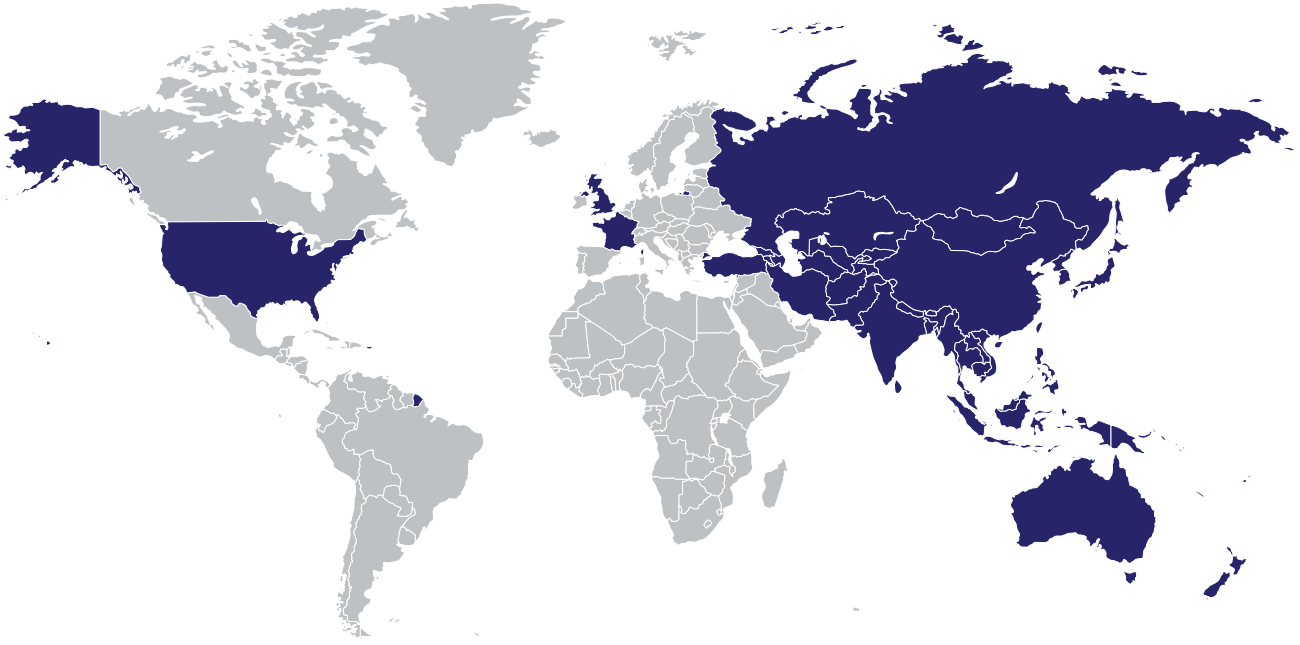
3rd Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific

Human Resource Development for Sustainable Agricultural Mechanization

9-11 December 2015
Manila, the Philippines

UNITED NATIONS ESCAP
Economic and Social Commission for Asia and the Pacific
CSAM

The United Nations Economic and Social Commission for Asia and the Pacific (ESCAP) is the regional development arm of the United Nations for the Asia-Pacific region. Made up of 53 Member States and 9 Associate Members, with a geographical scope that stretches from Turkey in the west to the Pacific island nations of Kiribati in the east, and from the Russian Federation in the north to New Zealand in the south, the region is home to 4.3 billion people, or two thirds of the world's population.



The darker area of the map represents the members and associate members of ESCAP

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This synthesis report comprises of the proceedings of the 3rd Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific, held on 9-11 December 2015 in Manila, the Philippines. It has been prepared by a team at the Centre of Sustainable Agricultural Mechanization (CSAM) under the overall guidance of Zhao Bing, former Head of CSAM, Katinka Weinberger, former Officer in Charge of CSAM, Li Yutong, Head of CSAM. The original presentations and speeches were provided by the respective participants/speakers.

Special thanks go to Cathy Lambuson, Camilla Stelitano, Zorikto Gomboin, and Feng Yuee for summarizing, compiling, and proofreading the country reports. CSAM is also grateful to Huajie Sun for lay-out and design of the report.

Content

Executive Summary

"Human resource development lies at the heart of economic, social and environmental development. A skilled, educated, healthy, capable, productive and flexible workforce, equipped with knowledge of newly emerging areas, is the foundation for countries to achieve sustainable economic growth and social progress." as highlighted by Mr. Zhao Bing, Head of CSAM.

On 9-11 December, 2015, around 400 key stakeholders of the Centre for Sustainable Agricultural Mechanization (CSAM) gathered in Manila, the Philippines, to share information and exchange ideas on "Human Resource Development for Sustainable Agricultural Mechanization" at the 3rd Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific. The participants covered government officials, researchers and academics, and representatives from international and regional organizations, NGOs, associations, and private sector from 16 countries in Asia and the Pacific, namely, Bangladesh, Cambodia, China, Fiji, India, Indonesia, Lao PDR, Malaysia, Nepal, Pakistan, Philippines, Republic of Korea (ROK), Russian Federation, Sri Lanka, Thailand, and Vietnam.

The Regional Forum on Sustainable Agricultural Mechanization is an annual strategic initiative of CSAM for high-level policy dialogue and regional cooperation in the field of agricultural mechanization in the region. The 3rd Regional Forum was organized by CSAM in collaboration with the Board of Agricultural Engineering of the Professional Regulation Commission, College of Engineering and Agro-Industrial Technology, University of the Philippines-Los Banos, Agricultural and Fisheries Mechanization Committee of the Philippine Council for Agriculture and Fisheries, and the Philippine Society of Agricultural Engineers.

His Excellency Benigno S. Aquino III – President of the Philippines, sent his written remarks emphasizing that agricultural mechanization and engineering "is vital to supporting our region and empowering our people to be active contributors to inclusive growth.", and wished a productive and insightful gathering at the event. Cynthia Villar, Senator and Chairperson of the Committee on Agriculture and Food, Senate of the Philippines, addressed the audience at the Opening Ceremony and reiterated that "Human resource development is an integral part of sustainable agricultural mechanization. We need to invest on people, for they will be on top of all our mechanization programs and projects."

Changing socio-economic patterns, weak implementation of human resource development (HRD) policies, and inadequate private sector engagement are among the challenges shared among the member countries in Asia and the Pacific. In light of these challenges, many member countries have started to promote strengthening of the current efforts in HRD, and to seek new approaches to address mounting concerns. This development involves providing institutional policy and funding support for HRD; introducing different training programmes and university courses to meet the demand for quality- and time-wise diversified education; addressing structural socio-economic changes in the agricultural sector by encouraging the youth and female workers to engage in educational activities; increasing the overall attractiveness of the agricultural sector for the young generation;

and introducing stimulating incentives for private sector to play an active role in the development of human resources.

The focus on HRD must be further supported by regional cooperation. Although the context of each member country is unique, many major and pressing problems are common to the whole region. Hence, cooperation can dramatically enrich the capacity of ESCAP member countries to address the pressing issues by means of information and experience sharing. Furthermore, to ensure flexibility and a holistic approach, this cooperation should include exchanges between different concerned stakeholders, including the farming community, academic and research institutions, educational institutions, governments and the private sector.

The participants at the 3rd Regional Forum agreed that a regional mechanism shall be established by CSAM to facilitate cooperation between and among different stakeholders in the field of human resource development of agricultural mechanization. This will be followed up and realized in the coming years.

The Proceedings synthesize the country papers presented by participating countries and presentations of peer organizations, and propose recommendations and the way forward for establishing a cooperation mechanism on human resource development of agricultural machinery in ESCAP member countries in support of sustainable agriculture, food security and poverty alleviation in the region.

Photoed by Yang Yunke

Abbreviation

ACEF	Agricultural Competitiveness Enhancement Fund
ACPE	ASEAN Chartered Professional Engineer
AEC	ASEAN Economic Community
ANTAM	Asian and Pacific Network for Testing of Agricultural Machinery
ASEAN	Association of Southeast Asian Nations
ASC	Agro Service Centers
AUCFA	ASEAN Universities Consortium on Food and Agro-based Engineering & Technology
BARI	Bangladesh Agricultural Research Institute
BSAM	Beneficiary Systems of Agricultural Machinery
CHRSAM	Custom Hiring for Rental Service of Agricultural Machinery
CSAM	Centre for Sustainable Agricultural Mechanization
CSEs	China Combine Service Enterprises
CSF	Crop Supporting Fund
DA	Department of Agriculture
ENAMA	Italian Body for Agricultural Mechanization and Engineering
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FAO-RAP	Regional Office for Asia and the Pacific of FAO
FTC	Farmers' Training Centres (India)
GDP	Gross Domestic Product
ICAERD	Indonesian Center for Agricultural Engineering Research and Development
ICT	Information and Communication Technology
IRRI	International Rice Research Institute
IRSAM	Institution for Rental Services of Agricultural Machinery
LLP	Low Lift Pumps
MARDI	Malaysian Agricultural Research and Development Institute
MoA	Ministry of Agriculture
NARC	Nepal Agricultural Research Council
OECD	Organization for Economic Co-operation and Development
PARC	Pakistan Agricultural Research Council
PT	Power Tiller
R&D	Research and Development
SAMS	Sustainable Agricultural Mechanization Strategy
SMAM	Sub Mission on Agricultural Mechanization (India)
SMS	Short Message Service
STW	Shallow Tube Wells
UN	United Nations
UPJA	(Bahasa) Please refer to IRSAM
UPLB	University of the Philippines Los Baños
VIAEP	Vietnam Institute of Agricultural Engineering and Post-Harvest Technology

Welcome Remarks

Ms. Cynthia Villar
Senator and Chairperson
Committee on Agriculture and Food
Senate of the Philippines

Thank you very much to the Board of Agricultural Engineering of the Professional Regulation Commission (PRC), Philippine Council for Agriculture and Fisheries (PCAF) of the Department of Agriculture, College of Engineering and Agro-Industrial Technology of UP Los Baños, and the Philippine Society of Agricultural Engineers for inviting me to be part of this twin event today – the 3rd Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific and the 3rd ASEAN Conference on Agricultural and Biosystems Engineering. I am happy and honored to be here with all of you.

And I must say that you have a very timely theme for your event – "Human Resource Development for Sustainable Agricultural Mechanization", it is very important to the agriculture sector, as the organizers of this event, are very much aware of.

As the current chairperson of the Senate Committee on Agriculture and Food, I am a staunch supporter of incorporating research and development (R&D) in the agriculture sector, which will also help improve agricultural mechanization efforts. Even the National Economic Development Authority (NEDA) has acknowledged that we need to invest in R&D, and that we can increase the productivity of agriculture and boost job creation in the industry through science and technology. This is also expected to fast track the growth in the Agriculture, Fisheries and Forestry (AFF) sector.

I learned that based on studies, two of the barriers confronting farmers, fisher folks and agricultural workers are lack of technical expertise and mechanization. Together with various government departments/agencies and organizations such as the hosts of this event, we should focus on working together towards breaking down those barriers.

For starters, we have reviewed the implementation of Agriculture and Fisheries Modernization Act or AFMA under Republic Act No. 8435, to ensure that it is maximized and reaches the intended beneficiaries. AFMA calls for the allocation of at least modernization-related programs and projects.

Actually, we started late in our mechanization efforts, only five years ago, while our Asian neighbors started mechanizing their farms in over three decades ago (1970s). So we have a lot of catching up to do. Data shown to me cites that the Philippines lags behind its regional neighbors in farm mechanization. According to Philippine Center for Postharvest Development and Mechanization (PhilMech), the country's level of mechanization is at 1.23 hp/ha, behind our Asian neighbors: Japan was at 18.87 hp/ha, Korea at 9.38 hp/ha and Thailand at 4.20 hp/ha.

We hope, with our concerted efforts, we can improve our standing because it will be very beneficial to all of us. Mechanization can significantly bring down the cost of labor particularly for labor intensive crops like rice, sugar, and corn.

The Agriculture and Fisheries Mechanization Law or AFMECH will help promote the development and adoption of modern, appropriate, cost-effective and environmentally safe agricultural and fisheries machinery and equipment to enhance farm productivity and efficiency to achieve food security and increase farmers' income.

AFMECH will promote the development and adoption of modern, appropriate, cost-effective and environmentally safe agricultural and fisheries machinery and equipment to enhance farm productivity and efficiency to achieve food security and increase farmers' income.

I am aware that the Department of Agriculture (DA) is also vigorously pursuing a P6-billion farm mechanization program (FMP), the implementation of which started in 2011 and will run until next year (2016). The amount is being used to purchase various production and postharvest machinery and equipment, which the DA provides to qualified farmer groups and cooperatives, irrigators' associations (IAs), and local government units (LGUs). The DA and PhilMech hope to bring the country's mechanization level to 3 or 3.5 hp/ha by next year.

We really need to improve the global competitiveness of our farmers and country's agriculture sector as a whole especially since the regional economic integration under the ASEAN Economic Community (AEC) is upon us. Competition will be more intense and we need to enhance our competitiveness.

But of course, mechanization is not all about machinery and equipment, as your event theme pointed out, human resource development is an integral part of sustainable agricultural mechanization. We need to invest on people, too, for they will be on top of all our mechanization programs and projects.

To that end, I have also pursued in the Senate the granting of TESDA scholarships for agriculture training. Through the courses that will be offered, scholars will learn basic knowhow such as operation and maintenance of modern machines and equipment. On top of that, they will also be taught about financial literacy, accounting, entrepreneurship, among other relevant courses. TESDA has allotted 500 million pesos for agricultural training of 45,000 scholars at 12,000 pesos each. State universities and colleges or SUCs will offer agri-related courses for the scholars, because they have the best network to do it. They have 454 campuses or one campus for every three towns in the Philippines.

I am also pursuing the extension of the utilization of the Agriculture Competitiveness Enhancement Fund or ACEF, until 2020, it is due to end this month. ACEF was created to help prepare farmers and fishermen compete with their counterparts in ASEAN countries, as markets become liberalized. In particular, it is aimed at helping small farmers and fisher folks increase their production and profitability as well as make them competent and competitive by funding their training, among others.

Small farmers and fisher folks need to learn and acquire winning skills and strategies give them competitive advantage. Continuing education and training is key. In my interactions with farmers, I found out that what separates an award-winning and profitable farmer from an ordinary one is simply employing the correct strategy in farming.

An award winning farmer earns 50,000 pesos/ha/mo, while an ordinary farmer earns 4,000 pesos. The difference lies in the fact that one is using more effective and profitable farming techniques – most probably mechanized ones – than the other.

ACEF can provide a level field in access to not only education and training, but opportunities to modernize and mechanize existing facilities of operations. Eighty percent (80%) of the fund will be in the form of credit with minimal interest, which shall not exceed five million pesos (P5,000,000) per project per loan, for the acquisition and establishment of agri-based production and post-production, and processing machines, equipment and facilities to achieve modern agricultural practices, to be managed by the Land Bank of the Philippines.

For the remainder of the fund (20%): Ten percent (10%) will be extended as grants for research and development of agricultural and fishery products, and the commercialization of such, including the upgrading of research facilities, of qualified state universities and colleges (SUCs), which again shall not exceed five million pesos (P5,000,000) per project; and ten percent (10%) will be used for the funding of a comprehensive scholarship and attractive grant-in-aid program for agriculture, forestry, fisheries, and veterinary medicine education, to be implemented by the Commission on Higher Education (CHED).

The bottom line in all our efforts, whether through our mechanization programs and legislations, is to boost the growth and development of the Philippine agriculture sector. In order to do that, we need to help farmers and fisher folks, who remain as among the poorest sectors in our country. Poverty incidence among farmers – at 40%, is higher than the average for the whole country, which stood at 25%. We need to correct that primarily because the Philippines is an agricultural country, two-thirds of our population are involved, directly and indirectly, in agriculture. Helping farmers, fisher folks, and agricultural workers is as inclusive as we can get.

On that note, thank you again and more power to all of you; let us continue working together in bringing back the glory days of agriculture, not only in our country but in the region as well.

Opening Remarks

Mr. Marc Proksch
Chief
Business and Development Section
Trade and Investment Division
United Nations Economic and Social Commission for Asia and the Pacific

Excellencies, distinguished delegates, ladies and gentlemen,

Welcome to the 3rd Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific. This forum is organized by the Centre for Sustainable Agricultural Mechanization in cooperation with the Board of Agricultural Engineering of the Professional Regulation Commission, University of the Philippines – Los Baños, Philippine Council for Agriculture and Fisheries, and the Philippine Society of Agricultural Engineers.

The theme of the 3rd Regional Forum is, "Human Resource Management for Sustainable Agricultural Mechanization". This theme is highly appropriate in view of the adoption of the UN Sustainable Development Goals (SDGs), in particular, SDG2: Ending hunger, achieve food security and improved nutrition and promote sustainable agriculture and the SDG8 (as part of the next development agenda), to "promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all".

Despite being one of the fastest growing regions in the world, the Asia and the Pacific region is still home to high concentrations of food insecure populations. Today, nearly 70% of the region's inhabitants which includes the majority of the populations of all 12 of the least developed countries (LDCs) relies largely on agriculture as the main source of income and employment.

Often these populations lag behind on rural infrastructure, suffer persistent forms of poverty, serious structural impediments to growth, low levels of human development and high exposure to shocks and disasters that pose long term challenges and call for long term impact oriented sustainable development strategies.

Additionally, rural poverty has numerous root causes, ranging from climate change, natural resource degradation, conflict, weak institutions, poor agricultural conditions and trade-related challenges. As the external economic environment become less stable and supportive and the specter of climate destabilization grows, progress rests increasingly on strategies that foster job-friendly and poverty-reducing resilient growth. While the specific circumstances, priorities and needs of each country differ, there is wide consensus that the level of education and skills of agricultural workers are significant factors in explaining inter-farm and inter-country differences in agricultural performance. What matters for development most is human capital, the capability of people to be effective and productive economic agents.

The development of skills relevant to achieve a more resilient and productive countryside will need to call upon accessing better quality education and training adapted to local conditions and

economic opportunities. Promoting training in farming methods and business skills, and how to receive low interest loans and access to crop insurance schemes in case of flooding or drought all are sustainable and progressive steps toward producing the human capital needed for more resilient livelihoods. In addition, expectations of such work would be the expansion of cultivated land, introduction of tool banks to provide low cost access to farm implements to increase agricultural production and improve produce and product quality, as well as moving rural populations and particularly youth away from highly vulnerable and exploitative forms of employment.

A healthy and dynamic agricultural sector is an important foundation of rural transformation, generating strong linkages to other economic sectors. To this end, both the global and regional dimensions of the development agenda require stronger partnership and regional cooperation among all key stakeholders, which is recognized as a key mechanism for supporting implementation of the post-2015 development agenda.

I am delighted to see that around 400 delegates from government, academic and research institutions, international and regional agencies, business and civil society are gathered here today in Manila to share experiences and practices, create synergies, and explore cooperation mechanism and opportunities on this important topic.

I would like to extend my special thanks to the Government of the Philippines for their commitment to this event. My sincere gratitude goes to all the delegates for your concrete support and significant contribution to this Forum, your continued support to ESCAP, and particularly to CSAM. We have all witnessed the notable progress of CSAM in recent years, which, however, is barely possible without your active participation and invaluable contribution to all its initiatives.

To conclude, I wish you a great success of this forum and look forward to your fruitful discussions and outcomes.

Opening Remarks

Mr. Zhao Bing
Head
Centre for Sustainable Agricultural Mechanization
United Nations Economic and Social Commission for Asia and the Pacific

Hon. Cynthia A. Villar, Senator and Chairperson of the Committee on Agriculture and Food Senate of the Philippines;

Distinguished Ms. Querobine Deapera, Acting Director for Economic & Development, Office of United Nations and Other International Organizations, Philippine Department of Foreign Affairs;

Distinguished Engr. Ariel T. Cayanan, Executive Director, Philippine Council for Agriculture and Fisheries;

Hon. Ariodear Rico, Chairman of the ASEAN Agricultural and Bio-systems Engineering Coordinating Committee;

Distinguished Mr. Dennis M. Guerrero, Chief of Staff, Office of the Secretary of the Philippine Department of Agriculture;

Distinguished Mr. Genaro M. Tolentino, President of the Philippine Society of Agricultural Engineers;

Distinguished Dr. Aura C. Matias, Dean of UP College of Engineering

Distinguished Mr. Marc Proksch, Chief of the Business and Development Section of UNESCAP;

Mr. Jose Luis Fernandez, Representative of the Food and Agriculture Organization of the United Nations in the Philippines;

Representatives from ESCAP member countries and international organizations and institutions;

Colleagues; Ladies and Gentlemen,

First of all, on behalf of the Centre for Sustainable Agricultural Mechanization, I would like to warmly welcome you to the 3rd Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific, the 3rd ASEAN Conference of the Agricultural and Bio-systems Engineering, and the 12th Engineering Research and Development for Technology (ERDT) Conference.

My heartfelt gratitude and appreciation goes to our Philippine partners and co-organizers - Board of Agricultural Engineering of the Professional Regulation Commission, College of Engineering and Agro-Industrial Technology, University of the Philippines-Los Baños, Agricultural and Fisheries Mechanization Committee of the Philippine Council for Agriculture and Fisheries, and the Philippine Society of Agricultural Engineers. The holding of these events were barely possible without the commitment and dedication of the Philippine host with incredible energy and performance.

Holding the 3rd Regional Forum of CSAM in the Philippines, the very place that CSAM started in 1977 from the Regional Network for Agricultural Machinery (RNAM) inspired me and my colleagues towards attainment of the goals and missions our successors set; meanwhile, we felt the responsibilities and urgent needs to adjust and shift the helm to keep abreast with the global moves, especially for sustainable development.

Hence, in the past few years, CSAM made enormous efforts to recraft its strategic direction, revive its vitality, re-delineate its project framework, and re-define its partnership strategies and outreaching endeavours. I am delighted to see, as you all witnessed, that the image and influence of the Centre has been significantly enhanced in the community of the agricultural mechanization in the region and beyond via implementing concrete and need-oriented projects and initiatives.

To name some, the Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific provides platform for high-level policy dialogues and regional cooperation; the Asian and Pacific Network for Testing of Agricultural Machinery aims to harmonize the testing standards and codes for better quality machinery; the regional database of agricultural mechanization pursues to facilitate evidence-based decision making; the Regional Council of Agricultural Machinery Associations in Asia and the Pacific targets for a vibrant and healthy agricultural machinery industry in the region.

More importantly, we have established extensive strategic partnerships with various key stakeholders covering government agencies, international/regional organizations, academic and research institutes, civil society organizations, and private sectors. This, the people, indeed, matters for the sustained development of an organization like CSAM; it also matters for the sustainable development of agricultural mechanization in the region.

Therefore, we gather together today, to share ideas and insights of the important topic of “Human Resource Development for Sustainable Agricultural Mechanization”. Human resources development lies at the heart of economic, social and environmental development. A skilled, educated, healthy, capable, productive and flexible workforce, equipped with knowledge of newly emerging areas, is the foundation for countries to achieve sustainable economic growth and social progress.

With consideration of the reality that food security remains an urgent issue that countries must face and resolve due to the highest concentration of hungry populations and grappling with resource and environmental constraints in the Asia and the Pacific, human resource development efforts in agriculture, and indeed, the whole rural population, become more significant and urgent.

Human resource development for sustainable agricultural mechanization, in specific, covers an entire set of variables that determines outcomes. It is vital to recognize that as much as it is depended on formal education and training systems, and workforce organizations, it is also depended on informal extension and awareness improvement efforts for the grassroots, particularly, the small-holders and women. Comparative studies from several countries provide evidences that a $1,000 increment in extension spending in agriculture was associated with a $2,173 or more increase in farm output within a two-year period.

It is fortunate that we will have chance to listen your insightful thinking and sharing good practices of your respective countries and agencies in these regards in the following session today and tomorrow.

Ladies and Gentlemen,

The importance of human resource development could never be overemphasised. The Chinese philosopher, Guanzi (551 - 479BC) said that:

"When planning for one year, there's nothing better than planting grain,

When planning for ten years, there's nothing better than planting trees,

When planning for a lifetime, there's nothing better than planting men".

I would like us to join hands, and work together to “plant” skilled, educated, healthy, capable, productive and flexible workforce and rural population conductive to the achievement of sustainable agricultural mechanization in the region.

Thank you.

Opening Remarks

Mr. Jose Luis Fernandez
FAO Representative in Philippines
Food and Agriculture Organization of the United Nations

Hon. Proceso J. Alcala, Secretary, Philippine Department of Agriculture, Chairman, ASEAN Ministers for Agriculture and Forestry

Hon. Cynthia A. Villar, Senator and Chairperson, Committee on Agriculture and Food Senate of the Philippines

Hon. Jesus S. Domingo, Assistant Secretary, United Nations and Other International Organizations, Philippine Department of Foreign Affairs

Mr. Marc Proksch, Chief, Business and Development Section, Trade and Investment Division, United Nations Economic and Social Commission for Asia and the Pacific

Hon. Angeline T. Chua Chiaco, Acting Chairperson, Professional Regulation Commission

Engr. Ariel T. Cayanan, Executive Director, Philippine Council for Agriculture and Fisheries

Mr. Zhao Bing, Head, Centre for Sustainable Agricultural Mechanization, UNESCAP

Dr. Aura C. Matias, Program Leader, Engineering Research and Development for Technology (ERDT), University of the Philippines

Ladies and Gentlemen:

It is a great pleasure and privilege to deliver this keynote message on behalf of Ms. Kadiresan Kundhavi, Assistant Director General and FAO Regional Representative for the Asia Pacific Region, to this third Regional Forum on Agricultural Mechanization in Asia and the Pacific. I wish to thank Mr. Zhao Bing for the kind invitation to deliver remarks on this occasion.

A shift from traditional labor-intensive production and post-harvest operations to mechanized labor-saving technologies is taking place across Asian agriculture. This is in response to rising labor scarcity and cost, greying farmer populations, increasing feminization of agriculture, and developing of modern value chains.

Mechanization is increasingly used in this region across the entire value chain – from land preparation, seeding, harvesting, to post-harvest handling and processing operations. Indeed, mechanization has been shown to tremendously increase efficiency, improve

quality and reduce post-harvest losses in a number of food value chains that integrate small holders in this region.

During the High Level Multi-stakeholder Consultation on Sustainable Agricultural Mechanization convened by FAO in June, 2014, participants identified capacity development and knowledge sharing on mechanization as key priorities for the region. They noted that curricula of higher education and training institutions in the field of sustainable agricultural mechanization are somewhat static, with limited capacity to support growth in usage of mechanized equipment.

Trained human resources are instrumental to the success of the uptake and use of sustainable mechanization. Training must take place at all levels and involve a broad range of stakeholders including ministries of agriculture, trade and industries as well as farmer organizations, agri-food supply chain stakeholders and those working in the agricultural machinery and implement supply chains.

It is also important that the scope of the curricula of higher education and training institutions is broadened in line with changing trends in the use of mechanization in the region, and in conformance with sustainability principles. Linkages should also be made between the mechanization supply side – i.e. suppliers of mechanization - the user base of the machinery, who are mainly small producers and value chain stakeholders and those involved in the maintenance and repair of machinery. Targeted training programs, including vocational training, short courses and/or evening courses designed to build the capacity of stakeholders involved in mechanization supply chains (sales, repair and maintenance, etc.) are also important.

The benefits of sustainable mechanization will not be fully harnessed by smallholders, unless effective linkages are created with extension systems. Extension systems must, therefore be upgraded in order to promote the appropriate selection and proper use of mechanization.

Ladies and Gentlemen,

Clearly quite a lot needs to be done, and the involvement of different actors and stakeholders is required to properly address human resource capacities in sustainable mechanization. I note your very interesting and tight agenda, and would like to wish you a successful outcome to your deliberations.

I look forward to learning of the outcomes of this meeting in due course.

Thank you.

I. Plenary Session – Keynote Speeches

Photoed by Agricultural Machinery Bureau of Hunyuan County

Achieving and Benefiting from Skills Mobility within ASEAN

Mr. Guntur Sugiyarto
Senior Economist
Development Economics and Indicators Division
Economics Research and Regional Cooperation Division
Asian Development Bank

The Association of Southeast Asian Nations (ASEAN) is a political and economic organization of 10 countries in Southeast Asia. The ASEAN community is based on the pillars of:

- Regional peace and stability
- Economic integration and cooperation
- Human and social development

ASEAN has made significant progress in dismantling barriers to the movement of capital and goods, but progress in the movement of its most important resource - human capital - is still in an embryonic stage.

The ASEAN Economic Community (AEC) was established in 2015 with the aim of establishing of a single market and production base that creates better economic opportunities for the region. A free flow of skilled labor is one of the key components of AEC.

AEC aspiration to facilitate a "free flow of skilled labor" is a timely policy goal for ASEAN in line with the major demographic, economic, and social changes that are sweeping across the region. Nonetheless, managing skill mobility in the ASEAN region poses great challenges.

Skill mobility in ASEAN would directly augment domestic production and increase productivity of workers and economy. To achieve a Managed and Transparent Skill Mobility System, policymakers need to make professional and academic qualifications portable among educational institutions, employers and member countries to ensure that professionals wishing to work in other member states have their qualifications recognized. Moreover, improved access to the ASEAN labor market is needed, since mutual recognition

Pillar 1	Pillar 2	Pillar 3	Pillar 4
Single Market and Production Base	Competitive Economic Region	Equitable Economic Development	Integration into the Global Economy
• Free flow of services • Free flow of investment • Free flow of capital • Free flow of skilled labor • Priority Integration Sectors (tourism) • Food, agriculture, and forestry	• Competition policy • Consumer protection • Intellectual property rights • Infrastructure development • Taxation • E-Commerce	• SME development • Initiative for ASEAN Integration	• Coherent approach toward external economic relations • Enhanced participation in global supply networks

arrangements does not provide guarantees in this regard. At best, since the mutual recognition arrangements enable professionals to register and be recognized to practice their professions on an equal basis in other ASEAN member countries. It is also necessary to promote intra-ASEAN mobility to meet the existing demand-supply gap

If effectively implemented, AEC by 2015 could lead to:

- A significant increase in output and job.
- GDP increases by 7.1 per cent from the baseline, with the largest gains for lower-income ASEAN Member States.
- A net increase of 14 million jobs in six ASEAN economies, accompanied by the expansion and decline of specific sectors (ADB-ILO 2014).

In the future, a broader and more integrated market under AEC will create more demand for different types of labor, increased employment and reduced skill mismatch. Even if largest demand will continue to target low- and medium-skilled workers, the demand for skilled workers will increase faster. In this contest, skill mobility will be able to create a self-reinforcing mechanism.

The ASEAN Agricultural and Biosystems Engineering Cooperation Framework in Support to ASEAN Food Security and Sustainable Agricultural Mechanization in Asia and the Pacific

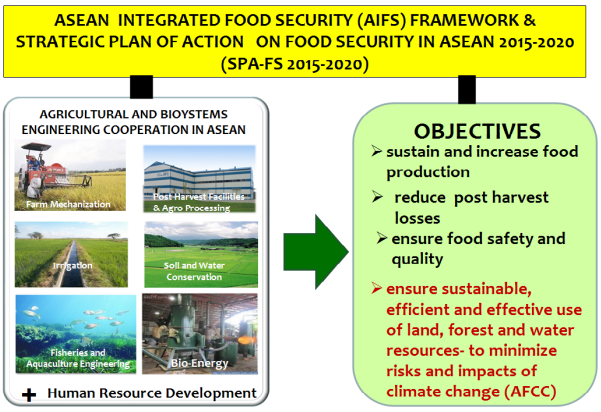
Mr. Ariodear Rico
Chairman
Board of Agricultural Engineering
Professional Regulation Commission
The Philippines

At the 1st ASEAN Conference on Agricultural and Biosystems Engineering (ACABE) held on September 23 to 24, 2014 and hosted by the Philippines through the Philippine Society of Agricultural Engineers and the National Agricultural and Fishery Council (NAFC), delegates adopted the "ASEAN Agricultural and Biosystems Engineering Framework for Cooperation and Complementary Action in support to ASEAN Food Security and Climate Change Adaptation and Mitigation".

The cooperation framework seeks to harmonize and globally align the practice of Agricultural Engineering in ASEAN into Agricultural and Biosystems Engineering. In this contest, Agricultural and Bio-systems Engineering is the application of engineering science and designs to the processes and systems for the sustainable production, post-production and processing of safe food, feed, fiber, timber and other agricultural and biological materials and the efficient utilization, conservation and management of natural and renewable resources to enhance human health in harmony with the environment.

Since the establishment of the framework, the second ASEAN Conference on Agricultural and Biosystems Engineering (ACABE-2) was held on 11-14 September. In this occasion member countries discussed the implementation of ABE

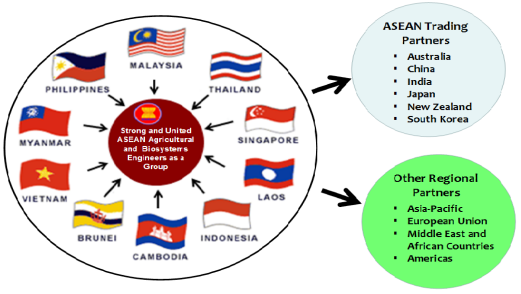
Cooperation Framework and the Philippines was elected as the chair of the ACABE Coordinating Committee.



Moreover, at the Special Senior Officials Meeting of the ASEAN Ministers on Agriculture and Forestry (SOM-AMAF) held on 12-14 August 2015 in Nay Pyi Taw, Myanmar, the Philippines presented the ASEAN ABE Cooperation Framework which was unanimously welcomed, and Philippines was tasked to develop the Action Plan in support to ASEAN Food Security Framework:

In addition, the ASEAN Universities Consortium on Food and Agro-based Engineering & Technology (AUCFA) organized the 3rd annual AUCFA meeting in parallel with the 1st International AUCFA Student Seminar and Idea Competition on Food and Agro-based Engineering and Technology, on October 15-17, 2014 at IPB International Convention Center, Bogor, Indonesia.

Furthermore, the ASEAN Mutual Recognition Arrangement (MRA) on Engineering is working on accreditation of ASEAN Chartered Professional Engineer (ACPE). In the future, the ASEAN Agricultural and Biosystems Engineers aims at engaging a wide range of stakeholders including ASEAN trading partners and regional players.



The Vision for ASEAN Agricultural and Biosystems Engineers

Sustainable Mechanization in Rice Research and Rice Agri-food Systems

Mr. James Quilty
Mechanization Specialist
International Rice Research Institute

"Mechanization is the process or system of introducing equipment and/or machines to do work." In order to design successful sustainable mechanization strategies for rice agri-food systems, it is important to analyze the historical drivers behind changes in rice production.

I. Drivers of Changes in Rice Agri-Food Systems

Nowadays, it is still possible to see a lot of the work in rice production carried out by hand tools and animal power. Still 90% of farmers in rural areas utilize cows at least in one of the phases of production.

The modernization of rice production encounters major constrains including the availability of labor and the aging population of workers in this sector: young workers have moved to manufacturing and constructions in urbanized areas. In addition, the high cost of energy and the availability of water, as well as, climate change deeply influences the development of rice systems. The research in new technologies is also effected by many factors, such as seed processing, sample collection and preparation of data and phenotyping.

Specifically, in Asia, major constrains to mechanization include:

- Small farm sizes
- Weak private sector, in particular in R&D
- Lack of institutional capacity in R&D, testing, and training
- Lack of suitable machinery options
- Lack of unbiased information
- Lack of support services (financing, training, business development)

Mechanization also poses several threats such as displacement of labor, potential exacerbation of inequities

(specifically for women and landless farmers). In addition, mechanization has a strong impact on the production system by effecting the soil, the level of emissions and the cropping system. When formulating mechanization strategies, it is important to prevent, control and limit the impact on existing systems of production.

Nevertheless, mechanization is proven to increase efficiency in farming, resource utilization and minimize the costs. Moreover, it optimizes the quality of products and reduces drudgery of agriculture. It also creates jobs in the supporting industry and keeps farming interesting for young people.

II. Research of IRRI

IRRI conducts diversity of research on mechanization, including:

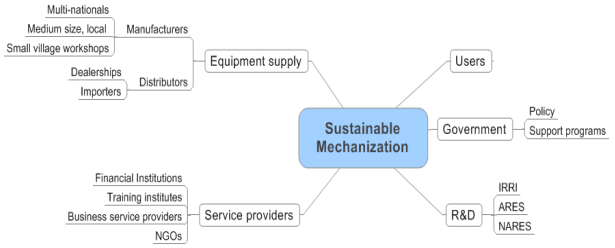
- Two-wheel multi-crop seed drill development
- Mechanized agronomy
- Drying technologies
- Energy efficiency of mechanization
- Straw management
- Reduced tillage mechanical transplanting
- Bioenergy production
- Gender and equity studies

As mentioned before, when implementing mechanization strategies, it is very important to carefully consider the impacts of energy efficiency imbalances and inefficiency. Hence, IRRI is trying to work across a vast range of systems, to see how they could be adapted to mechanization. We are currently looking at holistic approaches to assure positive impacts also on social and environmental basis. In cases in which the preparatory research highlights negative consequences, we try to elaborate systems to compensate.

IRRI has recently started to promote substantial research activity in mechanization, by looking at different kinds of equipment from manual transplanters to drum seeders up to tractors. IRRI has started to invest in efficiency and precision farming agriculture. These machines are digital and the GPS connection permits us to monitor all the phases of production from planting to harvesting. In addition, harvest & postharvest, tractor mounted system (multispectral reflectance, canopy temperature, canopy height, HD Video/8 MP RGB, georeferenced @ 2 cm, GPS auto-steer tractor), and drone platform (multispectral cameras, thermal imagery, high resolution) are also areas in research of IRRI.

III. Successful Mechanization

Promoting mechanization is more difficult than disseminating seeds. Mechanization requires a holistic approach that takes into consideration of manufactures, services providers and end-users.

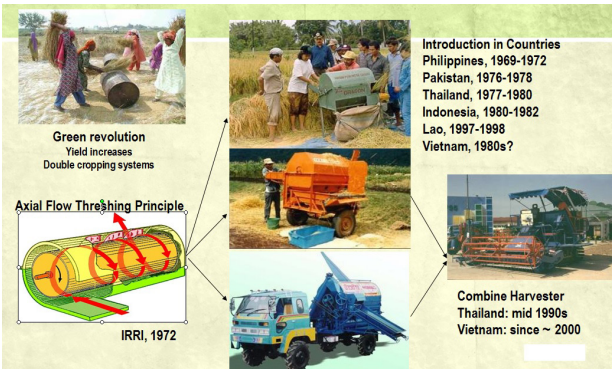


Based on our research, we have identified some examples of good machinery that do not alternate existing systems and enhance the farming experience. For example:

- Axial flow threshers
- Hydrotillers
- Combine harvesters
- Drying systems
- Laser leveling
- Mechanical transplanting

In particular, the Axial Flow Thresher is a good machinery because of the following characteristics:

- Simple technology: no change in cropping system
- Drivers: green revolution, increased yields, very wet crop →need for mechanized threshing
- Impact: transferred to most Asian countries, hundreds of manufacturers
- Support services included in program
  - industrial extension program (Small Farm Machinery Development Program)
  - sustained funding for 10 years, large, interdisciplinary RD team
- Policy: supportive in context of green revolution
- Roles of stakeholders
  - IRRI: R&D, industrial extension
  - NARS: Piloting, agricultural extension
  - Industry: Manufacturing and marketing



IRRI has observed that successful mechanization projects have the following characteristics:

1. Addressed a real need
2. Facilitated a multi stakeholder platform
3. Used appropriate technologies
4. Conducted participatory piloting
5. Used good practice approaches
6. Backed by support and advocacy activities
7. Capacity building is conducted at all levels
8. Included industrial extension
9. Helped establish equipment supply chains
10. Had sufficient resources and time

Training is also essential covering operator training, health and safety, and service and maintenance. In addition, it is well learnt that private sector is the key for manufacturing, distribution, and adaptive development; researchers shall stay involved to take the technology to the next step; technology champions and multi stakeholder platforms were important; and standardization / certification shall not be misused.

IV. Conclusion

Agricultural mechanization requires an inclusive approach involving all stakeholders along the value chain. On one hand, the private sector plays an essential role and should be driving mechanization. On the other hand, the government should facilitate an enabling environment to phase the introduction of new technology and train the end users to assure efficiency and safety. In this contest, it is important to keep researchers involved to oversee implementation and formulate strategies to correct any negative impact or imbalances. Many experiences with sustainable mechanization exist; and IRRI is ready to work with national partners to share these experiences.

Enabling the Business of Agriculture – Benchmarking Regulatory Good Practices

Mr. Farbod Youssefi
Program Manager
Enabling the Business of Agriculture (EBA) Project
World Bank Group

The World Bank (WB) project Enabling the Business of Agriculture (EBA) builds on the World Bank Group (WBG) Doing Business Report methodology, which has inspired close to 2,400 reforms in the area of business regulation.

The project was initiated by a G8 demand in 2012 to the WB to develop specific indicators for agriculture. Originally called Benchmarking the Business of Agriculture, it is a joint project of the World Bank's Agriculture Global Practice and Global Indicators Group. The Agriculture Global Practice defines the World Bank's strategic direction in agriculture, develops and deploys expertise globally, delivers integrated solutions while capturing and leveraging knowledge effectively for maximum development impact needed to end poverty and boost shared prosperity. The Global Indicators Group, which is part of the World Bank's Development Economics network, produces global datasets that document and explore the relationship between business environment reforms and key development outcomes. EBA is funded by several aid organization including Bill and Melida Gates foundation, USAID, the UK Department of International Development, the Government of the Nederland's and Development Denmark - Employment Promotion through Business and Skills Development (DANIDA).

The first report was published in 2014, it identifies and monitors regulations and policies that affect agriculture and agribusiness markets and aims to inform and encourage policy decisions that support inclusive participation in agricultural value chains and foster an environment that is conducive to local and regional business in agriculture. The report analyses multiple factors including the movement and migration of people from urban to rural areas, the growth of food demand will be almost completely dependent on the growth of urban food demand in developing region. Whereas the food demand in developed regions will remain stagnant, in developing countries will see an increase from 100% to 300%.

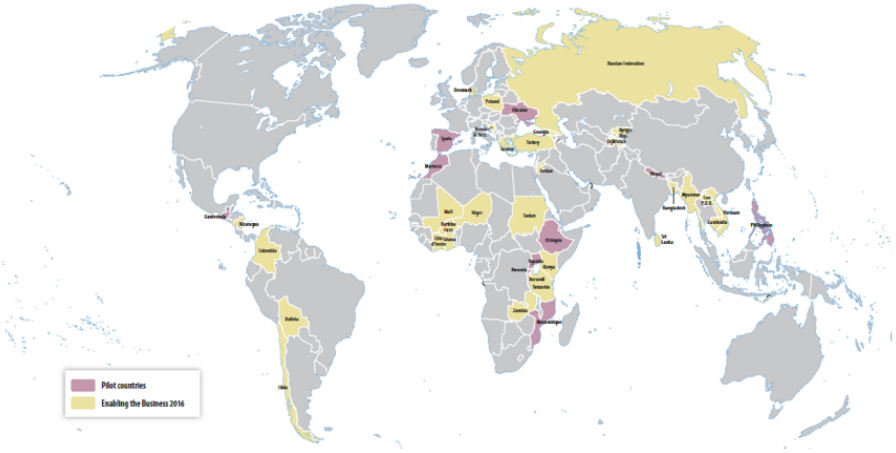
Because of this we have been concerned in enabling the right environment for agribusinesses; creating an enabling business environment to spur agricultural sector performance is an important prerequisite for unleashing growth, employment and income generation in rural areas. We started to look as several elements such as the legal and regulatory framework, the efficiency of institutions and administrative procedures and how they shape the environment in different countries.

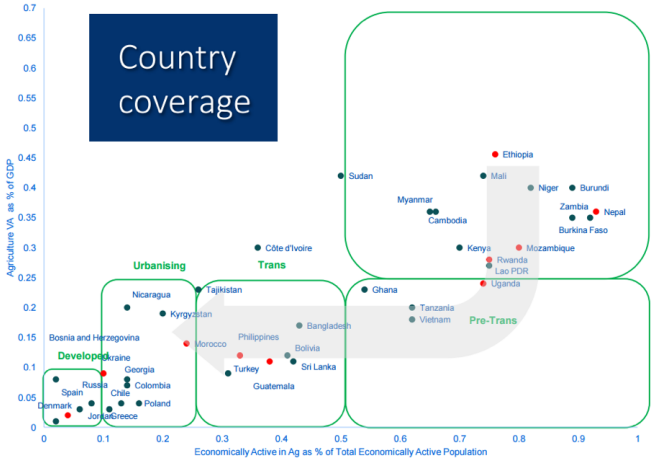
Benchmarking goes back in time, in agriculture goes back many

centuries when farmers used to compare yields and consequently adjust irrigation methods, seeding and so on. Moreover, benchmarking is proven to be an effective strategy for policy makers. In addition, international influences, such as actions and experiences of other countries in making policy changes, play a critical part in catalyzing policy shifts. Thus, we decided to bring together agriculture and benchmarking to develop a set of indicators. It was agreed that these indicators should be comparable for very different countries from France to Mozambique to Korea and the Philippines. Also, indicators should be actionable. Actionable refers to areas in which governments could act on, for example prices, volumes or hectares of arable land are not directly actionable by the governments.

By allowing cross-country comparison of practices and conditions, benchmarking indicators can point to issues in a country's enabling environment for agriculture, helping to raise awareness among policy makers and other stakeholders. In fact, the more that cross-country benchmarking reveals weaknesses in domestic policies—often through quantitative indicators exposing poor performance in international rankings—the less difficult it is for reform-oriented policy makers to justify the need for change. Benchmarking indicators may serve as a source of negative feedback, by measuring poor performance by a country in certain areas—but they also offer prospects for positive feedback as performance improves. Both types of feedback can be important in spurring recognition of the need for policy change. Moreover, benchmarking indicators provide a ready source of information on viable alternatives, another aspect shown to be essential in encouraging policy change.

In the first year we chose ten pilot countries, while in 2016 we have decided to extend the coverage:





The way we collected our data was by contacting with the agricultural ministries and the public sector as well as the private sector companies and associations. In a few countries, we conduct field research. In the second edition we will collect and incorporate a set of metrics that goes beyond legal and regulatory aspects.

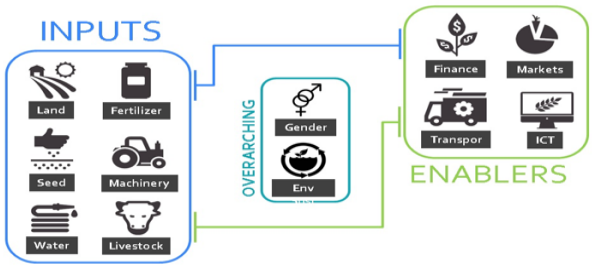
Public Sector

- Ministries of Agriculture, Transport, Environment, Trade and Commerce, Information and Technology
- Central Bank, Financial Supervisory Authorities
- Customs, State Inspectors, Land Registries, Cadasters, Agricultural Research Institutes and others

Private Sector

- Agricultural Input Companies (Fertilizer, Machinery, Seed, Irrigation)
- Trucking companies
- Freight forwarders
- Cooperatives and Farmers' associations
- Agricultural Holdings
- Mobile Network Operators
- Lawyers
- Commercial Bankers and Microfinance Institutions

We have looked at six inputs: fertilizers; seeds; machinery; land; water and livestock to be measured against four enablers: finance; markets; transport and ICT.



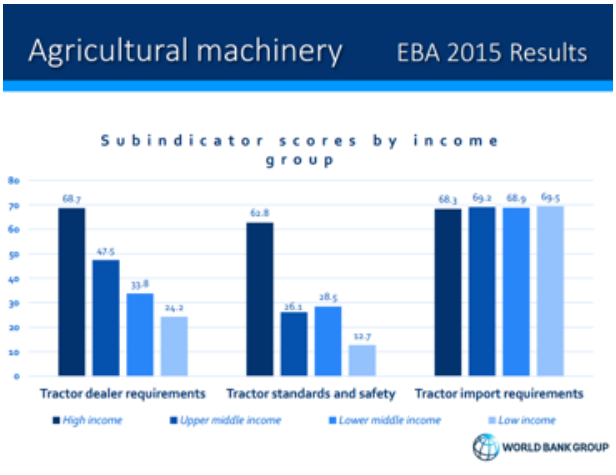
In to 2016, we've developed 2 kinds of indicators:

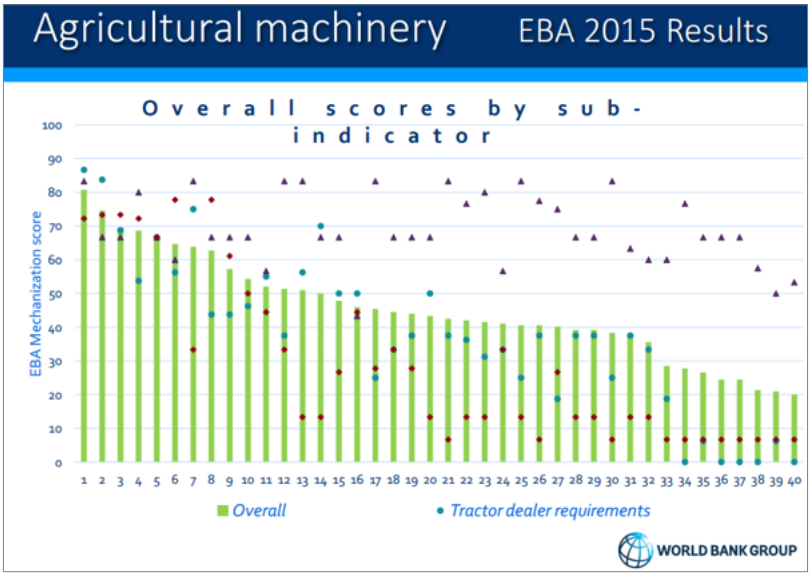
- Legal indicators emerge from a reading of the laws and regulations, and measure relevant aspects of the regulatory quality. For this, the team identified good regulatory practices for each topic area. Also, we have looked at efficiency of bureaucratic procedure.
- Time and motion indicators reflect the efficiency of a country's regulatory system - for example, the number of procedures and the time and cost to complete a process such as certifying seed for sale in the domestic market, registering fertilizer products or exporting agricultural goods. Data of this type is built on legal requirements, and cost measures are backed by official fee schedules when available. Time estimates often involve an element of judgment by respondents who routinely administer the relevant regulations or undertake the relevant transactions. To construct the time estimates for a particular regulatory process, such as completing the requirements to import fertilizer, the process is broken down into clearly defined steps and procedures. The time to complete these steps is verified with expert respondents - through conference calls, written correspondence and visits by the team - until there is convergence on a final answer.

LAND	FINANCE	WATER	SEED	FERTILIZER	MACHINERY
Land administration systems and tenure security	Lending supervision	Access to water use rights	Evaluation and registration of new varieties	Registration of fertilizer products	Tractor dealer requirements
Agricultural land sales	Branchless banking	Water User Associations	Seed certification	Fertilizer import requirements	Tractors safety standards
Agricultural land lease markets	Non-traditional collateral			Quality control	Tractor import requirements

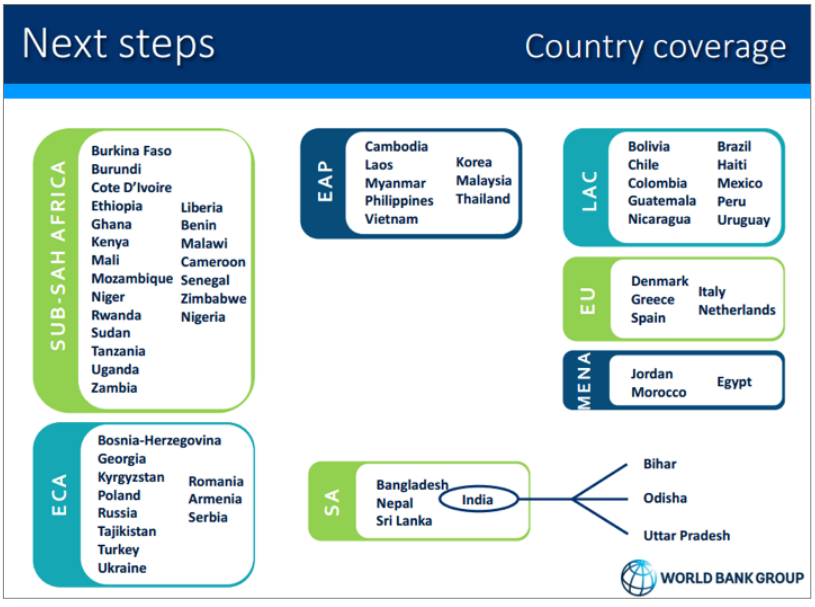
ICT	TRANSPORT	MARKETS	LIVESTOCK	ENV. SUSTAIN.
Licensing regimes	Licensing for trucking	Phytosanitary protection	Genetic resources management	Plant genetic resources: conservation, access and use
Government strategies to improve access to ICT in rural areas	Cross-border transportation	Production/sales	Animal disease prevention and control	Production and commercialization of land races
Agricultural e-extension services		Agricultural export	Safety of animal feed resources	Water resources management

For each of the areas that we have individuated, we have collected and selected data as proxy to show the situation in that given sector. For example, in the agricultural machinery we used tractors as proxy and we looked at registration procedure for equipment, legal safety requirements, and tractor import requirements. The results of the agricultural machinery EBA 2015 are showed below:





In next steps, the country coverage of EBA will expand to the following regions and countries:



Human Resource Development of Agricultural Mechanization in Pakistan

Mr. Nadeem Amjad
Chairman
Pakistan Agricultural Research Council
Pakistan

Despite remarkable progress in reducing the number of undernourished in the Asia-Pacific during the cycle of the Millennium Development Goals (MDGs), the region is still home to two thirds of the world's hungry. The efforts and ability of the region to provide sufficient food and eliminate rural poverty are further complicated by socioeconomic dynamics, such as population growth, urbanization and other factors including climate change water scarcity, land degradation and pollution.

Agricultural mechanization technologies are crucial for sustainable intensification of agricultural production. Mechanization has the potential to improve rural income, facilitate the efficient use and stewardship of natural resources and contribute to build resilience to climate change reliance.

According to World Bank Data, 1 USD generated through agriculture is more effective in eradication of poverty than 2 – 3 USD earned from other sectors. When the rural area's income increases by 5%, the income of urban areas automatically increased by 8%.

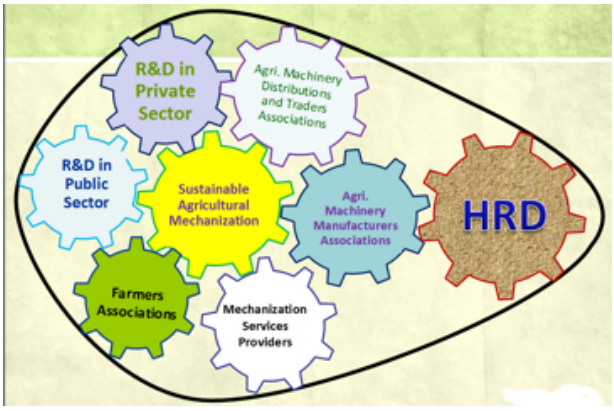
UNESCAP through CSAM is making an important effort to promote sustainable agricultural mechanization across the region. In the Asia Pacific Region where most countries are characterized by high employment rates in agriculture, it is crucial to effectively manage the human resource engagement in the sector.

Regarding the management of human resources, in Pakistan we typically focus on higher education and to a lesser extent to short training programmes. In this regard, we should also develop short training programmes along with accreditation programmes. One of the biggest problem in Pakistan is that both marketing capacity and production are limited.

Given the abovementioned, I think it would be important to strengthen vocational education by providing Professional Diploma programmes if the duration of 1 to 3 years and Certificate short term courses of the duration of 1 to 3 months. Regarding higher education there should be under graduate degree programs (Bachelors of Agricultural Engineering, Food Engineering, and Post-Harvest Technology) and postgraduate degree programs (M.Phil., PhD) and Post-Doctoral programmes. Major focuses should include:

- Precision agriculture
- Post-harvest technologies and value addition in fruits, vegetables & medicinal herbs
- Food processing (grading, packaging etc.)

- Milk and meat processing
- Livestock/dairy mechanization
- Aquaculture mechanization
- Standardization of agricultural machinery



The professional development of human resources should target technical, managerial and financial aspects of agricultural production. In this context, it will be important to engage in networking activities among practitioners including representatives from the private sector. Moreover, two other important steps needed in the Asia Pacific region are a stronger mechanism for development of patent development and standardization.

The involvement of the private sector will be particularly important specifically in advancements regarding the improvement of quality of products in the following areas:

- Material selection
- Jigs & fixtures
- Foundry
- Material for testing
- Design & development
- Fabrication (cutting, welding, milling, forging etc.)
- Heat treatment
- Marketing and distribution systems
- After sale services

In particular, agricultural machinery distributors and trader associations need to create more awareness among end-users by providing product catalogues in the local languages, online information, operator manuals and display their products at machinery exhibitions.

An important role can be played by farmers' associations to facilitate access to information. Specifically, to spread innovations from specialized institutes, the manufacturers websites and the distributors websites.

Agricultural machinery associations should invest in training of existing technical staff and in the establishment of raw material banks and foundries. Especially, associations could act as a bridge between different actors in mechanization, by providing information material, checking the application of standards and use of raw materials. Collaborations with provider should be based on establishment of rental service centers and development of managerial and entrepreneur skills. Providers should enhance their partnerships through a national and regional network of professional and work on capacity building of field staff.

To summarize the priorities for mechanization development in the region are as follows:

- Cross-sector support for the establishment of rental service centers
- Production of machinery and equipment respecting testing standards
- Establishment of raw material bank
- Effective displaying of new mechanized technologies in machinery exhibitions
- Financial and technical support for the establishment of machinery testing centers
- Establishment of professional institutional linkages
- Donors participation to boost the development of sustainable agricultural mechanization

Establishing Cooperation on Training and Vocational Education (TVET) Program on Agricultural Mechanization in Asia and the Pacific

Ms. Irene Isaac
Director General
Technical Education and Skills Development Authority
Philippines

Human Resource development in Agricultural Mechanization is the key for Agricultural modernization, as Sustainable Mechanization enhance Civil Mechanization. The region as the whole face the problem of attracting the youth towards training and education in agriculture. The urge to look for the way-out towards attracting the young is becoming more and more relevant.

The Philippines is specifically interested in ASEAN qualifications reference framework across ASEAN member states. This framework also enhances and supports countries' national education frameworks. ASEAN qualification reference framework could become a link towards European qualifications framework and other comparability mechanisms around the world. The Framework promotes mobility within the region by undertaking cross-border education and the flow of the workforce, facilitates free flow of services. It also helps to bring ASEAN countries closer in social and cultural dimensions. Agricultural mechanization is also included within the Framework system.

One of the most impeding moments is that if there's no National Skills Framework existent, it is very hard to come up with cross-border comparability of qualifications and blueprints towards recognition by the ASEAN framework.

The Philippines core principles for quality-assured system cover:

1. Pivot to competency-based system based on national framework system.
2. Priorities, standards and performance measures composed on users practice, documents of associations etc. are transformed into international benchmarks.
3. Available for secondary education graduates, for school-leavers, workers, and entrepreneurs. Limited specific competencies trainings are also available, e.g. for those with the higher educational background with a need for specific proficiency in the certain field.
4. Acceptance of skills achieved outside of the training centers for certification, e.g. through working experience.
5. Setting local quality-assured training centers at farms, enterprises etc.

There is a big challenge in the Philippines, as well as across the region, of enabling everyone to have an access to quality technical education. To address this challenge community-based trainings happening outside of the big cities at the farms and small towns. Another challenge for human resource development (HRD) in the Philippines, as well as across the region is the national employment

rate for graduates in the field of agricultural engineering. For Philippines, the rate now is 64.5%. Among the funded scholars, this rate goes up to 70.7%. In general, sizeable number of recent graduates encourage graduates and undergraduates in the field of agricultural engineering.

As it was noted above, National Assessment and Certification Centre allows recognition of skills gained through the working experience through the examination by credited assessors from the Centre. That means that anyone who will demonstrate the ability to meet the standards is given National Certificate. For example, in the period between July 2010 to December 2014, there were 4 million 438 thousand who participated in the assessing of the skills, among them 3,9 million gained the National Certificates.

Human Resource Development in Sri Lanka: Issues and Trends

Mr. Nandasiri Ratnayake Mudiyanselage
Additional Director General (Development)
Department of Agriculture
Sri Lanka

Human resource is a fundamental requirement for constructing or making anything. To achieve higher performance, it is necessary to upgrade skills of human resource in agriculture. The development of technology and machinery makes training of stakeholders, manufacturers, structural workers and farmers essential.

There are four big challenges in human resource development:

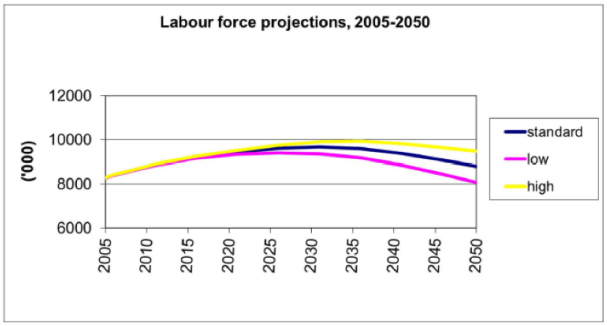
1. Population ageing and Reducing labor force
2. Globalization and human capital drain (brain drain)
3. Technological change and demand for better skills in labor force
4. Knowledge based economy and demand for highly skilled workers

Population ageing is one of the most important trends in human resource development in the recent years. The graph below is the depiction of the situation in Sri Lanka:

DCS, LFS

According to the UN population fund, one in eight people in the world are 60 years or older. Life expectancy increases rapidly, hence the percentage of senior population increases as well. Like in many other countries, the Sri Lankan labor force is ageing in a rapid pace.

According to UN population projection, labor force is growing slower and will soon decline. This global trend can be seen on the graph below: the production from 2005 2050



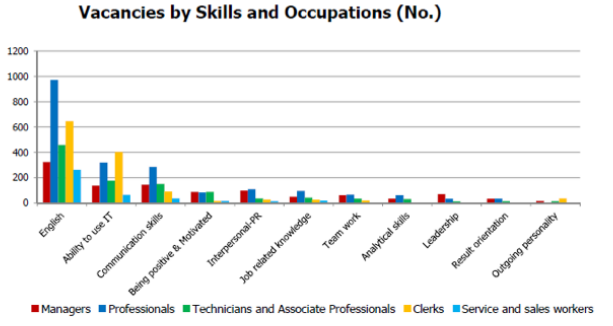
Source: Calculated using UN population projections and LFS data

There is a considerable flow inside the national stock of human resources from the youth reaching working age, immigrants and foreign workers.

The major outflows from the national stock are natural death rates, emigration, and the people that are not in the labor force (youth, retired seniors etc.)

I. Globalization and Technological Change: Increasing Demand for Skills not Matched by Supply

The world is becoming one interdependent global market. Technological changes have increased the demand for skilled workers in Sri Lanka. The need for machine operators have risen dramatically in recent years, and the overall number of professionals in all fields is rising in the fast pace. The demand for skilled IT workers have boomed in recent years in Sri Lanka. Demand for soft skills is also experiencing steep growth. The graph below shows that the demand for languages, computer and IT skills, communication skills, interpersonal PR, being positive and motivated, teamwork skills, analytical skills, leadership and result orientation is rising in Sri Lanka and everywhere else in the world across various range of professions.



Source: Based on LMI, 2009

II. Highly Skilled Workers: Low stock, Low quality, Underutilization.

To achieve higher performance in agriculture it is necessary to upgrade the skills of human resource engaged in the related fields of activities.

In the modern world different governments and companies struggle between each other to attract the best talent they can. This global battle for brains can be characterized by several governments statements:

“the UK needs lower taxes to attract and retain highly skilled workers” - the UK.

“What policy changes should be enacted to ensure that America retains and attract the world's top talent” - the US

“The battle for a brains halt to attract talent” - EU

“The issue: attractive and selecting the "best and brightest"” - the UK

Also it is noticeable that Sri Lanka have significantly lower human resource capabilities in the number of people qualified in science and technology. Training opportunities are low for adults. The current education studies in Sri Lanka (2009): in the age from 15 to 19, more than 60% of population engaged in some kind of education including general education universities and vocational training. From the age of 20 to 24, this percentage is only below 20%; from the age of 25 to 29, this percentage is below 5%; while from 30 to 34, this percentage is nearly non-existent

In conclusion some considerations on how to develop human resources divided by three objectives:

- Maximizing labor resources: improve participation of females and youth; flexible terms of work; better child care services; smoother school to work transition; continuous training opportunities.
- Increasing highly skilled workers: improving living standards; training opportunities for older workers, better remuneration; expanding tertiary education.
- Improving skills: improve the quality of education; continuous training; globally recognized training; improve relevance of education; soft skills training.

Human Resource Development in the Process of Agricultural Machinery Operation Services

Mr. Chang Zhouwei
Overseas Key Account Director
Zoomlion Heavy Machinery
China

I. Importance of Human Resource in Agriculture Mechanization

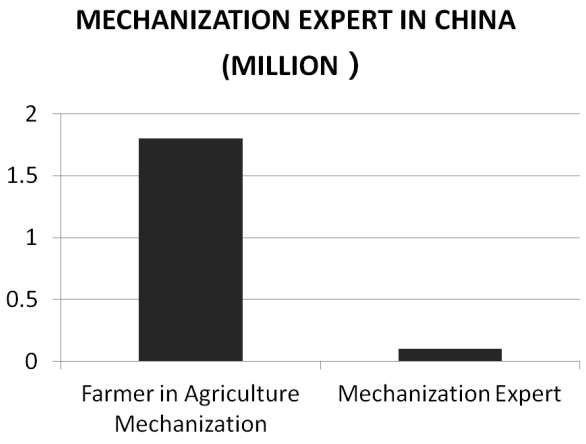
Agriculture has shifted from a subsistence activity to a full time profession, which requires higher skills and broader knowledge. Modernization caused privatization of agriculture and the development of larger agricultural projects.

Large scale projects, besides technicians, need farm managing skills to generate higher output and profit. In order to sustain modern agricultural mechanization, it is then essential to train human resources. In Zoomlion, we divide human resources into three categories:

- **Management expert:** land consolidation requires manager experts being able to coordinate planting, harvesting and the overall organization of farming operations. These professionals are required to have a background in business management and agriculture.
- **Mechanization expert** to take care and operate agricultural equipment.
- **Service providers** provide all kind of services from planting to harvesting.

Specifically, the Mechanization Expert has to increase the value of agricultural production by overseeing mechanical operations. This includes maintenance, management and improvement of machinery. In particular, it is very important to have experts being able to improve the machinery based on the situation on the ground.

Mechanization experts are particularly important in China because of the high number of large farms and the strong tendency toward land consolidation. In 2013, China had an increasing mechanization rate of 61% with an average increase of 4% yearly. Furthermore, the machinery used in China is characterized by higher horse power, multi-function and specified purpose machinery.



An important factor to be considered in the Chinese contest is that

machinery is often used cross-region for mechanical operations during harvesting season. Currently, there are over 168,000 machinery service providing organization, of which 42,000 are cooperatives. For example, in 2013, out of 500,000 wheat combined harvester, 300,000 were operated in cross-region modalities. Overall, in 2013 more than 36 million ha were cultivated using cross-region machinery operation. This trend highlights the importance of human resources training. When the machinery is used in a cross-region scheme, it is important that the operators are well trained to use the rented equipment. It is important to have a team of professionals to operate the machinery, fix the problems and coordinate cross-region transportation.

From our experience as service providers, we understood that having a well-trained team to design all the phases of cross-region operations is very important. We provide transportation for the machinery, an operational team, a call centre and a large number of local dealers to fix the problems in the fields.

Based on our experience and the needs we have encountered on the ground, we have come up with the following set of priorities to enhance training of human resources:

1. Re-definition of farmer: it is important to re-define basic knowledge, education and capacity requirements for farmers.
2. Change of training modalities: in the past, the training system was based on short term trainings. Nowadays, farmers need comprehensive education that allows to operate all kinds of machinery, from tractors, fertilizers to irrigators.
3. Multi-source of education: bring experienced farmer, manufacturer, university professor, cooperatives and agriculture enterprise to the education system.
4. Certified knowledge and skills system: there must be a standardized method to classify farmers' knowledge and skills.

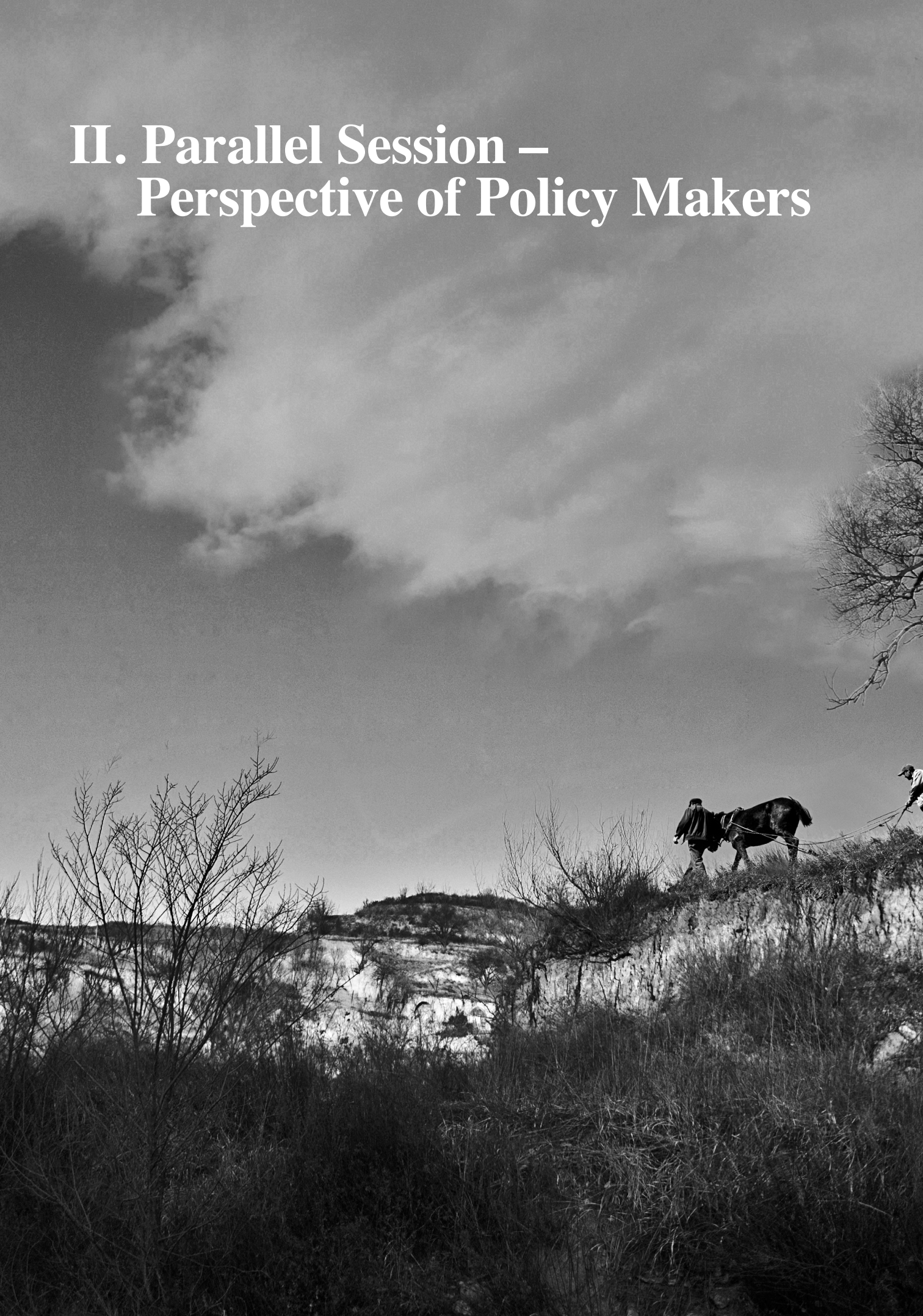
Based on the above, Zoomlion, under the guidance of Ministry of Agriculture, the Ministry of Education and in collaboration with more than 110 partners in the field of agriculture, established China Modern Agricultural Equipment Vocational Education Group.

The plan is to mobilize resources in the next 3 to 5 years to develop a network and to build a technical training centre to practice and study the use of modern machinery. After the training, farmers can have a certification that evaluates their capacities and abilities. In addition, specific courses can be designed based on the feedbacks and requests from the fields. Furthermore, the network aims at providing online consultant services and machinery information. In the future, this model can be internationalized to conduct international cooperation activities.

The latest activity organized by our Mechanization Division was the National Agriculture Machinery Skills Competition in collaboration with the Ministry of Agriculture. More than 2000 farmers participated from all over China and 76 arrived in the final round of the competition. Participating farmers included: technicians, operators, head of cooperatives and farm owners. The participants were divided into three subgroups based on their specialization (tractor, combine harvester, other machinery). The competition consisted in a theoretical test and a practical test concerning operational management and spare parts replacement.

In conclusion, two starting points are requested to enhance the technical level of human resources: 1) encourage more farmers to engage in education; and 2) establish an agriculture mechanization expertise certificate system.

II. Parallel Session – Perspective of Policy Makers



Photoed by Wang Jianhua

Bangladesh

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I. Overview of Human Resource Development Work in Bangladesh

1. Current Number and Employment Status of Agricultural Mechanization Workforce

The Agricultural Engineers are serving at various public and private sectors and NGOs in Bangladesh. They are making substantial contribution towards promotion of agricultural mechanization. The different organizations in Bangladesh where the Agricultural Engineers are working with reputation are: Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI), Bangladesh Institute of Nuclear Agriculture (BINA), Bangladesh Jute Research Institute (BJRI), Bangladesh Sugar Crop Research Institute (BSCRI), Bangladesh Agricultural Research Council (BARC), Department of Agricultural Extension (DAE), Rural Development Academy (RDA), Bangladesh Agricultural Development Corporation (BADC), Bangladesh Water Development Board (BWDB), Rural Electrical Board (REB) etc.; different universities of Bangladesh like Bangladesh Agricultural University, Sylhet Agricultural University, Sher-e-Bangla Agricultural University, Hajee Danesh Science and Technology University etc.; NGOs such as BRAC, PROSHIKA, RDRS, CIMMYT, WARPO, BSTI etc.; private agri-business institutions and various food processing industries.

Actually current statistics of workforces are unavailable due to various reasons. A few are available in the individual website which is enumerated in Table 1.

Table 1: Employment Status of Available Agricultural Mechanization Workforce

Institution	Division/Revenue/Project	Number	Occupation
Bangladesh Agricultural Research Institute (BARI)	Farm Machinery and Postharvest Process Engineering Division	10	Researcher
	Irrigation and Water Management Division	9	Researcher
	Machinery Repair and Maintenance Division	2	Researcher
	Postharvest Technology Division	7	Researcher

Bangladesh Rice Research Institute (BRRI)	Farm Machinery and Postharvest Technology Division	12	Researcher
	Workshop Machinery and Maintenance Division	4	Researcher
	Irrigation and Water Management Division	10	Researcher
	Grain Quality & Nutrition	2	Researcher
Bangladesh Institute of Nuclear Agriculture (BINA)	Agricultural Engineering Division	4	Researcher
Bangladesh Sugar Crop Research Institute (BSCRI)	Agricultural Engineering Division	4	Researcher
Bangladesh Jute Research Institute (BJRI)	Mechanical Processing Division	4	Researcher
Department of Agricultural Extension (DAE)	Revenue Post Development Post	25 30	Agricultural Engineer
Bangladesh Agricultural University (BAU)	Farm Power and Machinery Department	22	Teacher
	Irrigation and Water Management Department	19	Teacher
	Farm Structure Department	10	Teacher
Sylhet Agricultural University (SAU)	Farm Machinery Department	3	Teacher
	Irrigation and Water Management Department	7	Teacher
	Agricultural Construction and Environment Engineering Department	4	Teacher
Hajee Danesh Science and Technology University (HDSTU)	Department of Agricultural & Industrial Engineering Department	9	Teacher
Sher-E-Bangla Agricultural University	Department of Agricultural Engineering Department	3	Teacher

2. Agencies/Institutions Involved in Agricultural Mechanization Human Resource Development and their Current Programs/Projects

2.1 Bangladesh Agricultural Research Institute (BARI)

The list of trainings and field demonstrations on BARI developed farm machinery during 2014-2015 are given in Table 1. 59 training batches were conducted by Farm Machinery and Postharvest Process Engineering Division, BARI, of which 1,205 trainees were trained on BARI developed Farm Machinery. Different categories of participants, such as Upazila Agricultural Officers, Scientific Officers Assistant Professors, Lecturers, Sub-assistant Agriculture Officers (SAAO), Mechanic, Scientific Assistant, Farm Machinery Manufacturers and farmers were trained. Farmers' trainings were conducted in the Farm Machinery Technology Development and Dissemination (FMTD) project sites. Others trainings were arranged at Farm Machinery and Postharvest Process Engineering Division, BARI, Gazipur. The training courses have covered both theory and practical lessons on BARI developed farm machinery.

Aside from the trainings, 130 field demonstrations were conducted in different locations of the country under the project. In each field demonstration, 40 farmers participated and the total number of farmer participants during the demonstration was 5,200. These field demonstrations were conducted on BARI high speed rotary tiller, BARI USG (Urea Super Granule) applicator, BARI compost separator, BARI bed planter, BARI multi-crop thresher and winnower, etc. These field demonstrations were arranged in different project sites, such as, Manikgonj, Rajbari, Magura, Jhenaidah, Pabna, Shirajgonj, Barisal and Jhalokathi, Sherpur and Rangpur districts. All field demonstrations were conducted with direct collaboration of Department of Agricultural Extension (DAE). Farmers, local government representatives and DAE personnel participated in the demonstration programs. All of those participants of the demonstration remarked positively about the BARI developed farm machinery. Details are given in Table 2.

Table 2. List of Trainings and Field Demonstrations Conducted by FMPE Division during 2014-2015

Sl.	Name of training course	Duration (day)	No. of batch	Category of trainees	Trainees per batch	No. of person trained	Source of fund
1	Uses of Farm Machinery and Efficient Irrigation System Management	5	1	NARS Scientists and University Teachers	25	25	BARC
2	BARI Developed Farm Machinery	1	1	UAO	20	20	GoB (FMTD)
3	BARI Developed Farm Machinery	1	10	SAAO	22	220	GoB (FMTD)
4	BARI Developed Farm Machinery	2	45	Farmers/ operators	20	900	GoB (FMTD)
5	Mechanic Training	1	1	Mechanic	25	25	BARC
6	Manufacturing Technique of BARI Farm Machinery	5	1	Farm Machinery Manufacturers	15	15	GoB (FMTD)
7	Field demonstration on BARI Developed Farm Machinery	1	130	Farmers	40	5200	GoB (FMTD)
	Total Training		59			1205	
	Total Field Demo		130			5200	
	Grand Total		189			6405	

2.2 Bangladesh Rice Research Institute (BRRI)

Project: Farm Machinery Technology Development (FMTD) Project: BRRI Component

The objectives of this project were: to disseminate BRRI developed farm machinery to the farmer's field, create awareness among the farmers towards farm machinery use, minimize pre and postharvest losses through mechanization and improve the operational skills of the farmers on the use of farm machinery. The demonstrations in training progammes were conducted under this project. Technologies are: BRRI developed Thresher (Open drum, TH-7), BRRI USG/Prilled Urea Applicator, Power Tiller Mounted Reaper, BRRI Winnower and BRRI Weeder. The awareness among the farmers on the benefits of using BRRI farm machinery was created through demonstration in training programme. Nowadays, more farmers have been using BRRI machines including weeder, thresher and winnower. Adequate subsidies were provided to farmers for effective dissemination of costly farm machinery. Details are shown Table 3.

Table 3. List of Trainings and Field Demonstrations Conducted by Farm Machinery and Postharvest Technology Division of BRRI

Training/Demonstration	Number of participants per batch	Duration	Number of batch	Number of persons
Farmers/operator s training	20	2 days	221	4420
Field demonstration	40	1 day	664	26560
Scientific Officers training	25	1 day	2	50
Machinery manufacturer training	15	5 days	7	105
Sub-Assistant agricultural officer training	22	1 day	8	176

2.3 Department of Agricultural Extension (DAE)

The Department of Agricultural Extension (DAE) is a service oriented government organization under the Ministry of Agriculture. It encourages various partners and agencies within the national agricultural extension system to provide efficient and effective services which complement and reinforce each other, in an effort to increase the efficiency and productivity of agriculture in Bangladesh. DAE provides farmers training on specific technology under the activities of different projects. Keeping pace with the global technological development, DAE implements three projects to encourage the farmers in mechanization at different stages of crop production system. Farmers are trained in farming mechanization and improving irrigation and water management practices as shown in Table 4.

Table 4. List of Different Trainings and Field Demonstrations Under Three Projects Conducted by DAE

Project Activities	Projects		
	Enhancement of crop production through farm mechanization	Enhancement of crop production through improved on-farm water management technologies	Farm machinery technology development and dissemination project
Training, persons	Mechanic/farmers 36000	Farmers 5600 WM	Farmers 2200
Workshop, persons	Diff. level of Stakeholders 1200	1 WM	-
Agricultural Fair, nos	All farm machinery 2	-	-
Demonstrations, Nos.	Agricultural machinery 13000 Mechanized farm 20	10800 WM	185
Field Day, persons	-	90,000 WM	-

II. Strategies, Policies, and National Programmes/Initiatives of Human Resource Development of Agricultural Mechanization

Rapid expansion of mechanization is needed due to the dearth of animal draft power, farm labors and declining interest of young people in traditional agriculture.

DAE organizes trainings and demonstrations for farmers on agricultural, social and environmental development in their technology transfer process. Several other training institutions teach and train personnel who serve in agriculture sector. These institutions are National Agricultural Training Academy (NATA) in Joydebpur, Graduate Training Institute (GTI) attached to Bangladesh Agricultural University (BAU) in Mymensingh and 12 Agricultural Training Institutes (ATIs) located throughout the country. However, the training facilities vary considerably among the institutes and generally inadequate and need support for overall improvement.

Bangladesh, in the 7th five-year plan (2016-2020), human resources development and institutional capacity building for all research & extension agencies are as follows:

- Higher education (MS, PhD/Post-doc) at home & abroad
- Skill development training for officers and staffs at home & abroad
- Capacity building training in ICT
- Overseas training & study visits, seminar, workshop for scientists/officers
- Knowledge & technology based skill development training for farmers, traders & entrepreneurs
- Motivational tours/exposure visit for farmers

III. The Need Assessment of Human Resource Development of Agricultural Mechanization in Bangladesh

Development of skill and knowledge of the researchers working for the improvement of agricultural machinery is of immense importance. This can be achieved through trainings and visits to the countries with updated modern technologies in use. Such trainings and visits will enable the researchers to work with improved skills and adequate confidence.

The machine users, artisans and traders are mostly illiterate and don't have substantial knowledge and skills on machinery operation, repair and maintenance. The manufacturers do not provide 'after sale services' to the users. From field experience, it has been found that machines are left without working for minor and easily repairable faults. On availability of an artisan or a mechanic, the farmers get them repaired for a

substantial amount of money. But in other cases where mechanics are not readily available, they leave the machine without operation. The village artisans are rarely trained and lack adequate knowledge and skill about machines.

IV. Challenges and Constraints Faced by Human Resource Development of Agricultural Mechanization in Bangladesh

Agricultural research has been a neglected area with low budget allocation and comparatively lower research and financial facilities for scientists. This largely resulted in the "brain drain" of trained professionals who migrated to research centers of developed countries. This trend needs to be reversed by increasing research and extension allocation of budget to at least 5% of Agricultural GDP as against 1.5% of current allocation, including in situ promotion with good governance and accountability.

V. Solutions and Suggestions for Human Resource Development for Sustainable Agricultural Mechanization

Presently, the government has given emphasis on farm mechanization and is funding for rapid agricultural mechanization. But the problem lies with the development of expertise and skills of the researchers and the manufacturers. Both researchers and manufacturers need appropriate trainings on improved farm mechanization and associated machines so that they can design and develop better machinery. Further, the existing institutes do not have the proper modern facilities for fabricating and testing these machines. So, funds are required from donors for these purposes in addition to research and development.

Cambodia

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I. Status of Agriculture in Cambodia

1. Background

Cambodia is a country which occupies the southern part of Indochina and borders with Thailand to the north and west, Lao PDR to the northeast, and Vietnam to the east and southeast and it has a 443-kilometer (275 mi) coastline along the Gulf of Thailand, see Figure 1. The country has a land area of 181,035 square kilometers (69,898 sq mi) of which nearly 20 percent is under agriculture. It lies entirely within the tropics, between latitudes 10° and 15°N, and longitudes 102° and 108°E.

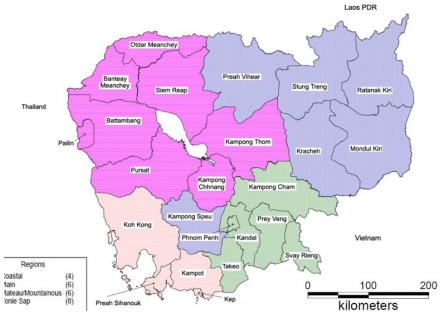


Figure 1: Map of Cambodia

The country's central plain, which comprises 75% of the total land area, is 10 to 30 meters above sea level. The plain area is drained by the Mekong, Tonle Sap Lake, and Basac Rivers through the Mekong Delta in Southern Vietnam. Other areas of the country are heavily forested, with mountainous area forming the border with Thailand and encircling Cambodia's central plains. To the north, the sandstone Dangrek Range extends eastward along the Thai border, falling abruptly southward to the plain. It mainly comprises of 24 provinces and the southwest provinces are covered by the granite Cardamom Mountains, with the highest peak at 1,813 meters. The lowland area around Tonle Sap great lake has the largest potential for agricultural and fisheries production.

In Cambodia, the main rainy season occurs from the period of Pisak (May) to Kadic (November) with September and October being the wettest months. The dry season is from the beginning of Kadic (November) to end of Chet (April). Rice is the most important food grain in Cambodia. Other crops grown are corn, sweet potatoes, cassava, peanuts, mung beans, sugar cane and vegetables.

Currently, more farmers are using agricultural machines in farming. However, the use of traditional tools and local made machines is still practiced by some farmers, especially those whose farms are not suitable to use the machinery, since their farm size is small or not leveled. These farmers cannot afford to use expensive machines and cannot use them to their full capacities.

1.2 Agricultural production in Cambodia

Cambodian farming systems are largely subsistence oriented and are dependent on rain fed conditions, thereby excessively exposing producers to production uncertainties. Most agricultural activities are based on low inputs and rain-fed production systems centered on paddy rice production.

Cambodia grows a range of agricultural crops over a cultivated area of 4,505,267 ha out of its total land area (181,035 km2), see Table 1. The paddy, which is the main crop, occupies about 68% of the cultivated area, followed by subsidiary and industrial crops which is 21%, rubber plantation which is 7%, and permanent crops of 4%.

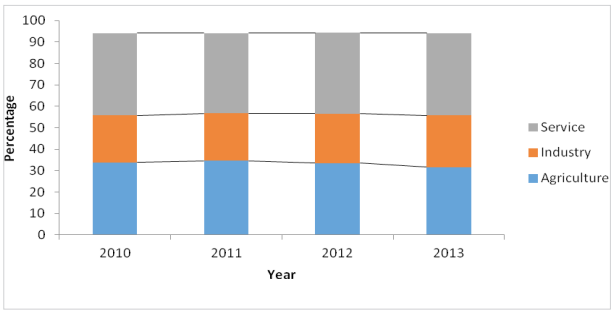
Table 1: The Cultivated Area in Cambodia in 2013

Crops	Cultivated area (ha)	Remarks
Rice crop	3,052,420	Wet & dry seasons, receding, floating
Subsidiary and industrial crops	941,028	Maize, cassava, sweet potatoes, vegetables, all kinds of bean, sesame, sugar cane, tobacco etc.
Permanent crops	183,048	Cashew, banana, oil palm, coconut, mangoes, coffee, durian, pepper, orange, and other fruit etc.
Rubber plantation	328,771	
Total	4,505,267	

Source: MAFF, 2014

The share of agricultural sector in the Gross Domestic Product (GDP) for the last four years remained fairly constant (Figure 2). Its contribution was about 33% on average, while industry and services were about 23% and 38% respectively. The increase or decrease of the contribution of agriculture sector was dependent on the other two sectors.

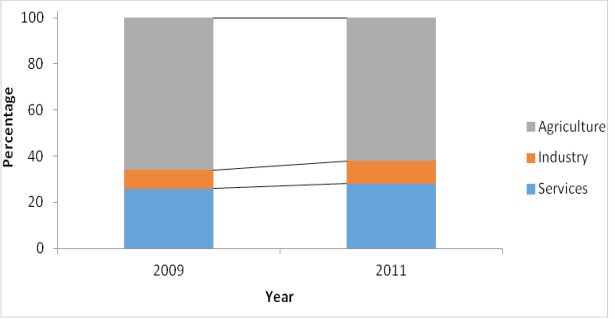
Figure 2: Share of Agricultural Sector in GDP from 2010 to 2013, Excluding Tax



Source: MAFF, 2014

Although the agriculture sector increases in both productions and yields, the share of labor force in agriculture had decreased from 66% in 2009 to 62% in 2011 (Figure 3). This decline was likely caused by farmers' migration to work in the cities, or the foreign countries such as Thailand, Malaysia, and South Korea.

Figure 3: Share of Labor Force in Agriculture in 2009 and 2011



Source: MAFF 2014

II. Overview of Human Resource Development Work in the Field of Agricultural Mechanization in Cambodia

1. Current Status of Agricultural Mechanization Workforce

Currently, more farmers are using agricultural machines in farming. However, the use of traditional tools and local made machines is still practiced by some farmers, especially those whose farms are not suitable for the usage of machinery since their farm size is small or not leveled.

As the demand for food increases, so the population grows. This is an opportunity for farmers to expand their food production by intensification. For example, some regions used to produce one crop per year; now, farmers grow two or three crops per year on their lands, or they expand growing areas. These are the reasons which forced farmers to begin using agricultural machines.

However, the majority of agricultural machinery users in Cambodia are less trained in any vocational training institutions. Normally, most of the users get little training from the seller in many agricultural machinery shops after buying an agricultural machine or equipment, and some have learned from friends or other people who have experiences on that particular machine or equipment. As a result, most of the agricultural machinery users are facing many problems, such as agricultural machines having technical issues in the field, which forces agricultural machinery users to spend more money on maintenance and repair for the agricultural machinery.

Beside this, local manufacturers, normally, produce threshers, water

pumps, local-made trucks for transportation, trailers, implements and spare parts. Threshers, which can be trailer or self-propelled types, are produced by local manufacturers in several provinces. Due to their technological capacities, they can manufacture only simple machines which do not require sophisticated production process or tools. Normally, they are small-scale or family-owned manufacturers.

Meanwhile, the statistical data on agricultural mechanization workforce is not available in Cambodia.

2. Institutions Involved in Agricultural Mechanization for Human Resource Development

- There are several institutions that are involved in agricultural mechanization for human resource development activities in Cambodia;
- Department of Agricultural Engineering of the General Directorate of Agriculture;
- Agricultural Engineering Division of Cambodia Agricultural Research and Development Institute;
- Provincial Office of Agricultural Engineering of the Provincial Department of Agriculture;
- Faculty of Agricultural Engineering of the Royal University of Agriculture;
- Faculty of Agriculture and Food Processing of the Meanchey University;
- Agricultural Mechanization Division of Preak Leap Agricultural School; and
- Several organizations such as NGOs and private companies providing short training courses on repair and maintenance of agricultural machinery and equipment.

2.1 Department of Agricultural Engineering

The Department of Agricultural Engineering (DAEng) is supervised by the General Directorate of Agriculture (GDA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF).

This department is mainly responsible for management, research and development, capacity building, and monitoring and evaluation in the field of agricultural mechanization in Cambodia and has its specific mandate as follows:

- Research on farm machinery & equipment and identified zoning for using agricultural equipment and machinery based on the classification of soils and type of crops in order to develop the agriculture sector;
- Research on appropriate pre and post-harvest technologies and value chains for agricultural production;
- Create guidelines and regulations on the utilization of farm machinery for agricultural production; and
- Make recommendations and provide technical extension on the utilization of farm equipment and machinery to users and relevant stakeholders.

The Department of Agricultural Engineering consists of 8 offices and 2 agricultural engineering centers listed below:

1. Administration, Planning, Accounting and International Cooperation Office;
2. Agricultural Pre-harvest Technologies Office;
3. Agricultural Post-harvest Technologies Office;
4. Agricultural Engineering & Agricultural Land Reform Office;
5. On-farm Irrigation Office;
6. Training & Community Development Office;
7. Toul Samrong Agricultural Engineering Center, Battambang province; and
8. Kbal Po Agricultural Engineering Center, Takeo province.

The main research and development activities on agricultural mechanization are in collaboration with the provincial department of agriculture, farmers and communities in the provinces.

2.2 Division of Agricultural Engineering of CARDI

The Division of Agricultural Engineering (DAE) is supervised by the Cambodian Agricultural Research and Development Institute (CARDI) of the Ministry of Agriculture, Forestry and Fisheries.

The DAE aims to increase the productivity and quality of agricultural crops through improving pre and post-harvest operation technologies which includes the development of prototypes. This DAE has conducted several experiments for pre and post-harvest research activities that focuses on cereal, legumes and vegetables.

The DAE program undertook a research and development program that help farmers to improve the efficiency and sustainablility of rice and non-rice crop production.

The Cambodian Agricultural Research and Development Institute (CARDI) is a semi-autonomous institution which is governed by a board of directors. It was established in 1999 and was founded upon a research program called CIAP, mainly concerned with rice

production.

2.3 Agricultural Universities and Schools

At present, there are several agricultural universities and schools that offer bachelor degrees for students who want to study in the field of agricultural engineering/mechanization.

Due to shortage of machines and equipment, most of the universities give more attention to lectures, than to the demonstrations and practice. As a consequence, students are not capable of producing good results after testing a machine or equipment.

2.4 Provincial Office of Agricultural Engineering

The Provincial Office of Agricultural Engineering (POAE) is supervised by the Provincial Department of Agriculture. The main activity of the provincial office is to apply and demonstrate agricultural machinery and equipment to farmers and communities in the province. Beside this, POAE also provides short course trainings to farmers and end users on repair and maintenance of agricultural machinery.

2.5 Vocational Training on Agricultural Machinery

There are several public, private organizations and NGOs that offer vocational or short course trainings to students who prefer to study on a short-term basis and then, they can find a job with private companies or open agricultural machinery repair shops on their own in their communities.

III. Strategies, Policies, and National Programmes/Initiatives of Human Resource Development of Agricultural Mechanization

The Royal Government of Cambodia (RGC) has set up the policy for promoting the rice production and exportation. Besides this, the RGC has set up recently the action plan for implementing policy paper on the promotion of paddy production and rice export. The RGC has set the year 2015 as the target year to: (1) achieve paddy surplus of more than 4 million tons and achieve rice export of at least 1 million ton; (2) ensure the international recognition of Cambodian rice. There are 2 approaches that had been defined by the Ministry of Agriculture, Forestry and Fisheries. These are as follows:

- For the short and immediate term, promote paddy production to meet market demand and promote rice export by shifting from the informal export to formal rice export; and
- For the medium and long term, focus on enhancing competiveness in rice export through the promotion of production technology, quality improvement, processing capacity, development of physical infrastructure, credit, trade facilitation and exploring market opportunities.

Regarding the government policy for promoting the rice production and exportation, the strategic plan on agricultural mechanization has been prepared always by the Department of Agricultural Engineering since 2011. This strategic plan aims at enabling access to mechanization, skill development, strengthening of commodity chains, and improving policy, legal and regulatory environment. It will serve as the four key drivers in promoting agricultural mechanization.

1. Enabling Access to Mechanization
   - Field mechanization options for Cambodia
   - Improving supply chain
   - Financing
   - Support services
   - Enabling designs
   - Alternative energy for farm production

2. Skill Development
   - Technical skills
   - Knowledge creation

3. Commercialization of Agriculture
   - Pre-harvest technologies
   - Post-harvest technologies

4. Better Policy, Legal and Regulatory Environment
   - Formulation of farm machinery laws and regulations
   - Cooperation between public, private sector and farmers
   - Gender mainstreaming
   - Environmental protection and climate change

However, the strategic plan on agricultural mechanization is not functioning and lacking of fund support to make it work effectively.

In order to address the problems of human resource development for agricultural mechanization in Cambodia, the Department of Agricultural Engineering has initiated and planned to establish agricultural mechanization services through entrepreneurial farmers. At the beginning, the government could help these farmers

establish the required services and at the same time, empower these farmers to provide the services on their own.

IV. Challenges and Constraints Faced by Human Resource Development on Agricultural Mechanization in Cambodia

The agricultural mechanization in Cambodia has grown significantly in the last few years. There are a number of reasons behind this growth, including migration of labor force from rural to urban areas or abroad, climate change and the price increase of agricultural products. However, there are still some issues in the promotion of agricultural mechanization which requires attention, support and incentive from the government as well as other stakeholders in order to sustainably develop the agricultural mechanization sub-sector.

- **Lack of HRD strategy in agricultural mechanization:** HRD strategy on agricultural mechanization is yet to be formalized;
- **Limited human resource:** The skilled workforce is still inadequate in agricultural mechanization in both national and provincial levels. Structure of the Provincial Office of Agricultural Engineering is still weak. There is no staff responsible for agricultural mechanization below the provincial level;
- **Limited financial resouce:** The annual budget allocated by the government for the implementation of agricultural mechanization activities fails to cover nationwide mechanization programme. External support for the development and promotion of farm mechanization are still inadequate;
- **Insufficient training and field demonstrations:** Due to limited budget support and lack of human resources, short course trainings and field demonstrations on agricultural machinery are limited;
- **Weak extension worker:** Most of agricultural extension workers have no background on agricultural mechanization, and
- **Lack of collaboration:** There is a gap in cooperation with universities, private sector and development partners dealing with agricultural machinery.

V. Conclusion

Cambodian agriculture will remain the key factor to contribute to the economic acceleration, and this sector is able to provide food for daily living conditions, supply raw materials for industries, and also able to be a main source of national revenue generated from domestic and export production.

Farmers have increasingly started to use agricultural machines since 2009 for their farm lands because of migration of young people from rural areas, who are moving to work in urban areas for garment factories, shoe factories, constructions or to work abroad. Another reason is climate change and, the increasing demand for food, which follows the population growth.

The majority of agricultural machinery users in Cambodia are less trained in any vocational training institutions. Normally, most of the users get little training from the sellers of agricultural machinery shops after buying agricultural machine or equipment, and some have learned from friends or other people who have experience in operating that particular machine or equipment.

Local manufacturers, normally, produce threshers, water pumps, local-made trucks for transportation, trailers, implements and spare parts. Threshers, which can be trailer or self-propelled types, are produced by local manufacturers in several provinces. Due to their technological capacities, they can manufacture only simple machines which do not required sophisticated production process or tools. Normally, they are small-scale or family-owned manufacturers. Short training courses and field demonstrations on agricultural machinery for farmers at the community level are limited and weak due to limited budget support and lack of human resources;

There are some issues related to the human resource development in agricultural mechanization as below:

- Lack of HRD strategy on agricultural mechanization;
- Inadequate skilled workforce in agricultural mechanization exists at both national and provincial levels;
- Lack of human and financial resources support;
- Most of agricultural extension workers have no background on agricultural mechanization;
- The relationship among public, private sectors and development partners are not in very favorable condition;
- There is a gap in cooperation with universities and the private sector that deals with agricultural machinery; and
- Most of the faculty of Agricultural Engineering/Mechanization give more lectures than demonstrations and practices.

VI. Suggestions for Human Resource Development for Sustainable Agricultural Mechanization

There are some key driving factors that should be considered as per below:

- Develop HRD strategy to enhance the agricultural mechanization sub-sector in Cambodia;
- Provide human and financial resources support on education, training and R&D for agricultural mechanization activities;
- Create a curriculum to meet the current development of agricultural machinery in the country;
- Conduct trainings that need assessment in agricultural mechanization for all levels to support agricultural mechanization activities;
- Provide in-service training for extension officers and workers to improve their knowledge and skills of agricultural mechanization;
- Improve collaboration with the public sector, private sector and development partners as well as agricultural universities in order to develop agricultural mechanization in Cambodia; and
- Better information sharing and extension of the technology through national and regional workshops on the benefits of agricultural mechanization.

China

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Ministry of Agriculture

I. Current Status of Agricultural Mechanization in China

The Chinese government pays great attention to the development of agricultural mechanization. The implementation of the Law of the People's Republic of China on the Promotion of Agricultural Mechanization in 2004 ushered in a golden decade for China's agricultural mechanization characterized by fast development. Farm machinery purchase subsidies from the central government finance increased to RMB 23.75 billion in 2013, from RMB 70 million in 2004, with the cumulative amount close to RMB 120 billion over the past 11 years. Additional measures have also been taken by the government. With such strong central and local government backing, China's agricultural mechanization has experienced great leap in development.

Firstly, the total holdings of farm machinery have increased rapidly. By the end of 2014, the total power of farm machinery nationwide had reached 1.08 billion KW, 1.6 times than that of 2004.

Secondly, the mechanized level of farming operations has risen significantly. The national integrated farming mechanization level in 2014 reached 61.6%, 27 percentage points higher than in 2004 — the growth is equivalent to the total of the previous 35 years.

Thirdly, the mechanized level of main crop production has experienced dramatic growth. For example, the whole process of wheat crop production is now possible with machinery operation. The mechanized level of rice cultivation has increased from 6.3% in 2004 to 39.5% in 2014, and the mechanized level of rice harvesting has grown from 2.5% to beyond 57%, while that of rice harvesting has exceeded 84%.

Fourthly, service organizations such as cooperatives for agricultural mechanization have undergone fast development, with their gross operating revenues in 2014 exceeding RMB 530 billion, more than double than that in 2004. There are now more than 42,000 agricultural machinery cooperatives throughout the country.

Fifthly, the agricultural machinery industry has been developing continuously and quickly for many years, achieving an annual growth of over 10% on an average in the past decade. The total output value of the agricultural machinery industry reached approximately RMB 400 billion, accounting for 45% of the total output value of the global agricultural machinery industry.

Yet problems also exist in the progress of China's agricultural mechanization. Uneven development across the sectors, crop types and regions is one of them. The planting sector has seen high agricultural mechanization level, while that of the animal husbandry, fishery and forestry sectors is much lower. Within the planting sector, the mechanization level of food crops is much higher than that of cash crops. In terms of regional disparity, plains

boast higher mechanization level than hilly areas. And some farm machinery operators should improve their skills and abilities for the utilization and maintenance of agricultural machinery.

II. Personnel Training in Agricultural Mechanization in China

China is a populous country with a big agricultural sector. It is also home to abundant personnel resources in the field of agricultural machinery. Currently, there are over 5,600 industry professionals in agricultural machinery research, machinery operation, maintenance, management, education and training, and technical extension, over 90% of whom are service personnel for the operation of agricultural machinery. The Chinese government has always taken personnel training for agricultural machinery seriously and has carried out a large amount of such trainings that have proved to be productive over the years.

1. Consistent improvement in the education and training system

There are now over 1,800 educational and training institutions on agricultural mechanization in China, with more than 20,000 professionals. A complete education and training system has formed in the field of agricultural mechanization centering around such educational and training institutions of various types and on all levels, and complemented by research institutes, technical extension agencies, production companies and service organizations.

2. Rich and practical content in training and educational programs

- Basic knowledge and skills on the operation of agricultural machinery: The programs teach farmers how to operate farm machinery efficiently and ensure safe production.
- New skills and technologies of farm machinery: In recent years, trainings have been carried out on rice seedling nursery and transplanting, mechanized harvesting of corn, rape and potato, mechanized subsoiling, conservation tillage, water-efficient dry land farming, precision seeding, and horticulture under structure.
- Integration of farm machinery with agronomy: More agronomic techniques on new variety breeding and cultivation have been added to the curriculum.

III. Strengthened Training Capabilities

Training institutions have been improving their infrastructure, teaching staff and teaching tools and materials. Innovations in the method of training have also been conducted to enhance the quality of training. Easy-to-understand and illustrative books and audio-visual training materials have been developed to meet the diversified needs of farmers. And adapting to the fast development of the Internet, online lessons are provided. Farmers can download the training videos and watch them and learn by themselves in their spare time.

IV. Established Training System

China's Ministry of Agriculture has formulated a series of rules and regulations, including the Management Measures on the Training of Tractor Operation. Provincial authorities in charge of agricultural mechanization have also drawn up work plans, schemes or implementation suggestions that suit local realities. Evaluation measures have also been put together to ensure effectiveness.

In the past 5 years, over 5 million personnel have received government-backed trainings, 85% of whom are farm machinery operators.

V. Suggestions on Enhancing Personnel Training in Agricultural Machinery in the Asia Pacific Region

1. Reinforce the cultivation of scientific and technological innovation personnel

Deng Xiaoping, the chief architect of China's reform and opening up policy, famously said, "Science and technology constitute the primary productive force". Scientific and technological innovation, like the lever that can move the entire world, can always create unexpected miracles. Exchanges and cooperation in the cultivation of innovation personnel in the field of agricultural mechanization should be intensified in Asia Pacific to encourage young people in the region to participate in machinery research and development. Universities and research institutions in particular should step up their efforts. A joint working mechanism should be set up for agronomic and mechanical engineering experts to push forward the integration of mechanical technologies with agronomic techniques, biotechnology, electronic information technology, environmental technology and engineering technology.

2. Strengthen personnel cultivation for farm machinery cooperatives

With the advancement of industrialization and urbanization in countries of the Asia Pacific region, rural workers have been moving to the cities in masses, leaving fewer and fewer farmers tending the lands in rural areas. As a result, farmland will become increasingly concentrated in the hands of those adept in farming. It is therefore necessary to develop specialized cooperatives for farm machinery and socialized services, facilitating the transformation of extensive production to intensive production, from fragmented operation to organized operation. Thus, more cooperative managers and machinery operators will be needed and their training is crucial. Through training, they can not only learn to operate and maneuver various kinds of agricultural machinery expertly, but gain knowledge and skills in corporate management as well.

3. Sep up Partnership in Farm Machinery Personnel Training between Countries in Asia Pacific

Exchanges and cooperation in farm machinery, both governmental and private, should be expanded in the region. Countries should freely choose whichever path to agricultural mechanization fits their national realities by drawing on each other's experiences. Building on the advantages of each country, cooperative projects on personnel training should be carried out to share the success stories of the countries in the region. We should continue to support the work of CSAM, so it could fully put into play as the platform of collaboration in Asia Pacific for sustainable agricultural mechanization, contributing to the overall level of mechanization, promoting agricultural modernization and people's wellbeing in the region.

Fiji Islands

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I. Introduction

The Fiji Islands are located in the latitude and longitude of 18.1667o S and 178.4500o E. Since Fiji is in the tropical region, the average temperature ranges from 18 to 32.8 °C. Fiji's terrain is mountainous; and this influences the quantity of rain received during the year. Fiji Islands receive rainfall from different sources. There are two distinct seasons, dry season and wet season. The trade winds, which blow from the southeast during May to November, reduce rainfall volumes, thus making this period dry. From November to April, the wind is from the east and brings 80% of the total annual rainfall in the country, thus, making this period as the wet season. The southeasterly shoreline of VitiLevu, Vanua Levu and Taveuni receive approximately 3,000 mm of rainfall per year with an increasing rainfall to about 5,000 to 6,000mm inland. The leeward northwestern coast receives approximately 1,500 to 2,000 mm of rain per year, and is usually dry. The lower Islands and leeward areas are most vulnerable to droughts. The wet zone is situated in the southeast area of each Island. Fiji is more prone to hurricanes and tropical storms usually from November to April.

The agricultural sector plays a vital role in economic development in Fiji Islands. The sector not only guarantees food security, but also contributes to employment generation, foreign exchange earnings, as well as livelihood improvement in the country. With the existing challenges like climate change and its impact on food security, energy, land subsidence, the agricultural sector needs to pay due attention to avert or at least minimize the adverse effects in order to relieve the people of Fiji Islands from future hardship.

Vision of the Agricultural Development in Fiji

It is no doubt that the Government of Fiji (GOF) puts every effort towards sustainable development, implementing a holistic approach together with international partners. The GOF has set up the vision for agricultural development to build up a sustainable community and establish a diversified and economically and environmentally sustainable agriculture economy in "Fiji 2020 – Agriculture Sector Policy Agenda". This vision is to be accomplished through the following core national agriculture development objectives:

- Building modern agriculture as an organized system of producing, processing and marketing crops, livestock and aquaculture products;
- Developing integrated production, processing, energy and transport infrastructure for agriculture;
- Improving delivery of agricultural support services;
- Enhancing capabilities to generate and secure investments

through foreign investment, private-public-partnerships and other innovative business arrangements, and
- Improving project implementation and policy formulation capacity within the Ministry of Agriculture and its partner institutions.

In order to accomplish these objectives, supporting for integrated farming systems has been considered as a major area to raise farmers' income and livelihood in the country. Accordingly, a comprehensive review is required to understand the possibility of integrating effective interventions to current farming systems, technological and agronomic research. Limitations in the current farming systems are primarily centered around unsatisfactory access to technologies, market and price structure, and access to information. Lack of adequate staff and facilities appears to hamper technology development through research.

Farming systems vary depending upon the weather conditions. As per the prevailing weather conditions, the farming systems in the Central region dominate with high water demanding crops. These crops include vegetables, rice, root crops, perennial crops and pasture coupled with livestock production. In dry areas, crops like sugarcane, pineapple, citrus, mangoes, and drought tolerant vegetables like pumpkin, cucumber, watermelon and eggplants, and pulses [green gram, black gram (Urud), peanut] are grown. The crops farmers grow depend upon the rainy period, water availability, and market demand.

Although mechanization remains the option for mitigating labor related issues, it is still challenging for farmers to buy tractors, implements, harvesters and threshers as well as small-scale rice mills. Therefore, the GOF supports farmers' groups with a subsidy scheme that provides 2/3 of the cost of machinery.

II. Overview of the Higher Education and Research Institutions that Offer Agricultural Engineering/ Mechanization Programme, and their Programme Settings in Fiji

The Agricultural Engineering programs (Certificate IV and Trade Diploma programs) have been offered by the College of Engineering, Science and Technology (CEST) under the School of Mechanical Engineering in the Fiji National University since 2006. Currently, the Trade Diploma in Agricultural Engineering is run as a bridging educational program for the student career between engineering tradesman (Certificate level) and professional agricultural engineer (Bachelor Degree in Agricultural Engineering). It aims to boost Fiji´s human resource capacity to sustain productivity in the agriculture and natural resources sectors, and contributing significantly to Fiji´s growing economy.

And CEST is actively developing a new program, the Bachelor Degree in Agricultural Engineering. This higher educational degree in agricultural engineering will be primarily research-orientated and technologically-capacitated to face the current and future technological challenges in the agriculture and natural resources management and operational demands and concerns focusing mostly on cutting-edge technological development, value adding strategies and environmentally-enhancing systems/approaches. The Bachelor Degree in Agricultural Engineering will focus on the following key areas:

- Precision engineering systems for agricultural production and natural resources conservation;
- Low-input and resource-efficient/cost-effective technologies and systems;
- Green and renewable/sustainable technological systems for agri-industrial production and manufacturing enterprises; and
- Waste recycling/re-use and resource management engineering and climate- change sensitive/resilient techniques/measures.

To address the country's problems and constraints currently experienced in the agriculture and natural resources sectors especially the threat of climate change worldwide, and to ensure sustainable productivity and development of the country in the future, Fiji is in urgent need of human resource equipped with the knowledge of engineering and sciences, economics and entrepreneurship, rural development and extension, and computer technology and information management for applications in agricultural machinery and appropriate mechanization systems development, agricultural infrastructure design and construction, agri-industrial processing and manufacturing, agricultural resources management, integrated agricultural systems analysis, rural development and extension, and so forth.

III. The Need Assessment, Challenges and Constraints Faced by the Higher Education and Research Institutions for Human Resource Development of Agricultural Mechanization in Fiji

The Agricultural Engineering programs are basically designed to develop agricultural engineering graduates equipped with some basic knowledge and skills on technology development and enterprise development and management of agriculture and

natural resources sectors to contribute significantly in improving and sustaining production and productivity of the sectors by 1) creating jobs and livelihood opportunities in the rural communities, thus helping to solve the unemployment problems; 2) conserving and efficiently managing renewable and marginal natural and agri-ecological resources, and 3) adding values and opportunities to farmers and other agri-industry players and stakeholders so to improve Fiji´s socio-economic development and sound environment and resource management.

Transformation and sharpening of skills and capacities of agricultural engineering graduates to meet the rising and demanding needs of the various agri-industries, is needed by the Fiji Government, NGO´s and other key stakeholders in the country, in the Region, and in other developing countries worldwide. Upgrading and provision of up-to-date/standardized facilities and educational machinery/equipment and support systems/ IT-enabling technologies is requested to support the educational and training needs/programs of the students/trainees of FNU agricultural engineering programs. World-class, research-oriented and high caliber lecturers and trainers are crucial of agricultural engineering programs. All of these require availability of rational, adequate, appropriate and sustainable funding support for the agricultural engineering programs and trainings.

IV. Suggestions for Regional Co-operation on Higher Education and Joint Research of Human Resource Development of Agricultural Mechanization

- Regional advocacy MOU for ISO/IPENZ/other advantageous international accreditations and world-class recognitions of FNU agricultural engineering graduates regionally and globally;
- MOUs and specific MOAs for Joint Regional Scientific Exchange, Research, Training and Extension among relevant agricultural engineering institutions/organisations and various governments in the Region;
- Establishment of the Regional Agricultural Engineering Database Centre and Management Information System to strengthen and reinforce existing agricultural engineering databases/information systems and create more responsive and efficient information resources in the Region and linked with available satellite and GIS-enabled systems;
- Establishment of a Regional Agricultural Engineering Centre to support educational, research, training, institution capacity building, and enterprise development of the agri-industrial sectors as well as support environmental management initiatives of various concerned institutions/organizations and countries in the region.

V. Contributions from Fiji for such Regional Cooperation

At present, the Agricultural Engineering Department of the School of Mechanical Engineering, Science and Technology of FNU have the highly capable domestic and oversee staffs, with necessary qualifications (from Certificate level to PhD degree), skills (with more than 30 years accumulated) and experiences (from both public and private sectors) to support any Regional programs to develop Regional capabilities in agri-industrial enterprise/business development and environmental resources management.

Fiji has available agricultural engineering technologies developed through the years comprised of agricultural machinery and mechanization systems, renewable energy resource development, precision engineering and IT-enabled systems, updated research capacities and business management skills, and resource conservation and recovery systems and knowledge.

Fiji could help to develop adaptable research and development (R&D) proposals prepared for funding and resource generation strategies, and strategic business planning and development.

Fiji would like to join and contribute to the domestic and/ or regional network and linkage for agricultural engineering development programs and initiatives.

India

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I. Introduction

Mechanization of agriculture is an essential input in modern agriculture. It enhances productivity, besides reducing human drudgery and cost of cultivation. Mechanization also helps in improving utilization efficiency of other inputs, safety and comfort of the agricultural worker, improvement in the quality and value addition of the produce. Efficient machinery helps in increasing production and productivity, besides enabling the farmers to raise a second crop or multi crop making the Indian agriculture attractive and a way of life by becoming commercial instead of subsistence. Increased production will require more use of agricultural inputs and protection of crops from various stresses. This will call for greater engineering inputs which will require developments and introduction of high capacity, precision, reliable and energy efficient equipment.

Looking at the pattern of land holding in India, it may be noted that about 84% of the holdings are below 1 ha. There is a need for special efforts in farm mechanization for these categories of farmers to enhance production and productivity of agriculture. The productivity of farms depends greatly on the availability and judicious use of farm power by the farmers. Average farm power availability for the cultivated areas of the country has increased from 0.48 kW/ha in 1975-76 to 1.84 kW/ha in 2014-15 and is likely to be achieved 2.0 kW/ha by 2017. Agricultural implements and machines enable the farmers to employ the power judiciously for production purposes. Agricultural machines increase productivity of land and labor by meeting timeliness of farm operations and increase work output per unit time. Besides its paramount contribution to the multiple cropping and diversification of agriculture, mechanization also enables efficient utilization of inputs such as seeds, fertilizers and irrigation water.

Operation, repair and maintenance activity in the farm mechanization holds the key to success. Skill of the operator plays a vital role in output capacity, quality of output and ultimately cost of operation. Repair and maintenance of machine is required at nearest possible place to reduce down time and cost of repair. Skill and infrastructural facility are required to repair the power source and farm machinery. Farm machinery manufacturing belongs to relatively small scale industry level. Technological advance in farm machinery design and development also requires better manufacturing technology, which requires continuous skill upgrade of the industrial workers. With introduction of custom hiring services in farm mechanization activities, these entrepreneurs need to be trained in the field of entrepreneurship skills, market studies, equipment selection, operation and maintenance of equipment, etc.

II. Skill Development in the Field of Agricultural Mechanization

Training is the basis on which the rest of the infrastructure operates. The need for training and the difficulties involved have been emphasized by Mackson (1973):

"Training of traditional hand cultivators of soil in developing countries to become equipment operators is not an easy task. Learning to perform very simple daily and weekly maintenance processes is difficult and tedious for farmers who have never been exposed to mechanical equipment. Machines of all types from the simplest to the most-complicated must be properly maintained, adjusted and operated. Mechanical power units and associated equipment are capital intensive inputs".

The economic feasibility of the equipment depends greatly on the skill, and competency displayed by the operator. A skilled competent operator does not gain his skills from a brief explanation of controls, a little practice and referral to the operators' manual. At best, such an approach to training will only produce a 'driver' but not a responsible operator. The training for farm mechanization thus involves skill building. It is distinct from the other training that involves only the transfer of information such as the use of better seeds, fertilizer and chemicals. Assessment of the total need and capacity of the existing facilities for training has to be made in this context.

Nearly 3.5 million tractors are estimated to be working on farms in India. Power tillers has also grown as the power source in small and marginal farms. The sales in the last few years have been about 5,00,000 units a year for tractor. Similarly, the power tiller having annual sale of about 45,000 units per year. The sale of tractors and power tillers in last ten years is presented in the Table 1. This annual demand is generated by two sets of customers - those who want to replace their old tractors/power tillers and those who are first-time buyers. Both types require training, but the kind of training they require would be different. Those who are buying to replace their old machines can be expected to have acquired by experience, if not by formal training, the basic knowledge needed for operation and maintenance of tractor and related equipment.

Table 1 - Year wise sale of tractors and power tillers

Year	Tractors Sale (Nos.)	Power Tillers Sale (Nos.)
2004-05	2,47,531	17,481
2005-06	2,96,080	22,303
2006-07	3,52,835	24,791
2007-08	3,46,501	26,135
2008-09	3,42,836	35,294
2009-10	3,93.836	38,794
2010-11	5,45,109	55,100
2011-12	5,35,210	60,000
2012-13	5,90,672	47,000
2013- 14	6,96,828	56,000
2014-15 (up-to Nov.2014)	4,74,538	-

Source: Annual report 2014-15, M&T Division, DAC, New Delhi

They may need to be updated, as new developments occur in mechanization, and equipment with more sophisticated controls becomes available. Those who are entering the market to acquire tractors and other machinery for the first time would require a training on proper selection, basic operation and maintenance.

In assessing the training need, it will be necessary to determine the proportion of people buying tractors for the first time. Assuming the average working life of a tractor to be 15 years, a power tiller for 10 years, replacement purchases can be estimated to be, on an average, between 2,00,000 and 2,50,000 tractors. This will put the estimate of first-time buyers at approximately 2,50,000 each year. The proportion of first-time buyers will be less in developed areas such as Punjab, Haryana, and Western Uttar Pradesh than in areas where mechanization is not so well developed such as in the eastern zone of Uttar Pradesh. Correspondingly, the need for skills updating training will be higher in Punjab, Haryana and western Uttar Pradesh and lower in areas which were quickly undergoing the process of mechanization in the last decade.

Skill Development Infrastructure

Realizing the importance of farmers' early training, the Government of India (GOI) established the first Agricultural Machinery Utilization Training Centre in 1955 at Budni in Madhya Pradesh (MP).

The activities of this Centre were augmented by establishing a Testing Wing in 1959, when it was renamed Tractor Training and Testing Station. The training imparted at Budni on selection, proper use, maintenance and repair of tractors and agricultural machinery was found to be very useful. Therefore, the government set up another Tractor Training Centre at Hisar in Haryana in 1963 and added facilities for a testing sub-station in 1972. To cater to the needs of the southern region, a third centre was set up at Garladinne in Andhra Pradesh (A P) in 1983 and fourth centre was setup at Biswanathchariali in Assam in 1990. Each of the four centres is now called a Farm Machinery Training and Testing Institute (FMTTI). All four FMTTIs offer identical courses and cater to their specific regions. The courses offered are presented in Table 2.

Table 2 Courses offered by FMTTI(s) in field of agricultural mechanization

Sl. No.	Course	Duration
1	USER LEVEL COURSES	
U1	Appropriate Mechanization Technology for Energy Management in Agriculture	4 weeks
U2	Selection, Operation, Safety and Maintenance of Improved Agricultural Machinery	6 weeks
U3	Operation, Maintenance and Management of Power Tiller	2 weeks
U4	Training Program on Agro Processing & Value Addition Equipment	2 weeks
U5	Gender Friendly Equipment for Women Farmers	3 days
U6	Utilization of Non-Conventional Energy Sources in Agriculture	1 week
U7	Water Management Through Sprinkler and Drip Irrigation & Water Saving Devices	1 week
U8	Selection, Operation, and Maintenance of Plant Protection Equipment	1 week
U9	Selection, Operation, and Maintenance of Improved Harvesting & Threshing Machines	2 weeks
U10	Selection, Operation, and Maintenance of Hand Pump	1 week
U11	Selection, Operation and Maintenance of Agri. Machinery for Dry Land Agriculture	2 weeks
U12	Crop Specific Machinery	2 weeks
2	TECHNICIAN LEVEL COURSES	
T1	Repair and Overhauling of Stationery Engines and Tractors	6 weeks
T2	Repair & Overhauling of Power Tillers	2 weeks
T3	Establishment and Management of Agricultural Machinery Repair and Maintenance Workshop	4 weeks
T4	Study & Repair of Hydraulic System in Agriculture Machines	4 weeks
T5	Repair and Maintenance of Auto Electrical Equipment and Battery Re-conditioning	3 weeks
T6	Repair, Maintenance & Rewinding of Electrical motors, and Submersible Pumps for Agricultural Use	3 weeks
T7	Operation & Maintenance of Land Shaping and Development Machinery	4 weeks

T8	Repair, Maintenance & Overhauling of Diesel Pumping Sets	2 weeks
T9	Maintenance, Repair and Installation of Combine Harvesters and Straw Reaper	3 weeks
3	MANAGEMENT LEVEL COURSES	
M1	Testing and Evaluation of Farm Machinery	1 week
M2	Agriculture Machinery Management	1 week
M3	Export Management of Agricultural Machinery	1 week
M4	Instrumentation for Farm Machinery Testing and Evaluation	1 week
M5	Entrepreneurship Development to Establish Custom Hiring Agro-Service Centre	8 weeks
M6	Farm Machinery Management for Dealers / Traders / Manufacturers, etc.	1 week
4	ACADEMIC LEVEL TRAINING PROGRAMME	
A1	Practical Training Programme on Farm Power & Machinery for Degree/Diploma Engineering Students	4 weeks
A2	Practical Training Programme on Farm Power and Machinery for ITI & Vocational Courses for 10+2 Students	4 weeks
5	AWARENESS COURSES THROUGH MULTIMEDIA SYSTEM	
AW1	Centrally Sponsored Schemes for Subsidy on Agricultural Machinery, Agri-Business and Agri Clinics	1 to 2 days
AW2	Straw Management in Agriculture	1 day
AW3	Safety in Agricultural Machinery	1 day
AW4	Adaptation of New Technology Machinery - Publicity	1 day
AW5	Bankers Training Programme for Financing Agril. Machinery	1 day
6	Training Programme for Rural Youth Under Swarn Jayanti Gramin Swarojgar Yojana	As per requirement of sponsoring organization
7	Training programme for Foreign National as per Requirements under Bilateral Programme.	10-18 weeks
8	Special Training Programme on Utilization, Operation, Maintenance and Repair of Agri. Machinery for Defence Personnel Sponsored by Director General of Resettlement (U-2 + T-1)	12 weeks
9	Need based Training Programme on Farm Mechanization	As per requirement of sponsoring organization

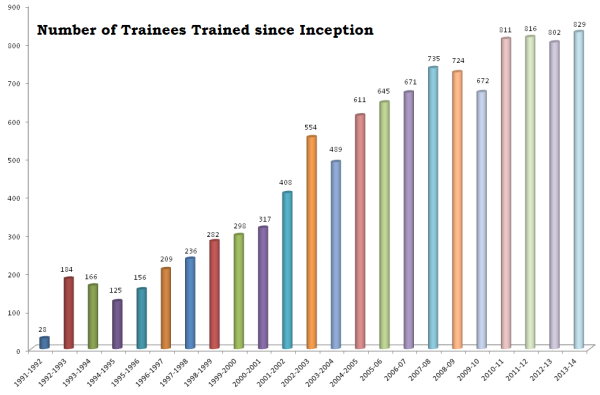
In addition to the FMTTIs, there are other organizations engaged in machinery related farmers' training. These are the Agricultural Universities (AUs), Farmers' Training Centres (FTCs), Krishi Vigyan Kendras run by the departments of agriculture of various states and tractor manufacturers.

Agricultural universities and Krishi Vigyan Kendras are a major group for training of farmers. There are now 74 agricultural universities in the country and 642 Krishi Vigyan Kendra(s) out of which about 35 AUs has agricultural engineering departments. Almost every state has one or more agriculture university and every district has Krishi Vigyan Kendra. The agricultural universities run programmes for the farmers as part of their extension activity. Some of their courses deal with farm machinery utilization.

The duration of the courses at agricultural universities is much shorter than that of course 'A' at the FMTTIs. Their content is accordingly less comprehensive. But the infrastructure and the quality of trainers at agricultural universities is good. Besides, they can be improved further easily. The combined capacity of the FMTTIs and the agricultural universities would be 8,000 approximately, which is still far below the estimated requirement of 2,00,000.

Fig 1 State-wise number of trainees trained by CFMTTI, Budni

Fig 2 Number of trainees trained by NRFMTTI, Hisar since 1991-92



Farmers' Training Centres (FTC): Next come the FTCs of the state governments. Each of the 26 FTCs in Gujarat handles about 250 farmers a year in a five-day programme. Their combined annual turnover would be about 6500. The annual turnover of the 22 FTCs in Andhra Pradesh would be of the same order. Karnataka, with greater facilities, has a higher turnover. Clearly, so far as the nominal capacity goes, the ability of the FTCs is large. But their programmes do not meet the skill-oriented training needs of farmers taking up mechanization for the first time. The content of their programmes relates only marginally, if at all, to farm machinery. Besides, the FTCs do not have the trained manpower to design and run skill-building courses. Pooled capacity of the Farmer's training centres across the country would be about 20,000 farmers per year.

Manufacturers' Training: Some of the tractor manufacturers have also developed training facilities. The infrastructure for training in Escorts, Tractors and Farm Equipment Ltd. (TAFE), and Eicher is good. Their interaction with farmers is rather limited. Their programmes, however, have a specific product oriented focus. They are meant primarily for dealers, sales personnel and repairmen. Their training methods and materials can be usefully adopted by other institutions engaged in training farmers.

Krishi Vigyan Kendra(KVK): About 642 Krishi Vigyan Kendras are located in each district of the country. Some districts have more than one Kishi Vigyan Kendras. This extension oriented setup is operated by ICAR, SAUs and some NGOs. Each Krishi Vigyan Kendra constitutes 6 subject matter specialists of which one is an agricultural engineer. Krishi Vigyan Kendra organizes trainings and demonstrations of farm machinery but these courses are more demonstration oriented than imparting skill. Very few programmes are organized with a well-designed curriculum.

III. Strategies, Policies and National Programme/Initiative of Human Resource Development of Agricultural Mechanization

Department of Agriculture, Cooperation and Farmers Welfare has integrated the components of agricultural mechanization under various schemes and programmes aiming at catalyzing an accelerated but inclusive growth of agricultural mechanization in India. The following specific interventions with a special emphasis on 'reaching the unreached' will bring small and marginal farmers' at the core. With this aim Sub Mission on Agricultural Mechanization (SMAM) has been introduced during 12th Five-Year Plan in April 2014.

The Sub Mission on Agricultural Mechanization includes the following components:

1. **Promotion and Strengthening of Agricultural Mechanization through Training, Testing and Demonstration:** Aims to ensure performance testing of agricultural machinery and equipment, capacity building of farmers and end users and promoting farm mechanization through demonstrations;
2. **Demonstration, Training and Distribution of Postharvest Technology and Management (PHTM):** Aims at popularizing technology for primary processing, value addition, low cost scientific storage/transport and the crop by-product management through demonstrations, capacity building of farmers and end users. Provides financial assistance for establishing PHT units;
3. **Financial Assistance for Procurement of Agriculture Machinery and Equipment:** Promotes ownership of various agricultural machinery & equipment as per norms of assistance;
4. **Establish Farm Machinery Banks for Custom Hiring:** Provides suitable financial assistance to establish Farm Machinery Banks for Custom Hiring for appropriate locations and crops;
5. **Establish Hi-Tech, High Productive Equipment Hub for Custom Hiring:** Provides financial assistance to set up hi-tech machinery hubs for high value crops like sugarcane, cotton etc;
6. **Promotion of Farm Mechanization in Selected Villages:** Provides financial assistance to promote appropriate technologies and to set up Farm Machinery Banks in identified villages in low mechanised states;
7. **Financial Assistance for Promotion of Mechanized Operations/hectare Carried out Through Custom Hiring Centres:** Provides financial assistance on per hectare basis to the beneficiaries hiring machinery/equipment from custom hiring centres in low mechanized areas; and

8. **Promotion of Farm Machinery and Equipment in North-Eastern Region:** Extends financial assistance to beneficiaries in high-potential but low mechanised states of north-east.

Out of the above mentioned, the 1st & 2nd components come under Central Sector (Central share 100%) and remaining (3 to 8) under Central Sponsored Scheme (Central Share 50%: State Share 50%)

Beside above interventions, the Department is promoting Farm Mechanization by making agricultural equipment available among farmers at cheaper rates. A level of 25-50% subsidy on procurement cost is made available under RKVY, NFSM, NHM & TMOOP scheme for different categories of equipment. The subsidy on tractors and power tillers is available on the models approved by the department under institutional financing.

IV. Challenges and Constraints

The skill development in the field of agricultural mechanization is a multidimensional activity. There are many major groups involved in the mechanization of the country. The major groups involved in the agricultural mechanization are research and development organizations, extension workers, farmers or users, manufacturers, rural level artisans, repairing and maintenance workers and custom hiring entrepreneurs. The skill requirement for all these groups varies considerably. The farmers/users require skill upgrade on operation and adjustment of the machinery, while manufacturer requires skill improvement on manufacturing technology. Similarly, rural artisans require basic manufacturing skill and handling of improved manufacturing system to fabricate hand tools and small farm machinery. In absence of any quantifiable data major challenge is ascertain the total need of the country in terms of skill development.

Some of the challenges and constraints of the skill development in the field agricultural mechanization is listed below:

- Inadequate infrastructure to support large scale training programmes in various parts of the country;
- Course curriculum utilized by various agencies to impart skill to various stakeholders varies considerably;
- Developing a coordination network to offer skill development is missing;
- Limited number of trainers is available at the institutes offering training programme. Often trainers are engaged in multifarious activities;
- Financial resources are limited; and
- In absence of proper database of trained manpower and manpower required training, estimation of training needs is difficult.

V. Solutions for Skill Development For Sustainable Agricultural Mechanization

It is clear from the analysis presented above, a large gap exists in current skill development infrastructure and estimated needs of the agricultural mechanization sector. To bridge the gap infrastructure support needs to be strengthened at Krishi Vigyan Kendra(s) and Farmers Training Centre located in various states. More number of institutions such as FMTTIs can be established. This would take a long time. In the near future, and for the long-term, it would be advantageous to create links between the FMTTIs, the AUs and selected FTCs, to bring the training capacity to the desired level. In addition to increasing the capacity, the quality of courses and the facilities can be upgraded through inter-institutional collaboration. There is a need to prepare standard courses based upon need of various interest groups. Trainers need to be trained to impart these skill oriented programmes.

The Machinery Division of the Government of India can initiate the building of linkages among these agencies. The effort may be divided into two phases. In the first phase, the FMTTIs and the AUs could pool their experiences and develop a package of courses. Funding to create infrastructure to support such programme needs to be strengthened. More farmers can be trained if the duration of the courses can be made shorter by improving the teaching techniques and a better division of labor between the two. Written and audio-visual materials could be developed by the FMTTIs in various languages with the help of AUs. The AUs can mount a larger number of shorter duration courses in a year and share a part of the training with the FMTTIs. Apart from that, each state has infrastructural facility available in ITI(s) which offer technical courses. This resource should be tapped and strengthened to impart skills to manufacturers, rural artisans and technical workers. KVKs has presence in each district of the state; however, all the KVKs are not manned with experts of mechanization and required resources. Considering each KVK can impart training to about 200 farmers per year, their annual capacity can be estimated to be 128400 per year. Many countries of the region may not be having adequate facility. FMTTIs have seats for foreign nationals to undergo training in various aspects of the mechanization. Member countries can use this facility to get their workers trained in India. Tailored training programmes can also be organized for specific needs of the countries of the region.

Indonesia

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I. Overview of Human Resource Development Work in the Field of Agricultural Mechanization in Indonesia

1. Current Number and Employment Status of Agricultural Mechanization Workforce

Human Resources in the agricultural sector include farmers and people who work in agriculture, including the officers / officials of agriculture (government employee), entrepreneurs in agriculture, and farmers. Central Bureau of Statistics defines that those employed in the agricultural sector are farmers, while agricultural employees are in the service sector. In general, human resources in agriculture can be categorized as (a) farmers, (b) structural officers, (c) functional officer, and (d) stakeholders involved in agriculture sector.

Figure 1. Number of agricultural extension workers by employment status in Indonesia, 2014

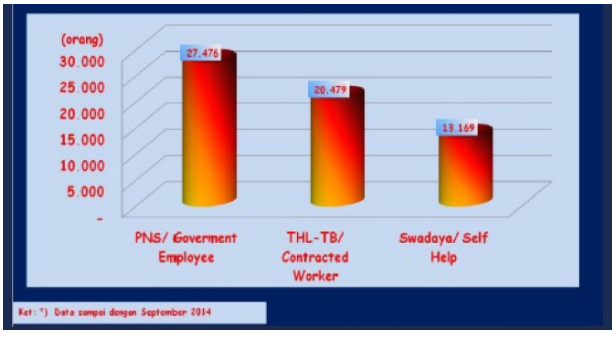
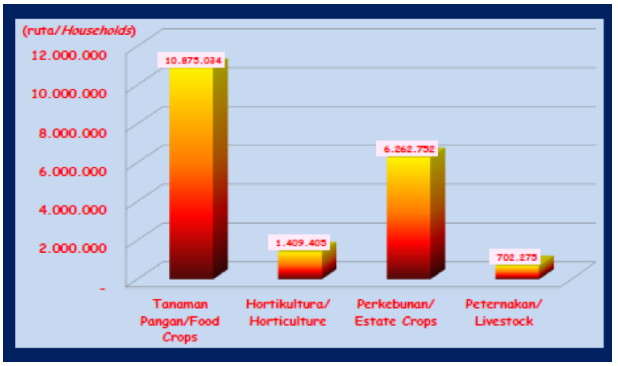


Figure 2. Number of farmer households by sub sector and province, 2013



2. Agencies/institutions involved in agricultural mechanization human Resource development and their current programs/ projects

Indonesian Center for Agricultural Engineering Research and Development (ICAERD) is one of work units of Indonesian Agency for Agricultural Research and Development (IAARD), Ministry of Agriculture (MoA). ICAERD was established based on the regulation of Minister of Agriculture No. 38 / Permentan / OT.140 / 3/2013, and was mandated nationwide as the technical field research, engineering and development of agricultural mechanization center under coordination and responsible to IAARD.

Cooperation efforts in the field of human resource development

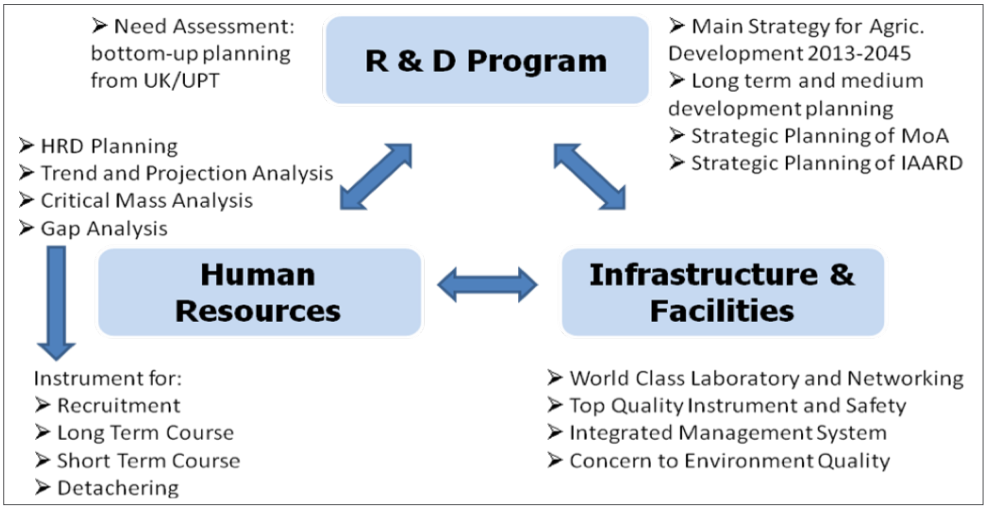
of agricultural mechanization have been taken by various institutions based on initiatives of ICAERD and cooperation partners. Cooperation was carried out with the reference to the agreement that was reached by ICAERD and cooperation partners. The institutions and agencies that already have cooperation agreements include: Center for Extension and Human Resource Development for Agriculture, the Provincial Agricultural Department, Vocational School in Agriculture, Academy, University, Assessment Institute for Agricultural Technology (AIAT) and local government (regency).

ICAERD as a part of IAARD follows the strategy, policy and program of IAARD as well as MoA. In general, human resource development is done through a detailed plan based on the needs of expertise and education, as well as through the functional composition of human resource of IAARD today and in the future. Analysis of human resource development of IAARD based on analysis of trends and projections, critical mass, and gap analysis. Various instrument of human resource development that can be implemented by increasing the levels of formal education, both undergraduate and postgraduate from domestic and abroad, training, and recruitment of new employees.

Infrastructure development and research facilities of IAARD aim to be able to provide support for the implementation of agricultural research and development programs. Developed infrastructure includes offices, laboratories, research stations, and other research facilities. Development of infrastructure is not only related to the physical facilities, but also management and utilization.

Development of infrastructure of agricultural research is expected to produce a world-class laboratory with extensive cooperation networks, good and reliable research instruments, integrated management systems. To achieve that, it should be supported by adequate human resources capacity. Figure 3 shows the synergy (link and match) among research and development programs, human resources and infrastructure of IAARD.

Figure 3. Link and Match Program Development, Infrastructure, and Human Resources of IAARD.



II. Strategies, Policies, and National Programs/Initiatives of Human Resource Development of Agricultural Mechanization

Human resource development of agricultural mechanization strategy is inseparable from the strategy of development of agricultural mechanization itself. Therefore, human resource development strategy is an inherent element in the development strategy of mechanization or agricultural technology. Similarly, the

strategy of development of mechanization, in principle, cannot be separated from the overall agricultural development strategy.

Human resource development strategy for the (transfer of technology) mechanization sequentially comprises the steps of: 1) identification of the current human condition; 2) the delivery of information through the use of various forms of media and through appropriate communication processes; to be able to 3) generate a positive response to "targeted stakeholders"; 4) the appropriate responses that arise, technology transfer can be carried out with appropriate strategies and media; 5) pattern and appropriate technology transfer strategies are expected to be able to generate the flow of expected changes; 6) standard models, benchmarking manual and very useful to actualize the ideal conditions expected; finally 7) the condition of human resources is expected that technology transfer can take place properly and continuous, HR ideal conditions must be established associated with the ability, willingness and capacity in the technology transfer process.

To determine a clear policy direction for the development of farmers, it requires good planning, the steps as follows:

- Establish the definition and qualification of farmers
- Specify the number of farmers needed
- Create a development plan based on the quantity and quality of farmers
- Establish criteria and indicators of the development of farmers
- Ensure monitoring and evaluation processes

Human resource development activities can be done through formal education, training and counseling. These three factors determine the quality of human resources.

III. The Need Assessment of Human Resource Development of Agricultural Mechanization in Indonesia

The gradually decreasing number of labor in agriculture year by year is in part the result of mechanization utilization in agriculture. Labors in the agricultural sector decreased by 1.4% from 38.88 million in 2012 down to 30.33 million in 2014 (Central Bureau of Statistics, 2015). The Decrease of labors in agricultural sector is largely due to the labor transfer from agricultural sector to other sectors, such as industry, construction and social services. It is assumed that working in agricultural sector is an old profession and less promising; however, agricultural sector requires sufficient labors to meet the demand for national food security. Application of agricultural mechanization is expected to complement the decreased labors in agricultural sector in Indonesia. However, assessment of human resource development of agricultural mechanization is urgently needed.

IV. Challenges and Constraints Faced by Human Resource Development of Agricultural Mechanization in Indonesia

Existing conditions of human resources in agriculture is the results of several social and economy aspects. In terms of education, it was known that the majority of farmer's education level was low. Even though there is improvement in the current generation, for example, they are able to finish the high school, the young generation generally does not carry on the profession of their parents.

The quality of agricultural human resource is comparatively lower than the other sectors'. It is due to the

low education level of the majority farmers. More than 70 percent of farmers only receive primary school education.

Human resource development in agriculture is not only able to improve the capacity of applying agricultural technology, but also to increase motivation and perception of modern agriculture.

V. Solutions and Suggestions for Human Resource Development for Sustainable Agricultural Mechanization

Sustainability of agricultural mechanization would require the management of human resources. Human resources management is a "tool" for managing, controlling and organizing human beings in order to remain at the desired destination. Efforts to improve the quality of human resources in sustainable agriculture mechanization include:

- Improving expertise in the field of technical management and agriculture.
- Leveraging its expertise in scrutinizing the market situation. However, the farmers must be able to penetrate the market with a good selling point. Actually, as a group, for example, through cooperative production, variety of products of small farmers can penetrate the export market.
- Improve farmers' access to banking, which involves mastery procedures for dealing with capital sources.
- Increase professionalism extension offices, institutions and authorities concerned.
- Actually the agriculture sector including human resources, in addition to farmers and extension officers related government agencies. Even among scientists include agriculture, whether in universities or research institutes.

Lao PDR

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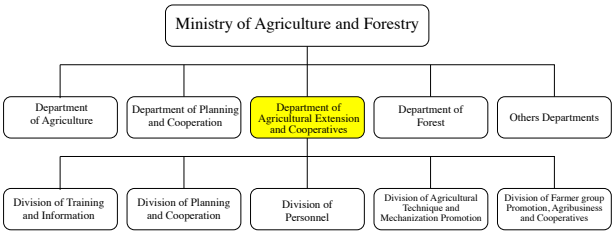
I. Background

Agriculture is central to Lao economy. It contributes 22.7 percent of GDP (2015), with agricultural growth rate of 3.1 percent annually. Agriculture contributes to at least 15 percent of the export revenue and employs 67 percent workforce. Most households in rural area are near-subsistence farmers engaged in rice-based agriculture, collecting forest products and raising livestock. With respect to agriculture, the strategy seeks to improve productivity and diversification. Agricultural mechanization is playing an important role to achieve the goals of food security, market-oriented production, poverty eradication and rural development.

The history of agricultural mechanization in Lao PDR can be divided into two distinct periods after the country revolution. The first period was marked to promote agricultural mechanization to farmer collective production. To support this process, the Government played an important role for the agricultural mechanization promotion. In 1980, an Agricultural Mechanization Section was established directly under the Ministry of Agriculture and Forestry. In 1989, the Section became dysfunctional due to lack of usage of agricultural mechanization, inadequate of Government supporting fund and lack of human resources on agricultural mechanization.

In Year 2001, the Government decided to establish Department of National Agricultural and Forestry Extension Service (NAFES) with the aim to translate the result of research to the farmer production group, to strengthen village extension workers, to mobilize village fund and supporting technical service; however, the role of NAFES for agricultural mechanization was not clearly defined. Policy and strategy have been developed by the Ministry of Agriculture and Forestry (MAF) to modernize agricultural sector so to increase agricultural productivity and promote commercialization production. To translate the mention policy and strategy, MAF decided to redefine the role and responsibility of NAFES, and changed its name to Department of Agricultural Extension and Cooperatives (DAEC) in 2012. Under DAEC, a Division of Agricultural Technique and Mechanization Promotion was established with a role of facilitating the farmers' groups and agricultural cooperatives to get access to the agricultural mechanization service, providing trainings to farmers, local Government Officers under DAEC at the provincial and district levels, demonstrating of using agricultural tools, equipment, machinery and technology. The Division acts as a coordinator between public sector and private sector including: local manufacturer, dealers, traders, agricultural machinery importers and farmers, as well as service providers. The Organization chart is showed below:



The Government's vision for the development of agriculture, forestry, natural resources and rural areas is based on a holistic concept of long-term and sustainable development, including economic, social and ecological dimensions. The development goals by the Year 2020 are:

- Gradual introduction and increased application of modernized lowland market-oriented agricultural production adapted to climate change and focused on smallholder farmers.
- Conservation of upland ecosystems, ensuring food security and improving the livelihoods of rural communities.

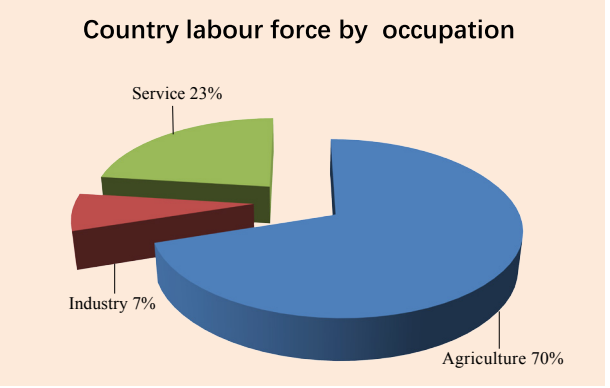
The specific goals include: 1) improvement of rural livelihood through agriculture and livestock to ensure food security - the first priority; 2) increased and modernized production of agricultural commodities leading to green value chain meeting the needs of domestic, regional and global market; 3) Sustainable production patterns, including the stabilization of cultivation and climate change adaptation measures adapting the specific socio-economic and agro-ecological conditions in each region; 4) Sustainable forest management preserving biodiversity.

The Government policy toward agricultural mechanization focuses on strengthening the roles of the Provincial Agriculture and Forestry Office (PAFO) and District Agricultural Forestry Office (DAFO) and its Technical Training Center so that they could facilitate farmers to access to the agricultural mechanization service, utilization of agricultural tools and machinery. DAEC is strongly supporting the Government policy to modernize agriculture, namely to expand or enlarge rice fields for mechanization utilization, to supplement the labor shortage in rural areas and release women from heavy manual labor; providing training and promoting technical knowledge of farm machinery to the users and lastly coordinating the relationship between local manufacturers, importers, dealers, tractor group service provider and farmers.

II. Overview of Human Resource Development Work in the Field of Agricultural Mechanization in Lao PDR

Currently, the rate of employment status of agricultural workforce is reducing - from 75.1% in 2010 to 71% in 2012, to 70% in 2015. According to the new data of DAEC, the population of large tractors are increasing nearly to 5,000 heads; medium size tractors around 4,000 heads, two-wheel walking tractors around 183,000 heads in 2014. The two-wheel walking tractors play a dominant role in agriculture. Besides the tractors, the farming equipment/ tools such as transplanting machine, combine harvester, threshers, seed dryer and rice mills are also increased.

Figure 1: Country labor force by occupation



III. Strategies, Policies, and National Programmes/Initiatives of Human Resource Development of Agricultural Mechanization

The overall development objectives of the Government are to continue focusing on the structural transformation of the economy and the improvements of the living standard of people especially in remote areas. To achieve these goals, the Government has identified eight National Priority Programmes listed below, which are outlined in the Socio-Economic Development Plan.

The agricultural sector pursues systematic development of agriculture and forestry in line with industrialization and modernization priorities in areas that have favourable conditions; ensuring food security; promoting commodity production for domestic use and export; improving productivity and enhancing end-product quality. The eight programs of Agriculture Master Plan are entitled:

1. Food Production Programme (Achievement of food self-sufficiency, mainly increasing rice production);
2. Commercial Production Programme (from subsistence crops to cash crops, increase of agricultural exports through diversification, commercialization and processing of production: cash crops, livestock, forest products);
3. Stabilization and Reduction of Shifting Cultivation Programme

(Stabilization of slash-and-burn agriculture by resettlement of upland farmers, by terracing, and by supporting alternative agricultural activities including agro-forestry and livestock);

4. Integrated Rural Development (Acceleration of rural development with special emphasis on the seven major plains of the country by introducing improved technology including irrigation);
5. Infrastructure Development (Expansion of the infrastructure network: communication, transport);
6. Human Resources Development (Improvement of human resources development to create a skilled work force capable of meeting national development demands);
7. Improved Socio-Economic Management and Foreign Economic Relations; and
8. Services Development Programme (Improvement of services sector development including tourism)

- Food security: it is planned to produce paddy rice equivalent to 4,2 million tons with the total cultivated land of around 949,000 hectares; the productivity of growing rice reaches at 3,5 tons per hectare on average; meaning that the paddy production should be reached 300 kg per head and year; meat together with fish reaches 53 kg per head and year.
- Commodity production: to produce high quality rice seed of around 100,000 tons, paddy rice for domestic and export market covers 1/3 of total domestic consumption (the average domestic production paddy rice circa 3.6 million tones, of which around 2.1 million tons is used for domestic consumption); maize production has a target of 1 million tons for animal feed and export to neighbour countries; 1 million heads a year of cattle for border trade, and 550,000 tons coffee bean to increase rural family income.
- Forestry contributing: increase forest green coverage to 65% of the total country's surface area by rehabilitating of deforestation and reforestation programs and etc.
- Irrigation scheme: it's a central resolution for agricultural production in the whole country for Lao farmers due to facing shortage of water specially in the dry season for agricultural production; currently the irrigated areas is approximately 120,000 hectares for growing paddy rice, vegetables and cash crop.
- Promoting research and agricultural extensions: this is plans to improve the existing agricultural training center of around 216 centers in the country to research, transfer necessary agricultural technique and technology to the farmers, providing information relate to market, access to input, to financial institutions, and partnerships.

The Governmental institutional organization plays a role to provide a condition for the largely self-sustaining development of sustainable agricultural mechanization strategy with a minimum direct intervention among others are:

- Review and harmonization of policies and regulation designed to attract investment in sustainable agricultural mechanization,
- Development of public-private partnership,
- Development and operationalization of testing and standards formulating mechanism for agricultural mechanization,
- Institutionalization of quality assurance of machinery, equipment and mechanization service, occupational health and safety,
- Development of research and development institutions to enhance innovations application in sustainable agricultural mechanization.

IV. The Need Assessment of Human Resource Development of Agricultural Mechanization in Lao PDR

It is necessary to do a survey of assessment need on human resource development of agricultural mechanization to understand the current situation of agricultural utilization, to identify a possibility of intervention to alleviate the problems while capitalizing on the use of existing potential. The 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 target subsidies for innovation implementations for sustainable agriculture.

To ensure the development of a knowledgeable, well-trained and disciplined labor force with capacity to drive and sustain private sector-led growth to the near future some specific activities should be addressed as follow:

- Building capacity of farmers – especially young farmers, extension staff and local Government officials on sustainable agricultural mechanization technologies,
- Building capacity of local manufacturers and distributors to supply inputs/ seeds, tools implements, machines, etc,

- Enhancing information dissemination on mechanical power technologies including profitability, environmental, social, economic aspects, as well as innovations made to agricultural machinery.

V. Challenges and Constraints Faced by Human Resource Development of Agricultural Mechanization in Lao PDR

Farmers' perspective: it has been observed that majority of small farmers in Lao PDR have had insufficient capacity in production planning (quality & quantity) to meet market demand; have limited technical knowledge of mechanization, including usage, maintenance of machinery and motorized/powered equipment for harvesting, threshing, post-harvest handling and processing operations including transportation and logistics.

Government's perspective: In reality, it has been found several challenges and constraints such as 1). Farmers do not diversify cropping patterns; 2). Extension technicians do not meet technical needs of farmers' organizations; 3). Foreign agribusiness investors lack experience working with Lao farmers; 4). Difficulty to organize farmers in groups (legal framework still unclear, powerful private commercial interests, lack of understanding from both farmers and extension staff); 5) Linkages between agribusiness and farmers are not easy to establish (due to trust does not exist for farmers or companies don't respect contracts, paradigm shift for agricultural extension organization now need to look at the market, not only at production; Agreed quality standards are still to be established and Infrastructure needs further improvements); 6). Farmers have a low access to information, technology (on farm process) and knowledge, finance, labor and land (land titling and mapping is in progress and needs to be continued); 7). However, agricultural commodity production and marketing models are developed; yet needs to be strengthened and replicated at large scale.

VI. Solutions and Suggestions for Human Resource Development for Sustainable Agricultural Mechanization

- Strengthening and rejuvenating the capacity of Government institutions to contribute to capacity building of farmers (especially for youth farmers' and women farmers), extension and research staff, local Government officials, manufacturers, distributors of inputs (new tools, equipment implements, machines), as well as franchise holders of agricultural mechanization supply chain;
- Enhancing agricultural mechanization service group;
- Strengthening public-private partnership;
- Establishing machinery cooperatives in each level;
- Promote private sector to provide services of farm machines and marketing;
- Diversification of agriculture and introduction of related farming equipment for small holder farmers; and
- Provision of knowledge on pre-postharvest technologies and marketing techniques to farmers.

Nepal

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I. General Background

Nepal is a landlocked country situated at the foothills of the Himalayas between 26° 22' N and 30° 27' N North latitude and 80° 04' E and 88° 12' E. It is rectangular in shape with an average length of about 885 km from East to West and width of about 193 km from South to North, encompassing an area of 147,181 km2. The altitudinal variation of Nepal extends from a plain 60 m to 8,848 m above sea level made up of Indo-Gangetic plain, hill slopes, river systems, valleys, doons and permanent snows. Mainly, the country is divided into three geographical regions and they are mountain, hill and terai.

Population census in Nepal takes place every 10 years. Total population of Nepal in 2011 census was 26,500,000 and growth rate per annum was 1.35 %. Population density per sq. km. was 180 (CBS 2011). The population of Nepal has been increasing continuously since the third census in 1930. The population is projected to increase up to 34.17 million by 2021.

Nepal has unique features because it lies near the northern limit of the tropics, due to complex topography, a wide range of climate, from the summer tropical heat and humidity of the terai to the colder dry continental and alpine winter climate through the middle and Northern mountainous sections are found.

Nepal is an agrarian country and around 66% of the population is engaged in agriculture and which accounts for 34% of national GDP. Due to the complex topography and variety of climate conditions, agricultural systems are different at different locations. Different types of crops are grown in different topographical zones. The main agricultural crops are: low land and upland rice, maize, wheat, millet, mustard, pulses, barley, buckwheat and potato etc. The cropping pattern and farming technology adopted in the country is mostly traditional. Most of the crops are grown in summer and rainy season due to the required soil moisture which is received by monsoon rain. The rainy season (wet season) crops are rice/paddy, maize, and millet. The winter season crops are wheat, barley, and mustard. Potato is grown in summer in mountains and in winter in hills as well as in Terai belts. In winter, most of the high mountain areas of the country are covered by snow, which is not favorable for the crops. However, these areas are suitable for spring crops when the snow starts melting. Thus, most of the cereal crops are not grown during winter, but, in hills and Terai some of the belt winter crops are grown.

II. Agricultural Mechanization Background

Most of the agricultural operations in the country are labor intensive. As the productivity of both crop and livestock is low, the returns from the labor is less lucrative. The application of

mechanization is limited for selected operations only.

Animate power is the main source of power in Nepalese agriculture. Human 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. Indigenous wooden plough, local hoes, sickle are the major implements/tools used for agricultural operation. In hills only 2.7 percent of holdings own animal drawn iron 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 urban 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 been made to improve more than 2000 local water mills by changing 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 (AM) related tools used are manual tools, animal drawn implements (ploughs, harrows, and cultivators) and mechanical power operated machinery. Traditional farm tools and equipment are still found to be widely used in terai. Spade, hoe, axe, sickle etc. are major hand tools used. Animal drawn traditional as well as improved implements are found to be used in agricultural operations in terai. Traditional wooden plough, iron mould 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) are common in terai, as 12 percent of the holdings own bullock cart in terai. Diesel pump-sets are also found to be commonly used for pumping water in terai. four-wheel tractor as well as two-wheel power tiller is increasingly used for tillage (with ploughs, harrows, cultivators, and rotavators) and transportation. Use of thresher and combine harvester (rice and wheat) are also increasingly used for harvesting and threshing operation. Table 1. shows the household using various Machinery/Equipment agricultural operations as per the National Sample Census of Agriculture, CBS,2012.

Households Using Various Machinery/Equipment for the Agricultural Operations

Machinery/Equipments used	No of Households	% Households
Iron ploughs	1,073,441	28.02
Tractor & Power tillers	920,371	24.03
Thresher	803,154	20.96
Pumping sets	548,203	14.31
Sprayers	574,014	14.98
Shallow tubewells	367,744	9.56
Deep tubewells	159,725	4.17
Treadle pump (Dhiki)	79,145	2.06
Animal drawn cart	334,978	8.74
Other Equipments	290,084	7.57

Source: National Sample Census of Agriculture, CBS, 2012

III. Statement of the Problem for Agricultural Mechanization

However, pace of agriculture commercialization has been slow and it has not been an attractive vocation for rural youths. Many of them feel agriculture is neither prestigious nor a profitable vocation that can provide full employment to them. Consequently, out-migration of rural youths in urban centers and abroad is in increasing trend. Which resulted aging and feminization in agriculture. The high cost of mechanization and the difficulty in accessing or utilizing machines in most parts of Nepal (due to land fragmentation, difficult terrain and remoteness among others) in not possible.

The average land holding per family across Nepal is found to be less than 0.65 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 and market opportunities majority of farmers are adopting traditional technology in their production system. Hence, agriculture has become job of old people and that of women farmers in the villages. In this context there is urgent need of appropriate agricultural mechanization in Nepal.

Agricultural mechanization is part of a complex system of

agriculture development as a whole. Besides agronomic, technical and social aspects there is also an important role played by institutional aspects such as agricultural education, extension and research and their capacity in execution of the quality standard.

Basic issue at present is poor access to right kind of agricultural machinery for modern agriculture. Implements are all imported and are not geared to the real needs of farmers. Its affordability and suitability is beyond the reach of small farmers and also there is no after sale service facility available in local areas. Same applies with spares parts services. Inadequate financial and human resources allocation in these areas is another hurdle on the road to mechanization. Tax for imported equipment and for raw material is different discouraging for the establishment of local manufacturing units. The existing Institutions lack authority and resource to provide services to the farmers on quality assurance of the equipment.

IV. Overview of Human Resource Development in AM

In all periodical plan of Nepal Human Resource Development (HRD) is one of the top priority sector for country's development. In the government service one month of in-service training will have added advantage gaining extra point for promotion to the higher post. All most all disciplinary department have training center. There are several government organization that conduct HRD for the employee as below:

1. Nepal Administrative Staff College (NASC)
2. Nepal Army Staff College
3. Nepal Electricity Authority Training Center
4. Water Supply Training Center
5. Directorate of Agricultural Training Center (DoATC) under Department of Agriculture (DoA)

NASC is the college for the government employee for entry point training for fresh employee as well as compulsory in-service training. DoATC under DoA train agriculture employee for both fresh and in-service in agriculture related subjects. It also conducts short term training. But both the organization is not training in AM and is capable to conduct it. There is no training center for AM, there is a proposal to establish Training and Testing Center in near future.

At present there are 32 under DoA and 50 under Nepal Agriculture Research Council (NARC) AM workforce including administrative support staff. The total agricultural engineering workforce registered with Nepal Engineering Council (NEA) is 225 studied in India, Bangladesh, Pakistan, Germany, and Japan before agricultural engineering studies started in the country. Agricultural engineers of been employed by DoA, Department of Irrigation, Department of Forestry, Department of soil Conservation, NARC, Universities/Educational, Banking and private sectors etc.

There are five University in the country but Purwanchal (Eastern region) Campus Dharan under Institute of Engineering (IOE) of Tribhuvan University (TU) is only college teaching four years program in agricultural engineering and in near future graduate program is going to be lunched in Land Development and Water Management Stream and farm machinery and power. The intake capacity of students was twenty four per batch from beginning till 2010 but now it has been double to forty eight. Till date around 300 undergraduates (Agricultural Engineers) has been graduated.

There is no separate entity to credentialing/licensing/regulations of agricultural engineers, all the engineering graduate have to be registered with Nepal Engineering Council, which is a sort of working license. There is no organization running course of sub-engineer like civil, mechanical or other engineering in agricultural engineering in the country. There is no mid-level technician generating organization. Now some initiatives have been taken by Council for Technical Education and Vocational Training (CTEVT) to train mechanics and other mid-level technicians for mechanization after 10 class. Negotiation is going on to conduct three years sub-engineering course in agricultural engineering. Tractor drivers and heavy machinery operators are getting driving license from the Department of Transport and Management.

V. Agencies/Institutions involved in AM Human Resource Development and their Current Programs/Projects

The promotion of agricultural mechanization and HRD are given priority in all annual and periodic plans. The agencies and institutions involved in human resources development are as below.

1. Agricultural Engineering Division (AED)

AED under Nepal Agricultural Research Council (NARC) are the organizations continuously working for the promotion of agricultural mechanization with programs in their annual and periodic plans. AED has tested, developed, and recommended technologies like zero tillage, improved iron plough, direct seeded rice, rice weeder, pedal paddy thresher, pedal rice-wheat thresher, corn sheller, coffee pulper, low cost solar dryer, cardamom dryer,

low cost poly-house, ginger washing machine, seed drill, jabs planter, millet thresher, testing of matching equipment for two-wheel tractor, low cost drip irrigations, fertigation system. It has also successfully introduced rice mechanical transplanting technology, sugarcane planter, potato planter & digger, milking machines, fish pond aerator, mini tillers, and two-wheel tractors. AED also help and train the local workshops for manufacturing such machinery.

2. Directorate of Agricultural Engineering (DoAEngg)

DoAEngg under Department of Agriculture (DoA) of Ministry of Agricultural Development (MoAD) has been established in the year 2004. Its mandate is extension of agricultural engineering technology which includes short term training, demonstration of agricultural machinery, resource center development, develop custom hiring centers, post-harvest centers and so on. DoAEngg has accomplished various HRD activates as listed below:

HRD for agricultural engineers/technicians working under DoA:

1. In Fiscal Year (FY) 2008/09 Refresher Training on Agricultural Engineering for 10 days to 20 agricultural engineers and sub-engineers.
2. FY 2009/10 Training on Gravity Goods Rope Way for 7 days to 20 agricultural engineers and sub-engineers in association with Practical Action Nepal.
3. FY 2010/11 Training on Procurement Including e-Bidding for 7 days to 27 agricultural engineers, sub-engineers and support staffs.
4. FY 2011/12 Training on Passive & Mechanical Cold Storage for 7 days to 28 agricultural engineers, sub-engineers and support staffs.
5. FY 2012/13 Training on Power Tiller Operation and General Maintenance for 7 days to 28 junior agriculture technician working under DoA.

Training Seed Producer Entrepreneur:

To establish community post-harvest service center working seed production business in FY 2008/09 the training on Community Post-harvest Storage Processing Technology had been conducted for 45 seed producer from farmer groups, cooperatives and private entrepreneur. Till date 12 such center has been established.

Agricultural Mechanization Program for Rural Livelihood:

1. Basic Training for Blacksmiths: Blacksmiths are the back bone of rural farmers for develop, repair and maintenance of their hand tools, hence DoAEngg has felt the need to upgrade black smith skill and started conducting short term training of 7 days from its establishment period FY 2004/05. Till date 250 had been trained. Training are conducted in association with AED and private manufacture Trishul Agri Tools and Engineering.
2. Special Training for Blacksmiths: Basic trained blacksmiths who are keen in their work are selected for special training of 7 days. Till date 60 had been trained and they are trained to fabricate hand corn sheller, mould board plough, harvesting screeted sickle, pedel paddy thresher, water can, biomass stove, jab seeder etc. Training are conducted in association with AED and private manufacture Trishul Agri Tools and Engineering.
3. Resource Center for Blacksmiths: In early years basically trained and in recent years special trained blacksmiths were supported with financing tools and machines like welding m/c, grinder, drill m/c, hand tools etc with cost sharing of around $800 from DoAEngg and around $100 from the legally registered trained black smith. Till date 29 resource center has been established.
4. Basic Training for Power Tiller Operator: Operation, Repair and Maintenance of power tiller/mini tiller for Farmers. Farmers having power tiller or willing to buy has been trained for 7 days to operate and general maintenance with its attachments. Till date 260 had been trained. Training are conducted in association with AED and private entrepreneur BTL Trade Pvt. Ltd, SKT Nepal.
5. Special Training for Power Tiller Repair and Maintenance: Farmers having basic training and keen in their work has been trained for 7 days to overhaul the engine, transmission system, fuel system etc. Till date 60 had been trained.
6. Resource Center for Power Tiller Repair and Maintenance: In early years farmers with basic training, and in recent years special trained farmers were supported with financing tools and machines like welding m/c, grinder, drill m/c, hand tools etc with cost sharing of around $900 from DoAEngg and around $100 from the legally registered trained power tiller operator. Till date 20 resource center has been established.

Demonstration and Exhibitions: Demonstration and exhibition are the tools of awareness and also can be consider as one of the form of HRD. DoAEngg has also conducted several activities.

1. Minimum Tillage Technology: Starting from FY 2005/06 minimum tillage technology with seed/seed cum fertilizer drill driven by power tiller has been demonstrated in farmers' field in wheat and later on direct seeded rice with side by side traditional

methods of cultivation. This showed comparative advantage of AM. Till date 26 demonstration has been conducted in different district. The crop has been monitor throughout the cropping season. Farmers field days are conducted 3 times in the cropping season. Due to this kind of demonstration the farmers had adopted the technology for cultivation.

2. Harvesting Technology: Power tiller attached reaper, self-propelled mini reaper and mini combine harvester were demonstrated in the area where minimum tillage technology and in other areas for harvesting wheat and rice. The demonstration has encouraged farmers to use such machine for harvesting. Till date more than in 50 locations have been demonstrated.
3. Mini Tiller Technology: Mini tiller for land preparation is been demonstrated in the mid-hill and high hill where there is narrow terrace land. It has encouraged farmers to use mini tiller rather than bullocks driven traditional or improved plough for land preparation. Till date more than in 50 locations have been demonstrated.
4. Mobile Demonstration: Audio visual equipped pickup jeeps loaded with seasonal machines are been taken to the village. The video related to the machine will be screen during evening time in the open air and the next day field operation of the machine will be carried out. This type of activate has encourage farmers for AM. Till date more than in 30 locations has been demonstrated.

AM Exhibitions: First National Agricultural Mechanization Exhition-2014 was organized in joined cooperation with AED, Agro Enterprise Center (AEC) of Federation Nepalese Chamber and Commerce at the terai plan of Chitwan district on February 21-24, 2014. Out of 75 district farmers, groups and cooperatives from 52 districts including policy makers, educationists, researchers, students, NGO/INGOs, entrepreneurs etc. visited the exhibitions. Altogether 35 thousand people have visited the exhibition. There were 72 exhibitors, exhibiting more than 500 agricultural machines, tools, equipment etc from 16 countries. Total turnover was 50 million Nepalese Rupees (around $ 480,000). There was no subject specific professional organization working in agricultural machinery manufacture, traders, dealers etc. hence ad hoc committee was formed to process the registration. Finally, Nepal Agricultural Machinery Entrepreneurs Association (NAMEA) was registered and began functioning.

Custom Hiring Center: Until now, the custom hiring of AM is an informal business. Model custom hiring centers titled "Community Agri Machinery and Implement Service Center for Custom Hiring" started operations in two locations of terai districts in the last 2 years. Due to the budgetary constraints infrastructure constructions like shed, training halls with some basic agricultural machines are provided on the cost sharing basis. It is expected to be operationally completed within the next 2 years.

Focus Program to Subsidies AM: Subsidy programme in AM has started within the last 3 years, answering the demands of the farmers. Shortlisted manufacturers, suppliers and dealers are being distributed to all 75 DADO. Farmers/farmers groups/ agriculture cooperative from 29 districts out of 75 chose 448 power tillers, 236 mini tillers and 344 attachments from the list in the FY 2013/14. In the first year 50 % subsidy was provided for the machines that will operate for more than 6 months, 75% subsidy that operate on a seasonal basis. In the second year FY 2014/15 subsidy percent was changed as per geographical regions: 25% terai, 30% mid hill, 35% for high hill. Farmers/farmers groups/ agriculture cooperative from 35 districts out of 75, chose 1299 power tillers, 1008 mini tillers and 1288 attachments from the list of subsidized machinery. In the current FY 2015/16, 13 Rice mission, 20 Fish mission districts and 24 districts highly affected by the recent earthquake are eligible for the program with 50 % subsidy in specialized machinery. The basic operation training of the machines in the cluster after delivery is mandated as per the agreement with the suppliers.

3. Samarth - Nepal Market Development Programme (NMDP)

Samarth-NMDP managed by Adam Smith International (ASI), is a UK aid funded five-year rural market development programme that aims to reduce poverty in Nepal, by increasing income of smallholder farmers and small-scale entrepreneurs. One of the components of this programme is Agriculture Mechanization in mid-hills, where the programme aims to stimulate private sector investment with the objective of improving competitiveness and ultimately providing enhanced benefits to smallholder farmers and small scale entrepreneurs. Samarth associated with F-skill training consultants, with private entrepreneurs and BTL Trade Pvt. Ltd had conducted a number of training in different mid-hill districts in operation and maintenance and small business management.

Samarth-NMDP is planning to invite Expression of Interest from interested parties (importers and suppliers) to take part in a survey being conducted jointly by Samarth-NMDP and DoAEngg in the near future. The result of the survey will show the current scenario of availability of repair and maintenance services in the mid-hill districts and identify the partners and districts who we can work with to establish better maintenance services through mechanization trainings. This will also lead to the selection of interested parties

who we can partner with to implement a mechanization trainings to enhance repair and maintenance services in the needed areas.

4. Feed the Future(FtF)

FtF program implemented by International Maize and Wheat Improvement Centre (CIMMYT Intl) under Cereal System Initiative for South Asia in Nepal (CSISA-NP) of USAID are working in Mid and Far West region of Nepal for smallholder farmers for generation of income through agriculture, conservation agriculture and AM. Their mandate is to demonstrate AM and training the AM users.

After the devastating 25 April, 2015 earthquake of 7.8 magnitude and major aftershock on 12 May, 2015 of 7.3 magnitude in the country, financial support from USAID-Nepal, CIMMYT/CSISA provided medium-term recovery plan to eight affected districts with grain storage materials and AM such as 400 mini tillers and attachments in 90% subsidy for individual farmers and 95% subsidy for farmer groups/cooperatives. The recovery program includes training package for basic operations. Training mechanics in local level for repair and maintenance. Collaboration with DoAEngg & AED also resulted in brief operation manual of mini tiller published for farmers to distribute during the handover of machines and trainings.

USAID- INDIA through CSISA-3 will be providing support for facility development for Training and Testing Center for DoAEngg and AED. The location is yet to be finalized since GoN have to provide required land for facility development. It will be supporting curricula development for service providers and repair technicians training, including modules for master trainers. There will be several service providers and repair technicians training.

5. Policy Reform Initiative Project (PRIP)

International Food Policy Research Institute (IFPRI)/USAID have several activities and tasks under AM in support of DoAEngg, AED and private sector NAMEA in line with AMPP.

Capacity Building: Organizing capacity building programs for key stakeholders and Observation tours/fair participations.

1. Training cum study visit to India from 9th to 19th August, 2015 was conducted at Zamindara Farm Solutions Pvt. Ltd. (ZFS), Fazilka district, Punjab for custom hiring practices for nine persons, one from DoAEngg, one from AED, one from MoAD, two from DADo, and two private sector custom hiring operators /user cooperatives. The participants have visited cum, and the training report feedbacks state that it was an excellent example of exposure to good custom hiring practices in India. The participation of the Managing Director of ZFS Dr. Vikram Aditya Ahuja and Officiating Program Director Er. Madhusudan S. Basnyat at 2nd Regional Forum on Sustainable Agricultural Mechanization in Asia and the Pacific "Enabling Environment for Custom Hiring of Agricultural Machinery" at Serpong, Indonesia organized by CSAM, introduced each other in the process of organization. We would like to thank CSAM for creating such opportunities, and enabling us to get to know each other, while working for the same goal in sustainable AM.
2. Training for Trainers (ToT): ToT on testing of tractor and attached equipment for four-wheel tractors will be organized at Central Farm Machinery Training & Testing Institute (CFMT&TI) Budni (M.P) from 6-12 Dec, 2015 for DoAEngg, AED and private sector dealing with four-wheel tractors. ToT on testing of tractor and attached equipment for two-wheel tractors will be organized in China. Correspondence with Nanjing Research Institute for Agricultural Mechanization, Ministry of Agriculture(NRIAM) through the coordination of Mr. Zhao Bing, the Head of CSAM, is in process and will be conducted soon. ToT for safety and ergonomics in AM at AED will also be organized at the earliest opportunity.
3. Exhibition Participation: Extend partial support for organizing outreach programs and interaction programs in a national Agricultural Mechanization fair and sponsor participation of traders/ fabricators in international Agricultural Mechanization fairs.

VI. Strategies, Policies, and National Programmes/Initiatives of Human Resource Development of Agricultural Mechanization

1. Constitution of Nepal 2072

Nepal has finally got the formal constitution of Nepal 2015(2072). on Sept 20, 2015, drafted by the representatives of the people, after nearly a decade of political paralysis. This constitution is the fundamental law of Nepal. All laws inconsistent with this constitution shall, to the extent of such inconsistency, be void. It shall be the duty of every person to uphold this constitution. The new Constitution has 37 divisions, 304 articles and 7 annexes. It will be divided into seven federal provinces, a move aimed at devolving power from the capital Kathmandu. But a disagreement surrounding the federal structure that will divide Nepal into seven provinces has triggered violence in the country.

Fig. Proposed 7 Provinces by New Constitution of Nepal, 2015(2072)

Part 4 of the Constitution "Directive Principles, Policies and Responsibilities of the State", mentions the policies in regards to agriculture. Another important mention of the Agricultural Development can be found in the Article 51. State Policies: Section (e) Policies regarding agriculture and land reform. The Point (5) calls for policies in "making arrangements for agricultural tools and an access to market with appropriate price for the produce has been clearly defined".

Human Resource Development (HRD) is the responsibility of Federal and Provincial Government, which was specified in, Schedule 7 (Related to Article 57(3), 109, 162 (4), and 197) "List of Concurrent (federal and provincial) Powers/Jurisdiction"; in S.N. 22 "Scientific research, science and technology and human resource development".

Schedule 8 (Related to 57 (4), 214 (2), 221 (2) and 226 (1)) "List of Powers/Jurisdiction for Local Level" also mentions SN. 15 "Farming and livestock, agriculture production management, livestock health, cooperative"; and S.N. 18 "Management, operation and control of agriculture extension".

Finally, Schedule 9 (Related to 57 (5), 109, 162 (4), 197, 214 (2), 221 (2) and 226 (1)) puts agriculture in the "List of concurrent Powers/Jurisdiction for Federation, Province and Local" Level S.N. 4 Agriculture.

2. Human Resource Development and Agricultural Mechanization in Agricultural Development Strategy (ADS)

Agricultural Development Strategy has been approved by the Government of Nepal (GoN) on Sunday, 26 July, 2015 and has been officially launched by the Minister of Agricultural Development on Friday, 20 November, 2015 with the grand function. Before ADS the plans and programs in agriculture were guided by Agricultural Prospective Plan (APP) which will be finished by 2015.

The vision of ADS for agricultural sector is "A self-reliant, sustainable, competitive, and inclusive agricultural sector that drives economic growth, and contributes to improved livelihoods and food and nutrition security leading to food sovereignty."

The ADS activities will have impact on three groups of farmers (commercial, subsistence and landless). Commercial farmers are directly affected by the most of the ADS measures and in some cases, the impact is direct and very strong, as such in the cases of irrigation, mechanization, value chain development, and exports.

Capacity and Human Resources in ADS

The basis for the education system in Agriculture under new Strategy is "Article 5.3.3 Activities related to Output 2.3 (Education) on a Strengthened Agricultural Education System". The ADS will support a comprehensive package of measures to ensure closer integration with research and extension, improved capacity of the University, agricultural colleges and vocational schools and better response to the needs of farmers and agro-enterprises. These measures will include:

- Improve facilities and capacity of Agricultural University, based on periodic requests for improved laboratories, audiovisual and ICT equipment.
- Establish new departments in the Agriculture and Forestry University, including an Agribusiness Department and a Technology Dissemination Department.
- Support for joint educational, research and extension programs with NARC institutes under NARF and other funding sources, and with extension departments and district officers, including under the voucher system.
- Establish Agricultural University partner operations with private sector. This may involve innovative ways such as: renting/ leasing facilities, training to private/community organizations, and contract research under IPR.
- Establish new agricultural/veterinary science colleges in other regions of Nepal.
- Strengthen capacity of Centers for Technical Education and Vocation Training (CTEVT) through curriculum improvement and training of trainers. Ensure trainers are well acquainted with the needs of commercial and subsistence agriculture and able to direct trainees to research and extension resources to address their specific problems.
- Strengthen capacity of professional staff from government, educational system, and private sector through overseas degrees and training. This will involve establishing an ADS Scholarship program to fund both short term and long term training and degrees for professional to study abroad, consistently with government regulations and needs. The program could be designed ensuring that after conferring degrees abroad, the beneficiaries have the obligations of returning to Nepal for a period of at least 2 years, in the same organizations from where they had left. The scholarship program should be open to government staff and non-government staff including educational organizations staff and students, and private sector professionals.
- Mainstream food and nutrition security into existing agricultural education system, through coordination between public health/ medical institutes and agricultural universities, colleges, and vocational schools.

Article 5.3.10 Activities related to Output 2.10 (Mechanization) on a Range of Mechanization Options accessible to Farmers through the Private Sector

- A mechanization strategy focusing on awareness creation, demand stimulation, a concessionary financing arrangement, technical capacity building of the dealer network, particularly for the two-wheel power tillers and mini-tiller dealers throughout the country and some modifications in taxation. This strategy needs a lot of coordination with the private sector equipment providers and with the commercial banking sector. The approach would be oriented to: (i) power tillers with multifunctional tilling options in the terai; (ii) gradual increase in the numbers of mini two-wheelers (with some optional attachments) in hilly areas; and (iii) labor-saving low energy implements and mechanized irrigation in the mountains. There would be six components to this strategy:
    1. Information dissemination: The private sector has engaged strongly in sales of four-wheelers with approximately 4,500 tractors sold in 2011, but most farmers and potential clients of 2-wheelers (and mini tillers) have little information on two-wheel tractor options and benefits. Therefore, ADS will support the conduct of social marketing campaigns on a cost sharing basis with two-wheel tractor importers and dealers emphasizing the advantages of a two-wheel tractor over the traditional forms of cultivation, harvesting etc. There would be three separate campaigns one for the mountains, one for the hills and one for the terai. Each one of them would have the same aim, to inform farmers of the potential options and choices, however the orientation and relative weighting of these options would be different in the three different agro-economic zones.
    2. Improve customer access to finance: Although four-wheel tractors fall under the regular financing schemes of the commercial banks (hire-purchase), the two-wheel tractors are largely ignored by bank financing and without license plates, the banks are hesitant to provide loans to the prospective owners of the mini-tillers. Likewise, the importers and dealers of the 2-wheeled power tillers have yet to pursue the same kind of aggressive financing implemented by a few of the four-wheel tractor dealers. Some commercial banks have shown a keen interest

in financing two-wheel tractor sales through dealer financing rather than through consumer financing. Dealers are already providing credit for mini tillers. With the dealers and importers co-investing in providing loans to the prospective clients, it is expected that sales would increase significantly from the first year itself. a. Promote commercial banks to finance dealers to on-lend to their customers under two options:

- Extend credit on commercial terms to dealers so that they can also on-lend at rates around 17% (Commercial banks must lend up to 3.5% of their outstanding portfolio to agriculture or face fines of 16% on loans unallocated to this sector. They therefore have an incentive to constantly look for lending to this sector. Commercial banks also have the option to access concessionary financing for the "deprived sector" (cooperatives and micro-finance institutions) at 10-10.5%, but there are restrictions on how the funds are deployed.)
- Access cheaper credit from the Rastra Bank's "deprived sector" lending program although there are restrictions on the targeting of end users.

3. Capacity building of service and maintenance providers: Though the 2-wheelers' and mini-tillers' technical configuration is relatively simple and can be compared to that of the diesel pump sets or even motorcycles, the linkage with after sales service and spare parts is poor. Hence it is proposed that ADS supports:
    - Dealers to increase the technical capacity of the smaller existing workshops that are scattered through the countryside, instead of setting up their own repair workshops. These workshops could also stock spare parts and act as small brokers for some of the 30-35 dealers operating in major commercial centers.
    - Dealers to offer technical training for 1,000 farmer/ service providers to enable them to become local experts in the impacts of mechanization (additional germination rates, cost saving implications, the advantage of zero leveling, the impact of seed drills etc.)
4. Enable the business environment for leasing agricultural equipment. Introduce the following legal measures that would allow leasing companies to operate:
    - Legal clarification (ruling) that the Banking Institutions Act does not restrict non-banking institutions to engage in leasing; and
    - Establish a pledge registry (under the Secured Transactions Act or under by amendment to the Contracts Act) to allow securing the financing for leasing operations by leasing companies.
5. Revise regulation and taxes to support mechanization: To accompany the three above mentioned components, government will implement the following supportive fiscal measures:
    - Waive the VAT amount and import duty on spare parts (which is over 28%), to reduce the proliferation of sub-standard spare parts brought illegally across the border and promote business of local dealers and sub dealers.
    - Remove the 5-year restriction on change of ownership of two-wheel tractors, to encourage mechanization.
    - Impose full VAT on the purchase of 4-wheelers but not on 2-wheelers. The majority of four-wheel tractors are used exclusively for commercial transport rather than for agriculture.
    - Reduce the road tax for 2-wheelers. Currently it is Rs. 2,900 for 4-wheeler and 2,300 for 2-wheelers, which is a disincentive for a two-wheel purchase if it is to be used for agriculture and is excessive in comparison to the 4-wheeler.
6. Pilot a voucher scheme. This may entail provision of a 30% subsidy on all attachments for 2-wheelers and 4-wheelers, to increase the rate of attachment usage (seed drills, reapers, laser levelers, planters etc.). This would last just 3 years and be accompanied by the above mentioned social marketing campaign.

Article 7.17 Decentralized Science, Technology, and Education Program (DSTEP)

The Flagship Program DESTEP aims at decentralizing the extension and research system while fostering coordination of research, extension, and education in order to enhance responsiveness to farmers and agro enterprises needs.

Article 7.17.2 Decentralized Research System

The ADS will support establishment of Agriculture Mechanization Centers in the terai (2), mid hills (1), and high hills (1) within existing research centers.

Article 7.17.3 Integration with the Agricultural Education System

The integration with the agricultural education system will include support to the Agriculture and Forestry University, Tribhuwan University, creation of a department of agribusiness in that university, capacity building of vocational schools and support to the establishment of regional agricultural colleges. Additional measures to ensure closer integration with research and extension include joint educational and research programs with NARC institutes, joint extension programs with departments and district officers, joint educational programs with CAESC, identification of innovative ways for the Agriculture and Forestry University and the Agricultural Colleges to partner with the private sector (example renting/leasing facilities, training to private/community organizations), and coordination with health and medical institute to mainstream food and nutrition security into the agricultural universities, colleges, and vocational schools.

3. Policy

1. National Agricultural Policy, 2004

The policy mainly focuses on transformation from traditional agricultural system to commercialized agriculture. Emphasis is given on the capacity building of staff, farmers, women etc. It does not mention anything of agricultural mechanization or HRD in mechanization. While drafting agriculture policy, there were some misconceptions that AM will displace labor from agriculture.

2. Agricultural Mechanization Promotion Policy, 2071

It has been approved by the Government of Nepal on 29th. August 2014.

The vision of the policy is: "To contribute national development through agriculture mechanization in present agriculture system to transform to modernization and commercialization."

In the policy Clause 9. Objective: there are four main goals to achieve agricultural mechanization in the country.

1. To increase productivity through appropriate agricultural mechanization as per the economic and geographical need of the country in order to develop the sustainable, competitive and commercial agriculture sector.
2. To develop the services and business of agriculture machinery through the coordination among the Government, private sectors and cooperatives in order to increase the access of the farmers and the business people.
3. Identification and promotion of women and environment friendly agriculture machinery.
4. To establish and strengthen the organizational structural development to develop quality standardization, regulation, monitoring and promotion of agriculture machinery for agricultural mechanization.

In Clause 10. Policy and Working Policy has described how to fulfill the objective. In line with human resource development, the different section of the policy has specifically mentioned as described below:

In Sub clause 10.1.2.: The outcome of the research and developed agriculture machine and equipment will be promoted through training, demonstration, exhibition and media.

In Sub clause 10.2.9.: With the coordination between government, private, cooperative or community Modern Agricultural Machinery Workshop and Resource Center will be established and developed for custom hiring, repair and maintenance, and training in all development region.

The 4th objective of AMPP is "To establish and strengthen the organizational structural development to develop, quality standardization, regulation, monitoring and promotion of agriculture machinery for agricultural mechanization", the following strategies and policies have been developed:

- Adequate human resource development for identification, research, development, and promotion of appropriate machinery for agriculture business.
- Capacity development of agricultural engineering academic/ educational institutions for to educate sufficient skilled manpower, in addition to encouragement training centers and Council for Technical Education and Vocational Training (CTEVT) to educate mid-level skilled agricultural engineering technician for promotion of AM.
- Organize different level of training for farmers and entrepreneurs to develop adequate mid-level skilled human resources in repair and maintenance of agricultural machinery,
- Encourage inclusion of agricultural engineering curriculum in secondary and higher secondary vocational education.
- Manufacturers and suppliers should compulsorily organize trainings to farmers on operation and maintenance of agriculture machines.
- Manufacturers, importers, and distributers will be responsible to provide spare parts and clear information on agricultural machines (on price, quality, capacity, type, make, model, safety use, repair & maintenance) in Nepalese language.

- Enhance agricultural mechanization extension services by adding or adjusting technicians/agricultural engineers/sub-engineers' manpower in the extension offices.
- Enhance AED under NARC by recruitment of technical manpower, establish and upgrade with well-equipped research workshop. Establish implement research centers in high hills, hills, and mid-west terai region and capacity building of agricultural implement research center at Ranighat.
- Government farms of NARC, DoA, DoLS should use appropriate number of agricultural machines to aware farmers about the utilization and benefits of such machines.
- A committee will be formed with the representatives from DoAEngg, DoA, and AED, NARC to define the standard of subsidized machines by the GoN.
- Test result of the machinery samples collected from market and results obtained from the research like saving, effectiveness safety etc. will be publicized.
- Create awareness and discourage the suppliers, distributers and consumers in the use of unauthorized, improper and inferior quality machines through effective monitoring mechanism.
- Assurance of intellectual property right for the production/ utilization of indigenous/ traditional tools and technologies.

Organization Structure

The Clause 11 of the policy has visualized organization structure for the effective implementation of AMPP.

- Establish DoAEngg as central level office under MoAD to coordinate programs and technical support as stated in the policy.
- Establish regional level offices under DoAEngg for regional services.
- Upgrade AED of NARC as central level office to centralize and coordinate AM research.
- Recruitment agricultural engineers to enhance capacity of District Agriculture Development Office and District Livestock Office.
- Capacity development of Agricultural Implement Research Center, Ranighat under NARC, in addition to the establishment of Agricultural Machinery Research Center at high hill, mid hill and mid/far western terai.
- Agricultural Mechanization Advisory Committee will be formed under the chairmanship of the Secretary of MoAD with the member from the concerned ministries for implementation of the policy and advisory function to GoN as requested.
- Agricultural Mechanization Technical Committee will be formed under chairmanship of Joint Secretary of Agribusiness Promotion Division under MoAD with the members from the concerned ministries and program director of DoAEngg, chief of AED for coordination. technical suggestion in the policy recommendation to the Advisory Committee.

VII. Need assessment of HRD for Agricultural Mechanization

The following points are to be considered for need assessment HRD of AM.

- DoAEngg is the only organization on the national level working for AM, 75 DADO do not have agricultural engineering manpower for pursuing the AM.
- Establish well equipped training and testing centers.
- Establish more academic and vocational institutes to educate AM technicians.
- Up-to-date skills training for agricultural engineers, introducing new technology.
- ToT in house and aboard for the machinery presently used in the country.
- Create sufficient job pool for the effective AM.
- Educate sufficient number of mid-level technicians for the effective AM.
- Establish local manufacturing/assembling unites to reduce the costs and imports of agricultural machinery from abroad.
- Appropriate training to local manufacturers for quality and standard agricultural machinery production.
- Human resource development for entrepreneurs and cooperatives for custom hiring service.
- Appropriate training for mechanics from the principle company of machinery in fault diagnosis and problem for quality repair and maintenance.
- Suppliers open sufficient workshops with a ready supply of spare parts.
- Train cycle and motorcycle mechanics in repair and maintenance of small machines to serve on local level and establish resource centers on the village level.
- Train blacksmiths to handle workshop tools and establish resource centers on the village level.
- Train farmers in AM to commercialize their production by lowering the production cost.
- Attract young generation with AM as prestigious occupation to address agriculture human resources migration to non-agricultural sectors, urban areas and abroad.
- Develop agriculture in line with the other industries development through AM.
- Train rural women in handling with less women-friendly

agricultural machines.
- Attract young human resources by generating employment opportunities through agricultural mechanization.

VIII. Challenges and Constraints Faced by HRD of Agricultural Mechanization

- HRD is the highest priority for effective implementation of AMPP, but required strategy, directive, guidelines etc. are not formed yet.
- AMPP was approved on the basis of the revoked constitution and the new AMPP with updates is needed as per new federal government system.
- Weak organizational setup in the government system. There are only 15 agricultural engineers in DoA and 25 in NARC to look over the whole country.
- Insufficient qualified human resources for quality training and research in AM.
- No specific training or testing centers in AM.
- Establishing training and testing center requires huge expensive.
- Inadequate infrastructure facility to conduct effective training for staff, farmers or mechanics.
- No mid-level manpower production in the country for AE compared to the other engineering faculties such as civil, electrical, mechanical engineering.
- Hard to retain mid-level technicians of the other faculties working under MoAD as they do not find career development opportunities.
- Annual budget is insufficient to organize more skill trainings and establish resource centers.
- Establishing training institutes/vocational colleges by the private sector is not viable, as AM growth is not as significant as in the other professions.
- Energy is another constraint for AM and HRD.
- Youth migration to urban areas and abroad, while leaving aged persons and women for agriculture is the major constraint for AM and HRD.
- Credit facility and interest rates from financial institutions is also a constraint for attracting the youth for AM and HRD.
- Easy availability of spare parts, lack of training on operation and maintenance of farm machinery.
- Inadequate facility for service and repairs of farm machinery.
- The blacksmiths indigenous skill and technology is at the verge of extinction from the community, due to lack of training in modernization of their skills.
- Due to lack of appropriate training in custom hiring of farm machinery (tractor, power tiller, combine harvesters, thresher, sprayer etc.), the custom hiring is still operating in an informal manner.
- Lack of R&D, human resources in AED and Agricultural Implement Research Center for effective research on appropriate AM
- IOE, Purwanchal campus, Dharan is the only institute producing AE.

IX. Solutions and suggestions for HRD of agricultural mechanization

National perspective:

- Due realization of plans and policies on HRD.
- Establish Training and Testing Centers in all regions of the country.
- Develop more academic and vocational institutions for HRD and upgrade their capacity (both by numbers and levels) through the investments.
- Encourage private academic/vocational institutions development with government control on the fee structures.
- Guarantee the employment opportunities to the trained human resources with the help of the government and private sector.
- Addition of Agricultural Engineer/Sub-Engineer posts in all extension offices (DADOs) and District Development Committees (DDCs)
- Encourage local manufacturing of Agricultural Machinery.

Regional perspective:

- Support by developed countries to undeveloped/ developing countries for HRD through scholarship provisions.
- Capacity enhancement to the existing human resources (Agricultural Engineers/Sub-Engineers) through trainings, visits and traveling seminars.
- Exchange of new innovations on Agricultural Mechanization among the member countries of CSAM through the strengthened linkages.
- Coordination among the organizations/institutes involved in AM in the SAARC mandated regions.
- Establish HRD for AM in SAARC mandated regions.
- Professional organization of the frequent regional meetings for cooperation.
- Establish support for AM Training and Testing Center by the development partners.
- Capacity building needed especially for training and testing from established and well equipped international institutes.
- Strengthen and expand ANTAM activities throughout the region
- CSAM to continue organizing regional meetings and seminars for coordination and cooperation in the area of AM.

Pakistan

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I. Introduction

Pakistan comprises four provinces i.e. Punjab, Sindh, Khyber Pakhtunkhwa, and Baluchistan. It lies between the latitude of 23° 30' and 36° 45' North, and between the longitudes of 61° and 75° 31' East. It has mountains to the North and West, and arid and semi-arid expanses to the South and East. Down in the Centre is a flat fertile plain, fed by the Indus and its tributaries. The Indus plain has the largest canal irrigation system in the world, making cultivation possible despite scanty and erratic rainfall and ranges of extreme temperatures.

Agriculture is the main foundation and pivotal sector of Pakistan's economy. It accounts for 20.9% of the Gross Domestic Product (GDP) in 2014-15, and is a source of livelihood of 43.5% of rural population. Among these more than one million people are directly engaged in agricultural mechanization. Agriculture provides raw materials for major industries; like cotton textiles and sugar, as well as medium and small scale industries. It has played a pivotal role in earning foreign exchange for the country through the export of rice and cotton.

Pakistan's largest food crop is wheat. In 2014, 25 million metric tons of wheat were produced, which is more than all of Africa (about 20 million metric tons) and nearly as much as all of South America (about 24.5 million metric tons). Rice is the second largest staple food crop and is also an exportable item. Its annual production is about 6.8 million metric tons. Maize is the third largest food staple food grain, with annual production of 4.70 million tons. Cotton and sugarcane are the important cash crops of Pakistan. Annual cotton production is 13.983 million bales, whereas the annual sugarcane production is about 62.7 million tons.

The use of mechanical power in Pakistan's agriculture first appeared in the early fifties in the form of private tube wells to tap underground water for irrigation purposes. Following the advent of seed and fertilizer revolution and rapid increase in tube wells, the introduction of tractor and tractor operated tillage equipment become inevitable in the mid-sixties. In general, farmers adopted mechanized operations that were time consuming, involved high level of drudgery and require simple devices for their mechanization, such as plowing with tine-cultivators, irrigation with engine pump-sets and threshers for cereal crops.

As the mechanization was initiated in the form of private tube-wells to tap underground water for agricultural purposes, this is the only operation that is 100% mechanized in Pakistan. About 331,948, 50,683, 21,524, and 20,937 tube wells are in operation in Punjab, Sindh, KPK, and Baluchistan, respectively, whereas 331, 905, 36,245, 24269, and 9,244 tractors were in operation in Punjab, Sindh, KPK, Baluchistan, respectively. Agricultural mechanization proved worth in improving agricultural productivity, profitability of farming, and livelihoods of the rural people.

Literature revealed that until 1962 relatively few agricultural

engineers from Allahabad, India along with some mechanical engineers had been working in agricultural engineering workshops administered by Govt. of Punjab, Pakistan. The first department of agricultural mechanization was set up in 1958 in the Engineering College workshops, University of Peshawar. In 1962, a formal education in agricultural engineering was introduced at the University of Peshawar. In 1963, a full fledge 4 years B.Sc. Agricultural Engineering program was launched at Faculty of Agricultural Engineering and Technology, West Pakistan Agricultural University, Lyallpur.

At present, there are five universities in the country, which are offering B.Sc., M.Sc., and Ph.D. programs in agricultural engineering. Besides this, there are number of technical centres, which are offering courses in Auto and Farm Machinery for period ranging from 6 to 36 months. Furthermore, there are 10 technical schools/centres offering tractor operator courses.

There is need to further train human resource in agricultural mechanization in fields such as farm machinery and power, precision agriculture, postharvest processing, on farm value addition, and renewable energy resources. There is need to review the performance of technical schools / centres, and necessary measures should be taken to increase their enrolment. Further efforts may be made to establish agricultural machinery centres and technical schools / centres at District level in Punjab, Sindh, Khyber Pukhtankhwa, and Baluchistan.

II. Status of Agricultural Mechanization

Table 1 presents the status and trend of farm machinery in Pakistan. It is revealed from this table that almost 92% of tractors were equipped with tine cultivators, 80% with land leveling blade, 60% with trolleys, and 34% with thresher. The M.B. plow and disk plow was used by only 10%, and 7% of tractor owners respectively. Therefore, there is need to popularize M.B. plow and disk plow for land preparation after cotton and sugarcane crops, and disc harrow / powered disc for seed bed preparation for sowing wheat after cotton and paddy crops.

Table 1: Status and Trend of Farm Machinery in Pakistan

Machinery	1968	1975	1984	1994	2004	% of Tractors
Tractor	18900	35714	157310	252861	401663	100
Cultivator	14338	31619	146863	236272	369866	92
MB Plow	2335	2734	7319	28413	40050	10
Disc Plow	2513	2938	6355	20372	29218	7
Blade	3925	4200	69004	164489	233126	58
Chisel Plow	-	-	712	6535	8514	2
Rotavator	-	-	2101	5594	47919	12
Bar/Disc Harrow	2007	2373	8140	13233	23764	6
Ridger	-	120	4711	10984	71338	18
Grain Drill	563	1174	11251	64126	70810	18
Sprayer	-	473	-	20778	21756	5
Trailer	-	18074	98787	176412	242655	60
Thresher	-	5635	78377	112707	137270	34
Reaper	-	-	-	8073	5341	1
Combine Harvester	-	-	-	395	1524	
Laser Leveler	-	-	-	-	2785	1

Source: GOP 2004

Grain drills and planters are critical to attaining required number of plants per acre and uniform plant to plant and row-to-row distance. Timely sowing is good cultural practice and it can affect up to 10% of the yield. It is interesting to note that only 18% of the tractor-owners have grain drills and ridgers (Table 1), which indicated that more work needs to be done by private and public sectors on the manufacturing of seeding machinery.

Land preparation was the second operation after irrigation tube wells, which was mechanized in Pakistan. At present, about 70% tillage operations were performed mechanically, and the "Spring tine-cultivator" was the most popular tillage equipment. Table 2 presents various tractor-operated implements owned by tractor – owners. It is revealed by this table that 92% of tractor – owners in Pakistan owns "spring tine-cultivator". The reason behind its popularity is its low price and easy availability. Disc harrows are getting popularity. About 5, 19, 2, and 4% of the tractor-owners in Punjab, Sindh, KPK, and Baluchistan respectively owned disc-harrows.

Table 2: Tractor's Operated Implements / Equipment owned by Tractor Owners (2004)

Sr. No.	Name of Equipment	Pakistan	Punjab	Sindh	KPK	Baluchistan
1	Tractors	401,663	331,905	36,245	24,269	9,244
2	Cultivar (% of tractors)	369,866 (92)	317,506 (96)	26,998 (75)	21,440 (88)	3,992 (43)
3	M.B. Plough (% of tractors)	40,050 (10)	27,093 (8)	6,357 (18)	3,004 (12)	3,596 (39)
4	Disk Harrow (% of tractors)	23,764 (6)	16,032 (5)	6,786 (19)	540 (2)	406 (4)
5	Disk Plough (% of tractors)	29,218 (7)	16,471 (5)	9,602 (26)	1,371 (6)	1,774 (19)
6	Drills / Planters (% of tractors)	70,810 (18)	66,700 (20)	2,147 (6)	1,644 (7)	319 (3)
7	Ridger (% of tractors)	71,338 (18)	66,806 (20)	3,471 (10)	658 (3)	403 (4)
8	Trollies (% of tractors)	242,655 (60)	195,332 (59)	21,881 (60)	18,709 (77)	6,733 (73)
9	Thresher (% of tractors)	137,270 (34)	112,655 (34)	11,626 (32)	9,761 (40)	3,228 (35)

The use of mould-board plough and disc-plough was more in Sindh and Baluchistan provinces of Pakistan (Table 2). Rotavators, in particular, were becoming increasingly popular due to the speed with which they can produce a fine seed-bed in a short period between the wheat harvest and the sowing of cotton or rice, resulting in high yield. About 18% tractor-owners owned drills and planters for sowing of wheat and cotton. In fact, mechanization of planting operations has seriously lagged behind the tillage operations. Rice transplanting is being done manually; however, efforts were made to introduce a low-cost non-matured seedling rice transplanter in the country. Wheat was being sown with drills only in rain-fed areas (30% of total wheat area). Cotton was mostly sown with drills, instead of planters. These not only use higher seed-rate, but also involved extra thinning cost. Knapsack and tractor-mounted boom sprayers were being manufactured locally; these were being used for spraying nearly 5.0 million hectares area of cotton and rice crops. The effectiveness of pesticide-application technology was very poor in the country. Research and development efforts were needed to improve the quality of locally manufactured sprayers.

Harvesting of wheat crop was about 37% mechanized. This was being harvested with 50,000 reapers and 12000 self-propelled combines. Threshing of wheat crop was mechanized up to 80% in Pakistan. According

to 2004 census of agricultural machinery, about 137,270 threshers were in operation in the country. These were all being manufactured locally. Sugarcane harvesting, striping and cotton picking were still performed manually. However, farmers do want to mechanize these operations, but appropriate machines were not readily available. Transportation of sugarcane from farms to sugar mills was being done with tractors and trolleys. At present, about 60% tractors owners also owned trolleys. This mean about 242,655 trolleys were available on the farms, which were being used for transportation of goods in the villages.

It can be concluded that tillage and threshing operation were mechanized, up to 70%, and 80%, respectively. However, great potential exists for mechanization of seeding / planting operation, harvesting of sugarcane and cereal crops, drying and storage of agricultural and horticultural crops.

III. Status of Agricultural Machinery Industry

- **Tractor Manufacturing Industry**

In private sector, tractor manufacturers have made significant efforts in indigenization of tractors by deleting substantial quantities of imported components. Local manufacturing of tractors has not only saved foreign exchange but also provided employment opportunities by establishing assembly lines at tractor manufacturers' premises and through vending industries. There were five firms licensed in assembly / local manufacturing of tractors in collaboration with the foreign firms of different makers, namely; Massey Ferguson (MF-240 & MF-265 / MF-375), Fiat (Fiat-480 & Fiat-640), Belarus (MTZ-50 & UMZ-6AKM), Ford (3600 & 4600) and IMT (540 & 560). There are however, two firms (M/s Millat Tractors and M/s Al-Ghazi Tractors) which are at present mainly engaged in tractor manufacturing and they have achieved around 85% deletion. Table 3 shows the price and production of locally manufactured tractors 2014-15 (July-March).

Table 3: Price and Production of Locally Manufactured Tractors 2014-15(July-March)

Tractors Model – Horse Power (HP)	Price / Unit Including GST (Rs.)	Production (in Nos.)
M/s Al-Ghazi Tractors		
NH 480-S (55HP)	706,200	3,630
NH 480-S with power (55HP)	717,200	1,285
Ghazi (65 HP)	785,400	5,641
NH 640 (75HP)	998,800	1,182
NH 640 WBD (75HP)	1,009,800	67
NH 640-S (85HP)	1,098,000	34
NH 640-S (WBD) (85 HP)	1,115,400	31
NH 55-56 (55HP)	756,800	3
NH 60-56 (60HP)	841,500	-
NH 70-56 (85hp)	1,424,500	45
M/s Millat Tractors Ltd		
MF-240 (50 HP)	715,000	8,668
MF-350 plus (50 HP)	761,200	50
MF-260 (60 HP)	794,000	4,104
MF-360 (60 HP)	819,500	920
MF-375-S (75 HP)	1,039,500	2,892
MF-385 (85 HP)	1,160,500	920
MF-385 4WD (85 HP)	1,760,000	171
Total:		31,963

- **Agricultural Machinery / Implements Manufacturing Industry**

There were 15 farm machinery manufacturers in 1959. As a result of liberal government policies such as rebate in import duty for raw material, exemption of sales and income tax, their number increased to around 530. Local farm machinery industry is producing farm implements / machines for land development, seedbed preparation, crop stand establishment, inter-culture, harvesting and threshing, crop protection and farm produce haulage. The quality of locally produced farm machinery is generally poor, mainly due to:

- Lack of availability of trained manpower;
- Poor machinery design;
- Improper manufacturing techniques;
- Non-availability of quality raw materials and non-standardization of components;
- Insufficient financing and lacking marketing skills; and
- Unawareness of manufacturers about standards, their non-availability in Urdu (national language) and missing government regulation on their enforcement particularly on safety and ergonomic requirements.

There is no legislation to ensure quality of locally produced machine through testing by a designated government agency before selling to the farmers. Neither farmers nor manufacturer are quality conscious. There is urgent need of:

- legislation to enforce standards particularly on safety and ergonomic aspects; spraying machinery, PTO shaft shields, canopy for tractors, guard on v-belt drives, forage chopper drives, etc.
- testing of locally produced and imported farm machines by an accredited agency and display of performance evaluation fact sheets by the manufacturers for facilitating the buyers;
- hiring of qualified and experienced engineers and technicians by the manufactures and developing in-house facilities to evaluate working of their products for performance and reliability;
- educating the manufacturers on benefits of using off the shelf standard components, preparing spare parts, catalogues and instruction manuals for their products.

IV. Status of Agricultural Mechanization Research

Research and Development (R&D) is an essential step for introduction / success of mechanical interventions. This is true for both local and imported farm machines. Farm Machines imported from industrialized countries may not suit due to the differences in agro-climate and socio-economic conditions and may need improvements / modifications. It is also necessary to make the locally developed product affordable by using available raw material, technical skills and production techniques. So far agricultural engineering research proves to be worth all the efforts in Pakistan; a number of imported machines were modified by the research institutes and adopted by the farming community. In addition, a few machines / techniques were invented to assist the growers of different crops.

For example, machines like reaper-windrower, zero tillage drill, groundnut digger and thresher, sunflower thresher, throw-in type paddy thresher, pneumatic row crop planter, and wheat straw chopper were modified and adopted to the local conditions of Pakistan. Whereas, machines like solar-cum-gas fired fruit dryer, fertilizer band placement drills, mobile seed processing unit, mobile flat-bed dryer and seeder for combine harvested paddy fields were invented and introduced to farming community.

However, there is need to add new dimensions in agricultural mechanization research for its sustainability:

- Precision Agriculture: A new farming concept that optimize fertilizer, pesticide, water use etc., while minimizing environmental concerns. It is necessary to train manpower in this area.
- Energy System Engineering Research: Pakistan is blessed with solar energy furthermore agriculture and forestry produce plant biomass either as residue or as the primary crop product that can be utilized as a renewable fuel resource. Therefore, expertise needs to be developed for harnessing renewable energy resources and their application in agriculture.
- Environmental Engineering: There is need to develop highly production and environmentally sound agricultural practices. Control of dust generation, chemical aerosol drift and gaseous emissions from open burning of agricultural residue may be the focus of future research.
- Post-harvest Mechanization: Post-harvest handling has a decisive effect on the extent of post-harvest losses, the final quality and market value of agricultural as well as horticultural crops. There is need to re-orient the priorities of agricultural mechanization research in this area.
- Livestock Mechanization: Livestock contribution to agriculture value added stood at 56.3% while it contributes 11.8% to national GDP. All the operations at farm level in livestock except poultry are being performed manually. There is need to focus

R&D efforts in proper animal housing, cooling and pasteurizing milk, on developing shearing machines for removing of sheep wool, and aeration gadgets for in-land fish ponds.

- Mechanization of Large Farming Operations: The mechanization of cotton picking, rice transplanting, sugarcane harvesting is still a distant dream for Pakistan's farmers. Therefore, research may be focused for mechanization of these operations in Pakistan.

V. Overview of Human Resource Development Work in the Field of Agricultural Mechanization.

1. Current Number and Employment Status of Agricultural Mechanization Work-force.

1.1. Employment in Universities

At present 5 universities are offering programs in B.Sc. (Agri. Engg), M.Sc. (Agri. Engg) and Ph.D. (Agri. Engg) in the country. About 185 persons are working in these universities related to agricultural mechanization at the level of Professors, Associate Profe`ssors, Assistant Professors, Lecturers, Engineers and Technical / Lab. Assistant. Table 4 presents the employment status in universities:

Table 4: Employment Status in Universities

Sr.No	University	Faculty/Department	Professors	Associate Professors	Assistant Professors	Lecturers	Assistant Executive Engineers	Technician/ Lab Asstt.
1	University of Agriculture, Faisalabad	Faculty of Agricultural Engineering and Technology	6	4	9	30	16	18
2	PMAS - University of Arid Agriculture, Rawalpindi	Faculty of Agricultural Engineering and Technology	2	1	1	4	1	5
3	Bahauddin Zakariya University College of Agriculture, Multan	Department of Agricultural Engineering	0	1	5	5	2	5
4	Sindh Agriculture University, Tandojam	Faculty of Agricultural Engineering	4	2	13	9	0	10
5	Khairpur College of Agricultural Engineering and Technology.	Affiliated with Sindh Agriculture University, Tandojam	1	0	1	6	0	2
6	University of Engineering and Technology, Peshawar	Department of Agricultural Engineering	4	1	4	5	0	8
Total:			17	9	33	59	19	48

1.2. Employment in Pakistan Agricultural Research Council (PARC), Islamabad

PARC is an apex agricultural organization, and there is Division of Agricultural Engineering focusing on research to agricultural mechanization, food process engineering and renewable energy technologies. PARC inducts agricultural engineers as scientific officer, and then they built their career up to the level of Chief Scientist-II. At present, one is working at the level of Chief Scientist-II, 07 at the level of Principal Scientific Officer, Two at the level of Senior Scientific Officer, about 20 at the level of technicians. However, about 15 Scientific Officers are likely to be inducted in near future. About 45 personals are working in the area of agricultural engineering / mechanization at PARC (Table 5).

Table 5: Employment status in PARC, Islamabad

Sr. No.	Organization	Division/Institute	Chief Scientist-II	Principal Engineer	Senior Scientific Officer	Scientific Officer	Technician
1	Pakistan Agricultural Research Council	Agricultural Engineering Division	1	2	0	0	0
2	National Agricultural Research Centre	Agricultural and Biological Engineering Institute	0	5	2	15	20
Total:			1	7	2	15	20

1.3. Employment in Departments of Agriculture of Provinces.

Directorate General Agriculture (Field) under the Departments of Agriculture, Govt of Punjab, Sindh, KPK, and Baluchistan are engaged in land leveling using bulldozers and drilling of tube wells. In fact, they are providing services to the farmers in these areas. Table 6 shows the manpower employed in these Directorates.

Table 6: Manpower employed in Departments of Agriculture of Provinces.

Province	Organization	Directorate	Director Agricultural Engineering	Agricultural Engineer	Assistant Agricultural Engineers	Technician
Punjab	Field Director General Agriculture	Directorate Engineering (HQ)			3	
		Directorate Agricultural Engineering, Multan	1	7	34	753
		Directorate Agricultural Engineering, Lahore	1	4	31	863
		Directorate Agricultural Engineering, Faisalabad	1	5	24	541
		Agricultural Machinery Research Institute, Multan	1	4	9	25
		Directorate Soil Conservation, Rawalpindi	1	2	6	166
Sindh	Field Director General Agriculture	Directorate General Agricultural Engineering and Water Management	1	5	22	500
Khyber Pakhtunkhwa	Field Director General Agriculture	Directorate Agricultural Engineering	1	3	11	240
Baluchistan	Field Director General Agriculture	Directorate Agricultural Engineering	1	1	3	50
Total:			8	31	143	3,138

1.4. Employment in Agricultural Machinery Manufacturing Industries:

Agricultural machinery industry in Pakistan is engaged in manufacturing of tractors, agri. Implements, threshers, and planting machinery. This industry employed about 675 persons as Manager, 623 as Secretarial staff, 595 as Foreman / Supervisor, 245 Engineers, and 8775 technicians / helpers. The total work-force engaged by this industry is about 10,913. At present, small scale industries do not employ engineers at their premises; resultantly the quality of the product they produce is poor.

1.5. Employment as tractor operators and skilled laborers in tractor repairing workshop.

At present about 527,195 tractors are in the country. The same number of tractor operators and helpers are engaged with these tractors. Furthermore, there are about 2500 repairing workshops in the country, and skilled and unskilled laborers working in these workshops are about 150,000. This mean that in total about 10, 54,540 persons are employed as tractor operators, helpers and skilled laborers in tractor repairing workshops.

2.1. Credentialing / Licensing / Regulations of agricultural engineers, agricultural machinery operators and technicians, if applicable.

Pakistan Engineering Council (PEC) is responsible for registering the Engineers in Pakistan including the agricultural engineers. Annex-I indicate that 3737 registered agricultural engineers are in Pakistan. PEC also conducts the exam to provide the certificate of professional engineers. Technicians are trained in different technical and vocational training schools, and they are provided certificate at the end of their training program. Besides, most of the technicians are trained by getting working experience in agricultural machinery industries, this practice is more common in the country. Tractor operators are trained in Agricultural Machinery Training Schools and in Technical Training Centres. However, percentage of the operators trained from these schools is very low, and majority of the tractor operators get on-farm training by attaching themselves with the trained tractor operators.

2.2. Agencies / Institutions involved in agricultural mechanization human resource development and their current programs / projects.

2. Institutions of Higher Learning

Following universities are offering the program in B.Sc. / M.Sc. / Ph.D. in agricultural engineering:

1. University of Agriculture, Faisalabad.
2. University of Engineering & Technology, Peshawar.
3. PMAS- University of Arid Agriculture, Rawalpindi.
4. Sindh Agriculture University, Tandojam.
5. Bahauddin Zakariya University College of Agriculture, Multan.
6. Khairpur College of Agricultural Engineering, Khairpur, Sindh.

Annual enrolment in different programs of agricultural engineering by the various institutions of higher learning is presented in Table 7:

Table 7: Annual enrolment in agricultural engineering Faculties/ Departments.

Sr. #	University	Faculty/Department	Degree Programs		
			B.Sc. Agricultural Engineering	M.Sc. (Hons.) Agricultural Engineering	PhD Agricultural Engineering
1	University of Agriculture, Faisalabad	Faculty of Agricultural Engineering and Technology	217	70	12
2	PMAS - University of Arid Agriculture, Rawalpindi	Faculty of Agricultural Engineering and Technology	51	12	7
3	Bahauddin Zakariya University College of Agriculture, Multan	Department of Agricultural Engineering	63	18	-
4	Sindh Agriculture University, Tandojam	Faculty of Agricultural Engineering	198	50	10
5	Khairpur College of Agricultural Engineering and Technology.	Affiliated with Sindh Agriculture University, Tandojam	60	-	-
6	University of Engineering and Technology, Peshawar	Department of Agricultural Engineering	36	15	5
Total:			625	165	34

3. Technical Education and Vocational Training Authorities

Punjab Technical Education and Vocational Training Authority (TEVTA) was formed through an ordinance (No xxiv of 1999) promulgated by Governor of the Punjab which has now been replaced by TEVTA Act x of 2010, Punjab. TEVTA offered tractor operator courses in their

following Schools / Center (Table 8):

Table 8. Training schools/ centers of Punjab TEVTA for tractor operator courses

Sr.#	Institute Name
•	Agricultural Machinery Training School, Faisalabad
•	Agricultural Machinery Training School, Sargodha
•	Agricultural Machinery Training School, Talagang
•	Govt Technical Training Centre (M) (ABAD), Kallur Kot, Bhakkar
•	Govt Technical Training Centre (ABAD), Zafarwal
•	Govt Technical Training Centre (ABAD), Kot Chutta
•	Govt. Technical Training Centre (AMTS), Bahawalpur
•	Govt Technical Training Centre (AMTS), D.G.Khan
•	Govt Technical Training Centre (AMTS), Multan
•	Govt Technical Training Centre (AMTS), Gujranwala

Table 9 shows the tractor operators and mechanics trained by these schools / centres from 2009 to 2015.

Table 9: Tractor operators and mechanics trained by TEVTA Punjab schools/centres.

Course	2009	2010	2011	2012	2013	2014	2015	Total
Tractor and Auto Mechanic (12 Months)	67	105	103	125	80	85	9	574
Tractor Mechanic (6 months)	25	-	50	46	75	78		274
Tractor Operator (6 months)	206	206	242	305	346	290	55	1650
Tractor Operator (3 months)	-	-	-	-	-	91		91

Table 10 shows the centres of TEVTA (Punjab), which offered courses in Auto and Farm Machinery:

Table 10: TEVTA (Punjab) centres, which offered courses in Auto and Farm Machinery

Sr.#	Course	Duration (Months)	Institute
1.	Auto & Farm (DAE)	36	Govt College of Technology, Bahawalpur. Govt College of Technology, Faisalabad. Govt College of Technology, Sahiwal.
2.	Auto & Farm Machinery (G-II)	24	Govt Technical Training Institute, Kamalia. Govt Technical Training Institute, Bahawlnagar. Govt Technical Training Institute, Harapa Road, Sahiwal. Govt Technical Training Institute, R.Y.Khan. Govt Technical Training Institute, Shorkot. Govt Technical Training Institute, Sillanwali Road, Sargodha.
3.	Auto & Farm Machinery (G-III)	12	Agricultural Machinery Training School, Sargodha. Agricultural Machinery Training School, Talagang. Govt Technical Training School, Gujar Khan. Govt Technical Training Centre (M), (ABAD), Jampur. Govt Technical Training Centre (M), (ABAD), Taunsa Sharif. Govt Technical Training Centre (ABAD), Khusab. Govt Technical Training Centre (ABAD), Pasurur. Govt Technical Training Centre (DMTC), Khundian. Govt Technical Training Centre, Choa Saidan Shah. Govt Technical Training Institute, R.Y Khan. Govt Technical Training Institute, Sillanwali Road, Sargodha.

4.	Auto & Farm (G-III)	12	Govt Technical Training Centre (M), (ABAD), Jand. Govt Technical Training Centre (M), (ABAD), Muree. Govt Technical Training Centre (ABAD), Zafarwal.
5.	Auto & Farm Machinery	6	Govt Technical Training Centre, Fortabbas. Govt Technical Training Centre, Sadiqabad. Govt Technical Training Centre Lalian (DMTC), Tehsil Chiniot. Govt Technical Training Centre (DMTC), Burewala. Govt Technical Training Centre (DMTC), Daharanwala. Govt Technical Training Centre (DMTC), Garh More, Jhang. Govt Technical Training Centre (DMTC), Gojra. Govt Technical Training Centre (DMTC), Jalalpur. Govt Technical Training Centre (DMTC), Kot Addu. Govt Technical Training Centre (DMTC), Kot Mithan. Govt Technical Training Centre (DMTC), Mailsi. Govt Technical Training Centre (DMTC), Shaher Sultan. Govt Technical Training Centre (DMTC), Shujabad. Govt Technical Training Centre (DMTC), Talamba Govt Technical Training Centre, Tamman Govt Technical Training Centre (DMTC), Hasilpur. Govt Technical Training Centre, Tranda Muhammad Pinnah.
6.	Auto & Farm	6	Govt Technical Training Centre (DMTC), More Khunda. Govt Technical Training Centre (DMTC), Manawala. Govt Technical Training Centre (DMTC), PirMahal. Govt Technical Training Centre Bhowana (DMTC), Tehsil Chiniot. Govt Technical Training Centre, Okara.

Table 11 shows the persons training in Auto & Farm Machinery in these centers from 2009 to 2015:

Table 11: Persons trained in TEVTA (Punjab) centers from 2009 to 2015.

Course	2009	2010	2011	2012	2013	2014	2015	Total
Auto and Farm DAE (36 M)	63	83	118	170	119	94	58	705
Auto and Farm (G-II) (24M)	69	21	91	95	115	138	25	554
Auto and Farm Machinery (G-III) (24M)	67	105	103	125	80	85	9	574

Under the administrative control of TEVTA Punjab, a Centre for Agricultural Machinery Industries is operational at Mian Channu. This centre was established with technical and financial assistance of the Royal Netherland Government in 1992. This centre offered technical courses in different trades, and provide services related to common manufacturing facilities to agricultural machinery industry in the area.

Sindh Technical Education and Vocational Training Authority were established to undertake and manage TEVTA institutions in the Province. There are 250 training centers being managed by Sindh TEVTA, but only one center at Khairpur is offering training course in Auto and Farm Machinery with annual enrolment of 25 students.

Khyber Pakhtunkhwa Technical education and Vocational Training Agency (TEVTA) was established under the TEVTA ordinance XXXIII of 2002 on February 09, 2002. There are 100 training centers/technology colleges are being managed by this Agency, but not even a single center is offering course related to Auto and Farm Machinery/ tractor operator.

4. Strategies, Policies and National Programmes/ Initiatives of Human Resource Development of Agricultural Mechanization.

There is no specific strategy/policy at national level exist for human resource development of agricultural mechanization. This task is being accomplished by the agricultural universities along with other training facilities of agriculture. Similarly, technical training related to agriculture machinery operation and maintenance is being imparted by technical education and vocational training authorities of the Provinces along with training of other disciplines (electrical, mechanical, civil, etc).

VI. The Need Assessment of Human Resource Development of Agricultural Mechanization in Pakistan:

1. Need Assessment of PhDs:

As there is need to add the new dimensions of agricultural mechanization research and education therefore, there is need to train personals from technologically advanced countries in following areas (Table 12):

Table 12. Need Assessment of PhDs.

Sr. No.	Area of Specialization	Level of Training	**Number to be trained**
1	Agricultural Engineering with specialization in Precision Agriculture	PhD	10
2	Agricultural/Energy system engineering with specialization in wind, solar and biomass energy	PhD	15
3	Agricultural/Food Engineering with specialization in Post-harvest Processing of Food Engineering	PhD	15
4	Agricultural Engineering with specialized in Livestock Mechanization	PhD	5

2. Need Assessment of Training for Technicians:

Trained technicians are in fact the backbone of the agricultural machinery industry and, the quality of agricultural machines can only be improved by imparting training to technicians in different trades. The need assessment for training of technicians is presented below (Table 13)

Table 13. Need Assessment for Training of Technicians.

Sr. No.	Trade for Training	Number to be Trained
1	Machinist	2000
2	Welder	2000
3	Welder (gas & other types)	1000
4	Fitter	1000
5	Jigs and Fixure designer	500
6	AutoCAD	1000

3. Need Assessment for Training of Agricultural Machinery Operators

For efficient use of tractor operations, it is very important that tractor operators may be trained properly.

At least, 5000 agricultural machinery operators need to be trained annually.

VII. Challenges and Constraints Faced by Human Resources Development of Agricultural Mechanization in Pakistan

- Country-wide schools do not exist for training of agricultural machinery operators. However, where schools exist, the resource poor people do not send their off springs for training because of limited resources in hand.
- Untrained manpower is the major cause of the inefficient use of farm machines. Most operators of tractors, threshers, drills, and sprayers are self-coached. Their knowledge about the use of these machines is very poor. There is legislation that tractor operator must get the driving license, but in rural areas this legislation is not being implemented.
- Because of economic reasons, the resource poor people do not send their offspring into the training centers, rather they prefer to attach them with any agricultural machinery manufacturing industry for training.
- As there is no legislation to ensure quality of locally produced machines, therefore, agricultural machinery manufacturers do not bother to hire Professional Engineers and trained technicians at their premises.
- There are no scholarship programs for university graduates for higher education in agricultural mechanization in technological advanced countries.
- There are no visit exchange programs for academics, researchers, and agricultural machinery manufacturers even between the countries in the region.

VIII. Solutions and Suggestions for Human Resource Development for Sustainable Agricultural Mechanization:

- Scholarships may be provided to the students of various centers of Technical education and vocational training authorities, who are engaged in providing training related to operation and maintenance of agricultural machinery.
- A project can be initiated to train PhDs from agricultural research institutions in various disciplines of agricultural mechanization from the institutions of technologically advanced countries.
- The manpower of the Faculty of Agricultural Engineering of various Universities may be trained from technologically advanced countries in the area of precision agriculture, renewable energy, post-harvest processing and Food Engineering.
- Training schools for agricultural machinery operators may be established at District level and scholarships may be provided to students of these schools during their training program. In addition, the existing schools may be strengthened.
- Centers for Agricultural Machinery Industries may be established at District level (similar to already been established in Mian Channu) for:
  - Training manpower in different technical trades.
  - Assisting local agricultural machinery industry in manufacturing critical parts of agricultural machinery and in providing heat treatment and other facilities.
- Small scale on-farm value addition units in production catchments may be established for training of rural masses in various values addition technologies.
- Regional industrial visit programs may be arranged in order to enhance the knowhow of the small scale manufacturers of agricultural machinery industry.
- Regional visit exchange programs may be arranged for academicians and researchers in regional countries in order to initiate cooperation in different fields of agricultural mechanization.
- There is need to develop linkage among the universities, R&D institutions, and local manufacturing industry, in order to improve the quality of graduate engineers.
- There is need for legislation to enforce local agricultural machinery manufacturers to hire qualified engineers and technicians.

Conclusions

It is concluded that there is need to further train human resource in agricultural mechanization in fields such as farm machinery and power, precision agriculture, postharvest processing, on farm value addition, and renewable energy resources. There is need to review the performance of technical schools / centres, and necessary measures should be taken to increase their enrolment. Further efforts may be made to establish agricultural machinery centres and technical schools / centres at District level in Punjab, Sindh, Khyber Pukhtankhwa, and Baluchistan.

There is need that an integrated approach may be adopted involving all stakeholders both at national and regional levels, to improve the education at universities, technical and vocational colleges, and training schools related to agricultural mechanization.

Philippines

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The Philippines

The policies in the Philippines are implemented in the form of the law. Based on the law, the programs get financing source, and there is a binding obligation for the government to implement these programs. One of the cornerstones of the Philippines' National Agricultural and Fisheries Mechanization Program 2016-2022 is the Republic Act 10601 “An Act Promoting Agricultural and Fisheries Mechanization Development in the Country”, updated in 2013. The national program includes Human Resource Development as one of the major components. The Republic Act 10601 also mandates the skill certification of agro fishery and machinery technicians, agricultural engineers, agricultural machinery technicians, and operators in all agricultural machinery pool centers, service centers and manufactories, which helps the employment of agricultural engineers.

The Republic Act 10659 “An Act Promoting and Supporting the Competitiveness of the Sugarcane Industry and for Other Purposes”, which was recently updated, also mandates and regulates the implementation of human resource development master plan for the sugarcane industry. It also directs the employment program of agricultural engineers, agricultural technicians in the sugarcane industry: as an example, for every 100 hectares of sugarcane it is required by the law for the industry to have at least one agricultural engineer with a proper license.

Another important basis for the program is the Republic art 8559 “An Act Regulating the Practice of Agricultural Engineering in the Philippines” of 1998, which regulate the practice of the agricultural engineering in the Philippines. It states that no one can be employed to work in the agricultural engineering without possessing a bachelor degree (5 years of education) in the field, and the license examination is required as well. As for the foreign agricultural engineers, it is required for them to hold a special permit to do the related work, which is issued by the same certifying organ, the same organ that issues the licenses. Agricultural engineers in the Philippines are supposed to sign engineering plans, same as the other nonagricultural specialization engineers. One of the parts of the practice is the testing and evaluation, as well as the conduction of feasibility studies.

There is 30.1% agricultural mechanization workforce employed in agricultural sector, the majority of them are employed in the farm production and the postproduction. In total, there are 8336 certified engineers, and 46 schools offering agricultural engineering education, and the overall enrolment rate is increasing. These are the basics of the Philippines' national agricultural mechanization Human Resource Development program. The ongoing projects also include the work education and training, welfare and benefits, Social protection (Health and occupational safety) and agricultural engineers' career progression plans drafting.

Sri Lanka

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I. Overview of Human Resource Development Work in the Field of Agricultural Mechanization

1. Current Number and Employment Status of Agricultural Mechanization Workforce

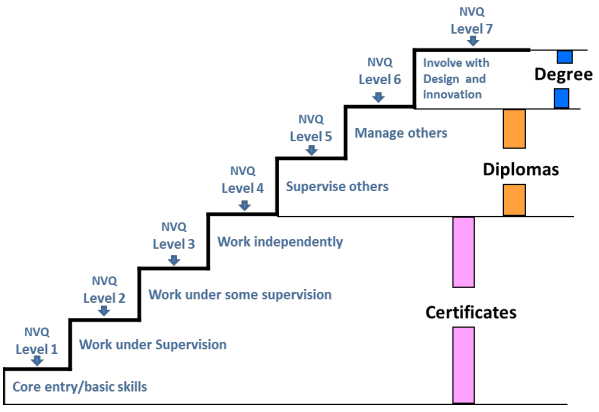
Promotion of Agricultural mechanization in the country is a collective effort of all categories of the community. It consists of farm machinery operators, craftsmen, Sales and service providers, Machinery manufacturers, Extension personnel and design Engineers.

Skill development, technology transfer and knowledge improvement depend on the education basic education standards of the different category.

2. Credentialing/Licensing/Regulations of Agricultural Engineers, Agricultural Machinery Operators and Technicians, if Applicable

National Vocation Qualification (NVQ) is the recognized standards now applied in all sectors. Almost all theoretical and practical educational qualifications leading up to basic degree are assigned with NVQ level as follows.

Level	Qualification	Generalized Description
Level 1	National Certificate	Acquisition of entry level competencies
Level 2, 4 and 4	National Certificate	Increasing level of competencies, level 4 recognizes as full craftsmanship competencies
Level 5 and 6	National Diploma	Increasing level of competencies of technicians including supervision and process management
Level 7	Basic Degree	Vocational level of competencies at bachelor Degree level



3. Agencies/Institutions Involved in Agricultural Mechanization Human Resource Development and their Current Programs/ Projects

There are several Institutions involved in human resource development activities.

Secondary school level - Recently Technology stream has been introduced in the secondary level school curriculum including Agricultural Engineering Technology.

National Vocational Courses

Vocational Training Authority of Sri Lanka conducts practical oriented technical courses relevant to the prevailing job market. This institute recently introduced craftsman level (up to NVQ 4) in the field of Farm machinery technology.

Technical Colleges – Apart from the general Engineering courses offered in most of the technical courses, there are some technical colleges offer specialized courses for farm machinery technicians. The responsibility of updating course curriculum and maintaining required standards is handled by the Department of Technical Education of Sri Lanka.

College of Technology

There are several Higher Technical Education Centres to offer National Diplomas in general Engineering Technology. The following centres offer National Diploma in Technology related to Agricultural Technology including farm mechanization as a subject.

Institute	Province	Courses offered
Hardi Technical College, Ampara	Eastern	General Agriculture
Technical College, Kulitapitiya	North Western	General Agriculture
Technical College, Dambulla	Central	General Agriculture
Aquvainas College, Colombo	Western	General Agriculture
Technical College, Anuradhapura	North Central	Farm Mechanization Technology

University Colleges

Recently established three University Colleges offer Farm Mechanization Diploma level and Certificate level courses along with the other technical courses.

Institute	Province
University College, Kuliyapitiya	North Western
University College, Jaffna	Northern
University College, Mathara	Southern

Schools of Agriculture

Department of Agriculture manages five Schools of Agriculture to produce Diploma holders (NVQ 6 level) to serve Agriculture sector in the country.

Institute	Province
Schools of Agriculture, Kundasale	Central
Schools of Agriculture, Pelwehera	Central
Schools of Agriculture, Angunakolapelessa	Southern
Schools of Agriculture, Karapincha	Sabaragamuwa
Schools of Agriculture, Vauniya	Northern

Annual intake -350

Department of Agriculture also manages another six Schools of Agriculture to produce Certificate level qualified (NVQ 5 level) to serve Ag ountry.

Institute	Province
Schools of Agriculture, Labuduwa	Southern
Schools of Agriculture, Anuradhapura	North Central
Schools of Agriculture, Bibila	Uva
Schools of Agriculture, Palamunai	Eastern
Schools of Agriculture, Kilinochchi	Northern
Schools of Agriculture, Wariyapola	North Western

Annual intake - 250

Farm Mechanization Training Centre (FMTC)

Farm Mechanization Training Centre (FMTC) of the Department of Agriculture is the only national level training institute for providing farm machinery trainings. FMTC offers training on tractors, water pumps, plant protection equipment, paddy reapers, paddy threshers, paddy combine harvesters and manually operated implements.

In addition to the above trainings, FMTC too make an effort to popularize micro irrigation techniques among the farming community of Sri Lanka. Generally, the service of FMTC is provided to farmers, officers in the agricultural sector, university undergraduates of faculties of agriculture, students of the schools of agriculture, technical colleges and general schools, private sector personnel involved in farm mechanization etc.

FMTC grants its support to the field extension staff in carrying out extension activities related to farm mechanization. Apart from that, FMTC provides advisory services on farm mechanization for the necessary institutions.

Farm Mechanization Research Centre (FMRC)

Farm Mechanization Research Centre (FMRC) of the Depart5ment of Agriculture also trains farm machinery manufacturers on manufacturing technology on new designs. At the introduction stage of a new technology in agriculture FMRC provide training on operation and maintenance on the new technology to trainers, operators and farmers.

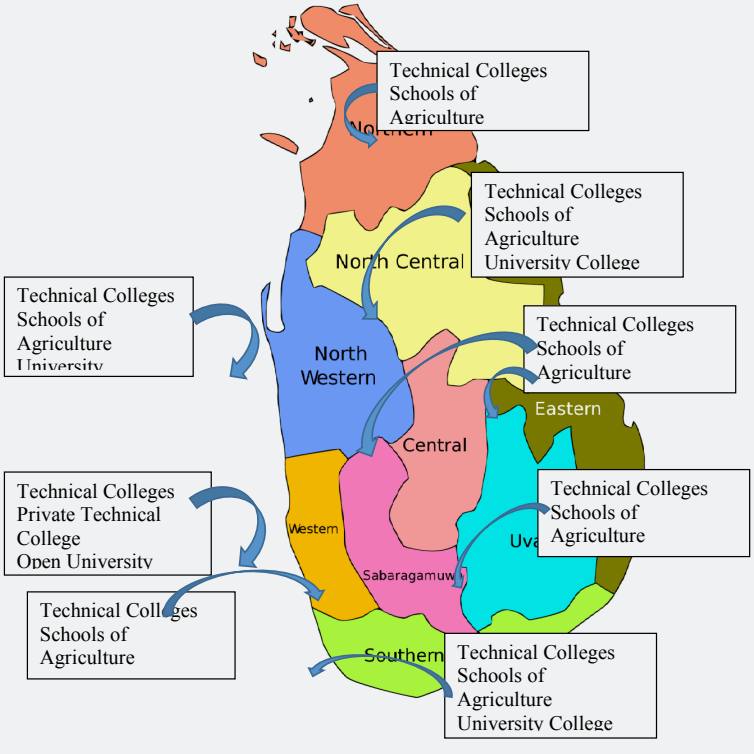
Universities

There are five state universities offer general Agriculture Bachelors Degree programmes including Agricultural Engineering as a subject in all semesters. Students can select Agricultural Engineering subject as specialized subject in the final semester.

Postgraduate Institute of Agriculture, University of Peradeniya offers postgraduate courses on Agricultural Engineering.

Private Sector

Private sector involvement in human resource development activities is negligible. They also seek government assistance to train their own staff. There are instances that the private sector support to conduct collaborative training programmes on specific areas.



Distribution of Institutes in Sri Lanka

II. Strategies, Policies, and National Programmes/Initiatives of Human Resource Development of Agricultural Mechanization

Recently, the need of human resource development in the field of agricultural mechanization has been identified as a priority area and has given the equal opportunity same as with the other sector. Therefore, gates are open to acquire knowledge and skills. However more systematic approach is needed by analyzing the problems in the present scenario.

III. The Need Assessment of Human Resource Development of Agricultural Mechanization in Sri Lanka

Development in Farm Machinery sector and introduction of new technology is a continuing process. Human resource development in the sector has to be updated in parallel with the technology improvement in the relevant field. A systematic need assessment has not been conducted and similarly with other sectors. Therefore, the need assessment in parallel with the technology development is an urgent need.

IV. Challenges and Constraints Faced by Human Resource Development of Agricultural Mechanization in Sri Lanka

Agricultural extension could play a key role in fostering sustainable agricultural Mechanization development programs through its human resource development programs. However there has been a growing realization that prevailing capacity building programmes have not been sufficiently effective in promoting adoption of sustainable agricultural mechanization practices. Extension organizations face several challenges in promotion activities especially due to lack of train personnel in technology dissemination. In addition, poor infra-structure, absence of participation of private sector participation in planning and implementation process of capacity building programs

On the other hand, the weaknesses in the present capacity building system, there is a very weak linkage between research and training wings. In addition, there is a fundamental lack of appropriate training in the roles and responsibilities of agricultural extension officers on sustainable agricultural mechanization development. Also the numbers of field staff working in the field of machinery usage management are not enough when compared to the large number of farmers. There is a need for educational Programs and training courses for farmers on sustainable agricultural mechanization, because farmers lack the operation & maintenance skill and knowledge on improved agricultural mechanization practices.

Most of the practical training providers are private sector organizations. The public sector capacity to accommodate all type of trainees is very limited. Keeping track of the training providers and reporting accurately on their capacity is a challenge. National Apprenticeship and Training Authority (NAITA) the co-ordinating body of most of human resource development activities in the country, maintain annual reporting of data by training providers a requirement for registration. However, the data processing capacity of the Institution is also not sufficient to update the data.

Farm Mechanization sector itself is not developed as an attractive livelihood for younger generation compared to other sectors at present. Therefore, the participation to the courses offered by most of the Institutions is with under capacity. The left out percentage is also comparatively higher than the other sectors. As a result of that there is a huge gap between the demand and the supply.

The existing infra-structure facilities such as accommodation, farm machinery, cut models available at most of the vocational training centres are not adequate and also out-dated in order to provide required training.

Despite many efforts in promoting human resource development activities in the country, the sector still lacks technically and professionally qualified human resources flexible enough to effectively respond to fast demand-driven approaches of the agricultural Mechanization markets. The following core problems are identified as reasons behind this.

- Compared to the progress in development of other sectors this sector has only received marginal attention. The limited enrolment capacity of the training institutions excludes a wide portion of the young population from vocational education and training and limits their chances of finding employment in agriculture.
- Fragmented and scattered technical and vocational training delivery that does not meet the needs of the fast growing agricultural mechanization sector.
- Low capacity, inadequate and outdated training materials & equipment and also lack of skilled and qualified trainers in training institutions.
- Teachers and trainers lack practical, pedagogical and didactic skills, and lack technology knowledge and competences to develop curricula.

- Weak linkages between private and public efforts National Apprenticeship Training Authority (NAITA) Industrial and agricultural universities and research.
- Efforts in rehabilitating training Centres and programmes in agricultural mechanization tend to rebuild on old systems instead of promoting modernized systems.

V. Solutions and Suggestions for Human Resource Development for Sustainable Agricultural Mechanization

Currently, the technical and vocational track is seen by school leavers as an unattractive dead-end track. There are many issues that need to be resolved in this regard. Those issues, in particular the expansion of training at the diploma level and the mobility to and from various types of training should be addressed in a national policy document and national development plan through expert consultations and stakeholder inputs. This process has to be speeded up with the assistance and financial contribution from the government. The following areas has to addressed in order to strengthen the human resource development programmes in the field of sustainable farm mechanization in the country as well as in the region.

- Bringing private sector or NGO training providers and the public sector providers together in public-private partnerships that lead to more efficient use of existing public sector facilities is another strategy.
- Develop new and innovative models to incorporate capacity building programmes of farm machinery into existing NVQ systems or to generate new institutions for Agricultural Engineering.
- Develop legislative frameworks ensuring and supporting National Vocational Qualification (NVQ) in operation and maintenance of farm machinery.
- Develop appropriate monitoring evaluation systems to trace the impact of human resource development programmes in regards to employability of graduates;
- Install incentives that encourage private sector participation in skills development activities
- Modernize existing facilities to cope with emerging innovations in training delivery.
- Support linkages between public and private initiatives among research, universities and the training authorities.
- Support the role of farmer organizations in assessing training needs and compiling overviews of available training institutions as well as to lobby for improved or changed curricula and for demand-driven training courses in the country or region
- Adopt models that have proved to be effective in generating vocational and professional capacity in other regions
- Integration of non-formal and formal training
- Education and capacity-building programmes for youth must be defined in a more participatory way and focus on best operational practices and knowledge sharing with other countries in the region.
- Youth platforms (rural youth and young farmer's platforms and councils) must be created to determine training and capacity building needs;

Thailand

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I. Overview of Human Resource Development Work in the Field of Agricultural Mechanization in Thailand

1. Current Numbers and Employment Status of Agricultural Mechanization Workforce

There is no specific information in the agricultural mechanization workforce. However, the labor shortage is one of the biggest problems in Thailand. The service business has expanded while lacking in the field labor and field skill labor. National Statistical Office reported that the population of labor age of 15-59 increased: from 41 million in 2005 to 43 million in 2015. However, the forecasted number in 10 years is 38 million. In the meantime, the labor over 60 of age is significantly increasing compared to other age group of people in 2005. The population of 6 million in 2005 (10%) is forecasted to be 16 million people in 2025 (25%). Projection shows an increase of 300% within 30 years. Moreover, census shows that seasonally inactive labor force of 2014 are 176.1 thousand people or 0.3% of people of age 15 year and over.

Thailand has developed its agricultural machinery service and operators' skill in a several ways:

1. The private agricultural machinery contractors are distributing in local area. The wide range of services are rice harvesting, plowing, planting, spraying, pudding and etc. There are services not only in their local area but across the region.
2. The Agricultural Cooperatives, Farmer Group and Community Enterprise. The range of services is focused on product collecting processes, short term storage and transportations.
3. The small agricultural machine owner. The main purpose of their machines is to work on their land. However, they work on their neighbors' land afterwards for more income.

The amount of Agricultural service on agricultural machinery is shown below:

4 wheel tractor under 18 H.P.	195,056
4 wheel tractor 18 - 50 H.P.	476,785
4 wheel tractor 51 H.P. and over	705,657
2 wheel tractor	1,053,505
Water pump	217,585
Sprayer	1,425,943
Weeder	191,549
Planter and Seeder	311,769
Harvesting machine	1,469,510
Thresher	1,652,106
Rice milling machine	2,471,425
Animal utilization	2,464
Transportation equipment	1,915,936

2. Credentialing/Licensing/Regulations of Agricultural Engineers, Agricultural Machinery Operators and Technicians

Thailand Professional Qualification Institute was founded in 2002 to encourage, support and develop profession standards and qualifications. As of now, the agricultural machinery operator and technician certifications are still in process of consideration for the future. Design engineers on the other hand need license approved by the Council of Engineers.

3. Agencies/Institutions Involved in Agricultural Mechanization Human Resource Development and their Current Programs/Projects

- The Intermediate Technology Research and Development Institutes are The Agricultural Engineering Research Institute (Department of Agriculture), The Universities and Academics of Agricultural Engineering and Technics, Asian Institute of Technology, MTEC, NECTEC, Iron and Steel Institute of Thailand, Thai-German Institute, Thai-Japan Institute. These groups focus are on research, development and testing of agricultural machinery and materials. Therefore, their agricultural mechanization human resource development is in the development of researchers both from the way of academic system and from on-the-job research and development.
- The 20 universities involved in academic agricultural engineering and related fields
- The organization involved in agricultural mechanization promotion is the Royal Initiative Extension with Area Management and Agricultural Engineering Division, Department of Agricultural Extension, Ministry of Agriculture and Cooperatives. They are the only organization of the government that takes part in the dissemination and promotion of agricultural mechanization. There are agricultural extension offices of the same department in each province supporting their work.
- The Thai Society of Agricultural Engineering (TSAE) was founded in 1976. They are involved in: to promote research and extension in the field of agricultural engineering, to provide consultancy and technical services, and to facilitate collaboration among stakeholders, e.g., government agencies, universities and industries

II. Strategies, Policies, and National Programmes/Initiatives of Human Resource Development of Agricultural Mechanization

1. Royal Initiatives Extension with Area Management and Agricultural Engineering Division Has Programmed to Promotion in Agricultural Machinery Such as:

- Promoting non-burning agriculture by using farm machinery such as ploughing instead of burning, and promotion of the conversion figure on N P K and their value in the straw
- Promoting farmers and farmer groups to use new procedure and farm machines such as to use sub-soiler to solve soil compaction problem, to use combine harvester to reduce the loss of harvester, and to use on-farm irrigation system to solve the problem of less water
- Develop 3,300 community mechanics within last 3 years and expected in the next year. There are 3 levels of community mechanics developed: Basic, Intermediate and fully Mechanics which difference in knowledge and skills.
- Training in 3 ranges of agricultural business managements in 2015 include of seed preparation and transplanting, milling, and rice harvester operation together with reparation and maintenance

2. The Thai Society of Agricultural Engineering (TSAE). Some of Their Activities are:

- Publication of Thai Society of Agricultural Engineering Journal and Agricultural machinery buying guide. There are bi-annual research journal and it is the only one in Thailand that is dedicated to agricultural engineering
- Organize TSAE Annual Conference, and Agricultural Engineering Student Senior-Project Conference
- Services in drafting/revising standards, technical training, and research
- Official partner of arranging the Agricultural Machinery Exhibitions in Thailand: SIMA ASEAN Thailand 2015, AGRI ASIA 2014, ISRMACH 2013, and etc
- Partnered up with various organizations on a wide range of activities: Thai Industrial Standards Institute, Iron and Steel Institute of Thailand, Agricultural Machinery Manufactures Industry Club, National Agricultural Machinery Center, Board of Investment of Thailand, Weed Science Society of Thailand, Leading national universities, and other private companies

III. The Need-Assessment of Human Resource Development of Agricultural Mechanization in Thailand

There is no need-assessment research in human resource

development of agricultural mechanization in Thailand. However, in the perspective of agricultural machinery contractor, supports such as loan from the government, the reasonably price of spare parts, the low fuel price, the knowledge, technological information and human resource development are needed.

IV. Challenges and Constraints Faced by Human Resource Development of Agricultural Mechanization in Thailand

Challenges and constraints faced by human resource development of agricultural mechanization in Thailand include the lack of priority put forth in skill development, not only intently but also continuously. Not only does the development of agricultural mechanization require knowledge and understanding, but it also involves development in skills and experiences in the specialized fields. Thus, the policy of skills and knowledge developments along with encouragement of industry and usage are vitally important.

Although the encouragement for farmers to invest in agricultural machinery opens up opportunities, it may be a financial burden. The informing of correct usage, condition maintenance, reparation, and the reinforcement of machinery production and merchandize become a challenge for human resource development of agricultural mechanization including agricultural machinery in Thailand

V. Solutions and Suggestions for Human Resource Development for Sustainable Agricultural Mechanization

The human resource development for sustainable agricultural mechanization requires informing of correct usage, condition maintenance, and basic reparation. Developing the skills of a small group of farmers or even a skillful farmer in each area allows for them to help other farmers in local area in several ways: dealing with technical problems, informing, and managing community agricultural machinery.

In the perspective of Thailand as a nation, the opportunities for agricultural machinery usage of farmers, the informing of correct usage, condition maintenance, and basic reparation should the priorities

In regional perspective, Thailand is capable of being the one to impart knowledge or certain skills and techniques of usage, maintenance, and reparation, as well as provide agricultural machinery and services for other neighboring counties. Thailand's geographical location gives it advantage in transportation of machinery and workers. Southeast Asian region is geographically similar all throughout as far as weather, seasons, and plants. Other than that, farmers in different countries in the region have fairly similar preference in farming methods and styles. Therefore, such process will allow the region as a whole to equally develop at a faster rate.

Vietnam

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I. Overview of Human Resource Development Work in the Field of Agricultural Mechanization in Vietnam

1. Current Number and Employment Status of Agricultural Mechanization Workforce

Vietnam currently has no overall survey on the number of employees serving agricultural mechanization. However, the status of qualified Mechanization in Vietnam is very low compared to the areas where the work force of agricultural mechanics is not well balanced or simply missing. The slow development of the process of mechanization make training demand inadequate. According to the Center for Forecasting Manpower Needs and Labor Market Information Ho Chi Minh City, the list of fields that are "missing" human resources include different fields of mechanical engineering, and this sector have the lowest supply (about 1.5% labor market). As such, training needs for mechanics and agricultural engineers are acute and overall higher degree of mechanization is required.

Unskilled manpower currently make up the majority of the work pool, while the proportion of high-quality human resources account for a very low percent rate. What is lacking in today's Vietnam is not ordinary human resources, but high quality manpower. According to the General Statistics Office in 2014, 18.2 million workers have been trained out of total 52.7 million labor force, there are only 3.3 million people have diplomas and certificates issued by the educational institutions in the country and abroad. People aged 15 and older are receiving

- Technical training: 81.8 %; vocational training 4.9%;
- Long-term vocational training: 3.7%; College: 2.1%; Graduate and above: 7.6%.

There are 6.4 million people working in the fields of agriculture, forestry and fishing); There are 3.9 million people working as plant and machine operators and assemblers.

Labor allocation structure by sector and imbalances. Engineering, technology, agriculture, forestry, fishery have acute shortage of labor, while the social sector e.g. law, economics, foreign languages have a much bigger labor pool than it needs. Many industries and sectors have both redundant and insufficient manpower. The areas currently experiencing labor shortages are business finance, audit, information technology, electronics, telecommunications, mechanical engineering.

As reported by the Department of Agri-Forestry Processing for Products and Salt Production - Fisheries, Ministry of Agriculture

and Rural Development, the engine management system of agricultural electricity from the central to local levels has not attracted sufficient attention; capacity of staff from the central to grassroots levels is insufficient and weak. Currently the monitoring and reporting on the use of machinery and agricultural equipment by the Department of Agriculture and Rural Development and the provinces is centrally allocated to the Departments of Rural Development or Agricultural Extension Center province, however most of their work force is working part-time and have no expertise in agricultural mechanical engineering or deep expertise in mechanized agriculture. Out of the agricultural mechanical engineers that have been trained previously, there are very few people still working in the professional field.

A survey in 34 Extension Centers of the provinces with the largest rice-growing area by National Institute of Agricultural Planning and Projection, Ministry of Agriculture and Rural Development) showed: 10 extension centers of the Red River Delta provinces (Bac Giang, Bac Ninh, Ha Nam, Ha Noi, Hai Duong, Hai Phong, Hung Yen, Nam Dinh, Ninh Binh and Thai Binh), 10 of the extension centers in Central Coastal provinces and the Central Highlands (Binh Dinh, Ha Tinh, Nghe An, Quang Nam, Quang Ngai, Thanh Hoa, Dak Lak, Gia Lai and Lam Dong) recommended no agricultural mechanical engineers or mechanical engineers.

The Department of Agriculture and Rural Development of the Northern Mountainous provinces hardly train engineers in Agricultural Engineering and the Department of the Interior of the province also has no civil service recruitment criteria for Agricultural Engineering sector.

Survey in the extension center, and extension of 13 Mekong Delta provinces showed human resource professional qualifications in the field of agricultural mechanization are very limited: only 1 center trains Agricultural Mechanics, 5 centers train engineers and 7 centers have no staff for training in Engineering degree. This is the major difficulty for the implementation of technical advances in mechanization of agricultural production locally.

Table 1. The status of human resource engineer at the Agriculture and Fisheries Extension Center of the 13 provinces in the Mekong Delta (4/2012)

N0	Agriculture and Fisheries Extension Center	Agricultural Mechanical Engineer	Mechanical Engineer	Graduation year
1	An Giang province	01	0	1986
2	Long An province	0	01	2006
3	Tien Giang province	0	01	2001
4	Kien Giang province	0	02	2007
5	Vinh Long province	0	01	2004
6	Tra Vinh province	0	01	2004
7	Can Tho province	0	0	
8	Dong Thap province	0	0	
9	Soc Trang province	0	0	
10	Bac Lieu province	0	0	
11	Hau Giang province	0	0	
12	Ca Mau province	0	0	
13	Ben Tre province	0	0	
Total		01	06	

The preliminary survey in some Mekong Delta provinces month 9/2010 also shows that the level of training of human resources in this field is very limited.

Table 2. Survey data manpower level manufacturing facilities combine harvester Mekong Delta

Province	N0	Facility Name	Number of employees	Qualifications are trained in mechanical engineering					
				University	College	Intermediate	Worker	Vocational certificates	Self- training
Long An province	1	Nhật Thành	50	0	0	10	0	0	40
	2	Chín Nghĩa	15	1	0	0	0	0	14
	3	Hiệp Hùng	19	0	0	14	0	0	5
Tien Giang province	4	Tư Sang	57	2	0	4	9	0	42
Dong Thap province	5	Phan Tấn	80	1	0	0	3	0	76
	6	Vạn Phúc	25	0	0	3	0	0	22
	7	Út Máy Cày	30	0	0	0	0	0	30
Can Tho province	8	Hoàng Thắng	30	3	0	3	6	0	18
	9	Năm Sanh	20	0	0	0	0	0	20
	10	Tâm Phúc	55	0	0	0	5	0	50
An giang province	11	Hai Tính	9	0	0	0	0	0	9
	12	Tư H`ồng	10	0	0	0	0	0	10
	13	Dũng số 5	20	0	0	0	0	0	20
	14	Cơ Khí An Giang	275	28	4	20	223	0	0
Kien Giang province	15	Đức Ngươn	15	0	0	0	1	0	14
		Tổng	710	35	4	54	247	0	370

The results above show that the number of engineers and engineering colleges in the training facilities have a very low percentage out of total. The facilities maintain the operations in old fashion, with the self-trained staff in the production process. Only 5 out of 15 fabrication facilities are manned with mechanical staff possessing a qualification of mechanical engineers. Without qualified manpower at present, most of the manufacturing facilities struggle to achieve due product quality and safety.

Mechanical Joint Stock Company An Giang has mechanical engineers, college, middle and trained workers from the largest schools in the fabrication facility of rowing harvesters and combine harvester in the region. This is the basis of making big rowing harvesters for annual supply of the domestic market and exports, estimated around 1,400 sets/year.

Under such circumstances, obviously, Agricultural Mechanization in Vietnam did not meet the needs of personnel to promote agricultural development.

2. Credentialing/Licensing/Regulations of Agricultural Engineers, Agricultural Machinery Operators and Technicians

Previously the country had five training University undergraduate level and postgraduate agricultural mechanics level degrees in: Hanoi Agricultural University (now is Vietnam National University of Agriculture), Nong Lam University in Ho Chi Minh City, Can Tho University, Hue University, Thai Nguyen University. Now the entire country has only two Faculty of Mechanics in Vietnam National University of Agriculture and Nong Lam University in Ho Chi Minh City, with trainings in Agricultural Engineering.

Faculty of Agricultural Engineering in Can Tho University haven't had a single student since 1999 so far no student studying Agricultural Engineering; Thai Nguyen University haven't had students studying agricultural engineering since 2007. Graduates of two universities stay on a school-level mechanical engineering degree in agriculture.

Colleges and vocational schools under the Ministry of Agriculture and Rural Development is tasked with training and certifying technicians and operating machinery. In 2014, the school enrollment quota was allocated for 43.630 people (electric fields of agriculture, construction, fisheries, agriculture, forestry and fisheries processing) in which the primary vocational training under 3 months accounted for 54 %, vocational 34% and 12 % vocational colleges. However, many schools do not recruit students, e.g. College of Engineering and Rural South from 1979 to 1995 had annual average of 150 trained practitioners using mechanical branches of agriculture. From 1996 up to present, 16 years the school was not operating. Now only some vocational colleges (Vocational College of Agricultural Machinery, College of Electrical Engineering of Phu Tho Province) are training in agricultural engineering, rural electrification with the number of participants of about 300 person/year.

The training and vocational qualifications for students is also done by the training center of the University and the Institute of Mechanical engineering (use and operation of equipment in agriculture).

3. Agencies/Institutions Involved in Agricultural Mechanization Human Resource Development and their Current Programs/Projects

Vocational Training:

- The vocational schools under the Ministry of Agriculture and Rural Development;
- The vocational schools under the Ministry of Labor-Invalids and Social Affairs;
- The training center of the universities and institutes
- Mechanical vocational schools.
- Facilitation of engineer training and agricultural mechanical masters:
- Vietnam National University of Agricultural
- Nong Lam University in Ho Chi Minh City

Training of Agricultural Engineering Ph.D.

- Vietnam National University of Agricultural
- Nong Lam University in Ho Chi Minh City
- Vietnam Institute of Agricultural Engineering and Post-harvest Technology (Ministry of Agriculture and Rural Development - MARD)
- Research Institute of Agricultural machinery (Ministry of Industry and Trade - MOIT)

Management of Human Resources:

- Ministry of Education and Training
- Ministry of Agriculture and Rural Development
- Ministry of Industry and Trade
- Ministry of Science and Technology
- General Department of Vocational Training, Ministry of Labor-Invalids and Social Affairs

The Program / Project Development of Human Resources of the Ministries:

- Scheme Training and retraining of civil servants and employees of the Agricultural and Rural Development for the 2013-2015 period and orientations towards 2020;
- Scheme improving the quality of human resources in the Agriculture and Rural Development 2015-2010 period;
- Strategy for labor and human resource development in agriculture and rural industrialization period, modernization 1999-2020;
- Scheme development of human resources and technological sciences 2011-2020;
- Scheme Training and retraining of human resources in science and technology in the country and abroad with the state budget in 2015.

II. Strategies, Policies, and National Programmes/Initiatives of Human Resource Development of Agricultural Mechanization

- Decision No. 121/2007/QD-TTg dated 27/07/2007 of the Prime Minister approving the planning of the network of universities, colleges, 2006-2020 specify: structural adjustment student number training in groups of lines to 2020 the rate: 9% basic Sciences; Pedagogy 12%; Technology-Technical 35%; Agriculture-Forestry- Fishing 9%; Health 6%; Economy-Law 20% and others 9%. But the years have not oriented human development of the country, not suitable for human requirements of these sectors, industries and regions.

- Decree No. 02/ 2010/ND-CP dated 08/01/2010 of the extension regulation policies supporting production lines, processing, storage, consumption in agriculture, forestry, salt production, fishery, irrigation, agricultural mechanical engineering, rural industries. To implement this policy, those who do rural service will be supported with machinery for the trainings, overall raising the awareness level, and to provide information, which is a study tour, in the demonstration of the machines' agricultural equipment, agro-processing capabilities etc.
- Decision No. 579/QD-TTg dated 19/04/2011 of the Prime Minister on approving workforce development strategy for the period of 2011-2020 in Vietnam which focused on team building of scientific and technological manpower, improving vocational training for rural labor and labor in labor intensive farming areas, regional economic restructuring, enhancing training, retraining and improving professional skills, teaching skills for teachers of vocational training schools, creating vocational training centers.
- Decision No. 186/2002/QD-TTg dated 26/12/2002 of the Prime Minister approved the "Strategy for development of Vietnam's mechanical engineering industry till 2010 and vision to 2020" in which the mechanical engineering service agriculture - forestry - fishery and processing industry was named as one of the priority sectors.

Development viewpoints are defined as: To develop effectiveness in promoting local resources combined with external resources. To encourage all economic sectors to participate in developing of the mechanical engineering industry in an organized way; focus on developing a number of specialized, key mechanical products; strengthen self-research and manufacturing; improving specialization and cooperation; encourage the production base of small and medium local mechanical equipment engaged in manufacturing machinery for agriculture and processing industry in an organized way; assignment and reasonable cooperation with businesses on local and international levels.

Development strategy raises some issues of mechanical engineering industry in policy support including market policies and policies to create capital, tax policy, investment policy for research and development, training policy, employer-employee policies.

- Decree No. 45/2012/ND-CP dated 21/5/2012 on industrial promotion policy provisions supporting individual units engaged in rural industry development and application of cleaner production. Metal processing is one of the priority sectors supported. Content supports include: Organization of vocational training and apprenticeships, supporting capacity enterprise management, construction and technical demonstrations, technology transfer, application of advanced technology, food product development, counseling, supporting businesses to set up investment projects, opening access to concessional resources of the state.
- Economic development strategy for 2011-2020 are social Congress XI National Communist Party of Vietnam (2012) defined one of three strategic breakthrough as "…Rapid development human resources, especially high-quality human resources…"
- Resolution No. 46/NQ-CP dated 29/03/2013 issued by the Government action program to implement Resolution No. 20-NQ/TW dated 11/01/2012 of the 6th Congress, the Executive Committee XI Party Central Committee determined to "formulate mechanisms and policies to develop human resources, use and promote staff qualification in science and technology"
- Decision No. 880/QD-TTg dated 09/6/2014 of the Prime Minister: The master plan for development of the industry Vietnam till 2020 with a vision to 2030. The plan sets a target to build a number specialized and key mechanical products to meet the basic needs of the economy, such as movers, machinery for agriculture, forestry and fisheries. The plan also includes a number of measures to implement the planning as measures of capital, market, science and technology, developing solutions for human resources.

III. The Need Assessment of Human Resource Development of Agricultural Mechanization in Vietnam

In mechanized agriculture there are two important factors that influence the production process: the use of human resources and equipment and technical status of the server farm.

Nationwide there are nearly 14 million agricultural households equipped with motivation levels average less than 1.6 cv/ha of cultivated land and the area has the highest dynamics fitted as both countries in the Mekong River Delta (MRD) will only reach 1.85 cv/ha, the percentage of households with tractors and agricultural machinery was low, 62 new households have a tractor. On the degree of mechanization (by the end of 2014) focus stayed mainly on some stages such as tillage, irrigation, threshing dams,

transportation and milling, while the stages as sowing, care, and preservation harvest have a low exposure to mechanization, with the labor being largely manual. The mechanization rate for land preparation, sowing, crop protection and irrigation is 90%, 30%, 70%, and 94% respectively.

The mechanics of agricultural machinery manufacturing have to move to the market economy situation, so there is no need to be subsidized by the State all the time, as the mechanical industry must strive, fierce competition and should face many difficulties. But under the leadership of the Government and the interest of the industry at all levels, the efforts of enterprises, the subsidies should gradually be removed. Enterprises manufacturing agricultural machines still exist and develop. Unit manufacturing industry key movers and agricultural machinery movers Corporation and Vietnam Agricultural Machinery (VEAM) under the Ministry of Commerce consists of 13 corporations and two research institutes. Ministry of Agriculture and Rural Development management unit has 30 specialized mechanics. Besides state-owned mechanical forces, there are also mechanical force of about 70 non-state enterprises.

According to data of the enterprise sales in business of agricultural machinery, agricultural machines produced in Vietnam including the manufacture and assembly has only about 30-40% of the market. Establishments manufacturing agricultural machinery of Vietnam are mainly local mechanical workshops. Their size is rather small, so design engineering and manufacturing technology opportunities are limited, the parts have not been standardized and the quality level is low. Consequently, increasing the cost of maintenance, repairs is reducing the overall competitiveness.

System services and after-sales machines handling is done mostly by cooperatives and private holdings, accounting for about 80% of the service facility. According to statistics of the Ministry of Industry and Trade, machinery for agriculture after sales introduction performed by the dealer. The market of after sale in the country has 1,267 establishments and over 18,000 who specialize in business; 1,218 establishments with 14,146 people specialized in repairs and maintenance of warranty machinery and agricultural equipment.

However qualified human resource pool in conducting mechanization of agricultural production in the use of machine, machine building and agricultural extension is limited, the majority have not been trained from school-level, and have not received specialization in agricultural mechanization. Therefore, the trainings on motorization for related activities should be set.

Vietnam agriculture will not be integrated and will not have higher added value if restructuring while promoting agricultural mechanization is not taken care of. Therefore, the focus on improving the capabilities and quality of trained agricultural mechanics and mechanization service is critical.

IV. Challenges and Constraints Faced by Human Resource Development of Agricultural Mechanization in Vietnam

The mechanics in general and engineering for agriculture and rural development in particular is a sector less attractive for the people (wages are low, work is hard, studies are also rather difficult, etc.). Agricultural production today with the economic restructuring and rapid industrialization will face labor shortages. The solution is to conduct mechanization. However, to develop the agricultural engineering industry we first need to focus on training engineers. nonetheless the universities are stopping to train in the field (Can Tho University, Hue University, Thai Nguyen University), or admission is very difficult and unstable (Vietnam National University of Agricultural and Nong Lam University in Ho Chi Minh City).

Number of trainings is low compared to the requirements of industrialization and modernization of rural agriculture, and while some students after graduation return to the countryside to serve agricultural production, this percentage is very small, around 3-5%. Most of the trainees choose other jobs in manufacturing sectors, woodworking, construction and business.

As an example, at the Nong Lam University in Ho Chi Minh City in four consecutive years 2008, 2009, 2010 and 2011; number of exam candidates in agricultural mechanics is very small, the entrance does not meet enrollment targets, especially in 2011, when no candidate registered to study agricultural engineering industry. The strength of the University of Agriculture and Forestry are the sectors related to agriculture-forestry-fishery, but in the season of the year on admission, even though two Universities have almost equal points in benchmarking scores, many branch exchanges bloc Engineering Agriculture and Forestry, Forestry still cannot recruit enough students.

Table 3: Summary of college students studying agriculture mechanics 2006-2015 of the Nong Lam University in Ho Chi Minh City

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number of Students	37	27	24	17	9	0	67	138	144	91

Table 4: Summary of college students studying agriculture mechanics 2006-2015 of the Vietnam National University of Agriculture

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Number of Students	160	206	51	115	100	96	114	150	176	135

There are many causes of the current situation there is no or very little students enrolled in Agricultural Engineering. But one of the important causes creating this situation is that the field is not attractive for study and work, while students are also aware of the industry prospects on career development are not good. According to the Ministry of Education and Training, in 2010 the number of students in engineering sector were accounting for 31.09%, while technologies in agriculture, forestry and fisheries accounted for 8.69% is very low.

Postgraduate education (Masters and Doctor): Input supplies are limited in quantity and quality, due to the nature of the research with specific characteristics requiring large cost, service facilities for research are limited, there is a lack of teachers to guide students. From 2006 to 2015 (within 10 years) more than 200 master's degree Engineering in Agriculture students have been trained by universities. The number of PhDs in Agricultural Mechanics is also very humble, just over 20 people. On the other hand, the staff of universities and research institutes, after being sent for further training abroad, do not work in the field of agricultural mechanics on their return, which is also very common. This reality makes it difficult for a lot of research and teaching.

V. Solutions and Suggestions for Human Resource Development for Sustainable Agricultural Mechanization

1. Need to do Good Work With the Enrollment in Vocational Agricultural Mechanical Engineering Trainings

For tertiary education institutions to really innovate the human resources training enrollment: enrollment training must be based on the needs of society. Strengthening the link between school/training institutions and enterprises. The training institutions and employers should pay attention to the needs of each organization signed the contracts concluded, and support each other in developing training and manpower supply.

The planning, management and open educational sector now need to study to match actual demand and development orientation of national human resources, and to meet the needs of human society. Failure to adjust and balance the supply-demand growing manpower imbalances, the implications on the development of economic life-society are indispensable in sectors including agriculture.

2. Need to Develop a Comprehensive Policy on Training for Agricultural Mechanics

State policy requirement for a rational amount of scholarships from the budget through general Regulators and from various sources at the national macro level is essential. Also, the state should have the appropriate policies to attract students to mechanical engineering sectors like it did with pedagogy.

The state should establish the system of research centers and technical service stations of agricultural mechanization in the agricultural production areas as key Mekong Delta, Southeast, Central Highlands, Delta Hong, etc. just to meet the requirements of industrialization of rural service, and ensure workplaces for

engineers and those local talents working in mechanization, technical service.

Need to reset the training level IV category in the system of national training programs for agricultural mechanical engineering

Agricultural mechanization is indispensable in the process of industrialization and modernization of agriculture and rural areas. One of the key factors for successful agricultural mechanization is the quality of human resources in agricultural mechanics. The report mentioned the basic issues and proposals in the training and development of Vietnam Agricultural Engineering.


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III. Parallel Session – Perspective of Researchers and Academics

Photoed by Sandro Liberatori

Bangladesh

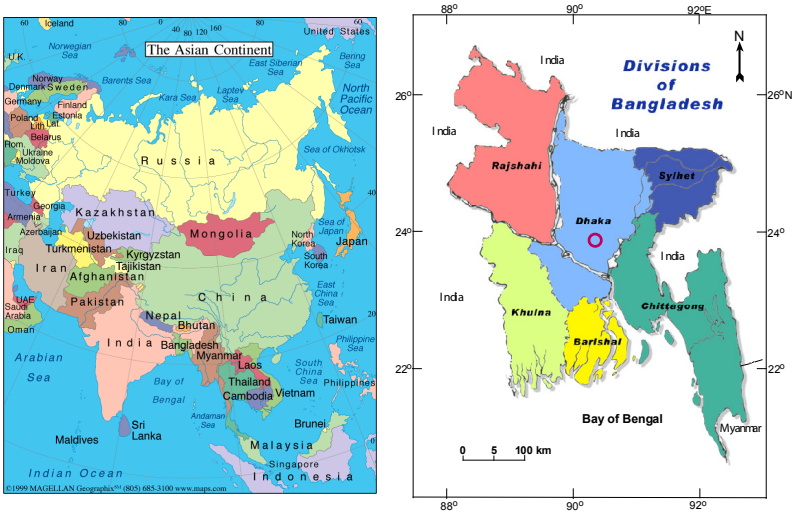
Mr. M A Matin
Director General (In-charge)
Rural Development Academy (RDA)

I. Introduction

Bangladesh, officially, the People's Republic of Bangladesh is the largest wetland in the world formed by the interaction of innumerable rivers and streams. Human habitation in this region is believed to be about one hundred thousand years old. Modern Bangladesh has a long story of struggle for national sovereignty and democracy. The liberation of Bangladesh on 16th December 1971 arises a new era of hopes and aspirations for the people of the country.

Bangladesh is located at the southern Asia, in the north-eastern portion of the Indian subcontinent, bordered on the west , north and east by India, on the southeast by Burma (Myanmar) and on the south by the Bay of Bengal. Bangladesh lies between 200 34' and 200 38' north latitude and 880 01' and 920 41' east Longitude with an area of 1, 47,570 sq. km.

Fig: Geographical Location of Bangladesh.



The capital and the largest city of Bangladesh is Dhaka. Geographically, historically and culturally, Bangladesh forms the larger and more populous part of Bengal, the remainder of which constitutes the neighboring Indian state of West Bengal.

The climate of Bangladesh is sub-tropical with temperatures ranging from a daytime low of 180C in the cold season to a maximum of 400C in the summer. Daily temperature ranges from 100C to 120C in winter months (December-January) and in the summer months from April to September it varies between 280C to 400C. The Annual rainfall ranges from160 cm. to 200 cm. in the west, 200 cm. to 400 cm. in the southeast and 250 cm. to 400 cm. in the northeast mainly in the monsoon. The country has mainly four seasons, the winter, (Nov-Feb), summer (Mar-June), Monsoon (Jul-Oct) and autumn (Nov-Dec). The winter is the most pleasant season.

Demographically, Bangladesh is the ninth largest and one of the most densely populated countries of the world. On the official estimate, the country's population stood now at 146.6 million. The population is evenly distributed throughout its 64 administrative districts except the three hill districts, which are relatively less populous. About 109.2 million population lives in the rural areas and the rest of the population lives in urban areas. About 88% of the populations are Muslims. Hindus are the largest minority group (nearly 10%) followed by Buddhists, Christians and few other ethnic groups. Bangladesh is viewed as a model of religious tolerance and harmony. At present Bangladesh has a population growth rate of 1.39, literacy rate of 58.3 % and the life expectancy at birth is 66.9 years. In Bangladesh 25 million (19.5%) people are living under the lower poverty line.

Table-1: Bangladesh at a glance

Area	:	1,47,570 Sq. Km.
Population	:	146.6 Million
Population Density	:	993 Persons/Sq. Km
Population Growth Rate	:	1.39
Population distribution Urban Area	:	37.4 in million
Rural Area	:	109.2 in million
Life Expectancy at birth	:	66.9 Years
Persons per physician	:	2860 persons/Doctor
Per Capita GDP at current prices	:	US $685
GDP growth rate	:	5.83
Moderate poverty	:	45 million that is (31.5%)
Extreme poverty	:	25 million that is19.5%
Literacy rate	:	58.3%
Per capita GNI at current prices	:	751 million Taka
Labor force	:	49.5 million
Male Labor force	:	37.3 million
Female Labor force	:	12.1 million

Source: BBS, 2011.

Bangladesh is an agricultural country. Major agricultural products are rice, jute (the golden fiber), wheat, potato, pulses, sugarcane, tea, tobacco etc. The country is the world's largest exporter of jute and jute goods. Tea, leather and frozen shrimp are also major foreign exchange earners. There has also been a rapid growth in manufacturing industries, which offer a wide range of exportable goods such as leather goods and ready-made garments. Export of handicrafts is gaining significance gradually. Remittances from Bangladeshis employed abroad have contributed significantly toward foreign exchange earnings. Although Bangladesh is on course for Middle Income Country status by 2021, agriculture remains the largest employer in the country by far; and 47.5% of the population is directly employed in agriculture and around 70% depends on agriculture in one form or another for their livelihood. Agriculture is the source of food for people through crops, livestock, fisheries; the source of raw materials for industry, of timber for construction; and a generator of foreign exchange for the country through the export of agricultural commodities, whether raw or processed. It is the motor of the development of the agro-industrial sector including food processing, input production and marketing, and related services. As main source of economic linkages in rural areas, it plays a fundamental role in reducing poverty, which remains a predominantly rural phenomenon. The role of agriculture is also fundamental in promoting nutritious diets, especially in the countryside where production and consumption patterns are closely linked. According to the HIES (2010) 35.2% and 21.1% of the population in rural areas lives below upper and lower poverty line respectively. It also plays a fundamental role in the sustainable valorization and preservation of natural resources and in preserving and promoting the resilience to natural calamities and climate change of rural communities and agro ecological systems. However, as Bangladesh develops, and other sectors grow (such as readymade garments), the share of agriculture in Gross Domestic Product (GDP) has naturally declined. During the fiscal year 2012-13, the broad agriculture sector1 contributed 16.77% to the total GDP. The contributions of crop, fishery, livestock and forestry subsectors in GDP were 9.49%, 3.68%, 1.84% and 1.76% respectively. The provisional estimates show that contribution of the broad agriculture sector to GDP in 2013-14 would be 16.33% (BER 2014). Nearly three fifth of the agricultural GDP comes from the crop sub-sector; the other contributors in order of magnitude are fishery, livestock and forestry.

Recent History of Agricultural Mechanization in Bangladesh

In the early 1970s, when some influential people in policy circles characterized Bangladesh as a "basket case", no one could have foreseen that the country would, in 2010, have one of the most mechanized agricultural economies in South Asia (Mandal, 2002, Islam, 2009). Significantly, about 80 percent of all land preparation and other primary tillage operations are mechanized. This is performed mainly by 300 000 small two-wheel tractors (2WTs) and the rest by a few (15 000) four-wheel tractors (4WTs). Additionally, 60 percent of land is irrigated by over 1 million small diesel powered pump-sets and most of the wheat and much of the rice crop is threshed by small machines. There is a small number of combine harvesters in Bangladesh10. While some commentators might describe this as a situation where farmers on their own small farms use small-scale equipment, this is not the case. While the average size of land holding is small (less than 2 ha) there is a high degree of inequality in ownership. Small scale equipment is owned by rural entrepreneurs, who may use the equipment on their own holdings, but rent out and hire in services. There are highly developed markets for tractor, thresher, pump-set and other services derived from the spread of small diesel engines. Bangladesh has a remarkable history of mechanization, in which the Bangladesh Government and the Bangladesh private sector both played important roles. Furthermore, for as yet not well-understood reasons the Bangladesh private sector11 (as compared to the private sector in Nepal and India) focused on the import of cheap, low-hp engines and other machinery from China. While there had been various experiments with Japanese and other 2WTs and pump-sets during the 1970s and early 1980s, perhaps the main reason for the rapid spread of 2WTs in the 1990s was a major change in policy in the late 1980s as a result of a national food crisis. After a cyclone hit Bangladesh in 1988 within two and half years of a previous one, taking not only a major toll on human life, but also on the draught oxen population, President Ershad asked what machinery would be most appropriate for their quick replacement. He was told that the Chinese 2WTs could do this, but due to the standards committee they could not be imported. To overcome this problem Ershad disbanded the committee. This action combined with market liberalization policy and the lowering of tariffs resulted in the massive import of small pump-set engines for irrigation and later 2WTs and other equipment. These developments coupled with the more recent spread of tens of thousands of small scale mechanized rice, wheat, and maize threshers - mainly powered by the Chinese diesel pump-set engines makes Bangladesh possibly the most mechanized and labor intensive agricultural sector in South Asia, with substantial employment and other growth linkages to other rural and urban sectors.

10 4WTs have been promoted at different times in Bangladesh. For example, in the 1960s at Bangladesh Academy of Rural

Development, Comilla (Lewis, 1996). 2WTS were promoted in Bangladesh in the early 1970s by a Japanese aid programme, which amongst other things established a training and service centre just outside Dhaka.

II. Higher Education and Research Institutions that Offer Agricultural Engineering/Mechanization Programme, and their Programme Settings in Bangladesh

1. Bangladesh Agricultural University (BAU), Mymensingh, Bangladesh

Bangladesh Agricultural University (BAU) is the premier seat of higher agricultural education and research in the country. The main task of the university is to tone up the quality and standard of higher agricultural education and to produce first-rate agriculturists, agricultural scientists and researchers for shouldering the responsibilities of agricultural development of the country. The missions of university have been to develop the art and science of agriculture for the wellbeing of mankind, and to educate agriculturists of high standards of scientific, managerial and professional competence in harmony with the environment, and to share knowledge and skills with world partners. The Faculty of Agricultural Engineering & Technology of Bangladesh Agricultural University is the only institution in the country to shoulder the responsibilities of increasing the capacity of the students of Agricultural Engineering and Food Engineering programmes for nation building activities since 1964. By providing high quality services to students, the faculty significantly contributes in improving the capabilities of its student and helps develop the country in the long run. This faculty is boosting up production to sustain the process of human development by adding research and teaching activities in the areas of agricultural machinery, irrigation and water management, farm structures, post-harvest technology, food processing and preservation, system analysis and computer science in agriculture. The faculty has started implementing the new curricula and the syllabuses since 2002. It offers two separate degree programmes, one for B.Sc. Agricultural Engineering and another for B. Sc. Food Engineering.

The faculty of Agricultural Engineering & Technology has the following academic departments for offering B.Sc. Agril. Engg., B.Sc. Food Engg., M.S., Ph.D. degrees:

- Department of Farm Structure & Environmental Engineering
- Department of Farm Power & Machinery
- Department of Irrigation & Water Management
- Department of Food Technology & Rural Industries
- Department of Computer Science & Mathematics

2. Hajee Mohammad Danesh Science & Technology University (HSTU), Dinajpur, Bangladesh

Hajee Mohammad Danesh Science & Technology University, Dinajpur, Bangladesh is the first Science and Technology University in the northern region of Bangladesh. It stands away from the urban din and bustle at a beautiful and scenic location some 13km north of Dinajpur town by the side of the intercity highway that links Dinajpur to Dhaka, the capital of Bangladesh. The Faculty of Engineering was established in 2014 which is previously known as Faculty of Agro-industrial and Food-processing Engineering which offers two different degrees (i) B. Sc. in Food and Process Engineering (ii) B. Sc. in Agricultural Engineering to graduate human resource development in the field of agricultural mechanization. The Faculty's distinguished method of qualifying its students in various engineering fields serves to promote progress at the local and regional levels. The Faculty, living up to its vision and mission statements, started Master's Degree program, and introduced a number of well-equipped research laboratory aided by HEQEP CP-2245 Project.

3. Sylhet Agricultural University (SAU), Sylhet, Bangladesh

Faculty of Agricultural Engineering and Technology (FAET), Sylhet Agricultural University (SAU) was founded in 2011 to meet the increasing demand for skilled agricultural engineering graduates. Its goal is to position engineering graduates to be problem solvers, project leaders, communicators, and ethical citizens of a global community. With a combination of expertise and innovation, the FAET seeks new approaches to some of the most critical challenges of the 21st century, thriving within the domains of Farm Mechanization, Irrigation and Water Management, Agricultural Construction, Environmental Engineering, Food Technology and application of Computer Engineering in agriculture. The Faculty is dedicated to providing first-rate education that instills strong basic knowledge for sound practice in agricultural engineering. Through innovative curricula, a teamwork approach, and leadership-building experiences, the students gain vital communication and critical-thinking skills. Working closely within the Sylhet Agricultural University, state and industry leaders, the FAET has a clear vision of its role. Faculty must continue to provide outstanding talents for companies engaged in the competitive global markets. Presently FAET is providing only 4 years undergraduate degree in B.Sc.in Agricultural Engg.& Tech.

in combination of following four distinguished departments:

- Department of Agricultural construction & Environmental Engineering
- Department of Farm Power & Machinery
- Department of Irrigation & Water Management
- Department of Food Engineering & Technology
- Department of Computer Science & Engineering

From inception of FAET no student has been graduated. But total 187nos. students are taking degree under different academic session.

4. Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh

The bucolic serene green campus of Sher-e-Bangla Agricultural University (SAU), Dhaka is located in the heart of the gleeful Dhaka city. Over the last 77 years, it has transformed into a public university with three faculties and produced more than 14000 agricultural graduates those have founded the firm base of agriculture of the nation. The mission of Sher-e-Bangla Agricultural University is based upon the firm belief that agricultural education, particularly higher education provides a critical pathway to leadership development in academic and research fields as well as in achieving sustainable agricultural development, socio-economic progress of the country.

Agriculture graduates are taught Agricultural Engineering knowledge focusing on the systems, processes, and machines that are used to generate or utilize energy, food, and water by the Department of Agricultural Engineering. This program provides students with background in mechanical design, hydraulics, instrumentation and control, finite element analysis, electronics and sensors to design, develop, analyze and operate machines and systems for agricultural and biological products and processes, materials handling, construction and mining, forestry, lawn-and ground-care, and food and fiber production and processing.

5. Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Dhaka, Bangladesh

Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU) is a government-financed 13th public university of Bangladesh and third agricultural university after Bangladesh Agricultural University and Sher-e-Bangla Agricultural University. It is located at Salna, Gazipur. It is providing MS degree in the field of agriculture and agro processing engineering to foster human resource development for agriculture mechanization by the following two departments:

The Department of Agricultural Engineering started functioning in 2005 with a view to disseminating the basic knowledge of Agricultural Engineering among the graduates of this university. It helps engender knowledge in the field of Farm Power Machinery, Irrigation Water Management, Farm Structure and Farm mechanization as a whole. The department accomplishes its intended activities and research using two highly equipped laboratories e.g., Farm Power Laboratory and Irrigation Laboratory along with an Engineering workshop. The academic quality, continuous efforts for excellence and our responsiveness to the students is our distinction.

Department of Agro-processing has recently been opened in this university with the vision to foster agro processing education in view to globalized market of the agricultural products and the environment. Agro-processing refers to transformation of products originated from agriculture into other value added products. Agriculture as a source of raw materials, the country must look to agribusiness development both as a generator of employment and as a basis for value addition to its main economic resources. The agribusiness sector of Bangladesh covers the commercial production of and processing agricultural commodities (including crops, livestock, fisheries and forestry) into different products, provision of inputs supply to the production of agricultural commodities such as agro-chemicals, equipment and the storage, marketing and distribution. Therefore, to take the advantages of expanding agribusiness and increasing employment opportunities in rural areas education in agro-processing would play an important role to impart adequate knowledge and training on the students for successful interventions technologies in order to boost up the economic development of the nation as a whole.

6. Bangladesh Agricultural Research Institute (BARI), Gazipur, Dhaka, Bangladesh

Farm Machinery and Postharvest Process Engineering Division

Farm Machinery and Postharvest Process Engineering (FMPE) division is one of the 16 research divisions of BARI. The division started functioning in 1990 after generation of Irrigation and Water Management (IWM) division and FMPE division from the mother division of Agricultural Engineering. The main responsibility

of FMPE division is to develop suitable farm machinery and technology for different agricultural operations including postharvest process activities for the farm people of Bangladesh to make the best use of our limited natural resources. FMPE division has developed 35 farm machinery and technology for different agricultural operations. The scientists of this division apply knowledge of engineering and biological science to transform the traditional agriculture production system to mechanized production system for maximizes the farm production from the decreasing agricultural land. Besides the development of modern farm machinery, the division also works on the postharvest processing techniques of different crops, vegetables and fruits. To minimize the postharvest loss of agricultural products this division develops low cost postharvest handling, storage and packaging methods for the producers and processors. Use of renewable energy as an alternative for fossil fuel in agriculture is one of the research area of this division. Solar powered irrigation pump and non-edible jatropha oil as bio-diesel for the farm engines are the successful outcomes from this research area. Testing and evaluation of the field performance and suitability study of different imported and local made agricultural machinery for Bangladeshi farmers is a regular task of FMPE division. In addition, dissemination of matured technologies to the targeted users through training, field demonstration, seminar, workshop, mass media and participation of different fair is ongoing activities of this division. Also technical training and technical assistance for the local manufacturers are provided to ensure the quality and durability of locally made agricultural machinery.

Research Areas of FMPE Division:

- Design and Development
- Testing and Performance Evaluation
- Postharvest Process Engineering
- Renewable Energy

Activities of FMPE Division

- To develop suitable farm machinery for different agricultural operations
- To develop new machines and improve the performances of the existing ones
- Utilization of renewable energy for agricultural use
- To study the suitability of imported farm machinery
- Dissemination of developed machinery through training, field demonstration, seminar, publication, workshop, mass media and participation indifferent fair.

7. Bangladesh Rice Research Institute (BRRI), Gazipur, Dhaka, Bangladesh

Farm Machinery and Postharvest Technology Division

Farm Machinery and Postharvest Technology (FMPHT) division is one of the 20 research divisions of BRRI. The main responsibility of FMPHT division is to develop suitable farm machinery and technology for different agricultural operations including postharvest process activities for the farm people of Bangladesh to make the best use of our limited natural resources. The scientists of this division apply knowledge of engineering and technology to transform the traditional agriculture production system to mechanized production system for maximizing the farm production. Testing and evaluation of the field performance and suitability study of different imported and local made agricultural machinery for Bangladeshi farmers is a regular task of FMPT division. In addition, dissemination of matured technologies to the targeted users through training, field demonstration, seminar, workshop, mass media and participation of different fair is ongoing activities of this division. Also technical training and technical assistance for the local manufacturers are provided to ensure the quality and durability of locally made agricultural machinery. FMPHT division has developed many farm machinery and agriculture technology till now. The main farm machines are BRRI Diaphragm Pump, BRRI Animal Driven Pump, BRRI Open Drum Thresher, BRRI Close Drum Thresher, BRRI Power Tiller, BRRI Weeder, BRRI Seeder, BRRI Self Propelled Reaper etc. Besides different types of projects and research activities for invention, development and promotion of farm machinery are being implemented in many parts of the country.

Research Areas of FMPT Division

- Design and Development of farm machinery
- Testing and Performance Evaluation of farm machinery
- Postharvest technology of different crops

Activities of FMPE Division

- To design, develop and suitability analysis of farm machinery for rice production.
- To develop new machines and improve the performances of the existing ones
- To develop new technology for minimizing postharvest losses
- Utilization of renewable energy for agricultural use

- To study the suitability of imported and country made farm machinery
- Dissemination of developed machinery through training, field demonstration, seminar, publication, workshop, mass media and participation indifferent fair.

8. Rural Development Academy (RDA), Bogra, Bangladesh

The Rural Development Academy (RDA), Bogra was established on 19 June, 1974 as a specialized Rural Development Institution for training, research and action research. It is located at 16 kilometers away from Bogra town by the highway towards Dhaka. The Academy campus covers an area of 48.50 hectares of which 19.00 hectares has been apportioned for office, residence, school & college, playground, children's park and other establishments. The remaining 29.50 hectares has been earmarked for demonstration farm for undertaking research in farm machinery, farming, horticulture, floriculture, tissue culture, pisciculture, livestock, Poultry etc. Rural Development Academy provides training especially for skill development of rural farmers to govt. higher officials. RDA is providing training of human resources development under different training courses to the technicians of related field, govt. officials, students and farmers like:

- Farm Machinery Repairing and management;
- Irrigation Pump and Engine management;
- Plumbing and Electrical;
- Internship program for Agricultural Engineering students of different universities;

Farm Technology, Irrigation and Water Resources Management Division

Farm Technology, Irrigation and Water Resources Management is one of the 8 divisions of RDA. From very inception it is doing research, action research, providing training to different staffs of GOs and NGOs, and providing consultancy services to various organizations through the 8 nos. of Agricultural Engineers. The specific objectives of this division are following:

- To provide training in the field of agricultural mechanization, irrigation and water resources management in order to make skilled manpower in these fields.
- Doing research in the field of agricultural mechanization, farm machinery
- To express the results of farm technology and mechanization related research in regional/national/international seminar, symposium, workshop, meeting and demonstration.

RDA-KMT workshop

RDA-KMT workshop is an action research project under public private partnership (PPP) concept which started at RDA by signing MoU on 17/05/12. From government part RDA and from private sector KMT (Kamal Machine Tools) are working together.

This project was under taken for following objectives:

- Bogra is a raising sector of Agricultural Machinery, to continue this, providing technological support to the established workshop for producing quality products especially (agricultural machinery) and developing entrepreneurship.
- Develop human resources in agricultural mechanization field;
- Create opportunities to arrange practical field level training program for participants;
- Conduct research for development and production of agro based good quality machines,

This workshop is playing important role for human resource development in agricultural mechanization field by continuing training, research and developing different spare parts or agriculture machinery. The following spare parts/ Agricultural Machines have been developed through this workshop till today:

Liner C-16, 20, 25; Liner C-12 ; Liner C-6 ; Liner CD-4 ; Open Drum thresher ; Close Drum thresher ; Cow-dung crushing Machine ; Chopper Machine; Grass cutting Machine

Bed former (Single); Bed former (Double); Power Winnower; Hand Weeder; Standard cow feed mixing machine etc.

Agro Processing, Preservation and Marketing Unit

Since inception APM unit of RDA is working to minimize post-harvest losses of agricultural products. APM unit is comprised of different processing machines and equipment for reducing postharvest losses. This unit has capacity to produce processed product like jam, jelly, chutney, souses, tomato ketchup, fruit candy, mustered oil, pasteurized milk, ghee, spices etc.

The major objectives of this project are:

- To conduct research in the field of agro processing sector for development of mechanization;

- To commercialize developed technology through action research;
- Provide training on developed commercial agro processing technology;
- Conduct consultancy service to entrepreneur/GOs/NGOs
- To generate human resources for the agro processing sector;

Agro Tech International Exhibition

In Bangladesh, labors are being migrated from agriculture day by day. Due to this labor shortage, the mechanization of agriculture in Bangladesh has been an issue of utmost importance. To cope up this situation, mechanization in agriculture is crucial. RDA believes seeing is believing. Again in house training arrangement for all people is not possible from revenue budget. From this thinking the introduction of different machines and technologies scattered all over the country as well as world, Agro Tech International Exhibition can play an important role for human resource development for agricultural mechanization. Considering the potentials of the Exhibition Rural Development Academy (RDA), Bogra has organized "5th Agro Tech' Bangladesh-2015" Exhibition at International Convention City Bashundhara, Baridhara in Dhaka premises under RDA-LIMRA brand following the present government's Public Private Partnership (PPP) concept. RDA-LIMRA arranged "1st Agro Tech International Exhibition-2011", "2nd Agro Tech International Exhibition-2012", "3rd Agro Tech International Exhibition-2013" and "4th Agro Tech International Exhibition-2014" successfully in previous years in the RDA premises for this purposes.

III. Challenges and Constraints faced of the Higher Education and Research institutions for Human Resource Development of Agricultural Mechanization in Bangladesh

There are a lot of challenges faced by the Higher Education and Research institutions in Bangladesh (Ahmmed, Mortuza 2013). Corruption is one of the barriers of higher education. Besides, nepotism, recruitment of less meritorious teacher by political identities are created obstacle in the higher education. Nevertheless, financial crisis, lack of residential halls, shortage of seats for the applicants as well as the Involvement of teachers with other activities are also been identified by the respondents as the barriers of quality education in Bangladesh. The traditional teaching method is the common feature in our universities. Here, the sharing of knowledge and students Participation is very minimal. The brain storming discussions and presentations by the students enables them for a better grooming up. But this is almost absent in our university education system. Moreover, the monologue type of teaching and learning, the traditional system of distant relationship between teachers and students act as barriers in the congenial atmosphere of free learning in the universities of Bangladesh. Simultaneously, modern teaching methods and facilities like internet, multimedia, sound system are also been absent at the public university of Bangladesh. Poor quality of teaching staffs who fail to satisfy the students needs both in quantity and quality. Most of them have lack of specialized research and training on higher education. Moreover, due to the recruitment of political consideration a good number of teachers have no scientific and update knowledge that assist them to change their teaching methods. Adequate library and laboratory facilities are very important particularly for the university education. But the quality and other facilities both in library and laboratory are very poor and outdated. There is shortage of modern equipment in the laboratory. On the other hand, recent text and reference books, Professional journals are hardly available in library. So, inadequate library and laboratory facilities are hindering the quality of higher education in public universities in Bangladesh.

The government allocation that is given for the university and other institutions, mostly spent for the salary and allowances of the faculty and staff members. So, by the weak financial base do not play their assigned role. Even lack of finance some university do not spend anything for research. But higher education and research must go together. Party politics both teachers and students have created a great problem in the higher education sectors. Both teaching and learning is greatly interrupted by the teacher and students politics.

IV. Constraints and Challenges of Human Resource Development for Agricultural Mechanization in Bangladesh

The agricultural machinery sector also faces some problems. One of them is that the public sector is dominating in agricultural mechanization and the quality of machinery produced is sometimes not acceptable. Because of inadequate R&D funds for innovation of machinery, promotion, extension and dissemination efforts by the GoB is limited, though inconsecutive budgets the agriculture sector received the highest allocation. The agricultural machinery sector is mostly import dependent. Local manufacturers have to compete with low tariff imported machinery. A lack of adequate, trained manpower and the inadequate technical knowhow of manufacturers are barriers to the successful fabrication quality

machinery and to developing a market demand for Bangladeshi machinery. There are limited funds available for R&D and an absence of linkages among researchers, manufacturers and extension personnel. The high price of raw materials and imported parts and inefficient marketing and sale services negatively impact the development of this sector. Non-availability of soft and hard infrastructure like credit facilities and material testing facilities are other mentionable constraints faced by the sector. As an emerging sub-sector, agricultural mechanization faces many constraints. However, few major constraints that have grave implications on the growth of the sub-sector are illustrated in this section.

Lack of Modern Capital Machinery at Producers' level Resulted in Low Productivity and Poor Quality of Products:

Agri-machinery sub-sector is comprised of small and medium sized entrepreneurs. The entrepreneurs have mostly emerged from repair and maintenance service sector and lacking in experience and technical knowledge related to manufacturing of sophisticated agricultural machines and equipment. Also, they are lacking of information about appropriate machines and equipment suitable for production of quality machines and spares; lacking of appropriate design, drawing and manufacturing processes; and lacking of knowledge about the sources of these technical information. All the foundries and machining workshops are lacking of modern capital machinery. Mostly they are depending on age-old outdated machines for manufacturing agricultural machines and spare parts. As a result, producing quality compromised products and facing tough competition with the imported machines and spare parts from abroad, especially products from China. For an example, few years back, a number of manufacturing workshops in Bogra were producing piston rings. The quality of the product was inferior due to lack of quality raw material and modern capital machinery, and consequently driven out of market by the imported quality Chinese piston rings. Some spare parts, like plunger nozzles depend totally on import, because no manufacturing units in the country possesses modern capital machinery require for this production. Awareness programme along with formulation of policies for soft credit facility and zero tariffs on modern capital machinery import are urgently needed for a break-through in this sub-sector.

Lack of Supply of Quality Raw Materials to the Foundries and Manufacturing Workshops Hampers Production and Increases Production Cost:

Foundries, pump and spare parts manufacturers solely depend on the supply of imported raw material such as pig iron, ship breaking scraps and local scrap iron, steel, brass etc. They also depend on imported hard coke and furnace oil. The supply of old ships for ship breaking industries decreases in recent years due to international competition, especially with China and India. Moreover, syndicate of few importers' based in Chittagong and Dhaka controls the imports of these raw materials. Most entrepreneurs strongly believe that these syndicates are manipulating the supplies of ship breaking scraps and hard coke, and responsible for price hike. In 2010, the prices of ship breaking scraps and coal were increased to Taka 45/kg and Taka 62/kg, respectively that generated sensation among the business communities. The crisis intensifies with multiple VAT on raw materials and finished products at different stages of sales. As a result, unusual demand of local iron scraps caused a price hike and unavailability on demand. The use of local iron scraps also reduces the quality of product. Furnace oil supply in border districts such as Jessore, Dinajpur is restricted by 'kota' system. As a result, small foundries are hard hit at peak demand, as their working capital is not sufficient enough to allow them to stockpile the furnace oil over time. The high price and unavailability of raw materials poses a great threat to the domestic agri-machinery and spare parts production in terms of production cost and quality compared with the imported machines and spare parts especially imported from China. The raw material supply situation in fact is not at all congenial for the growth and development of this sub-sector.

Lack of Skill Related to Fabrication and Machining; Iron, Alloy Steel and Brass Casting, and Heat Treatment; Repair & Maintenance of Agricultural Machinery; and Management & Accounting at the Producer Level Resulting in Low Productivity of the Sub-sector:

The sub-sector is lacking of skilled and experienced workforce almost in all levels of manufacturing, repair & maintenance and management of businesses. Most of the agri-machinery entrepreneurs are lacking of appropriate knowledge and skill on heat treatment, metal casting and fabrication of agri-machinery products. Qualified engineers or diploma holders are scarce in the sub-sector and therefore, lacking of knowledge and skill related to design, drawing, manufacturing process and quality control, and resulted in production of quality compromised products, which faces hard competition in the market. The scarcity of skilled and competent personnel in the sub-sector increased the tendency of migration of such workforce from one enterprise to another. There are some who join an enterprise strictly to gain experience. They eventually leave the organization, with a view to start their own operation with the limited capital at their disposal. The growth of mostly inexperience small enterprises is causing serious financial

repercussions in the enterprises, e.g., low quality output, low productivity, non-delivery of products in scheduled time, increased wastage of raw materials etc. These in fact, inflicted with poor profitability and low quality outputs of the enterprises and as a whole slow down the growth of the sub-sector.

Lack of Steady Supply and Rationing of Electricity Restricts the Production and Business at Producer and Farmers Level:

Frequent load shading of electricity causes a severe problem in production and marketing of products. Machines used in manufacturing of machines and spare parts are mostly operated by electricity. Any disruption of supply of electricity restricts the production capacity of the enterprise. In recent time a significant number of pumps used in irritation are also operated by electricity and frequent load shading in peak hours causing a significant loss in crop production. In the current irrigation season the government has issued mandatory shut down of commercial places and markets including agri-machinery and spare parts manufacturing industries and workshops after 8:00 pm for electricity saving and to allow the irrigation pumps to operate unhindered. The electricity rationing policy also included Monday as the weekly holiday in industrial sector instead of Friday in Bogra. This virtually reduced the industrial working days into five in a week, as workers like to have holyday on Fridays for saying 'Jumma' prayer. No doubt it is a national priority. However, the uninterrupted supply of irrigation water to the Boro crop not only demand electricity but also the steady supply of pumps and engine spare parts. Therefore, the production units of agri-machinery and spare parts must be kept beyond these restrictions for the sake of uninterrupted production of pumps and spare parts to irrigation equipment. Moreover, the agri-machinery manufacturers have to pay at the industrial rate of Taka 5.30/kW-hr for electrical energy. As the priority sector the energy rate must be subsidized to keep the market price of the agri-machinery and spare parts within the purchase ability of the farmers.

Lack of Testing and Standardization Facility Hinders Production of Quality Agri-machinery and Spares Parts:

The existing agri-machinery and spare parts industries and workshops in the country do not have standardized quality control facilities in formal manufacturing industries to ensure quality products. Therefore, the quality-compromised products are facing tough competition from the imported ones. The farmers are being conscious about the quality of the products through experience and the market dictates the necessity of quality control facilities in agri-machinery industries. Inexpensive quality control measures are being introduced in some agro-industries but some expensive quality test and operation facilities such as, testing of metals and alloys, performance test of pumps, heat treatment of metals and alloys etc. cannot be owned by small agri-industries and workshops. There should be a common facility in every major center of agri-machinery and spare parts production either in public or private sector initiatives.

Lack of Working Capital Hinders Production in Agri-machinery and Spare Parts Industries and Workshops:

The demand of agri-machinery is mostly seasonal. To meet the machinery demand in season, the agri-machinery manufacturers must have sufficient working capital in off-season to manufacture the machine and spare parts in sufficient quantity, so that it can meet the demand in season. However, most of the enterprises in this sub-sector are very small in size and lacking sufficient working capital for production in off-season and stockpile for the peak season. Only in centrifugal pump production sub-sector in Bogra has Taka 475 million unmet market size because of limited supply in peak demand. This sub-sector needs medium term soft credit facility from govt. and private sector banks, financial institutions and cooperatives. Recently, Bangladesh Bank has allocated Taka 40 crore with a 10% interest as an incentive to Bogra agro-machinery sub-sector. However, the commercial banks disbursed this incentive only to their clients, who have reputation as agri-machinery producer.

Lack of Space and Infrastructural Facilities Hinder Growth of This Sub-sector in Bogra:

Bogra has identified as the center of agri-machinery and spare parts production and marketing. Almost 80% of the agri-machinery and spare parts production in the country is concentrated in Bogra. However, the industries have been grown scattered in Bogra town, especially in BSCIC industrial area, Goail road, Railway market etc. BSCIC industrial area is too small to accommodate the number of agri-machniery and spare parts industries established in and around Bogra town. In Railway market and Goail road the manufacturing workshops have hardly any infrastructural facilities and spaces favouable for production. The workshops are very congested and unhealthy. For further improvement, these workshops must be shifted to a specialized zone called 'Agri-machinery Production Zone (APZ)', similar to EPZ at the outskirt of Bogra town.

Lack of Market Information at Producers and Sellers Level Resulting in Slow Growth of the Sub-sector:

Most of the entrepreneurs of the sub-sector are small and have limited capacity for gathering market information such as size of market, cluster of market and potential for export. The promotional efforts on the part of the producers and sellers are generally confined to personal relationship. As a result, the sub-sector registered a very slow growth, although there is a huge unexplored opportunity for expansion of the market. The producers estimate their production size depending on the sell of previous year and little information gathered through their customers at different districts and upazillas. Formal market survey is beyond most entrepreneurs financial and logistics ability. Marketing of most of the agricultural machines and spare parts are localized. However, pump, piston and liner manufacturers have developed few non-formal channels throughout the district towns of the country. Few piston and liner producers have channels for export to Nepal and Bhutan. However, still a huge potential for export of piston, liner, pumps, sprayers and spare parts etc. is unexplored. In recent time, few potential manufacturers are trying to explore the export market of pumps and spare parts to India. Removal of tariff and non-tariff barriers from Indian side through state negotiation can create a favorable condition for export and growth of this sub-sector along with capacity building of the entrepreneurs regarding market information and expansion of the market. Recently, Bangladesh and India have established border markets (hats) for the benefits of the people of both the countries. By allowing formal trading of agricultural machinery and spare parts at these markets may further strengthen border trade and expansion of agri-machinery market to India.

Lack of Ability to Collectively Safeguard the Interest of the Sub-sector, Resulting in Inadequate Reflection of the Needs and Expectation of the Sub-sector in the Policies and Regulations:

The development and growth of the sub-sector is comparatively new and mostly comprises of small to medium enterprises. The sub-sector is also expanding at a high rate. As a result, coordination amongst the sub-sector actors is practically nonexistent. In recent time Foundry Owners' Association of Bangladesh (FOAB), Bangladesh Shilpa Malik Samity (BSMS) and Bangladesh Agricultural Machinery Manufacturers Association (BAMMA) are in action in the sub-sector, but a small portion of the actors are actively associated with the activities of the associations. Lack of coordination and coherence among the enterprises yet to make the association effective to influence by lobbying and advocacy activities with various policy formulating bodies.

V. Recommendations

Modify the Syllabus

The syllabus of university education should be modern, time-bound, need-based and international standard. The university authority has to monitor properly to add new and innovative courses and ideas in the learning process so that the students can face the challenges of new millennium. Besides, the credit transfer system should open from any Bangladeshi university to abroad.

Research Based Education

Higher education should be highly participatory, reciprocal and research based. Both teachers and students spontaneously participate in this learning process and research activities. Besides, the class hour must be at least 1 hour and 50 minutes in lieu of 45 minutes so that students can get more time to participate properly in the learning process. Simultaneously, facilitators can get time to explore them in the classroom.

Need-Based Education

Higher education should be need-based. That means necessary institutes or departments should be opened in every neglected field of education those have close connection to employment opportunities and income generating activities. Simultaneously unnecessary, self or specific group interest related initiatives should be discouraged. Moreover, new institutes should be opened aiming at reducing regional imbalances and resource mobilization.

Transparent Recruitment

The recruitment policy should be planned and transparent. Unplanned and political recruitment reduces the standard of education. In this context, priority should be given to the merit, academic result and research work. Besides, a commission relating to teachers recruitment should be formed so that non-political and bias free recruitment is ensured.

Introduces Teacher/Staff Evaluation

The university and research organizations management have to introduce teacher and staff evaluation system in the education process. The evaluation may be by the students, university and organizations authority. But this evaluation should bias free. If the system introduces teacher's and staff's consciousness,

motivation and responsibilities will increase.

Teacher-Student Politics

The university should free from political interfere. Student politics must be constructive and students' welfare oriented. On the other hand, teachers should avoid the servile of political parties. In order to create safe and sound atmosphere and ensure the standard of education it is burning question to reform of teacher and students politics. Moreover, the internal conflict of teachers should be removed.

Intervention by Competent Authorities

- Bogra and Jessore to be declared as 'Agri machinery districts' to ensure infrastructural facilities such as non-interrupted supply of electricity, gas, water etc. for agri-machinery and spare parts production units;
- Establishment of 'Agri-machinery Production Zones (APZ)' on the outskirts of Bogra and Jessore towns to accommodate existing and potential agri-machinery industries and workshops;
- Establishment of 'Common Facility Centre' at each APZ to facilitate quality services related to heat treatment, material testing, test and standardization, advisory services etc. on public and private initiatives;
- Provisions for duty free access to India, Nepal and Bhutan, and formal trading of agri-machinery at border markets (hats) through bilateral negotiation;
- Establishment of a 'Central Institute of Agricultural Engineering (CIAE)' for continuation of innovation through R&D;
- Formulation of National Agricultural Mechanization Policy;
- Establishment of National Standardization Committee for agri-machinery and spare parts;
- Modernization of local Foundries through collaboration and experience sharing activities among SAARC countries, especially with India;
- Strengthening capacity of agri-machinery entrepreneurs through transfer of proto-type machines and technologies among SAARC countries;
- Access to soft and flexible long and mid-term credit facility for capital machinery and working capital;
- Policy options for removal of multiple VAT on imported raw materials and strengthen rules and regulation against illegal hoarding of raw materials for the growth and development of agri-machinery sub-sector;
- Policy options for zero tariff/nominal tariff on modern capital machinery import for agri-machinery sub-sector;
- Inclusion of agri-machinery sub-sector for BBS data base; and
- Strengthening capacity of Foundry Owners' Association of Bangladesh (FOAB), Bangladesh Shilpa Malik Samity (BSMS) and Bangladesh Agricultural Machinery Manufacturers Association (BAMMA) to safeguard the interest of the sub-sector.

VI. Conclusion

Due to the low quality of training, lack of combination of knowledge and practice, poor capacity and quality of graduates, the existing education system of higher education institutions of Bangladesh is in vulnerable position. It is losing its articulation and image that making its inappropriate in the present competitive market economy. As a result, higher education institution is going to fail to keep the tradition as well as quality of training, research and the social accountability. Human resource development for agricultural mechanization can meet the needs of the economy. It promotes an overall development of society, viz., social, economic, technological, human resources development etc., which are highly correlated. The development of higher education, training and research play an important role in facilitating these changes and producing adequately trained manpower. The effectiveness of higher education and other research and training based institutions contribute to development both internally and externally. So, higher education needs sustenance and quality with time and space. For sustaining and improving quality in the higher education, research and training it is need to reorient of curriculum and introduce vocational and job oriented courses.

Cambodia

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I. Overview of Human Resource Development Work in the Field of Agricultural Mechanization in Cambodia

1. Current Number and Employment Status of Agricultural Mechanization Workforce

Currently in Cambodia, the main employers of agricultural mechanization workforce are institutions under the umbrella of the Ministry of Agriculture, Forestry and Fisheries such as Department of Agricultural Engineering (DAEng) of the General Directorate of Agriculture (GDA) and Provincial Departments of Agriculture (PDA). Majority of the workforce is employed by DAEng. Some PDAs have Office of Agricultural Mechanization and some do not have depending on the significance of agricultural mechanization in those provinces.

In the private sector, graduates from agricultural mechanization programs are working with food processing companies such as rice mills, beverage companies, agricultural machinery and/or input suppliers.

2. Credentialing/Licensing/Regulations of Agricultural Engineers, Agricultural Machinery Operators and Technicians, If Applicable

Agricultural engineer is registered with the Board of Engineers Cambodia as registered engineer, professional engineer, or ASEAN engineer.

Agricultural machinery operators and technicians are not yet strictly required by regulations to have licenses in order to be employed or run business. Anyone with driving license can operate tractor. Informal education is still widely practiced to train machinery operators and technicians. Workshops need to have a license to operate business, which is obtained through registration with Ministry of Commerce to provide service in sales, repair and maintenance. In a case when the workshop manufactures products, registration with Ministry of Industry and Handicraft is also required. Government institutions or big companies need technicians or mechanics to have a degree or certificate for employment.

3. Agencies/Institutions Involved in Agricultural Mechanization Human Resource Development and their Current Programs/Projects

There are two universities and one school that offer degree programs related to agricultural mechanization. These are: Royal University of Agriculture, Mean Chey University, and Prek Leap

National School of Agriculture. Mean Chey University offers both master and bachelor programs in Agricultural Engineering under the Faculty of Agriculture and Food Processing. Royal University of Agriculture offers bachelor programs in Agricultural Technology and Management, and Agricultural Engineering under the Faculty of Agricultural Engineering. Prek Leap National School of Agriculture offers only associate degree (two-year program) in Agricultural Machinery.

Some vocational training schools/centers are also providing training courses related to agricultural mechanization.

II. Strategies, Policies, and National Programmes/Initiatives of Human Resource Development of Agricultural Mechanization

As one of its top priorities; Ministry of Education, Youth, and Sports is promoting Science, Technology, Engineering and Maths (STEM) through the means such as providing funding to establish labs to improve the quality of education in these fields. Some donors are also focusing their funding to promote STEM. Less than 10% of Cambodian university's students are studying STEM fields, however the demand for qualified workforce is high.

III. The Need Assessment of Human Resource Development of Agricultural Mechanization in Cambodia

There is a need to raise awareness of the public on the importance of agricultural mechanization, to get their support and attention since labor shortage is a major issue. It is very crucial to attract more students to enroll in program/training related to the field.

The quality of education needs to be improved by building capacity of lecturers/trainers on new technologies which are in use as well as improving facilities for supporting practical activities of the program.

IV. Challenges and Constraints Faced by Human Resource Development of Agricultural Mechanization in Cambodia

Although the importance of agricultural mechanization is increasing, the funding for human resource development in this field is still limited.

Most programs are in their infancy, and capacity of lecturers/trainers is still limited in means to deliver a high quality of education services provided.

In addition, infrastructure to support teaching and research is also limited.

V. Solutions and Suggestions for Human Resource Development for Sustainable Agricultural Mechanization

Quality of teaching and training in agricultural mechanization needs to be improved in order to respond to the job market's demand. This can be achieved by promoting local and regional collaborations among stakeholders for mutual benefits. These collaborations include students and staff exchange, information and resources sharing, and joint research.

China

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I. Brief Introduction of NRIAM

Nanjing Research Institute for Agricultural Mechanization (NRIAM), Ministry of Agriculture, established in 1957 authorized by the State Council, is a public national research institute in agricultural engineering, which is mainly responsible for the technological innovation of agricultural equipment, quality testing, education training and so on. During the early time from its establishment, NRIAM developed the first rice motor transplanter in the world, and reached significant achievements in machinery for crop protection, charge plough paddy field, walking tractor, rotary cultivator and threshing machine. Besides, NRIAM carried out a large number of agricultural mechanization mode and policy research and set a lot of standards of agricultural quality and machinery operation. At present, NRIAM extended its scope to further research field as following: Machinery for food crops, Machinery for economic crops, Facility equipment and engineering in agriculture, Crop protection and environment engineering technology, Agricultural products processing engineering technology, Agricultural resources development engineering technology, Agricultural machinery quality test and control technology, and Agricultural mechanization policy and technology model, etc.

II. General Situation of Agricultural Mechanization of Human Resources Development

Talent resource is the first resource of science and technology innovation. NRIAM has a staff of 260 with 24 researchers and 61 associate researchers in eleven key disciplines, i.e. machinery for tillage and soil preparation, machinery for planting and sowing, equipment for crop protection, machinery for underground fruit harvesting, machinery for crop grain harvesting, machinery for fruit, vegetable and tea harvesting, machinery for crop stalk harvesting, equipment for agro-product classification and storage, technology and equipment for agro-product processing, equipment for biomass conversion and utilization and agricultural mechanization and system assessment.

In the aspect of agricultural mechanization of human resources development, NRIAM carried out its work focus on the following points: 1)Formulating concessional introduced intelligence policy to attract high-level talents of science and technology for domestic and overseas; 2)Establishing incentive system of science and technology evaluation, in order to create better innovation atmosphere, as inspiration for researchers; 3)Encouraging researchers to update their knowledge, strengthening cooperation and communication

with universities and enterprises at home and abroad.

In the aspect of cultivation of graduate students, NRIAM has the right to confer Master's Degree and Doctoral Degree in agricultural mechanization engineering programs, with 3 doctoral tutor and 30 master student supervisor. NRIAM combines training with Nanjing Agricultural University and Anhui Agricultural University of the postgraduate, and has 50 graduates at present.

In the aspect of domestic agricultural mechanization talent training, NRIAM has a National Agricultural Mechanization Training Center, mainly conducts trainings on aspects of senior management personnel, technical personnel and leaders of cooperatives and family farms of agricultural mechanization, with a total account in organizing 10 training courses which including more than 300 trainees annually.

In the aspect of Foreign agricultural engineering technical training, NRIAM has the experience of holding "Aquatic products or livestock and poultry breeding technology training" annually in Vietnam, Thailand and other ASEAN countries. In 2014, the "Rice production mechanization technology training" had been successfully organized toward ASEAN and African countries. This year, 2015, NRIAM has conducted a training oriented to SCO countries, whose full name is "Policies supporting agricultural mechanization and technology management workshop", which help promote exchanges and cooperation among the developing countries in the field of agricultural equipment technology.

III. Future Plan on Human Resources Development

It surely seems that strengthening human resources development in agricultural mechanization field is about to face good opportunities. First of all, China is actively promoting the strategy of reinvigorating China through human resource development and innovation-driven, which may provide resources and project support. Secondly, Chinese modern agricultural development steps into an era of mechanization, reverting to a strong demand for agricultural mechanization management and technical personnel. The third, the Agricultural "Go Out" and "One Belt and One Road" strategy suggested by the Chinese government, helps in providing wide space to strengthen international cooperation and communication in agricultural equipment technical field.

For the time to come, NRIAM will move on to the following works:

1. To strengthen international cooperation and communication in agricultural equipment technology. For instance, by technology project cooperation, in aspects of researching and developing the agricultural equipment technology adaptability improved experiment and demonstration, and establishing joint laboratories as well; by talent exchange training, in aspects of short-term visiting scholar, professional technical training and academic exchange, etc. In addition, to build mechanization demonstration farms in expect of comprehensive experiment and demonstration on variety, agriculture and mechanization technology.
2. Organize more training courses toward agricultural mechanization talent in Asia-Pacific region. NRIAM is preparing training courses to the agricultural mechanization talent in Asia-Pacific region, mainly focus on the following fields: quality inspection of agricultural machinery, rice production mechanization, Conservation tillage technology equipment, agricultural pesticide technology and equipment, small tractors and complete set of agricultural machinery use, etc. Furthermore, master graduate students majored in Agricultural mechanization engineering will be recruited on a larger scale.
3. Set up the mechanism of agricultural mechanization normalization of cooperation in the Asia-Pacific region. One of the important tasks is to connect with local agricultural machinery science and technology organizations, academies, industry associations and agro-machinery enterprises in Asia-Pacific countries, in aims of establishing platform of innovation and diffusion for agricultural equipment technology development in the Asia-Pacific region. We hope on forming a regular contact consultation mechanism, hosting academic conferences, communicating research progress and ultimately promoting scientific research achievements conversion applications.

China

Mr. Ma Teng
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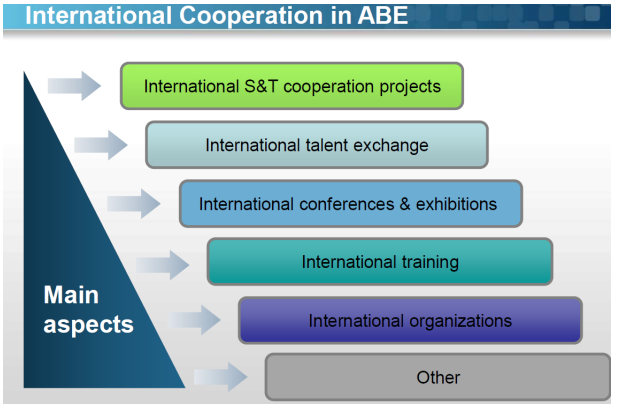
International Cooperation Department.,
Chinese Academy of Agricultural Mechanization Sciences

Chinese Academy of Agricultural Mechanization Sciences was founded in 1956 as a research academy of agricultural machinery. In 1999 it was transformed into a large-scale commercial enterprise. In 2009 it became a subsidiary of SINOMACH, and in the period between 2011 and 2013 it took over 3 companies. CAAMS has 7899 employees in total with majority of professional technicians. CAAMS has 5 industrial zones, 13 production bases and 1 logistics technology park with headquarters in Beijing.

Main business areas include Modern Agricultural Equipment, Animal Husbandry Equipment, Product Processing & Packaging, Renewable Energy & Environment, Survey, Design & Construction.

CAAMS also participates in media dissemination and networking with:

- 24 Journals, 1 newspaper ,1 academic Journal, 1 yearbook and 4 websites
- 2 International academic journals:
  - CIGR Journal, sponsored and issued by International Commission of Agriculture and Biosystems Engineering (CIGR)
  - International Agricultural Engineering Journal (IAEJ), sponsored and issued by Asian Association for Agricultural Engineering (AAAE).



CAAMS international S&T cooperation projects partners include government departments, universities, enterprises, research institutions from all over the world: US, Canada, Chile, Cambodia, Sri Lanka, Australia, Vanuatu and other countries.

Our activities in the sphere of S&T include joint trainings, technical exchange, visiting professors, international conferences & exhibitions and participation in international organizations such as International Commission of Agriculture and Biosystems

Engineering (CIGR) and Asian Association for Agricultural Engineering (AAAE)

CAAMS has several key research areas such as:

- Grain production for ensuring food security
- Economic crops/fruits for value-added production
- Agro-product processing and food safety
- Renewable energy
- Precision farming for sustainable development

Overall objectives of CAAMS are: promote S&T international cooperation through setting up the collaboration platforms, joint research centers, conveying talent training, participating in international joint projects and in general support commercial cooperation.

India

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Agricultural Machinery Research Centre
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Tamil Nadu Agricultural University

I. Introduction

World population will be around 9.15 billion in 2050 according to UN population projections which implies that the increase will be 2.25 billion over the next 35 years. But it will be much lower than that of 3.2 billion increase during the period between 1970 and 2010. This includes fast growth in some countries and slow growth in some other countries. This reduction in population growth will also impact world agriculture by lowering its rate of growth compared to the past. But depending on the demographic issues, the food requirement for this population has to be satisfied. The food needs may vary from region to region and the solutions are to be customized for each situation. For the zone related to a rice-based diet, the local needs will be more than double the amount of the average need for the world.

Table 1. Global and regional per capita food consumption (kcal per capita per day)

Region	1964 - 1966	1974 - 1976	1984 - 1986	1997 - 1999	2015	2030
World	2358	2435	2655	2803	2940	3050
Developing countries	2054	2152	2450	2681	2850	2980
Near East and North Africa	2290	2591	2953	3006	3090	3170
Sub-Saharan Africa[a]	2058	2079	2057	2195	2360	2540
Latin America and the Caribbean	2393	2546	2689	2824	2980	3140
East Asia	1957	2105	2559	2921	3060	3190
South Asia(including India)	2017	1986	2205	2403	2700	2900
Industrialized countries	2947	3065	3206	3380	3440	3500
Transition countries	3222	3385	3379	2906	3060	3180

Source: http://www.fao.org/docrep/005/ac911e/ac911e05.htm

The world per capita food consumption was 2803 kcal/capita/day during 1997-1999 and has increased to

2940 kcal/capita/day. This indicates that there is sufficient food consumption for everyone. But there are about 2.3 billion people who live in countries with food consumption under 2,500 kcal.

The Population projections show that the overall food production should be increased to about 70 per cent with more emphasis on production in developing countries.

The global resources are sufficient but the production depends up on the local resources in each country. India with a population of over 1.271 billion people, is the second most populous country in the world. Already containing 17.5% of the world's population, India will be the most populous country in the world by 2025. The GDP contribution through agricultural sector was about 17.8 % which is very much higher than the world's average of 6.1 %. according to CIA Factbook. But the contribution towards GDP is declining continuously from 1950. India is the second largest producer of Agricultural product contributing 7.68 % of total global output. As the economy improves there is a movement of agricultural workers to higher productivity sectors. During the period from 2004 to 2012, there was an increase in the size of total work force in the country, but the size of agricultural work force was reduced by 30.57 million people. Indian Agriculture is not remunerative and sustainable. The factors may be many like low productivity, fragmented land holdings, poor irrigation facilities, rudimentary market infrastructure, poor application of technology, destitute use of good practices, weak HRD base and poor extension services.

Agricultural Mechanization has played a major role in increasing production and productivity, profitability of farming, through appropriate mechanization inputs for production and post-production agriculture. To put forth complete use of Agricultural Mechanization, at the milieu of increasing demand of food, strategies and policies are to be formulated to achieve the food production. An integrated approach involving all the key stake holders at national and regional levels is necessary in the form of University and College education, Vocational training programmes.

II. Higher Education and Research Institutions that Offer Agricultural Engineering/Mechanization Programme, and their Programme Settings in India

The agricultural educational structure and training programmes in agricultural sectors is important for effective and efficient positional work force and economic growth. To empower Indian Agriculture, the Indian Council of Agricultural Research (ICAR) was established during 1929 at New Delhi. It is an autonomous organization under the Department of Agricultural Education and Research(DARE), Ministry of Agriculture and Farmers Welfare, Government of India. The council is the zenith body for coordinating, guiding and education in Agriculture including, Horticulture, Fisheries and animal sciences in the entire country. There are 101 ICAR Institutes and 71 Agricultural Universities spread across the country. This is one of the largest Agricultural systems in the world. There are 56 State Agricultural Universities in India, 4 Central Universities (having agriculture faculty) and 1 Central Agricultural University.

The Agricultural Education Division, located at the ICAR Head Quarters headed by the Deputy Director General (Education) has three sections, namely, (i) Human Resource Development, (ii) Education Planning and Development and (iii) Educational Quality Assurance and Reforms, each headed by an Assistant Director General (ADG).

The Education Division is involved in planning, development, co-ordination, human resource development (HRD) and quality assurance in higher agricultural education in the country.

The national agricultural education system has several activities through a major scheme entitled "Strengthening and Development of Higher Agricultural Education in India" which includes

1. Development and Strengthening of Agricultural Universities, Niche Area of Excellence, Experiential Learning and Library strengthening,
2. Educational Quality and Reforms
3. Human Resource Development and
4. Modernization of Agricultural University Farms

The National Academy of Agricultural Research Management (NAARM) a constituent component of the Division facilitates capacity-building of the National Agricultural Research System (NARS). Further, a time-bound special initiative, Indo-US Agricultural Knowledge Initiative (AKI) has also been steered for targeted capacity-building by the division.

There are about 90 colleges offering degree programmes in Agricultural Engineering in the country.

Table.2. Number of Colleges offering Agricultural Engineering courses.

S.No.	State	Number of Colleges
1.	Andhrapradesh	13
2.	Arunachal Pradesh	1
3.	Assam	1
4.	Bihar	4
5.	Chhatsigarh	3
6.	Delhi	1
7.	Gujarat	5
8.	Haryana	2
9.	Jammu and Kashmir	1
10.	Karnataka	2
11.	Kerala	2
12.	MadhyaPradesh	2
13.	Maharashtra	13
14.	Manipur	1
15.	Orissa	2
16.	Punjab	1
17.	Rajasthan	5
18.	Sikkim	1
19.	Tamil Nadu	2
20.	Telangana	1
21.	UttarPradesh	25
22.	Uttarakhand	1
23.	West Bengal	1
		90

Source:https://targetstudy.com/colleges/btech-agricultural-engineering-degree-colleges-in-india.html

The Bachelor's degree offered in the State Agricultural Universities covers all the basic engineering courses and agricultural sciences in the first two years and goes on to teach Agricultural engineering specifically in the rest of the course tenure. These undergraduate courses are generally four year courses. At postgraduate level, specialization in the constituent fields like farm machinery, crop process engineering, soil and water conservation and irrigation practices are dealt with. The Ph.D programmes are offered only in a few colleges. About 1400 students are graduating each year. Out of these only few are preferring higher education, most of them are employed in Private and Government sectors.

Tamil Nadu Agricultural University

Tamil Nadu Agricultural University (TNAU) rated as the Best Agricultural University in India by Indian Council of Agricultural Research, New Delhi is an institute of excellence for higher education in Agricultural and allied subjects. It was established in the year 1868 as an Agricultural school at Chennai, Tamil Nadu. It was later relocated at Coimbatore as Madras Agricultural College. During 1971, Tamil Nadu agricultural University was established. The University is offering Thirteen Undergraduate Degree Programs, Forty Graduate Degree Programs and Twenty six Doctoral Programs in 14 Colleges distributed in 11 campuses all over Tamil Nadu. TNAU has 36 Research Centers for agrotechnology development and 14 Farm Science Centers for outreach.

Agricultural Engineering College and Research Institute, Coimbatore is one of the constituent colleges of the Tamil Nadu Agricultural University. This is the first college started in South India for providing agricultural engineering education in 1972 with a mission to help the farming community in improving their levels of living, by developing and disseminating Agricultural Engineering technologies through quality research, education and training. Master degree programmes in Agricultural Engineering were started during the year 1977 and Ph.D. in Agricultural Engineering was started in the year 1987. The college was shifted to Kumulur, Trichy District in the year 1992 and it is the only constituent College of Tamil Nadu Agricultural University offering B.Tech.(Agrl.Engg) and Masters and Doctoral programmes in farm machinery and soil and water conservation engineering. The college at Coimbatore offers four-year degree programme in B.Tech. (Food Process Engineering) starting from 1998 and B.Tech. (Energy and Environmental Engineering) starting as first of its kind in the entire country in the year of 2004. Masters and Doctoral programmes in the field of Food and Agricultural Processing and Bio Energy are offered in the Coimbatore campus.

The total number of seats offered in the B.tech (Agrl.Engg) programme are 80.For ICAR candidates 15 seats are allotted, 10 seats are allotted for Non Resident Indians and 10 seats under Industrial sponsorship, with an aim to coordinate with industrial people in human resource development.

III. Need Assessment, Challenges and Constraints Faced by the Higher Education and Research Institutions for Human Resource Development of Agricultural Mechanization in India

Agricultural Mechanization should be farmer friendly. The development in this field should be in synchronization with the developments of other disciplines of science and engineering. With increase in number of Engineering colleges all over the country from 1,511 colleges in 2006-07 to an amazingly

high 3,345 in 2014-15.9 Other disciplines of Engineering, like mechanical, electrical, electronics, robotics, are eager to do research in Agricultural engineering. But unfortunately, since of their lack in exposure to agricultural crops and practices as taught in Agricultural engineering, they are not able to succeed in their effort in developing useful machinery. Though the syllabus content of Agricultural engineering has been formulated with inclusion of all the basic engineering courses, thorough knowledge in specialized subjects was not possible. So human resource development in Agricultural engineering in the evolving scenario of our country is a challenge. Hence the syllabus of Agricultural engineering should also be dynamic to include specialization as per the current need of the farm scenario. Fortunately, this happening in many of the State Agricultural Universities. Over the past two decades, India has transformed higher education in to a low cost/high class education for students of all levels. But India's higher education institutions are not the best in the world. However, India's post-secondary education system is reasonably good leading to the fact that India has emerged as the regional hub of education and attracts learners from all over the world. These higher virtues of education can be imparted in Agricultural engineering also.

The mission of higher education is to provide employability, quality, justice and to create knowledgeable society and economy. There are different constraints in the system namely the education system should be student-centric rather than staff-centric. The evaluation of colleges and teachers should be done periodically. There should be better sharing of resources between universities and mobility of faculty. The financial constraints are there but the funds are to be spent effectively. There should be more smart class rooms and smart laboratories and the syllabus should be revised regularly. The digital connectivity should be enhanced and Meta Universities are to be established.

IV. Suggestions for Regional Cooperation on Higher Education and Joint Research of Human Resource Development of Agricultural Mechanization

The twelth five-year plan (2013-2017) for higher education offers three challenges namely excellence, equity and expansion to improve teaching and learning, involving all category of people in the society and scaling up the capacity in existing institutions12. To meet the future needs, a learner centered paradigm of education should be adopted, Industry oriented courses are to be included in the syllabus, the research and education should be in collaboration with international institutes. There should be conducive research environment with high quality research oriented faculty members. The infrastructure development plays a major role to improvise high quality higher education. Low cost, high quality education can be provided through MOOCs (Massive Open Online courses) platform. These require contact practical classes where it was found to be very effective in real class rooms.

The regional cooperation and cross border collaboration was successful in western countries. Leading universities of Advanced Asian countries are having branch campuses in developing countries. This may play important role in sharing country level basic lessons and researches. These types of network offer the greatest advantage to the weakest partners.

The success of these programmes depends upon the transparency in decision making.

Contributions from Tamil Nadu Agricultural University for Regional Cooperation

Tamil Nadu Agricultural University has a Constituent unit, Directorate of Open and Distance learning, offering distance learning programmes through correspondence mode namely, diploma, degree and postgraduate programmes for the benefit of farming community, entrepreneurs, selfhelp groups etc. There is also student's exchange programmes with Canadian Universities like McGill University and Cornell University in USA. Many of the TNAU scientists have been trained abroad.

Students from South African countries like Nigeria, Kenya and also from Iran are pursuing higher studies in Agricultural Engineering at Tamil Nadu Agricultural University. Many programmes are being devised to empower the students to meet the global needs.

V. Conclusion

As it was stressed in the beginning, that to meet the food demand, the human resource base for the Agricultural sector has to be strengthened. Agricultural Mechanization has proved to be a major factor in increasing the productivity and production of Agricultural produce. The human resource base in this area is still weak. Necessary initiatives have to be taken for intensifying this and the role of Universities is vital in this area. The capacity building may go with international collaboration in teaching and research activities. Digital learning techniques through ICT enabled system, Open Educational resources and MOOC platforms where the students can access the best teaching materials. The teachers are to be trained to handle the Flipped class room model where the

class room can be used for higher level understanding and skill development. With regional cooperation and revised policies of the Government in improving higher education, India will become the major talent resource for the world and best Regional Education hub for higher education at low cost, attracting learners from all over the world.

Indonesia

Mr. Lilik Sutiarso
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Faculty of Agricultural Technology, UGM
President
Indonesian Society of Agricultural Engineering

There are a lot of problems with agricultural production that are needed to be addressed. Existing problems for Agricultural Production are: land conversion; low level of technology use, slow development of food industry, farmers' institutional weakness, poor access to credit/financial institutions, lack of farm labor resources, low quality of labor resources, deterioration of irrigation infrastructure, high cost of production and transportation, weakness of seed production and distribution system.

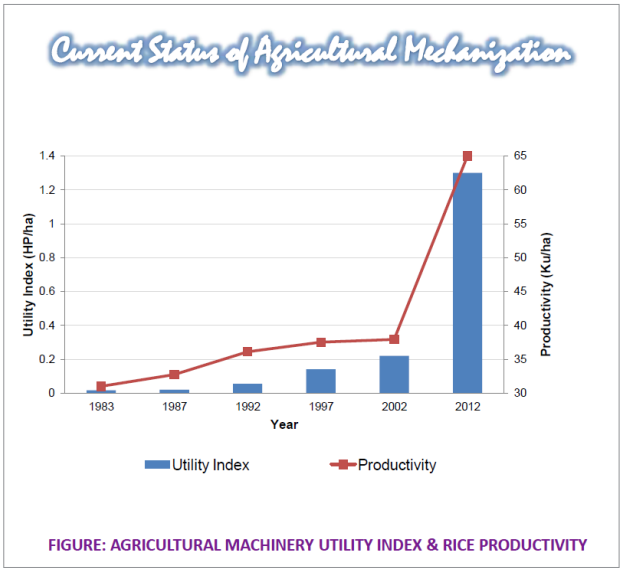

FIGURE: AGRICULTURAL MACHINERY UTILITY INDEX & RICE PRODUCTIVITY

In order to address the problems, a set of policies, objectives and strategies should be installed. The policies for Agricultural Mechanization include:

- Promotion & dissemination of new technology
- Revitalization of farmer groups & farm machinery service units
- Capital subsidy for farmer groups to provide agricultural machinery
- Increasing the capacity of Infrastructure
- Improvement of National Standardization & Certification system of agricultural machinery

Objectives for Agricultural Mechanization include: Increasing crops productivity & reduce post-harvest losses; maintaining & improving quality of agricultural products; increasing efficiency & productivity of Agricultural resources; promoting local agricultural machinery manufacturers; strengthening collaboration among small, medium and large scale industry.

Strategies include conducting research for agricultural mechanization development; design & develop prototypes of suitable agricultural machinery; develop model for agricultural mechanization; test new prototypes & Agricultural Machinery, which will be marketed in Indonesia; conducting research for

policy formulation on Agricultural Mechanization Development.

The priorities for the policy-makers to accelerate the development of Agricultural mechanization in Indonesia are: policy and government regulation support; institutionalization of farmers and business services, supporting facilities, infrastructure and funding.

These strategies are to be implemented through various forms of financing schemes by the Government, including: agricultural financing services scheme; community direct aid for agricultural investments incentives; down payment assistance for the procurement of agricultural tools and machinery; business capital reinforcement for Groups

There are 3 large scale, 30 medium scale and 1063 small scale agricultural machinery manufacturers in Indonesia. Categories of the ownership of companies differ from private or local state-owned ventures to joint ventures. The level of technology in such enterprises is low & medium technology level. The target of such enterprises are local market, as well as export.

Some factors to consider while distributing Agricultural machinery:

1. Areas of crop production centers for hand tractors, water pumps and rice transplanters, cultivators and choppers for the use in the horticultural and animal husbandry centers.
2. Understanding specific local conditions for operational technical requirements for agricultural tools and machinery.
3. Prioritizing the areas where the saturation level is still low, while the strong presence of commitment exists to support the program for the increase of agricultural production output.

Distribution system & Methods of Agricultural Machinery.

1. Agricultural tools and machinery assistance for each province are distributed by the suppliers directly appointed by the Ministry of Agriculture.
2. The distributed agricultural tools and Machinery must be in good condition, perfectly assembled, have passed a running test and come up with a manual or instructions for the use and maintenance.
3. If the agricultural tools and machinery are not used by the recipients, the department of Agriculture at district / municipality level may relocate such tools and machinery to the other groups, either within the same sub district or cross-regions.

Malaysia

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Engineering Research Center
Malaysian Agricultural Research and Development Institute (MARDI)
Ministry of Agriculture and Agro-Based Industry

I. Introduction

Malaysia is located in the heart of Southeast Asia, with an area of 329,750 km2. The country is divided of two main regions: Peninsular Malaysia (formerly West Malaysia), on the Asian mainland, and the states of Sarawak and Sabah, known together as East Malaysia, on the island of Borneo. Peninsular Malaysia, protruding southward from the mainland of Asia, comprises an area of 131,587 km2. It is bordered on the North by Thailand, on the East by the South China Sea, on the South by the Strait of Johore, and on the West by the Strait of Malacca and the Andaman Sea. Although East Malaysia occupies the larger portion of Malaysia's total area, it is primarily comprised of undeveloped land and jungles. Hence about three quarter of its 23 million population stay in the Peninsular Malaysia. The climate of Peninsular Malaysia is equatorial, characterized by fairly high but uniform temperatures (ranging from 23° to 31°C throughout the year), high humidity, and copious rainfall (averaging about 250 cm/100 in annually).

II. Agricultural Sector

The agricultural sector in Malaysia accounts for about 8.4% of the GDP and employs 14.5% of the total labor force. Malaysian agricultural production consists of tree crops (mainly for export), rice and livestock (mainly for domestic consumption), and fruits and vegetables (both export and domestic consumption). Main export crops include oil palm, rubber, cocoa, pineapple and pepper and cover over 75% of cultivated land. The government is encouraging a shift of production to higher value crops. A minimum area will remain under paddy because of its strategic importance. The domestic rice self-sufficiency production target is set at 65 percent. The land use is divided as follows: arable land 5.46%, permanent crops 17.54%, other 77%.

III. Overview of the Higher Education and Research Institutions that Offer Agricultural Engineering/ Mechanization Programme, and their Programme Settings in Malaysia

Malaysian Agricultural Research and Development Institute, MARDI is a statutory body which has been mandated to conduct research in agriculture, food and agro-based industries for crops other than oil palm, rubber and cocoa. MARDI research endeavors for almost 40 years had fruitfully generated many new crop varieties and clones, animal breeds and its management practices. Cutting edge technologies in food processing and post-harvest handling are also developed for horticultural and livestock products. ICT technologies are being exploited in farm management and

operations such as precision farming technology for rice estate, and yield estimation. New techniques are being developed in environmental management and optimum utilization of agricultural resources particularly soil, water and genetic resources.

Besides performing contract research & development (R&D) projects, MARDI also provides technical services and entrepreneurship development in food, agriculture and other fields related to the industry. The technical services are in the forms of advisory, consultancy, technical trainings, analytical laboratory services and quality assurance, product development and processing and also technology upscaling.

Farmers and entrepreneurs that had adopted MARDI technologies had contributed to the development of the national food, agriculture and agro-based industries. This has made the agricultural sector a compelling contributor to the national economy.

As an organization doing research in science and technology as its core business, MARDI provides a pool of experts in relevant fields and contributes significantly to the global knowledge corpus.

All information, scientific findings and agricultural skills acquired from the R&D activities are channelled via publications, exhibitions, conferences and seminars at national and international levels.

To ensure MARDI is not behind in food and agriculture technology evolution at the global stage, liaisons with national and international research institutions, universities, and group networking is enhanced.

IV. Brief Introduction of MARDI and Specific Programmes/ Research Focuses

Farm mechanizations are the main enabler to overcome labor shortage, to increase productivity and timeliness in production. With adaptation of mechanizations, it will decrease the production cost, improve product quality and less human intervention. Mechanization could be boost further by incorporating automation into the working processes. By having the Engineering Research Centre (ER) as one of its main research Centre, MARDI had taken necessary efforts to introduce the aspects of mechanization and automation in Malaysian agricultural and food production practices.

MARDI Engineering Research Center

Engineering Research Center in MARDI was established to conduct R&D on topics related to mechanization and automation for agricultural and agro-based industries (crop production, food, non-food and biomaterials engineering) agricultural engineering, post-harvest processing engineering and food engineering. The goals of Engineering research center are:

- To provide research and development in post-harvest mechanization, primary processing and downstream processing of agricultural and food products.
- To develop research in areas of soil and water engineering, farms mechanization, bio energy and establish of the agricultural machinery testing center.
- To develop intelligent systems, semi-robotic, sensor detection measurement technology and intelligent controlled structure for agricultural production.

ER Centre's mission is to accelerate the transformation of the agriculture and food industry towards effective world producers through the application of technology / mechanization and automation system at cost effective by 2020.

Vision ER Center is to perform research and development of technology / mechanization and automation systems to support sustainable and competitive manufacturing productivity continues to stabilize the country's agriculture and food industry in the global economy.

Organizational structure if Engineering Research Centre MARDI

1.1 Administrative Office (ER0)

- Assist the Director, Deputy Directors and employees of the Engineering Research Center for managing all affairs related to administration, finance and accounts.

1.2 Post-Harvest Mechanization and Food Processing Program (ER1)

- Mechanization of post-harvest handling system for agricultural production
- Mechanization of primary processing system for agricultural products.
- Develop machine prototypes for food processing system.
- Mechanization systems of high-tech food processing chain.

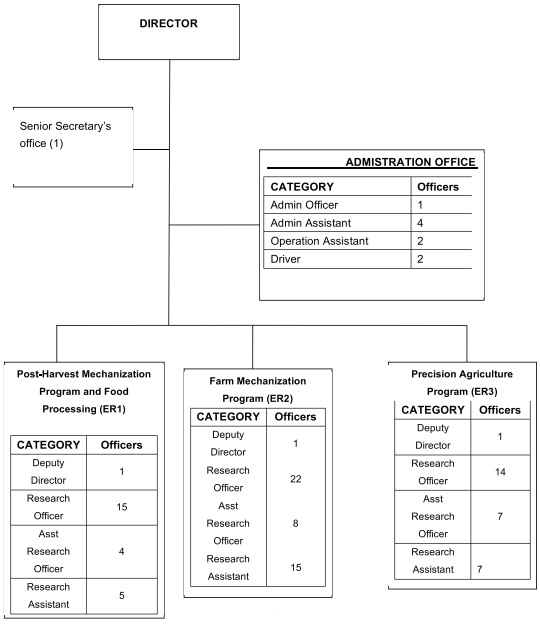
1.3 Farm Mechanization Program (ER2)

- Mechanization of irrigation and drainage system for agriculture.

- The layout of the farm infrastructure and structural improvements on problem soils for the mobility of machinery.
- Develop machinery and implement prototypes for farm mechanization.
- Mechanization of the use bio-resources for the production of bio-value added products and renewable energy.
- To establish a central testing and certification of agricultural machinery.

1.4 Precision Agriculture Program (ER3)

- Intelligent systems for crop management.
- Detection and measurement technology for agriculture production automation system.
- Semi-robotics in agricultural production.
- Structure and intelligent control systems viable for the production of upland crops in the lowlands.



V. The Need Assessment, Challenges and Constraints Faced of the Higher Education and Research Institutions for Human Resource Development of Agricultural Mechanization in Malaysia

Several factors have been identified as major constraints in human resource development for mechanization and automation in Malaysia mainly:

- Duplication of training by various departments and agencies
- Facilities and resources for the purpose of learning is incomplete
- The lack of skilled teaching
- The recognition of teaching standards is not uniformed.
- The lack of skilled labor in agriculture mechanization and automation
- Limited transfer of technology
- Young generation are not interested in agriculture

VI. Suggestions for Regional Cooperation on Higher Education and Joint Research of Human Resource Development of Agricultural Mechanization

It is suggested that cooperation between member countries of UN-CSAM in technical training can be carried out such as:

- Training of new and suitable machinery in Malaysia.
- Inter-regional training for testing of agricultural machinery
- Inter-regional training of agricultural machinery from research output
- Information sharing of expertise of agricultural machinery through regional network
- Establish SOP for training of operators
- A regional training module should also be made available so that ideal training programs can be strategized to meet industrial requirements.

VII. Contributions from MARDI for Regional Cooperation

To solve issues pertaining to human resource development of agricultural mechanization, MARDI has established programs to highlight research outputs through:

Technology incubators

MARDI Technology incubator is defined as a new technology pilot plant equipped with latest machinery and equipment on a commercial scale. MARDI Technology Incubator aims to produce graduates established (incubatees) to the business aspects of a viable / competitive in terms of financial, has a strong market and technical skills who are able to grow.

The Incubator offer services as follows:

1. Technical Services:

Technology information, further R&D for diversification of the Product, hands-on guide on operating and quality assurance services for the final product.

2. Physical Infrastructure

Including a shared office space for administrative services, and incubate access to specific facilities such as laboratories and testing facilities. The premise also will be provided with connection for incubates supporting telecommunication and ICT facilities.

3. Legal Assistance and IPR Management Services

Incubator will provide incubate legal assistance for incorporation, drafting licensing agreements, and ensuring all intellectual properties are protected.

4. Business, Marketing Development and Networking Services

Incubator will develop with the Incubate business plan regarding to the product and market forecast for the upcoming product. Industrial networking will be organized via business forum or smart partnership with the finance to strengthen the link of the incubate with another region of international business prospects.

Training and Courses

MARDI Training Program provides training and training consultancy services in the agricultural and food sector. MARDI has a staff of more than 400 researchers from various science and technical disciplines and expertise. This is supported by a relatively complete infrastructure and networking with experts at the national and international levels. The institute is able to provide training and training consultancy services of high quality to clients locally, nationally and regionally.

Services provided:

- Conducting courses (scheduled/unscheduled)
- Providing trainers/facilitators
- Administrative attachment courses (backup)
- Training consultancy services

MARDI Industrial Training (Internship)

As a government agency entrusted with the role of generating technologies on agriculture and agro-based industry as well as the promotion and commercialization of these technologies, MARDI is now the focus of both Public and Private Institutions of Higher Learning within and outside the country to provide industrial training to their students.

In order to realize its corporate social responsibility to the nation, MARDI provides the opportunity and facilities for industrial training to students of Public and Private Institutions of Higher Learning to apply the knowledge, skills and experience learned within a real working environment as well as increasing their marketability for employment.

Nepal

Mr. Yam Kumar Rai
Programme Coordinator
I.O.E. Purwanchal Campus Institute of Engineering
Tribhuwan University

I. Background

Nepal is landlocked country situated at the foothills of the Himalayas between 26° 22' N and 30° 27' N North latitude and 80° 04' E and 88° 12' E. It is rectangular in shape with an average length of about 885 km from East to West and width of about 193 km from South to North, encompassing an area of 147,181 km2. The altitudinal variation of Nepal extends from a plain 60 m to 8,848 m above sea level made up of Indo-Gangetic plain, hill slopes, river systems, valleys, doons and permanent snows. Mainly, the country is divided into three geographical regions and they are mountain, hill and terai.

Population census in Nepal takes place every 10 years. Total population of Nepal in 2011 census was 26,500,000 and growth rate per annum was 1.35 %. Population density per sq. km. was 180 (CBS 2011). The population of Nepal has been increasing continuously since the third census in 1930. The population is projected to increase up to 34.17 million by 2021.

Nepal has unique features because it lies near the northern limit of the tropics, due to complex topography, a wide range of climate, from the summer tropical heat and humidity of the terai to the colder dry continental and alpine winter climate through the middle and Northern mountainous sections are found.

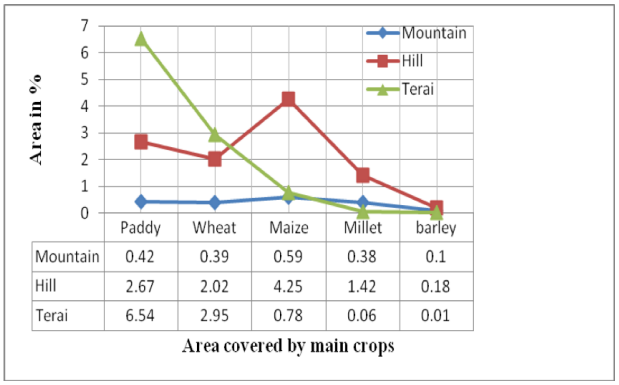
Nepal is an agrarian country and around 66% of the populations are engaged in agriculture and they hold 34% of national GDP. Due to the complex topography and climatic variation, agriculture systems are different at different locations. Different types of crops are grown in different topographical zones. The main agricultural crops are: low land and upland rice, maize, wheat, millet, mustard, pulses, barley, buckwheat and potato etc. The cropping pattern and farming technology adopted in the country is mostly traditional. Most of the crops are grown in summer and rainy season due to the required soil moisture which is received by monsoon rain. The rainy season (wet season) crops are rice/paddy, maize, and millet. The winter season crops are wheat, barley, and mustard. Potato is grown in summer in mountains and in winter in hills as well as in Terai belts. In winter, most of the high mountain areas of the country are covered by snow, which is not favorable for the crops. However, these areas are suitable for spring crops when the snow starts melting. Thus, most of the cereal crops do not grow during winter, but, in hills and Terai belt winter crops are grown.

II. Agriculture Scenario of Nepal

Nepal is unique country in the world because of its special topography features. It has plain 60 meter above from sea level to high mountain range up to 8,848 meter above from sea level. Himalaya range covers 35% of total land area of the country, which

is almost all seasons, are covered by snow. Similarly; hill and plain region (Terai) occupies 42% and 23% area respectively. According to CBS, 2013 Nepal, cultivated land of Nepal is 26.03%, which are distributed 2.17 %, 11.40 % and 12.46 % mountain, hill and terai region respectively. Figure 1: shows the % area covered by main crops in mountain, hill and terai region.

Figure 1: Percentage cultivated land area covered by main crops of Nepal



	Paddy	Wheat	Maize	Millet	barley
Mountain	0.42	0.39	0.59	0.38	0.1
Hill	2.67	2.02	4.25	1.42	0.18
Terai	6.54	2.95	0.78	0.06	0.01

Production of main crops is increasing slowly year by year but not satisfactorily results are found in comparison to application of agricultural input. Figure 1 and 5 shows the area covered by main crops and cash crops and figure 2 and 4 shows the production of main crops and cash crops of Nepal. Similarly; figure 3 and 6 shows the productivity of main crops and cash crops.

Figure 2: Production of main crops in Nepal.

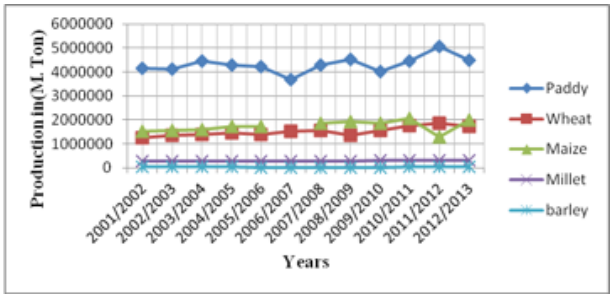


Figure 3: Productivity of main crops of Nepal

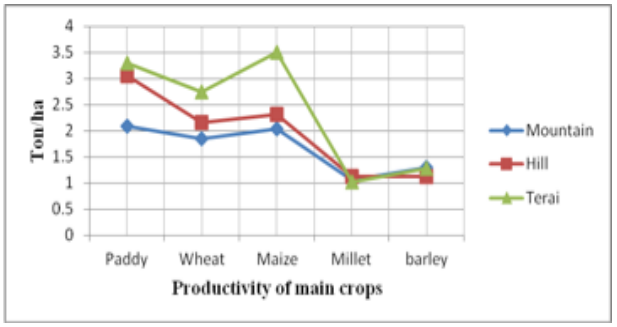


Figure 4: Total production of cash crop of Nepal (M. Ton)

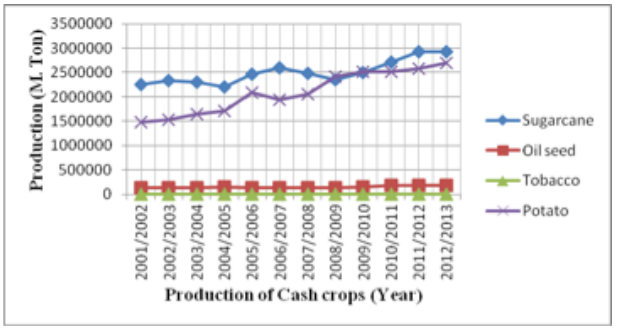
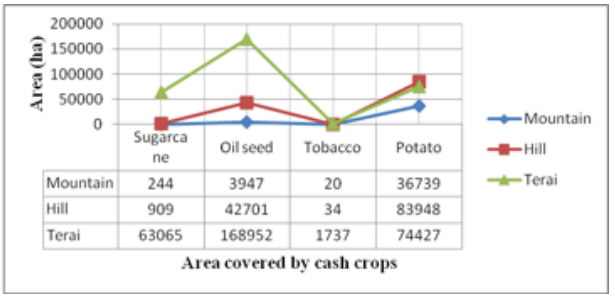
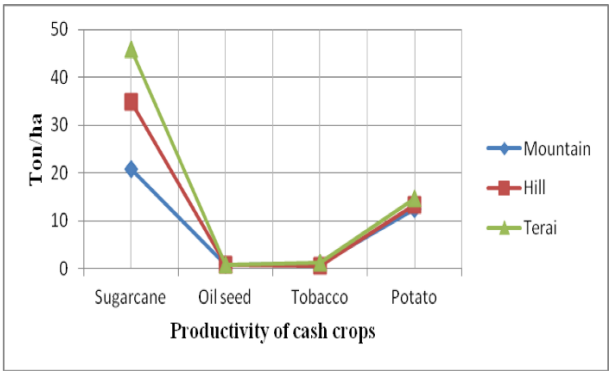


Figure 5: Region wise area covered by cash crops (ha)



	Sugarcane	Oil seed	Tobacco	Potato
Mountain	244	3947	20	36739
Hill	909	42701	34	83948
Terai	63065	168952	1737	74427

Figure 6: Region wise productivity of cash crops (Ton/ha)



Source: (CBS Nepal, 2013)

III. Need of Agricultural Mechanization in Nepal, its Challenges and opportunities

Agricultural work is drudgeries, time consuming, tedious and less profitable occupation. Working on open space at high temperature in muddy field with traditional tools and implements; really, young people are drive back from this occupation. Rural youth and young are migrating towards city and town for search of clean and easy job. Beside these; young and active people are leaving the country for new and better employment in foreign countries. More than 2,200,000 active young people are outside of the country; therefore, agricultural land of Nepal is converting in barren land. Due to all these reason total production is going to be in decreasing

order. Hence; there is urgent need of appropriate agricultural mechanization in Nepal, to attract the young and active people toward agricultural occupation.

The main constraints of agricultural mechanization in Nepal are as follows:

- Diversified topography
- Small land holding size (< 0.65 ha)
- Lack of infrastructure development
- Traditional thinking of farmer
- Lack of education
- Low investment capacity of farmer
- Lack of trained manpower
- Lack of local level developer
- Lack of spare parts of machinery and maintenance facilities
- Lack of coordination between related stakes holders
- Lack of commercialization of agriculture
- Weak government policy

Agricultural mechanization is difficult task in context of Nepal because of its geographical condition. Mostly animate power is used in mountain and hilly region of Nepal; therefore, modification and development of locally available hand tools and animal drawn implements is necessary. Design and development of such tools and implements in efficient, fit from the ergonomic point of view and in cheap way is very difficult. Small modification in hand tools and animal drawn implements may bring agricultural revolution in mountain and hill of Nepal. Even today; Nepal is dominated by animate power in agricultural mechanization field. Human 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 around 23 percent. All most all 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.

The opportunities of agricultural mechanization of Nepal are as follows:

- Design, development and modification of hand tools, animal drawn implements and small size power operated machines in mountain region
- Design, development and modification of hand tools, animal drawn implements and power tiller operated implements in hilly region
- Design, development and modification of hand tools, animal drawn implements, power tiller operated implements and Tractor drawn implements in terai region
- Establishment of small scale industries for machine and implements fabrication
- Establishment of repair and maintenance workshop
- Establishment of commercialization agriculture system
- Establishment of custom hiring business
- Establishment of cooperative farming and land consolidation system
- Bust up the agri-business

Therefore; modifications on hand tools, design, development, and modification in power tiller operated implements are the opportunities of the farm mechanizations in Nepal. But, in terai region improvement in tractor drawn, power tiller drawn, animal drawn implement and in hand tools are necessary. In terai region around 29% of iron plough is used to tillage and similarly around greater than 25% of Tractors and power tillers are used to accomplish the primary as well as secondary tillage. Selection of proper power source (Tractor) and design and development of tillage implement according to land holding size is very important. Most of the agricultural Tractors are oversized; therefore, inefficient use of tractor may losses time and money of the farmer.

Planting and transplanting of crops in Nepal is all most all manually done; but nowadays, zero tillage and minimum tillage seed drill is promoting for wheat sowing in terai region. Rice is transplanted manually by female manpower which is drudgeries work. Small sized manually operated rice transplanter is necessary in mountain and hill and power tiller operated rice transplanter is necessary in terai region of Nepal. Maize and vegetable are planted with dibbling methods in all regions. Walk behind the plough method is also adopted in hill and terai region of Nepal. Similarly; tools and technology used in intercultural operations are traditional, therefore modification is necessary in such kinds of tools.

Harvesting tools used in mountain, hill and in terai region are still traditional. Sickle, kuto, khurpi and knives are used to harvest main crops and underground crops. Tractor drawn reaper, power tiller operated reaper and combined harvester are being popular in terai region; but due to small land holding size, greater harvesting loss is found during harvesting time. Therefore; modification in hand tools and development of machine according to plot size is very necessary. Similarly; development of portable size of manually and power operated threshing machine is necessary for mountain, hilly region and introducing small size of combine harvester and power tiller operated reaper will be better for terai region of Nepal.

IV. Role of Academic and Research Institutions, challenges and constraints for Agricultural Mechanization

In Nepal; there are only five universities which are offering higher education in different discipline to produce required qualified manpower and to conduct research in various fields. Tribhuvan University (T.U.) is renowned pioneer university of Nepal. Institute of Engineering (IOE) is conducting higher engineering education in different discipline under the umbrella of Tribhuvan University. Institute of Engineering has four constituent campuses; which are Paschimanchal (Western region) Campus Pokhara, Thapathali Campus Kathmandu, Pulchowk Campus Lalitpur and Purwanchal (Eastern region) Campus Dharan. IOE is producing qualified manpower and conducting research in various engineering fields. IOE is providing formal education up to doctoral level. Purwanchal Campus Dharan is offering agricultural engineering discipline among the various disciplines, which is pioneer and only one discipline in Nepal. The main objectives of agricultural engineering discipline is to produce medium and higher level qualified manpower in the field of agricultural engineering and conducting research at the related field and extension of technology by mobilizing students up to the farmers field level.

Purwanchal (Eastern region) Campus Dharan was established in 1977 under the financial assistance of Asian Development Bank (ADB) and technical assistance of ODA of British Government and this project was completed in 1986. The main purpose of establishing the Purwanchal (regional) campus was to support the needs of skill technical manpower on a regional basis and to reach the skill manpower national wide. In 1992 this program was upgraded in different discipline for producing medium level of manpower to the country. In the year of 2000/2001 Purwanchal Campus lunched undergraduate four years program in agricultural engineering and very soon graduate program is going to be lunched in Land Development and Water Management Stream and farm machinery and power. The intake capacity of students was twenty four per batch from beginning to 2010 but in the year of 2011/2012 the intake capacity was doubled. From starting to now around 300 undergraduate (Engineers) are produced by the department of agricultural engineering Purwanchal Campus, Dharan .

Department of Agricultural Engineering is conducting diversified courses like farm machinery and power engineering, soil conservation and watershed management engineering, irrigation and drainage engineering, dairy and food engineering, renewable energy engineering and post-harvest engineering and technology. Beside these; workshop, seminar and project work are conducted to the students to enhance their quality. Research work conducted with the involvement of students and faculties are the regular program of department. Design, development and testing of power tiller operated multi crop planter, development of manually operated rice transplanter and modification of its seedling release finger are some of remarkable jobs of the department; but vigorous testing is required to bring them in commercial form.

IOE, Purwanchal campus, Dharan is conducting extra activities, like research and development work, short term training, testing of engineering materials and other consulting work through the research training and consultancy units (RTCU). Department of agricultural engineering and RTCU team jointly planning to conduct training on

- Operation of tractor and power tiller with different implements
- Repair and maintenance of agricultural tools and implements

Similarly; experiment on green house is conducting for different vegetable crops under the RTCU and Department of Agricultural Engineering, with the involvement of final year students.

Department of Agricultural Engineering Purwanchal Campus is waiting to see the following benefits achieved by the nation after pass out the graduates.

- Farmer will be aware of new agricultural mechanization technology and their uses
- Proper tools and equipment are disseminated and replaced traditional tools and equipment
- Reduces the production cost of agricultural product
- Rural farmers' life will be comfortable and prestigious through agricultural mechanization
- Research and innovation programs will be enhanced in fast and efficient way
- Increased the productivity of land and crops and reduces the deficit of food crisis from the nation

The history of Department of Agricultural Engineering Purwanchal Campus is not so long. In the pace of 15 years around 300 qualified undergraduate students are passed out and during this period so many problems and challenges faced by the department. Lack of faculty member to conduct courses in time, lack of available upgraded technology and equipment/machine, lack of laboratory and lack of investment on time are the main constraint to conduct the higher education in agricultural mechanization. Fund provided by university is common basket fund therefore; it

is difficult to manage the fund for research activities in agricultural mechanization sector.

Role of research institutions in agricultural mechanization will be the formulation of problem and find out their solution, in context of Nepal. During design and development of machinery and implements the geographical condition and land size must be considered. Precision technology will be for future coming days because of lack of perfect man power and investment capacity of the farmers. Therefore; design and improvement of hand tools, animal drawn implements and power tiller operated implements are suitable for Nepal. Recommendation should be made by the research institutions to import small size of implements and machines to the government and private sector.

V. Role of Stakeholders for Sustainable Agricultural Mechanization

The government agencies and private sectors both are responsible for promoting agricultural mechanization in Nepal. The main stakeholders and their role in agricultural mechanization of Nepal are:

- Agricultural Engineering Division which is running under the Nepal Agriculture Research Council (NARC) is basically responsible for conducting research on mechanization field, testing of machinery; recommend the tools and machinery to the farmer, development of agricultural machinery and provided the training to the professionals.
- Directorate of Agricultural Engineering; which is running under the Ministry of Agriculture is responsible for formulation of policy, preparation of agricultural mechanization act, providing guidelines to the institutions and other stakeholder, technology extension, dissemination throughout the country and provided the training to the professionals and related stakeholders.
- Department of Agricultural Engineering, Purwanchal Campus Dharan is producing required qualified manpower for agricultural mechanization and renewable energy field as well as it is conducting research in the field of agricultural mechanization and in the other fields.
- Agricultural machinery importers, fabricators and repair and maintenance workshops are other stakeholders who are promoting agricultural mechanization in Nepal by providing technical knowledge and services.
- Progressive farmer are the best stakeholders, for promoting agricultural machinery in Nepal.

VI. Suggestions for Regional Cooperation on Higher Education and Joint Research of Human Resource Development of Agricultural Mechanization

- Farm mechanization related regional institute must be established in regional level
- Scholarship to the faculty member and students should be provided by regional cooperation to the member countries of CSAM
- Research exchange program should be established regional cooperation and institute
- Faculty and student exchange program must be established with the regional institution and the member countries of CSAM
- The regional institute must conduct the short term training and post-diploma courses to promote skill and knowledge

Contribution from IOE, Purwanchal Campus, for Such Regional Cooperation

Nepal has diversified climatic conditions due to its typical geographical condition. Therefore; this place may be a good place for researcher to conduct research in diversified field. Therefore; Institute of Engineering, Purwanchal Campus Dharan can be contribute to the researcher as a research station by providing available lab facilities and manpower. Institute will be ready to provide any kind of information related to agricultural engineering and other related fields.

VII. Conclusion

Sustainable agricultural mechanization is not possible with a single stakeholder; therefore, mutual cooperation is necessary of all stakeholders and regional cooperators to solve the problem faced in agricultural mechanization.

Pakistan

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Research and development institutions are confined in public sector and non-existent in private sector. Some of Pakistan key R&D Institutes in Public Sector include:

- Agricultural and Biological Engineering Institute (ABEI), Islamabad
- Agricultural Mechanization Research Institute (AMRI), Multan
- Faculties of Agricultural Engineering, Universities of Agriculture, Faisalabad and Tandojam
- Agricultural Engineering Department, University of Engineering & Technology, Peshawar

Salient Achievement of R&D Institutions:

Description	Agricultural & Biological Engineering Institute (ABEI), NARC, Islamabad	Agricultural Mechanization Research Institute (AMRI), Multan
Mechanization technologies developed and commercialized	Tractor front mounted reaper-windrower, groundnut digger, groundnut thresher, sunflower thresher, paddy thresher, pneumatic row crop planter, zero-till drill, fertilizer band placement wheat drill, canola thresher, wheat straw chopper-cum-blower, hand operated groundnut shellers, ABEI olive oil extractor, wood shredder, and Mobile seed processing unit.	Seed drills, planters, ridger, bed shaper, weeders, wheat thresher, rotary slasher, potato planter, groundnut digger, maize sheller, rotary tiller, boom sprayer, fertilizer spreader, axial flow pump, seed cleaner grader, hand dibbler, furrow bed/shaper planter, soil hard pan tester, bullock drawn implements, and mobile bhoosa chopper and baler.
Mechanization technologies being Commercialized	Pak seeder, PTO disk plough, vegetable planter, turmeric dryer, solar-cum- gas fired dryer, mini seed cleaner cum grader, flat bed dryer for canola, sunflower & maize, date dryer, mango picking & pre-cooling technology harvester and nursery raising plant, hot-water treatment plant for eradicating mango fruit fly infestation.	Power tiller, chain trencher, fodder cutter bar, sugarcane base cutter, pneumatic drill, rotary ditcher, ejector pump, maize cob harvester, cheaper biogas planter, vegetable nursery transplanter, groundnut sheller, rice thresher, seed- bed finisher, stubble shaver, and orchard sprayer.

One of the research institutions is Agricultural and Biological Engineering Institute

(ABEI), former Farm Machinery Institute (FMI). Its mission is to contribute to food security poverty reduction environment protection by fostering sustainable enhancement in productivity of agricultural

production resources through farm machinery; development/adaptation; testing & standardization and commercialization. The leading projects are Machine systems engineering program, Energy systems engineering program and Bio-processing and engineering program.

ABEI's Machine systems engineering program strives to:

- To develop and evaluate agro-processing technologies for cereals, legumes, and medicinal plants
- To develop and evaluate technologies for processing of bio-wastes into useful products
- To develop and evaluate food processing technologies in order to add value to agricultural produce
- To develop image processing technologies and controls for applications in food processing
- To disseminate innovative bio-processing technologies among the end users

Energy systems engineering program:

- To design, develop and evaluate innovative energy systems engineering technologies for drying and cooling of agricultural produce
- To develop technologies for on-farm production and utilization of biomass and bio-fuels energy, and solar energy
- To conduct energy conservation studies in order to optimize energy consumption for crop production
- To disseminate innovative energy and post-harvest technologies among the end users

Bio-processing and engineering program:

- To develop and evaluate agro-processing technologies for cereals, legumes, and medicinal plants
- To develop and evaluate technologies for processing of bio-wastes into useful products
- To develop and evaluate food processing technologies in order to add value to agricultural produce
- To develop image processing technologies and controls for applications in food processing
- To disseminate innovative bio-processing technologies among the end users

ABEI's facilities include Design Office, Machinery Testing Lab and Prototype Workshop.

One of the most important field of activities is Testing & Evaluation. In total 25 prototypes, 27 Commercial/ Local, 55 Imported machines were tested. There is 53 standards of Farm Machinery, 10 Plant Protection equipment standards, 18 Earth-moving machinery standards were developed.

Other activities also include Trainings for Engineers in testing & evaluation of farm machinery; for Extension Officers and farmers in operation, repair and maintenance of farm machinery. Technical Assistance is provided to manufacturers in manufacturing of FMI developed technologies. Moreover, Policy Input provided to Government in formulation of farm mechanization strategies for the country.

There is a substantial number of projects, researches and commercialization of technologies, ongoing and completed, by ABEI including Investigation of Factors Causing Low Head Rice Recovery; Post-harvest process and Value Addition of Dates in Khairpur, Sindh; commercialization of Fertilizer Band Placement Drill; Development and Evaluation of Vegetable Planter and Transplanter etc.

Philippines

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I. Higher Education Institutions with Agricultural Engineering (AE) or Agricultural and Biosystems Engineering (ABE)

There are 46 Higher Education Institutions currently offering AE/ABE curriculum; by the island group Visayas has 8 HEIs with AE/ABE curriculum, Mindanao has 13, and Luzon has 25.

For Bachelor Studies in Agricultural Engineering; in Agricultural and Biosystems Engineering the length of curriculum is 5 years. For Master Studies in Agricultural Engineering, and in Agrometeorology the curriculum is 2 years. For the PhD in Agricultural Engineering the length of curriculum is 3 years, and for Post-doctorate fellowships it is 6 mos. or more.

The work on curriculum is ongoing, and the current development include:

- Streamlining of the Bachelor Studies in AE/in Agricultural and Biosystems Engineering curriculum to the K-12 and OBE Educational System (The Outcome-Based Educational System);
- Responding to international accreditation and globalization;
- Changing the Curriculum from a five-year program to a four-year program;
- Integrating TVET program to HEIs.

A paradigm shifts from traditional education system into OBE in national and international HEIs where there is greater focus on program and course outcomes; student-centered teaching and learning activities; regular assessment and evaluation; continuous improvement.

International mutual agreements on educational qualification frameworks and mechanisms utilizing OBE in the academic programs include many fields such as accounting, computer science, medicine etc.

Engineering is also one of the fields under these agreements, such as:

- Washington Accord –1989
  For undergraduate engineering programs
- Sydney Accord-2001
  For engineering diploma/polytechnic programs
- Dublin Accord–2002
  For engineering technician program
- Seoul Accord–2008
  For Professional Engineers in computing/IT and related fields

II. Agricultural Mechanization/Agricultural and Biosystems (AM/ABE) Research and Development and Extension (RDE) in the Philippines

The basis for RDE in the related field in the Philippines is the "Agricultural and Fisheries Mechanization Law" of 2013 (AFMech Law).

AFMech Law formulates the National Agricultural and Fisheries Mechanization Plan (NAFMechP), which includes following components:

- Standards and Regulations;
- Support Services and Institutional Development;
- Local Assembling and Manufacture of Agri-fishery;
- Research, Development and Extension;
- Human Resource Development Component.

Under the umbrella of the AFMech law and in order to implement the RDE component of the Plan, RDE Network (AFMechRDEN) was established. The same law dictates that this Network should be composed of research and educational institutions, LGUs, nongovernment organizations and the well-established associations of agricultural and fisheries machinery assemblers, manufacturers and distributors, agricultural engineers, farmers and fisherfolks. It also suggests that the Network will integrate all a will integrate all agricultural and fisheries mechanization RDE programs and projects of all stakeholders including national government agencies, local government units (LGUs), and SUCs.

Since then, the Network already participate in 13 different activities in 2014-2015, with the most recent ones include National Consultative Workshop on the Formulation of Agricultural and Fisheries Mechanization Research, Development and Extension Agenda for Livestock and Poultry taking place in November 2015.

Challenges	Recommendations
Fast-tracking the conversion of HEIs from AE into Agricultural and Biosystems Engineering	Active and continued advocacy, assist other HEIs to attain this goal
Aligning BSABE with international standards	
Integration of TVET program to HEIs	CHED institutional support Assuring the implementing mechanism that would not affect the role of HEI in producing professionals in AE/ABE
Strengthen the capabilities of HEIs to produce world-class human resource	Strong government support
Operationalization of AFMechRDEN	Formalize the implementing mechanisms with corresponding budget
Implementing technology transfer mechanisms to realize the benefits of RDE activities	Technology transfer mechanisms should include institutional and support services for sustainability

III. Conclusion

AEC implementation/integration:

- Aligning the educational system with international standards will allow free flow of goods and services (agricultural engineers and technicians).
- Successful implementation of the AFMech Law in 2013 will result in sustainable RDE in agricultural mechanization

Republic of Korea

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I. Introduction

Agricultural Engineering of Korea has played an important role in the improvement of food self-sufficiency rate to develop the country from the poorest countries to the rich countries. It has a leading role in the phenomenal development to overcome the barley hump, a serious food shortage until the 1950s in just 50 years. However, now there are many efforts to teach our Agricultural Engineering-based agriculture · rural development technology and experience based on the accumulated technology and compressed experience, and economic strength of the country to the international community. Before it is too late, we need to globalize valuable development experience and technology to promote the country, to aim to national interests, to create new employment, and, to contribute to the securing of overseas food base that can be ready for the future.

Past and present of Korean Agricultural Engineering

After the 1900s in Korea, Agricultural Engineering can be distinguished by another five era features as shown in below.

1. 1900-1945 was the time that modern irrigation works was established with some irrigation association, and agricultural water management system was introduced to farmers at that time. Mainly it was a colonial era of Japan, but it was time laid the foundation for the modernization of the agricultural base that has lagged behind. However, agricultural infrastructure modernization during this period, was mainly dark time, and it was used as a means of food exploitation of Japan's colonialist.
2. 1946-1969 was the time that water management works for the overcoming of poverty and food shortages after release. Because of an insufficient agricultural infrastructure, they experienced serious food shortages every year, as floods and drought, so deployed infrastructure development and reclamation projects was very actively conducted in full-scale since the 1960s.
3. 1970-1989 was the time to achieve self-sufficiency of rice that is an agricultural base to expand promotion of large-scale agricultural development projects and ongoing agricultural base business.
4. 1990-1999 was the time to focus on strengthening agricultural competitiveness as investment and maintenance of agricultural production base in order to correspond to the era of globalization to strengthen. Investment for the improvement of large-scale farming and farming & fishing community life environment.
5. 2000 to date, as the humanity, agriculture and nature coexist, we are trying to ensure the quality of the rural life. For this reason, it is put farming and fishing community development, restoration of the natural and ecological environment that has been damaged in the development full commitment, and the

emphasis on the tip facility agriculture in order to develop export agriculture.

The time of 1) and 2), the financial state after liberation and colonial rule was not enough, so accordingly it was not carried out full-scale agricultural development. However, there is a margin for successful finances of the state, and some portion of them was expanded to rural areas and development investment in the economic development plan from time 3). And agriculture and industry technology dramatically development also let us live well to the diffusion of the Saemaul Movement showing that civic movement could be promoted to vigorous agricultural development. For this reason, Korea was able to succeed in agriculture & rural modernization in which the Agricultural Engineering technology had greatly developed for a short period of time that is not passed 50 years. There are also efforts for restoring, protecting and conservation the natural ecosystems with the farming and rural advancement at the same time.

Research of Korean Agricultural Engineering

As you may know, like many other Asian countries, there are Korean Societies of Agricultural Engineering (KSAE) and Agricultural Machinery (KSME) in Korea separately, and they have made significant contribution on development of rural area as well as agriculture for last more than 50 years. In this subchapter, I want to introduce publications on those two journals to show current status of researches actively conducted in Korea.

Considerations of the Globalization

Globalization at Agricultural Engineering field has brought the era of infinite competition inevitable. We have to solidify scaffold that can be into the world by our development experience, technical capabilities and utilizing such public assistance. Globalization is can be a product of economic, science and technology, socio-cultural and political power, and it is also receiving criticism that the world restructuring focused on economic powers.

Globalization, it is also true that is made to deepen the exclusive economic and technology focused on a huge capital, technology, and service. There are also lots of typical case that more and more huge because of globalization such as smartphone, electronic components, automobile, pharmaceuticals, agricultural seeds. A result of globalization, as well as interpersonal, is allowed to deepen the gap between rich and poor between nations, so globalization in the future, also feel that it is possible to provide a cause of regression to protectionism from the free trade principle. Thus, cooperation of collaboration between all stakeholders from experts of agriculture and industry areas to students in order to develop as an independent field by grading up the Korean Agricultural Engineering with the world Agricultural Engineering.

II. Recent Status of Agricultural Engineering Research in Korea

1. Automation of Agricultural Machinery

Rice weeding robot, hybrid riding type manager, and soil pH meter were developed using Information & Communication technologies (ICT). A plant-based recycling technology developed hydroponic nutrient solution through waste separation and recovery. Vehicle and personnel access control systems for swine monitoring were developed using RFID (Radio-Frequency Identification) that makes efficiently manageable. We also developed a whole-grain planter and harvest for upland farming. In order to efficiently produce sweet potato, the sweet potato stem shredder and transplanter were also developed.

2. Energy-saving Technology and Facilities Modernization

A heat pump using remaining solar energy inside greenhouse was developed to efficiently heat a greenhouse. In contrary to an air source heat pump, a heat pump using inside remaining solar energy improved its performance up to 32%. This pump also saves the heating cost up to 80% compared to diesel air heater and reduces the carbon footprint up to 42%. A summer seedling greenhouse temperature control was developed and is capable of cooling air which is very useful for greenhouse cultivation. For a renewable energy recovery, a microbial fuel cell was developed to recycle livestock manure and recreate energy source.

3. Agri-food Distribution and Processing Systems

Research on agricultural and livestock products were carried out to improve the value added. For food safety, a washing and sterilization device was developed to process agricultural products. A lightweight structured carton was developed to reduce paper use. An electronic weighing and sorting system was developed to preciously measure a weight of dried persimmon and automatically sort/count them by size. For a long-period storing fresh apples, the controlled atmosphere (CA) and modified atmosphere (MA) were developed to store fresh apples over a period of time.

4. Agricultural Production and Farm Work-based Safety Technology

The specification of a spiral pile foundation and its standard manual were prepared to protect agricultural facilities against natural disaster. For elderly workers, an auxiliary walking-carrying wagon shovel, working shoes, cooling suit, and protective clothing for pesticide were develop to make farm work easy and safe. A computer-based simulator was developed to provide hands-on training of agricultural machinery, such as a tractor.

Russia

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I. Overview of the Higher Education and Research Institutions that Offer Agricultural Engineering/Mechanization Programmes and their Programme Settings in Russia

The system of agricultural education of the Russian Ministry of Agriculture includes 59 higher education institutions (26 universities, 32 academies, and 1 institute) located in 51 subjects of the Russian Federation, 25 institutions of further vocational education (further training institutes and academies). 90% of these higher education institutions have faculties for training engineers and farm machinery operators.

More than 87 percent of the total number of students is studying in the field of agriculture, the remaining - in vocations the specialties needed for the development of rural areas and their infrastructure.

Preparation of personnel with higher education is carried out in 122 vocations and 70 areas of undergraduate and graduate programs. Training of personnel with secondary vocational education is carried out by 26 higher education institutions in 51 vocations.

429.2 thousand students (including 197.8 thousand of on-campus students) and 9.5 thousand of post-graduate and postdoctoral students are involved in higher education vocational programmes (Bachelor's programme, Specialist programme, Master's programme); in secondary vocational education programmes - 25.6 thousand students.

The Ministry is constantly engaged in optimization of the system of agricultural education, and, by now, possesses a positive experience in reorganization and amalgamation of higher education institutions. The Omsk State Agrarian University named after P.A. Stolypin was established on the basis of the agricultural and veterinary institutes in Omsk in 1994, and in 1998, in Saratov, the Saratov State Agrarian University named after N.I. Vavilov has amalgamated the Academy of Veterinary Medicine, the Agricultural Academy and the Agro-engineering University. Nowadays, these amalgamated universities are among the largest and most efficient higher education institutions functioning under the Ministry of Agriculture of the Russian Federation. In addition, for the last decade, agricultural higher education institutions have amalgamated 22 secondary technical schools, 41 institutes for continuing education, and 1 research institute. For several years, the issue of amalgamation of the higher education institutions located within the same territory of the Russian Federation is being discussed to create large multiple-discipline agro-technological universities to provide for the comprehensive

solution of educational and scientific objectives put forward by our time realities.

II. The Need Assessment, Challenges and Constraints Faced by Higher Education and Research Institutions for Human Resource Development of Agricultural Mechanization in Russia

As a result of the All-Russian inspection conducted by a supervising authority, the higher education institutions subordinated to the Ministry of Agriculture of Russia have a number of industry-specific features:

- All agricultural higher education institutions demonstrate a low Unified State Exam (USE) index. This is explained not by their low efficiency, but the low prestige of agricultural education, as the level of wages in agriculture is 50% of the average in the industry, and rural areas are socially underdeveloped. Therefore, the agricultural institutions are preferred by graduates from rural schools (more than 60%) whose average USE index is lower compared to graduates from urban schools;
- Agricultural institutions have lower indices due to two financial criteria; historically, they are underfunded (on average, the federal budget allocates 25-30% less funds per one student of the agricultural institution compared to higher education institutions). Low rate of return of agricultural enterprises does not allow them to attract funds to conduct scientific research.

The Russian Ministry of Agriculture has conducted a departmental monitoring of subordinated higher education institutions regarding 11 indicators. In addition to the monitoring indicators, the Ministry of Education and Science of the Russian Federation considered the following indicators: ratio of positions occupied by full-time lecturers with academic degrees and titles, total number of positions; ratio of positions occupied by Doctors of Science and Professors to the total amount of positions; specialization of ongoing educational programs; employment in the agricultural sector; effectiveness of post-graduate education; number of established business entities. According to the results of the departmental monitoring, 14 higher education institutions need optimization.

Optimization is expected to result in: amalgamation of educational institutions, increase in the educational and scientific process funding, increase in the average wage of scientific and pedagogical specialists, prevention of duplicating similar training programs, and improvement in economic efficiency of such institutions.

Areas of educational, scientific and other activities being carried out by each an institution in accordance with its profile today will be remain unchanged after amalgamation and will receive further development in the newly established university. Student campuses (institutes) with specific training will be established. No doubt, deep historical tradition and uniqueness of each institution will be taken into account. Academic councils, faculties and departments of reorganized higher education institutions will take part in the development of the amalgamated university concept.

In addition, to enhance effectiveness of higher education institutions of the Ministry of Agriculture of the Russian Federation activities are undertaken in the following areas:

- The Management of departmental higher education institutions is instructed, together with the subjects of the Russian Federation, to develop the program for the development of educational institutions till 2020 and short-term optimization programs;

- The Management of higher education institutions is being strengthened: new presidents of the Irkutsk and Nizhny Novgorod State Agricultural Academies have been elected, presidents of the Azov-Black Sea State Agro-Engineering Academy, Smolensk, Chuvashia, and Penza State Agricultural Academies were relieved of their duties.
- The material-technical base of the agricultural higher education institutions was improved, construction and reconstruction of educational buildings and dormitories is being carried out, and the land-property complex optimized.

III. Briefing of Rosagromash and Specific Programmes/ Research Focuses

No own training programmes available in the Association Rosagromash.

IV. Suggestions for Regional Cooperation on Higher Education and Joint Research of Human Resource Development of Agricultural Mechanization

- Join external programs of leading Universities in the region;
- Student exchange;
- Joint research programs;
- Joint regional forums, lectures and seminars;

- Exhibiting activities.

V. Contributions From Your Institution for Such Regional Cooperation

The Association Rosagromash, as the organizer of the International Exhibition of agricultural machinery, AGROSALON-2016, that will be held in Moscow in October 2016, within the framework of regional cooperation, suggests:

- Within the framework of the exhibition, to organize the joint training and business program (a series of workshops and lectures) by involving scientists, students, technicians, and responsible officials;
- To contribute to the preparation of the joint stand on the topic: «Human Resource Development for Sustainable Agricultural Mechanization»;
- To render the all-round organizational and methodological support for the development of regional cooperation.

Sri Lanka

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I. Overview of the Higher Education and Research Institutions that Offer Agriculture Engineering/Mechanization Programme, and their Programme Settings in Sri Lanka

The modern university education system was established in Sri Lanka (then Ceylon) in 1921 in the form of a University College preparing students for some of the external degrees of the University of London. University of Ceylon was established on 1st July 1942 with four faculties; Arts, Oriental Studies, Science, and Medicine (Mahalingam, 2000, http://www.pdn.ac.lk/eng/eng/about/history.html). The first Faculty of Agriculture and Veterinary Science in Sri Lanka was established in 1947 in the University of Ceylon at Peradeniya and admitted only 16 students for the agriculture degree (www.pdn.ac.lk). At present, there are eight Faculties of Agriculture/Agricultural sciences in the country and produce about 800 agriculture graduates per year although the potential is about 1250 (UGC Graduate Output, 2014, 2013 & 2012). However, only about 11% of them major/specialize in Agricultural Engineering (Table 1). Average of about 7 credits of courses are offered in a degree with a practical component of about 150 h. In addition, there are other machinery related trainings are also offered at different private/state institutes (Table 1). From this fraction, the students directly involved in agricultural machinery related research projects at undergraduate level is limited to about 38 number per year in the country. In addition to the Faculties of Agriculture, a few engineering undergraduates, especially from mechanical engineering discipline also engage in agricultural machinery sector. Although the exact numbers are not available, out of the total number of about 1400 engineering graduates produced by the five faculties in the country (UGC Graduate Output, 2014, 2013 & 2012), less than 10 may engage in this sector. This is mainly due to the poor attraction for Mechanical Engineers in the farm machinery sector in the country in relation to other industries. Therefore, the total number of Mechanical Engineering professionals engaged in the agricultural machinery sector is also limited. Only a limited number is working for the research sector in the state sector and the rest serves at the management levels in the private sector.

Contribution of the public sector in higher education in Sri Lanka is still higher than the private sector due to the free education policy of the country implemented since 1948 (Ministry of Human Resource Development, Education & Cultural Affairs, 2002). State sector higher education institutions of the country falls mainly under the Ministry of Higher Education and Highways. Majority of the state sector higher education institutions are governed by the University Grants Commission (UGC) under the ministry. There are 15 universities, three campuses and 18 degree-awarding

institutes (ie. Postgraduate Institutes) are governed by the UGC. Only four state sector universities are not governed by the UGC. From among the 15 universities under UGC, only eight universities including the Open University of Sri Lanka have Agriculture/ Agricultural Sciences Faculties and offer Agricultural Engineering/ mechanization related training and research. Out of 18 degree-awarding institutes governed by the UGC, only two; Postgraduate Institute of Agriculture (PGIA) of the University of Peradeniya and Institute of Agro-Technology and Rural Sciences of the University of Colombo (only up to degree level) offers Agricultural Mechanization related training programmes. The latter is mainly focused on training people who are already engaged in the farming sector. The PGIA is the oldest and leading graduate training institution in the country and the mandated institution for advance human resources development in the agricultural sector in the country. Therefore, it contributes significantly to the agricultural mechanization and since related research since 1975.

In addition to the universities, campuses and institutes governed by the UGC, there are 17 other state/privately owned institutions accepted by the UGC for awarding degrees. (http://www.ugc.ac.lk/). Out of these 17 institutions, privately owned Aquinas College of Higher Studies has a Faculty of Agriculture but offers only a two-year Diploma leading to NVQ level 5/6 (Degree qualifying) in Agriculture and Animal Husbandry, which has an Agricultural Engineering component on farm machinery maintenance. (http://www.aquinas.lk/courses_and_programs.php?). At the moment, the second privately owned institution, South Asian Institute of Technology and Medicine (Pvt) Ltd. (SAITM) is in the process of initiating a new degree programme in Biosystems Engineering which includes mechanization related to Agro-processing (Ranamukaarachchi, 2015). There are many other private sector institutions offering higher education training in the country jointly with international universities as business ventures, but none of them are involved in capacity building in the Agriculture/Agricultural machinery sector.

In addition to the state universities governed by the UGC, there is a Defense University (KDU) which is governed by the Ministry of Defense but they do not offer any training related to Agricultural Engineering/Mechanization (http://www.ugc.ac.lk/).

One of the other state sector universities managed by the Department of Technical Education and Training under the purview of the Ministry of Youth Affairs and Skills Development offers degrees through the University of Vocational Technology (UNIVOTEC). This university is catering for the students going through the National Vocational Qualifications (NVQ) from, five university collages, 61 collages of technology and 680 technical collages established under the same ministry throughout the country (http://www.dtet.gov.lk/). Although, there are large number of vocational training institutions in the country, only one collage of technology located in Anuradhapura offers a degree qualifying NVQ level 5 'Farm Machinery Technology Diploma' for a group of about 20-25 per year. In addition, three newly established university collages at Kuliyapitiya, Jaffna and Ampara are also planning to offer the same programme in future. This is one of the best education system to satisfy the human resources needs in the machinery service sector as there is a good demand for Mechanics.

With respect to the research institutions in the country, all the state sector institutions are under the purview of five ministries, Ministry of Agriculture, Ministry of Plantation Industries, Ministry of Technology and Research, Ministry of Fisheries and Aquatic Resources Development and the Ministry of Livestock and Rural Community Development at present. However, majority of them are under three ministries. The four main plantation research institutions, Tea Research Institute, Coconut Research Institute, Rubber Research Institute and the Sugarcane Research Institute, are governed by the Ministry of Plantation Industries. Among these institutions, Tea Research Institute (TRI) and Sugarcane Research Institute (SRI) involve in research and training in mechanization aspects on field operations as well as harvesting and processing aspects. The Coconut Research Institution (CRI) is has limited research activities in mechanization aspects with respect to field operations but the institution has involved in processing machinery aspects. The Rubber Research Institute has limited research involvements related to the mechanization aspects except some involvements in processing machinery.

Under the preview of Ministry of Agriculture, there are two departments; Department of Agriculture and Department of Export Agriculture (Ministry of Agriculture, 2015). The Department of Agriculture plays a major role in agricultural machinery research and training. Food Research Unit (FRU) of the Department conducts research related to food processing and offers large number of trainings to entrepreneurs in food processing sector. They have some involvements with processing machinery manufactures on developing new machines for customer needs. The Farm Mechanization Research and Training Centre (FMRC) of the Department conducts research on processing machinery as well as farm machinery and it is the government authorized institution for testing and evaluation of farm machinery.

The Department of Export Agriculture manages two research stations; Central Research Station at Matale and Cinnamon Research Station at Pallolpitiya. Although there is little research on machinery related aspects at the Cinnamon Research Station, the Central Research Station has actively engaged in developing processing machinery for spice crops (http://www.agrimin.gov.lk/web/index.php/en/about-us-3).

In addition to the two above Departments under the Ministry of Agriculture, the Institute of Postharvest Technology (IPHT) and Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) are also directly governed by the Ministry of Agriculture. The IPHT conducts research and development related to postharvest and processing machinery and also involved in conducting large number of training programmes related to the mechanization aspects (http://www.agrimin.gov.lk/web/index.php/en/about-us-3). Hector Kobbekaduwa Agrarian Research and Training Institute (HARTI) has very much limited research involvements directly related to agricultural mechanization aspects except a joint study conducted in 1990-91 on a national farm machinery survey investigating the status and potential of farm mechanization in the country jointly with the PGIA and FMRC as a student research. They are more focused on the research on socio-economic aspects and livelihood development of the farming communities.

There are five other research institutions governed by the Ministry of Technology and Research (http://www.motr.gov.lk/web/images/document/subjects.pdf) but only two institutions; National Engineering Research and Development Centre (NERD) and the Industrial Technology Institute (ITI) are involved in Agricultural Engineering aspects and farm/processing related machinery research and development activities (http://nerdc.lk/). Engineering services unit under the Research and Development division of the Industrial Technology Institute (ITI) in Sri Lanka conducts machinery development contract research especially related to agro-processing machinery (food & fibre) (ITI, 2015).

National Aquatic Resources Research and Development Agency (NARA) is the research centre on aquatic products and it is under the purview of the Ministry of Fisheries and Aquatic Resources Development. However, this research institution involves very little in the agricultural engineering aspects except few fish processing machines like dryers (http://www.fisheries.gov.lk/content.php?cnid=intn, http://www.nara.ac.lk/).

The Veterinary Research Institute in Sri Lanka (VRI) is administrated by the Department of Animal Production and Health under the purview of the Ministry of Livestock and Rural Community Development. The institute is working on research on livestock, livestock product development and related waste management but has no engineering division to work on machinery or mechanization related aspects at present (http://www.vri.lk/home.php).

II. Department of Agricultural Engineering of the Faculty of Agriculture, University of Peradeniya - Specific Programme/Research Focuses on Agricultural Machinery and Mechanization

The University of Peradeniya is the oldest and the largest residential university having nine faculties in one location, four postgraduate institutions and nine centers with a undergraduate student population of about 32370 (12,870 internal and 19,500 external) and about 6,600 graduate students (University of Peradeniya, 2015) . The nine Faculties are Faculty of Agriculture, Faculty of Allied Health Sciences, Faculty of Arts, Faculty of Dental Sciences, Faculty of Engineering, Faculty of Management, Faculty of Medicine, Faculty of Science and Faculty of Veterinary Medicine & Animal Science. The specialty is that all the faculties are in the same location and none of the other universities in the country has this faculty combination so far. This is the main strength of the University especially for interdisciplinary research. The Faculty of Agriculture of the University of Peradeniya is the oldest faculty in the country and the Postgraduate Institute of Agriculture is serving as the postgraduate training arm of the Faculty of Agriculture. The Faculty is composed of eight Departments and the Department Agricultural Engineering established in 1973 (Faculty of Agriculture, 2008) is responsible for providing training on engineering technology required for agriculture. The Department offers general courses on farm machinery and mechanization for the core programme of the degree and a Majoring Module on "Agricultural & Biosystems Engineering". This includes teaching and practical training on agricultural machinery design, selection, operation and maintenance and special courses on postharvest and processing machinery. The Department has a collection of farm machinery; implements, harvesting machines etc. and about 10 ha farm in the close proximity for farm machinery testing and training purposes. In addition, students are also trained in the Farm Machinery Training Center (FMTC) and Farm Machinery Research Center (FMRC) of the Department of Agriculture. Further, experience in the agricultural machinery sector is given in leading farm machinery companies in the private sector for about two months as in-plant training. Student-industry interactions are

developed through invited presentations and discussion forums jointly with the private sector. Students are also involved in machine assembling, testing and evaluation, machinery needs assessment and post-sales consumer feedback surveys etc. under the private sector involvements during their holidays.

The Department plays a major role in graduate raining under the Postgraduate Institute of Agriculture (http://www.pgia.ac.lk/index.php) and offers masters to PhD degrees in 'Agricultural and Biosystems Engineering' which includes farm power and machinery as a thematic area. The teaching staff and other physical resources in many other institutions are integrated together to improve the quality of teaching and research programmes. The teaching staff includes mainly from the Department of Agricultural Engineering, University of Peradeniya but experts from Faculties of Engineering, other Faculties of Agriculture, Research Institutions, Department of Agriculture, and Independent Consultants/Visiting Professors etc. Some of the graduate researches on machinery are conducted jointly with the industries, with other universities, Department of Agriculture or any other machinery research institution in the country.

The Department of Agricultural Engineering has involved in a wide variety of machinery development work such as weeding machines, Paddy transplanters, seeders, threshers, cleaners, dryers for tea and other crops, milking machines, harvesting tools/machines etc. The Department was a member of the former Regional Network for Agricultural Machinery (RNAM), partner of the former GTZ assisted farm machinery development project of the FMRC of the Department of Agriculture, and currently represents the Sri Lanka Korea Rural Development Administration (an Alumni Association on mechanization), while the staff members serve in national level machinery policy formulations, research advisory boards of many other machinery development and mechanization related research and training institutions. The linkages between the Department of Agriculture and the Department of Agricultural Engineering on farm machinery related research and training are well established for a common goal.

The Department has engaged with international funding agents like, USAID, FAO, World Bank, International Development Research Centre (IDRC), GTZ, ODA, JICA since its establishment in 1973 and gained experiences of working with large number of international universities in the world on Research & Development activities in Agricultural Engineering related disciplines. At present, the Department has involved in research on a tea dryer, a portable paddy dryer, a milking machine, under national research grants.

III. The Need Assessment, Challenges and Constraints Faced by the Higher Education and Research Institutions for Human Resource Development of Agricultural Mechanization in Sri Lanka

Needs assessment for human resource development is a primary need for national planning in any specialized sector in higher education. Except for the professional career programmes like Medicine, Dental Science, Vet Medicine, Engineering, Allied Health Sciences, there is no exact idea about the need of human resources for the country. Therefore, needs assessment in the agricultural mechanization sector has a paramount importance in proper national level planning of the human resources development. Since such data is not available in the country, the higher education is demand driven. One of the main challenges faced by the higher education institutions on human resources development is the limited number of job opportunities available in this sector. With respect to the farm machinery research sector, although machines are developed locally, it is really difficult to produce them at a comparative price in comparison to the large scale manufactures in many other countries due to high cost of production. This is a main setback for the country as it is very small and the demand is so small. Therefore, the private sector involvement on machinery development is extremely limited and they prefer to import machines from other countries and maintain only training and services very few companies have their own research officers. Instead, the training on operation and maintenance of agricultural machinery has a big demand while the demand for testing and evaluation is also limited as the national Farm Machinery Act is not yet passed by the government.

IV. Suggestions for Regional Cooperation on Higher Education and Joint Research of Human Resource Development of Agricultural Mechanization

Education plays a major part in the life and culture of Sri Lanka and it has the highest literacy rate in South Asia and, one of the highest literacy rates in Asia mainly due to the free education provided up to the university level. Although we have many challenges on the scale of demand on agricultural machinery, being an agricultural based country, there is a very high potential for expanding higher education training in agricultural mechanization discipline, similar to other sectors in agriculture. To harvest the potential of human resources in the country, we should initiate research and training through a regional network on Agricultural Machinery Research and Development. The country will be able to develop new technological advances and train human resources

through sharing experiences and available technology the region. Specially, the technology developed could be transferred to large scale manufactures in the region through such a network. Further, initiation of joint research between countries where same technology could be used in the cluster through a research network will expand the opportunities for better outputs. This system would work on both technology development as well as identification of new technological needs of the countries in the regional network and share the experiences of the network partners as well.

V. Contributions from the Department of Agricultural Engineering, University of Peradeniya for such Regional Cooperation

The Department of Agricultural Engineering, Faculty of Agriculture of the University of Peradeniya has already established a network of other institutions working in the machinery sector in the country and it could function as a focal point/management body together with the Department of Agriculture. The Faculty of Agriculture also as a separate unit called Agriculture Education Unit (AEU) (http://agri.pdn.ac.lk/) for coordinating and facilitating this kind of educational and training programmes. A national core-group should be formed together with other universities, research institutions and private sector organizations to link up public-private partnership in addressing the technological issues in agricultural machinery sector. These national level management committees should be formed in all the partner countries and should be linked together to form the regional network.

Thailand

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R&D in agricultural mechanization, and agricultural bio-systems engineering in Thailand:

The Agricultural Engineering Research Institute (AERI) is an institute under the Department of Agriculture, Ministry of Agriculture and Cooperatives, whose mandates are as following:

- to conduct research and development on agricultural machinery and agricultural process,
- to providing technologies as well as technical services to government and private agencies involved,
- to conduct cooperative researches as well as to provide technical support to other agencies involves, and
- to provide services to other agencies of the Department of Agriculture.

Education

In Thailand, there are 22 universities that offer agricultural engineering or mechanization program.

Vietnam

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I. Overview of the Higher Education and Research Institutions that Offer Agricultural Engineering/Mechanization Programme, and their Programme Settings in Vietnam

During 60s and 70s of the 20th century, level of agricultural development in Vietnam at that time mainly focused on recovering and promoting cultivation with the main objective of solving food problem for the society. At that time, breeding under traditional technology, mainly breeding in the household were a supporting part of cultivation. Until the end of the 1970s, some pilot farms of raising pig and chicken with modest scale. Agricultural engineering training in this period was in service of mechanizing farm under Soviet-style by using large machines 50-80 HP (MTZ 50; MTZ 80) into production. In the early 1980s, Ministry of Agriculture suggested the Government to liquidate 50 poultry feed processing plants imported from socialist countries in the 1970s across the country. This was mostly derived from the reason that society didn't have the need yet. It is a testament that development needs of moderns agricultural production work were very strange to Vietnam agriculture at the time. After 10 hiring (1990), agricultural machinery in Vietnam mainly focused on small machines, manual labor due to fragmented paddy fields.

Since 1996, after the eighth Party Congress, industrialization of the country was set out as the focus of agricultural industrialization. Agricultural works due to foreign companies, or learnt by farmers from foreigner quickly developed on every region of the country, not only in cattle-breeding of livestock, poultry, aquatic products, but also in cultivation such as greenhouse, grid house and processing bases of agricultural products.

In such spontaneous development process, it was inevitable that the works themselves lack scientific nature; general layout of works in the same industry and coordination among the industries also lacked science. This led severe environmental pollution which does not only affects the existence of the works, but also affect living environment of social community.

The reason behind this is that when entering a period of comprehensive agricultural industrialization, the countryside lacked knowledge and technical force to master contents and the ability to perform agricultural industrialization. Therefore, pressing issue arises now is to train technical staff to guide farmers, help conduct the planning, design, implementation of industrial work with farmers in a scientific and sustainable way.

Because level of agriculture in Vietnam at present is still low, many difficulties will appear when entering the period of deep integration with the world; however, it cannot help taking over and selecting achievements of industrialization, modernization in agriculture of

the country going ahead to make industrialization, modernization in agriculture in Vietnam have ability to protect and survive.

Scientific level of agricultural works has now been applied with achievements of many fields of science in the late 20th century. Thus, in order to acquire the works which are suitable to Vietnam, the engineers are required to comprehensively understand basic things of relevant scientific fields which include : (1) basic things in the areas of basic science need to be understood include: Systems theory, systems of agriculture, agricultural works system: Environment of plant and animal biology; Plant and animal physiology; Microclimate plant and animal ; Physiology of post-harvest products; Plant and animal nutriology; Animal behavior; Plant and animal of physics. (2) Technical areas of expertise include: Planning, design for structures of plants and animals in nationwide and each eco-region; The work nature of agricultural raw materials; Mechanization of agriculture; Electrification of agriculture and electronic techniques in agriculture; Agricultural architecture and biological agricultural works; Pedology protection and science of water use; System of works for processing and preserving agricultural products; System of works for pollution treatment in the process of modernization, industrialization in agriculture, rural areas; Protection of agricultural environment and rural energy sources; Planning, layout agricultural works and population area.

Despite many content areas, some specialties have available designs, such as waste treatment facilities, some similar works of previous countries with available models; it is just know how to select improvements to suit local conditions.

Only one field Vietnam must find ways to resolve called planning, design for structures of plants and animals in the industrialized period taking into account climate change and deep integration of world markets since it is entirely new.

This type of engineer can be named agricultural engineer with the missions of serving agriculture, rural areas under basic tasks including basing on technology of agricultural products production and processing , agricultural ecological protection, planning research, architectural design and selection of equipment for agricultural buildings, use and management of machinery and equipment: research for designing agricultural environment and natural resource protection works, insurance for sustainable development of agriculture.

However, agricultural engineer is not almighty. In order to implement such tasks, they must work closely with farmers, irrigation engineers, mechanical engineers, electronic engineers, chemical engineers, physicists, economists, sociologist...

They are required to have broad knowledge of the basic fields aforementioned such as plant and animal physiology, soil, water, and environment; at the same time master the theory and method of systems analysis.

Especially agricultural system is the synthesis of three systems: biological system, environmental system and economic system. The three systems are fluctuating over time; so they make it difficult and complex for processing and analysis.

The science of agricultural works is in the field of applied science but it shows its fluctuation because being dependent on factors related to biology, environment and economy; therefore, results of the design research should be tested to perfect new models before being launched universally, even though the treatment process has been applied to computer using simulation method and analysis modern physics method.

The process of expanding and improving must be always attached to the achievements of basic science areas and underlying fields to adjust the design, and improve through practices. This is the development process of agriculture and also the development of industrialized agriculture. In recent years, Vietnam has been implementing land consolidation, large rice paddies ... focusing on developing medium-sized machine 24-35 HP. At present, airplanes of China, Japan have been imported significantly into Vietnam.

With this situation, training program in agricultural engineering in Vietnam has caught up with real demands of practicality. Training product is agricultural mechanical engineers who can:

- Work in factories, design workshops, manufactures machinery and equipment for food processing and preservation;
- Repair, maintain and operate technological lines, machines and equipment in the factories, food manufacturing enterprises;
- Work in business and transfer technological processes and equipment of food processing; consult, design and construct the factories install machinery, equipment.
- Involved in researching and teaching in the institutes and research centers, universities, colleges, professional secondary school in the field of mechanical engineering.
- Working in the State administration agencies

Perform training under applied career orientation: engineers can

operate, maintain, repair, replace, manufacture, associated with the practice.

Applied research today is small and medium-sized machine associated with the demand of reality.

II. Briefing of Vietnam National University of Agriculture (VNUA) and Specific Programmes/ Research Focuses

In Vietnam, there are 2 faculties that train the agricultural mechanics resources. The first one belongs to Vietnam National University of Agriculture (VNUA), the second one, has been separated from VNUA since 1976, belongs to Forestry University in Ho Chi Minh City. The situation of training agricultural mechanics resources is the same, so VNUA will be represented to introduce here.

About Vietnam National University of Agriculture (VNUA)

Vietnam National University of Agriculture is formerly Vietnam National University of Agriculture, abbreviated VNUA) is a university specialized in agriculture located in Trau Quy town, Gia Lam district, Hanoi suburb and 12km away from the center of Hanoi.

The University has 14 faculties, 9 departments, 13 institutes and centers with 29 graduate programs and 24 postgraduate programs. Faculty of mechanical and electrical engineering is one of 14 faculties specializing in Agricultural mechanical engineering. Total number of students of Faculty is 649 students.

There are 69 staff members including 7 Associate Professors, 18 Doctors, 30 Masters, 17 engineers and bachelors, 7 technicians and 1 technical staff. Staffs involving in research of the faculty are trained in the field of agricultural engineering, mechanics engineering, mechanical aerodynamic, mechanical maintenance and processing of agricultural products, rural area, industrial automation, electrical systems. The field of research focuses on agricultural mechanical engineering and post-harvest technology, mechanization of production, preservation and processing of agricultural products.

Almost the staffs are actively involved in scientific research; however, due to limited funding and facilities, about 60% of officers have been involving in research topics from the Ministry over, 30% of officers have been taking subject at grassroots, guiding student in Science research, Seminar, and only about 10% of officers are not participating in science research.

Number of admissions of agricultural mechanical engineering in the past 10 years (table 1)

Table 1. Admission Situation of Agricultural Mechanical Engineering Sector at All Level in Vietnam National University of Agriculture from 2006-2015.

Year	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
University	160	206	51	115	100	96	114	150	176	135
Master'	7	8	9	12	14	15	12	14	11	2
Doctor	1	0	1	1	0	2	2	1	1	1

General research orientations of the faculty include:

- Study to design, newly manufacture and improve existing machinery, equipment for the purpose of

serving mechanization of land cultivation, sewing, care and harvest. Particularly focus on mechanization of rice production and a few crops of corn, cassava, sugar cane, shallow tea, soybean, peanut;
- Study technology and equipment for storage and processing of agricultural products, food (paying attention to fine and deep processing of potential products and vegetables): rice, tapioca, arrowroot, potatoes, sweet potatoes, pineapple, litchi, longan, citrus, sprouts, leaf vegetables, tea, honey, meat, shrimp and sea fish;
- Technology and equipment system for processing of animal feed aquaculture; mechanized equipment for farms, slaughter and preservation of livestock products and aquatic products;
- Technology and equipment for processing of by-products of agricultural, forestry and aquatic products to create animal feed, feed mill, fuel and fertilizer;
- Study, perfect and develop advanced systems that serve high-tech agricultural house;
- Apply electric engineering and automation in the agricultural production and storage, processing of agricultural products;
- New and renewable energy, make use of agricultural by-products to generate power;
- Transfer technology and equipment serving for agricultural production and storage and processing of agricultural products;

Training Staff, Technicians and Upgrade the Laboratories.

- Enhance training for staffs, especially young staff: encourage the staffs to participate in short-term training programs, learn MA, and become research student in developed countries or prestigious training establishments in the country.
- Search funding sources of training technicians to make them become skilled and able to deploy research idea.
- Find funds to build 02 key laboratories: Laboratory of machine-building and Laboratory of mechanical and electrical engineering measurement combined with training of technical team using equipment of these laboratories.

Orient Cooperation in Scientific and Technological Research

Domestic cooperation:

- Promote scientific research in movement through research project at levels, seminars, guiding of students in science research.
- Promote cooperation in scientific research between subjects in the faculty, among the faculties; Build multidisciplinary research teams; inter majors to be able to solve many problems of society.
- Promote research cooperation with research institutions, enterprises and business establishments of agricultural equipment to design, manufacture and market research results.
- Cooperate with local regions to capture the need for mechanization, automation of agricultural production, technology and equipment transfer or participate in research projects on demand.

International cooperation:

- Promote research cooperation with universities, research institutes of the countries all over world and special areas such as Japan, China, South Korea, Thailand, and Bulgaria.
- Learn experiences in the introduction of mechanization, automation to agricultural production and market research products.

In terms of the training program in agricultural engineering at Vietnam National University of Agriculture:

Require general capacity of the training program:

- Communicate with professionals, leaders, people who use mechanical equipment and use English in communication.
- Understand social problems, the law of the State.
- Plan and solve expertise problems independently or in a group, showing leadership abilities.
- Design, manufacture products of machinery, food equipment to meet the market demand and applications in machine design.
- Repair, maintenance and operate food machinery
- Transfer technology, technical advances and new food machinery into production.
- Detect problems, develop scientific research activities, and apply information of processing research results in the expertise field.

Profession after graduation:

- Mechanical engineer working in factories, design workshops, manufacturing machinery and equipment for food processing and preservation;
- Mechanical engineer in charge of repair, maintenance, and operation of technological lines, machines and equipment in factories, food manufacturing enterprises;
- Mechanical engineers working in the business and transfer technological processes and equipment of food processing; consult, design and construct the factories install machinery, food equipment.
- Involve in researching and teaching in the institutes and research

centers, universities, colleges, professional secondary school in the field of mechanical engineering.
- Mechanical engineers working in the State administration agencies

III. The Need Assessment, Challenges and Constraints Faced of the Higher Education and Research Institutions for Human Resource Development of Agricultural Mechanization in Vietnam

In recent years, putting machinery in agricultural production has contributed to the liberation of labor power of farmers. Besides, yield, crop quality have been enhanced, income of the households of agricultural production is also improved. However, level of putting mechanism into agricultural production of our country remains modest and the mechanization process is still experiencing difficulties.

- The State's investment in recent years has been modest without paying more attention agricultural engineering, supporting policies of the State in mechanization programs of agricultural production mechanism show many inadequacies. Although the State has supported policies in term of interest rates to purchase machinery and equipment for agricultural production; in fact the access support is not simple. Loan procedure is also cumbersome with many steps from loan records to equipment and machine purchasing records. As a result, people are not eager to this issue.
- Local propaganda to farmers to make them realize positive effects of the mechanization of agricultural production is still limited. Support of the province in the application of mechanization in agriculture is insignificant.
- Cultivated land remains fragmented. Although many localities have directed drastically land consolidation, the results obtained are still not high. There still have been fragmented plots with complex terrain making it difficult to put machines into production.
- Life of farmers is also poor. Income from agriculture is still low; therefore, entirely new investment in mechanized equipment with 100% of capital of the farmer is very limited. Meanwhile, capital recovery is slow making farmer have without the capital to invest.
- Cultivation customs of farmers are difficult to change. The application of equipment into the production requires farmers to have intensive level of vertical expansion together with willingness to change cultivation customs.
- Market supplying devices, mechanization equipment of agricultural production are limited in number and type. Price of such equipment is high with uneven quality. The use of machinery in farmers is not yet synchronized. Today, the use of mechanization in agriculture is mainly based on experience, habits, without intensive training, guidelines in terms of technical operation, maintenance. Consequently, farmers encounter many problems in the treatment process. Machine-building technology of Vietnam is still poor and the products do not meet requirements. Competition of agricultural machines in China, Japan, and Thailand makes domestic production limited.
- Human resources development is limited since agricultural engineering students find it hard to seek work while salary is low.

To promote the mechanization of agricultural production, in addition to policies of the State, the local region should continue to implement the planning of cultivated land vigorously. At the same time, propaganda should be conducted effectively to make people realize its effectiveness and actively implement land consolidation which creates favorable conditions to put machines into production. Functional sectors focus on opening the training techniques of cultivation, maintenance, using agricultural machinery in order to ensure productivity and reduce post-harvest loss rate. Besides, it is necessary to have mechanism for farmers to be applied scientific research results into production practices.

IV. Suggestions for Regional Cooperation on Higher Education and Joint Research of Human Resource Development of Agricultural Mechanization

- It is required to have information to investigate the needs of human resources in agricultural engineering, agricultural production to cooperate, share information, coordinate the investigation
- Countries in the region should cooperate in training (basic study in Vietnam and then continue further studies and internships abroad).
- Study to find appropriate learning models for students.
- Conduct research cooperation of high technology application in agriculture

Contributions from VNUA for such Regional Cooperation

- Appoint officers and students to participate in the workshops to research problems of the countries in the region.
- Organize scientific conferences, share technical expertise information and new research methods.

Photoed by Si Min

ANNEX 1:
Programme of the 3rd Regional Forum

3RD REGIONAL FORUM ON AGRICULTURAL MECHANIZATION IN ASIA AND THE PACIFIC

December 9-11, 2015

Century Park Hotel, Manila

Time	Activity	Location
	Tuesday, 8th December	
08:00-20:00	Arrival and Registration of Delegates	Century Park Hotel
	Wednesday, 9th December	
05:00-08:00	Ingress/ Setting up of Exhibits	Grand Ball Room Lobby
07:00-08:45	Continuation of Registration of Delegates	
08:45-09:15	Cutting of the Ribbon and Opening and Viewing of the Exhibits	Grand Ball Room, Lobby
09:15-10:30	OPENING CEREMONIES a. Entrance of Colors b. Ecumenical Prayer & Singing of National Anthem c. Presentation of Delegates **Engr. Genaro M. Tolentino** *President, Philippine Society of Agricultural Engineers* d. Welcome Remarks **Engr. Ariel T. Cayanan** *Executive Director, Philippine Council for Agriculture and Fisheries* **Hon. Jesus S. Domingo** *Assistant Secretary, United Nations and Other International Organizations, Philippine Department of Foreign Affairs* e. Messages from the Organizing/Host Institutions **Mr. Zhao Bing** *Head, Center for Sustainable Agricultural Mechanization, UNESCAP* **Mr. Aura C. Matias** *Program Leader, Engineering Research and Development for Technology (ERDT), University of the Philippines* **Hon. Angeline T. Chua Chiaco** *Acting Chairperson, Professional Regulation Commission* **Hon. Proceso J. Alcala** *Secretary, Philippine Department of Agriculture Chairman, ASEAN Ministers for Agriculture andvForestry* f. ntroduction of Keynote Speakers **Ms. Rossana Marie Amongo** *Director and Program Coordinator, AMDP-BIOMECH, IAE, CEAT-UPLB* **Engr. Juana T. Tapel** *Member, Board of Agricultural Engineering, PRC* **Engr. Francia M. Macalintal** *Philippine Council for Agriculture and Fisheries* g. Keynote Messages **Mr. Marc Proksch** *Chief, Business and Development Section, Trade and Investment Division, United Nations Economic and Social Commission for Asia and the Pacific* **Ms. Cynthia A. Villar** *Senator and Chairperson, Committee on Agriculture and Food Senate of the Philippines* **Mr. Jose Luis Fernandez** *FAO Representative in Philippines, Food and Agriculture Organization of the United Nations* h. Declaration of the Formal Opening of the Conferences **Mr. Ariodear C. Rico,** *Chairman, Board of Agricultural Engineering and Chairman, ASEAN Agricultural and Biosystems*	Grand Ball Room

10:30-11:30	PLENARY PRESENTATIONS/KEYNOTE SPEECHES FROM INTERNATIONAL ORGANIZATIONS (15 TO 20 MINUTES) ***a. ADB -*** Mr. Guntur Sugiyarto Senior Economist, Development Economics and Indicators Division, Economics Research and Regional Cooperation Division, Asian Development Bank, Manila - "Achieving Skill Mobility in the ASEAN Economic Community, and in the Asia and the Pacific" ***b. ASEAN –*** Mr. Ariodear C. Rico Chairman, Board of Agricultural Engineering Professional Regulation Commission and Chairman, ASEAN Agricultural and Bioystems Engineering Coordinating Committee - "The ASEAN Agricultural and Bioystems Engineering Cooperation Framework in support to ASEAN Food Security and Sustainable Agricultural Mechanization in Asia and the Pacific" ***c. IRRI- Mr.*** James Quilt Mechanization Specialist, International Rice Research Institute, Manila, Philippines – "Sustainable Mechanization in Rice Research and Rice Agri-food Systems" ***d. WB - Mr.*** Farbod Youssefi Program Manager, Enabling the Business of Agriculture (EBA) Project, World Bank Group - "Enabling the Business of Agriculture – Benchmarking regulatory good practices"	Ball Room
11:30-12:00	Open Forum Master of Ceremonies- Mr. Rodolfo Estigoy (PhilMech) Engr. Cristy Polido (DA-CAFED)	Ball Room
12:00-13:00	Lunch Break	
13:00-16:30	PLENARY PRESENTATIONS/KEYNOTE SPEECHES FROM ACADEMIC AND STAKEHOLDERS IN MEMBER COUNTRIES (15-20 MINUTES) e. PAKISTAN – ***Mr. Nadeem Amjad*** Chairman, Pakistan Agricultural Research Council -"Human Resource Development of Agricultural Mechanization in Pakistan (Tentative)" f. PHILIPPINES- ***Ms. Irene Isaac*** Director General, Technical Education and Skills Development Authority, Philippines - "Establishing Cooperation on Training and Vocational Education (TVET) Program on Agricultural Mechanization in the Asia and the Pacific" g. SRI LANKA - ***Mr. Nandasiri Ratnayake Mudiyanselage*** Additional Director General (Development), Department of Agriculture – "Human Resource Development in Sri Lanka, Issues and Trends" h. CHINA– ***Mr. Chang Zhouwei*** Overseas Key Account Director, Zoomlion Heavy Machinery - "Human Resource Development in the Process of Agricultural Machinery Operation Services"	
16:00-16:30	Open Forum	
16:30-17:30	PANEL DISCUSSION Facilitator/Moderator: **Mr. Zhao Bing,** CSAM The cooperation actions and mechanisms on human resource development for sustainable agricultural mechanization at the national and regional level, and among different stakeholders	Ball Room

18:30-22:00	**Welcome Dinner and Fellowship Night** Introduction of the Guest of Honor- **Hon. Yolanda D. Reyes** *Commissioner, PRC* **Guest of Honor: Hon. Rosalinda Dimapilis-Baldoz,** *Secretary, Department of Labor and Employment* Cultural Presentations: **UPLB Filipiniana Dance Troupe**	Ball Room
	Thursday, 10th December	
Time	**Activity**	**Location**
08:00-12:00	**COUNTRY PRESENTATIONS**	Ball Room A
	SESSION 1: Policy and status briefing of human resource development of agricultural mechanization by government officials of member countries a. BANGLADESH – **Mr. Sultan Ahmmed** *Director Member (NRM), Bangladesh Agricultural Research Council (BARC)* b. CAMBODIA – **Mr. Saruth Chan** *Director, Department of Agricultural Engineering, General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries* c. CHINA – **Mr. Lu Yubin** *Deputy Division Director, Department of Agricultural Mechanization, Ministry of Agriculture* d. FIJI – **Mr. Ratu Penaia Vosawai** *Senior Research Officer, Ministry of Agriculture* e. INDIA – **Mr. Krishna Kumar Singh** *Director, Central Institute of Agricultural Engineering* f. INDONESIA – **Mr. Astu Unadi** *Director, Indonesian Center for Agricultural Engineering Research and Development (ICAERD)* g. LAO PDR – **Mr. Phatnakhone Khanthamixay** *Deputy Head, Division of Agricultural Technique and Mechanization Promotion, Department of Agricultural Extension and Cooperatives, Ministry of Agriculture and Forestry* h. NEPAL – **Mr. Madhusudan Singh Basnyat** *Officiating Program Director, Directorate of Agricultural Engineering, Department of Agriculture, Ministry of Agriculture Development* i. PAKISTAN – **Mr. Munir Ahmad** *Director General, Agricultural Engineering Division, Pakistan Agricultural Research Council (PARC)* j. PHILIPPINES – **Mr. Ariodear C. Rico** *Chairman, Board of Agricultural Engineering Professional Regulation Commission and Chairman, ASEAN Agricultural and Bioystems Engineering Coordinating Committee* k. SRI LANKA – **Mr. M.H.M.A. Bandara** *Chief Engineer, Department of Agriculture* l. THAILAND – **Ms. Dares Kittiyopas** *President, Thai Society of Agricultural Engineering Director, Agricultural Engineering Promotion Division Department of Agricultural Extension Ministry of Agriculture and Cooperatives* m. VIETNAM – **Mr. Nguyen Duc Long** *Head, Department of Science, Training and International Cooperation* *Vietnam Institute of Agricultural Engineering and Postharvest Technology (VIAEPT)*	

08:00-12:00	**SESSION 2:** Education and research briefing of agricultural mechanization, and agricultural and biosystems engineering in member countries a. BANGLADESH – **Mr. M A Matin** *Director General (In-charge), Rural Development Academy (RDA)* b. CAMBODIA - **Mr. Lytour Lor** *Acting Dean, Faculty of Agricultural Engineering, Royal University of Agriculture* c. CHINA – **Mr. Cao Guangqiao** *Deputy Director, Nanjing Research Institute for Agricultural Mechanization, Ministry of Agriculture* d. CHINA – **Mr. Ma Teng** *Director Assistant, Chinese Academy of Agricultural Mechanization Sciences (CAAMS)* e. INDIA –**Mr. Surendrakumar Allimuthu** *Professor (Farm Machinery), Tamil Nadu Agricultural University* f. INDONESIA – **Mr. Lilik Sutiarso** *Dean, Agricultural Engineering Faculty, Gadjah Mada University* g. MALAYSIA – **Mr. Md. Hamid Akhir** *Research Officer, Malaysian Agricultural Research and Development Institute (MARDI), Ministry of Agriculture* h. NEPAL – **Mr. Yam Kumar Rai** *Programme Coordinator, I.O.E. Purwanchal Campus Institute of Engineering, Tribhuwan University* i. PAKISTAN – **Mr. Tanveer Ahmad** *Director, Director/Principal Engineer, Agricultural and Biological Engineering Institute, National Agricultural Research Centre (NARC), Pakistan Agricultural Research Council (PARC)* j. PHILIPPINES - **Ms. Rossana Marie C. Amongo** *Director, Institute of Agricultural Engineering and Program Coordinator, Agricultural Mechanization Development Program (AMDP) now Center of Agri-Fisheries and Biosystems Mechanization (BIOMECH), College of Engineering & Agro-industrial Technology, University of the Philippines Los Baños* k. REPUBLIC OF KOREA – **Mr. Jehoon Sung** *Agricultural Engineering Planning Team Leader, National Institute of Agricultural Science* l. RUSSIA – **Mr. Viacheslav Pronin** *President Assistant, Expert of Standardization Russian Association of Agricultural Machinery Manufacturers* m. SRI LANKA – **Mr. Nimal Dharmasena Dunu Arachchige** *Head, Department of Agricultural Engineering Faculty of Agriculture, University of Peradeniya* n. THAILAND – **Mr. Viboon Thepent** *Director, Postharvest Engineering Research Group Agricultural Engineering Research Institute, Department of Agriculture* o. VIETNAM – **Mr. Bui Tran Anh Dao** *Director, Training Management Office, Vietnam National University of Agriculture*	Ball Room B

12:00-13:00	LUNCH BREAK	
18:30-20:00	Fellowship Dinner CSAM Delegates Sponsored by: UPLB-AMDP-BIOMECH	Katchina
Friday, 11th December		
Time	**Activities/Institutions**	
06:00-06:30	Assembly/Departure from Hotel	
09:00-10:15	Philippine Rice Research Institute (PHilRice), Maligaya, Maligaya, Nueva Ecija	
10:45-11:45	Philippine Sino-Center for Agricultural Technology (PhilSCAT), Science City of Muñoz, Nueva Ecija	
11:55-13:45	Philippine Center for Postharvest Development and Mechanization (PHilMech), Science City of Muñoz, Nueva Ecija	
15:15-16:15	Supert Trade Machinery Global, Inc. -leading distributor of agricultural machinery – Assembly Plant, Sta. Rita, Bulacan	
16:15-18:15	Travel back to Manila	
18:15-20:00	Farewell Dinner c/o CSAM- Century Park Hotel (Katchina)	

ANNEX 2: Participants List

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