Open Meeting of the Club of Bologna

Farm Machinery to Feed the World

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Innovations in agricultural mechanization for food security in Asia

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  * CSAM
1. Introduction

1.1 Food security - a major challenge in many countries

At present the World is facing multiple challenges of feeding growing populations, alleviating poverty, protecting the environment, and responding to climate change. During the period 2010 to 2012, thirteen percent of the population of Asia and the Pacific region experienced severe forms of hunger and malnutrition. However, while this proportion has fallen from 22 per cent during the period 1990 to 1992, still as of 2012, about two thirds of the World’s under nourished people lived in the Asia and Pacific region (FAO, 2013). The world is facing perhaps the greatest challenge of how to feed two billion more people by 2050. This, combined with increasing incomes in the developing world and growing needs for energy, is likely to lead to increased demand for agricultural products at an unprecedented rate. The global demand for food is expected to increase by 60 per cent by 2050 (OECD-FAO, 2012).
1. Introduction

1.1 Food security - a major challenge in many countries

Asia has the largest land area in the world, comprising about 45 billion ha (30 per cent) of the global land area with more than 50% of the world population and with only 36% (504 million ha) of the world’s arable land. Cereals, fruits and vegetables and livestock production continues to be the main activity and rice and wheat remain the staple food crops in Asia. Over 90 percent of the world’s rice supply comes from Asia.

Due to increased incomes food habits are changing and the agricultural production systems are changing to meet those demands. During 1970s cereals constituted 40% of agricultural production in monetary terms and by 2010 contribution of cereals reduced to 25%. During the same period the share of fruits and vegetables and livestock production increased from 18% and 15%, respectively in 1970 to 27% and 28%, respectively by 2010 shown in Figure 1 (Briones and Felipe, 2013).
1. Introduction

1.1 Food security - a major challenge in many countries

Figure 1 - Percent Composition of Agricultural Output (constant $) for Asian Countries, 1970 and 2010
1. Introduction

1.1 Food security- a major challenge in many countries

Worldwide in 2013, 842 million (12%) people were reported to be chronically hungry and 2.2 billion (15%) people were near or living in multidimensional poverty (UNDP, 2014). According to the World Bank (2014) projections (Table 1) the population of South Asia will continue to grow through 2050 where about half of the World’s under nourished population lives at present.

Agriculture is the most effective route to reducing poverty in many of the poorest parts of the world. One per cent growth in the agricultural economy results in a 6 per cent increase in spending by the poorest 10 per cent of the population. Far less income filters down to the poor from the growth of other sectors of the economy (World Bank, 2008).
1. Introduction

1.1 Food security - a major challenge in many countries

Table 1 - Projected Population (Billion People). Source: World Bank, 2014

<table>
<thead>
<tr>
<th>Region</th>
<th>2020</th>
<th>2030</th>
<th>2040</th>
<th>2050</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Asia &amp; Pacific (Developing)</td>
<td>2.10</td>
<td>2.18</td>
<td>2.20</td>
<td>2.17</td>
</tr>
<tr>
<td>South Asia</td>
<td>1.81</td>
<td>1.99</td>
<td>2.13</td>
<td>2.21</td>
</tr>
<tr>
<td>World</td>
<td>7.67</td>
<td>8.37</td>
<td>8.79</td>
<td>9.47</td>
</tr>
</tbody>
</table>
1. Introduction

1.2 Decreasing share of agricultural labor and increasing urbanization

The percentage share of agriculture in the total work force has been decreasing in all countries. The decline in absolute number of workers in agriculture sector is related to development of industry and service sectors of a country. The absolute number of workers in agriculture sector started to decline in Japan in 1955 and in Republic of Korea in 1977. By now the absolute number of workers in agriculture sector is decreasing in most of the countries.

Urbanization is driven by three factors: natural population growth, rural to urban migration and reclassification of rural areas into urban areas. In 2012, 1.96 billion (46%) people of Asia and the Pacific region lived in urban areas. By 2020 urban population is expected to reach 50% (UNESCAP, 2014).
1. Introduction

1.2 Decreasing share of agricultural labor and increasing urbanization

This is making less labor available for farming as more people, especially the young, move to cities to look for jobs outside of the agricultural sector. Shortage of labor and rising rural wages are forcing farmers in Asia to adopt labor-saving technologies, i.e. farm mechanization. Also with increasing feminization of agriculture due to the propensity of more men migrating to urban areas than women, there is an increasing demand for labor saving technologies as well as gender specific interventions in farm mechanization.
1. Introduction

1.3 *Decreasing share of agricultural sector in GDP faster than decrease in agricultural labor force*

According to World Bank (2013), worldwide during 2012 agriculture sector employed 36% of work force and its contribution to world GDP was only 3%. While services and industry sectors employed 41% and 20%, respectively and their contributions to world GDP were 70% and 27%, respectively. The share of agriculture sector in GDP is extremely low compared to labor force employed in this sector. Even for developing countries in East Asia and the Pacific the contribution of agriculture sector in economy is very low (11%) and it is 18% for South Asia while agriculture sector employs about one third of the workers in East Asia and the Pacific and about half of the workers in South Asia. Due to very low income of farm workers many of them are migrating to urban areas. This has resulted in shortage of labor and rising rural wages resulting in increase in mechanization.
1. Introduction

1.3 Decreasing share of agricultural sector in GDP faster than decrease in agricultural labor force

<table>
<thead>
<tr>
<th></th>
<th>East Asia &amp; Pacific (Developing)</th>
<th>South Asia</th>
<th>World</th>
</tr>
</thead>
<tbody>
<tr>
<td>GNI per Capita ($) 2013</td>
<td>5,536</td>
<td>1,474</td>
<td>10,584</td>
</tr>
<tr>
<td>Agriculture GDP (%)</td>
<td>11</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>Services GDP (%)</td>
<td>45</td>
<td>56</td>
<td>70</td>
</tr>
<tr>
<td>Industry GDP (%)</td>
<td>44</td>
<td>26</td>
<td>27</td>
</tr>
<tr>
<td>Manufacturing GDP (%)</td>
<td>30</td>
<td>14</td>
<td>16</td>
</tr>
</tbody>
</table>

Table 2: Share of Agriculture, Industry (including manufacturing) and Services Sectors in GDP. Source: World Bank (2014)
1. Introduction

1.3 Decreasing share of agricultural sector in GDP faster than decrease in agricultural labor force

<table>
<thead>
<tr>
<th>Country</th>
<th>Percent GDP</th>
<th>Percent Employment</th>
<th>Value Added per Person, $</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agriculture</td>
<td>Industry</td>
<td>Services</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>17</td>
<td>29</td>
<td>54</td>
</tr>
<tr>
<td>Cambodia</td>
<td>36</td>
<td>24</td>
<td>40</td>
</tr>
<tr>
<td>China</td>
<td>10</td>
<td>44</td>
<td>46</td>
</tr>
<tr>
<td>India</td>
<td>18</td>
<td>25</td>
<td>57</td>
</tr>
<tr>
<td>Indonesia</td>
<td>14</td>
<td>46</td>
<td>40</td>
</tr>
<tr>
<td>Korea</td>
<td>2</td>
<td>39</td>
<td>59</td>
</tr>
<tr>
<td>Malaysia</td>
<td>9</td>
<td>41</td>
<td>50</td>
</tr>
<tr>
<td>Nepal</td>
<td>35</td>
<td>16</td>
<td>49</td>
</tr>
<tr>
<td>Pakistan</td>
<td>25</td>
<td>22</td>
<td>53</td>
</tr>
<tr>
<td>Philippines</td>
<td>12</td>
<td>31</td>
<td>57</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>11</td>
<td>32</td>
<td>57</td>
</tr>
<tr>
<td>Thailand</td>
<td>12</td>
<td>43</td>
<td>45</td>
</tr>
<tr>
<td>Vietnam</td>
<td>18</td>
<td>38</td>
<td>44</td>
</tr>
<tr>
<td>Japan</td>
<td>1</td>
<td>26</td>
<td>73</td>
</tr>
<tr>
<td>U.S.A.</td>
<td>1</td>
<td>20</td>
<td>79</td>
</tr>
</tbody>
</table>

Table 3 - GDP, Employment and Value Added per Person in Agriculture, Industry and Service Sectors of Selected Countries. Source: World Bank (2014)

*Japan has a very large number of hobby (weekend) farmers who have regular job outside agriculture
1. Introduction

1.4 Increase in land and labor productivity

As shown below, the cereal yields in most countries have increased very significantly. The cereal yields in many countries in the region are higher than average yield of cereals in the world while in other countries these are lower (FAOSTAT and World Bank, 2013). The output per worker in agriculture sector rose by 2.2% per annum during 1980-2010.

![Cereal Yield: Decadal average](chart.png)

Cereal yield, measured as kilograms per hectare of harvested are includes: wheat, rice, maize, barley, oats, rye, millet, sorghum, buckwheat and mixed grains. Production data on cereal relate to crops harvested for dry gain only.

Figure 2 - Average of cereal yield over decades. Source: Soni (2014) calculation based on data from FAOSTAT and World Bank, 2013)
1. Introduction

1.4 Increase in land and labor productivity

**Table 4:** Cereal Yields in Countries of Asia and the Pacific Region (2011).

<table>
<thead>
<tr>
<th>Country</th>
<th>Yield (Kg/ha)</th>
<th>Country</th>
<th>Yield (Kg/ha)</th>
<th>Country</th>
<th>Yield (Kg/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>4191</td>
<td>Indonesia</td>
<td>4886</td>
<td>Malaysia</td>
<td>3920</td>
</tr>
<tr>
<td>Cambodia</td>
<td>2925</td>
<td>Japan</td>
<td>4911</td>
<td>Pakistan</td>
<td>2718</td>
</tr>
<tr>
<td>China</td>
<td>5706</td>
<td>Korea</td>
<td>7038</td>
<td>Philippines</td>
<td>3341</td>
</tr>
<tr>
<td>India</td>
<td>2883</td>
<td>Lao PDR</td>
<td>4045</td>
<td>Thailand</td>
<td>3065</td>
</tr>
<tr>
<td>Vietnam</td>
<td>5383</td>
<td>Myanmar</td>
<td>3880</td>
<td>World</td>
<td>3708</td>
</tr>
</tbody>
</table>
1. Introduction

1.5 History of mechanization in Asia

Until 1950s traditional methods of using animate (human and animal) power were used in all crop production operations throughout Asia. However, three regions of Asia, namely, north east, south, south east experienced somewhat different developments in agricultural mechanization. In the north east, Japan was the first to mechanize as a result of rapid industrialization immediately after the Second World War. Republic of Korea followed due to its own industrialization and access to technologies from Japan. The two-wheel tractor or power tiller developed in Japan became the mainstay of agriculture in these countries which are being replaced by four-wheel tractors.
2. Present Status

2.1 Main power source-equipment systems used in operations

At present, countries across the region differ widely with respect to how they make use of following main sources of farm power in performing various on-farm and off-farm operations.

- Human labor
- Animal power
- Engine (petrol/diesel)
- Electric motor
- Two-wheel, single axle tractor (2WT)
- Four-wheel, two axle tractor (4WT)
- Self propelled machines
2. Present Status

2.1.1 Human Labor

Manual labor is predominantly used in many countries for broadcasting of seeds and fertilizers; sowing; transplanting of rice and vegetable seedlings; spraying using knapsack sprayers; weeding, inter-culture, ridging, leveling and bund making using hand tools; reaping of crops using sickle; plucking of fruits; plucking and harvesting of vegetables; bundling of harvested crops including fodder crops, transportation of inputs (seeds, fertilizer, etc.) to field and harvested crops to threshing floors; threshing of crops by beating (including against a log); transportation of produce to drying floor and homestead; bagging and loading on transport vehicle.
2. Present Status

2.1.2 Animal Power

In many countries animal draught power is still being used for tillage, sowing, inter-culture, irrigation (water lifting), threshing (trampling), and transport operations.
2. Present Status

2.1.3 Engines (Petrol/Diesel)

Most of the engines are diesel engines and are used to power stationery machines like water pumps, threshers, winnowers, cleaners, graders and processing machines.
2. Present Status

2.1.4 Electric Motor

Electric motors are used to power stationery machines like water pumps, threshers, winnowers, cleaners, graders and processing machines.
2. Present Status

2.1.5 Two-Wheel, Single Axle Tractor (2WT)

Two-wheel, single axle tractors are mainly used for tillage and transport operations. A 2WT equipped with a rotary tiller is commonly known as Power Tiller. With a belt and pulley mechanism engines of these 2TWs are also used to power stationery machines like water pumps and threshers.
2. Present Status

2.1.6 Four-Wheel, Two Axle Tractor (4WT)

Four-wheel, two axle tractors are mainly used to power equipment for tillage, sowing/planting, inter-culture, weeding, ridging, bund making, leveling, spraying, reaping and harvesting, and transport operations. Using PTO shaft (with a belt and pulley mechanism) these 4TWs are also used to power stationery machines like water pumps, threshers and other machines.
2. Present Status

2.1.7 Self Propelled Machines

The most common self propelled machine in use in the region is combine harvester for grain crops, mainly wheat and rice. Other self propelled machines which are gaining popularity mainly by custom-hire operators are rice transplanter and sugarcane harvester. Corn (maize) pickers, forage harvesters and cotton pickers are also being introduced by custom-hire operators.
2. Present Status

2.2 Availability of power sources

The land and water resources in Asia and the Pacific region are already fully exploited and with only significant inputs of energy we can improve the use of these resources to increase food production. Agricultural mechanization plays a pivotal role as machines make it possible to apply and use inputs like seeds, fertilizers and chemicals and water at appropriate place and time in desired quantities in an efficient way.
2. Present Status

2.2 Availability of power sources

The experience of the region shows that mechanization of processing and pumping has tended to precede the mechanization of crop care and harvesting operations. The use of irrigation pumps has increased exponentially in the region: in India the use of pumps grew from 6 million in 1980, to 28 million in 2010. In Bangladesh, the use of pumps grew from 0.3 million in 1996 to 1.3 million in 2010; while in Cambodia, it increased from 0.06 million in 2001 to 0.17 million in 2010.
2. Present Status

2.2 Availability of power sources

Japan, Russia and Korea have already mechanized most of the operations. Malaysia, Thailand, China, India, Pakistan, Sri Lanka, Bangladesh, Vietnam have mechanized land preparation and transportation operations using 4W and 2W tractors and milling, water pumping and threshing using stationery engines and electric motors.

In Thailand, Indonesia, Vietnam, Cambodia, Philippines, Bangladesh and Nepal 2W tractors (in stationery mode) are also used to power irrigation pumps. For harvesting combines are being used extensively in Malaysia and gaining popularity in Thailand, China, India and Pakistan. Combines are also being used to limited extent in Philippines, Cambodia, Bangladesh and Nepal.
2. Present Status

2.2 Availability of power sources

The use of animal draft power has declined significantly in all countries since 1990s. In India the number of draft animals in use declined from over 85 million in 1975 to about 50 million in 2010 and is projected to decline to 18 million by 2030 (Singh, 2013).

The number of 4W tractors, 2W tractors, irrigation pumps and combine harvesters and power available in selected countries is given in Table 5.
1. Introduction

1.5 History of mechanization in Asia

<table>
<thead>
<tr>
<th>Country</th>
<th>4W Tractors (000's)</th>
<th>2W Tractors (000's)</th>
<th>Irrigation pumps (000's)</th>
<th>Combine harvesters (Units)</th>
<th>Power kW/ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>5</td>
<td>60</td>
<td>10</td>
<td>700</td>
<td>220</td>
</tr>
<tr>
<td>Cambodia</td>
<td>0.3</td>
<td>9.5</td>
<td>0.5</td>
<td>152</td>
<td>1.0</td>
</tr>
<tr>
<td>China</td>
<td>814</td>
<td>5270</td>
<td>6981</td>
<td>17523</td>
<td>7255</td>
</tr>
<tr>
<td>India</td>
<td>1200</td>
<td>5430</td>
<td>31</td>
<td>440</td>
<td>12900</td>
</tr>
<tr>
<td>Indonesia</td>
<td>4</td>
<td>2.8</td>
<td>17</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Rep. Korea</td>
<td>31</td>
<td>278</td>
<td>739</td>
<td>640</td>
<td>326</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2.5</td>
<td>8</td>
<td>2.1</td>
<td>35</td>
<td>70</td>
</tr>
<tr>
<td>Nepal</td>
<td>6</td>
<td>30</td>
<td>1</td>
<td>12</td>
<td>23</td>
</tr>
<tr>
<td>Pakistan</td>
<td>231</td>
<td>573</td>
<td>5</td>
<td>2</td>
<td>288</td>
</tr>
<tr>
<td>Philippines</td>
<td>6</td>
<td>32</td>
<td></td>
<td>107</td>
<td></td>
</tr>
<tr>
<td>Russia</td>
<td>1366</td>
<td>260</td>
<td>N/A</td>
<td>N/A</td>
<td>79.4</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>15</td>
<td>1.5</td>
<td>24</td>
<td>2.8</td>
<td>52</td>
</tr>
<tr>
<td>Thailand</td>
<td>45</td>
<td>334</td>
<td>583</td>
<td>1750</td>
<td>851</td>
</tr>
<tr>
<td>Vietnam</td>
<td>5.2</td>
<td>170</td>
<td>20</td>
<td>380</td>
<td>168</td>
</tr>
</tbody>
</table>

Table 5: Number of 4W Tractors, 2W Tractors, Irrigation Pumps and Combine Harvesters and Power Available in Selected Countries. Source: Participants to Regional Meetings organized by CSAM-UNESCAP.
2. Present Status

2.2 Availability of power sources

The use of animal draft power has declined significantly in all countries since 1990s. In India the number of draft animals in use declined from over 85 million in 1975 to about 50 million in 2010 and is projected to decline to 18 million by 2030 (Singh, 2013).
2. Present Status

2.3 Local production and imports of farm machinery

The AP Region has emerged as the largest market in the world in terms of agricultural machinery sales – projected to have sales of about USD 50 Billion in 2015 (World Bank, 2010). In 2012 the globally the output value of agricultural machinery industry was about US$120 billion of which China accounted for about US$50 billion and India about US$ 15 billion.

The 4W tractors (two axles) are mainly produced in China, India, Japan, Korea and Pakistan. Other countries in the region import tractors from countries within the region as well as from countries outside the region. The 2W tractors (single axle) or power tillers are mainly produced in China, India, Japan, Korea, Thailand, Philippines, Indonesia, and Vietnam.
2. Present Status

2.3 Local production and imports of farm machinery

Mainly Japan, China, Korea and India are producing combine harvesters in large numbers. Thailand also produces locally made track type combines mainly to harvest rice from wet fields. Other countries in the region import combines from these countries in the region as well as from the countries outside the region. Most counties in the region are producing engines (petrol/diesel) and electric motors with the exception of Laos, Cambodia, Nepal, Fiji and PNG. Similarly most of the countries are producing implements and equipment powered by 4W and 2W tractors and water pumps and threshers. However some countries still rely on imports from China, India, Thailand, Japan, Korea and some countries outside the region.
2. Present Status

2.4 Level of mechanization for different operations

The level of mechanization for different operations varies significantly from crop to crop and in big countries it varies from region to region in the same country. The level of mechanization for different operations also varies significantly for the same crop.

In 2013 in China, the national comprehensive mechanization level, comprising of crop tillage, planting and harvesting reached 59.5%; with tillage at 76.0%, planting at 48.8% and harvesting at 48.1% as given in Table 6 (MOA China, 2014). Among crops wheat had the highest level of comprehensive mechanization at 93.7%, followed by rice at 73.1% and maize at 59.5%. For tillage, tractor plowing for wheat was 98.9%, for rice it was 95.1% and for maize it was 76.0%. The level of mechanical sowing for wheat was 86.7%, for rice only 31.7% and for maize it was 84.1%. Similarly, the level of mechanical harvesting for wheat crop was 93.8%, for rice 80.9% and for maize it was only 51.6%. Even for the same crop and the same operation the level of mechanization varies in different parts of China.
## 2. Present Status

*Example China:*

<table>
<thead>
<tr>
<th>Items</th>
<th>Comprehensive mechanization level (%)</th>
<th>Tractor plowing (%)</th>
<th>Mechanical sowing (%)</th>
<th>Mechanical harvesting (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops</td>
<td>59.48</td>
<td>76.00</td>
<td>48.78</td>
<td>48.15</td>
</tr>
<tr>
<td>Wheat</td>
<td>93.71</td>
<td>98.90</td>
<td>86.69</td>
<td>93.82</td>
</tr>
<tr>
<td>Rice</td>
<td>73.14</td>
<td>95.09</td>
<td>36.10</td>
<td>80.91</td>
</tr>
<tr>
<td>Corn</td>
<td>79.76</td>
<td>97.67</td>
<td>84.08</td>
<td>51.57</td>
</tr>
</tbody>
</table>

*Table 6 - Mechanization level for main crops and their operations in China in 2013*

*Source: Department of Agricultural Mechanization, MOA, China*
2. Present Status

2.5 Common custom hire services

Initially the ownership of machinery was with big farms/farmers and they provided very little custom hire services. With shortage of labor many medium farmers owned machines for their own work and custom hired these machines to other farmers. Now in most countries custom hire services are being provided by the entrepreneurs, both farmers and non-farmers. The size of machines owned by service providers is relatively larger compared to those owned by farmers for their own work. Many enterprises providing custom hire services own multiple sets of various machines and some enterprises provide services at far away distances from their home base.
3. Challenges

3.1 Small land holdings

About 90% of the World’s more than 500 million small farms (<2ha) are in the Asia and the Pacific region. The average size of land holdings in Asia is only about 1 ha. Average size of holdings for the countries in the AP Region are: Bangladesh: 0.5 ha; China: 0.54 ha; India: 1.2 ha; and Nepal: 0.7 ha. In most countries even these small holdings are made up of a number of small plots scattered in different locations. Many of these plots have limited access to relatively large size farm machines like combine harvesters and even tractors. Due to small size of land holdings majority of the farmers have low investment capacity and cannot afford to buy even small machines like 2W tractor or power tiller. Due to shortage of labor such farmers rent equipment on hire from service providers. Consolidating the holding of a farmer at one or two places will increase the size of operational plot. It will be easier to use a relatively big equipment at reduces cost of operation.
3. Challenges

3.2 Limited manufacturing capacity

Only a few countries in Asia and the Pacific region like Japan, China, India and Korea have well developed industry for the manufacture of agricultural equipment and these countries are also exporters of equipment. Pakistan, Thailand, Vietnam and Indonesia also have agricultural equipment manufacturing industries. However, these countries import certain critical components from other countries. Countries like Bangladesh, Sri Lanka, and Philippines import prime movers like tractors, engines and motors and farm implements and equipment like plows, harrows, seed drills, sprayers, threshers, irrigation pumps and milling machines are produces locally.
3. Challenges

3.3 Shortage of power and fuel

Most countries in the region face shortage of power due to which there are frequent shut downs. Many days the industrial workers sit idle for long hours in factories for non availability of power. This reduces productivity of workers and increases the cost of manufactured items. Many times, interrupted power supply also affects the quality of product.
3. Challenges

3.4 Need for institutional framework at regional level

Asia Pacific region is emerging as a leading global player in the manufacture and use of mechanization inputs. The challenge is how to incentivize manufacturers to R&D and produce quality machinery at affordable cost. Like in North America and Europe the academic and research institutions should work in close collaboration with private sector. South-south collaboration in R &D to achieve economies of scale through regulatory framework for patenting and licensing of technologies at regional level should be encouraged. A large manufacturing base in the region and trade in mechanization technologies requires a regional mechanism for standards and testing of these technologies.

ANTAM (CSAM-UNESCAP) offers this opportunity by supporting establishment of testing centers and harmonization of testing protocols across the region to facilitate trade in mechanization technologies regionally and globally.
3. Challenges

3.5 Need for human resource development

• Policy
• R&D
• Extension
• Farm level
• …
4. Findings & Recommendations

The region has made great progress over the past six decades in transforming farm power situation from over 90% from animate sources in 1960s to over 60% from mechanical sources by 2013 in many countries.

Four main types of mechanical power sources are becoming popular: i) 2Wheel-Single Axle tractors for wet tillage, transportation, water pumping and threshing; ii) 4Wheel-Two Axle tractors for dry tillage, transportation, planting and seeding, inter-culture, spraying, harvesting and threshing; iii) Electrical motors and Diesel engines for irrigation pump sets and many post harvest processing operations; and iv) Self propelled machines like combine harvesters for grain harvesting, trans-planters for rice and vegetable crops, fodder harvesters and sugarcane harvesters.
4. Findings & Recommendations

Present level of mechanization and crop yields in many countries are quite low. There is labor shortage during peak periods and available agricultural labor is getting older and proportion of female labor is increasing. **More labor saving and ergonomically appropriate equipment are required** to facilitate the work of women and elderly agricultural workers.

In all developing countries the percentage of labor in agriculture is very high compared to contribution of agriculture sector to GDP, resulting in relatively very low incomes of farmers and other agricultural workers. Mechanization helps in increasing yields by timely conduct of operations, efficient placement and application of inputs (seeds, fertilizers, pesticides and water) and decreasing drudgery. **Governments should have policies to promote mechanization** for growth in agriculture, improved incomes of agricultural workers and improved food security.

Land holdings in many countries are small and fragmented. Consolidation of fragmented holdings helps in organizing resources and inputs more efficiently and provides easier access to farm machines even on small holdings. Governments should have policies to **consolidate fragmented holdings**.
4. Findings & Recommendations

Asia and the Pacific region has the largest area under irrigation and the use of electric and diesel pump-sets has increased significantly and will continue to increase. Due to increased demand for water from other sectors of economy, availability of water for agriculture is expected to decline. There is an urgent need to provide technical and financial support for **development of irrigation infrastructure and R & D efforts** particularly for controlled irrigation systems to improve water use efficiency and fertilizer use efficiency in irrigated agriculture.

Mechanization technologies were first adopted by the large farmers followed by medium scale farmers. Ownership of many farm machines is not economic for farmers if these machines are utilized only on their own holdings. The large numbers of owner farmers are the ones who are able to provide mechanization and other services to the more numerous small holder farmers. **Increased and improved efficiency of utilization of machines available with farmers through custom hiring** to neighbor farmers and or through larger operational holdings makes ownership of machines economic and profitable.
4. Findings & Recommendations

In many countries the large numbers of owner farmers played a critical role in facilitating the creation of a viable agricultural machinery and implement distribution and services sector. The high level of effective demand for agricultural machinery and equipment led to the creation of a competitive and viable manufacturing industry such that Japan, Korea, China and India have become globally leading players in this sector including becoming exporters. There is a need for favorable government policies to expand the manufacturing sector in all countries. Items of high demand like simple tools, implements, sprayers, irrigation pumps, threshers, etc. should be produced locally. Manufacturing processes need improvements to produce quality machines with improved safety standards. There is need to develop and/or adopt low energy consumption machines and practices like no-till drills/planters and conservation agriculture.
4. Findings & Recommendations

Governments in many countries are providing support services for research and development; testing and standards; and for human resources development in support of agricultural mechanization. The agricultural engineering programs established in universities have been instrumental for the success of agricultural mechanization in these countries. A new breed of experts is required to implement new emerging technologies for sustainable agricultural mechanization. This requires strengthening of both public and private sectors institutions.

There is need to revise curricula of colleges and universities to introduce new concepts like conservation agriculture (CA), precision farming, etc. Trainings of operators, farmers and technicians are necessary for successful implementation of new emerging technologies for sustainable agricultural mechanization. There is a need for favorable government policies to expand these support services to meet the needs of mechanization. In some cases regional training programs may offer economies of scale which may be organized with assistance from CSAM.
4. Findings & Recommendations

Business and enterprise friendly policies, laws, and regulations as well as physical and institutional infrastructures which encourage commercial activities and entrepreneurship in farming, input supply, produce handling, processing and marketing as well as in manufacturing have been and remain, the key factors to success of agricultural mechanization in most countries.

In recent years the efforts related to agricultural mechanization at regional and international level have increased. The Center for Sustainable Agricultural Mechanization (CSAM) and the Asia-Pacific Network for Testing Agricultural Machinery (ANTAM) should play major roles in facilitating regional cooperation in policy assistance, information sharing, collaborative R&D, harmonization of standards and testing procedures, capacity building, technology transfer and trade and investment facilitation.
* CSAM

History
Established in 1977 in the Philippines – RNAM (Regional Network for Agricultural Machinery);
Moved to Beijing in 2003 and became UNAPCAEM;
Renamed CSAM in 2013.

Vision:
‘...to achieve production gains, improved rural livelihoods and poverty alleviation through sustainable agricultural mechanization for a more resilient, inclusive and sustainable Asia and the Pacific.’
* CSAM

Member Countries
All 62 members of ESCAP
‘Core’ members: ASEAN countries, SAARC, Pacific Islands, Central Asia and China, Japan and RoK start to participate

Key Partners
International agencies
National governments
Academic and research institutions
NGOs and farmers’ organizations
Private sector
* CSAM

**Strategic Functions:**

- regional forum for regular policy dialogues
- hub of information and data
- reference point for standards and protocols;
- centre for capacity development
- facilitating agro-business development and trade
* CSAM

Current projects/initiatives:

Annual Regional Forum
ANTAM-Asia and Pacific Network for Testing of Ag. Machinery
Regional Database
ReCAMA-Regional Council of Agricultural Machinery Associations
Capacity building programmes
R&D collaborations...
Thank you!

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