Regional Training on Appropriate Scale Mechanisation for Conservation Agriculture

Siem Reap & Bos Khnor, Cambodia
6th to 9th May 2019

swisscontact

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

CSAM

cirad

List of Abbreviations:

ALiSEA	Agroecology Learning Alliance in South East Asia
ASEAN	Association of Southeast Asian Nations
CA	Conservation Agriculture
CANSEA	Conservation Agriculture Network for South-East Asia
CARDI	Cambodian Agricultural Research and Development Institute
CASC	Conservation Agriculture Service Centre
CASF	Conservation Agriculture Service with a Fee (Project)
CIMMYT	International Maize and Wheat Improvement Center
CIRAD	French Agricultural Research Centre for International Development
CSAM	Centre for Sustainable Agricultural Mechanization
ESCAP	United Nations Economic and Social Commission for Asia and the Pacific
DAEng	Department of Agricultural Engineering
DALRM	Department of Agricultural Land Resources Management
GDA	General Directorate of Agriculture
GST	Good and Sale Tax
LICA	The Lao facilitated ASEAN initiative on Agroecology
MAFF	Ministry of Agriculture, Forestry, and Fisheries
MIGIP	Mekong Inclusive Growth and Innovation Program

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1. About the Training

The Regional Training on Appropriate Scale Mechanisation for Conservation Agriculture was held on May 6-9, 2019 in Siem Reap and Bos Khnor, Cambodia. The training was jointly organized by the General Directorate of Agriculture (GDA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF), Cambodia, and the Centre for Sustainable Agricultural Mechanization of the United Nations Economic and Social Commission for Asia and the Pacific (CSAM-ESCAP), the Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD) and Swisscontact.

The training was co-funded by GDA/MAFF, CSAM, CIMMYT, Centre of Excellence on Sustainable Agricultural Intensification and Nutrition (CE SAIN), Appropriate-Scale Mechanization Consortium (ASMC) of the Feed the Future Innovation Labs for Collaborative Research on Sustainable Intensification (SIIL) funded by USAID, Towards Agroecological Transition in South-East Asia (ACTAE) funded by the French Agency for Development (AFD), the Conservation Agriculture Network for South-East Asia (CANSEA), Mekong Inclusive Growth and Innovation Program (MIGIP) funded by the Swiss Agency for Development and Cooperation (SDC).

2. Objective

The objectives of the training were:

- To understand the mechanisation aspect for conservation agriculture
- To understand the importance of market systems analysis and the engagement with the private sector
- To understand the policy issues favouring appropriate-scale mechanisation for conservation agriculture
- To identify needs for future training that can be offered by the Bos Khnor Research Station.

3. Training Organization

The training was attended by over 37 participants from 17 countries including Azerbaijan, Bangladesh, Cambodia, China, France, India, Laos, Malaysia, Mongolia, Nepal, Pakistan, Philippines, South Korea, Russia, Sri Lanka, Thailand and Vietnam. Seventeen national and international trainers, all experts in their field, facilitated the training sessions regarding conservation agriculture for the 4-day training sessions.

During the 4 days training, the participants greatly benefitted from 17 presentations from different trainers and two demonstration sessions at Bos Khnor research station.

3.1 Training Content

Various topics were covered during the training.

3.1.1 Policy Issue on Sustainable Agricultural Mechanisation

Five countries with Lao PDR, China, India, Pakistan and Cambodia, presented the current situation of mechanisation of their respective countries. The Lao PDR presentation gave an overview of the country agriculture sector, mechanisation trend and insight on the government policy that supports sustainable agricultural mechanisation. In addition, highlight was given to the Lao facilitated ASEAN Initiative on Conservation Agriculture and Agroecology (LICA), which held its first meeting in 2016. LICA's aim is to provide ASEAN experts and decision-makers with inputs that will feed into the design of an ASEAN position on agroecology and to identify the *ad-hoc* policy tools and mechanisms to support agroecology transition in ASEAN. After the presentation, participants expressed their wishes to understand more about LICA and some information is available on ALISEA website (https://ali-sea.org/).

The presentation of China provided insights into Chinese government support to promote sustainable agricultural mechanisation which includes promoting the progress in agriculture mechanisation, raising utilisation rate of agriculture machinery and perfecting agricultural machinery service system. Close to its conclusion, the presentation informed about 4 different CA mechanisation interventions that are being used in China. They relate to straw returning, surface tillage, no or minimum tillage, and mechanical subsoiling. During the discussions, participants wondered how other countries can select and/or sort appropriate scale machinery from China, since there are so many machineries from so different mechanisation companies. The suggestion to tackle this difficulty was to develop a database, which would easily help make decisions during purchasing of the machinery.

The presentation from India gave an idea of the national policy that pushed the uptake of technology from 20% in 1990 to 40% in 2019. The policy introduced by the Indian government included subsidy on different agricultural machineries, rebate on agricultural loan, introduction of new crop to deal with end-user needs, and promotion of new sustainable practice like CA. Currently, the total land that is covered by CA technology in India amount to around 1.5 million hectares with different machineries such as Happy Seeder, Zero Till Drill, Bed Planters, etc.

There were other several national policy measures and implementing strategies presented that helped to push the uptake of technology in Pakistan, which includes the reduction of importing tax and reduction of Goods and Sale Tax (GST), promotion of innovative practice that increase yield, etc.

The last presentation was from Cambodia. The presentation showcased four strategic objectives which include enabling access to

mechanisation, develop broad-based skills and strengthen capacity in agricultural mechanisation, commercialisation of agriculture through mechanised farming, and improving policy, legal and regulatory environment for agricultural mechanisation.

Overall, the session reviewed national experience with a range of policy interventions for enabling sustainable agricultural mechanization including the outcomes and the challenges faced. It was also stressed that policy formulation and implementation is an iterative process rather than a linear one and learning and feedback need to be constantly fed back into the process in order to achieve the desired impact.

3.1.2 Understanding Mechanisation for Conservation Agriculture

This session explained the obstacles surrounding low uptake in technology and the important role of Research for Development (R4D) to help overcome it. Low uptake in technology can be traced back to two contributing factors, internal and external. Internal factors refer to age, education and capital, etc., and the external factors are technology transfer, demonstration, tangible result, etc. With the understanding of these constraints, agriculture companies can develop a proper market segmentation tool to overcome internal factor, while R4D teams can conduct demonstration of the new technology to show tangible result and build trust out of the result in which will overcome the external factor.

In the discussion session, the group was divided to discuss the challenges that they face in their home country regarding the uptake of technology, as well as the importance of a training on "how to overcome low technology uptake for R4D?" and its appropriate trainees. The participants were divided into 7 different groups to discuss the topic provided by the trainer. After the group session, a few key challenges were presented by each group such as lack of knowledge on Conservation Agriculture, low level of skill/knowledge to overcome the market constraints, lack of supportive voice from the policy makers, low support on the transition to new technology, youth migration, climate change, lack of support from the government to ensure the product quality of the private sector.

All the participants agreed that training on "how to overcome low technology uptake for R4D?" is very important. The appropriate trainees that should be invited to this training would be the pool of experts from the development sector market actors (manufacturers, importers, workshop owners, etc.), and policy makers.

3.1.3 Understanding Systematic Constraint and Business Model

This session focused on the way to overcome market system constraint and introduce a proper working business model to private sector partners. The presentation identified three steps to overcome market system constraint. Step one is to understand market actors and market dynamics, then draw out an updated market map with all the supporting functions and regulations. Step two is to analyse the service weakness within the market map, then provide a solution to the service weakness through the vision of change. The last step is to identify potential private sector to partner with, then propose a business model that will overcome the service weakness within the market. As market system is unpredictable, activities must adapt to change through course correction measures.

During this training, the selection of appropriate machinery for the commercialization of CA in Cambodia was among the key areas of deliberation. Participants exchanged views on which brand/country machinery can be considered as appropriate for smallholder farmers. In summary, it was opined that the selection of appropriate machinery should not be based on brand, but instead the needs and preference of the farmers.

3.1.4 Introduction to CA and Linkages to Climate Resilience

This session gave an introduction to CA and Sustainable Intensification and emphasized the need to invest in soil health, the main tools (i.e., genetic plant diversity and appropriate-scale mechanization) that can be used to sustain soil fertility, improve productivity and to adapt farming system to climate variability and changes. Examples were taken from Cambodia but also from temperate countries (France, Canada) to highlight that the principles are the same whatever the agroecosystem. During this session, participants were curious about the history of CA in Cambodia. The CA research for development in Cambodia started in 2004 in Kampong Cham as the first province where activities where implemented. Recently, the Feed the Future Innovation Lab came with a scale up project called Conservation Agriculture Service with a Fee (CASF) bringing together a range of partners (RUA, CE SAIN, DAEng, DALRM/CASC, CIRAD) with among them Swisscontact and the Mekong Inclusive Growth and Innovation Program (MIGIP). Swisscontact brought its expertise engaging the private sector (manufacturer and local service providers) into a transition to CA and Sustainable Intensification. The scale up project is to engage with private sectors to bring CA machinery to Cambodia and push for commercial activities of CA planting/sowing service for the future sustainability. Participants believed that the principle of CA should not stick to just three (i.e., minimum soil disturbance, permanent soil cover and diversification) as there are many different countries practicing differently.

3.1.5 Appropriate scale Mechanisation and Conservation Agriculture

This session shared case studies on appropriate scale mechanisation and conservation agriculture from Cambodia, China, India and West Indies. The case study from Cambodia showed the benefit of CA in yielding rates, profit increase and soil health improvement for rice farmers. In the case study from West Indies, appropriate scale mechanisation was able to drive the transition from chemical-based to organic-based practices. Case study from China provided the CA mechanisation options based on their experience. And lastly, CIMMYT presented about their exciting work and provided the case study in India of how enabling policy helped push CA practice to nearly around 800,000 ha in Punjab. All the case studies from different countries presented the diversity of CA implements as well. After the training session, the participants were curious about the enabling policy in India that pushed the CA practice. Policy makers and scientists met to discuss solutions for sustainable agricultural practice. After several events and discussion of science-based evidence the policy makers were convinced that CA is a way forward to sustainable agriculture in India. The government came back with a policy that provides $100 million in subsidy to farmers, where each farmer gets up to 50% discount from purchasing a seeder.

Figure 1: Demonstration of rice no-till seeder developed by the Department of Agricultural Engineering through the project Appropriate-scale Mechanization Consortium (ASMC)

3.2 Purpose of the Training and demonstration at Bos Khnor

The purpose of this training was to sensitize the participants on the various trainings that can be offered in the field of Conservation Agriculture. It also served as a platform to gauge the interest of the various members. The content of the 2020 training in Bos Khnor is presented in Annex 5 and the content will be updated as the training offers will be finalized in December 2019.

3.2.1 Demonstration of machineries

A range of agricultural equipment was demonstrated with no-till planter (maize, pulse crops, sorghum, sunflower) and roller crimper, cassava no-till planter, rice seeder, seed and fertilizer broadcaster, and A-Click roller crimper and seeder. Three main stops were organized for the participant to have enough time to follow each demonstration and interact on benefits and challenges of each equipment.

Figure 2: Demonstration of cassava no-till planter by the Department of Agricultural Land Resources Management and the Conservation Agriculture Service Center

Figure 3: Demonstration of roller crimper, no-till planter and seed broadcaster by the Department of Agricultural Land Resources Management and the Conservation Agriculture Service Center

Figure 4: Demonstration of the A-Click by the Faculty of Agricultural Engineering of the Royal University of Agriculture, Mr. Horace Clemmons and Dr. Manny Reyes from Kansas State University

3.2.2 Impacts of contrasted land use on soil profile, SOM and soil structure

The objective of this session was to raise awareness about the negative impacts of plough-based management on soil fertility, the need for alternatives and the positive impacts of CA-based cropping systems with use of cover crops on soil functions and soil ecosystem services.

3.2.2.1 Soil profile

Three soil pits were opened up to 2-m deep with one pit under plough-based management, one pit under a mix of cover crops (sorghum + juncea + cowpea, 7 months after sowing) that was sown in September after an early maize, and one pit under a pastureland of Mullato 2 sown in June 2018 (10 months old at the date of the training). Topsoil layer disrupted under plough-based with a slightly hard pan observed at 20-cm depth. Under the mix of annual cover crops only the sorghum was still green in May 2019 and fine roots were observed at 2-m deep. Positive impacts of the cover crops to re-create the soil aggregation on the top soil, to protect the soil, save/retain water and explore deeper soil horizons. Beneficial role of roots on soil structure, aggregation, water

Figure 5: Soil pit under plough-based management

infiltration, nutrient cycling, soil biota and SOC. This diversity of roots represents also a diversity of root exudates with positive impacts on soil biota, soil aggregation, flow of labile-C and soil organic carbon accumulation. The pasture of *B. mullato* exhibited a dense and deep root systems below 2-m deep emphasizing the impact of such specie on soil structure, nutrient cycling and even C cycle with the root exudates that area released into the soil profile. This soil pit is a good example of what should be approached with annual cropping systems where mix of cover crops should be used to improve soil functions and soil ecosystem services. Study that will be published in the coming weeks in Soil & Tillage Research highlighted that water infiltration rate was two times higher under CA-based cropping systems (140 mm/h) when compared with plough-based management (75 mm/h). Additional studies should be carried-out both under experiment trials and on-farm for a range of CA-based cropping systems and conventional management to highlight the positive impact on water and nutrient management that are the main pillars of an adaptation process for rainfed small-scale farming. Once again, the green sowing technology is among the most appropriate practice to improve the overall efficiency of the annual cropping systems.

Figure 6: Soil pit under CA-based cropping systems

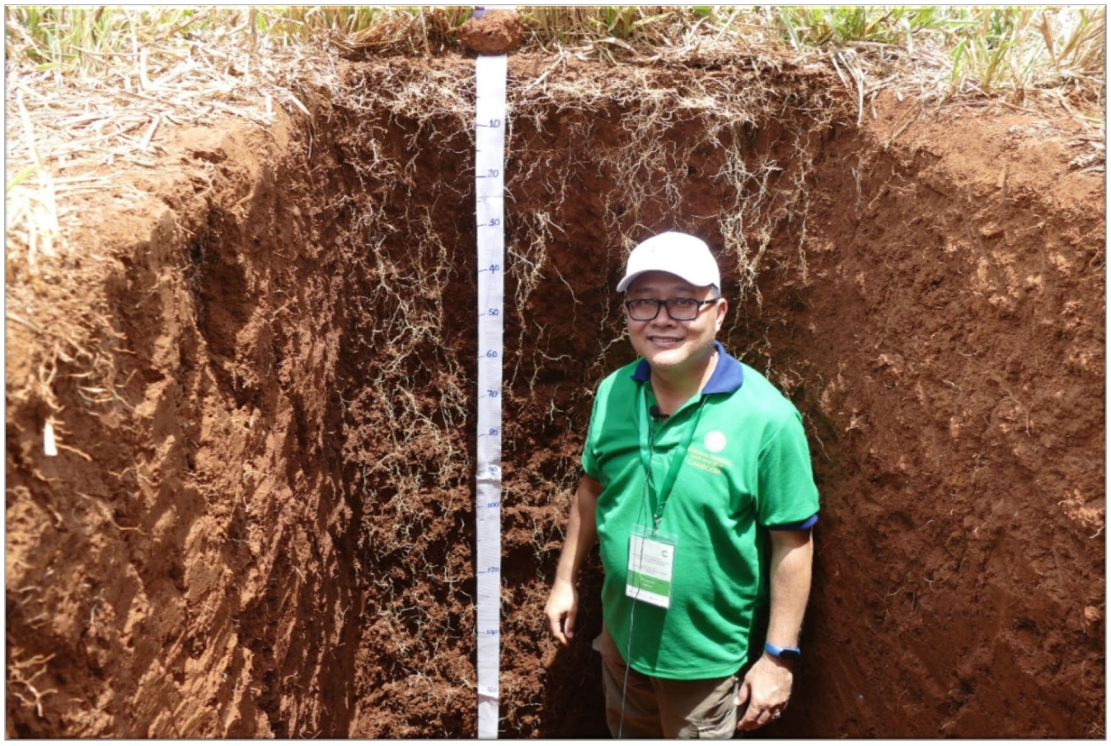

Figure 7: Soil pit under pastureland of Brachiaria mullato. Comments on soil pits were provided by Mr. Rada Kong (CASC), Mr. Hoá Tran Quoc (CIRAD), Mr. Florent Tivet (CIRAD) and Dr. Seng Vang (DALRM/CASC).

3.2.2.2 *Impacts of contrasted land use on SOM, soil structure*

The impacts of contrasted land use on soil organic matter content and soil structure were explained to the participants comparing soil clods from forest (or un-disturbed environment), plough-based management and CA-based cropping systems. Soil organic matter decreased drastically since the conversion from forest to agricultural land. In the uplands of Battambang, it is considered that SOM decreases from 6.0% under forest to less than 3.6% under plough-based management representing a decrease of 40% on the last two decades. Soil structure, through the water-stable aggregate, was also assessed between land use emphasizing larger macro-aggregates under forest and CA-based cropping system when compared with plough-based management. Macro-aggregation is a key element of soil fertility management protecting 'fresh' soil organic compounds and contributing to an accumulation of soil organic matter under CA.

Figure 8: Impacts of land use changes on soil organic matter content between forest (left), plough-based management (middle) and CA-based cropping systems (right); soils from Rattanak Mondoul, Battambang province

Figure 9: Inputs of biomass under contrasted land use and impacts on soil aggregation. Dr. Lyda Hok, Director of the Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CE SAIN, RUA), presented this section of the training.

3.2.2.3 *Assessing main soil functions through Biofunctool*

The Biofunctool is a simple, low cost and accurate tool used to assess the changes in three main soil functions with carbon transformation, nutrient cycling and soil structure.

Figure 10: Demonstration of the Biofunctool by Mr. Sambo Pheap, colleague from the Royal University of Agriculture and Faculty of Agronomy

4. Conclusion

The participants were asked to provide feedback on the last day of the training. The feedback was divided into three different sections; a) Training; b) Regional Coordination; and, c) Overall Event.

4.1 Feedback on the Training

Participants believed that the training should **showcase more prototypes developed** by different universities/research institutions and government departments. **Successful case studies** of CA from all around the world should also be presented during this training. As knowledge sharing is important, **more time should be allocated to country reports** the whole training duration should be longer. One session should be **dedicated to providing solutions on scaling up CA mechanisation** and another should be dedicated to opportunities **involving donors** as well as networking platform such as LICA. As this training is about CA mechanisation, more influential players, like the **private sector and policy makers, should be invited**. If there is involvement from the private sector in the future, there should be a **networking event for the private to talk business** and negotiate deals on CA machineries.

4.2 Feedback on Regional Coordination

The participants believed that there should be a **database of all CA related machineries** (could be considered by CSAM) available to the public, so it will be easier for countries to identify the appropriate scale machinery before purchasing. Apart from database on product, CSAM could create a **database/platform for document storage of all its event/workshop**, so countries can access these important knowledge and information even if they were not present in the training. A platform, via group email or other channels, of good practice, knowledge sharing, and policy should be created. Besides the communication platform, there **should also be a physical collaboration between countries to conduct research** on developing well-equipped prototype models of CA machinery.

4.3 Feedback on the Overall Event

The participants **appreciated organizers from the host country Cambodia for the overall professional organization of the event**. The participants believed that the event should be **rotated each year to different countries**. There is a definite **need for gender balance in the future events**. Even though the mix was good this year, adding more countries would be better. There should be **more attention given on the participants for the event based on the theme of the training**, as some participants found it hard to understand the technical aspects of the training and some found it difficult to communicate due to language barrier. **Social media awareness** should be improved, regional trainings, such as this, should also follow the **trend to provide live field demonstration video**.

Annex

ANNEX 1: TRAINING SCHEDULE

The Regional Training on Appropriate Scale Mechanisation" in Siem Reap, Cambodia

Monday, May 06, 2019		
Time	**Detail**	**Location**
09:00-10:00	Inauguration and Introduction to the Training	Angkor Paradise Hotel
10:00-10:30	Coffee Break	
10:30-12:00	Policy Issues on Sustainable Agricultural Mechanisation	
12:00-13:00	Lunch	
13:00-14:30	Understanding the Mechanisation for Conservation Agriculture	
14:30-15:00	Coffee Break	
15:00-16:30	Understanding Systemic Constraints and Business Models	
	Welcome Dinner	
Overnight Stay at Angkor Paradise Hotel, Siem Reap		
Tuesday, May 07, 2019		
Time	**Detail**	**Location**
08:00	Departure to Bos Khnor	Hotel Lobby
11:00-12:00	Lunch in Kampong Thom	Prey Pros Restaurant
13:00-14:30	Introduction to CA and Linkages to Climate Resilience	Bos Khnor Research Station
14:30-15:00	Break	
15:00-16:30	Appropriate scale Mechanisation and Conservation Agriculture	Bos Khnor Research Station
19:00	Dinner	LBN Asian Hotel
Overnight Stay at LBN Asian Hotel, Kampong Cham		
Wednesday, May 08, 2019		
Time	**Detail**	**Location**
07:00	Departure to Bos Khnor	Hotel Lobby
08:00-09:00	Field demonstration—Appropriate Scale Mechanisation	Bos Khnor Research Station
09:00-10:30	Field demonstration—Impact of Appropriate Scale Mechanisation	Bos Khnor Research Station
10:30-12:00	Case Studies on Service Providers (Cambodia/ Bangladesh)	Bos Khnor Research Station
Lunch at Boeung Samrith Resort, Baray District, Kampong Thom Province		
Departure to Siem Reap		
19:00	Closing Dinner with Traditional Dance Show	Angkor Paradise Hotel
Overnight Stay at Angkor Paradise Hotel, Siem Reap		
Thursday May 09, 2019		
Time	**Detail**	**Location**
09:00-10:00	Role of Gender in Appropriate Scale Mechanisation	Angkor Paradise Hotel
10:00-10:30	Coffee Break	
10:30-12:00	Demand Assessment of Future Training & Closing Ceremony	
Lunch		

ANNEX 2: LIST OF PARTICIPANTS

No	Country	Name of Participants	Affiliated Organisation
1	Azerbaijan	Taghiyev Urfan	Azerbaijan State Agricultural University
2	Bangladesh	Muhammad Arshadul Hoque	Farm Machinery and Postharvest Process Engineering Division, Bangladesh Agricultural Research Institute (BARI)
3	Cambodia	Chhel Chhen	Department of Agricultural Land Resources Management (DALRM)/ General Directorate of Agriculture (GDA)
4	Cambodia	Chhoeur Sothunn	Department of Agricultural Engineering (DAEng)/ General Directorate for Agriculture (GDA)
5	Cambodia	Chuong Eang	Department of Agricultural Land Resources Management (DALRM)/ General Directorate of Agriculture (GDA)
6	Cambodia	Ho Doremi	Department of Agricultural Engineering (DAEng)/ General Directorate for Agriculture (GDA)
7	Cambodia	Lor Lytour	Royal University of Agriculture (RUA)
8	Cambodia	Mao Minea	Department of Agricultural Extension/ Ministry of Agriculture, Forestry and Fisheries (MAFF)
9	Cambodia	Meas Piseth	ASPIRE and Sustainable Land Management Program
10	Cambodia	Pheav Sovuthy	Ministry of Environment (MoE)
11	Cambodia	Roeun Chantha	Department of International Cooperation/ Ministry of Agriculture, Forestry and Fisheries (MAFF)
12	Cambodia	Som Bunna	Cambodian Agricultural Research and Development Institute (CARDI)
13	Cambodia	Theng Dyna	Royal University of Agriculture (RUA)
14	Cambodia	Thun Vathana	Prek Leap National College of Agriculture
15	China	Li Hongwen	China Agricultural University
16	China	Jian Feng	China Agricultural Machinery Testing Centre
17	China	Wanzhang Wang	Henan Agricultural University
18	China	Yanxing Xu	Luo Yang Xinle Machinery Equipment Co. Ltd
19	China	Qiyan Li	Luo Yang Xinle Machinery Equipment Co. Ltd
20	China	Yuanyuan Fang	Luo Yang Xinle Machinery Equipment Co. Ltd
21	China	Pengli Guo	Luo Yang Xinle Machinery Equipment Co. Ltd
22	China	Yuting Pan	Luo Yang Xinle Machinery Equipment Co. Ltd
23	France	Ginot Gauvin	CIRAD
24	India	Krishna Pratap Singh	Indian Council of Agriculture Research (ICAR)
26	Laos	Thongsavanh Keonakhone	Planning and Cooperation Division, Department of Agricultural Land Management (DALAM), Ministry of Agriculture, Forestry and Rural Development
27	Malaysia	Hafidha Binti Azmon	Malaysian Agricultural Research and Development Institute (MARDI)

28	Mongolia	Odontungalag Khainzan	State Administration and Management Department, the Ministry of Food, Agriculture and Light Industry
29	Nepal	Madhusudan Singh Basnyat	Department of Agriculture
30	Nepal	Swoyambhu Krishna Shrestha	Nepal Agricultural Machinery Entrepreneurs Association (NAMEA)
31	Pakistan	Liaqat Ali Shahid	Pakistan Agricultural research Council (PARC)
32	Philippines	Terence Marion Ancheta	Philippine Center for Postharvest Development and Mechanisation
33	Republic of Korea	Seunghwa Yu	Rural Development Administration
34	Russia	Sergei Komarov	Volga State Machinery Testing Station
35	Sri Lanka	Prasanga Samith Kumara Kulasooriya Marasinghe Arachchillage	Department of Agriculture
36	Thailand	Yuttana Khaehanchanpong	Agricultural Engineering Research
37	Vietnam	Hoi Thi Dinh	Vietnam Institute of Agricultural Engineering and Post-Harvest Technology

ANNEX 3: ORGANISING AND COORDINATING TEAM, LIST OF TRAINERS

Organising Team

No	Name	Position	Organisation
1	HE Dr. Chan Saruth	Advisor	Under Secretary, MAFF
2	HE Dr. Ngin Chhay	Chair	DG, GDA/MAFF
3	Mr. Ngin Kosal	Member	Director, DAEng
4	Dr. Seng Vang	Member	Director, DALRM
5	Dr. Florent Tivet	Member	CIRAD
6	Mr. Rajiv Pradhan	Member	Swisscontact

Coordinating Team

No	Name	Organisation
1	Ms. Feng Yuee	CSAM
2	Ms. Loeung Mara	Swisscontact
3	Ms. Mann Mara	DALRM
4	Ms. Tong Phanideth	DAEng
5	Ms. Un Sophea	GDA

List of Trainers

No	Name	Organisation
1	Mr. Anshuman Varma	CSAM
2	Dr. Elena Javier	De La Salle University - Manila
3	Dr. Florent Tivet	CIRAD
4	Mr. Hin Lyhour	RUA
5	Mr. Hoa Tran Quoc	CIRAD
6	Dr. Hok Lyda	CE SAIN
7	Mr. Horrace Clemmons	Cleber
8	Mr. Leng Vira	CIRAD
9	Dr. Li Hongwen	China Agricultural University
10	Dr. ML Jat	CIMMYT
11	Dr. Manual Reyes	Kansas State University
12	Mr. Ngin Kosal	DAEng
13	Mr. Pheap Sambo	RUA
14	Mr. Pierre Vernet	CIRAD
15	Mr. Rajiv Pradhan	Swisscontact
16	Dr. Seng Vang	DALRM
17	Dr. Timothy Krupnik	CIMMYT

Annex 4: Evaluation Questionnaire Summary

Number of compiled questionnaires: 29

I. Objectives

A. The objectives of this training were clearly set out			
1. Agree strongly	25	86%	Five participants specifically stated that the objectives of this training were very clear and well demonstrated, which is sufficient for participant with zero conservation agricultural knowledge.
2. Agree moderately	4	14%	
3. Agree slightly	0	0%	
4. Disagree slightly	0	0%	
5. Disagree strongly	0	0%	

B. The structure and arrangement of the training enabled to reach the objectives			
1. Agree strongly	17	59%	Two comments suggested that the contents of this training were good combinations, and particularly stated that the interactive lectures and demo were very good. One participant didn't answer this question.
2. Agree moderately	11	38%	
3. Agree slightly	0	0%	
4. Disagree slightly	0	0%	
5. Disagree strongly	0	0%	

C. The training fully achieved its objectives in general			
1. Agree strongly	19	66%	One participant proposed that more machine demonstration should be carried out. One participant didn't answer this question.
2. Agree moderately	8	28%	
3. Agree slightly	1	3%	
4. Disagree slightly	0	0%	
5. Disagree strongly	0	0%	

D. The overall quality and usefulness of the training was			
1. Excellent	23	79%	One participant commented that the quality of power point presentation was below his expectation. Another comment stated that if worksheet and ppt were sent out to the participants, then more value would be added. One participant didn't answer this question.
2. Above average	4	14%	
3. Average	1	3%	
4. Below average	0	0%	
5. Extremely poor	0	0%	

E. The quality and usefulness of the presentation and meeting materials was			
1. Excellent	17	59%	One participant mentioned that the presentations by experienced speakers were excellent. One participant didn't answer this question.
2. Above average	11	38%	
3. Average	0	0%	
4. Below average	0	0%	
5. Extremely poor	0	0%	

II. Effectiveness and Efficiency

F. The organization of the training was efficient			
1. Agree strongly	23	80%	Two participants agreed that the organization was very well done and managed. One participant didn't answer this question.
2. Agree moderately	5	17%	
3. Agree slightly	0	0%	
4. Disagree slightly	0	0%	
5. Disagree strongly	0	0%	

G. The duration of the training was appropriate to cover all topics			
1. Agree strongly	12	41%	Three participants mentioned that the training schedule was a bit hectic and suggested that the training should be enhanced from 4 days to 5-6 days which includes the excursion day. They further suggested that more machine demonstrations from each country should be shown, preferably in the form of video. One participant asserted that the training topics are comprehensive enough for a minimal training and proposed that the subsequent training should focus on training needs identified by region. One participant didn't answer this question.
2. Agree moderately	13	45%	
3. Agree slightly	3	10%	
4. Disagree slightly	0	0%	
5. Disagree strongly	0	0%	

H. I am willing to share and spread the information of the Network to pertinent stake holders			
1. Agree strongly	20	69%	One participant didn't answer this question. No comment was given.
2. Agree moderately	6	21%	
3. Agree slightly	2	7%	
4. Disagree slightly	0	0%	
5. Disagree strongly	0	0%	

III. Benefits have been drawn from this training, apart from the designated objectives of the event

There were four main points that the participants felt beneficial to them from the training. A very large number of participants agreed that they had **learnt a lot from both the lecturers and their colleagues**. The obtained knowledge included but not limited to: 1) professional knowledge of CA (conservation agriculture), such as soil fertility management, subsidy policy and national demand of CA; 2) advance technologies and innovations; 3) development future of CA; 4) business models; and, 5) gender aspect in the activities of CA. The other common view is that the training provided the participants a **forum to interact and connect with each other**, which has greatly benefited them in their search of collaborative opportunities. Three of the participants stated that the training **enabled them to learn, compare, and question the studies of CA from different countries** and regions.

IV. Ways that participants could extend the knowledge and insights gained from this training

The participants were **eager to share the CA knowledge they learnt** from the training with their colleagues, students, researchers, workers and, most importantly, farmers. Some of them are also going to **reference their knowledge about CA and agricultural mechanisations** in their future work on their fields and in their research projects. A small number of the participants stated that they **had built networks with their future collaboration partners**. Some participants remarked about their **interest to join national plan or programs related to CA**. Some others further asserted that they would like to put their efforts over **building CA group farmers or associations**. They also mentioned that they had **recognized the gender aspects** and will try their best to enhance women's role in in the area of CA and agricultural mechanisation.

VI. Comments/ suggestions for improvement and future focus

Of the nineteen participants that gave specific feedback, twelve people commented/suggested to 1) extend training duration to 6-7 days; 2) conduct the training more often; and, 3) more time to be given for mechanization practices. Three participants did not seem to be satisfied with the location where the training took place. Two of them suggested that the training group should have spent more time in the Bos Khnor Research Station in Cambodia, where they believe it could have been more beneficial for the training purposes.

Some viable topics for future trainings were suggested and they are:

1) Ways to scale up the utilization of mechanisation for conservative agriculture
2) Details about theories of conservation agriculture
3) More gender equality related topic in the field of CA/agricultural mechanisation
4) Service maintenance and spare parts availability
5) Well-documented best practices

Many of the comments mentioned that lecture notes and ppts should be sent out among the participants and should have a common website for CA information sharing. Several participants suggested CSAM to promote conservation agricultural alliance among the region. There are also other piecemeal proposals: 1) The training event should be easier to comprehend for non-engineers. 2) Invite two or more people from each department in each country. 3) Include more private sector companies that advocate 'open system' and local regional manufacturers into the training event. 4) More training opportunities for service providers and farmers on CA. 5) Set up teamwork for each participant as private sector, service providers and farmers to discuss what they need for each group.

ANNEX 5: POTENTIAL TRAININGS THAT WILL BE OFFERED AT BOS KHNOR 2020

The following are the training topics and the institutions that have tentatively agreed to provide the trainings:

Appropriate Scale Mechanisation
Role in Reaching, Benefitting, and Empowering Women

Overview	Mechanisation has the potential to benefit female farmers by reducing drudgery, ensuring labour efficiency and reducing their time burden. However, technologies are not inherently gender neutral; therefore, implementers need to consciously mainstream gender by ensuring that mechanisation reaches, benefits and empowers women.
Content	Appropriate Scale Mechanisation should follow the approach of Reaching, Benefitting and Empowering women. An overview of training modules includes: 1. **Reach**: a. Provide targeted technical and financial training for women farmers to enable the adoption of technology. B. Provide training and skills development for men and women trainers, extension workers, technology developers to better reach/design for women farmers 2. **Benefit:** a. Assess gendered barriers and enablers to mechanisation adoption. Address constraints faced by women. B. Provide access to financial services, technical assistance, and markets. 3. **Empower:** a. Ensure improved access and ownership of technologies. B. Enable participation in income generating activities or other value chain addition activities
Supporting Institution	University of Illinois

Appropriate Scale Mechanisation
for sustainable intensification of maize systems

Overview	Maize is the most widely distributed cereal in the world after wheat and rice. It is used mainly for three purposes: as a staple food crop for human consumption, as feed for livestock, and as a raw material for many industrial uses, including bio-fuel production. Recently, maize has emerged as a potential commercial crop in Asia with the development of several new maize-based cropping systems involving rice, pulses, cassava, etc. These maize production systems involve intensive labour and drudgery throughout the whole production cycle. However, labour availability at the peaks of critical operations is often uncertain due to drudgery of the work and other competing sectors. Timeliness of farm operations significantly influences the production, productivity and profitability of maize systems in the region.
Content	• Overview of Maize Production Systems, production system constraints and innovative agronomic management practices in maize systems in Asia • Application of appropriate scale mechanisation for sustainable intensification of maize based systems in South-East Asia (SEA) • Potential opportunities for Conservation Agriculture (CA) in maize systems of SEA • Develop new generation of researchers at national programs and local institutions on scale appropriate mechanisation and CA-based sustainable intensification • Bring global experience and expertise on scale appropriate mechanisation, CA, sustainable intensification (SI) in maize systems to SEA
Supporting Institution	International Maize and Wheat Improvement Center (CIMMYT)

Service Provision in Conservation Agriculture Mechanisation

Overview	Conservation Agriculture is key to sustainable crop production intensification in feeding a growing world population while conserving ecological and natural resources. Mechanisation including seeders, roller crimper, and seed broadcaster are key inputs for Conservation Agriculture, but smallholder farmers often face challenges in investing in these machineries. A solution to tackling this challenge is ensuring a sustainable input supply chain by supporting local manufacturers and Conservation Agriculture service providers to provide the necessary services to the farmers.
Content	• Overview of supply chain in Appropriate Scale Mechanisation • Roles of service providers in contributing to sustainable input supply chain • Calculate the incentives for the service providers • Business models for scaling Scale Appropriate Mechanisation • 4S market segmentation model
Supporting Institution	Swisscontact

Agroecological cropping systems for annual upland crops

Overview	Within a few decades, intensive monocropping practices replaced traditional upland agriculture based on shifting cultivation, which historically prevailed across Southeast Asia. The high market demand for crops such as maize and cassava for feedstock or biofuel has driven this rapid conversion of smallholder production systems from subsistence to market orientation. This fast land conversion was associated in many places with deforestation, erosion of soils and biodiversity, pollution from increasing use of chemical inputs that gradually undermined the sustainability of the upland farming systems. The training intends to provide knowledge and know-how to co-design with farmer communities agroecological-based cropping systems for annual upland crops using a large diversity of plants and appropriate scale mechanisation to improve cropping system efficiency. The training will focus on maize, cassava, pulse crops cultivation along with several cover/relay crops with a specific emphasis towards organic management.
Content	• Overview of the trajectories of farming systems and main constraints faced by small-scale farmers in the uplands of SEA • Promote plant diversity and identify key cover/relay crops based on contexts • Co-design agro-ecological-based cropping systems for annual upland crops and shift towards an organic management • Appropriate scale mechanization for upland farmers • Conditions for the adoption of such innovative systems
Supporting Institution	GDA/DALRM/CASC, CIRAD

Agroecology, Soil health, Plant Diversity and Climate Resilience

Overview	Productivity, food security and safety shall be improved while preserving and enhancing natural resources and environment. Limitation to land and water availability within the ecosystems is often worsen by climate change. Agroecological-based cropping systems help increase yields, improve soil fertility, increase water infiltration and retention, and improve nutrients cycling. Therefore, sequestering C in soils represents an objective with beneficial consequences for crop productivity, agricultural sustainability and mitigation of climate change. Even a small increase in the soil carbon stock is crucial to improve soil fertility, agricultural production, adapt small-scale farming to climate variability and change. Nutrient and carbon cycling, soil structure maintenance and pest regulation in soils are under the regulation of beneficial soil organisms whose functions and diversity should be improved through adequate agroecological practices. The training aims at describing the linkages between agroecological management and climate resilience and to provide knowledge on soil ecology, soil health and how to assess the impacts of contrasted land uses.
Content	• Principles of Agroecology • Linkage between Agroecology and Climate Resilience: plant diversity as a driver of soil – crop interactions and ecosystem services • Soil ecology, fundamentals and ecosystem services • Soil health assessment and impacts of contrasted land uses • The Biofunctool approach, an in-situ tool to assess key soil functions with C transformation, nutrient cycling and soil structure.
Supporting Institution	IRD, Royal University of Agriculture, GDA /DALRM, CIRAD

Agroecological Crop Protection

Overview	Agroecological Crop Protection (ACP) is a crop protection concept based on ecological principles which aims to make agroecosystems more sustainable; the concrete application of ACP requires the adoption of an ordered implementation strategy of cropping practices, resulting from a systemic and participatory approach, that gives priority to preventive measures to ensure the management of pest populations (animal pests, plant pathogens and weeds) and beneficial (predators, parasitoids or pest pathogens, pollinators, organic matter recyclers). ACP corresponds to the declension of agroecology principles to crop protection. ACP is based on two main axes: i) soil health and ii) biodiversity and appears to be a relevant alternative to significantly reduce pesticides uses.
Content	• Context overview: (i) Issues of Agriculture in SEA, (ii) Evolution of Crop Protection worldwide, (iii) The local situation. • The use of pesticides as a last resort in the only critical situations: (i) The limits and constraints of chemicals, (ii) Good practices for chemical applications, (iii) The use of biocontrol agents, (iv) Towards redesigning agroecosystems. • From agrochemistry to agroecology: (i) The ESR approach, (ii) The limits and constraints of chemicals, (iii) The use of biocontrol agents, (iv) Agroecological agroecosystems. • Principles of ACP: (i) Agroecology, (ii) What is ACP? (iii) From the concept to the field: strategy and case studies. • Bicoenosis in agroecosystems: (i) Bioagressors, Beneficials, Functional biodiversity (vegetable and animal), (ii) Dynamics and interactions) • The main axes of ACP: (i) Soil health, (ii) Biodiversity. • Main agroecological practices: (i) Preventive measures, (ii) Habitat management, (iii) Biological Control. • Monitoring, assessment and predicting pest damages: (i) Field survey tools, (ii) Qualitative modelling (IPSIM).
Supporting Institution	CIRAD, Royal University of Agriculture, GDA, ITC

Adoption and Scaling up of Conservation Agriculture Mechanisation

Overview	The adoption and scaling-up of Conservation Agriculture not only increases farmers' yields but also contributes to environmental and economic benefits of a country. Yet, in many developing countries, several challenges persist that undermine the adoption and scaling-up of Conservation Agriculture. These challenges include lack of awareness on the Conservation Agriculture technologies among stakeholders; lack of immediate returns for farmers; legal and institutional framework constraints; and, market and communication constraints.
Content	• Systems thinking while dealing with adoption and scale • Challenges in adoption and scaling-up of Conservation Agriculture • Strategies and approaches in adoption and scaling-up of Conservation Agriculture Mechanisation • System around Valley of Death
Supporting Institution	Swisscontact

Agro-ecological and Organic Banana-based Cropping Systems for South East-Asia

Overview	Industrial banana plantations have increased in South East in the last decades due to an increase of the regional demand (e.g. China). However, banana cropping systems remain strongly dependent on the massive use of chemical inputs (herbicides, fungicides and insecticides) in the region. Agro-ecological alternatives have already been developed in other countries (e.g. FWI) and these innovative cropping systems could be easily co-designed and adapted in South-East Asia. This course will also demonstrate that agro-ecology and Conservation Agriculture (CA) should not be systematically opposed to industrial agriculture and could be adapted for small to large-scale farms under certain conditions.
Content	• Overview of the main agronomical constraints and pests in industrial (Cavendish) banana production; • Role of biodiversity in the pest management; • Good practices for the control of the leaf diseases; • Organic fertilization management; • Co-design of agro-ecological banana-based cropping systems; • Conditions for the adoption of such innovative systems.
Supporting Institution	CIRAD

Agro-ecological Crop-Livestock Integration

Overview	The production of livestock systems is growing strongly in South East Asia, to cover the growing demand. However, livestock systems are known to cause serious damage to the environment (GHG, water pollution, overgrazing, energy, etc.). It is necessary to design more productive and more sustainable livestock systems. In the region, livestock activities are often practiced by mixed farms in parallel with cropping systems, fish farming, agroforestry, etc. Crop-livestock integration practices, if they are reasoned at the farm and territory level, could contribute to an agroecological transition of production systems. The training course will provide an overview of crop-livestock integration practices, tools and methods for diagnosis and co-designing innovations to strengthen crop-livestock integration (farm and territory level) and contribute to an agroecological transition.
Content	• Overview of mixed farming system and crop-livestock integration practices; • Draught power for transportation, ploughing, and so on cropping systems; • Forage production and feed management; • Organic fertiliser production by an efficient management of manures; • Tools and methods to diagnosis crop-livestock integration and identify potential avenues for improvement; • Co-design of innovative crop-livestock integration practices in mixed farming systems and at territory level, and conditions for the adoption of such innovative systems
Supporting Institution	CIRAD

Policy in Conservation Agriculture

Overview	Policy and institutional support are important for introducing and increasing the adoption of Conservation Agriculture. Adequate policies can shorten the process of adopting Conservation Agriculture by facilitating suitable legislation, regulatory frameworks, research and development, and incentive and credit programmes. At the regional level, the Lao facilitated Initiative on Agroecology for ASEAN (LICA) is working closely with ASEAN to raise awareness about the agroecological transition in the region. This training will also facilitate coordination among LICA focal points.
Content	• Policies supporting adoption of Conservation Agriculture • Case studies and success stories
Supporting Institution	China Conservation tillage Research Center, Ministry of Agriculture and Rural Affairs (CTRC), Lao Facilitated ASEAN Initiative on Agroecology (LICA)

Annex 6: Opening Remarks by Director General of GDA, H.E. Dr. Ngin CHHAY

Opening Remarks by H.E Dr. Ngin CHHAY, Director General of the General Directorate of Agriculture, Ministry of Agriculture, Forestry and Fisheries, Kingdom of Cambodia delivered at the The Regional Training on Appropriate Scale Mechanisation for Conservation Agriculture, Siem Reap, 6th May 2019

1. Mr. Anshuman Varma, Representative of Center for Sustainable Agricultural Mechanisation of the UN Economic and Social Commission for Asia and the Pacific (CSAM/UN-ESCAP);
2. Dr Philippe Girard, AGREENIUM representative, CIRAD Regional Director for Continental South East Asia;
3. Mr. Rajiv Pradhan, Country Director of Swisscontact for Cambodia;
4. Mr. Mangi Lal Jat, Representative of the International Maize and Wheat Improvement Center (CIMMYT);
5. Dr Hok Lyda, Director for Center of Excellence on Sustainable Agricultural Intensification and Nutrition (RUA);
6. Mr. Ngin Kosal, Director of the Department of Agricultural Engineering (GDA);
7. Distinguished delegates, participants, colleagues, ladies and gentlemen!

Dear Participants,

Good morning! On behalf of the General Directorate of Agriculture, I am pleased and honoured to be here at the opening session of "The 1st Regional Training on Appropriate Scale Mechanisation for Conservation Agriculture", which is held from 06 to 09 May, 2019 in Siem Reap and Bos Khnor, Cambodia. I would like to thank all my colleagues at the Ministry of Agriculture Forestry and Fisheries, General Directorate of Agriculture (GDA), Cambodia, Department of Agriculture Engineering, Centre for Sustainable Agriculture Mechanisation (CSAM), CIRAD, Swisscontact, all our supporting organisations and the organising team for working diligently in putting this wonderful event together. Also, a sincere note of gratitude to all the trainers and facilitators for investing your precious time towards your sessions, and all the guests for your attendance. Taking this opportunity, I specifically welcome the presence of Dr. Anshuman Varma, on behalf of Dr. Li Yutong, Head of Centre for Sustainable Agricultural Mechanization of UN-ESCAP.

I would like to thank CSAM for the concerted effort in promoting agricultural mechanization in our region. This Regional Training provides an excellent opportunity for the industry peers in the region to get together and work to enhance and improve the scale of mechanisation. I feel happy to announce that this event is being attended by participants from 18 countries with trainers and facilitators from all over the world. This event is the first of many to come and we aim to have more participants from more countries in the upcoming years.

Ladies and Gentlemen,

This event reflects the annual CSAM Governing Council meeting that was held in Jakarta, Indonesia, on November 30th, 2018, and thank to the CSAM and Governing Council members for supporting the organization of this Regional Training in Cambodia.

As we all know, current farming is facing diverse challenges due to the shifting of labour force from agriculture to other sector. Climate change will also have strong impacts on farming efficiency and profitability. Thus, the development of appropriate-scale mechanization is a key element to address these challenges.

Taking this opportunity, I would like to inform you that the vision of Agriculture sector in Cambodia for 2030 is toward "A modern Agriculture Sector which is competitive, inclusive, resilient and sustainable to contribute to food security, safety and nutrition for the prosperity and wellbeing of the Cambodian people". In this regard, the Ministry of Agriculture, Forestry and Fisheries has set two main objectives (1) Enhancement of inclusive agricultural growth by increasing productivity, diversification, competitiveness, and agricultural commercialization and (2) Promotion of Sustainable Agricultural Land Use, Forestry & Fisheries Resources Management and Development.

Over the past decades, increase in agricultural production have provided huge productivity gains and profits under conditions of intensive resource use and a 'predictable' environment. We have to recognize that these gains have led to simplified cropping systems with monocropping and agricultural landscapes, increasing pressure on soils, and notably on soils organic carbon stocks. Our soils need to be valued for their productive capacities as well as their contribution to food security, maintenance of key ecosystem services and well-being of rural communities. A healthy soil is a soil that will offer much more opportunities for smallholder farmers to diversify their crops, to be economically viable, productive, to reduce the impacts of climate variability and change and market shocks.

With the development of agricultural mechanization in Asia and Pacific region, we need to address this issue of land degradation, soil fertility depletion and increasing water scarcity for some regions. We need to work together to find ways to keep the soil fertile and prevent the erosion. The increase demand for agricultural mechanization should be part of an integrated approach of soil and water management, targeting a sustainable intensification of the farming systems in the lowlands and in the uplands from the vegetable, rice, rainfed annual crops to perennial plantations.

Conservation agriculture, that is part of a sustainable intensification effort from field to landscape, is one of the most relevant option responding to the above challenges. Conservation agriculture practices protect the soil, increase soil organic matter, retain more water in field, and increase nutrient availability by utilizing crop residues and green manure/cover crops and keeping these residues as a mulch.

We know that sustainable mechanisation is vital to meet the Sustainable Development Goals (SDGs) in the Asia Pacific region, including SDG 1: No Poverty, SDG 2: Zero Hunger, SDG 13: Climate Action, and SDG 15: Life on Land. The Regional Training on Appropriate Scale Mechanisation for Conservation Agriculture presents an exciting opportunity for us to get together, learn and pave way to work collectively to enhance and improve the scale of mechanisation in the region. This training will strive to induce a better understanding of the mechanisation aspects for conservation agriculture; the importance of market system analysis and engagement with private sectors; and, the policy issues favouring appropriate-scale mechanisation. The training also aims to identify needs for future events that can be offered by GDA and other institutions at Bos Khnor Research Station, Cambodia.

Specifically, we need:

- To design or benefit for on-going works developed on sustainable mechanization by other countries from the region.
- To improve access to appropriate-scale mechanization to smallholder farmers while preserving soil resources and producing better food quality.
- Improving access to smallholder farmers require to involve different segments of the private sectors with:
    - local service providers that need to be engaged into a transition to Sustainable Intensification, and we have to assess under which conditions this transition to Sustainable Intensification will be for them a profitable business.
    - retailers and importers should also be part of the process at the early stage to bring on the market agricultural implements that will improve farming system efficiency while contributing to the production of ecosystem services.
- We also need to strengthen knowledge on farm infrastructures for rice farming but also for rainfed upland crops such as fruit tree and banana plantation, among others.

- Research and development in pre and post-harvest technologies is also needed to improve the crop management, the efficiency of the work, to address the scarcity of labour force while targeting the product quality.
- Water management is key for a large range of crops from vegetable, rice, rainfed annual crops to perennial plantation. Water-use efficiency will be a crucial component of farm sustainability in the coming years and decades.

Another important highlight of this training is the Bos Khnor Research Station of GDA which we will all visit tomorrow. The Bos Khnor Research Station is the oldest conservation agriculture practice system (CAPS) experimental site in Southeast Asia in which the system was set up in 2004 under the collaboration between General Directorate of Agriculture (GDA) of the Ministry of Agriculture, Forestry and Fisheries (MAFF) and the French Agricultural Research Institute for International Development (CIRAD) with financial support from French Agency for Development (AFD). With undefeated reputation for CA research for development, Bos Khnor Research Station aims to become a "Regional Training Center on Conservation Agriculture and Sustainable Intensification". Most relevant trainings are being planned and will be delivered from 2020 with collaborative efforts and support from various national and international institutions.

This initiative is certainly the right step towards enhancing and improving scale mechanisation in Cambodia, and the Asia Pacific region.

Finally, I would like to thank you for your participation in the training and I wish you to have a good time in Cambodia.

Thank you