holland, Kubota, Yanmar etc have established their offices in China. The number, assets and sale income of state-owned or state-owned holding enterprises, nongovernmental enterprises and sino-joint venture, cooperative business and exclusively foreign-owned enterprises in China are as following (see Table 2).

Table 2:

<table>
<thead>
<tr>
<th>Enterprise type</th>
<th>Number</th>
<th>The total assets</th>
<th>Sale income</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Assets value</td>
<td>Ratio (%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(100 million Yuan)</td>
<td></td>
</tr>
<tr>
<td>Scale enterprises</td>
<td>1469</td>
<td>659</td>
<td>100</td>
</tr>
<tr>
<td>State-owned or state-owned holding enterprises</td>
<td>481</td>
<td>328.3</td>
<td>49.8</td>
</tr>
<tr>
<td>Nongovernmental enterprises</td>
<td>918</td>
<td>287.4</td>
<td>43.6</td>
</tr>
<tr>
<td>Sino-joint venture, cooperative business and exclusively foreign-owned enterprises</td>
<td>70</td>
<td>43.3</td>
<td>6.6</td>
</tr>
</tbody>
</table>

1.4 The rapid development trend of agricultural machinery industry in China

The agricultural machinery industry in China has stably grown in recent years. Because
the nation economy develops rapidly, the central government pays great attention to the development of agricultural machinery industry and agricultural mechanization, and the rural labor forces move into industry production. The increase rate for the total output value of industry and sale income have both been over 20% since 2003. The economic benefit has also risen year after year, the increase rate reached 61.7% in 2003. The situation of production, sale and profit for the scale enterprises, excluding the enterprises of farm diesel engine and irrigation and drainage machinery, in 2002, 2003 and in the half of 2004 are as following (see Table 3).

### Table 3:

<table>
<thead>
<tr>
<th>Year</th>
<th>The total output value of industry (100 million Yuan)</th>
<th>Sale income</th>
<th>The total profit</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Output value</td>
<td>Increases rate (%)</td>
<td>Income value (100 million Yuan)</td>
</tr>
<tr>
<td>2002</td>
<td>634.8</td>
<td>18</td>
<td>551.8</td>
</tr>
<tr>
<td>2003</td>
<td>753.4</td>
<td>22</td>
<td>695.9</td>
</tr>
<tr>
<td>The half of 2004</td>
<td>437.4</td>
<td>20</td>
<td>400.8</td>
</tr>
</tbody>
</table>

1.5 The imports and exports for agricultural machinery has forcefully increased

Due to the practicality and lower price, the exports of Chinese agricultural machinery has risen rapidly in recent years. According to the statistics of Chinese customs, the main exported agricultural machinery, including diesel engine and irrigation and drainage machinery, were mid-small-power diesel engine, farm irrigation and drainage machinery, tractor and spare parts in the past three years. Meanwhile the imports of agricultural machinery has also increased greatly on account of the adjustment of agricultural structure in China. The main imported agricultural machinery include diesel engine, big-horsepower tractor, cotton picker, grass machinery, agricultural products processing machinery and so on(see Table 4).

### Table 4:

<table>
<thead>
<tr>
<th>Year</th>
<th>Exports value (100 million USD)</th>
<th>Imports value (100 million USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>15.21</td>
<td>19.55</td>
</tr>
</tbody>
</table>
1.6 Chinese agricultural machinery industry does not completely meet the market demand yet.

Although Chinese enterprises can produce over 3,000 kinds of agricultural machinery, the type and quality of product can not meet the demand of market. There exists the overcapacity in the ordinary products such as small-size tractor, single-cylinder diesel engine, farm vehicle and small-size processing machinery for agro-products. However, Chinese enterprises are not able to supply the present market needs of big-horsepower tractor and its attachment implements, the planting and harvesting machinery for paddy, corn and rape, grass machinery and deeply processing machinery for agro-products, which have to be imported from foreign countries. In addition, the reliability of Chinese agricultural machinery is not satisfied yet and its manufacturing quality should be improved further.

2. The Development Trend of Agricultural Machinery Industry in China

2.1 China is the big market for the international agricultural machinery.

It has brought a good market for Chinese agricultural machinery with the rapid development of national economy and the adjustment of agricultural structure. Recently, the Chinese central government has issued series of support policies for the development of rural areas, agriculture, and the increase of farmers’ income, which ensure the flourishing market for agricultural machinery in China. The farmers’ purchasing power has been raised along with the reduction or exemption from agricultural tax, the subsidy offered for the farmers of growing grain and increase of farmers’ income. This year, the central finance department provides the subsidy to buy machinery with 70 million Yuan, 40 million Yuan of it for the agricultural areas and 30 million Yuan for the cultivation and reclamation areas, in the meantime, the local governments will also supply 410 million Yuan as the subsidy, which greatly arouses the enthusiasm of the farmers to buy agricultural machinery. More subsidy will be provided by central government later. The Chinese agricultural machinery industry will continue to develop rapidly in the future years and China will still import some big-size agricultural machinery from the international market. The forecast of average output for the main agricultural machinery in three to five years is as following (see Table 5).

Table 5:

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>21.31</td>
<td>42.19</td>
</tr>
<tr>
<td>The half of 2004</td>
<td>14.92</td>
<td>32.34</td>
</tr>
</tbody>
</table>
### Product Name

<table>
<thead>
<tr>
<th><strong>Product Name</strong></th>
<th><strong>Unit</strong></th>
<th><strong>The forecast of average output</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Big-mid-size tractor</td>
<td>10,000 set</td>
<td>7.0~8.0</td>
</tr>
<tr>
<td>Small-size tractor</td>
<td>10,000 set</td>
<td>180~200</td>
</tr>
<tr>
<td>Gas engine</td>
<td>10,000 kw</td>
<td>30,000~40,000</td>
</tr>
<tr>
<td>Big-mid-size cultivating machinery</td>
<td>10,000 set</td>
<td>25</td>
</tr>
<tr>
<td>Small-size cultivating machinery</td>
<td>10,000 set</td>
<td>150</td>
</tr>
<tr>
<td>Motorized plant protection machinery</td>
<td>10,000 set</td>
<td>30</td>
</tr>
<tr>
<td>Self-propelled grain combine</td>
<td>10,000 set</td>
<td>4.0~4.5</td>
</tr>
<tr>
<td>Grain drying machinery</td>
<td>10,000 set</td>
<td>0.04</td>
</tr>
<tr>
<td>Animal husbandry machinery</td>
<td>10,000 set</td>
<td>105</td>
</tr>
<tr>
<td>Processing machinery for agro-products and byproducts</td>
<td>10,000 set</td>
<td>60</td>
</tr>
<tr>
<td>Irrigation and drainage machinery (water pump and sprinkler)</td>
<td>10,000 set</td>
<td>230</td>
</tr>
<tr>
<td>Farm vehicle</td>
<td>10,000 set</td>
<td>280</td>
</tr>
<tr>
<td>Three-wheeled farm vehicle</td>
<td>10,000 set</td>
<td>230</td>
</tr>
<tr>
<td>Four-wheeled farm vehicle</td>
<td>10,000 set</td>
<td>50</td>
</tr>
</tbody>
</table>

#### 2.2 The stress on the structure adjustment and the urgent development for agricultural machinery

China has achieved remarkable development in all sectors of agriculture in the past half century, which has been recognized by the world. The food problem for over 1.2 billion Chinese has been solved. However, there are still some problems such as higher operating costs and lower income for farmers due to the less land and large population, small managing scale and the limitation of new technology. The objective of agricultural structure adjustment is to heighten the utilization ratio of agricultural resources and the productivity, to improve the quality of agricultural products and the general benefit, to increase farmers' income, to realize the changes from quantity type to quality type of agriculture and also from the intensive products of farmland to ones of labor combined with technology.
In order to adapt to the adjustment of agricultural structure, the structure of agricultural machinery should be realized as following.

2.2.1 The adjustment from the stress on mid-small-size field operating machinery to that on big-mid-size field operating machinery, from single operating machinery to complex operating machinery, so as to supply equipments for the intensive agriculture, increase productivity and assure grain production safety.

2.2.2 The adjustment from roughing equipments to finishing equipments, from single machine to whole sets of equipments, so as to provide equipments for the industrialized agriculture and increase the additional value of agricultural products.

2.2.3 The adjustment from field operating machinery to that for the whole process of agricultural production, from machinery of grain production to that of agriculture, forestry, animal husbandry, sideline production and fishery, so as to offer equipments for the structure adjustment of agricultural industry, tap the latent power of income increase.

2.2.4 The adjustment from equipments of resource utilization to equipments of resource protection, from traditional equipments to that of high-new technology, so as to supply equipments for the sustainable agriculture, richly use and protect the agricultural resources.

In a word, the present development of Chinese agricultural machinery industry focuses on big-mid-size machinery of grain and industrial crop production for intensivism, on whole sets of equipment of precisely & deeply processing of agro-products for agricultural industrialism, on whole sets of equipment of factory breeding for the efficient and none-pollution animal and poultry, on machinery of grass production and processing, on irrigation equipment, attachment implements and key spare parts.

2.3 To renovate the traditional technology with new and applicable technology to improve the product quality.

One hand, enterprises should strengthen technical updating to enhance manufacturing capability and improve the product quality by introducing the advanced technology and equipment. On the other hand, enterprises should introduce new management concept, establish standard and scientific management mechanism, to form modern enterprise system.

2.4 The adjustment of industry organization structure and capital structure
Several large enterprise groups will come into being progressively according to the market mechanism among agricultural machinery industry, which can become the lead part to promote the progress of whole agricultural machinery industry, to participate in international competition and to stabilize the overall situation with more abundant capital, huger spread of products and strongly competitive capacity. Meanwhile, a number of giant enterprises will form around the groups, which are characterized for superiority in market and technology in one or several types of product, and manufacture not only the special products, but also the attachment product and spare parts for the groups. Thus there will exist one industry structure mode, which is big & strong, small & specialized enterprises develop together others.

The industry capital structure should also be adjusted in accordance with the adjustment of industry organization structure. The national capital will further withdraw from the capital structure, the amount of private and foreign capital will be increased, and the final three-part-capital structure will form step by step with the proper share, in which the groups with national capital, or state-owned holding or share-holding system are the lead part, the mid-small-size enterprises especially nongovernmental ones are the main part and foreign-capital enterprises are the supplement part.

2.5 To exploit the international market for Chinese agricultural machinery

The export advantage is obvious to Chinese agricultural machinery, which has many kinds and types as mentioned before, and can cover fields widely and has abroad adaptability. In the meantime, Chinese agricultural machinery is very suitable for the needs not only of farmers in the developing countries, but also of small or spare-time farmers in the developed countries. The entry into WTO has brought a good opportunity for Chinese enterprises of agricultural machinery to come into the international market and the governmental support policy on export has also provided favorable conditions for them to export products.

3 The Final Conclusion

Chinese central government has been paying great attention to the development of agricultural machinery industry and has also given support policy as a big agricultural country. Along with the rapid development of economy and the adjustment of agricultural structure, there is a new opportunity for the domestic research center of agricultural machinery and its production, enterprises as well as for that of the foreign countries. Chinese market needs new product and technology from foreign countries. The cooperative methods as technology introduction, research and development, cooperative production and sole-joint venture have opened up the successful doors into
Chinese market for foreign friends and companies, such as John Deere, New Holland, Kubota, Yanmar and etc., their successful experiences have fully proved that foreign companies can get the deserved benefit from the great Chinese market. Welcome all foreign friends to China, devoting into Chinese agricultural machinery industry and exploiting the domestic and overseas market together with the field of Chinese agricultural machinery.

China Association of Agricultural Machinery Manufacturers, which is the only national industry organization for Chinese agricultural machinery industry, consists of about 2,000 members. We are willing to be the bridge between Chinese enterprises and foreign friends and companies to promote the mutual cooperation so as to initiate a new prospect for Chinese agricultural machinery industry together.
Agricultural Mechanization in Developing Countries and World Agricultural Machinery Industry

Yoshisuke Kishida
President
Shin-Norinsha Co., Ltd.
Tokyo, Japan

The world population continues to grow to be over 6.3 billion. China has the largest population in the world. India will have more than 1.5 billion in mid this century. With this population pressure, the most important key word in the 21st century is “developing countries”. The problem of agricultural mechanization in developing countries has been a matter of great concern for the author while publishing specialized journal, AMA-Agricultural Mechanization in Asia, Africa and Latin America, to promote agricultural mechanization in developing countries. In this presentation, author’s view on present situation and some suggestions are mentioned.

1. Population pressure in urban areas

One of the most prominent in world population problem is rapid population increase in urban areas, especially in developing countries. In The U.S. rural areas population has fallen to nearly 2% and the situation is same in most developed countries. Also in developing countries, population is rapidly shifting from rural areas to urban areas.

Why are people attracted to cities? Because the shift from agriculture of old industry to new industry generates far higher additional value on products. The present population shift would not have occurred in the opposite situation. This means that current trade condition between agriculture and other non-agricultural industries is always unfavorable to rural areas. There are the attempts to solve this problem through agricultural administration, but ends to be unsuccessful. Overconcentration of population in urban area is also the root cause of destruction of ecological system.

In the election in The U.S., where 98% of votes represents the people in urban area, the elected congress persons stand for the interest of urban people. Their agricultural policy is based on the thought how to provide city consumers with good quality agricultural products in cheap price.
Even grown up in large scale farms with more than 500ha, young people tends to live in cities rather than succeeding farming. The pressure on ecological system will be accelerated unless unfair trade condition between urban and rural areas is changed.

Destruction of environment is going on in terrible speed in spite of the efforts to protect environment having many international conferences on the issue, which makes the solution of agricultural and mechanization problems more difficult.

Half of world population is in rural areas of developing countries and more than half of them suffer poor livelihood. There is much difficulty in carrying out a reform of agriculture in those areas where farmers have only weak purchasing power. The means of communication has much developed today. Uneven distribution of wealth is easily recognized worldwide, which might cause tremendous frustration in poor people on this narrowing earth. Regional conflicts and terrorism are much related to this economic gap. Therefore the mechanization of agriculture in developing countries is essential to make our planet peaceful and wealthy place.

In carrying out technological program in developing countries, agricultural engineers need to make it rather profitable to rural areas.

2. Mechanization program

Agriculture is basically to grow the crops native to each local area in world nature. This diversity requires different agricultural technology suitable each local area. Moreover the agriculture always changes dynamically from time to time and timely farm work is required. That is, different technology and mechanization system must be provided matching to the state of the agriculture. What is expected to agricultural machinery industry is to provide the machines suitable to certain location and certain time.

Machines being used in The U.S. or Japan are not always appropriate for the farms in developing countries. Actually many efforts have been made to develop the machines matching to each local situation in developing countries. Those attempts have been successful in some areas and not in others. To meet the demands of each local area, it is necessary to form the integrated system near local sites, in which from research and development to manufacturing and distribution of the machines are done consistently. Every developing country needs some agricultural machinery industry system.

Major components of the system to promote agricultural mechanization are;
1) government 2) financial institution 3) research and development sector 4) education and extension sector 5) manufacturing sector 6) distributing sector 7) related organizations. Mutual organic work of those components will make it possible to supply the machines most fitting to time and place.

3. Lively machines

Working out a design of agricultural machines appropriate to local situation is like a design of new seed. The first comes the functional design. In machine design, the kind of crops, the place, weather and the state of operators are considered firstly. Functional design is possible in most research and experiment stations.

Next comes production design and distribution/maintenance design. How to get repaired when machines get out of order and how to cut production cost in the case of manufacturing in developing countries are the important issues to be considered. Various conditions in actual use must be considered in selecting machine parts. Also parts design must fit to production technology available in developing countries.

The last comes profit design. It is important to provide the machine that brings profit to farmers who use that machine, to distributors and to manufacturers. Once the machine that brings profit to these three is developed, the mechanization will get along, and further development of production and distributing system will be expected.

Usually the agricultural machine is used in one farm for a long term. In the case, however, the farm condition changes year by year, the machine needs to be replaced to new one at certain time. Agricultural machinery industry has the responsibility to supply suitable machine continuously. In order that this process goes well, the role of information system is very important. The core of information system is the dealers of agricultural machines. The useful information such as how the machine is used on field or what improvement is required could be fed back to manufacturers through dealers. That will help manufactures make necessary improvements at early stage. Those channels to link farmers with manufacturers is very important in promoting agricultural mechanization and it decides the speed of agricultural mechanization.

Though it is the key to design the machine that brings profit to all three sectors, farmers, machine distributors and manufacturers, there is much difficulty in making it come true, partly for poor human resources.

Here is a good example made by Dr. Amir U. Khan who was the head of agricultural engineering department of IRRI (International Rice Research Institute). He made designs for various types of machines which could be manufactured in developing
countries, promoted the development of agricultural machinery industry through industrial extension services. He was most successful in working out a design of axial flow thresher, which created many thresher makers in developing countries. Needless to say this thresher released farmers from hard labor of harvest.

Agricultural machinery industries in developed nations have contributed to the mechanization of agriculture in developing countries exporting their machines. Also there have been the efforts to transfer the technology from developed countries to developing countries to establish the plants for tractors and other implements in developing countries.

4. World agricultural machinery industry and developing countries

China has the world largest population. In 1977 the author visited China and had the opportunity to observe large-scale government-managed factory, which looked not so productive. In those days most farms in China were a kind of collective farms managed by people’s commune. Those farms seemed far behind with mechanization. After that agricultural policy was changed under new leader. Farms became free to purchase agricultural machines. In 1985, visiting China again, the author witnessed surprising progress of mechanization. Chinese agricultural machinery industry has grown to be one of the greatest in the world.

What made China different from other developing countries? The big difference is that all of machine parts are supplied from domestic parts industry. In China, machine design or the design technology is generally transferred from developed countries. However in China, many machines of their own development and design are seen lately.

China is a good example, where agricultural machinery industry has successfully developed in the history of agricultural mechanization in developing countries after World War II. The reason for that growth might be worth knowing, as some know-how could be applied to the development in other developing countries.

For the farmers in developing countries it is difficult to purchase expensive machines because their agricultural products are sold at very low price. So inexpensive machines of China will be a large driving force to promote agricultural mechanization in developing countries. China is expected to make the effort of growing new agricultural machinery industry in developing countries as well as exporting inexpensive machines.

In globalized economy, people have many business options. With internet the
industries can search most suitable machine parts on global basis. Actually this way of supplying parts is getting more and more popular in the world. Based upon this point of view, global optimization of agricultural machinery industry is needed to promote proper development of agricultural mechanization in the world including developing countries. This drives us to the discussion and inspection whether diesel engines should be produced in every country, or whether it is proper to export the same implements used in developed countries to developing countries and etc.

Diesel engines and tractors are basic part of mechanization and they produce the highest additional value. However such intention must be completely re-examined from the view point of global optimization.

The role of government is getting more limited as market economy advances all over the world. It might be partly difficult to control agricultural machinery industry through governmental policy. In capitalistic economy, the course of management of major agricultural machinery enterprises with big capital has a large impact on world agricultural machinery industry. It may hit the young industry which has just begun to thrive when big firms look after only their own interests.

The export of agricultural machines from developed nations to developing nations is hardly a paying business. The export from Japan, due to high prices, has largely shifted to developed nations.

Still under this circumstances, the tie-up of world agricultural machinery industries is essential to reasonable development of mechanization in developing countries. Though agricultural machinery industries compete with each other, it is possible to build up cooperative relationship by the aid of communication.

Chinese agricultural machinery industry is getting to take the leading part in the world. China also needs to have further technical support from many developed nations, especially from neighbor countries. Cooperative relationship will be furthered among China, Korea and Japan in Far East.

Chinese agricultural machinery industry will give large impact on world agricultural mechanization in this century because of its enormous production capacity to meet large domestic demand. Thus China plays a key role in promoting agricultural mechanization in developing countries.

5. Intelligent machine
In the long history of mechanization, machines were only to save human labor especially its muscle power. Today intelligent machines like computer, sensor and various information devices have made remarkable progress. Agricultural machines are undergoing a change to intelligent ones, too. Late years the quality of intelligent device and its softwares put in the tractor has been a key factor to evaluate it. Agricultural robots may be a final machine in other words. When an operator’s intelligence as well as his muscle is mechanized, agricultural mechanization system will get the large change and progress.

Unlike big intensive farms in North America, a number of small farms are scattered in Japan. Completely intelligent and small scale machines are needed for efficient mechanization of those small farms, namely, the mechanization system of using intelligent 20h.p. tractors in fifty fields at the same time instead of using one 1000h.p.in one field. The progress of such new technology will make agriculture more flexible, and even have the possibility to change unfavorable farm condition to favorable one. Also the progress of intelligent machines will lighten the operator’s skills and make it possible to do farm work like taking pictures with the latest style of automatic camera.

Mechanization of agriculture in developing countries is inevitably involved in the progress of intelligent machines. The author firmly believes that intelligent machines will also develop new possibility of mechanization in developing countries.

Intelligent device has greatly extended also to the field of machine design. Today engineers working out a design on computer display using C.A.D. instead of on large drawing desk go on increasing. Computers have high potentiality to be used in various sectors. If the data base of geographic information about whole world agriculture and crops is well supplied, it might be possible to work out a design of mechanization system in remote area with computer.

The progress of high speed information net work like internet will promote the development of new agricultural machinery industry and new mechanization system. Mankind and other ecological system should be in harmony so that mankind can survive. Agricultural mechanization technology plays key role in improving agriculture in developing counties and ensuring harmonization of ecological system and mankind. World agricultural machinery industries must join the efforts for this objective.
Promoting the Development of Agricultural Mechanization in China According to Law

Tianzuo Zhang
Deputy Director-General
Department of Agricultural Mechanization, Ministry of Agriculture, P.R.China

Law of the People’s Republic of China on Promotion of Agricultural Mechanization was deliberated and adopted during the 10th session of the Standing Committee of the 10th National People's Congress of PRC on June 25 this year. It foreshows that the agricultural mechanization in China has come into a new era. I was invited to make a brief introduction to the achievements of agricultural mechanization in China and the basic thought for the further development of agricultural mechanization.

1. The Achievements of Agricultural Mechanization in China

China is a developing country with a large population; agriculture is very important in the national economy. Chinese government has devoted to develop agriculture for years. We have supplied sufficient food for 22% of the world population with 7% of the world tilth land. With the adaptation of the requirements of agricultural development, the agricultural mechanization in China has grown steadily, which mainly represents as follows:

1.1 The gross of agricultural machinery is increasing steadily. By the end of 2003, the original value of farm machinery reached 336.2 billion Yuan, averagely over 1,300 Yuan per farmer household, covering about 25% of the productive fixed assets for them. The large-mid-sized farm tractors and their attachments increased by 972,600 and 1,689,500 respectively; farm transport vehicles reached 10.28 million. Combines reached 362,200, 18 times than that of 1978. The total power of farm machinery had reached 604 million kw, which increased over 4 times compared with the 118 million kw of 1978.
1.2 Field operation mechanization level has increased remarkably. In the early years of the foundation of P R China, agricultural production mainly depended on manpower and animal power; and in 2003, the areas of mechanized plowing, sowing and harvesting are 60.943 million ha, 40.714 million ha, and 27.36 million ha respectively. The percentage of mechanized plowing, sowing and harvesting reached 46.8%, 26.7% and 19% respectively.

1.3 The service areas of Agricultural mechanization are extending. The service areas of agricultural mechanization have been extended mainly from field operation to pre-production and post-harvesting and other fields. A large quantities of equipments for facility agriculture, processing machinery for agricultural and by-products, and machineries for livestock, forestry, plant protection, transportation, farmland infrastructure and so on increased rapidly.

1.4 The service of agricultural machinery develops toward market-orient and socialization. Since the production scale is small, it is not economical for Chinese farmers to buy large or middle-sized agricultural machinery. It is very important therefore, to promote the combination between farmland and machinery, and to develop socialized system for mechanized service. Since 1996, Chinese relevant departments have jointly launched trans-regional wheat harvesting using combines, by taking the advantages of time differences from the South to the North, and increased the combine service from 7-10 days to over one month per year in average, and improved the usage rate of combines, and met the requirements of mechanized harvesting for farmers and promoted the benefit of machinery buyers and the holding amount of combines and finally the mechanized level. There were 60,000 combines nationwide in 1994; compared with 360,000 in 2003. The mechanized harvesting rate increased from 47% in 1995 to 82% in 2004. At present, trans-regional mechanized service has extended to wheat sowing and plowing, paddy harvesting, young seedling planting, maize harvesting, straw crushing and returning-to-the-field and other process of agriculture production; a batch of mechanized harvesting specialized households, agri-mechanized associations and mechanized working companies appear. By 2003, there are 30.82 million various agri-mechanized working organizations with total income of 227 billion Yuan. Agri-mechanized working service develops rapidly toward market-oriented and socialization.

1.5 The International exchanges and cooperation of agricultural machinery technology have been strengthened. In recent years, many international agricultural machinery enterprises aimed at Chinese market, cooperated with Chinese government and enterprises, and achieved a good record. Some large domestic enterprises speeded up technology innovation and products upgrading, and improved the quality of
domestic agricultural machinery products through absorbing foreign advanced experience and technology.

2. Basic Thoughts for Further Promotion in Agricultural Mechanization

It is well known that the agricultural mechanization level in China lags behind that of the developed countries. The quality and technical contents of Chinese agri-machinery need further improvements. With the continuous increase of national economy, Chinese traditional agriculture turns to modern agriculture gradually; agricultural input will be further strengthened; village laborers will be further transferred out from the heavy physical labor, which will surely enlarge the demand for agricultural mechanization.

China is a developing agricultural country. According to the situations in China and the successful experiences in foreign countries, the guideline of agricultural mechanization is as follows: China will adopt a supporting policy to fully exert the function of market mechanism, lead and support farmers and agricultural production service organization to choose suitable advanced machinery so as to promote agricultural mechanization in accordance with the local conditions, economy and efficiency, safety guarantee, and environmental protection.

*Law of the People’s Republic of China on Promotion of Agricultural Mechanization* will be implemented on Nov. 1, 2004. Its legislative purposes are to mobilize enthusiasm of every aspect and help farmers and agricultural service organizations that directly engage in agricultural production to choose suitable advanced agricultural machinery so as to speed up agricultural mechanization through market mechanism and policy support. In the coming periods, we will create a more favorable environment for the development of agricultural mechanization and promote agricultural mechanization to develop persistently, rapidly and healthily on the basis of carrying out *Law of the People’s Republic of China on Promotion of Agricultural Mechanization*.

2.1 Further perfecting laws and regulations system of agricultural mechanization. *Law of the People’s Republic of China on Promotion of Agricultural Mechanization* (hereinafter, *Law of the PRC on PAM*) specifies the responsibility of governments at all levels, and support measures to scientific research and development on agricultural machinery and production, purchasing agricultural machinery for farmers, mechanized service and product quality guarantee and other aspects. The promulgation and
implementation of Law of the PRC on PAM will further improve the environment of agricultural mechanization development, and greatly arouse the enthusiasm that farmers and agricultural production service organizations purchase and use machinery, promote popularization of applying for new technology and new machines, which will produce positive and far-reaching influence to the development of agricultural mechanization. Law of the PRC on PAM regulates only the guidelines for development of agricultural mechanization and varieties of supporting policy. We must establish some specific regulations and local rules to ensure the implementation of Law of the PRC on PAM. We will take Law of the PRC on PAM as the fundamentals, speed up the construction of associated regulations, vigorously improve the maneuverability and form a relatively perfect law system for agricultural mechanization so as to provide agricultural mechanization with law guarantee.

2.2 Positively support scientific research. Scientific research is very important for the development of agricultural mechanization. Our agricultural machinery has a low reliability with lag manufactural techniques, insufficient science and technology innovation input and insufficient attentions to. And therefore, it leads to a low capacity in international competition. We will work hard to shorten the gap between domestic agricultural machinery and advanced international level. The provincial and above governments and the relevant departments must organize to tackle key technical problems, test, demonstration and other measures to promote basic, key and commonweal agricultural scientific research and the extension and application of advanced and suitable agricultural machinery. Chinese government supports to strengthen the research on basic theory and application technology of agricultural machinery, and sustain the combination of research, education, production and extension for agricultural mechanization in order to make agricultural machinery adaptable for the demands of the development of agricultural production technology and to provide technical support for agricultural mechanization.

2.3 Great efforts will be made for the quality improvement of agricultural machinery. At present, the qualities of some of the domestic made agricultural machinery are very low. It affects the efficiency and quality of machine operation, and restricts the development of agricultural mechanization. In order to conquer the quality problems and protect farmers' benefits, China will speed up the establishment of standardization system for agricultural mechanization, constitute and perfect the standard for the product quality, maintenance quality and operational quality and so on. Simultaneously, quality surveillance to agricultural machine products will be strengthened. Ministry of Agriculture and provincial departments who are in charge of agricultural mechanization will organize to carry on investigations on applicability, security, reliability, and conditions of post-saling service for the specific kinds of agricultural machines in using and will publicize the results of investigations in time according to the complaints from
the users and actual requirements of agricultural production. The manufacturers and vendors of agricultural machinery must guarantee and take some measurements to improve their product quality.

2.4 Strengthening the extension of agricultural machinery. Agricultural machinery is important production material in agriculture; it occupies an important proportion in the production investment of farmers. In order to generalize the advanced suitable agricultural machinery and improve the utilizing efficiency of machinery, we will lead farmers and agricultural production service organization to adopt suitable and advanced agricultural machines and technology, and encourage farmers to use agricultural machines cooperatively through the establishment of demonstration bases and other methods. Ministry of Agriculture will establish the catalogue of suitable advanced agricultural machines which is supported by central government to be popularized nationwide; and provincial departments will also establish the corresponding catalogue that adapts to local area, and supports the development of agricultural mechanization in accordance with the local conditions and to lower farmers labor intensity, improve their production benefit, make them fully enjoy the fruit of modern civilization so as to continuously liberate and develop agricultural productivity through popularization of suitable advanced agricultural mechanization technology.

2.5 Strengthen and perfected the socialized service system of agricultural mechanization. On the basis of sticking to family-contract responsibility system, and under the double deck of management system of planning and distributions, we encourage and support to develop multiple forms of agricultural mechanization service organizations; we support agricultural machinery to be used on trans-region maner, and support farmers and agricultural mechanized organizations to develop paid services, and support the agricultural machinery technical extension stations, which were established by the government, to supply freely commonweal services on extension and training service. The unifying and normative markets of agricultural machinery with competition in order must be established including three fields, such as sales, maintenance and mechanized services. Through the development of market-oriented and socialization in agricultural mechanized services, we will realize that working in wide scale on the basis of family-contract responsibility system and improvement of agricultural mechanized utility rate and efficiency and will foster the enthusiasm of farmers’ purchasing and using machines so as to exert the farmers’ function as principal body and promote agricultural mechanization.

2.6 Enhanced the supporting policy to agricultural mechanization. In the past years, China central government and local government at all levels have formulated series of support policies and measures to promote agricultural mechanization, which greatly mobilized the enthusiasm of farmers and agricultural production organizations in using
machines. *Law of the PRC on PAM*, which will be implemented, has made a positive conclusion to the above-mentioned policies and measures in the form of law. The support measures includes: China will take steps to support agricultural machinery manufacturers to increase research and development input, and support technical innovation in agricultural machinery industry; subsidies or interest subsidies will be directly offered to farmers and agricultural production service organizations who buy the suitable advanced agricultural machinery supported to be popularized by Chinese government. The income for agricultural mechanized organizations engaging in agricultural mechanized service will enjoy preferential revenue according to the regulations, and financial subsidies will offer to fuel oil for agricultural mechanized farm working; construction and maintenance for infrastructure facilities will be intensified. Meanwhile, governmental departments at all levels in charge of agricultural mechanization should provide information service free of charge for farmers and agricultural production service organizations. The above-mentioned measures are international routines and accord with WTO rules. A support system of agricultural mechanization will be gradually established.

Ladies and gentlemen, China is a developing agricultural country. The development of Chinese agriculture depends on policy, investment, science and technology, and agricultural mechanization. In the coming era, technology of agricultural mechanization will get a larger demand and development in China. On one hand, we hope domestic agricultural machinery enterprises, scientific research institutes, and relevant departments work together in the field of enhancing research, development and production of suitable advanced agricultural machinery so as to provide equipments for agricultural mechanization; on the other hand, we hope every side of the society keep high attention to support the establishment and perfection of agricultural machinery socialized service system; simultaneously, we hope strengthen international exchange and cooperation, introduce into advanced technology and management experience, depend on common efforts from every possible side to promote agricultural mechanization cause in China.

Looking into the future, we are confident with a persistent, stable and rapid development of agricultural mechanization in China.
Proposal Speeding Guangdong Agricultural Mechanization

Xiwen Luo
South China Agricultural University

1 Introduction

Guangdong is located in the foreland of reform and opening, and is an economical strong province in China. According to the statistics of 2001, the 8 main economical indicators of Guangdong province, which includes GDP, increasing value in above scale industry, gross fixed assets investment, total export in foreign trade, total utilized value of the foreign capitals, total retail volume of social consumable, local financial revenues, and residual between deposit and loan of financial organization, occupied all the first places in whole nation, GDP accounts for 11% of national GDP. The overall level of agricultural mechanization in GD, however, is in the lower position in the whole nation. The statistics show, by the end of 2001, the mechanization levels, soil tillage for main crops was 53.52%, rice planting was almost zero, rice harvesting was 6%, gross level was 17% only, ranked the 22nd in China. It extremely does not match with GD’s status of economical strong province.

The development level of agricultural mechanization of GD is, therefore, difficult to meet the need of improving agricultural competitiveness after China’s affiliating to the WTO, difficult to meet the needs of agricultural structural adjustment and raising the peasants’ income. The lag behind in Agricultural mechanization has already become one of the main factors of restricting the modernization course in GD.

There are many reasons made the lag behind of agricultural mechanization in GD. Geographically, 70% is mountain area. 10% water, 20% cultivated land. The scattering little hilly land bring objectively certain difficulty to mechanized development. But the main reasons are as follows: 1) underestimating the status, function and importance of agricultural mechanization; 2) insufficient input; 3) legislation is lag behind; 4) agricultural machinery does not match with agronomy; 5) ability of research, production and extension is weak; 6) social service system is imperfect.
After investigations, a report based on large number of data and facts was repaired by the Guangdong Provincial administration for agricultural mechanization and sent initiative to the members of the Guangdong Provincial People’s Congress in order to get their understanding, realizing and supporting. February 2002, at the fifth Session of the Ninth provincial People's Congress, 22 proposals on "Regarding the support for development of agricultural mechanization" were submitted by 19 delegations which including 316 representatives. It is the first time in the history of GD People’s Congress that so many representatives in so many delegations to proposed on same topic. Reviewing and coordinating by specialized committee, the proposal was finally transferred to the provincial government as the only proposal for transaction. In December 2002, a resolution on the proposal was passed by the ninth Standing Committee of the provincial People's Congress. According to the resolution, from in 8 years from 2003, Guangdong Province will arrange 700 million RMB in provincial financial project to actively boost the leap-forward development of agricultural mechanization which possess Guangdong characteristics. It is also the only proposal regarding the development of agricultural mechanization and passed by the provincial People's Congress in whole nation until present. All the people working in this area in whole province were inspired as soon as the proposal is issued. In the new century while China enters the new developing stage on comprehensive construction of an easy society and accelerating advancing socialist modernization, Guangdong took the leading act of "supporting the development of agricultural mechanization " in the whole nation, it caught the key problem in agricultural modernization development. It is a fundamental and strategic measure with overall importance. This big action Guangdong Province made for catch up in agricultural mechanization has already caused the nationwide concern. A personage in economical circles have pointed out that Guangdong will rely on its rich economic strength, take the lead position again in realizing the historical change from traditional agriculture to modern agriculture.

2 Objects and contents of proposal

2.1 Directive thinking

Guide line: takes the leading position in comprehensive construction of an easy society and basically achieves agricultural modernization. Rely on: characteristic resource in the south subtropical zone. The core point: improving the ability in international competition and increasing peasant's income; Power: scientific and technical innovation; main path: agricultural structural adjustment; The principles: "unified planning, moderate leading, develop the tarmal needs, regional arrangement, Different methods for different types of areas, Demonstration and so on ", accelerate the leap-forward development of agricultural mechanization with Guangdong' characteristic.
2.2 Development object

The proposal is divided into two stages. From 2003 to 2005, it is the stage for adjustment and foundation. By 2005, comprehensive mechanization level of rice production in the commercial grain production base would be about 40%. The equipment for aquaculture, such as oxygen-increasing machine, silt clear machine and pump will be used more popular. It that the tache of The mechanization in the main steps producing agricultural products with Guangdong’s characteristics and the main processing of farm products will have greater development. From 2006 to 2010, it is the stage of the accelerating development. By year 2010, the comprehensive mechanization level in rice production in the commodity grain production base of the whole province should be increased to about 70%. The application rate of the oxygen-increasing machine of the aquaculture pond, silt clear machine will be more than 70%, It will basically realize mechanization in the main taches and main processing in agricultural product with Guangdong’s characteristic.

2.3 Developmental emphases

(1) Paddy rice Production Mechanization

Paddy rice is the main crop in Guangdong Province. There are about 2,700,000 hm$^2$ which are used to plant rice, accounts for more than 50% of the total planting area for crops. Paddy rice mechanization is both the emphases and difficult points. There are three key taches in rice production, which are seeding and seedling, harvesting and drying. It is important to develop or fetch in suitable key technology and machinery for paddy rice production as soon as possible.

(2) Horticulture mechanization

At the new stage of agricultural development in Guangdong, the horticulture industry has already become the advantage industry of agricultural economic growth, become planting structural adjustment and important industry of improving agriculture’s whole quality. Mechanization will offer the technical support and guarantee for development of the horticulture industry, it is new growth point and breach of Guangdong agricultural development. Regarding the order of development, more emphases should put into the staple specialized production, in the sweeping management base of the horticulture crop production. Seeding and seedlings mechanization before planting and the postpartum to wash, keep fresh, advance cooling, packing, preserving mechanization. Accelerating the mechanization in tillage, transplanting, plant protection, and Harvesting.
(3) Breeding production mechanization

Poultry and livestock industry, and fishery all are the pillar industries in Guangdong’s agriculture, and are the superiority industry for agriculture structure adjustment. In 2001, the poultry meat 333.25 ten thousand T was produced in Guangdong, which was in the 7th position of the gross outputs of the whole nation. The aquatic product meat 609.67 ten thousand T, residencing the second gross outputs of the whole nation. Developing breed mechanization is the requirement that raises the competition ability. The emphases in poultry breed mechanization should be the advanced complete set equipments that suitable for the large-scale breed. The aquaculture mechanization should be the fry nessury, the pond oxygen-increasing machine, silt clear machine, feedstuff throwing machine, pump, fishing, fresh keeping, transportation, water quality environmental checkout etc machineries and equipments.

(4) Agricultural products processing mechanization

Agricultural products process is the linkage which links the agriculture and the market, and is also the important means which added the value for the agricultural products. However, in Guangdong, the ratio of the value after and before process still doesn't reach 1:1, which is far behind from the advanced standard in the world, so quickening agricultural products process mechanize has been the most pressing matter of the moment. The focal point is to develop the process machinery for staple agricultural products, which have the Guangdong characteristic and superiority.

2.4 The major contents and the measures

2.4.1 Strengthening the building of the socialized service system

(1) Building the regional specialty markets for agricultural machinery

Building one specialty market in the Pearl River delta and the western district of Guangdong province respectively. Making it become the service center, which included agricultural machinery productst exhibition, business, information, training and service into organic whole, and self management and is responsible for profits and losses.

(2) Establishing a special subsidy fund for purchasing agricultural machinery

There are 222,100 thousand Yuan to be used as subsidy for agricultural machinery in the proposal, and Guangdong provincial government has laid down Guangdong province <<agricultural machinery purchasing subsidy management method>>, which
announces the models of the agricultural machineries subsidized, and announces the subsidy standard for different districts every year.

The subsidy emphases is on 3000-4000 agriculture top enterprises and agricultural machinery specialty service organization, as well as the kinds foster and influential family, agricultural machinery specialized household. They are subsidized to purchase the agricultural machinery by the focal point, so as to increase the society capacity possessing of the agricultural machinery, raise the organization level of agricultural machinery school assignment by a wide margin, and effectively dispose the agricultural machinery resources, and raise agricultural machinery utilization ratio and management beneficial result.

(3) Building the agricultural mechanization information network

On the foundation of Guangdong province agriculture information network, the agricultural mechanization information network must be built. The agricultural machinery information resource database must be perfected. Build 200-300's information contact point step by step, and stand up the contacts such as agricultural machinery organization, guild, agricultural machinery specialty service organization, specialized household and peasant etc, and develop management, technology and market information serving.

2.4.2 Perfect the scientific research & extension system of agricultural mechanization

(1) Support constructing the research development center of modern agriculture equipment engineering technique in Guangdong province

Consulted the concerned national standards and regulations to support constructing the research & development center of modern agriculture equipment engineering technique in Guangdong province. To investigate the feasibility of agricultural mechanization, tackle key problems which have restricted the development of agricultural mechanization in Guangdong ,and transfer the achievements etc.

Enlarge the scientific research and development of agricultural machinery. By way of inviting public bidding, examined and appraised by experts, start the research and development project, digest and innovate subjects of 30 agricultural machinery key technologies and equipments step by step, settle the "bottle neck" problems about mechanization technologies for paddy rice, horticultural crop and agricultural products process etc.

Advance the development ability and manufacturing standard for agricultural machinery
industry. Positively pushing on the scientific and technical productions transfer, encouraging the enterprises to put into effect, attracting home and abroad agricultural machinery scientific research organizations and productive enterprises to joint venture or cooperate with Guangdong, at the same time, creating conditions to export technologies and products of agricultural machinery to the developing countries.

(2) Lay special emphasis on supporting Guangdong agricultural machinery extension station

Lay special emphasis on supporting extension station of Guangdong agricultural machinery to make them become the province grade agricultural machinery extension center consisting of five functions: agricultural machinery testing, demonstrating, training, guiding as well as consulting services.

(3) Strengthening and perfecting 80 regional agricultural machinery extension stations

According to the regional superiority of agriculture industrial structure adjustment, supporting 80 regional extension stations of agricultural machinery to intensify extension function and playing the bridge and the tie effect in the exertion of technology extension organizations of skeleton agricultural machinery.

(4) Developing technology extension of agricultural mechanization

According to the implemental emphases of proposal, give emphasis to the selection, trial, demonstration and popularization etc. of agricultural machinery and produces process machines in key link of paddy and horticultural crops’ production, organize demonstration on the spot and exhibition about new technologies and machines of agricultural mechanization, and guide the systemic construction of agricultural machinery extension.

(5) Build 30 agricultural mechanization demonstration bases

According to different agricultural regions and agricultural types, combining with the agricultural modern demonstration areas and the construction of agricultural comprehensive exploitation items, to support building 30 agricultural mechanization demonstration bases. Apply agricultural machinery by different main management bodies of bases, induct peasants to adopt agricultural machinery and technology which are advanced and suitable, explore the operating mechanism and management model of agricultural mechanization, and make them become the demonstration "window" of modern agricultural development.
2.4.3 Perfecting the Safety and Quality Supervisory System for Agricultural Machinery

(1) Accelerate the Agricultural Machinery Legislation

Make an issue “the Agro-machinery Supervisory Regulations of Guangdong Province” as soon as possible, define the duties of relevant administrative service divisions in agriculture mechanization, standardize practitioner's behavior, and then make the management of agricultural mechanization go on the track of legalizing and standardizing progressively.

(2) Coordinate the Function of Supervisor and Strengthen the Supervisory Means

Make the safety supervisory system of agro-machinery in order, and perfect the organization of the safety supervisory system of agro-machinery, improve the means and equipment of the agro-machinery safety supervisory system at all levels. Strengthen and perfect the construction of the product quality supervisory system of the agro-machinery and do it well.

(3) Support the Construction of the Guangdong Provincial Agro-machinery Appraised Station

According to national relevant standards, support and build the Agro-machinery Appraised Station of Guangdong Province, make it become a quality appraisal and detect center of agro-machinery products in Guangdong Province, give full play to the appraised service divisions of agricultural machinery.

(4) Set up the rule of market admittance

Impose the license to the agricultural machinery products that are used in Guangdong Province, and through such means as customer's follow-up investigation, quality testing, etc., attack the fake and forged agricultural machinery products, protect peasants' legitimate rights and interests conscientiously.

2.4.4 Improving the Whole Quality of the Agro-machinery Specialized Personnel

With the development of agricultural mechanization, the demand for qualified specialized personnel of agro-machinery is increasing. Agro-machinery education can supply various support such as intellectual, knowledge and technique. It plays a significant role in the development of agriculture mechanization. Therefore, it is necessary to give full play to all kinds of training organization and train the qualified personnel that fit the demand of the development of agricultural mechanization in Guangdong in the 21st century. Focus on the construction of training organization of
agro-machinery in Guangdong Province, and to train the manager and technology extension personnel, improve the whole quality and professional skill of the agricultural machinery team.

3 The effects of implementing proposal

In the course of implementing proposal, all kinds of agricultural mechanization departments carried out their work seriously according to the object of the proposal. They created good developmental environment for agricultural mechanization and obtained evident effects.

3.1 Enhancement cognition and increasing devotion

All levels of governments paid much attention to the proposal. They organized special investigations and researches to make developmental layout of agricultural mechanization. Many leading groups of agricultural mechanization was built and charged by the mayor of administering agriculture to enhance the work in many cities. According to the incomplete statistics, more than thirty files about supporting the development of agricultural mechanization was enacted by all levels of governments. Agricultural mechanization office made relative regulations and methods for implementing proposal. It was helpful to create good policy environment for the development of agricultural mechanization. The proposal advanced and guaranteed the agricultural mechanization of Guangdong Province.

Many local governments regarded the capital used as developing agricultural mechanization as a part of finance budget and increased the financial support to develop agricultural mechanization. According to the incomplete statistics, all levels of local governments devoted 5.3 million yuan to support the development of agricultural mechanization and society devoted 0.2 billion yuan directly in the Guangdong Province in 2003. The lever function of the proposal appeared gradually.

3.2 The organizations of agricultural machinery is getting stronger

The organizations of agricultural machinery about management, extension, scientific research, appraising, inspection, education, providing and service were built in many cities. Service stations of agricultural machinery were also built in the country. According to statistics, the numbers of the management organizations of agricultural machinery had reached to 1548 and the number of the people who engaged in the providing, maintaining and servicing of agricultural machinery have reach to about 1 million. The number of serving organizations of agricultural machinery had reached to
73.08 ten thousand including 11.52 ten thousand professional families. The management of agricultural machinery was being marketable and socialized.

3.3 Broadening service fields for agricultural mechanization

Machine for farming now becomes available from paddy to vegetables, flowers, fruits, aquiculture, pasturage, environment protection, cleaning, etc. And its applications have ranged from single planting machine to agriculture, woods, graze, fishing, transportation and processing, and set up a bridge between pre-production and post-production. Meanwhile the main body of such service readily varies from individual to organization, service organization from single organization to multi-organization, and its service area from local to other provinces. Increment of agricultural machinery transforms to improving quality instead of pure quantity. And in some way there take on a good scenery. And the People and government are satisfied with the great benefits.

3.4 Continuously improving ways of agriculture mechanization, and continuously optimizing its structure

Agricultural machinery are adjusted to not only in quantity, but also in structure, the requirements of optimized structure, industrialized management and producing on a scale, and its science and technology level is improved more and more. It shows itself in both quality and quantity, as follow:

By the end of 2003, the general power is up to 18,000,000kw, increasing about 3.4 percent than last year. The general amount of tractors is 366,000, the large-middle types of which rises greatly to 32 percent; The level of tillage by machine is 58 percent, 3.28 percent higher than last year; The combine is 5000, increasing approximate 26 percent. The mechanical harvesting level is 10 percent. And other agricultural machinery, such as transportation, drain and irrigation equipment, agricultural products processing machines, oxygen machines, bait casting machines, mini-cultivators, sprinklers, ridgers, digging machines and canopy to fit to gardening production and mechanization breeding have developed in different extent.

3.5 Advancing abilities of scientific research, producing and extending in agricultural machinery

Agricultural machinery research institute in GuangDong Province combined some enterprises to develop a series of agricultural technologies and equipments, including palm house, machine to produce feedingstuff, equipments to raise poultry, devices to manufacture fertilizer, machine to process agricultural production and technology for saving water and irrigating etc., and they have boosted local economy greatly. The
Zhujiang series and Danxia brand combines developed independently have become main harvest machines in Guangdong province. And Guangzhong Panyu agricultural machine extension service centre, as mechanization demonstration base in Guangdong has become a base of ‘quaternity’, of demonstration, extension, training and service.

3.6 The Organizing Form And Function Rules Getting Some Innovation

According to the object and emphasis drawn by the mechanization of farming 《Proposal》, the function rules were innovated in different regions which grasped ‘the paddy rice elevating and the trait making best’ and encircled the goal that farming enhanced benefit, farmer increased incoming. Manifold developing patterns and service forms of the farming mechanization came into being by probing the functioning patterns that the socialization of farming mechanization serviced the marketing, and the constructing patterns of the agricultural model base, and the stock system, and modeling of the cock enterprise etc. For example, The Agricultural Mechanical Institute was founded, then that made the farmers more specialization and enhanced the using efficiency and management benefit of the agricultural mechanism. Due to the innovation of management organization and function rules, a result was yielded that ‘composition of forces was aggrandized and livingness was enhanced’.

3.7 Accelerating the development of farming mechanism by items, name brand and stock enterprise driving

In 2003, according to the project and emphasis 《Proposal》 drew, through argumentation by specialist, some measures were implemented, including 21 farming mechanism modeling base constructing items, 13 territorial farming mechanism popularizing station and 5 farming mechanism scientific research tasks. All levels farming departments investigated idiographic item constructing method, encircling the method ‘items, name brand and stock enterprise driving items, name brand and stock enterprise driving’. For example, the method of constructing paddy rice mechanism modeling base brought by Leizhou city were that they applied booking farming in order to boost the scope and industrialization of the paddy rice yielding, depending on the modern modeling base in Baisha town, Leizhou city, taking the stock enterprise, (HUILEI FOODSTUFF PROCESSING CO.,LTD.) as investing main body, drawing the stratagem of making a famous brand ‘byland paddy rice’; That not only created the condition for paddy rice yielding but also formed standardizing and mechanical requirement of the paddy rice yielding, going with the benefit increasing that drove the development of paddy rice yielding mechanism, a goal that farming enhanced benefit, farmer increased income, village developed was realized. It deserved attention that all farming mechanism modeling bases could follow the centre that farming enhanced

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78
benefit, farmer increased incom; They took those as goal which making high quality, high efficiency, exporting, enhancing the standardization and enhancing competition, then booting socialization service and realized fast development of the base at last.
United Nations  Nations Unies

Asian and Pacific Centre for Agricultural Engineering and Machinery

(UNAPCAEM)

联合国
亚太农业工程与机械中心

CONTENTS

• Background
• Mission
• Functions
• Areas of Focus
• Vision
• Organizational Chart
• Financial Resources
• Cooperation
BACKGROUND

- The predecessor of UNAPCAEM was the Regional Network for Agricultural Machinery (RNAM) established in the Philippines in 1977 with the initiative of 8 countries and support of UNDP, FAO, UNIDO and other countries;

- RNAM was incorporated with UNESCAP later and the office moved to Bangkok, Thailand in 2000;

- With the extension of its mandates, RNAM was changed as Regional Network of Agricultural Engineering and Machinery (RNAEM); (Cont’d)

BACKGROUND

- United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM) came into being in 2002 with China’s pledge to host the Centre in Beijing;

- The Centre began to operate officially in November, 2003. It is only a one-year-old baby but of great potential perspective. (Cont’d)
BACKGROUND

• At the occasion of the plaque unveiling ceremony of UNAPCAEM, Former President Jiang Zemin of the host country met with Dr. Kim Hak-Su, Under-Secretary General of UN & Executive Secretary of UNESCAP in Beijing 27 November 2002. Mr. Jiang said: 'China is an agricultural country. We hope it will expand its agricultural cooperation globally through UNAPCAEM. We are ready to welcome more agricultural as well as other organizations to locate their headquarters in China.'

(Cont'd)
BACKGROUND

- At the opening ceremony 26 November 2002, Premier Wen Jiabó (then the Vice Premier in charge of agriculture) said: “China, as usual, will support UN activities. We sincerely hope that UNAPCAEM will perform as a model and more UN organizations will locate in China.”
MISSION

• The Millennium Development Goals of UN (MDGs)

• Mission of UNAPCAEM

MILLENNIUM DEVELOPMENT GOALS

• MDGs were put forward in the United Nations Millennium Declaration in 2000 which emphasizes that poverty eradication remains a significant challenge for many countries.

• United Nations MDGs Action Agenda and the World Summit on Sustainable Development held in Johannesburg, South Africa in 2002 called for fighting against poverty, enhancing food supply quality through application and management of post-harvest and food processing technologies.
MISSION OF UNAPCAEM

- 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.

MEMBER COUNTRIES

- 15 member countries in Asia and the Pacific
- To share the resources of 53 member countries and associate member countries of UNESCAP
FUNCTIONS

• To provide assistance to its members by disseminating info of the improvement of agricultural products and other achievements including agricultural mechanization and automation, sustainable development of rural areas, biotechnology and genetic engineering;

• To assist its members in capacity-building through the promotion of research and development collaboration, establishment of data banks and information-sharing including the utilization of information technology in those areas, and the adaptation of agricultural and agro-related engineering technology based on farm products, including exchanges of prototypes and expertise;
  
  (continued)

FUNCTIONS

• To provide assistance to its members through the organization of training in the above-mentioned areas and the organization of events for the commercialization and market expansion of suitable technologies;

• To assist in poverty alleviation and rural development through demonstration and pilot projects, replication of proven practices and empowerment of rural women through their integration into agricultural mechanization and production activities including on-farm agro-product processing.

  (Cont’d)
FUNCTIONS

• To assist in the formulation of policies and strategies for appropriate agricultural engineering and mechanization so as to keep up with the trends of globalization and technological advancements;
• To provide agro-engineering and agro-technical services to promote trade in agro-machinery products and technologies and training on adaptation to ISO and ISO9000 standards and environmental management standards (ISO14000) for agro-based products.

AREAS OF FOCUS

• Agricultural mechanization and adoption, development and transfer of other agricultural technologies;

• Adoption and transfer of technologies on post harvest processing, food processing, increased use of agricultural by-products, and other high-value addition;

• Best practices of policies implemented in other countries, especially the more developed UNESCAP countries, in the focus areas of activities; (Cont’d)
AREAS OF FOCUS

• Sustainable income generation to the rural areas by agro-based enterprises development;

• Making available the benefits of new agricultural technologies including agricultural bio-technology in cooperation with private sectors to increase agricultural production and processing efficiency;

• To enhance export and market access of agricultural products of the rural SMEs.

OUR VISION

• To become a leading centre and eventually a “centre of excellence” in Asia and the Pacific in promoting cost-effective technologies for farmers and efficient and appropriate agricultural engineering and machinery, value addition and agro-industrial linkages for productivity improvements, employment generation and overall rural development and poverty alleviation in the Asian and Pacific economies.
FINANCIAL RESOURCES

- US$3.80 million from the Chinese government for 5 years;
- EURO1.25 million from Finish government for 5 years;
- Funds received from other countries;
- Voluntary contributions of the members and associate members of ESCAP;
- Funds received from private sectors, international and national institutions for project support;
- Money obtained from the sales of publications and services provided by UNAPCAEM;
- Other funds
COOPERATION

- Chinese Academy of Engineering (CAE), a leading institution of the nation in this field has played an important role as a focal point in hosting UNAPCAEM in China. Both sides will refresh their cooperation;
- To enhance cooperation with the member countries’ governmental institutions and private sectors;
- To foster cooperation with other UN organizations, international R & D institutions and enterprises;
- Other prospective cooperation.

Contact us:
Tel: (8610) 8225 3581
Fax: (8610) 8225 3584
Email: apeaem@un.org
Address:
A/7F, China International Science and Technology Convention Center
No. 12, Yumin Road, Chaoyang District, Beijing, 100029
P.R. China
THANK YOU!

MEMBERS OF UNAPCAEM

- 15 member countries:
  Bangladesh, China, DPRK, Fiji, India, Indonesia, Iran, Mongolia, Nepal, Pakistan, Philippines, ROK, Sri Lanka, Thailand, Vietnam
MEMBERS OF UNESCAP

• 53 MEMBERS:
  Afghanistan, Armenia, Australia, Azerbaijan, Bangladesh, Bhutan, Brunei Darussalam, Cambodia, China, DPRK, Federated States of Micronesia, Fiji, France, Georgia, India, Indonesia, Islamic Republic of Iran, Japan, Kazakhstan, Kiribati, Kyrgyzstan, Laos, Malaysia, Maldives, Marshall Islands, Mongolia, Myanmar, Nauru, Nepal, Netherlands, New Zealand, Pakistan, Palau, Papua New Guinea, Philippines, ROK, Russian Federation, Samoa, Singapore, Solomon Islands, Sri Lanka, Tajikistan, Thailand, Timor-Leste, Tonga, Turkey, Turkmenistan, Tuvalu, UK, USA, Uzbekistan, Vanuatu, Viet Nam
  (Cont’d)

MEMBERS OF UNESCAP

• 9 Associate Members:
  American Samoa, Cook Islands, French Polynesia, Guam, Macao of China, New Caledonia, Niue Island, Northern Mariana Islands
REGIONAL CENTERS OF UNESCAP

• APCIT: Asian and Pacific Center of Technology Transfer, founded in 1977 and moved to New Delhi in 1993. It involves in technology transfer of SMEs in Asian and Pacific region, and promote the technology import and export within member countries.

• SIAP: Statistical Institute for Asia and Pacific, founded in June 1970 in Japan. It aims to strengthen the capability of the developing countries of the region through training; to collect, analyze and disseminate statistics as well as high-quality statistics that can be utilized for economic and social development planning. It has nine Governing Board member countries. The training program are mainly funded by JICA.

• CGPRIT: Regional Co-ordination Center for Research and Development of Coarse Grains, Pulses, Roots and Tuber crops in humid area of Asia and the Pacific. It is located in Bogor of Indonesia.