Roundtable on Developing Environmentally Sustainable Agricultural Mechanization Strategies (SAMS) for Countries in the Asia-Pacific Region

8 - 9 December 2011

Bangkok, Thailand

Sustainable Agricultural Mechanization Strategies

Regional framework report

February 2012

Executive Summary

During the period 8-9 December 2011, a Roundtable to discuss Sustainable Agricultural Mechanisation Strategy (SAMS) in Asia was jointly convened by the United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery (UNAPCAEM), and the Food and Agriculture Organisation of the United Nations (FAO), at the FAO Regional Office for Asia and the Pacific in Bangkok. This Roundtable included the participation of fifteen individuals representing twelve countries in the Asian region, one representative each from the Asian Development Bank and the Japanese Embassy, along with technical staff from both organisations and an international consultant.

The objectives of the Roundtable were:

- To develop a perspective of agricultural mechanization in Asian countries, share experiences and identify constraints as well as best options for achieving environmentally sound sustainable agricultural mechanization in the region.
- To develop a draft Sustainable Agricultural Mechanization Strategy for Asian countries (SAMSA).

The Roundtable commenced with opening remarks by Mr. Hiroyuki Konuma, FAO Assistant Director General and Regional Representative for Asia and the Pacific and Mr. Leroy Hollenbeck, Director of UNAPCAEM, Economic and Social Commission for Asia and the Pacific. Both speakers underlined the importance of environmentally friendly agricultural management practices and the critical role of agricultural mechanization in promoting environmental sustainability while generating economic and social benefit in agricultural production systems.

Country presentations reported on the status of mechanisation policies, constraints and best practices. These were followed by working group discussions and deliberations geared toward achieving the key output of this workshop: the development of a framework for Sustainable Agricultural Mechanisation Strategy (SAMS) in Asia.

The **overall strategic goal** of the SAMS framework developed, is ***"To address the UN Millennium Development Goals No. 1 and 7 (food security, poverty alleviation, and environmental sustainability) through sustainable intensification of agriculture by creating an enabling environment through a SAMS for the Re*gion.**" This goal will be met through activities under five major strategic pillars:

- Surveys, assessments and analyses of the current status of agricultural mechanization
- Enabling policies and institutions
- Human capacity development
- Financial support to enhance investment in SAMS.
- Advocacy on sustainable agricultural mechanization.

The SAMS framework is not an end in itself but rather marks the beginning of a long-term approach. Within this context, key recommendations to be taken into account with respect to national implementation, include:

- The identification of potential roles and responsibilities of FAO, UNAPCAEM and other development partners in supporting investment in mechanisation in Asia.
- Formulation of annual work plans (activities, time frame, and budget) for implementing each pillar of the SAMS framework in terms of the milestones to be accomplished.

- The need for clustering of countries in accordance with predefined criteria such as geographic location and the level of development of SAMS, in view of the gradient of development across the region.
- The identification of key pilot institutions in each regional grouping that could serve as/be developed as regional centres of excellence for SAMS.
- Initiating pilot projects in accordance with country priorities. In the immediate-term, pilot projects could be initiated in Nepal and Mongolia for example.
- Establishing a steering committee tasked with the responsibility of overseeing the implementation of SAMS. Members would be nominated at the regional level and would include representatives of a broad range of relevant and interested institutions.

Following on Workshop discussions, the appended workplan was elaborated by FAO and UNAPCAEM.

Immediate-term Objective – Establishment of Institutional Arrangements (Year 1)

- Finalizing institutional arrangements for SAMS Development
- Development of linkages/partnerships with the private sector and other donors
- Development of regional centers of excellence for SAMS
- Development of a financial resource mobilization strategy to enhance investment in SAMS
- Development of SAMS Communications Plan, including dedicated FAO / UNAPCAEM website
- Follow up with interested countries (Nepal and Mongolia) on development of SAMS pilots

Medium-term Objective - Advancing SAMS in other countries in the Asia–Pacific Region (Year 2-5)

- Implementation of pilot projects on SAMS in two countries
- Expand country coverage of pilots
- Documentation and analysis of successes, failures and lessons learnt during pilots
- Development of technical publications and guidelines
- Dissemination of successes
- Information sharing through regional meetings, workshops

Long-term Objective – Expansion and Replication of Successes and Policy Development (Year 5 and beyond)

- Advocacy with Governments to strengthen the enabling environment for the adoption of SAMS
- Promotion and facilitation of policy dialogue on reforms related to the implementation of SAMS in the region
- Development of policy briefs on SAMS
- Information sharing through meetings, workshops
- Replication of successes

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LIST OF ABBREVIATIONS

AM	Agricultural mechanization
CA	Conservation Agriculture
FAO	Food and Agriculture Organization
NGO	No governmental organization
PPP	Public–private-partnership
SAM	Sustainable Agricultural mechanization
SAMS	Sustainable Agricultural mechanization strategy
UN	United Nations
UNAPCAEM	United Nations Asian and Pacific Centre for Agricultural Engineering and Machinery

1. Introduction

At a global level there is no alternative but to increase agricultural productivity or crop yield per unit area; and associated total and individual factor productivities, or biological output per unit of total production input and output per unit of individual factors of production such as energy, nutrients, water, labour, land and capital, to meet global food, feed, fibre and biofuel demand and to alleviate hunger and poverty. This scenario poses a great challenge for Asia and the Pacific Region where population density is in many areas very high and population growth continues, while land and water resources are getting to their limits for providing food and other agricultural outputs.

Agricultural intensification has, until now, had a negative effect on the quality of many essential resources such as soil, water, land, biodiversity and ecosystem services resulting in declining yield and factor productivity growth rates. Another challenge for agriculture is its environmental footprint and the impact of climate change. Agriculture is responsible for about 30 % of the total greenhouse gas emissions of carbon dioxide, nitrous oxide and methane, while being directly affected by the consequences of a changing climate.

The new paradigm of "sustainable production intensification" recognizes the need for productive and remunerative agriculture that conserves and enhances the natural resource base and environment, and which positively contributes to the delivery of environmental services. Sustainable crop production intensification must not only reduce the impact of climate change on crop production but must also mitigate the factors that cause climate change by reducing emissions and by contributing to carbon sequestration in soils. Intensification should also enhance biodiversity in crop production systems both above and below the ground in order to improve ecosystem services for better productivity and a healthier environment. This concept is very well described in the recent FAO publication titled "Save and Grow,"[1] which explains how agricultural practices in the future could still result in increased production while conserving the natural resource base.

The functionality of environmentally friendly agricultural management practices is highly dependent on suitable mechanisation technologies. Agricultural mechanization removes the drudgery associated with agricultural labour, overcomes time and labour bottlenecks to perform tasks within optimum time windows and can influence the environmental footprint of agriculture leading to sustainable outcomes. On the other hand, inappropriate mechanisation can place pressure on fragile natural resources by increasing soil erosion and compaction, promoting overuse of chemical inputs and encouraging farmers to open lands that currently serve as valuable forest and rangelands. Other environmental costs include the contribution of mechanisation to changing climate conditions by adding greenhouse gas emissions.

Asian countries are currently at different stages in the adoption of agricultural mechanisation strategies. Some Asian countries are currently experiencing a rapid rate of agricultural mechanisation, while others lag behind in mechanisation and/or have suffered from inappropriate and fragmented approaches to mechanisation. Agricultural production and food security in the latter group of countries is, therefore, adversely affected owing to the insufficient use of farm power and inappropriate use of farm machinery thereby negatively impacting on environmental sustainability, labour productivity and/or labour scarcity.

The foregoing discussion underlines the critical importance of moving toward sustainable agricultural practices, by increasing access to environmentally sound agricultural machinery that contributes to the enhancement of rural livelihoods and reduces pressure on natural recourses that are the lifeblood for producing food.

[1] Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production http://www.fao.org/ag/save-and-grow/

It is against that background a two-day Roundtable was jointly convened by FAO and UNAPCAEM in Bangkok during the period 8 to 9 December 2011. The objectives of the Roundtable were:

- To serve as a first step in providing a clearer picture of agricultural mechanization in Asia, share experiences among Asian countries and identify constraints as well as best options for achieving environmentally sound sustainable agricultural mechanization in the region.
- To develop a framework for a Sustainable Agricultural Mechanization Strategy (SAMS) in Asia.

The SAMS is expected to serve as the foundation to create a policy, institutional and market environment in which farmers and other end-users have the choice of farm power and equipment suited to their needs within a sustainable delivery and support system.

Inputs to the Roundtable
Inputs to the roundtable were country status reports outlining mechanization policies, constraints and best practices.

Working Group Sessions
Participants were divided into working groups in order to elaborate a framework for SAMS development in the region.

2. Synthesis of Key Regional Issues from Background Papers

Countries within Asia and the Pacific Region differ widely with respect to their sustainable use of agricultural mechanization. With the exception of China and India where the use of sustainable mechanization practices was highlighted, much of the focus of other countries in the region has been on harnessing mechanical farm power. The Chinese Ministry of Agriculture currently subsidizes no-till seeding technology to replace tillage mechanization with the mechanization of direct seeding technologies compatible to conservation agriculture. Similarly the government of India also provides subsidies for no-till seeders and no-till or strip-till equipment in India is now available for animal traction, tractors and, more recently, also for single axle tractors.

While China and India and to some extent Cambodia, Thailand and Vietnam have made strides with the development of agricultural mechanization, it is still at a very basic stage of development in most other countries. In Nepal, for example, mechanical power is used on only 23 per cent of the total cultivated land area while animal traction and human power are used on 41 per cent and 36 per cent respectively. In Myanmar, as in many countries, the government is still involved in the manufacture and distribution of farm equipment.

Key constraints to the development of farm mechanization in the region include:

- Small size, sloping topography and scattered holdings of the farmers stand in the way of mechanization.
- Majority of small cultivators are poor and are not in a position to purchase costly machinery like tractors, combine harvesters etc.;
- The lack of spare-part and maintenance services and replacement facilities especially in the remote rural areas;
- Due to the seasonal nature of agriculture, farm machinery remains inactive for much of the time. Thus, unoccupied machinery means unnecessary high costs unless proper alternate use of such machinery in the off-season is made;
- Weak information systems with regard to the delivery of information: new technologies, prices of machinery and implements, commodity prices, etc.;

- Insufficient extension activities (Number of extension workers and facilities are limited due to governmental budget. Extension activities cannot cover the entire chain of agricultural production. There is still a need for private sector participation);
- Suitability of imported machinery to the local context.

All countries are aware of the need to develop and apply environment friendly technology and techniques. Few programs that address environmental sustainability are, however, implemented despite environmental concerns in the region. With the exception of China and India, where CA is already being practiced, the concept is being slowly introduced into other countries across the region.

3. Results of Working Group Deliberations

3.1. The Positive and Negative Aspects of SAMS for Asian Countries

During working group deliberations, participants were requested to provide feedback on their perspectives of the pros and cons of SAMS.

Positive Aspects of SAMS

- SAMS should help in increasing yields and incomes of farmers;
- SAMS could address labour shortages in countries with high levels of rural-to-urban migration;
- Farming should be need based and market oriented;
- SAMS is useful for the production of agricultural machinery;
- SAMS is useful for utilization of agricultural machinery
- Precision farming can be part of SAMS and it will help to make more efficient use of inputs.

Negative aspects of SAMS

For Farmers	• Mechanization will displace rural labour; • Financial disincentive to develop a SAMS; • Mechanisation might not be economically viable for farmers in specific countries; • A "S"AMS will put brakes on the need for increasing food production; • Larger sized equipment puts more pressure on the environment • New equipment may be under-utilized due to seasonal nature of special equipment for SAMS.
Of relevance to Inputs	• Farmers become more dependent on international products of input suppliers; • Farmers lose traditional crop varieties and agricultural biodiversity; • Safety and health issues; • SAMS will have a negative impact on traditional manufacturing lines of equipment and can pose a risk for the manufacturer; • Traditional power/equipment combinations (tractor/disc; power-tiller/rotovator) must be carefully examined; • Farmers engaged in traditional practices cannot benefit from SAMS since it would disrupt traditional agricultural practices, • Local service providers may lose business;

	• Local artisans may lose their jobs; • Smallholder manufacturers: will have more risks if SAMS is adapted; • More subsidies for certain schemes to increase food production and security; • Incentives for SAMS can be expensive; • Additional extension services would be required for SAMS
For the Environment	• Indirect effects • More land would be required to produce more food • The entire production system would be affected by SAMS • More energy requirements to implement SAMS

3.2 Criteria for developing SAMS in a country

Participants deliberated on important pre-conditions for the formulation of SAMS. These include:

- The relative importance of the agricultural sector (production, mechanization, post-harvest) in the national economy;
- Access to/availability of solid communication infrastructure;
- Sufficient political commitment/will;
- Adequate financial & human resources
- Articulation/recognition of the need for change by stakeholders (farmers, private sector, manufacturers, NGOs, finance institutions, etc.)

3.3 Country Priorities with regard to SAMS

Participants from each country highlighted their priorities with regard to SAMS (Table 1).

Table 1 Priorities of Countries with regard to SAMS

Countries	Priorities
Philippines	Comprehensive National Program for SAMS
Sri Lanka	Standardization of Agricultural machinery standards for SAMS
Malaysia	Providing access to appropriate equipment to farmers
India	Optimize capitalization of agricultural machinery use; Develop and promote agricultural machinery that is resource and energy efficient and conserve natural resources.
Indonesia	Increasing the availability of agricultural mechanization technology to farmer / stakeholders
Bangladesh	Strengthened capacity of agricultural mechanization technology on the supply side of AMT
Nepal	SAMS
Vietnam	Applying appropriate machinery and equipment for agricultural production
Mongolia	Improve planning and implementation coordination of Government agricultural mechanization (SAMS)
Thailand	Promote standardization of local agricultural mechanization
Myanmar	Training and education for farmers Select suitable farm machinery for different types of soil

4. Regional Framework for SAMS

4.1 Strategic Priorities

SAMS is a planning strategy that contributes to the agricultural goal of sustainably meeting food self sufficiency objectives. Thus, the overall goal of SAMS as defined by Roundtable participants would be:

"*To address the UN Millennium Goals No. 1 and 7 (Food security, poverty alleviation and environmental sustainability) through sustainable intensification of agriculture by creating an enabling environment through a SAMS for the Region."*

This goal would be achieved through activities developed under 5 strategic pillars:

1. Surveys, assessments and analyses of the current status of agricultural mechanization
2. Enabling policies and institutions for SAMS development
3. Human capacity development
4. Financial support to enhance investment in SAMS.
5. Advocacy on sustainable agricultural mechanisation.

Strategic pillar 1: Surveys, assessments and analyses of the current status of agricultural mechanization

The success of a SAMS necessitates a thorough understanding of the current situation in a country. This constitutes a condition for identifying possible interventions to alleviate problems while capitalising on the use of existing potential.

Activities would include:

- Assessment of existing agricultural practices and analysis of supply chains;
- Analysis of existing policies;
- Assessment of existing intra- and inter- institutions involved in agricultural mechanization;
- Assessment and identification of technologies suited to specific ecological zones;
- Assessment of the use of targeted subsidies for innovative implements for sustainable agriculture.

Strategic pillar 2: Enabling policies and institutions for SAMS Development

The principal role of governments is to provide the conditions for the largely self sustaining development of SAMS with minimum direct intervention. The purpose of any interventions should be clearly identified and fall within the framework of the SAMS with explicit attention to the effects of other policies on the level and use of equipment in agriculture. With SAMS a new challenge is to formulate and implement policies and strategies that lead to government interventions in a consistent and efficient manner.

Activities would include:

- Review and harmonization of policies, and regulations designed to attract investments in SAMS;
- Development of Public–private-partnerships (PPP);
- Development and operationalizing a testing and standards formulating mechanism for agricultural mechanization;
- Institution of quality assurance of machinery, equipment and mechanization services; occupational health and safety;
- Development of R & D institutions to enhance innovation in SAMS.

Strategic pillar 3: Human capacity development

The idea is to ensure the development of a knowledgeable, well-trained and disciplined-labour force with the capacity to drive and sustain private sector-led growth. Specific activities would include:

- Building the capacity of farmers, extension staff and local government officials on SAM technologies.
- Building the capacity of manufacturers and distributors to supply inputs (seeds, tools, implements, machines).
- Enhancing information dissemination on mechanical power technologies (including profitability, environment, social, economic aspects, and innovations made to agricultural machinery).

Strategic pillar 4: Financial support to enhance investment in SAMS

Agricultural mechanization is capital intensive making it difficult for the majority of farmers to afford, given their dependence on cash financing. In an ideal situation machinery would be financed by borrowing or leasing with repayments taken retrospectively over the life of the machine.

Specific activities would include:

- Review and harmonization of policies, and regulations designed to attract investments in agricultural mechanization.
- Increasing financing for agricultural mechanization from the private sector.
- Improving access to loans for the purchase of mechanization inputs.
- Improving financing for mechanization activities through the establishment of an Agricultural Mechanization promotion fund.

Strategic pillar 5: Advocacy on sustainable agricultural mechanization

It is important to influence public-policy and resource allocation decisions within political, economic, and social systems and institutions. Advocacy encompasses many activities including media campaigns, public speaking, commissioning and publishing research at both the regional and country level. Specific activities include:

- Promoting a strategic vision for SAMS based on national development objectives (economic growth, sustainable development and poverty reduction as well as increased investment in environmental services);
- Facilitating information sharing and lessons learned about good practice on SAMS;
- Ensuring effective participation by all stakeholders (including non state actors and private sector) in SAMS processes;
- Developing and maintaining partnerships with the scientific community, non-state actors and the private sector and;
- Ensuring wide dissemination of knowledge generated by SAMS and contributing to policy and decision making processes.

5. Conclusions and Recommendations

The development of agricultural mechanization will constitute a very important challenge for Asian countries for several years to come. While some countries have made progress with the development of sustainable agricultural mechanization, more work needs to be done and many constraints must be overcome in the region. Emphasis must be placed on the environmental dimension of agricultural mechanization as it impacts the long-term sustainability of food production along with considerations

for the economic and social dimensions. This will necessitate the mobilization and commitment of all stakeholders.

The strategic priorities elaborated in the SAMS framework provide a good basis for action in Asian countries. The framework provides the principles and guidelines that will, through their application, contribute to sustainable agriculture and improve the complementarity of diverse contributions to national and regional priorities.

Participants noted that the SAMSA framework is not an end in itself but rather marks the beginning of a long term approach. Within this context, key recommendations to be taken into account include:

- The need for identification of the potential roles and responsibilities of FAO, UNAPCAEM and other development partners in supporting investment in mechanization in Asia.
- Formulation of annual work plans (activities, time frame, and budget) for implementing each pillar of the SAMSA framework in terms of the milestones to be accomplished.
- In view of the gradient of development across the region, there is the need for clustering of countries in accordance with predefined criteria such as geographic location and the level of development of SAMS.
- The identification of key pilot institutions in each regional grouping to be developed as regional centres of excellence for SAMS.
- Initiating pilot projects in accordance with country priorities. Pilot projects could be initially initiated in Nepal and Mongolia for example.
- Establishing a steering committee with the responsibility for overseeing SAMSA implementation. Members would be defined at the regional level and would include representatives of institutions.

6. Workplan proposal of FAO-UNAPCAEM

Immediate-term Objective – Establishment of Institutional Arrangements (Year 1)

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Long-term Objective – Expansion and Replication of Successes and Policy Development (Year 5 and beyond)

- Advocacy with Governments to strengthen the enabling environment for the adoption of SAMS

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- Development of policy briefs on SAMS
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Annex 1

Workshop Agenda

Annex 1

Workshop Agenda

Purpose: This Roundtable brings together key country stakeholders and experts on agricultural mechanisation to discuss the modalities in developing Sustainable Agricultural Mechanisation Strategies as well as gauge country interest in conducting SAMS in individual countries.

	8 December 2011 (Day 1)
8h00 – 8h30	Registration
8h30 – 9h00	Opening Remarks Mr. Hiroyuki Konuma Assistant Director-General and Regional Representative FAO Regional Office for Asia and the Pacific Mr. LeRoy Hollenbeck, Head of UNAPCAEM Group Photo
9h00 – 9h15	Participant introductions Roundtable - Why we are here and what we expect to accomplish Presenter: Mr. Eric Roeder, Economic Affairs Officer UNAPCAEM
9h15 – 9h40	Purpose for developing a sustainable agricultural mechanisation strategy Presenter: Mr. Josef Kienzle, Agricultural Engineer (Unit Leader) Agricultural Machinery and Infrastructure Unit (AMI) Rural Infrastructure & Agro-Industries Division (AGS), FAO
9h40 – 10h05	Building climate resilience in the agriculture sector of Asia Presenter: Mr. Theodor Friedrich, Senior Officer, Crop Production Systems Intensification; Plant Production and Protection Division (AGP) of FAO Discussion
10h05 - 10h20	Coffee Break
10h20 – 10h40	Perspectives from the private sector Presenter: Mr. Sanjeesh Bera -Private Sector Ag Company
10h40 – 11h10	Country Presentations (South Asia): Status of agricultural mechanisation in Asian countries India Presenter: Dr. Harminder Singh Sidhu, Sr. Research Engineer-cum-Manager, IRRI-CIMMYT CSISA Project, Punjab Hub, Punjab Agricultural University Ludhiana Participants' comments
11h10 – 11h50	Farm mechanisation in Punjab and its social, economic and environmental implications Presenter: Dr. Neelima Jerath, Executive Director Punjab State Council for Science & Technology, Dept of Science, Technology and Environment, Government of Punjab Intensive Agriculture in Punjab : An Environmental Appraisal Presenter: Dr. Gurharminder Singh, Senior Scientific Officer Punjab State Council for Science & Technology, Dept of Science, Technology and Environment, Government of Punjab Participants' comments

11h50 – 12h50	Lunch
12h50 – 13h20	Country Presentations (South Asia *cont'd.*): Status of agricultural mechanisation in Asian countries Sri Lanka Presenter: Mr. M.H.M.A. Bandara, Deputy Director, Farm Machinery Research Centre (FMRC), Department of Agriculture, Maha-Iluppallama, Sri Lanka Participants' comments
13h20 – 13h50	Country Presentations (ASEAN countries): Status of agricultural mechanisation in Asian countries Indonesia Presenter: Mr. Astu Unadi, Director Indonesia Centre for Agricultural Engineering Research and Development (ICAERD) Banten, Jakarta, Indonesia Participants' Comments
13h50 – 14h20	Country Presentations (ASEAN countries *cont'd*): Status of agricultural mechanisation in Asian countries Malaysia Presenter: Mr. Mohd Zainal Ismail, Director, Mechanisation and Automation Research Center, MARDI, Kuala Lumpur, Malaysia Participants' comments
14h20 – 14h50	Myanmar Presenter: Mr. Ko Ko Maung, Director, Agricultural Mechanisation Department, Ministry of Agriculture and Irrigation, Naypyitaw, Republic of the Union of Myanmar Participants' comments
14h50 – 15h10	Coffee Break
15h10 – 15h40	Philippines Presenter: Rossana Marie C. Amongo, PhD. Acting Director, IAE & Program Coordinator, AMDP CEAT, UP Los Baños Participants' Comments
15h40 – 16h10	Thailand Participants' comments
16h10– 16h40	Viet Nam Presenter: Mr. Nguyen Quoc Viet, Head of Dept. of Science, Training and International Cooperation Vietnam Institute of Agricultural Engineering and Post-harvest Technology (VIAEP) Hanoi, Viet Nam Participants' comments
16h40 – 17h10	Country Presentations (North-East Asia): Status of agricultural mechanisation in Asian countries Mongolia Presenter: Mr. Lkhasuren Choi-Ish, General Director of Strategic Planning and Policy Department, Ministry of Food, Agriculture and Light Industry, Ulaanbaatar, Mongolia Participants' comments
17h10 – 17h15	Brief wrap-up Day 1

	9 December 2011 (Day 2)
8h30 – 9h00	Country Presentations (North-East Asia *cont'd*): Status of agricultural mechanisation in Asian countries China Presenter: Mr. Li Hongwen. Professor, China Agricultural University, Conservation Tillage Research Centre, MOA., Beijing, China Participants' comments
9h00 – 9h40	Modalities of conducting an agricultural mechanisation strategy Presenter: Dr. Karim Houmy, Professor, Department of Agricultural Engineering "Institut Agronomique et Vétérinaire Hassan II"
9h40 – 10h00	Coffee Break
10h00 – 11h30	Group Work (break-out session 1) Topic: SAMS in each of the participating countries? Facilitators: FAO & Dr. Houmy
11h30 - 12h00	Plenary – Group presentations
12h00 – 13h00	Lunch
13h00 – 14h30	Group Work (break-out session 2) Topic: Pre-conditions and actions facilitating the development of SAMS Facilitators: FAO & Dr. Houmy
14h30-15h00	Plenary – Group presentations
15h00 – 15h30	Coffee Break
15h30 – 16h30	Plenary Session: Advancing SAMS Elaborate a regional framework for SAMS
16h30 – 17h00	Wrap-up and Close

Annex 2

Opening Speeches

منظمة الأغذية والزراعة للأمم المتحدة | 联合国粮食及农业组织 | Food and Agriculture Organization of the United Nations | Organisation des Nations Unies pour l'alimentation et l'agriculture | Продовольственная и сельскохозяйственная организация Объединенных Наций | Organización de las Naciones Unidas para la Agricultura y la Alimentación

OPENING REMARKS

by

Hiroyuki Konuma
Assistant Director-General and
FAO Regional Representative for Asia and the Pacific

delivered at the

Roundtable on Developing Environmentally Sustainable Agricultural Mechanization Strategies (SAMS) for Countries in the Asia-Pacific Region

FAORAP, Bangkok
8 December 2011

Mr. LeRoy Hollenbeck, Head of UNAPCAEM,
Distinguished representatives from the diplomatic missions and from regional organisations
Ladies and Gentlemen:

It is my pleasure to welcome you all here today, to participate in this Round Table on Developing Environmentally Sustainable Agricultural Mechanisation Strategies for Countries in the Asia-Pacific Region, organized jointly by UNAPCAEM and FAO. FAO is particularly pleased to collaborate with UNAPCAEM in the organisation and implementation of this Roundtable.

At a global level there is no alternative but to increase agricultural productivity or crop yield per unit area; and associated total and individual factor productivities, or biological output per unit of total production input, and output per unit of individual factors of production such as energy, nutrients, water, labour, land and capital, to meet global food, feed and biofuel demand and to alleviate hunger and poverty. This scenario, indeed poses a great challenge for this region where population density is in many areas very high and population growth continues, while land and water resources are getting to their limits for providing food and other agricultural outputs.

Agricultural intensification has, until now, had a negative effect on the quality of many essential resources such as soil, water, land, biodiversity and ecosystem services resulting in declining yield and factor productivity growth rates. Another challenge for agriculture is its environmental foot print and the impact of climate change. Agriculture is responsible for about 30 % of the total greenhouse gas emissions of carbon dioxide, nitrous oxide and methane, while being directly affected by the consequences of a changing climate.

The new paradigm of "sustainable production intensification" recognizes the need for productive and remunerative agriculture that conserves and enhances the natural resource base and environment, and which positively contributes to the delivery of environmental services. Sustainable crop production intensification must not only reduce the impact of climate change on crop production but must *also* mitigate the factors that cause climate change by reducing emissions and by contributing to carbon sequestration in soils. Intensification should also enhance biodiversity in crop production systems both above and below the ground in order to improve ecosystem services for better productivity and a

healthier environment. This concept is very well described in the recent FAO publication titled "Save and Grow", which explains how agricultural practices in the future, could still result in increased production while conserving the natural resource base.

The functionality of environmentally friendly agricultural management practices is highly dependent on suitable mechanization technologies. Agricultural mechanization removes the drudgery associated with agricultural labour, overcomes time and labour bottlenecks to perform tasks within optimum time windows, and can influence the environmental footprint of agriculture, leading to sustainable impacts.

Agricultural mechanization generally addresses issues of farm power and increasing the efficiency of agricultural labour. The impacts of mechanization in the crop sector are, however, varied in that it can have both positive and negative impacts. The positive impact of mechanisation lies in its contribution to reducing the environmental footprint of agriculture, while its negative impact relates to the acceleration of environmental degradation.

While recognizing the importance of market mechanisms, the direction taken by agricultural mechanization should not only be left to market forces, particularly in view of the fact that environmental sustainability is not yet well reflected in market economies. Sustainable Mechanization strategies *must, therefore*, address much more than the technical and socio-economic aspects of agricultural mechanization.

While it is important to facilitate the establishment of an enabling environment with appropriate infrastructure for the agricultural mechanization sector to flourish and to provide the services necessary for success, it is equally important to provide guidance on the *type of technologies* used in agriculture to achieve the dual goals of intensifying production and achieving environmental sustainability. The latter is particularly important for this region which is already beginning to face serious environmental challenges to maintain its agricultural production base.
Ladies and Gentlemen:

The formulation of sustainable agricultural mechanization strategy is a complex undertaking and is not as straightforward as it may seem, at a first glance. It is firstly important to underscore that agricultural mechanization is not an end in itself, but must be guided by policies and strategies if it is to result in increased productivity from finite resources, with minimal negative environmental impact.

Within the current global economic paradigm the crucial role of the private sector must be recognized. The mechanization technology supply chain from manufacturer to end user must provide livelihood opportunities to all participating stakeholders and this is what will provide sustainability to the process. At the same time the public sector also has a crucial role to play in providing an enabling socio-economic environment within which mechanization technology supply chains can function effectively while reflecting the objectives of agricultural production growth and environmental protection. This will include provision and improvements to infrastructure and utility supply, as well as encouraging the supply of raw materials and markets for end products via supportive fiscal and import duty regimes.

Support for local manufacture and distribution of agricultural machinery is important if local manufacturers are to operate in a friendly environment in which their products can be competitively priced. The supply of manufacturing input supplies should be ensured at prices that permit competitive domestic production. Dealer networks should be encouraged with the necessary local incentives which allow them to function in an equitable economic environment without being subjected to destructive taxation regimes. End users and farmers, should be encouraged to act cooperatively to capture more attractive prices for their products and to improve their bargaining power for inputs, and particularly farm machinery inputs. Access to finance must also facilitated through public sector policies and actions which reduce the risk of exposure of the essential private sector actors.

Political support for local manufacture within a rational agricultural mechanization strategy can have a dramatic impact on the success of local industries, resulting in a positive effect on national agricultural

productivity, on world markets and last but not least on environmental sustainability. The success of the Indian and Chinese agricultural machinery industries provides a good example of what can be achieved through the application of judicious supportive policies. Currently, India is the world's market leader in tractor production, and China is rapidly catching up, with the inclusion of elements of environmentally sustainable mechanization such as the promotion of Conservation Agriculture.

Other good examples of mechanization policies addressing the above sectors exist in the region. The spectrum covered is very broad, ranging from reducing soil degradation by introducing no-till technologies, more sustainable water management with irrigation technologies, to reducing the pressure on production by reducing post harvest losses with better storage and processing facilities.

FAO has, over the past decades, assisted member countries with the development of agricultural mechanization strategies, encouraging private sector involvement and a demand driven, market oriented approach, while at the same time stressing the importance of environmental sustainability of farming. All of this is very well documented in the FAO publication Save and Grow.

Ladies and Gentlemen,

A key output of our deliberations over the next two days will be the elaboration of a framework for the development of SAMS. We have two full days of discussions and deliberations ahead of us to think around and discuss all of the issues I have highlighted here today within the context of the various scenarios that exist across this region. I would, therefore, like to end by wishing you a productive outcome to your deliberations and look forward to the ouputs of this roundtable.
Thank You.

Opening Remarks

delivered at

Roundtable on Developing Environmentally Sustainable Agricultural Mechanization Strategies (SAMS) for Countries in the Asia-Pacific Region

By

Mr. LeRoy Hollenbeck
Head, UNAPCAEM, Beijing

Mr. Hiroyuki Konuma, Assistant Director General and Regional Representative,
FAO Regional Office for Asia and the Pacific

Honourable representatives from diplomatic missions and regional organisations

Ladies and Gentlemen...good morning

On behalf of the UN Under-Secretary General and Executive Secretary of ESCAP Dr. Noeleen Heyzer, I, too, would like to welcome you to the UNAPCAEM-FAO Joint Roundtable on developing environmentally sustainable agricultural mechanization strategies, or SAMS. The Executive Secretary, as do I, want to express our sincerest gratitude to all the technical expertise that has gathered here with the expectation that this Roundtable will be the catalyst for tangible actions on enhancing resiliency within the agricultural sector to produce more food and sustain rural livelihoods.

FAO is an important partner organization of UNAPCAEM and we are indebted to Mr. Konuma and your staff for your overwhelming support, not only assisting in organizing this roundtable but ensuring that it will lead to a solid regional framework for SAMS.

Agriculture is the main livelihood of the poor throughout the Asia-Pacific region providing employment for an estimated sixty per cent of the working population, a population under increasing pressure to produce more food. Increases in global population and subsequent rise in demand for both food and fiber are occurring when the total agricultural labour force is declining annually. Farmers throughout the region are, as a result, adopting more mechanised agricultural production techniques aiming to increase production, reduce costs and bridge labour shortages.

Not only is sustainability in agricultural production being tested from an economic perspective, environmental aspects of agriculture are, likewise, generating greater concern and interest. Today's environmental focus on agriculture includes energy efficiency; reduction in carbon and other gas emissions; use of flexible fuels; application of more sustainable agricultural practices, such as conservation and low-tillage agriculture; and more efficient and appropriate use of fertilizers and pesticides.

The Asia-Pacific region does not yet have a focused, internationally-recognized mechanism for sharing and disseminating good agricultural practices in the area of technology and machinery testing. Such a mechanism would facilitate small farmer access to the latest agricultural technologies and machinery enhancing their efforts in more effective resources management. Test codes and schemes for agricultural machinery could promote synergy in the region in the application of uniform, mutually

recognized testing procedures addressing occupational safety and health, performance and quality, environmental standards, and trade issues.

Finally, increased inter- and intra-regional trade and investment in agricultural machinery, equipment and technologies can play a significant role in addressing food insecurity, not only in increasing agricultural machinery options available to farmers, improving the quality of agricultural machinery through increased competition in the market, but would also stimulate technological innovation.

UNAPCAEM is now spearheading the establishment of an Asian and Pacific Network for Testing Agricultural Machinery, or ANTAM. FAO is our partner in this exciting endeavour. When fully functional, ANTAM will facilitate trade in agricultural machines and will help to meet the common requirements of machinery operation and performance, environmental sustainability and food safety.

Rapid agricultural mechanization has been successful, contributing to increased food production, productivity and advancement of rural economies. However, our planet has finite resources, and agricultural mechanization should be tailored to use natural resources in a more sustainable way, meet regional food demands and innovate to be more resilient to erratic weather that can disrupt the production of food.

Sustainable agricultural mechanisation strategies can serve as the foundation to create a policy, institutional and market environment giving farmers and other end-users the choice of farm power and equipment suited to their needs within a sustainable delivery and support system.

UNAPCAEM remains committed to enhancing environmentally sustainable agricultural and food production, applying green and modern agro-technology for the well being of producers and consumers of agricultural/food products.

Ladies and Gentlemen,

As with our FAO colleagues, it is our hope and desire that the next two days of focused discussions will provide a solid framework from which to formulate sustainable agricultural mechanizations strategies.

I look forward with great interest over the next two days your participation at this important and extremely relevant Roundtable event. Let’s use this Sustainable Agricultural Mechanization Roundtable as a platform to enable the Asia-Pacific region to move toward agricultural systems that are resource efficient and environmentally sustainable.

Thank you.

Annex 3

Background to the Work of FAO and UNAPCAEM on Mechanization

Background to the work of FAO and UNAPCAEM on Sustainable Agricultural Mechanization

FAO has vast experience in developing appropriate Agricultural Mechanisation Strategies in many countries with particular experience in Africa[2]. FAO has been assisting member countries for over two decades to formulate strategies and implement action plans in order to develop agricultural mechanisation. A recent policy document published by FAO, titled *Save and Grow*[3] calls for sustainable crop production and intensification while conserving resources, reducing negative environmental impacts and enhancing natural capital in the flow of ecosystem services.

UNAPCAEM provides the platform allowing groups of diverse countries to share experiences and coordinate their development activities for greater regional impact through regional cooperation. The Centre is committed to strengthen national food security programs, promote research and development on environmentally sustainable agriculture and encourage regional cooperation when responding to food crises. UNAPCAEM can also identify and assemble the appropriate expertise, bring together key stakeholders via various meeting formats, outfit decision-makers with up-to-date information and advocacy products and suggest policy options that can enhance food security and rural livelihoods.

[2] FAO Agricultural mechanization strategy (AMS)., http://www.fao.org/ag/ags/agricultural-mechanization/agricultural-mechanization-strategy-ams/en/

[3] Save and Grow: A policymaker's guide to the sustainable intensification of smallholder crop production http://www.fao.org/ag/save-and-grow/

Annex 4

Background to SAMS

Background to SAMS

Karim Houmy

FAO International Expert
Department of Agricultural Engineering
Institut Agronomique et Vétérinaire Hassan II

SAM should be considered as one element of sustainable development that integrates consideration for economic, social and environmental concerns (Diagram 1):

From an economic perspective, farmers must invest in mechanization and generate income and profit from their production. Productive agricultural income is required to fund input suppliers, such as the suppliers of income. Consideration must be given to the link between farmers and other stakeholders, including retailers, wholesalers manufacturers and importers of equipment. A fundamental requirement for a sustainable sub-sector is a strong linkage between these different stakeholders. All of these stakeholders must be able to make a livelihood from their businesses.

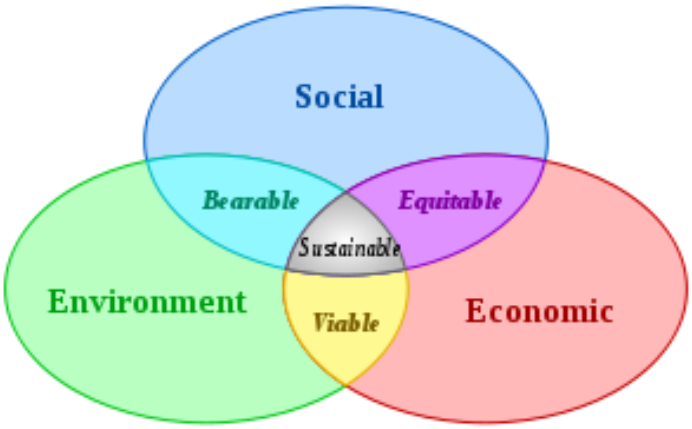

Diagram 1. Schematic of sustainable development: at the confluence of three constituent parts. (Wikipedia 2006)

SAMS must also be seen in a social context. In fact, agricultural mechanization aims to provide additional benefits to the user, such as a reduction in the drudgery of farm work and increased opportunity for leisure. These are subjective benefits and are difficult to translate into economic terms. The impact of mechanisation on employment constitutes a very controversial issue in the social context. While on one hand, mechanization is considered to be a key in reducing employment and de-skilling of labour, mechanization addresses rural labour shortages and conversely reduces unemployment through the development of new employment opportunities such as in manufacturing, and repair, mechanization services.

Environmental concerns are critical in a SAMS strategy. Agricultural mechanization has been criticised for its negative impact in particular with regard to the degradation of natural resources through intensive tillage, overuse of inputs, and its role in reducing biodiversity and particularly agricultural biodiversity. During the past years many actions have been taken toward environmental protection. Conservation agriculture is one of those very important concepts that was developed during the past decades. This concept includes the basic elements of reducing the need for external inputs and

the environmental footprint of farming. It is as “a concept for resource-saving agricultural crop production that strives to achieve acceptable profits together with high and sustained production levels while concurrently conserving the environment” (FAO 2007). Key elements of the concept are (1) reduced and no-tillage practices (including direct seeding technologies); (2) permanent soil cover and the use of leguminous cover crops plus (3) suitable and crop rotations and associations in order to avoid plant disease and pest outbreak and to allow soils to re-balance their nutrient availability and to sustain fertility.

SUSTAINABLE AGRICULTURAL MECHANIZATION STRATEGY: PRINCIPLES AND PROCESS

Josef Kienzle[4], Karim Houmy[5] and Rosa Rolle[6]

Executive summary

This paper was prepared for the expert Roundtable meeting, jointly organised and implemented by FAO and UNAPCAEM in Bangkok, Thailand from 8th to 9th December 2011. It focuses on the main issues that must be addressed in the development of a Sustainable Agricultural Mechanisation Strategy (SAMS). SAMS is a very important step for developing and promoting the sustainable use of farm power since it gives a clear orientation to political actors and stakeholders on actions to be taken.

During the last decade FAO has acquired a tremendous amount of useful experience in preparing Agricultural Mechanisation Strategies (AMS). New approaches have been adopted and many new methods and tools developed. A question, however, remains as to how the sustainability of agricultural mechanization can be enhanced. These are some of the main issues to be considered during the development and implementation of a SAMS.

Implementation of a SAMS necessitates an understanding of the political context. Countries must first of all, review the role of government and the private sector. The basic aim of SAMS is to ensure that farmers, who create the demand, can operate under secure and sustainable conditions allowing them to invest in farm machinery as well as in other inputs. At the same time, manufacturers, distributors and retailers, who constitute a supply system, must be able to make a profit from their business. So the purpose must be the creation of the linkages among stakeholders while addressing the issues that affect the profitability of one or more of these stakeholders. In this process, the stakeholders should pay special attention to the principles of environmental sustainability.

Secondly prior to designing and implementing SAMS it is very important to take into account the pre-conditions which should be in place. Indeed SAMS constitutes only one of various government strategies and must be developed and implemented within a framework of the political orientation of the country. It follows that political will, the economic and sociological state of the country, the developmental status of other sectors and the degree of mobilization of all concerned stakeholders are some of the indicators to be considered within a SAMS. Thirdly, SAMS must be developed according to very precise rules. This necessitates the involvement of key stakeholders during all the phases of development. A national coordinator and a steering committee must play an important role during the formulation of SAMS.

SAMS should adopt a participatory approach where the participation of all stakeholders is crucial. Their ideas, suggestions and experience constitute a very important guarantee that SAMS outputs assure sustainability in the agricultural sector. This also ensures their engagement during the implementation phase. SAMS should adopt a systems approach to review sustainable agricultural mechanization in the context of the agricultural engineering sector and should emphasize the linkages between the different key components.

Finally suitable methods and tools should be used in order firstly to allow the generation of information in a structured manner and to work through the successive stages whilst developing good communication among all stakeholders from the moment of formulation of the strategy through to its implementation and follow-up.

[4] Agricultural Officer, FAO-Rome
[5] FAO Consultant, IAVE, Morocco
[6] Senior Agro-Industry and Post-harvest Officer, FAO RAP

Introduction

Human development is a priority of most developing countries. Fighting malnutrition, illnesses, poverty and unemployment, are major challenges for most developing countries. In countries where agricultural production is the basis of the economy efforts must be focused on sustainable agricultural intensification practices.

It is now widely acknowledged that farm equipment, together with other production factors, is an important input for sustainably intensifying crop production. In this context, governments must continue to encourage farmers to use agricultural machinery through development programmes and through the provision of incentives.

Governments and donors, in general, have adopted a piecemeal approach to promoting mechanization without reviewing the agricultural engineering sector in its entirety. “What types and what levels of mechanization must be promoted to assure sustainability?”, “What are the respective Roles of Government and the Private Sector?”; “What kind of investment is needed to boost the development of sustainable agricultural mechanisation?” These are among questions that can be clarified by a global vision through a national SAMS.

Over the past twenty years, FAO has led many projects in Africa, Asia and Latin America to assist countries aspiring to elaborate their SAMS. The approach adopted has evolved in line with developmental philosophies of member countries and financial supporters. Methodologies and new tools continue to be developed according to these new approaches.

Sustainable Agricultural Mechanization Strategy Concepts

Before presenting the concept of a SAMS, it is very important to be clear as to the definition of the meaning of agricultural mechanisation. Indeed this term has always been confused with powered equipment or sophisticated machines. In reality it covers all levels of technology from the simplest and most basic handtool to the highest and very modern machine.

What is very important is that the technology adopted meets the real needs of the farmer and that it can be used efficiently and effectively, while contributing to environmental sustainability. In other words, mechanization doesn’t mean large investments in equipment such as tractors and combines but necessarily involves shifting to an alternative combination of land, capital and labour, which results in improved farm income without causing environmental degradation. This is achieved either through increasing output or through reducing costs, or through a combination of both.

Agricultural mechanisation technology in developed countries has reached a very high level of sophistication and has resulted in increases in labour and land productivity while reducing production costs. Farm power and equipment have not, however, played as important a role as expected due to many constraints amongst which the institutional aspects are very crucial.

Sustainable agricultural mechanisation is considered as a system where each component is dependent on those both before and after it in the flow of goods and services from the manufacturer to the final end user. The strength of the whole system, which is dynamic, depends on the effective function of all components and the linkages between them.

The main groups of directly interested parties in the system are:

- Farmers
- Retailers and Wholesalers
- Manufacturers
- Importers

The farmer, the main stakeholder, is the first target in an agricultural mechanization strategy. In most developing countries, farmer capacity varies widely from subsistence farmers whose farm output is adequate only for meeting the food requirements of the family to commercial farmers whose farm output consists mainly of cash crops.

The linkage between the farmer and other stakeholders is of critical importance to the successful and sustainable development of agricultural mechanization. A fundamental requirement is that stakeholder "businesses" are profitable. If farmers are not making money they will not be able to purchase inputs; if retailers cannot sell items at profit then they will not stock them and if manufacturers are not fabricating tools and machines at a price that is affordable by the farmer, then their business is unsustainable.

The purpose of a sustainable agricultural mechanisation strategy is to create linkages among stakeholders and to address issues that affect environmental sustainability as well as the profitability of one or more of these stakeholders. This dictates how national governments should provide the basic conditions for the largely self-sustaining development of agricultural mechanization within a policy of minimum direct intervention.

Sustainable Agricultural Mechanization Strategy Approaches

The introduction of agricultural technology, including mechanization, is a complex process. It depends mainly on country-specific characteristics of the economy, the developmental status of the country and of its agricultural sector. Many approaches have been adopted for analyzing this process.

When formulating a SAMS, emphasis should be placed on using a participatory approach which basically means a process for the creation of opportunities for all concerned actors to participate in the formulation. The involvement of all actors in all steps of the AMS strategy must, therefore, be clear if it is to constitute a substantial guarantee for the success and the impact of projects that are eventually implemented.

Strategy formulation should adopt a holistic approach for reviewing agricultural mechanization not only as a subsector but within the context of the agricultural engineering sector (Diagram 1). The agricultural mechanization analysis should take into account many important points:

Sustainable Agricultural mechanization demand

Farming systems are central to the analysis of sustainable agricultural mechanization. The pattern of production, the ownership of resources, participation by household members in farming, gender division of labour, environmental concerns and the profitability of farm enterprises influence the range and scope of sustainable agricultural mechanization.

Sustainable Agricultural mechanization supply

It is important to analyse supplies from manufacturers, retailers, wholesalers, and importers. It is also essential that the existing farm machinery and equipment supply chain be thoroughly investigated and clearly understood. This will mean an in-depth collection of data about manufacturers, importers, artisanal activity, and national, regional and local distribution and retail systems.
Others factors that can have a great influence on sustainable agricultural mechanisation, include:

- Domestic and international markets for farm products
- National policies (trade, industry, fiscal, labour, environment..)
- International trade
- Infrastructure level
- Institutional support
- Raw material availability

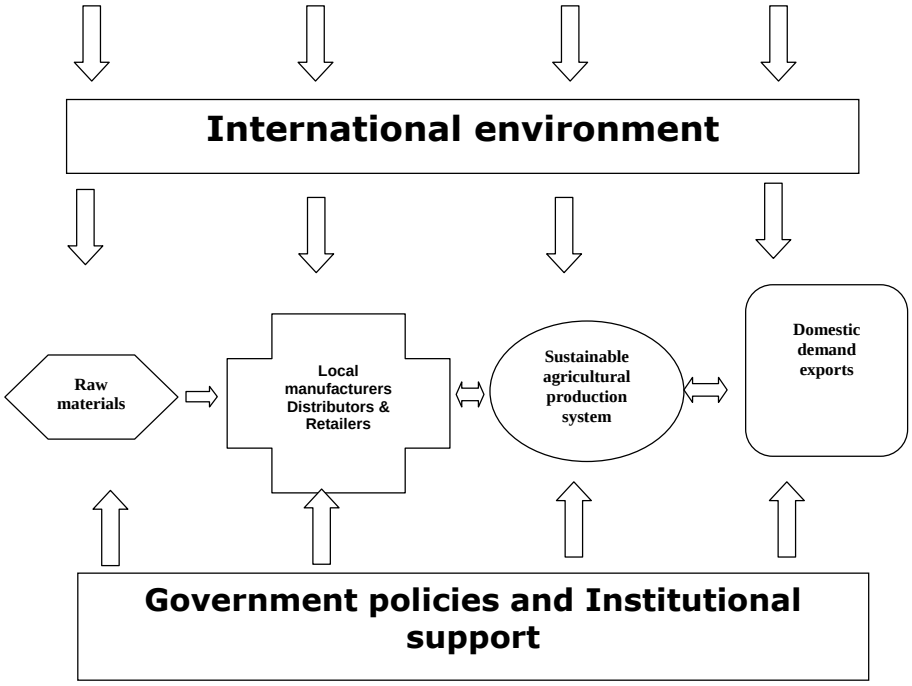

Diagram 1 The agricultural mechanization supply system

Pre conditions for development of SAMS

For the success of a SAMS, it is important to consider the pre-conditions that should be in place. First of all a SAMS must emanate from a real need expressed by a political will. This depends on the political, economic and sociological status of the country. Agricultural engineering and environmental sustainability must be perceived to be sufficiently important by the broader community, to justify strategy formulation. They should be able to participate in a full and open exchange of views at all stages of strategy development.

There must be broad consensus on the fact that bottlenecks and constraints exist within the agricultural engineering sector and that these hinder environmental sustainability and the development of the agricultural sector. This can guarantee the adherence of all partners and therefore enhance the opportunity for success of the strategy and its eventual implementation. Skilled personnel and sufficient funds are required for preparation of the strategy, producing results in a time frame that is reasonable.

The timing must also to be right with regard to developments in other sectors. While there may be some argument for agricultural mechanization to lead the way with regard to strategy formulation, the initiative may be severely hampered if there are significant weaknesses in other sectors of the economy. Thus, it is essential that developments in the agricultural engineering sector are complementary to, and move in step with, developments elsewhere.

SAMS must be relevant to the needs of the country in general and specifically to agriculture. However, if agricultural mechanization does not emerge as a priority issue at present, it may be appropriate to postpone the preparation of the strategy until other issues have been addressed.

The Sustainable Agricultural Mechanization Strategy Process

A typical formulation of a SAMs comprises several steps (Diagram 2). The first step to be carried out is an analysis the existing national farm mechanization situation with a view to enhancing sustainability. This Diagnostic constitutes a prior condition for identifying possible interventions that are supposed to alleviate problems and so as to ensure using the existing potential.

So, what kind of information has to be collected, how does this information have to be collected and how should this information be analyzed? These are some of the questions which are usually raised during the first step of developing a SAMS. It makes little sense to handle vast amounts of information just because it is interesting; this will result in loss of time and wasted resources.

Similarly, in this step, the policy issues which impact on farm mechanization are identified and an analysis of problem areas and constraints is conducted. This is generally carried out in close co-operation with officials from Ministries of Agriculture as well as with other ministries. In this manner, awareness can be created about the implications of political measures on agricultural mechanization and its potential effect on agricultural production.

The second step is to identify the optimum future scenarios or Goals. The resulting strategy will be the definition of the actions required to move from the existing situation to this objective. It will generally be divided into defining the respective roles of both the private and government sectors.

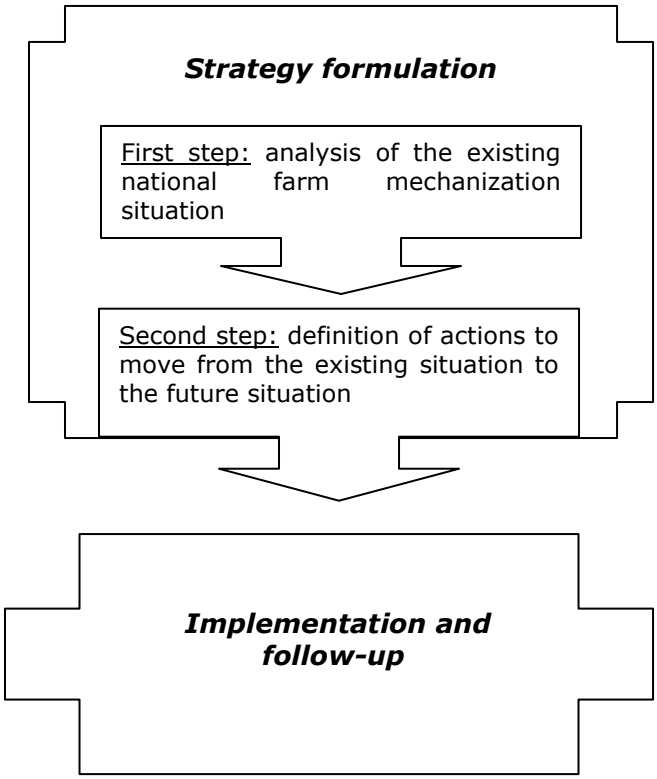

Diagram 2 Main steps in Strategy formulation

Finally, the strategy should clearly define follow-up actions and activities to assist policy makers and planners in implementing the strategy – the Action Plan. These follow-up activities generally consist of policy adjustments to correct distortions in the sub-sector, investment plans to develop manufacturing, commercial companies and farm mechanization, and definition of realistic and realizable government actions and activities required for the development of the sub-sector. For all the interested and involved parties involved in mechanization, there are several fundamental requirements for a thriving and sustainable sub-sector.

Steps towards Implementation

If all points addressed before are respected, it is important to make a very important decision regarding the final acceptance of the strategy: how it is to be implemented, what funding is required, and what the potential funding agencies for specific programmes and projects are. One way to facilitate implementation is to identify linkages with other development initiatives, where appropriate.

It must be recognized that strategy formulation and implementation is a dynamic process. As the economy develops and farming systems change, farm power needs will change. Moreover, government policies will adjust to reflect new circumstances and development philosophies. New programmes and projects will need to be identified, and new ways of sustainably incorporating farm power into broader development projects will have to be developed. Thus, the strategy will need to be monitored regularly and revised to reflect key changes in the economic, policy and institutional environment.

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Building climate resilience in the agriculture sector of Asia
- the ***Save and Grow*** view –

Theodor Friedrich

Outline

- Challenges in Crop Production in Asia
- Save and Grow – Climate resilient systems
- Application to Asian agriculture
- Implications for mechanization
- Conclusions

Challenges in Crop Production in Asia

- Rapidly growing population
- No additional land resources
- Water resources already at verge of overexploitation
- High GHG emissions from rice
- Stagnating crop productivity
- Increase of extreme weather

Save and Grow – Climate resilient systems

- Save and Grow: the concept of sustainable intensification
- Base concept for Save and Grow: Conservation Agriculture, complemented with other good practices (IPM, IPNM, Biodiversity/Genetic Resources management, integrated water management, SRI...)

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Agriculture and Consumer Protection Department
Global Overview of the Spread of Conservation Agriculture

Save and Grow – Climate resilient systems

Conservation Agriculture (CA) is an approach to managing agro-ecosystems for improved and sustained productivity, increased profits and food security while preserving and enhancing the resource base and the environment. CA is characterized by three linked principles, namely:

1. Continuous minimum mechanical soil disturbance.
2. Permanent organic soil cover.
3. Diversification of crop species grown in sequences or associations.

(www.fao.org/ag/ca)

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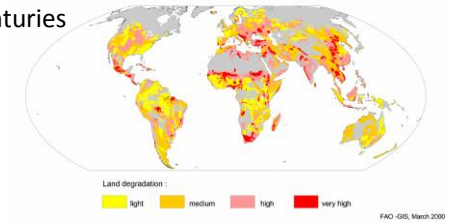
Save and Grow – Climate resilient systems

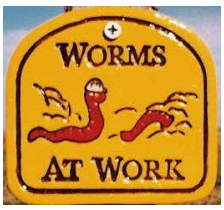
Climate resilience starts with healthy soils – agricultural soils have been degraded over centuries

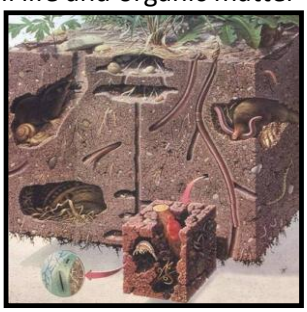


(suggested reading: Dirt – the erosion of civilizations by David Montgomery)

Save and Grow – Climate resilient systems

Healthy soils build up with soil life and organic matter – this is incompatible with mechanical soil tillage





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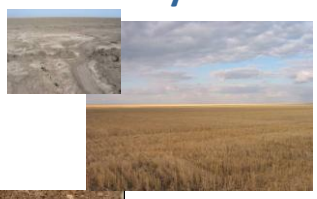
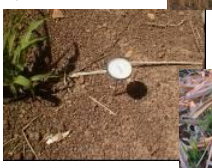
Save and Grow – Climate resilient systems

Adaptation extreme events:

- Erosion:
  stubbel, mulch, crops
  aggregate stability (OM)
- Heat: mulch
- Frost: mulch





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Save and Grow – Climate resilient systems

Adaptation to heavy rain:

- water recharge (biopores)
- water quality (leaching/erosion)
- Better/deep infiltration (flooding during monsoon)

Save and Grow – Climate resilient systems

Adaptation to drought:

- better rooting
- snow catching with residues
- more water in soils (1 % OM = 150 m3/ha)
- reduced water losses (evaporation)
- better efficiency (water/crop -30%)

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Save and Grow – Climate resilient systems

Increase the resilience through:

- diversity in the cropping
- diversity in the overall production
- higher flexibility/more timely operations
- agronomic practices that work for drought, rain, heat, cold, wind

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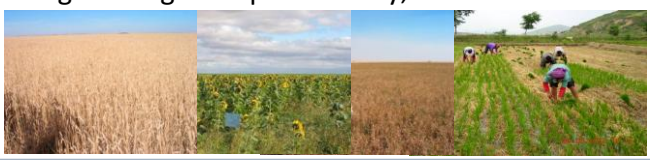
Save and Grow – Climate resilient systems

Diversity = rotations = long term profit

- different rooting structures
- pest and desease management
- weed management
- soil cover/residue managment strategy
- higher long term productivity, risk reduction



Application to Asian agriculture

Conservation Agriculture based cropping systems adapted to all cropping systems, complemented with other GAPs

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Application to Asian agriculture

The special case of rice:

- No-till, no puddling
- Direct seeding or no-till transplanting
- No hardpan, no permanent flooding
- Option: permanent bed and furrow systems
- Residue retention/management
- SRI based management

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Implications for mechanization

- No ploughing, puddling

- No-till seeding/planting with residue handling

Implications for mechanization

- Harvest preferably combining to reduce turnover time/retain straw residues in field

Conclusions

- Conservation Agriculture based cropping systems can increase climate resilience and mitigate climate change = climate smart
- This climate smart agriculture impacts on the mechanization requirements and can be facilitated by appropriate technologies
- Suitable mechanization solutions exist already in Asia for those cropping systems

Save and Grow
the Agriculture of the Future – the Future of Agriculture

More information:
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http://www.fao.org/ag/ca

Join the CA-CoP!

Annex 5

Country Status Reports

STATUS OF AGRICULTURAL MECHANIZATION IN BANGLADESH

Dr Md Abdul Wohab
International Fertilizer Development Centre (IFDC) Asia Division Bangladesh

Bangladesh is predominately an agricultural country. Farm mechanization for crop production has become an important issue for agricultural production in the country. To feed her 150 million people from 8.2 million hectares of cultivable land is difficult. Every year almost 0.20 million people are adding to the total population whereas the estimated annual reduction of agricultural land is about 0.08 million hectares due to constructions of houses, offices, roads, mills, factories etc. The country's food production has increased from 11.0 million tons in 1971 to about 30 million tons in 2007. Now, the country is self sufficiency in cereal production. This is due to mechanized tillage and irrigation development and also partial mechanization in other agricultural operations as well as development in other crop production sectors. But to meet up the food requirements of the ever growing population of the country in 2015, an additional 5 million tons of food grain need to be produced from the continuously decreasing agricultural lands. To increase food production and cropping intensity, the most important task will be the faster development of agricultural mechanization and other crop production sectors. Replacing the traditional inefficient agricultural tools, efficient mechanized cultivation must be introduced and extended. The government has already given due importance to agricultural mechanization in the National Agricultural Policy. In the Policy it is included that "The Government will encourage production and manufacturing of agricultural machinery adaptive to our socio-economic context. Manufacturing workshops and industries engaged in agricultural mechanization activities will be provided with appropriate support." Over the past two decades, the use of farm machinery has increased rapidly. Now, irrigation is almost mechanized by using more than 1.5 million diesel and electric driven pumps. The cultivable land under irrigation is about 61 percent. The next operation that has been mechanized is the tillage operation mainly done by power tiller (two wheel tractor). Now, use of tractor is increasing day by day and about 80 percent of the land preparation is done by power tillers and tractors. The next operation that is being rapidly mechanized is threshing. Power operated multicrop threshers and shellers are widely using by the farmers for threshing paddy, wheat and maize. Shelling of maize is accomplished almost 100% by power and hand maize shellers and those of paddy and wheat are over 80% by both power and manual threshers. At present, the most important operation to be mechanized is the harvesting of paddy and wheat. Due to lack of timely harvesting of paddy and wheat, a considerable amount of food grain is lost every year in the country. Power required for crop production operations are always shortage. In 1960, farm power availability was only 0.24 kW/ha, which has increased to 1.05 kW/ha in 2006. Present Government has realize the shortage of farm power and has undertaken some project to mechanize different crop production operations like tillage, seeding transplanting, fertilizing, weeding, herbicide spraying, harvesting and threshing. Government will subsidize 25 to 60 percent price to the farmers to purchase different farm machinery to perform the above mentioned operation in time. It is expected that the introduction of farm machinery through project will enhance agricultural mechanization program in Bangladesh.

Table Present Status of Farm Machinery used in Crop Production

Farm machinery	
Name of Machines	**Quantity**
Power tiller	3,50,000
Tractor	40,000
Seeder	2,000
Weeder	2,00,000
Fertilizer applicator	8,500
Sprayer	12,50,000
Reaper	50
Combine harvester	100
Power thresher	2,00,000
Maize sheller	2,000
Winnower	200
Irrigation machinery	
Name of Machine	**Quantity**
Low lift pump	1,40,000
Deep tube well	31,300
Shallow tube well	13,05,000

AGRICULTURAL MECHANIZATION STATUS AND CONTEXT IN CHINA

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Agricultural Mechanization Status in China

Equipment amount increased rapidly.

In 2010, the total power of national agricultural machinery reached 0.92 billion KW, with the increase by 34% than 2005. As the continuous optimization of agricultural equipment structure, large medium tractors, transplanters and combine harvesters increased respectively by 26%, 35% and 20% each year, in which maize combine harvesters by 71%, the possession quantity proportion of large medium tractors and small tractors improved from 1:1 to 1:5, and the amount of different kinds of reduced and no tillage planters reached beyond 0.6 million.

Agricultural mechanization operation significantly improved.

In 2010, national crop tillage-plant-harvest combine mechanization level reached 52%, 16 percent higher than 2005, which means 3.2 percent improvement each year, much higher than the amplification with 0.7 percent during Tens Five-Year Plan. The main crops production mechanization proceeded quickly. Rice production mechanization got a large development: machine plant and harvest level reached 16.7% and 56.7% respectively, which represented 2.4 percent and 5.8 percent improvement each year separately; maize machine harvest entered a fast development stage with the level of 16.9% and 3.5 percent improvement each year; main economic crop such as potato, rape, cotton, peanut and tea etc. production mechanization got a breakthrough. Animal production and aquaculture, fruit industry, agriculture facilities and agricultural products processing etc. mechanizations all-roundly developed. As a new technology of continuous mechanization agriculture, the acreage of conservation tillage has reached more than 4.3 million ha.

Agriculture machinery cooperation and other services organizations vigorously developed, and socialization service ability of agriculture machinery strengthens continuously.

Until 2010, the amount of national agricultural mechanization operation service organizations reached 0.185 million, and the total output reached 370 billion *Yuan*, with 63% higher than 2005; especially agriculture machinery professional cooperation grew out of nothing and developed 20,000 and the number of people involved reached 330,000 until 2010.

The situation and tasks of agricultural mechanization development in China

Opportunities

1. Continuous improvement of relative laws, regulations and policies provides strong technical support for agricultural mechanization;
2. That, the ability of national finance support improved, income of farmers continuously increased and experienced socialization service market of agriculture machinery increased, lays a solid foundation for agricultural mechanization.
3. Industrialization and urbanization accelerated pace, growing contradiction of young adults labour shortage, and dignified life and decent work which farmers longs for lead to vigorous and urgent command for agricultural mechanization;
4. Resource, environment and continuous development promote conservation tillage steadily developed.

Challenges

Firstly, ineffective supply of agriculture machinery equipment and technology; Second, unreasonable agriculture machinery equipment structure and distribution; Third, unmatched combination of agriculture machinery and agronomy; Fourth, construction lag of agriculture machinery public service system; Fifth, non-matching agriculture machinery development infrastructure; Sixth, upgrade organization degree of agriculture machinery operation service; Seventh, slow pace on renovation and discard for old agriculture machinery, and immense task of energy saving and emission reduction and safety supervision for agricultural mechanization.

Objectives

Food, cotton, oil, sugar and other staple crops mechanization level forecast obvious improvement, and crop tillage-plant-harvest combine mechanization degree reaches beyond 60% during the twelfth five-year plans. Agricultural mechanization technology innovation capacity and technology application level are obviously enhanced, and combination of agriculture machinery and agronomy is improved and agricultural mechanization technology for yield increasing and synergism, resource-saving and environment friendly is used extensively. Significant progress is made in agricultural mechanization public service system construction.

CONSERVATION AGRICULTURE AND SUSTAINABLE AGRICULTURAL MECHANIZATION STRATEGIES

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During past half century, Global food supply has kept pace with demand due to impressive economic growth and linking global markets. In this endeavour, achievements of Indian agriculture during the second half of the 21st century are among major global success stories. But, the real challenges have surfaced in the recent years with ever-increasing food demand due to burgeoning populations, degradation of land & natural resources. To compound the challenges further, global climate change is likely to impact crop and livestock production, hydrologic balances, input supplies and other components of agricultural systems, making production much more variable than at present. There has been a tremendous shift in the production variables of modern farming over traditional plough based farming. Even then, the most agronomic works revolved around tillage and labour intensive farming. Declining soil organic carbon (SOC) status of soils has been main shift in agriculture from 'traditional animal based subsistence' to 'intensive chemical and tractor based' agriculture that multiplied problems associated with sustainability of natural resources. The SOC concentration in most cultivated soils of India is less than 5 g/kg compared with 15 to 20 g/kg in uncultivated virgin soils. More specifically, due to intensive ploughing, residue burning/removal and mining of soil fertility has resulted in loss of C from SOC pool and hence C based sustainability index in Punjab has declined substantially after Green Revolution. Large acreage of cultivated lands shows fertility fatigue and deficiency of multiple-nutrients in many intensively cropped areas. This adds to our challenge of making farming more profitable.

Conservation agriculture based crop management technologies are an "open" approach, easier to mainstream. CA therefore, will be able to quickly address two critical needs that address concerns faced by South Asian agriculture today- farm economics and natural resources. Several studies conducted across the production systems under varied ecologies of South Asia revealed the potential benefits of CA based crop management technologies on resource conservation, use efficiency of external inputs, yield enhancement and adaptation to terminal heat effects. Laser assisted land levelling being practiced over 1.5 m ha in south Asia saves on water by 25-30 %, improve yields by 5-15 % with other associated benefits. Zero tillage in cereal systems have helped in saving in fuel, water, reduce cost of production and improve system productivity & soil health. Residue management in zero till systems (surface retention) helps in improving soil health reducing GHG emission equivalent nearly 13 tonnes/ha and also regulates canopy temperature at grain filling stage to mitigate the terminal heat effects in wheat. CA practices have been widely adopted in tropics/subtropical and temperate regions of the world for rain-fed and irrigated systems. Acreage of Conservation Agriculture is increasing steadily worldwide to cover about 108 m ha globally (7% of the world arable land area). Thus, CA is an innovation process of developing appropriate CA implements, crop cultivars, etc. for iterative guidance and fine-tuning to modify crop production technologies. Recent estimates revealed that CA based RCTs are being practiced over nearly 3.9 mha of South Asia. Keeping the emerging challenges before the Asian farmers, there is a need to develop a appropriate mechanization strategies as a collective movement on Conservation Agriculture in the region. For accelerating the pace of adoption of CA in the region, development & Evaluation of CA Equipment and Human Resource Development in core competence of CA is an immediate action as ***"Un-sustainability cannot be an option in the modern agricuture"***.

Brief mechanization status in India: The economic development and labour scarcity are the two major drivers for farm machinery and equipment demand. Presently, India is the largest manufacturer of tractors in the world accounting for about one third of the global production and more than 50 per cent of tractors in <60 hp category (Singh and Mani 2009). During 1981, the average farm power available was about 0.47 kW/ha which increased up 1.46kW/ha in 2005 comprising of about 84 per cent from mechanical and electrical sources and 16 per cent from animal power and human labour. Now it is estimated that average farm power available India will increase up to 1.9 kW/ha by 2011-12

(Kulakarni 2005) as there is a strong linear relationship between power available and agricultural productivity. Improved agricultural tools and equipment are estimated to contribute to the food and agricultural production in India by savings in seeds (15-20%), fertilizers (15-20%), time (20-30%), and labour (20-30%); and also by increase in cropping intensity (5-20%), and productivity (10-15%). But there is need to increase access to environmentally sound agricultural machinery that both sustains and enhances rural livelihoods and reduces pressure on natural recourses that are the lifeblood for producing food.

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THE STATUS OF AGRICULTURAL MENCHANIZATION IN INDONESIA

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Introduction

Indonesia had occupied a total land area of 192 million ha. The total population in 2010 was 238 million, in which more than 100 million people rely on agriculture and forest. 13.33% of the populations are poor people of which 20.62 million are living in rural areas. Agriculture plays an important and strategic role. Majority of agricultural areas are rain-fed and irrigated lowland.

The target of national development program in agricultural sector are: (a) achieving production to enhance food security mainly rice, maize, soybean, sugar cane and beef cattle, (b) Increasing food diversification, (c) Promoting added value, competitiveness, and export; and (d) Improving farmers income and welfare. These target will be achived through revitalization of: agricultural land, seed, facilities and infrastructures, human resouces, agricultural funding system, farmer organization, technology and agro industry. Rice is the main indicator for food security in Indonesia. During five year, Indonesia rice production increases from 34.38 million tones in 2006 to 41.67 million tones of milled rice in 2010 while rice consumption is 139,5 kg/capita-year.

Expansion of agricultural area, new high yielding variety and technology has contributed in increasing rice production in Indonesia. However land conversion, fragmentation and climate change have threatened the sustainability of food security. Labor shifting from agriculture to industry and service has also handicapped in increasing rice production.

Total lowland and irrigated paddy field area was 8.5 million ha in 1995 and had decreased to 7.70 million ha in 2005 most of them occurred in Java Island. While climate change has shifted rainfall pattern which has caused the shifting in copping calendar. The northern part of the equator becomes wetter while the day of rainfall at the southern hemisphere became shorter. This will affect rice production unless some efforts have been made.

Development of Agricultural Mechanization in Indonesia

Since the introduction of high yielding variety and rice production technology, agricultural mechanization had been used by farmers intensively to speed up land preparation, pest control, harvesting and processing of rice product. However, in some areas, manual labor is still being used in rice production. The number of agricultural machinery in Indonesia is given in Table 1. Those agricultural machineries are mainly being used for rice farming. The number of agricultural machinery is relatively small compared to agricultural land area. This is mainly because of the low affordability of farmer to buy agricultural machinery and lack of knowledge to operate agricultural machinery.

Efforts have been carried out to increase the number of machinery such as: (1) promotion and dissemination; (2) capital subsides for farmer group; (3) revitalization of farmer group for leasing the machinery through Farm Machinery Service Unit; (4) increasing the capacity of infrastructure (farm road, irrigation canal, local workshop); (5) improving human resource capability on mechanization; and (6) improvement of national standard and certification of agricultural machinery.

Table 1 Number of Agricultural machinery in Indonesia used for rice production

NO	Types of Machinery	2006	2010	Additional requirement 2010 (Unit)
1	Two wheel tractor	123 166	126 453	148 406
2	Four wheel tractor	1 652	2 969	NA
3	Water Pump	81 509	18 7801	100 679
4	Harvester	NA	NA	470 974
5	Power thresher	199 416	20 1241	187 075
6	Dryer	2 804	2 857	5 876
7	RMU	56 202	58 512	13 127

The development of agricultural mechanization in Indonesia is mainly to accelerate the utilization of agricultural machineries for crops production, post harvest and processing activities. Policy for agricultural mechanization development in Indonesia have been set up to: (a) increase crop productivity and efficiency of agricultural resources, (b) increase quality and added value of the agricultural products and its by products, (c) promote the opportunity of local agricultural machinery industry to produce better quality of the machines which are suitable to local conditions, (d) to strengthen the collaboration among small, medium and large scale of agricultural machinery industry.

Based on Indonesia's farming conditions, an apropriate strategy to promote agricultural mechanization is required. The concept of agricultural mechanization will be implemented in selected area such as production center for a certain commodity, and supervised by government (Research Center and Extension Office) to create an agro-industry project in village areas. This pilot project will be managed by local farmers.

Various level of strategy has been established in promoting agricultural mechanization development to farmer, i.e. selective, progressive and participative strategy of agricultural mechanization. Selective strategy means that the level of technology and type of mechanization should be suitable to the physical, socio-economic and cultural condition, farming system and farm infrastructure aspects. In the Progressive strategy, the level of technology will be implemented and gradually improved from low level to higher level. These changes of technology level are subjected to agricultural development from traditional into modern. In the Participative strategy level, the development of agricultural mechanization have to be done by involving agribusiness society; consumers, farmers, agricultural machinery industry and producers and banking institutions. Therefore, this development could not be handled by single institute.

Status of Agricultural Mechanization Research and Development

Indonesian Center of Agricultural Engineering Research and Development (ICAERD), IAARD-MoA was established in 1987. The mandate of this Research Institute Since are (1) to conduct research on agricultural mechanization, (2) to design and develop prototypes of agricultural machineries and tools, (3) to develop model development of agricultural mechanization , (4) to test of new prototype of agricultural machineries and tools and (5) to conduct research for policy formulation of agricultural mechanization. A number of prototypes of agricultural machineries and model development of mechanization for food crops, estate crops, horticulture and livestock has been produced and some of them has been adopted by farmer and fabricated by Industry.

In October 2003 Testing Laboratory of ICAERD has been recognized as a competent testing laboratory through accreditation based on ISO/IEC 17025: 1999 updated to ISO 17025: 2005. Various national standard of agricultural machinery consist of Test Codes-Procedures-Methods, and Minimum Technical Performance Requirement of Agricultural Machinery has been produced for national references.

Agricultural Machinery Industry

Indonesia's agricultural machinery industry in have been active since the introduction of farm machinery for estate crops particularly for sugar cane during Ducth colonial. Foundry center such as in Ceper and Tegal, Central Java has been establised to supply the machinery component for sugar industry. After the colonial era, small scale rice farming was introduced and large machinerary was not suitable for this farming system. Small machinery for rice farming from Japan was sucessfully introduced in Java, South Sulawesi and West Sumatera. Since then, agricultural machinery industry has been growing from producing implement and then producing various types of machiney. Nowdays Indonesian agricultural machinery industry has been able to produce main agriculture machinery for its own rice farming system. The production capacity of agricultural macinery in Indonesia as shown in Table 2.

Table 2 Number of agricultural Manufacturer in Indonesia and its capacity

No	**Scale of Industry**	**Number**	**Prod. Capacity (Unit/year)**	**Level of technology**
1	Large scale manufacturer	3	955.550	Medium-high
2	Medium Scale manufacturer	30	125.000	Medium
3	Small scale manufacturer	1063	15.000	Low

Indonesia exports agricultural machinery for rice farming, however the value of import is higher than its export (Table 3). The import of machinery is mainly for large machine such as four wheel tractor.

Table 3 Value of export and Import of agricultural machinery (US$)

No	**Export/Import**	**Tipe of Agricultural Machinery**	**Year**	
			2005	**2010**
1		Field machinery and tools	66 000	270000
	Export		48 992.061	53 623 679
	Import			
2		Post harvest machinery & tools		
	Export		20 000	100 000
	Import		454 027	68 104
3		Processing machinery & tools		
	Export		734 000	100 000
	Import		25 974 989	37 014 359
4		Component and tools		
	Export		546 000	1 400 000
	Import		24 416 535	48 827 070

Standardization of Agricultural Machinery

Testing and evaluation of agricultural machinery are the important aspects in the development of agricultural machinery. The objectives of testing and evaluation of agricultural machinery In Indonesia are to:

(1) Protect the consumers need
(2) Quality assurance
(3) Strengthen research and development
(4) Strengthen the growth of local agricultural machinery industry

To control agricultural machinery marketed in Indonesia, Government of Indonesia (GoI) has launched an Act No. 81/2001 refer to Tolls and Machinery for Crops Plantation. All agricultural machinery either locally made or imported must be tested before release to Indonesian market. Testing should be carried out by legal institution or testing laboratory which has been accredited. 15 laboratories have been assigned by the Ministry of Agriculture to carry out testing.

Recently there are only 2 (two) laboratories testing for agricultural machinery are in operation, i.e.: (1) Laboratory of Agricultural Machinery Testing, Indonesian Center for Agricultural Engineering Research Development (ICAERD, IAARD), Serpong; and (2) Laboratory of Agricultural Machinery Testing, Agricultural Machinery Testing and Quality Center (AMTQC – MoA), Depok – Bogor. The output of activities for these laboratories is a test report of machinery with a standard of SNI. Within a last decade till 2011, these laboratories have tested more than 1,500 unit of various machineries and about 150 test report has been released. Based on those test reports, about one third is matched to the National Standard (SNI) which is proofed by the Letter of Conformity (LC) and only 5 kinds of machinery (43 models) have received SPT-SNI.

The testing laboratories test agricultural machinery commonly used in Indonesia. The testing scope and capacity of two laboratories are listed in Table 4 and Table 5.

Table 4 Testing laboratory facility of ICAERD- IAARD, MoA, Serpong

No	Testing Laboratory	Capacity / Scope
1	Testing Laboratory for 4 Wheel and 2 Wheel Tractors	Max 100 kW
2	Testing Laboratory for Irrigation Centrifugal Pumps	Max 250 mm discharge pipe
3	Outdoor Testing Laboratory for grain post harvest machinery.	Up to 3,000 kg/hour
4	Laboratory for post harvest and processing agricultural machinery	Any food and horticultural machinery
5	Testing Facilities for sprikler irrigation and hand sprayer	Large gun sprinkler (25 m) and 25 L tank hand sprayer.
6	Other tool and agricultural machinery	From: sickles, manual pump, crusher, grass chopper, palm shredder and so on.

Table 5 Scope and testing laboratory facility of AMTQC - MoA, Depok

No	Testing Laboratory	Capacity / Scope
1	Testing Laboratory for pre and post harvest tools.	18 kinds of tools
2	Testing Laboratory for pre and post harvest machinery	68 kinds of agricultural machinery
3	Testing Facilities & Instrumentation	About 45 kinds of instrument and measuring tool

According to Government Act No. 81/2001, all machineries tested by any testing institutions should be certified by a standard procedure in order to guarantee the machinery for farmers or other users.

Closing Remarks

Development of agricultural mechanization in Indonesia is a process of technological evolution. It guides to a strategic role in the dynamic transformation from the subsistence to modern farm. Those roles are: (a) increase production and productivity, (b) increase efficiency of the process and natural resource utilization, (c) improve quality and added value of the agricultural product, and finally (d) increase income of the farm households.

In line with the development and introduction of agricultural machinery, the quality of machinery is very important. To guarantee quality of agricultural machinery in Indonesia, testing and evaluation are very important. Therefore, testing systems, networking, facilities and human resource of the testing center have to be strengthened to improve the accuracy of testing.

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AGRICULTURAL MECHANIZATION STATUS & ISSUES – MALAYSIA

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Introduction

Mechanization cover the whole spectrum of the value chains from land preparation to final processed products, particularly in the areas of primary productions, handlings, packaging, processing and waste management of crop, livestock and fishery industries. Mechanization inputs are essential not only to overcome certain operational constraint such as low and inefficient work rate, but more importantly to stimulate agricultural growth within the globalized economy.

The Third National Agricultural Policy (NAP3) emphasizes on the modernization and commercialization of the agricultural sectors to ensure its continued competitiveness. Mechanization and automation play the leading roles in the modernization of the agricultural sectors in Malaysia.

The agricultural sector, specifically the primary commodities, faces serious labor shortages. As a short term measure immigrant workers have been employed to fulfill this requirement. The long term solution to the problem is the application of mechanization and automation technology. Labor productivity in agriculture is only about 60 per cent of the labor productivity in the manufacturing sector. Increasing the mechanization inputs will reduce the labor requirement in this sector while increasing its labor productivity.

The future and targeted agricultural production situation in 2020 is highly mechanized and operated like a business entity, professionally and skillfully managed with the advantage of the economics of scale that emphasizes on productivity and competitiveness.

There are many issues affecting the application and advancement of mechanization within the agricultural sector in this country and specific strategies and action plans are needed to address and to overcome these issues.

Technology Status

Most of the technologies for crop production are available. The availability of the technologies ranges from field water management, land preparation to harvesting of the produce. The adoption of these technologies depends on the local condition and the skill of the farmer or the contractor/operator. The selection and adoption of machine size and weight in particular the prime movers and self-propel machines depend on farm and lot size as well as soil bearing capacity while the sophistication of the technology depend on the skill of the farmers or the service providers or operators. All sectors adopt the highest level in mechanization technology for land preparation. In harvesting process, only paddy production adopted the highest level of mechanization.

Utilization of Machinery in Paddy Farming

Paddy and rice processing are among the mechanization operations that have reached the highest level in Malaysia. The Malaysian Agricultural Research and Development Institute, MARDI has also experimented the precision farming technology in the major growing regions in the north, making use of sensors to optimize inputs. Other mechanized activities include:

- ***Land preparation activities***
  - Straw/weed slashing – slasher (locally made)
  - Repair and bund construction - disc ridger and rotary bund former
  - Primary tillage – poly plough and rotary tiller (rotovator)
  - Secondary tillage – rotary tiller (rotovator)
  - Land leveling and smoothing – rear bucket, scraper, rake, niplo harrow, box leveler

- ***Crop establishment***
  - Transplanting
    - Seedling preparation – tray sowing machine
    - Planting - transplanter
  - Direct seeding – knapsack power blower, spreader, row seeder
- ***Crop care and maintenance***
  - Fertilizer application – knapsack power blower
  - Chemical protection application – knapsack power sprayer
- ***Harvesting***
  - Combine harvester – recondition combine harvester
- ***Transportation*** – bulk handling (lorry – 3 to 10 ton lorry)

Utilization of Machinery in Vegetable Farming

Generally, all farm implements for conventional vegetable production are readily available in the market except for mechanized harvesting. However due to the small plot sizes involved (< 0.5 hectares), the technologies adopted are limited to land preparation and spraying. The trend now is for farmers to adopt the use of rain-shelter technology to produce high-value vegetables, especially in the highland. In the lowlands, vegetable productions are carried out mainly in the open fields. However, vegetable production especially for the export market are grown under netted structures which are not subjected to the vagaries of nature such as heavy rain, drought, high temperature and pests. The current practices in post-harvest packaging and handling of vegetables need to be improved to maintain quality and presentation.

Utilization of Machinery in Fruit Farming/Plantation

The mechanization technology for fruit production is generally available except for harvesting. This is especially so for the labor intensive production systems in star fruits and guava, where manual labor is still required in fruit wrapping and harvesting. The application of irrigation technology is picking up especially at the commercial fruit farms. The existing farms are however not planned for mechanization and the level of mechanization is generally low, especially in traditional orchards in smallholdings of less than 12 hectares that are widely scattered throughout the country.

The total area under fruits has expanded from 135,000 hectares in 1988 to 261,000 hectares in 1998. To produce high quality fruits, good management is necessary. In addition, irrigation, heavy fertilization and pest control all require high quality inputs. Various plantations have experimented with fruit farming using modern technology but have failed to venture further, probably due to the very high capital investment that are required and the high risk involved. Availability and cost of labor are the limiting factors in the production of perishable fruits.

Post-harvest losses are still high. Technology for post-harvest handling of fruits is available but automated system needs to be established in order to reduce manual labor and increase productivity and efficiency. Production and export of fresh and processed fruits, including fruit juices and dehydrated fruits is on the increase.

Implementation Problems

Most agricultural machineries are difficult to be owned by the farmers due to their high maintenance costs. Low income is another reason the farmers could not afford to have the highest farm mechanization technology and systems. They also lack skill in handling the agricultural machineries hence are more comfortable to use the traditional methods in managing their agricultural activities; otherwise they resort to the service providers.

Geographical factor is also one of the constraints in the implementation of farm mechanization in Malaysia. Most agricultural areas in Malaysia are on hilly and undulating lands. Other issues include the economics of scale as it is not efficient to mechanize small farms. Lack of infrastructure such as roads, bridges, canals and farm power in the rural areas is also a major factor.

Conclusions

For Malaysian agriculture to compete effectively in the global environment, it has to change from current method of farming to modern commercial farming. The Third National Agricultural Policy (NAP3) emphasizes on the modernization and commercialization of the agriculture sector to lower production cost and to increase labor and land productivity. Mechanization and application of engineering technologies constitute major aspects of this agricultural modernization and transformation. The success of adopting mechanization and engineering technologies is highly dependent on government policy, infra-structure, services, skills, machine quality, availability, durability, costs, etc.

AGRICULTURAL MECHANIZATION STATUS AND CONTEXT IN MYANMAR

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Ministry of Agriculture and Irrigation

Overview

Myanmar is primarily an agricultural country. After the World War II agri-machinery was introduced because of shortage of labor, and draught cattle. After gaining Independence, the government tried to promote farm mechanization jointly with Whole-sale Cooperatives by importing the farm tractors, and providing land tilling service to the farmers. Later, it encouraged forming the village co-operative and sold the farm tractors to those cooperatives. Then it established the factories which produce the agricultural tractors, spare parts and other farm machines and implements.

Mechanization Demand

After take-over at 1988, government introduced market-oriented economy, allowing the private sector to participate in external trade. Agricultural exports have risen and increase income of the cultivators in general. Thus the farmers who own large plot of cultivated land, realized the benefit of using farm machinery, began to use the agricultural machines. In addition to their own use, those farmers hired their tractors, power tillers and power threshers to other farmer to generate extra income. They also used those tractors and power tillers with trailers as a means of transportation of farm products to other villages or to towns. That is the driving force to other farmers to buy and utilize those machines for multiple purposes as well.

The traders and importers found a potential in the agricultural machinery business, so they importe machines, especially power tillers and water pumps, and sell them to the farmers. Facing with brake down of farm machineries cause farmers to learn about mechanic works. This in turns leads to the farmers giving orders to the mechanical workshops to modify the machines. From then onwards the private sector has started to be involved in the agricultural machinery by modifying and producing the machines for the cultivators.

Current status of utilization of farm machinery and equipment is listed below

Sr No	Type of Machine	Quantity
1	Tractor	11479
2	Power Tiller (Hand Tractor)	199668
3	Power Thresher	37678
4	Manual Thresher	2147
5	Inter-cultivator	155487
6	Seeder	40314
7	Reaper	1441
8	Water pump	177032
9	Sprayer	130545

Status of Manufacturing Farm Machinery

Government Sector

In Myanmar, there are three Ministries which are monitoring agricultural machinery industry in government sector. They are;

(i) Ministry of Agriculture and Irrigation (MOAI)
(ii) Ministry of Industry II (MI.II).
(iii) Ministry of Cooperative

Ministry of Agriculture and Irrigation (MOAI)

Agricultural Mechanization Department (AMD) under the Ministry of Agriculture and Irrigation has started the production of agricultural machinery since 1993. Three farm machinery factories were further established to produce power tillers and farm implements. Nowadays, these farm machinery factories manufacture various types of machines such as power tillers, mono wheel tractors, cultivating roller boats, threshers, paddy reapers, gasifiers etc. The most productive volume is that of power tillers and is annually about 4000 units.

Not only production, A.M.D distributes the agricultural machines to farmers and provides tractor hire service to farmers through the 99 Tractor Stations, farm mechanization units, under management of AMD which are located around the whole country.

For the purpose of providing repair service and maintenance of farm machineries and implement, two base workshops and eight medium workshops were also functioning under AMD.

Ministry of Industry II

Two farm machinery factories under the Ministry of Industry II manufactures farm tractors (50-70 h.p), power tillers, threshers, harrows and ploughs and machine parts in farm machinery production factories. Its annual capacity is quite low and is about 300 tractors and 1000 power tillers and some implements.

Ministry of Cooperative

Ministry of Cooperative also manufactures farm machinery and implements such as paddy threshers, seeders, weeders, water pumps and edible oil extractors from the cooperative industries under the ministry and distributes to farmers. The production capacity is also relatively low and is in hundreads numbers respectively.

Private Sector

Since 1995, the Myanmar government established a committee for the development of agriculture machinery. Then a sub-committee was formed by organizing the private industrial entrepreneurs. These private industrial entrepreneurs were given conditions; norms and standards and types of machine designed by the government. Furthermore, government laid down the production and provided training and workshops to these entrepreneurs. With the help of UNIDO, the Ministry of industry II arranged the training for entrepreneurs.

In the resent decades, there were only small-scale mechanical workshop and small industries producing the spare parts. Then the workshop started to produce paddy threshers and spare parts themselves. After that, the small industries started to cast the water pump but producing limited quantity only. As a result of market oriented economy more and more agricultural machineries were needed and so the industry started increasing the production of farm machineries.

Thresher machinery production started to boom in 1992. Nowadays, many private companies import the various kinds of farm machinery and implements and distributed to the farmers from the retails outlet of the companies throughout the country. During 2011 fiscal years, they have imported and distributed to farmers about 20000 units of power tillers and 200 units of farm tractors, and its implements.

Issues relating to manufacturing farm machinery

- In the most of government factories, new production machines and tools installed are made by China
- Inaccuracy of products occurs when the machine tools worn out within short life time
- Out of precision dimensions leads to troubles at assembling work
- Some spare parts imported from abroad can not be fixed in specified part due to importing from various sources
- Some existing machine tools are obsolete nowadays
- Old manufacturing technology does not meet the challenging demand of agricultural machinery & implements

Policy and Institutional Aspects

Regarding the agricultural mechanization development, unique principle has laid down in the new Union Institution as follows:

Article 29:

The Union shall provide inputs, such as technology, investments, machinery, raw materials, so forth, for changeover from manual to mechanized agriculture.

Article 35:

The economic system of the Union is market economy system.

Government encourages ensuring agricultural mechanization development in macro sector in the following policies:

1. -Selling the farm machinery to the farmers on credit and installment payment systems
2. -Distributing farm machinery on agricultural loan from the Myanmar Agricultural Development Bank under the Ministry of Agriculture & Irrigation
3. -Custom duty and commercial tax exemption on agricultural machinery import.

Constraints

Common constraints and challenges to develop agricultural mechanization in systematic means are expressed below;

1. Technical inefficiencies of farmers
2. Low adoption of proven facilities in cultivation
3. Inadequacy of capital of farmers
4. Insufficient extension activities of the government and private services
5. Weak agricultural information Systems
6. Small land holding size or small scale plots

Best Practices

1. Realization of benefits of practicing agricultural mechanization by farmers themselves
2. Utilization of appropriate agricultural machinery and its implements for each process of cultivation
3. Land Development works to reform mechanized farm from small land plots
4. Technical Cooperation among ASEAN, ESCAP members countries for development of agricultural mechanization

Way forward to sustainable agricultural mechanization development

1. Capacity building trainings for service personnel to refresh with new technology

2. Substitution and installation of advanced machines and equipment at government farm machinery workshops
3. Dissemination of operation, maintenance and repair of agricultural machinery to local farmers' groups
4. Establishment of rural workshops for repair of farm machinery owned by farmers
5. Technical collaboration with the private sector and international organizations will speed up the adaptation rate of appropriate technologies.

Conclusion

Proper agriculture machinery operation, maintenance and repair is critically needed for development of farm mechanization.The present capacity of the government‘s departments are limited. Myanmar's burgeoning private sector needs exposure to the latest technological development. Enhancing the capacity of both will assist to mechanize the agricultural sector.

Collaboration among various agricultural mechanization stake holders could strengthen and ensure the sustainable development toward from the national food security to regional stable prices of food and security in the near future.

STATUS OF AGRICULTURAL MECHANIZATION IN NEPAL

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Background

Nepal is a small land locked country situated in between India and China. Agriculture is the backbone of national economy, means of livelihood for majority of population, main source of GDP, income and employment opportunities in Nepal. The agriculture contributes to about 34.7% to national GDP and provides part and full time employment opportunities to 73.9% of its population (MOF 2011 & NLFS 2008). The average land holding per family across Nepal is found to be less than 0.8 hectare. Because of small land size, unavailability of the other employment opportunities in the country, majority of farmers in the country are compelled to adopt subsistence agriculture. Due to low investment capacity and lack of infrastructure & market opportunities majority of farmers are adopting traditional technology in their production system. Due to unavailability of attractive employment opportunity in the country, the majority of young people are going abroad (mainly in Gulf and Malaysia) in search of jobs. In the first eight months of F Y 2010/11, about 0.21 million youth formally went to various countries (mainly Malaysia and Gulf) to work as labour with formal approval of government. The trend of young people leaving Nepal for foreign employment is increasing every year. The number of people visiting abroad through unauthorized means taking undue advantage of open border with India is assumed to remain at large. Hence agriculture has become job of old people and that of women farmers in the village. In this context there is urgent need of appropriate agricultural mechanization in Nepal.

Status of Agricultural Mechanization

Animate power is the main source of power, in Nepalese agriculture. Human power and animal power occupies 36.3 and 40.5 percent of the total farm power available in the country respectively. The available mechanical power in the country is only 23 percent. Most of the mechanical power is concentrated in Terai, the share of available mechanical power in terai is 92.28% that of total available mechanical power of Nepal. (FBC, 2006)

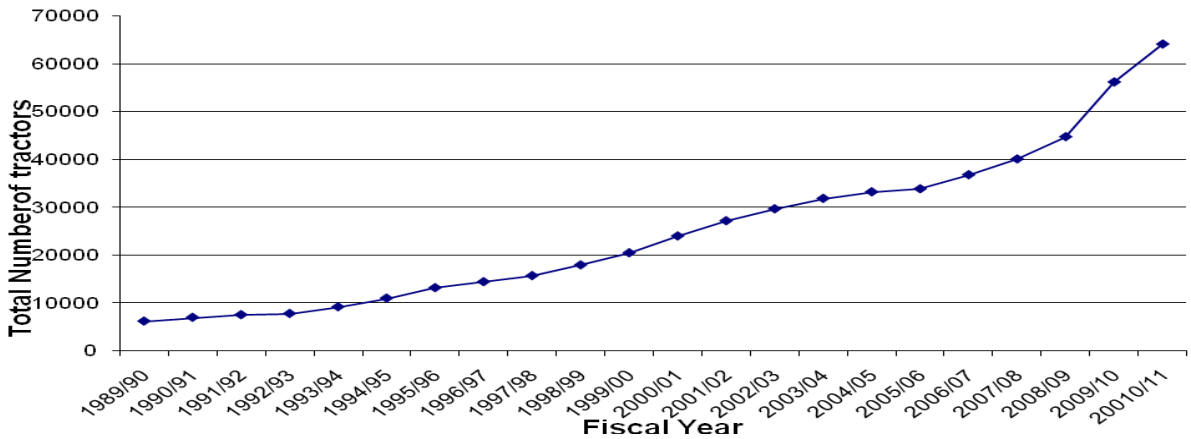
The traditional wooden tools and implements have continued to remain in use in the hills and mountains. There has been some improvement in their design and performance capabilities over time. Due to the lack of physical facilities (viz. road networks and electricity) and cultivation in narrow terraces in hilly areas; hill agriculture is mainly depended upon human and animal power. Indegeneous wooden plough, local hoes, sickle are the major implements/ tools used for agricultural operation. In hills only 2.7 percent of holdings own iron animal drawn plough for tillage. In the valleys near the road heads it is observed that farmers have started using power tiller for tillage operation and it is spreading along with the extension of rural road. Due to increasing cultivation of vegetables near uraban and peri urban areas about 3 percent of the holdings in the hills own hand sprayer.The paddy sheller and polisher and mechanical grinding mills are found to be adopted in majority of villages of terai and hills. However in the mountains, still the milling is found to be performed in local devices such as mortar & pestle, quern and traditional water mills. Attempts have made to improve more than 2000 local water mills by changing the wooden runner in to metallic one to increase the grinding capacity and to derive power for multiple processing operations (viz. hulling, oil expelling etc.).

In Terai, agricultural mechanization related tools used are manual tools, animal drawn implements and mechanical power operated machinery. Traditional farm tools and equipment are still found to be widely used in Terai. Spade, hoe, sickle etc. are major hand tools used. Animal drawn traditional power as well as improved implements are found to be used in agricultural operations in Terai. Traditional wooden plough, iron mold board plough, disc harrow, wooden plank etc, are major animal drawn implements. More than 51 percent of holding in terai own and use animal drawn iron plough

due to increased field efficiency than traditional plough and easy availability in border towns. Animal power is also widely used for threshing through tramping action. Similarly bullock carts with traditional type (wooden wheel) as well as improved type (rubber tyre wheel) is also common in Terai, as 12 percent of the holdings own bullock cart in terai. The zero tillage and minimum tillage technologies has been tested and validated by NARC and it is found to be preferred by the farmers in terai and the valleys. Major constraint is found to be the availability of machinery and governments support in promoting these beneficial implements. Diesel pumpsets are also found to be commonly used for pumping water in Terai. 4-wheel tractor as well 2-wheel power tiller is increasingly used for tillage and transportation. Use of thresher is also increasingly used for threshing operation. It is reported that labour is getting scarce during peak agricultural periods (transplanting and at harvesting rice) and their wage is increasing. From time to time, farmers are complaining on increased cost of production and reduction/unexpected fluctuation of price of certain commodities like rice, wheat, maize etc. So, some innovative farmers have imported few (20 nos) combine harvesters for custom hiring.

Number of tractors being registered with the Department of Transport Management is increasing every year. Total number of four & two wheel tractors registered had reached 64164. 4- wheel tractors in the terai and 2 wheel tractors in the valleys have brought revolution in the tillage operation and there is increasing trend on the adoption of tractors in Nepal and the trend of tractor use in agriculture is given in Figure 1.

Fig. 1: Cumulative Number of Tractors Registered in Nepal



Agricultural Mechanization Related Institutions

Agricultural Engineering Division under Nepal Agricultural Research Council, Agricultural Engineering Directorate under Department of Agriculture and Purbanchal Campus, Institute of Engineering under Tribhuvan University are major research, extension and education institutions related to agricultural mechanization in Nepal respectively.
Blacksmiths are the primary suppliers of agricultural traditional hand tools in the country. It is estimated that more than 85% of tools/implement used by the farmers especially in hilly areas are made/repaired by the blacksmiths/rural artisans (Manandhar, 1998). Major problems of the blacksmiths are lack of capital, good quality raw material, coal and knowledge on improved technology.

There are also several small metalworking industries in Nepal mainly involved in the production of small tools & implements and the tractor attachments, milling equipments etc. hand hoe, plough, threshers, feed mill, feed mixture, tractor/ power tiller trailer, case wheel, oil expeller, sheller mill, treadle pump etc. are found to be fabricated by these small metalworking industries on demand basis. Even though there is demand of agricultural tools and implements in the country, they are not in the position to supply due to the lack of favorable policy, technical capability and financial constraints. Tractor dealers dealing with different brands of tractor are promoting their tractor and attachments

among farmers through their marketing network in Nepal. Only few dealers have their own service workshop for after sales service. Majority of the tractor dealers are found to be focussing on tractor sale only they have least interest on the sale of tractor attachments. High interest rate on agricultural machinery, lack of awareness on the benefit of agricultural machinery, insurgency situation in terai are major problems faced by agricultural machinery dealers and retailers. The importers have also raised problem regarding the high custom duty and value added tax (VAT) during import of agricultural equipments. Five-year time bar for the transfer of ownership of tractors and power tiller is also realised as one of the constraints for the availability of credit from other commercial banks other than ADBN.

Agricultural Mechanization Policy

The prevailing major agriculture related policy (viz. Agriculture perspective Plan (APP), Agriculture policy, 5year and 3 year plans etc.) is silent on agricultural mechanization. Because of this, investment on agricultural mechanization and institutional set-up and efforts on agricultural mechanization in Nepal is found to be weak. Hence a clear-cut policy and strategy on agricultural mechanization needs to be formulated. Similarly other related policies and legislations (land reform, transport, energy, irrigation, agricultural extension, industries, road, transport, labour sector etc.) need to be reviewed and streamlined. Because of the demand of appropriate policy, at present Ministry of Agriculture is working to prepare agriculture mechanization Policy.

Issues and Constraints Related to Agricultural Mechanization

- Small and fragmented land holding with subsistence level of agriculture is the major constraints for promotion of agricultural mechanization in the country.
- Since, women farmer has got dominant role in crop production activities (except tillage and marketing) their contribution is rarely recognized and their drudgery problem is not addressed.
- The lack of access road & electricity distribution lines in the farm; nearby market facilities, repair and maintenance workshops facilities etc. are the few infrastructure related constraints for mechanization and commercialization of agriculture in Nepal.
- Even though, there is extension of credit institutions in Nepal, the interest rates are found to be more in rural sector than in urban sector (viz. housing loan, car loans etc.). Many co-operatives and micro credit institutions have been evolved in the villages, but they need awareness on co-operative farming for intensification and commercialization of agriculture with appropriate mechanization.
- As the farm holding size socio-economic background of Nepal is diverse and is mainly dominated by small farmers and poor farmers, the mechanization need to be focused on appropriate mechanization technologies addressing the needs of different category of farmers and at different agro ecological zone and cropping system.
- The major technological constraints in farmer's perspective are difficulty in availability of spare parts, lack of training on operation and maintenance of farm machinery, inadequate facility for servicing and repair of farm machinery. Moreover the cost of spare parts is also reported to be high.
- The blacksmiths are the deprived group in the community and their indigenous skill and technology is at the verge of extinction from the community, due to lack of commercialization and modernization of their skills as well as lack of recognition of their contribution by the community and the state.
- Custom hiring of farm machinery (tractor, power tiller, combine harvestor, thresher, sprayer etc.) is taking place in an informal way in each village without any support from government.
- Due to lack of clear-cut policy on agricultural mechanization, the agricultural mechanization is not found to be streamlined as per the need of the farming communities and national development goals on commercialization of agriculture in Nepal.

- Even though the progressive farmers in the hills and terai are in search of appropriate agricultural tools and machinery, but they fail to get in the local markets. Farmers of terai are in search of rice transplanter, tractor drawn seeding equipments for bold grain crops (maize, rajma, chick pea etc.), power weeders, efficient multi crop threshers, small scale processing equipments etc. Similarly the progressive farmers in the hills are in search of efficient animal drawn implements, single yoke harnessing system, efficient hand tools, small mechanical power tillage technology in the hills and small fruit and vegetable processing equipments. R & D system in Nepal could not respond effectively to meet their demand for adaptation and development of appropriate equipments to meet their demand.
- Agricultural Engineering Division (AED) and Agricultural Implement Research Center (AIRC) under NARC and directorate of Agricultural Engineering under Department of Agriculture are to be strengthened for effective R & D and the promotion of appropriate mechanization in Nepal.
- For the sustainable development of agricultural mechanization in Nepal, it is needed to locally fabricate widely used agricultural tools, implements and machinery. However, the prevailing policy does not favor production of agricultural machinery locally (high custom duty of raw materials, no support in promotion, irregular power supply, high electricity cost, poor research & testing support etc.). Hence there is need of reform in policy and program to encourage and support local fabricators to fabricate/ manufacture agricultural machinery locally.
- There is need of testing and standardization of agricultural machinery to reduce the accidents related to agricultural machinery and to provide quality standard agricultural machinery to the Nepalese farmers.

Intervention areas

In spite of low level on present status of agricultural mechanization there is urgent need on appropriate mechanization in the country to bring down the cost of cultivation, address the agricultural labour shortage in the villages, support intensification and commercialization in agriculture for the food security as well as for enhancing the socio economic condition of farmers in the country. There is urgent need for the interventions in following areas for the promotion of agricultural mechanization in the country.

- Formulation of Appropriate Policy and Institutional Reform for Agricultural Mechanization
- Development/ Adaptation & Promotion of Efficient Hand Tools, Animal Drawn Implements, small horse power hand tractor for hills, Efficient Processing Machinery and Conservation Agriculture.
- Promotion of Land Consolidation and Cooperative Farming
- Public & Private Partnership for promotion of Agricultural Mechanization

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MECHANIZING PHILIPPINE AGRICULTURE FOR FOOD SUFFICIENCY[1]

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Introduction

Agriculture is one of the prime movers of Philippine economy. The country has abundant raw materials that can be used to produce a wide spectrum of products for food, feed, and industrial applications. About 32% (9.56M has) of the total land area of 29.817 million hectares is under intensive cultivation, where 51% and 44% are arable and permanent croplands, respectively (Figure 1, BAS, 2010). In 2010, the major agricultural land utilization by area harvested is devoted to palay, corn, coconut, fruits and vegetables as presented in Table 1 (BAS, 2010).

Of the 94.01 million population with a rate of 2.04% (NSO, 2010), about 86% lives in the rural areas. Seventy-five percent (75%) of them depend on agriculture for employment and income. Although about 32% of the employment share comes from agriculture, many Filipinos remain unemployed or underemployed.

In 2010, the agricultural sector alongside fishery and forestry, contributed to about 12% of the gross domestic product (GDP) of PhP 9,003 Billion and accounts for about 8% of the county's export revenues (PhP 185 billion FOB)(BAS, 2010). The present condition of agriculture to the export market can be improved and expanded to include non-traditional products and processed products. There is a high potential of generating labor and livelihood activities in the areas of agricultural products and by-products processing, expansion of areas for cultivation, and intensification and diversification of agricultural production systems. These potentials however, are being hindered due to lack of appropriate agricultural engineering and mechanization technologies.

The application of environment-friendly and suitable technologies can possibly enhance and sustain cultivation of an additional eight million hectares. The introduction of environmentally sound agricultural machinery will, among others, enable the agricultural sector to fully utilize farm products and by-products; cultivate uplands, hilly lands, swamplands and other non-arable lands on a sustained basis; intensify and diversify farming systems which will, in turn, generate employment; conserve or even earn foreign currencies through local manufacturing and export of agricultural engineering technologies; reduce or minimize postharvest losses; increase the value added to farm products through secondary and tertiary processing; reduce pressures in the environment and help bring equity to the access of basic production resources.

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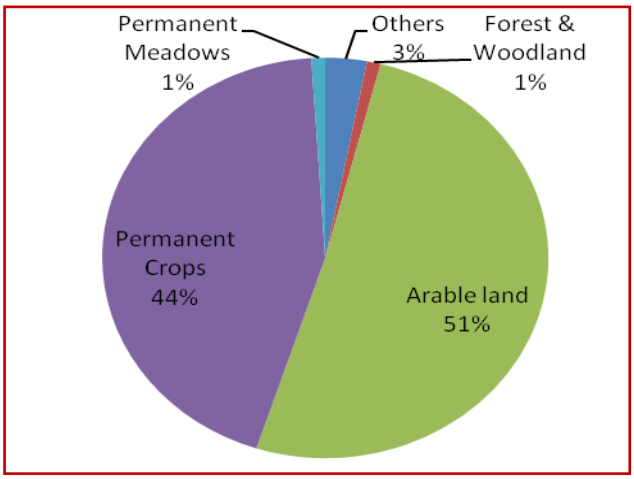

Figure 1 Distribution of agricultural area by type of utilization.
Source: BAS, 2010. Facts and Figures on the Philippine Economy

Table 1 Agricultural production of the Philippines, 2009

(Year 2009) Crop	**Area (Has)**	**Value (Million PhP)**
Palay	4,532,310	238,353.57
Corn	2,683,896	76,952.29
Coconut	3,401,500	64,663.12
Sugarcane	404,034	29,906.86
Fruits	714,245	118,759.70
Rootcrops	330,373	17,068.40
Legumes	66,893	1,831.62
Vegetables	65,387	12,321.80
Fiber	135,081	2,355.04
Coffee	122,645	5,528.91
Cacao	9,538	-
Tobacco	26,104	3,057.74
Rubber	128,337	13,227.92

Source: Bureau of Agricultural Statistics.2009. http:countrystat.bas.gov.ph.

With the new government in place, efforts are being exerted to increase the production of agricultural products in the countryside. This intensified effort from the agricultural sector can reduce the dependence of the country on importing basic food products and expanding its capacity to export agricultural products. In 2010, the major agricultural products exported were coconut oil (31%), banana fresh (8%), tuna (9%), pineapple and products (6%). Major markets include the Netherlands, USA, Japan, Germany and Iran. The total value of agricultural imports on the other hand, was PhP 334 billion which accounted to 13% of the total import. The top agricultural imports were rice (22%), milk and cream and products (8%), wheat (7%) and soybean oil/cake meal (5%) (BAS, 2010).

Present Farming Conditions

Soil Conditions

The Philippines has 15 regions with different soil characteristics which are as follows:

a. Well drained High fertility soil: Region 4
b. Well drained, generally acidic, high fertility volcanic soils: parts of Region 4
c. Well drained, deep, low fertility soils: most of Regions 1,2,3-5, 8-15
d. Poorly drained, flood prone soils: parts of regions 2-4, 6, 10-12
e. Poorly drained, high to moderate fertility soils: parts of Regions 3, 5, 6, 11, 12
f. Heavy textured soil with shrink-swell potential: parts of Regions 1-4, 6, 11, 12
g. Droughty, low fertility sandy soils: Parts of Regions 3 and 6.

Irrigation and Drainage

Irrigation and drainage play an important role in producing agricultural crops in the country. In 2002, about two million farms (41.1 percent of the total farms in the country) with a total area of 2.9 million hectares were supplied with water, or 30.3 % of the total farm area of the country. Individual system of irrigation is most common which supplied water to 660.8 thousand farms with an irrigated area of one million hectares. The national irrigation system administered by the National Irrigation Administration (NIA) followed next, which covered 774.7 thousand hectares of farms while communal irrigation system came in third, supplying water to 581.5 thousand hectares of farms. There were other systems of irrigation used by farms such as water fetching, waterwheels, etc., which supplied water to 522.8 thousand farms with a total irrigated area of 573.6 thousand hectares (NSO, 2002).

Cultivation System

The average landholding of farmers in the country is around 2 hectares with plot sizes ranging from 500 to 10,000 sq. meters (NSO, 2002). There are around two cropping seasons implemented by farmers per year with rice as the main crop and some cash crops or leguminous crops as the second crop. In areas where water is abundant throughout the year, three croppings are being observed

The main draft animal used in land preparation operation is the carabao with a single native moldboard plow trailing behind. This system is used in land preparation for rice and corn. It is also utilized in coconut growing areas when the area is being intercropped with corn and other agronomic crops. In recent years however, the use of two wheel tractor has been increasing. Most farmers especially those that are growing rice and corn which are the staple food of Filipinos use 2wheel tractors for land preparation operations. For sugarcane plantations however, four-wheel tractors are being utilized. The main tillage implement used are as follows: for draft animals- native moldboard plow; for power tillers- disk plow, single moldboard plow, rotary tillers; for four wheel tractors- moldboard plow, disk plow, disk harrow, rotavators.

Availability of Labour

Although the country is experiencing a soaring population, the available labor in the farm has been decreasing over the years. In 2008, there were 12.03 million persons employed in the agriculture sector which accounts 35% of the total employment in the country and about three-fourths were male workers. In 2010, it went down to 11.96 million persons accounting to 33% of the total employment share (BAS, 2010). It is also interesting to note that the average age of farmers is about 57 years old. In the CALABARZON region, most of the farmers involved in the farm ages 41 years and older consisting of about 65% and this proves that the active farmers are aging as shown in Figure 2 (Amongo, 2011).

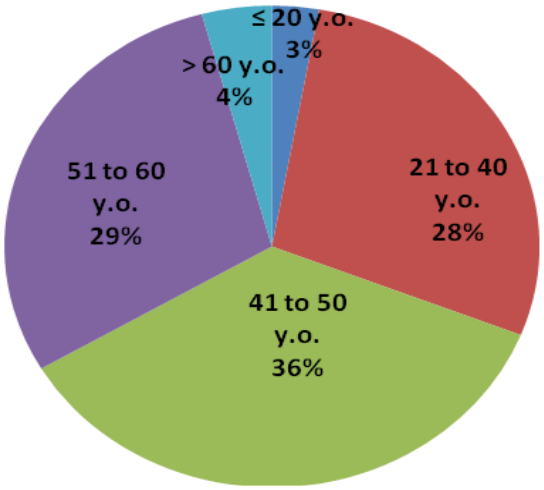

Figure 2. Age distribution of farmers in CALABARZON region.
Source: Amongo, 2011

Present Situation of Agricultural Mechanization

Levels of Mechanization

In the Philippines, there are three major levels of mechanization according to UPLB-BAR, 2001. These are as follows:

1. Low mechanization which means that the operations are done with the use of non-mechanical power source such as man and animal.
2. Intermediate mechanization which means that the operations are done with the use of non-mechanical power source in combination with the use of a mechanical power source operated by man.
3. High mechanization which means that the operations are done solely with the use of mechanical power source operated by man.

A fourth level considered is full mechanization, which means that the operations are done with the use of mechanical power source with limited human intervention such as computerized machines or robots.

In spite of the various advancements in mechanization technologies, the level of agricultural mechanization in the Philippines in terms of available mechanical power in the farm is still low at 1.68 hp/ha (Rodulfo & Amongo, 1994) compared to other Asian countries such as Japan, Korea and China.

The level of agricultural mechanization in the different farming operations of selected crops is shown in Table 2. In rice and corn production, only land preparation and threshing are done with the use of mechanical power source operated by man, while milling operation is highly mechanized. The use of locally fabricated, imported or second hand (imported) hand tractors in plowing and harrowing operations has increased over the years. Threshing is done using axial flow threshers powered by diesel engines while cleaning and bagging are done manually. At the farmers' level, sun drying is still the predominant method of drying in multipurpose pavements (e.g. basketball courts) and rakes for mixing palay, although some farmers are using the flatbed dryers. Traders and millers who buy wet palay from farmers utilize mechanical dryers (e.g. continuous flow or batch recirculating dryers). Rice milling operation is done using rubber roll rice milling machines by small-scale rice millers, while big rice millers utilizes modern and energy-efficient rice mills.

For corn production, harvesting is done manually although in clustered farms, there is an effort to introduce mechanical harvesting. Dehusking is either done manually or through the use of a husker sheller. Shelling is predominantly done using mechanical shellers while drying is done through sun drying or with the use of flatbed dryers or other mechanical dryers.

Table 2 Mechanization levels in various operations of selected crops

Operation	Rice & Corn	Vegetables Legumes & Root crops	Coconut	Sugarcane	Fruits	Fiber Crops
Land Prep	Intermediate to High	Low		Intermediate to High	Low	Low
Planting/ Transplanting	Low	Low	Low	Low to Intermediate	Low	Low
Crop care cultivation	Low	Low	Low	Low to High	Low	Low
Harvesting	Low	Low	Low	Low		Low
Threshing/ shelling dehusking	Intermediate to High	Low (Legumes)	Low			
Cleaning		Low				
Drying	Low	Low (Legumes & Rootcrops)	Low			Low
Milling/Village level processing	High	Low	Low		Low	Low

Source: PCARRD, 2009

The predominance of manual operation and absence of mechanical power in the production of other crops yields a lower level of mechanization than those of rice and corn. However, the level of mechanization is high for sugarcane, pineapple and banana due to the presence of imported machines for large-scale operations of multinational corporations. Although harvesting is still done through manual labor, there are attempts to introduce mechanical harvesters, especially in large-scale sugarcane plantations. The other postharvest and processing operations are mostly done using mechanical machines.

Distribution of Farm Machinery

Table 3 shows the data of the census of major farm machinery in the Philippines in 2002. There had been a rapid increase in the utilization of hand tractors from about 200,000 units in 1998 to 1.5 million units in 2002 because of the need at that time to produce more food for the increasing population.

Table 3 Census of major farm machinery in the Philippines, 2002

Farm Machinery	Number of Units
Plow	2,723,850
Harrow	1,643,325
Sprayers	1,941,050
Hand Tractor	1,526,557

Source: Bureau of Agricultural Statistics.2002. http:countrystat.bas.gov.ph.

Farm Machinery Manufacturing

There are around 350 identified agricultural machinery manufacturers and dealers in the country as shown in Table 4. Sixty nine percent are located in Luzon, 11% in the Visayas and 20% in Mindanao. About one-third of them are based in the National Capital Region. Many of these agricultural machinery manufacturers and dealers are not organized except for a few who are members of the Agricultural Machinery Manufacturers and Dealers Association (AMMDA) with only about 30 members.

A mixture of importation and local manufacturing characterizes the local agricultural machinery manufacturing industry. Four-wheel tractors and engines are wholly imported (Table 5). The demand for four-wheel tractors has increased in the last four years and is estimated to be 500 units per year. The increase in the demand may be due to the competitive price of sugar in the world market and the increasing production of yellow corn for animal feeds. Another potential use of the four-wheel tractors are the recent developments in the production of raw materials for alternative fuels such as sugarcane and Jatropha (Canapi, 2010).Tractors with 90 Hp are at the forefront of land development of crop plantations for alternative fuel.

Other machines such as power tillers, pumps, transplanters, seeders, weeders, reapers, and postharvest equipment are locally manufactured. However, these manufactured machines have high import content since the engines, electric motors, gearboxes, bearings, chains, sprockets, cold roll steels and perforated sheet metals are all imported.

Table 4 Distribution of agricultural machinery manufacturers and dealers

REGION		NUMBER	PERCENT
Luzon:	I	18	5.1
	II	22	6.2
	III	35	9.9
	NCR	113	31.9
	IV	29	8.2
	V	27	7.6
Visayas:	VI	30	8.5
	VII	2	0.6
	VIII	7	1.9
Mindanao:	IX	13	3.7
	X	18	5.1
	XI	19	5.4
	XII	21	5.9
TOTAL:		354	100

Source: AMTEC Data 1999

Table 5 Sales of agricultural machinery by AMMDA (as of January 2009)

MACHINE	Brand	YEAR				
		2006	2007	2008	2009	Total
Tractors						
Standard (>32 hp/ 23.87kW)	John Deere, Valtra, Kubota, Daedong, Massey Ferguson, New Holland, Same, and Eurostar	195	242	182	10	629
Compact (≤ 32 hp/ 23.87kW)			1	10	2	13
Combined Standard & Compact Tractors		195	243	192	12	642
Two-wheel Tractors						
Pull Type	Fieldstar Orec Kuliglig Kato	1608	552	485	28	2673
Floating		314	49	44	4	411
With rotary			75			
Postharvest/ Structures and Farm Processing Equipment						
Reaper	ACT, Kuliglig, Kato	2	100			102
Rice Thresher		1020	8	45	18	1091
Corn Sheller		6	9			15
Farm Trailer				55		55
Rice Mill		71	61	207	6	345
Dryer						
Flatbed Type	Fix, Casareno, KOLBI, Kuliglig, Kaneko, ACT	7	1	5		13
BPRE Type	PADISCOR	7	1	3		11

Source: PCARRD, 2009

Agricultural Machinery Testing and Evaluation

The Agricultural Machinery Testing and Evaluation Center (AMTEC) of the College of Engineering & Agro-industrial Technology (CEAT), University of the Philippines Los Baños (UPLB) was established in 1977 to ensure the standard quality of agricultural machineries being distributed in the country. Its main job is to establish technical standards and test the machines to meet these standards. However, testing of machines is voluntary and only manufacturers participating in government bidding for agricultural machinery are required to submit their machines for testing. Further, AMTEC is not mandated to issue certificates of performance on machines tested.

Figure 3. AMTEC Facilities for agricultural machinery testing.

AMTEC has been active in performing its role. To date, about 152 standards were developed and adopted through the leadership of AMTEC. Moreover, 263 machines (Figure 3) were tested from 2006 to 2009 which consisted of prime movers, irrigation machinery, production machinery and postharvest equipment (AMTEC, 2010).

Maintenance and Repair System of Farm Machinery

The manufacturers and dealers of various farm machineries offer after sales services. These services come in the form of parts replacement and guarantees. To some extent, they also provide free service and repair. The government also conducts training on operation, repair and maintenance (ORM) of machines as part of its extension activities. The Agricultural Mechanization Development Program (AMDP) of the Institute of Agricultural Engineering (IAE), College of Engineering & Agro-industrial Technology (CEAT), University of the Philippines Los Baños (UPLB) is one of the government agencies that conduct training on ORM of agricultural machineries.

CEAT established the Agricultural Mechanization Development Program (AMDP) in 1979 in response to the project of the United Nations Development Programme (UNDP) implemented by the Economic and Social Commission for Asia and the Pacific (ESCAP) named then as the Regional Network for Agricultural Machinery (RNAM) and now known as the Asia and the Pacific Center for Agricultural Engineering and Machinery (APCAEM). The program remains an essential activity of CEAT with APCAEM being the Philippine representative in the promotion of technical cooperation among developing countries for the advancement of agricultural mechanization in Asia and the Pacific. AMDP serves as the research and extension arm of CEAT which conducts policy formulation, research, development and extension (RDE) of agricultural mechanization technologies. It has assisted various levels of government through its RDE activities and manpower training.

Particularly, AMDP had developed tools, implements and/or technology packages for rice, corn, coconut, cassava, fiber, vegetables, livestock production and processing, technologies for farm waste treatment and management, and technologies on renewable sources of energy; and drilling equipment for shallow tube irrigation. The shallow tube well technology then became the centerpiece of the Agricultural & Fisheries Modernization Act of 1997 (AFMA). Some of the technologies developed by AMDP included the UPLB hand tractor, village-level rice mill, cassava lifter, UPLB drilling rig, manual corn sheller, motorized corn sheller, multicrop dryer, oil expeller, forage chopper, whole-nut cashew sheller, corn mill, organic fertilizer applicator, mini-hand tractor, windmill, village level ethanol production system, and corn planter.

AMDP had conducted various training programs such as trainors' training for the DA Agricultural Extension Workers on the operation and maintenance of agricultural machinery; and training for agricultural machinery manufacturers. Moreover, it has published and disseminated journals namely, the Philippine Agricultural Mechanization Journal (PAMJ) and the Philippine Journal of Agricultural and Biosystems Engineering (PJABE). These publications provided the researchers, extension workers and students with the recent developments in agricultural engineering and machinery. The PJABE is the only refereed journal in the Philippines on agricultural and biosystems engineering.

CEAT/IAE-AMDP's participation to APCAEM (formerly RNAEM) has been proven beneficial in terms of manpower development through attendance in training, study tours, regional workshops, and seminars on agricultural mechanization. It has provided a venue for technical cooperation among the member agencies in terms of prototype exchange of agricultural machinery; exchange and sharing of accumulated experience of the National Institutes; access to valuable and up-to-date publications and information on agricultural mechanization, information and communication technology networking among member countries; and access to the RNAM testing codes for the improvement of the quality of agricultural machinery for increased efficiency and environmental and safety standards.

AMDPs RD&E efforts developed a pool of experts, engineers and technical staff with expertise in design, development and testing of agricultural technologies; packaging of technology for extension effective delivery system; publication of journals on agricultural and bio-systems engineering; continuing collaboration/ networking and providing policy recommendations for the improvement of the agricultural sector the country.

At present, the current RDE efforts of AMDP focused on corn mechanization, high-value commercial crops (HVCC) mechanization, farm power and renewable energy mechanization, and other special projects towards the promotion of agricultural mechanization utilization/adaptation in the country. The list of current AMDP projects is shown in Appendix A.

Cooperative and Financing System

The Cooperative Development Authority (CDA) in the Philippines is tasked to deal with the formation and promotion of cooperatives in the countryside. Credit for agricultural machinery may come from bank or non-bank sources. The non-bank source comprises mostly of machinery dealers and landlords. Manufacturers and distributors also extend in-house credit which requires a 50% downpayment. The remaining balance is payable after the first harvest, where the machine cost is mainly based on the list price which is 20% higher than the cash price. The government banks or financing institutions such as the Land Bank of the Philippines (LBP) and the Development Bank of the Philippines (DBP) grant loans to farmer cooperatives for the acquisition of different farm inputs including farm machineries. These banks also grant loans for livelihood programs related to the processing of agricultural commodities for food and other products.

Enacted Laws that Support the Advancement of Agricultural Mechanization

Basically, the main targets of agricultural development in the Philippines are the farmers and fisherfolks in the countryside. These are the people who produce the country's basic food requirement and the raw materials needed in the industrial sector.

In the past, various agricultural policies were enacted into laws to ensure the delivery of various goods and services for the development of the agricultural sector in the country. Among the most popular laws that were enacted are the Comprehensive Agrarian Reform Law (CARP) of 1988 and the Agriculture and Fishery Modernization Act (AFMA) of 1997. CARP is pursued to promote social justice among landless farmers/farm workers and to move the nation toward sound rural development and industrialization. On the other hand, AFMA is pursued to modernize the agriculture and fisheries sectors of the country to enhance their profitability and prepare these sectors to the challenges of globalization through an adequate, focused and rational delivery of necessary support services.

Another law, known as the Biofuels Act of 2006 was enacted to reduce the country's dependence on imported fuels with due regard to the protection of public health, the environment, and natural ecosystems consistent with the country's sustainable economic growth that would expand opportunities for livelihood. The law mandates the use of biofuels as a measure to develop and utilize indigenous renewable and sustainably-sourced clean energy sources to reduce dependence on imported oil, mitigate toxic and greenhouse gas (GHG) emissions; increase rural employment and income, and ensure the availability of alternative and renewable clean energy without any detriment to the natural ecosystem, biodiversity and food reserves of the country. With this law, greater potentials were opened for the agricultural industry to produce the raw materials that would be used in producing biofuels. This also opens the opportunity of utilizing mechanization technologies in biofuels production and post production processes.

To date there is a pending bill for legislation on agricultural mechanization which would rationalize the implementation of agricultural mechanization in the country.

Current Government Efforts Toward Food Sufficiency

The recent worldwide problem on food, energy and environment has led to different scenarios in the Philippines. In 2008, the price of rice has soared to its highest level in 34 years, causing social and political unrest. The price of rice in the Philippine market soared to $ 1.15 per kilo in March 2008 from as low as 50 cents few weeks earlier. This period also made most of the urban poor line up in the streets to buy rice. Thus, millions of Filipinos faced food insecurity and hunger.

To address this problem, the government provided stop gap measures. One of which is the importation of rice from other countries like Vietnam, Thailand and the United States amounting to 2.2 million tons. The government also imposed lower tariffs and doubled the import quotas to encourage more participation from the private importers (Grenfell, 2008). The Department of Agriculture planned to improve the agriculture sector by launching the program "FIELDS" meaning -- F for fertilizer, I for irrigation and infrastructure, E for extension and education, L for loans and insurance, D for dryers and other post-harvest facilities, and S for seeds in the middle of the rice crisis. This is to give assistance to rice farmers and other stakeholders in the rice industry and billions of pesos were allotted for this emergency agricultural program. The private sectors were also encouraged to practice corporate farming or to ensure that employees are given rice subsidies through planting of rice by the country's biggest corporations (Palatino, 2008).

However, some government officials were saying that the rice crisis was just an artificial phenomenon. They blame it to rice hoarders and smugglers for distorting rice inventories in the country. They believed that the Philippines is only experiencing a rice distribution crisis and that supply is stable. Many speculations came out because of the soaring price of rice. Some says that this is a political matter. Others say that it is a rice cartel scenario. Peasant groups on the other hand, believed that rice importation is the reason behind the worsening rice crisis and placing the country in greater food insecurity.

With the new government in 2010, the DA has rationalized its different units to address the current flagship program of the government in agriculture particularly to attain food sufficiency. The government launched the program Agri-Pinoy - Food Staple Sufficiency (FSS) Program. This program does not focus only on rice and corn but also on other root crops and plantain and consider these crops as critical for food and income security. It considers self-sufficiency to include policies that drive a wedge between the domestic and the world price of rice. With the FSS Program, they estimated the supply and demand of rice in the next 5 years which is expected to soar up as presented in Figure 4.

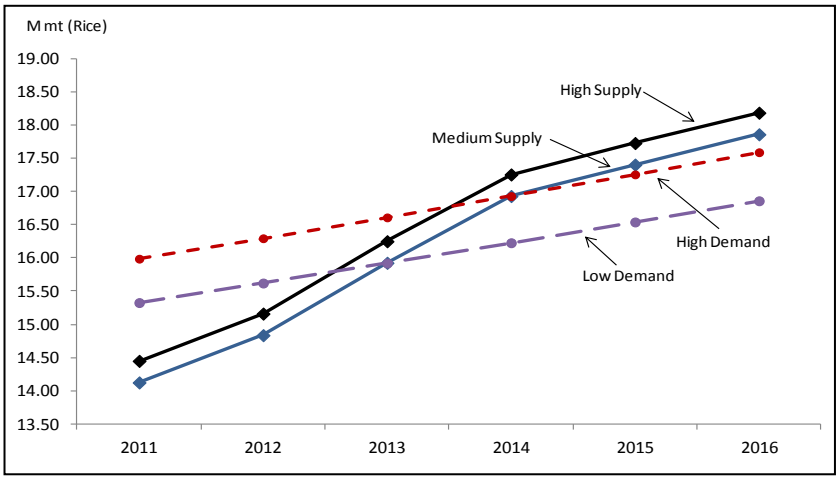

Figure 4 Rice supply and demand estimates, 2011-2016
Source: DA Rice Program, 2011

The FSS program aims among others the upliftment of productivity and competitiveness of farmers by enhancing economic incentives and enabling mechanisms to achieve food sufficiency. It also envisions to manage food staples consumption and strengthen the program management and implementation.

To enhance productivity and competitiveness of farmers, the FSS program include the generation, rehabilitation, restoration, and modernization of irrigation facilities; promote access of farmers to quality seeds be it inbred or hybrid seeds; promote R&D activities through Location Specific

Technology Development (LSTD) and Impact Assessment and Policy Researches; ensure timely farm operations and reduce labor cost thru on-farm mechanization (tillers, transplanters, harvester-threshers); minimize losses in the drying and milling operations using mechanical dryers and modern rice mills. On the other hand, the enabling mechanism to implement the program needs market reforms by strengthening the price support and procurement policy of the government through its line agency, the National Food Authority. It must also strengthen its credit and insurance facilities for easier availment by the farmers and other stakeholders (DA Rice Program, 2011).

According to the Philippine Center for Postharvest Development and Mechanization (PhilMech, 2011), there are three national major policy/programs needed to achieve rice self-sufficiency by 2013. These are: expansion of production area and irrigated land; improvement of productivity (yield) through provisions of HYVs, fertilizer, ESETS, mechanization, etc.; and reduction of postharvest losses. PhilMech is mandated to take the lead role in implementing the different plans and programs of the government in mechanizing the agricultural sector to increase yield and to attain food sufficiency. Among its goals are: to enable rice farmers to increase their access and use of appropriate production and postproduction systems and to be able to realize added income for farmers of at least 15% from efficient production activities, drying and milling operations. To achieve its goals, PhilMech plans to implement the provision of farm mechanization facilities and equipment to Farmer Associations (FAs). Primary machineries such as hand tractors,4-wheel tractors, threshers; ssecondary machineries such as seed cleaners, reapers, drum seeders, mini combine harvesters and combine harvesters; and postharvest facilities such as dryers and multi purpose drying pavements will be made available to FAs in the form of grant under counterpart scheme. Moreover, rice milling system such as rice mills, warehouses and other milling facilities will be made available to farmers through the counterpart scheme and private millers through soft loans. The physical target of the Center is shown in Tables 6.

Table 6 Farm mechanization physical target of PhilMech for 2012-2016

Farm Machinery	Total
Primary	
Hand Tractor	31,000
4-Wheel Tractor	500
Thresher	10,333
Secondary	
Seed Cleaner	1,800
Drum Seeder	4,000
Reaper	3,000
Combine Harvester	80
Mini Combine	80
Postharvest Facilities	
Mechanical dryers	3,253
Multi purpose drying pavements	3,577
Rice mills for farmers	329
Rice mills for private millers	125
TOTAL	58,076

Source: PhilMech, 2011

Another government institution, the NFA supports the program of the government on rice sufficiency. Among the programs of NFA is the implementation of the NFA Grains Highway to improve the postharvest situation and reduce production and postharvest losses. The grains highway is defined as "the supply chain that links production, post harvest and marketing activities in both the major rice/corn production and consumption areas, including their support infrastructure for the efficient delivery and timely movement of quality grains and cereals from the farmers to ultimate consumers." These facilities will be established in major rice producing and distribution areas. The objectives of the program are to: improve and broaden the base to reduce post-harvest losses; facilitate the inflow of rice

and corn at any time; make the rice and corn quality requirement available to traders and consume; eliminate wide price fluctuations in the market and wide gaps between supply and demand; and allow access to NFA warehouses and other post-harvest facilities to small and medium scale food businessmen (Navarro, 2007).

The Philippine Grains Postproduction Consortium (formerly Philippine Rice Post Production Consortium) is an alliance of 5-government agencies and the International Rice Research Institute as collaborating agency, concerned with grains postproduction research and extension to address numerous problems of the grains industry. The government member agencies are the Philippine Center for Postharvest Development and Mechanization (PhilMech), National Food Authority (NFA), Philippine Rice Research Institute (PhilRice), the University of the Philippines Los Baños (UPLB), and the National Agricultural and Fishery Council (PGPC Brochure, 2011).

Problems, Issues and Constraints in Agricultural Mechanization and Recommendations

There are many problems and issues besetting the implementation of agricultural mechanization in the country. Many experts have analyzed the various factors that interplay in the success or failure of mechanizing the agricultural sector. Among others, these included:

Absence of a comprehensive national program for agricultural mechanization development.

The country has fragmented policies and programs aimed at only one or few aspects of agricultural mechanization. Although there are efforts of the government to create a body in charge of coordinating and orchestrating the various efforts being done by the government and private sectors toward the development of agricultural mechanization, there has been no comprehensive national program that will address the problems of agricultural mechanization. These efforts should be integrated and molded into a national program for agricultural mechanization to create the desired impact on the country's agricultural development.

The present mandate given to the Philippine Center for Postharvest Development and Mechanization (PhilMech) on mechanization is envisioned to integrate mechanization efforts for the agricultural sector in the country. This will be reinforced by the present bill on agricultural and fisheries mechanization which will give various research and development agencies (including AMDP) to have their respective roles concerning mechanization.

Inadequate coordination of agricultural mechanization R&D activities.

At present, various government agencies and private sectors involved in agricultural mechanization conduct separate R&D activities that lead to duplication of efforts and misuse of resources. Moreover, only few have been done on the comprehensive assessment of the status, resources available and needs for agricultural mechanization. Hence, there should be an in-depth study of the status and needs for agricultural mechanization in the country to come up with an appropriate strategies for its successful implementation.

Small farm sizes

Small farm sizes and fragmented farms have always been the issue in the implementation of an economically sound agricultural mechanization strategy. Small farm size defies the principle of economies of scale and would not produce the volume needed for bulk processing. Hence, land consolidation or farm clustering should be encouraged for efficient utilization of agricultural machinery. It should be noted that most countries implementing successful mechanization programs like Japan, Korea and Thailand, have consolidated their farms for a systematic, synchronized farming operations with the help of agricultural mechanization technologies that increased their agricultural and labor productivity and efficiency in performing farm operations.

Inadequate extension program and technology transfer mechanisms

The benefits derived from agricultural mechanization are still unclear to most farmers in the countryside. The education and training of farmers, operators and even extension workers are inadequate and need intensification from both government agencies and machinery manufacturing firms. Extension workers together with the machinery manufacturers are agents of change, hence they should be well-equipped in extending agricultural mechanization technologies. They must have the interpersonal communication skills as well as the technical qualifications (Paras & Amongo, 2004).

Moreover, the results of R&D do not reach the intended end-users and, therefore, could not create the necessary impact in the countryside. The breakdown of many machines in the field is mainly due to the lack of training of machinery operators. Hence, there should be a massive information campaign together with the formulation of a comprehensive program that would encourage the use of farm machinery in the countryside. Extensive demonstrations and training on the operation, repair and maintenance of agricultural machinery at the farmers/operators' level should also be undertaken to promote the adoption and use of mechanization technologies. Moreover, agro-industrial extension for the manufacture of agricultural machinery especially outside the NCR should be a continuing effort.

Inadequate support services

The demand for agricultural machinery is greatly dependent on the availability, cost, and ease of obtaining credit. The limited credit for machinery from government credit programs has resulted in the sales of agricultural machinery on a cash basis. Nonetheless, the purchase of agricultural machinery through credit via the commercial banks is no longer viable because of the high interest rates. Even where there is a credit facility available, the long and tedious processing of loans discourages both farmers and manufacturers/distributors. Also, the lack of comprehensive program in agricultural mechanization limits the acquisition of farm machinery through credit from cooperatives. Further, groups of farmers who are not members of cooperatives have no access in acquiring machines through credit.

There should be a comprehensive program to encourage acquisition of farm machinery outside the cooperative to allow small groups of farmers in availing such technologies. Aside from this, farmers, manufacturers and rural entrepreneurs should also be encouraged to join cooperatives and associations that have the leverage to transact business with government lending institutions and guarantee the repayment of loans. Aside from credit support, the government should also establish support facilities that would take care of after sales services and effective marketing systems to ensure the machines' acceptability to farmers to further promote the use of agricultural machineries in the country.

Other support system from the various line agencies of the government especially those that directly involve in the agricultural production system have been in place. It is hoped that continued government support and interventions coupled with the appropriate investments on environmentally sound and appropriate agricultural mechanization technologies will improve productivity, income of stakeholders, reduce postharvest losses of rice and corn and other agricultural commodities to achieve food sufficiency.

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Appendix A. List of AMDP on-going projects

College/ Unit	Title of Project	Project Leader/In Charge
Corn Mechanization Sub-Program		
AMDP- IAE, CEAT	Design, Fabrication and Test of a Push-Type Fertilizer Applicator for Side Dressing	JC Orozco
AMDP- IAE, CEAT	Design, Fabrication and Test of a Push-Type Corn Planter	JC Orozco
AMDP- IAE, CEAT	Development of Corn Sheller for Seeds (High Moisture Sheller)	A.C. del Rosario
AMDP- IAE, CEAT/ w/ CA-FSTP	Development of Small-Scale Corn Machinery and Equipment for FSTP	J.D. De Ramos A.C. del Rosario
AMDP- IAE, CEAT	Design and modification of mini corn mill	VA Rodulfo, Jr.
High Value Commercial Crops Mechanization Sub-Program		
AMDP- IAE, CEAT	Development of a technology package for cassava flour processing	RS Pangan
AMDP- IAE, CEAT	Development of a low-lift pump utilizing locally available materials to be attached to a savonious windmill	RS Pangan /JD De Ramos
AMDP- IAE, CEAT	Establishment of HVCC Production Farm Training Center Utilizing Appropriate Mechanization Technologies	RS Pangan/BC Geronimo
AMDP- IAE, CEAT	Development of Production Machinery for the Production of Organic Fertilizer	RSPangan/BC Geronimo
AMDP- IAE, CEAT	Design and development of mechanization technologies for Adlai and Peanut	J.D. De Ramos A.C. del Rosario
Other R&D Projects		
AMDP- IAE, CEAT	Design and development of a pneumatic dryer for agricultural by-products	VA Rodulfo, Jr.
AMDP- IAE, CEAT	Characterization of selected feedstocks (jatropha, oil palm, adlai)	MR Santiago
AMDP- IAE, CEAT	Design and Development of Mechanization Technology for *Jatropha* waste and by-products processing	MR Santiago
AMDP- IAE, CEAT	Optimization of the citronella oil extraction facility	VA Rodulfo, Jr. RS Pangan J.D. De Ramos
AMDP- IAE, CEAT	Socio-economic and mechanization profile of the corn production-processing system of the Calamba project site **(with R&D and Extension component)**	MVL Larona MC Bueno
AMDP- IAE, CEAT	Updating the level of mechanization collaborative activity with PHILMECH (Proposal Stage)	RC Amongo VA Rodulfo, Jr. MVL Larona A.C. del Rosario
Faculty-based Projects		
ABPROD-IAE, CEAT	Rice Hull/Corn Cob Furnace for Non-Power Applications	AR Elepaño EV Casas
PHRTC & ABPROD-IAE, CEAT	Mechanization of Heat Treatment of 'Carabao' Mango for Quarantine Disinfestation and Disease control	KF Yaptenco JD De Ramos
AMD-IAE, CEAT	Design and Installation of a Micro-Hydro Generator	RC Amongo

College/ Unit	Title of Project	Project Leader/In Charge
		AL Fajardo RLCatriz
AMD-IAE, CEAT	Anthropometric Survey of Farmers for Agricultural Machinery Design in the Calabarzon Areas	RC Amongo MC Petingco
LWRD-IAE, CEAT	Evaluation of the sustainability of a drip irrigation system and its potential in increasing the level of mechanization in a corn-based farm in Kay-Anlog, Calamba City	MG Villano AL Fajardo
Extension Projects/Activities		
AMDP- IAE, CEAT	Field Testing of Multicrop Pneumatic Planter (Modification of Fertilizer Applicator)	BC Geronimo JC Orozco
AMDP	Introduction of Corn Mechanization Technologies in Region 7	AC Del Rosario JD De Ramos MC Bueno
AMDP	Corn Production and Processing Mechanization Program in Region IV (Calamba City)	MCBueno
AMDP	High value crops and Corn Production and Processing Mechanization Program in Region IV Introduction of mechanization technologies for white corn production in Bondoc peninsula	BC Geronimo RS Pangan
AMDP	Pilot testing of the AMDP Corn Mill for Food and Feed Milling in Pilot Area	VA Rodulfo, Jr. MC Bueno
AMDP	Publication of the Philippine Journal of Agricultural & BioSystems Engineering (PJABE); Philippine Agricultural Mechanization Bulletin (PAMB); other extension materials (e.g. leaflets, posters in tarpaulin, etc)	RC Amongo JL Movillon EK Peralta RB Saludes AA delos Reyes MV Larona
Dean's Office/ AMDP	Publication of the CEAT Newsletter	RC Amongo MVL Larona Dept/Div Coordinators
AMDP	Promotion of AMDP developed agricultural mechanization technologies • Production of audio/visual presentation for AMDP • Publication of printed materials for information dissemination of agricultural mechanization (brochures, leaflets, posters, etc.)	MC Bueno BC Geronimo MR Santiago/MC Bueno MVL Larona/MR Santiago
AMDP	Conduct of symposiums/conference	MR Santiago MC Bueno MVL Larona
AMDP	Establishment of network/collaborative activity with local manufacturers	VA Rodulfo, Jr. MVL Larona MC Bueno
AMDP	Development of the AMDP Website (effective July 2010)	JD De Ramos MVL Larona
AMDP- IAE, CEAT/ w/ CA-FSTP	National Implementation of Farmer Scientist Training Program (FSTP) collaborative project with FSTP-College of Agriculture	J.D. De Ramos A.C. del Rosario

MECHANIZATION STATUS IN SRI LANKA

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Introduction

Democratic Socialist Republic of Sri Lanka is an island lying close to the South East coast of the Indian sub continent. Its land area is 64,630 square kilometers and for administrative purpose the country is divided in to nine Provinces. The total population is nearly two million.

Agricultural Background

The country is predominantly a agricultural based country and agriculture plays a dominant role in the economy in terms of food security, value addition, employment generation and export earning. The total arable land area is about 1.887 million hectares and out of that about 1.0 million hectares is under permanent plantation crops mainly tea, rubber and coconut. Annual crops , such as paddy, maize, sugar cane, green gram, vegetables, finger millets cover about 0.887 million hectares. About 38 percent of the economically active population is engaged in agriculture contributing 19 percent of GDP where as the contribution to the GDP by service sector is about 53 percent.

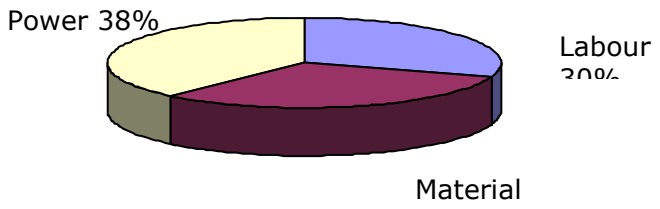
The island receives rain mainly through two monsoons. The rainfall intensity varies across the country due to its geographical features where tall mountains located in the centre and the plains located around the central hills. There are four distinguish climatic regions namely, the wet zone (annual rainfall more than 2500 mm), the dry zone (annual rainfall less than1750 mm), the intermediate zone (annual rainfall less than 2500 mm and more than 1750 mm), and the arid zone (annual rainfall less than 1000 mm).

Rice is the most important food crop, occupying nearly 29% of the total agricultural land in Sri Lanka and provides the livelihood of the peasant agricultural sector and maize has become the second major crop. The paddy is grown in two seasons in most part of the country and other crops also grown in two seasons.

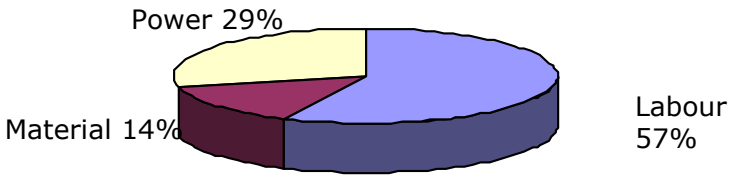
The labour scarcity for agricultural activities gradually becomes a serious problem and if immediate remedial measures are not taken, the percentage of the population engaged in agriculture will further decline and output targets laid down in the policy papers could not be achieved.

Cost of Cultivation

Cost of cultivation of paddy in large scale cultivating are and small scale cultivation area is different. In the latter case it is very labour intensive activity and in large scale cultivation recently introduced machinery, specially combine harvesters, are used. Introduction of efficient small scale machinery and implement is necessary to improve the productivity of small scale farmers.

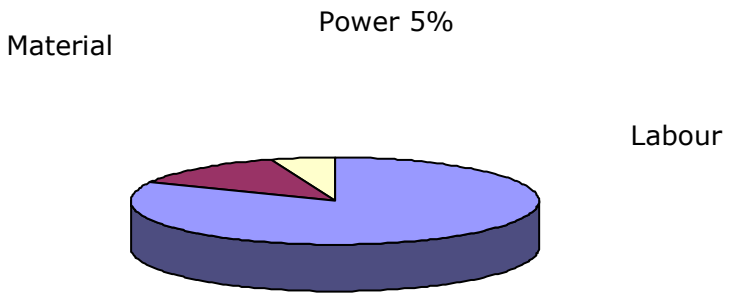


Cost of production of paddy in large scale



Cost of production of paddy in small scale

The major component of the cost of cultivation of vegetable and other field crops is labour. In chilli cultivation it is relatively very higher and accounted 82% of the total cost. Mechanization has to play a major role to solve the labour scarcity problem prevailing in this field.



Cost of cultivation of Chilli

Mechanization Status

Land Preparation

Power tiller with rotovator is the commonly used land preparation machine in both lowland and highland in the country. However in large scale cultivation, specially commercial growers and highland maize cultivation areas four wheel tractors (with disc plough or tine tiller) are used. The population of four wheel tractor is considerably lower than the power tiller population. The riding type 12 hp tractor version is the most popular power tiller because of its riding facility and comparatively high field capacity. Use of animal power and manual power is still practiced in the areas where mobility problems and accessibility problems exists.

Irrigation

Most of the paddy fields are fed by gravity irrigation system which is systematically arranged throughout the country since more than 2000 years back. However new irrigation schemes are being constructed to facilitate water to the dry zone areas by utilizing the excessive rainfall receives in other

parts of the country. In other field crop cultivation and vegetable cultivation areas centrifugal type small size (3 hp – 5 hp) engine driven pumps are commonly used.

Low cost power tiller driven axial flow water pumps are being used specially in the Eastern province to irrigate paddy fields in the absence of surface irrigation facilities not available.

Micro irrigation systems are being introduced and being popularized in protected agricultural techniques. However the use of micro irrigation systems is confined to specific places.

Crop Establishment

Majority of the farmers still practice hand broadcasting of pre-germinated paddy. This practice is not suitable for crop management and use for mechanical harvesters. In this process the application of chemical herbicides is necessary and this will result an environmental pollution issues. There are other social implications as well.

Two types of direct seeding machines for paddy have been introduced recently and gaining popularity. There are many advantages in use of seeders. Reduce the application of chemical herbicides by protecting environment, use of harvesting machines in harvesting and increased yield (10% - !5%) are some of the benefits of seeder-weeder combination.

Transplanting of rice is almost not practiced due to lack of appropriate transplanting machines. However research is being done to modify the existing manual transplanter to reduce the drudgery involved with the machine and to develop semi mechanized or self propelled transplanter. Possibility to introduce imported transplanting machine having the recommended planting space is also being investigated.

Box type paddy seeder
(For band sowing)

Drum type paddy seeder
(For hill sowing)

Seeders for planting highland crops, especially for maize, have been developed and introduced and gaining popularity. The following types are available for technology dissemination.

- Two wheel tractor drawn highland seeder
- Manually operated highland seeder
- Manually operated seeder for small size seeds
- Tractor drawn rolling injector planter

Weed control

To minimize the use of chemical herbicides by protecting environment, the cono weeder, developed by IRRI, has been slightly modified and introduced. However because of the drudgery involved with the operation of this implement, a motorized rotary weeder has been developed and yet to be introduced after thorough testing.

Cono-weeder

There is no efficient weeding tool to use in highland farming except the use of power tiller rotovator as an inter-cultivator in maize cultivation. The use of this cultivation is limited because of the row spacing of other crops. An appropriate motorized weeder has a very high potential among the farmers and it is an urgent need.

Use of two wheel tractor rotory as an inter-cultivator

Harvesting and Threshing

In the Eastern province where the paddy cultivation is done extensively in large size plots, the majority of the farmers use large scale combine harvesters imported mainly from India. In other parts of the country reaper windrower and backpack type modified brush cutter is used in paddy reaping followed by combine thresher for threshing. Though, the use of dryers is necessary after use of combine harvesters, appropriate dryers yet to be introduced. As a result of inadequate drying of rice, the quality is deteriorated when storage.

Combine thresher

Combine Harvester

Processing and value addition

Various types of processing machines for seed production and for end products have been developed.

Onion seed extracting machine

This machine is designed to extract seeds from dried onion seed bulb. It is a simulation of hand rubbing system. The machine is powered by a single phase electric motor

Seed Graders

Manually operated and electrical motor driven seed graders have been developed and are being used by research stations in production of breeder seeds.

Groundnut decorticators

Two type of decorticators can shell the groundnut for consumption and also for seeds. Manual operated machine has the capacity of about 50 kg per hour and the electrical motor driven machine has fairly a large capacity.

Maize shellers

Most of the farmers practiced traditional maize shelling techniques which consumes more labour and also it was very tiresome. The quality of the produce was also very poor. As a result of converting maize cultivation as a commercial business, second to the paddy cultivation, newly introduced shellers are being used.

Pulse Processing Machine

Farmers can earn more income if the produce is sold to the market as a value added product. The pulse processing machine is designed to grade, de-hull and split the pulses.

Drying & Storage

The Institute of Post Harvest Technology has introduced new dryers and effective storage systems for paddy and other crops. Adaptation of this technology is yet to be done.

Mechanization Policy

Testing & Evaluation of Farm Machinery

The National Testing & Evaluation centre, Farm Mechanization Research Centre of the Department of Agriculture is entrusted to conduct tests and certify the appropriate farm machinery. At present, the certificate issued by FMRC is not a compulsory requirement for import and distribute farm machinery. However most of the machinery suppliers are volunteered to get tested their products in order to verify the performance. Combination of the test codes and procedures formulated by RNAM, Indian Test codes and Japanese test codes are being used in testing of the machines.

Farm Machinery Act

There are many acts in effect in the field of agriculture like seed certification act, plant protection act, and land use act etc. A draft of fatm machinery act has been prepared and submitted to the Ministry of Agriculture in order to get approved by the government. The purpose of *The Farm Machinery Act* is to regulate the sale and distribution of Farm Machinery or parts . *The Act* is applicable to leases as well as sales. *The Act* provides legal guidelines for warranties, sales contracts, emergency parts service and compensation claims. It will protect farmer, distributor, dealer and environment

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STATUS OF AGRICULTURAL ENGINEERING IN THAILAND

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Abstract

Thailand is one of the world suppliers in agricultural production. Approximate 41% of the total area (210,377 km^2) of the country is under agriculture; of which about 105,020 km^2 are paddy lands. The total population is about 61 million and approximate 60.4% live in the rural areas and most of their earning by farming. Mechanization plays more important roles in the present Thai agricultural production system. Thai government has enhanced the mechanization development plan which had firstly been included in the Seventh National Economic and Social Development Plan (1992-1996). In the Eighth (1997-2001) and the Ninth (2002-2006) National Economic and Social Development Plan, the mechanization policy is not explicitly stated like in the previous two Plans. The general objective of developing the agricultural sector was to improve capacity to complete in agricultural production by promoting the replacement of human labour by agricultural machinery. At present Thailand is under the Tenth Plan. No mechanization development plan or programme clearly state in the policy. Nonetheless, several policy issues need support from agricultural engineering and machinery technologies. Agricultural engineering and machinery technology on post harvest and food processing have a quite importance role to play in the implementation of the strategies project "Local Community Product" which mostly dealing with the processing of agricultural produces.

Research and Development on agricultural engineering are conducted by the Department of Agriculture and universities in corporation with local manufacturers. Thai government has established some policy to promote research and development in industry by joint corporation with researchers in universities and National Science and Technology Development Agency. The extension of agricultural machinery is conducted by the Department of Agricultural Extension whereas, the Department of Agriculture corporate with local manufacturers.

Introduction

The survey conducted by Office of Agricultural Economics in 1995 to 1999 indicated that average farm size declined from 4.2 to 3.71 hectare/household. The farmers in the Central plain region had the highest farm size, followed by farmers in the Northeast, the South, and the North. Farmers in the Northeast have the highest owner operated holding area per farm, followed by farmers in the Central Plain, the South, and the North. Farmers in the Central Plain have the highest rented holding area per farm. Thus, the problems facing each region are different. Problems of land rent mostly occur in the Central Plain. Most farmers in the Northeast have their owned land, but, they face problems of poor soil conditions and high risks from climatic variations. Two crops a year is a common practice in rice cultivation in the area under irrigation. Some area in the central plain utilized under ground water can accomplish five crops in 2 years. In the past time water buffalo and cow were draft animals popularly used in cultivation system for land preparation. Nowadays they are found very few and only in the remote rural area. Almost of cultivation system is under mechanized. Various kinds of tillage implements are used differently in land preparation depending upon crop, tilling purpose and area. For paddy field in the irrigated area, disk plow equipped to two-wheel tractor or small four-wheel tractor is generally used at present and followed by rotary tiller. Moldboard plow is also used but in a declining number. For field crop, disk plow, disc harrow, spring-loaded cultivator, and rotary tiller are used, commonly equipped to big tractor. There are several methods of rice planting depending upon area and labor condition. Transplanting methods is a major practice for seasonal crop. While broadcasting and direct seeding are general practices in high land or rain-fed area. Every method is most done manually.

From the Agricultural Engineering Research Institute (AERI), Department of Agriculture survey in crop year 1999-2000, it shows that paddy was harvested by manual using sickle 57.2%, by combine harvester 35.2% and by reaper 7.6%. Threshing is mostly done by using power thresher about 88.3%. After harvest, farmers usually sell their product immediately at high moisture content. Sun drying is still a prevailing method for paddy drying. However, as an increasing number of combine harvester in a past few year, it burdens large amount of high moisture paddy to market at peak in a short period especially in the second crop. This leads to an increasing number of dryer to solve the problem.

Status and Trends of Agricultural Machinery in Thailand

Farm machineries in Thailand are essential in land preparation. For dry land soil preparation mainly large four-wheel tractors with disc tillers are used while locally made power tillers (8-12hp) are popularly used for the wetland cultivation. In some area, farmers have changed their planting practice from transplanting method direct seeding method by using rolling injection planters or seedling transplanted essentially in maize and soybean land. In the harvesting process of rice, the adoption of local rice combine harvesters has been rapidly expanding during last decade. In addition, sugarcane harvesters and corn combine harvester were used in custom service since 1995.

In 2000, The distribution of selected farm machinery which are power tiller, the small four-wheel drive tractor, the large four-wheel drive tractor, irrigation pump, power thresher, power sprayer and rice combine harvester, approximately 1.75 million units, 150,383 units, 183,704 units, 2.32 million units, 12,400,187 units, 76,386 units, 3,000 units respectively (OAE,2000)

Over the past two decade the agricultural machinery manufacturing industry in Thailand has become relatively modernized. Starting with the production of non-mechanical animal-drawn equipment, local manufacturers have developed the capability to supply the growing demand for new types of power-intensive machines, such as two-wheeled tractors (power tillers), threshers, agricultural sprayers and water pumps. Such machines are now produced on a relatively large scale along with other machines such as farm trucks. Prompted by new demands for further productivity, the manufacturing of more sophisticated, control-intensive machines has recently been taken up by some companies. At present, the majority of farm machines used are locally produced. Only the large tractors, 75% of engine powered sprayers and 30-40% of irrigation pumps are imported (Kiatiwat, 1996). The local production for the last two items trends to increase every year. The 217 manufacturers surveyed by the Agricultural Engineering Research Institute (former Agricultural Engineering Division), Department of agriculture, and the Thailand Institute of Science and Technology Research in 1987 were grouped into the following three categories with reference to the number of workers employed:

1. Small - up to 10 employees -100 manufactures or 46%
2. Medium - more than 10 and up to 30 employees -74 manufactures or 34%
3. Large - more than 30 employees -73 manufacturers of 20 %

These are located in different regions but mostly in central plain around capital, Bangkok. Presently local agricultural machinery industry is capable in producing machines to fulfill the needs of farmers. The annual turn over of this industry is about US$ 240 million, This includes the production of three joint venture Thai-Japanese small diesel engine manufacturers (Kiatiwat, 1996)

Therdteppitak reported in 1998, during the past decade, the agricultural machinery industry in Thailand has grown rapidly both in production volume and product development. Due to the impacts of low crop price and economic stagnation in recent years, there is a big drop in sales of agricultural machinery in Thailand. Anyway the recovery is expecting to come very soon. Approximate annual production in 2001-2002 of some major agricultural machinery and equipment in Thailand is given by the following:

1.	Small diesel engine	100,000 units
2.	Small gasoline engine	400,000 units
3.	Two wheel tractor	80,000 units
4.	Disc plow for two wheel tractor	150,000 units
5.	Disc plow for farm tractor	5,000 units
6.	Water pumps	50,000 units
7.	Rice-harvester combines	600 units

The importation of agricultural machinery is still the important player to satisfy the farmers and agro industry sector for more sophisticated advanced and high technology machinery and equipment. Four-wheel tractors are the major import item with the quantity about 5,000 units, in which 70% is used tractor. Used tractors below 40 HP are imported from Japan and higher power tractor from UK. The brand-new tractors are imported from UK, Japan, China, Italy etc. Others import machinery are as follow:

1. Pre-harvest machinery such as irrigation system, power sprayer, weeder etc.
2. Post-harvest machinery such as sugarcane harvester forage cutter and baler,
3. Agro industry machinery such as poultry, cattle and dairy machinery etc.

Trend and future of agricultural machinery in Thailand, Due to the present socio-economic condition of the country, farm labor shortage has become a critical problem in most agricultural operations. Undoubtedly demand for agricultural machinery and equipments will be in increasing but the expansion rate will differ from region to region, particular agricultural operations and machinery types. Other important factors on crop price and government policy must be taken into consideration.

There will be a growing market for four wheel tractor of less than 40HP with rotary implements which will replace two wheel tractors for rice cultivation in the central plain region and the lower part of the northern region. Due to labor shortage during harvesting season, especially for paddy rice and sugarcane, most farm owners or farmers are looking forward to an appropriate and high efficient harvester. It is quite obvious that agricultural mechanization in Thailand is at the turning point from labor intensive machines towards control intensive machines such as planting machines, irrigation system machines, powered sprayers, combine harvesters, dryers using biomass fuel, silo and storage handling, advanced and high quality rice mill machines etc. Eventually these machines will be rapidly adopted by farmers or proprietors. However, much effort should be taken to develop modification and adjustment to suit the local condition.

Government Policies

Thailand started its first Economic and Social Development Plan in 1961. By the end of the 2nd plan, 1971 the development in terms of basic necessities, namely irrigation, electricity and transportation resulted in increased production. However, although there was an increase in the GDP, a study on the income of population revealed an increased gap of among population of different occupation and areas within the country. Thus in the 3rd Plan (1972-1976), the Government concentrated on income generation and social equality including emphasis decrease population growth rate, improving agricultural institution and price guarantees of agricultural produce. Due to unsuccessful outcome during the past 14 years, the 4th Plan (1976-1980) was set to solve basis and urgent problems facing the nation. The strategies among others included.

1. increase in agricultural production potential,
2. improvement in the industrial structure to export oriented industries, thus promoting income generation as well as increase rural employment,
3. decrease the population growth rate, and
4. enhance science and technology development rate.

As for the attempt to reduce the population growth rate, the government had succeeded appreciably. Is should also be observed that working population had increase, particularly in the last decade though

the active population had not increased. In addition, the population engaged in industry in crease to a considerable extent in the last two decades.

Throughout the First to Third plan (1961-1976), the goals for increasing agricultural production were achieved by increase of agricultural use area. But during the fourth and Fifth (1981-1986) plans, the strategy was to increase agricultural production by the development and use appropriate technology e.g. increased production per unit of land, improving cropping system, livestock improvement etc.

During the Sixth National Economic and Social Development Plan (1987-1991), the national agricultural mechanization policy was included with the general objective of developing the agricultural sector to increase productivity. In accordance with the general objective, the activities involved were expected to achieve the following.

1. Farmers will have machines for their production at low cost.
2. Agricultural machinery must be good quality in terms of price and maintenance cost.
3. Agricultural machinery must be appropriate for use under various conditions in the rural areas.

During the Seventh National Economic and Social Development Plan (1992-1996) mechanization plays an important role in agricultural production. Labour shortage and the necessity to reduce production cost have obviously shown off. However, it was the first time that agricultural machinery was named as one of necessary inputs for the agricultural production system of the country. Two immediate objectives concerning mechanization as follows:

1. Improvement of the productivities of local manufacture:
    - 1.1 Promote and support research and development of agricultural machinery to suit various farming condition.
    - 1.2 Render technical assistance to private manufacture and promote the collaboration between concerning public and private agencies.
    - 1.3 Promote standardization and quality control of agricultural machinery by mean of testing, evaluation and certification services.
2. Strengthening of research and extension of appropriate agricultural machinery to farmer in order to increase agricultural productivity and farmer's income:
    - 2.1 Promote training on selection, operation, maintenance and repair of agricultural machinery to extension officials and farmers.
    - 2.2 Promote long term credit loan to small manufacturers to improve their productivity and farmers in purchasing appropriate machinery.
    - 2.3 Promote agricultural machinery custom hiring services.
    - 2.4 Support farmers and private sector in invention of small appropriate agricultural machinery.

In the Eighth (1997-2001) and the Ninth (2002-2006) National Economic and Social Development Plan, the mechanization policy in not explicitly stated like in the previous two Plans. The general objective of developing the agricultural sector is to improve capacity to compete in agricultural production by promoting the replacement of human labour by agricultural machinery.

The current plan is the Tenth Plan which will be implemented at a time of great economic volatility, rising oil prices, rising inflation, political uncertainty and higher expectation and demands for state services. The Plan will focus on 'human' as center of development efforts. Three main elements are accentuated: sufficiency economic, sustainable development, long-term planning vision spanning the next 20 years to provide 'change management'.

One of the policy statement of the council of Misters delivered by General Surayud Chulanont, Prime Minister of the Kingdom of Thailand to the National Legislative Assembly on Friday,3 November 2006 on economic policy as follow:

The Government's economic policy will be based on the philosophy of "Sufficiency Economy." Among other things, this means making use of moral principles to lead economic development under the free market system. This so as to drive the grassroots economy, which can be likened to the taproot of the nation, the market economy and the overall economy so that all sectors contribute to economic expansion in an adequate and sustainable manner. The emphasis will be on the leading role of the private sector and the latter's synergy with the public and civil sectors

The Government policies and strategies relate to agricultural engineering are as follows:

Promote agricultural development based on the "New Theory" as an important alternative for small farmers; at the same time, expand opportunities for product development and improve product quality through the use of technology, management and access to markets;

Local Community Products will be supported so that they are recognized by consumers as quality products in line with their market potential, whether at the regional, national or export levels; this can be accomplished through the establishment of an integrated project management system that will improve technology and management as well as provide market support;

Small and Medium Enterprises (SMEs): make use of the public-private sector alliance to increase the effectiveness of, and thereby strengthen, all SMEs through science and technology and management; in addition, special importance will be give to those SMEs that make use of intellectual property;

Promote energy efficiency, energy saving, the development and use of alternative energy, the survey and development of domestic and international sources of energy-including the joint development areas with neighboring countries-the use clean energy, and appropriate price structure for energy and restructuring of the management of energy affairs by ensuring that there is a clear division between energy policy-making and regulation, and promoting long-term competition in the energy business as well as research and development of alternative energy.

Future Plan for Agricultural Development

According to the prediction result, agricultural areas will continuously decrease, which can cause reduction in total productivity unless the yield per area is improved.

Additionally, due to the increase in the numbers of farm household, average farm size is reduced, which will make the amount agricultural production per household decrease in the future. Furthermore, the increasing labour demand in non-agricultural sector will make the total number of agricultural population decrease in future. In order to cope with increased productivity both the land-saving technologies and lobour saving technologies should be developed and applied.

Land-saving technologies are referred to technologies that can increase the production per unit area or yield/area. Most of these technologies involve genetic, fertilizer, weed and pest control and water resource management.

Labour-saving technologies are referred to technologies that can increase the production per unit labour or yield/man-hour. Most of these technologies involve any means that can help farmer to work faster, in other word, help the farmer to manage wider area within the same time.

Government Organizations

The government organizations involved in Agricultural Engineering, Food Chain Management and Agro-base enterprise development are:

1. Agricultural Engineering Research Institute (AERI), Department of Agriculture, Ministry of Agriculture and Cooperatives is responsible for research and development on agricultural machinery,

agricultural process and providing technologies as well as services to government and private agencies involves.

2. Post-harvest and Products Processing Research and Development Office, Department of Agriculture, Ministry of Agriculture and Cooperatives is responsible for conduct research, study and develop technology on post-harvest, processing, extraction of natural substances, and packaging and analysis, test and inspection of agricultural produce and products.

3. The National Bureau of Agricultural Commodity and Food Standards (ACFS), Ministry of Agriculture and Cooperatives was established on October 9, 2002. This is to designate the National Bureau of Agricultural Commodity and Food Standards (ACFS) as a focal organization to control agricultural products, food, and processed agricultural products by certifying and enforcing standards from food producers to consumers, to negotiate with international partners in order to reduce technical barrier to trade (TBT) and to improve and enhance competitiveness of Thai agricultural and food standards.

In June 17, 2003, the government cabinet approved the Ministry of Agricultural and Cooperatives to found Food had resolution to found the Laboratory Center for Food and Agricultural Co., Ltd. ("LCFA") for the purpose of centralized laboratory facilities service and export reference lab service and information support for agricultural & food product exporter. LCFA operates under direct supervision of the Ministry of Agriculture and Cooperatives and signed MOU with Department of Livestock Development, Department of Fisheries and Department of Agriculture to provide lab services, complement and cooperate with competent authorities to issue "Health Certificate" under "One Stop Service" concept . In addition, LCFA also signs an MOU with Central Sciences Lab (UK), a central lab of the UK government for information and staff exchange and project work.

LCFA provides service with world class standard approach to lab test in each specific product requirement to comply with export market destination. In addition, LCFA also provides lab service for monitoring and general lab services according to customers' requirement and for import clearance with Thai FDA. Our seasoned scientists in each various specialized lab; chemistry, biology, and physical product testing lab, coupled with our advanced equipments, can provide timely service with reasonable price to assist customer in various areas.

LCFA established to be a focal point of reference lab information for Thai exporter to search for export requirement and get update on market trend for exporter. LCFA is proud to be one of the mechanisms to support exporter from six branches around Thailand.

4. Office of Agricultural Economics, Ministry of Agriculture and Cooperatives is responsible for collect data of agriculture and agricultural economic. Then, analyze data and report to government and public.

In the year 2005 Bureau of Agricultural Development Policy and Planning, Office of Agricultural Economics (OAE), has set for Agro Economic Zone plan which is set up as "Area Approach". Implementation of the plan has applied to all country, plus more than 6.8 thousand Tombon (sub-districts) level, in each particular area provinces through Thailand. According to the plan of Area Approach will respond to Thai Government Strategy that would be helping to increase ability in agricultural competitive capability. The extension on cultivation will educate to farmers how to choose the suitable plants to accompany with the resources in the area. Aiming for better field crop production, harvesting and activities of management of the farming in each area that would bring about to reduce cost and also increase more income to all farmers. Therefore, the capacity of competition has spread to agriculture sector and industry sector. Besides, the Area Approach plan is classified to 12 important agricultural products to Tombon (sub-districts) level throughout Thailand.

5. Farm Mechanization Sub-Division, Department of Agricultural Extension is undertaking about extension activities.

6. Thai Industrial Standard Institute (TISI), Ministry of Industry is responsible for standardization of agricultural machinery.

7. Thai International Cooperation Program (TICP), Ministry of Foreign Affairs
Since 1963, TICP, formerly DTEC, has been responsible for the technical cooperation which Thailand provides to other developing countries, as well as mutual assistance programs organized among developing countries. Many of these activities are funded entirely by the Thai government. However, some are paid for by foreign governments. At present, Thailand provides technical cooperation to other developing countries under the scheme entitled "The Thai International Cooperation Program" (TICP).

Activities performed under the TICP banner include development projects, missions, awarding of fellowships and other forms of training, and the dispatch of experts and equipment. Projects focus mainly on priority sectors (agriculture, education and public health), which have been identified by Thailand's cooperating partners, and are designed to help Thailand's partners reach their development goals.

8. Bank of Agriculture and Agricultural Cooperatives, Ministry of Finance is responsible for loan extension to agricultural cooperatives and farmer.

9. Universities, Colleges of Agriculture and other technical institutes are undertaking research and development on agricultural machinery.

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CURRENT STATUS OF AGRICULTURAL MECHANISATION IN VIETNAM

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Background

The number and types of machinery and equipment for agricultural production, forestry and fisheries have seen rapid growth.

In agricultural production

By 2009, there were nearly 500,000 tractors of all kinds with a total capacity of about 5 million horsepower (HP), an increase three times higher than in 2001, including two-wheeled tractors under 12 HP accounted for 65%, tractors over 12 to 35 HP 27% , a large tractors (over 35 HP) accounted for 8%. National average of power equipped level is 1.2 HP per ha of cultivated land. Average rate of mechanization in agricultural production activities as follows:

Agricultural production activities	Mechanization Rate (%)
Soil preparation for rice cultivation	72
Soil preparation upland crops	65
Active irrigation for rice	85
Transport in agriculture and rural	66
Rice drying in summer-autumn season in Mekong River Delta (MRD)	38.7
Rice harvester in MRD	15
Rice thresher	84
Rice milling	95

In forestry production

- 70% of stages in seedling production is mechanized: tillage, plant bags, etc.
- Some mechanized models successfully applied in soil tillage for cultivation in slope land and afforestation for wood
- Forest exploitation: machanization in some basic steps like tree cutting (80%), wood transportation (90%), use of chains for wood minimal-proccessing in the forest gate to reduce transport cost and increase usable wood rate

In fishing and Aqua-production

- Fishing ability is increasing rapidly:
  - app. 3.8 %/year in quantity
  - 10.17 %/year in power
  - 18.3 %/year in total capacity of boat engine
  - Currently, 95,600 fishing boats with total capacity of 5.8 mil. HP
- Over 90 factories:
  - produce 1.7 mil. tons of animal feed from aqua products,
  - meeting 60% of feed consumption in the whole nation

Irrigation

Irrigation water for agricultural production, including water supply and drainage. Currently, the level of mechanization reached about 50% (50% area is irrigated by machine, the remaining 50% is irrigated using gravity flow and by-hand pump means).

Supply Issues

Rapidly forming agricultural machinery market:

- diversity (attachments, engines, tractors with capacity of 18-35 HP – either in-country manufactured or imported).

- agricultural machinery services (outlet, after-sale service).

Policy and Institutional Aspects of Agricultural Mechanization

Since 2004, Vietnam government has issued policies to support farmers to buy machines for agricultural production using budget's provinces.

- In 2008, 30 provinces and cities implemented the supporting policy:
    - 70-80% loan with a low interest rate, or
    - 50-100 % of interest rate,
    - the time to pay the loan: during 3 years
- During 2001-2008:
    - tens of thousands of tractors and agricultural machines were used by farmers
    - speeding agricultural mechanization
    - training operation and maintenance skills of machines for farmers

Finacial policy (tax) has many changes to be relevant to the WTO integration

- For ASEAN countries: tax rate since 2010 for imported agricultural machines is 0%, or 5% in some cases
- Manufacturers of tractors and agricultural machines: priority investment under the Key Program of Mechanization

Constraints

Low level and uncompleted development of agricultural mechanization (average: 1.2 HP/ha)

- Low quality of agricultural and rural infrastructure makes it difficult to apply machines and equipment (farm land use of each houshold: 0.7 ha with 7-8 plots)
- Post-harvest technology is still poor with high Post-harvest loss rate for:
    - rice: 12%
    - corn: 18-19%
    - soyabean: 6.2-14%
    - peanut: 8.5-15%
- Inadequate research of science and technology in agricultural mechanization, delayed transfer of technologies
- Agricultural mechanic section does not meet the demand of agricultural production activities
- Low quality labor source, untrained operators/users of agricultural machines

Sustainable Agricultural Mechanization

- To ensure sustainability of soil, using proprriate machinery is needed (not using too heavy machinery/equipment
    - Zero tilage
    - minimum/reduce tilage
    - mulching soil
- For sustainable mechanisation development
    - After-sale service: providing prepairing network of maintenance, enough spare parts…
    - Comprehensive mechnisation
    - Organising training courses for operators
- Policy support for agricultural machinery manufacturers.

Conclusion

- In the past years, Vietnamese agricultural production has obtained rapid, steady growth. Thanks to this, Vietnam basically ensured its food security, paved the path for shifting structure of agricultural economy and for developing non-agricultural industries. Several export agro-products of Vietnam have been in the world highest rank such as black pepper, coffee, rice and cashew nut.
- According to the MARD of Vietnam; however, Vietnamese agricultural economy has achieved great initial results, but process of its development is seen not completely sustainable.

The rapid shift of structure of crops and domestic animals makes changes of exploitation mode of resources of land, water and biology in large scale. Moreover, activities of survey, design, control and supervision are still insufficient; therefore, many dangers occur such as ecological imbalance, threat to the competitive ability of agricultural sector.

- For this reason, simultaneous with application of mechanisation and safer technology to reduce environmental pollution, Vietnam has done its utmost to prevent deforestation, conserve biological diversity, improve environmental hygiene, create jobs and increase standard of living for the people. To protect the environment, many countries have waged environmentally friendly movements in various names as sustainable agriculture, ecological agriculture, appropriate agriculture, integrated agriculture, etc. with the activities of research and application of production modes oriented to sustainable development in all sectors.

Annex 6

List of Participants

Annex 6

LIST OF PARTICIPANTS

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