



# FEED <sup>THE</sup> FUTURE

The U.S. Government's Global Hunger & Food Security Initiative

## APPROPRIATE-SCALE MECHANIZATION CONSORTIUM FOR SUSTAINABLE INTENSIFICATION

Final Report  
Cambodia, 2019



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## List of Abbreviations

ASM	Appropriate scale machinery
ASMC	Appropriate Scale Mechanization Consortium
CA	Conservation Agriculture
CAPS	Conservation Agriculture Production System
CASC	Conservation Agriculture Service Centre
CASIC	Conservation Agriculture for Sustainable Intensification Consortium
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Développement
CSAM	Center for Sustainable Agricultural Mechanization
DAEng	Department of Agricultural Engineering
DALRM	Department of Agricultural Land Resources Management
FAE	Faculty of Agricultural Engineering
GDA	General Directorate of Agriculture
HAC	Hub Advisory Committee
MAFF	Ministry of Agriculture, Forestry and Fisheries
PDAFF	Provincial Department of Agriculture, Forestry and Fisheries
RUA	Royal University of Agriculture
RUAS	Royal University of Agronomy Science
SI	Sustainable Intensification
UBB	University of Battambang
UN-ESCAP	UN Economic and Social Commission for Asia and the Pacific





# Table of Contents

1. Project Overview.....	1
2. Implementing Institutions.....	3
2.1 Royal University of Agriculture (RUA) – Faculty of Agricultural Engineering (FAE) .....	4
2.2 Department of Agricultural Engineering (DAEng).....	4
2.3 Department of Agricultural Land Resources Management (DALRM) and the Conservation Agriculture Service Center (CASC).....	5
2.4 CIRAD .....	5
2.5 University of Battambang (UBB) .....	5
2.6 Swisscontact.....	5
3. Achievements .....	7
3.1 Engaging stakeholders and assessing country specific challenges, opportunities and priorities.....	8
3.1.1 Established Hub Advisory Committee .....	8
3.1.2 Developed strategic plan of agricultural mechanization in Cambodia for 2016-2020 .....	8
3.1.3 Assessed and identified the existing use of agricultural machinery and equipment.....	8
3.2 Implementing country specific activities with emphasis on suitability, scalability and sustainability .....	9
3.2.1 Testing/modifying/promoting a diversity of implements.....	9
3.2.2 Conservation Agriculture Cropping systems .....	11
3.2.3 Identifying mechanisms to engage local service providers into a CA transition .....	12
3.3 Capacity building and youth engagement .....	12
3.3.1 Youth engagement .....	12
3.3.2 Capacity building for stakeholders, operators and smallholder farmers.....	14
3.3.3 Knowledge sharing and networking.....	15
4 Lesson Learned.....	17
5 Future Direction .....	19
6 Aggregated Results .....	22
7 List of Scholarly Outcomes .....	23
8 Conclusion.....	26
9 References.....	29



# I. Project Overview





Appropriate Scale Mechanization Consortium (ASMC), a 4-year project, was launched in October 2015 to address agricultural mechanization and its role towards extending sustainable intensification (SI) and conservation agriculture (CA) activities in different agroecosystems of Cambodia.

In Cambodia, the share of labor force in agriculture has been decreasing from 66% in 2009 to 41% in 2017 (MAFF, 2018) due to migration of farmers to work in cities, garment factories or abroad such as Thailand, Malaysia and South Korea. The scarcity of labor has generated tremendous changes in the lowland and upland farming systems and mechanization became a central element of farming system to offset a continuous decrease in labor force. In the lowland's farmers shifted from rice transplanting to seed broadcasting and service providers started to offer services with rice seeders. In the uplands, forests were converted to farmlands which generated a fast depletion of soil fertility and the degradation of other natural resources. Cambodia needs to make a shift towards sustainable intensification and conservation agriculture, and this can happen through appropriate-scale mechanization. ASMC's overall objective is to intensify small holder farmers' cropping systems and on-farm operations through mechanization in a sustainable manner.

The activities took place in Battambang (Northwest Cambodia) and Kampong Thom (Central plains) Provinces. The main agroecosystems can be schematically divided into lowlands and uplands. In the lowlands, farmers mainly produce one to two rice crops when complementary irrigation is available for the second rice cycle. Yields are often limited by low soil levels of nutrients, fluctuating water level on the paddy field and its impacts on nutrient forms and availability in the soil (Seng et al. 1999; Pheav et al. 2005). In the uplands of Battambang, intensive mono-cropping practices of commodities crops (i.e., maize and cassava) replaced the traditional subsistence farming systems within a few decades (Kong et al. 2019). However, the increase of non-conservation oriented mechanized farming practices resulted in significant soil fertility depletion, leading to a decrease in the productivity and profitability of such crops (Montgomery et al. 2017; Kong 2019).

For a sustainable change to occur in farming systems, there is a need to test and promote appropriate-scale mechanization that fit with the principles of sustainable intensification and to engage the private sector into this transition. The private sectors play a crucial role in providing technologies, know-how and information needed for different value chains. They are needed to make technology available, affordable and serviceable in local markets and at rural communities' level.

### Goal and Specific Objectives of The Project

The goal is to improve the resilience of farming systems in the rain-fed lowland areas of Cambodia promoting appropriate-scale mechanization along with innovative rice cropping systems. Specific objectives are:

- (i) to design and assess the performances of appropriate-scale mechanization (ASM) for rice farming systems, vegetable production and diversification (i.e., affordability, practicability, efficiency, labor saving),
- (ii) to train smallholders, service operators and students on the use of ASM,
- (iii) to support multi-stakeholder initiatives, initiating a negotiation process between farmers for the individual or collective management of fodder sources or crops diversification after wet season rice, and
- (iv) to engage the private sector into a transition to sustainable intensification.



*The ASMC prototype was tested in Kampong Thom province on 140 Ha of farmland.*



## 2. Implementing Institutions





The ASMC Cambodia includes members with substantial institutional capacity and expertise, and active collaborations with institutions and entry point organizations; **Royal University of Agriculture** (Coordinator and in charge of capacity building component), **Department of Agricultural Engineering** (Mechanization intervention), **Department of Agricultural Land Resources Management/Conservation Agriculture Service Center** and **CIRAD** (Rice-based cropping systems intervention and mechanization testing), **University of Battambang** (Vegetable cropping systems and tools intervention) and in the later stage **Swisscontact** (support on implementation and the private sector engagement).

## 2.1 Royal University of Agriculture (RUA) – Faculty of Agricultural Engineering (FAE)



Established as the Royal University of Agronomy Science (RUAS) in 1964, the institution developed into Royal University of Agriculture in 1994. In 1999, it became the first public administrative institution in Cambodia. RUA's mission is to contribute to the development of agriculture and related sectors and to the sustainable use of natural resources by providing higher-education programs, research and extension in line with national and international development issue and job market needs. In 1985, established as the Department of Agricultural Mechanization on April 1, 1985 with the support from the former Soviet Union as the fifth department of Institute of Agricultural Technique Chamkar Daung, the department was renamed in 1996 as the Faculty of Agricultural Engineering (FAE). In 2000, the faculty was renamed to Faculty of Agricultural Technology and Management with its new curriculum focused on farm management and agricultural environment to meet the need of labor market at that time. Later on, as the need to intensify agricultural production became great and more machinery started being used in agricultural production, the faculty was renamed again to Faculty of Agricultural Engineering (FAE) which is comprised of three departments: Soil and Water Engineering, Agricultural Machinery and Agricultural Energy and Environment.

In ASMC, the main role of RUA was to establish Hub Advisory Committee, improve educational degree and staff capacity building, organized short-term training courses, organize study visit for students and to share knowledge through field days, reports conferences and website.

## 2.2 Department of Agricultural Engineering (DAEng)



Department of Agricultural Engineering (DAEng) is one of the nine departments under the supervision of the General Directorate of Agriculture (GDA). This Department has the major roles and responsibilities of developing agricultural engineering in Cambodia by: (1) Researching and identifying agricultural zones for the use of agricultural machinery and equipment, and agricultural machine based on soil classification and crops to develop the agricultural sector; (2) Researching and initiating the production and invention of agricultural equipment, and take action and research measures to reduce the use of human power in agricultural production; (3) Advising and sharing the technical knowledge with users of agricultural machinery in agricultural production during and after harvesting to increase and improve agricultural production and productivity; and (4) coordinating and facilitating with private sector investment to take part in investing in agricultural tools and equipment that are more suitable for Cambodian conditions.

In ASMC, the main role of DAEng was to review the design and working mechanism of existing machinery, organize focus group discussion with users of farm machinery, produce technical drawing of modified machines and prototypes, and share knowledge through field days, reports, conferences, and website.



## 2.3 Department of Agricultural Land Resources Management (DALRM) and the Conservation Agriculture Service Center (CASC)



The Department of Agricultural Land Resources Management (DALRM) and the Conservation Agriculture Service Center (CASC) are under the supervision of the General Directorate of Agriculture (GDA). DALRM has the mandate to (i) draft the policies, land use plans and soil fertility management guidelines to increase crop productivity and profitability while ensuring sustainable use and management of natural resources, (ii) draft the laws for the land resources management to improve soil fertility in compliance with the policies of the royal government of Cambodia and national, regional and international agreements, (iii) assess and develop agricultural zoning, land suitability, and soil fertility management guidelines for specific crops and agroecosystem, (iv) implement research and on-farm experimental activities, (vi) provide technical assistance for the assessment of soil fertility and crop status, and (v) collaborate with relevant international institutions and implement conventions and agreements that refer to land resources management.

## 2.4 CIRAD



Centre de Coopération en Recherche Agronomique pour le Développement (CIRAD), the French Agricultural Research Centre for International Development, is an organization working for the sustainable development of tropical and Mediterranean regions, in the South and French overseas regions. From its regional offices, CIRAD conducts joint operations with more than 90 countries. It also has scientific platforms with a regional vocation in the French overseas regions. CIRAD has a staff of 1800, including 800 researchers. CIRAD with DALRM initiate the dynamic on Conservation Agriculture within the GDA and at the national level on Conservation Agriculture since 2004. CIRAD provides technical and scientific backstopping to GDA/DALRM and will pursue his support in the coming years along with different

partners (CE SAIN/RUA, KSU, French Research Institute for Development/IRD, Institute of Technology of Cambodia).

The main role of DALRM/CASC and CIRAD was to manage experiments in Battambang and Kampong Thom, establish on-farm demonstrations in both locations, to test existing equipment and prototypes of ASM and assess their performance, build capacity through field days trainings for smallholder farmers, service operators and students, engage service providers into a transition to sustainable intensification and share knowledge.

## 2.5 University of Battambang (UBB)



The University of Battambang (UBB) was founded by Samdach Krola Hom Sar Kheng, Deputy Prime Minister of Interior, in 2007 with the vision of providing opportunities to students living in rural areas, especially in north-western Cambodia. These opportunities include access to higher education and services that contribute towards the development of their individual careers as well as to that of local communities while at the same time reducing the knowledge gap between the rural and urban population.

In ASMC, the main role of UBB was to establish conservation agriculture commercial vegetable home gardens with drip irrigation, identify tools and tasks to improve efficiency of women in conservation agriculture commercial vegetable home garden production, conduct time-motion study and task analysis, and hold focus group discussion to determine how to improve efficiency of production and priorities future interventions.

## 2.6 Swisscontact



Although not part of the original implementing team, Swisscontact, through its flagship project, Mekong Inclusive Growth and Innovation Program (MIGIP), has supported on implementation of several activities – organizing events, trainings, private sector engagement, internship program for FAE, curriculum development for FAE and promotion of broadcaster.



Swisscontact, along with other partners has been instrumental in engaging ASMC in the important regional seminar on conservation agriculture held in May 2019. Besides the work with ASMC, Swisscontact is also supporting the formation of CAMTA (Cambodia Agriculture Machinery and Technology Association) and CASIC (Cambodia Conservation Agriculture for Sustainable Intensification Consortium) and will be the secretariat for both the consortiums.

Swisscontact – the Swiss Foundation for Technical Cooperation – is an independent, non-profit foundation based in Zürich, founded in 1959 by leading figures from the Swiss private sector and Swiss universities. It is exclusively involved in international development, active in more than 36 countries with 110 programmes with more than 1,400 staff members. At the heart of all Swisscontact's work stand the private sector and its crucial role for achieving more inclusive economic growth. Swisscontact approaches this through 4 thematic areas; a) Skills, b) Enterprises, c) Finance, and d) Environment. Swisscontact has been present throughout South-East Asia for more than 30 years.

Swisscontact has been operating in Cambodia since 2013, establishing its office in the country in April 2016. In Cambodia Swisscontact operates in two working areas – enterprise promotion, skills development – always acting through private sector development. Building on the wider organization's regional and global experience, Swisscontact strives to support local areas of focus, including agricultural innovation, tourism, impact investment, and renewable energy. Swisscontact currently implements the SDC-funded Skills Development Programme (SDP), leads the implementation of the Senior Expert Corps (SEC), Mekong Inclusive Growth and Innovation Programme (MIGIP) in destination management in the tourism sector and technology commercialization in the agriculture sector, USAID-funded Regional Investment Support for Entrepreneurs (RISE), USAID-funded Conservation Agriculture with a Fee (CASF) and Cambodian Horticulture Advancing Incomes and Nutrition (CHAIN) project as a consortium partner.



### 3. Achievements





For the purpose of this report, it is organized in three sections which include: 1. Engaging stakeholders and assessing country specific challenges, opportunities, and priorities, 2. Implementing country specific activities with emphasis on suitability, scalability and sustainability, 3. Building capacity and youth engagement.

### 3.1 Engaging stakeholders and assessing country specific challenges, opportunities and priorities

The promotion of sustainable intensification production systems requires fundamental transformations and among all changes, needs new institutional arrangements between stakeholders. Therefore, the activities that the partners, RUA, DALRM/CASC, CIRAD and DAEng conducted as a consortium as well as the role of the extended partners such as UBB and Swisscontact is essential to note. At the inception meeting, which was conducted on Feb 1-2, 2016 at RUA, the specific roles and responsibilities of the partners RUA, DALRM/CASC, CIRAD and DAEng were outlined with timelines. This event was attended by 40 participants from the industry. The consortium organized and conducted activities to engage various stakeholders in Cambodia specifically by establishing the Hub Advisory committee, and by assisting in the printing and distribution of strategic plan of agricultural mechanization in Cambodia for 2016-2020.

#### 3.1.1 Established Hub Advisory Committee

The Hub Advisory Committee (HAC) was established in October 2017 with **14 representatives** from the ASMC project partners, government, private sectors, and civil society. The HAC was established to oversee and guide the planning, coordination, communication, implementation and evaluation of all ASM innovation hub activities. The Hub Advisory Committee meetings are organized twice a year to review and provide feedbacks on the activities of ASMC project, and advice on future direction. The number of participants has increased to 32 in the 4<sup>th</sup> meeting in April 2019 where Australian researcher of

CamSID project, Swisscontact, CAVAC, CARDI, CE SAIN, and a greater number of local manufacturers joined.



*1st Hub Advisory Committee meeting*

#### 3.1.2 Developed strategic plan of agricultural mechanization in Cambodia for 2016-2020

The strategic plan of Agricultural Mechanization in Cambodia was developed for the period from 2016 to 2020 by the Department of Agricultural Engineering (DAEng), General Directorate of Agriculture (GDA), Ministry of Agriculture, Forestry and Fisheries (MAFF). This strategic plan was prepared by the management and technical staff from DAEng during 1 year through consultations with several relevant local and international experts. The plan details the current status of mechanization in the country, policies in national and regional context, the vision of mechanization in 2020 and the steps to be taken to achieve the set goals. The strategic plan is available both in English and Khmer. Through the ASMC project, five hundred copies of the plan were printed and distributed to the Royal University of Agriculture (RUA), Department of Agricultural Engineering (DAEng), General Department of Agriculture (GDA), 25 Provincial Department of Agriculture, Forestry and Fisheries (PD AFF), agricultural machinery workshops and agricultural machinery importers.

#### 3.1.3 Assessed and identified the existing use of agricultural machinery and equipment

In 7 areas, which included Phnom Penh, Takeo, Battambang, Kampong Thom, Banteay Meanchey, Kampot and Prey Veng province, DAEng conducted



assessment and identification of existing usage of agricultural machinery and equipment by interviewing farmers and local manufacturers. Although, the assessment was planned for 4 provinces, Kampot, Beante Meanchey and Prey Veng were added later as there have been some innovations and use of new and diversified agricultural machinery in those provinces. The outputs of this field assessment are: 1. To study and assess the existing agricultural machinery & equipment used in that provinces; 2. To meet and discussed with farmers and relevant stakeholders on specific needs related to selected prototypes identified by ASMC; 3. Gathering information and development of prototype's design for discussing in consultation meeting for comments and suggestions. Two consultative meetings on agricultural machinery and equipment were organized at DAEng office in Phnom Penh with 104 attendees, representatives of producers, government, private sectors, and civil society.

### 3.2 Implementing country specific activities with emphasis on suitability, scalability and sustainability



*DAEng team conducted field testing of seed drill for four-wheel tractor and seed broadcaster in farmer's field in Battambang*

Cambodia needs to make a shift towards sustainable intensification and conservation agriculture, and this can happen through appropriate-scale mechanization. ASMC's overall objective is to intensify small holder farmers' cropping systems and on-farm operations through mechanization in a sustainable manner. Appropriate-scale mechanization should be designed to fit with the principles of sustainable intensification

specifically improving farming system efficiency, improving productivity and profitability, offsetting the scarcity of labor force while preserving the natural resources (i.e., soil, water and biodiversity) (Leng et al., 2019; Pheap et al., 2019). ASMC focused their activities on three complementary dimensions of an appropriate-scale mechanization development for CA farmers including (i) testing, modifying and promoting a diversity of agricultural implements, (ii) designing and assessing rice-based conservation agriculture cropping systems, and (iii) identifying the mechanisms that have to be implemented to engage local service providers and manufacturers into a CA transition.

#### 3.2.1 Testing/modifying/promoting a diversity of implements

ASMC has been testing a diversity of implements and identifying mechanisms to engage importers/retailers and local providers into CA/SI transition (Chan et al., 2019). ASMC designed and developed mechanization prototypes for a diversity of implements including: (1) conventional and no-till seeder, (2) bucket scraper for laser land-levelling, (3) broadcaster for seed and fertilizer, and (4) roller-crimper. All six prototypes were completed and delivered to partners for testing, disseminating, training, and adapting. Technical drawing and fabrication instruction of the prototypes were made, and local manufacturers and other stakeholders were trained. Service manuals of all prototypes are being prepared and are expected to be finalized before the project ending of September 2019. Additional ASMC also worked on several vegetable hand tools.

**Seed Planter:** Rice seeder prototype for Conventional Tillage (CT) cropping systems for 4WT and 2WT has been developed by DAEng after assessing the existing seeders. In addition, a prototype of no-till planter has been designed by DAEng and tested for rice and maize cultivation. DAEng made technical drawing and fabrication instruction of the rice seed planter for the local manufacturers.

Appropriate-Scale Mechanization Innovation Hub (ASMIH) promoted the use of the no-till planter in the uplands, flood plains and rainfed lowland conditions. No-till sowing holds high promises for



Parameters, 4 on-farm tests	Cambodian NT planter		Conventional planter		Imported NT Planter	
	mean	Std. dev.	mean	Std. dev.	mean	Std. dev.
Sowing depth (cm)	5,04	0,06	2,01	0,01	3,96	0,03
Plant per meter	4,3	1,2	5,0	1,3	3,6	0,7
Average interval between plant	21,9	7,3	22,1	6,5	26,0	5,4
Yield (ton/ha)	3 647	517	3 575	624	4 461	608
Gross income (\$/ha)	729		715		892	
Potential work rate (ha/day)	3		6		5	

*Table 1: Comparison of planters used for maize sowing (0.6-m inter-row) in the uplands of Battambang province, 2018. 4 farmer fields were used for the test with 5 inner replicates per field of 14.4 m<sup>2</sup>. The imported NT planter is from Vence Tudo, Brazil*

farmers in Cambodia. Beyond time and labor savings, these machines allow a better crop profitability, through yield improvement, soil conservation and restoration. The no-till planter designed by DAEng has been tested both in the lowlands and in the uplands. In the uplands, the results and performances were compared with conventional maize planter and imported no-till planter used by CASC team. The comparison of three planters (i.e., no-till planter from DAEng, conventional corn planter and imported no-till planter) showed that the no-till planter prototype has similar performances than the conventional planter, widely used for maize sowing while exhibiting a lower working capacity in the upland for maize sowing (Table 1).

In the lowlands and for rice farming, the no-till rice seeder is currently used by a local service provider from Banon district offering service for rice sowing. This service provider is testing farmer's demand, assessing technical feasibility of the planter and profitability. He offered so far services on 20 ha with a service fee of \$35/ha. This service provider but also the representative of the Sangke cooperative (covering 4 communes, 7 villages, 1,700 ha) located in Along Tamei village (Banon district, Battambang) are in interacting with the team from Swisscontact, DALRM/CASC and with a local manufacturer/importer to purchase no-till rice seeders in the coming months. That means that the demand of rice seeding both under conventional and no-till management is increasing and the work conducted through ASMC and with the engagement of the private sector represented an essential step to move forward a wider dissemination of no-till seeders.

**Laser land-leveling:** In the lowland, proper emphasis should be given on the management of water usage. Soil levelling planning, through a laser land-levelling system, was targeted to increase yield and grain quality, to improve water use efficiency, the use of others non-water inputs (fertilizer), but also for high potential crops after wet season rice. Three bucket scraper prototypes for laser land-leveling were modified and tested by DAEng. These prototypes were delivered to RUA and DALRM/CASC for evaluation testing and dissemination to users. DAEng also made technical drawing and fabrication instruction that local manufacturer can use for principal guidance. The modified bucket scraper's field capacity is about 7 hours/ha, compared to 8-10 hours/ha for the previous version. This improvement was due to stronger receiver holder stand, and because this prototype is heavier and stronger than that of the previous version bucket scraper.

**Broadcaster:** Rice seed broadcasting is still the main practice used by farmers to sow rice. High rice seed density not only increase production cost but also decrease the adaptability of rice to climate variability and change and to disease prevalence. Rice seed broadcaster has been developed by DAEng. It was assessed for accuracy when compared with hand broadcasting. Additional experiments were started in May and June 2019 and conducted by DALRM/CASC & CIRAD. The results are expected in December 2019 with a comparing performances of seed broadcaster with rice seeders and traditional hand broadcasting. The record of rice emergence, density, tillering rate, productivity, and the prevalence of weeds and disease will be assessed.



**Roller-Crimper:** Roller crimper with elliptical bars was developed by the DAEng and tested by DALRM/CASC & CIRAD both in lowland and upland areas. Roller crimper helps improve the overall efficiency of the cropping system by reducing the number of pass between rolling down the cover crop and sowing the main crops through the mulch of the cover crops. It also reduces or eliminates the need to use herbicide to terminate the cover crops and during the maize cycle, contributing to soil health, improving

### 3.2.2 Conservation Agriculture Cropping systems

The CA principles have been applied for lowland rice and vegetables productions with drip irrigation in Banan district, Battambang province and Santuk district, Kampong Thom province. Hundreds of farmers are involved in CA ice for lowland (146 households, 213 ha, 2018) and upland (117 households, 378 ha, 2018) crops in Battambang and Kampong Thom province (Table 2 & 3).

Province	Village	Households	Area (ha)	Use of cover/relay crops			
				Soil fertility	fodder source	Seed cover crop	Permanent pastureland
Battambang	Samrong	27	35,8	29,7	3,0	3,5	0,2
	Veal Kropeu	29	85,6	74,1	4,0	7,0	0,5
	Along Tamei	17	12,6	10,9	0,5	0,0	1,2
	Kdoang	17	18,8	12,7	3,5	0,0	2,7
Total		90	152,7	127,3	11,0	10,5	4,5
Kampong Thom	Trapaing Toem	2	0,2	0,2	0,0	0,0	0,0
	Laak	29	44,9	27,6	5,8	0,0	11,8
	Boueng Lvea	13	5,7	5,7	0,0	0,0	0,0
	Khvek	12	9,3	8,3	0,0	0,0	1,0
Total		56	60,0	41,7	5,8	0,0	12,8

Table 2: Farmers network, establishment of cover crops after wet season rice (2018/2019) in Battambang and Kampong Thom provinces.

Villages	Area sown under NT (ha)	Households	Area sown under NT (ha)	Households	Diversification with cover crops before maize	
	Season 2018		From 1st July onwards		ha	households
Pichangva	36,3	19	20,4	10	-	-
Sangha	318	93	194,2	68	7	3
Okmum	31,7	5	23,7	8	2	1
Total	386	117	238,3	86	9	4

Table 2: No-till sowing of maize in 2018, Rattanak Mondoul, Battambang. Two periods are presented with (i) the full season 2018 and (ii) the activities specifically implemented after July 1, 2018 corresponding to the start of the CASF project.

water infiltration and retention. However, vibration from roller crimper (straight bar roller design) needs to be improved for power tiller and a specific roller crimper with elliptical bars should be designed.

**Vegetable Hand Tools:** More than 30 types of hand tools brought from the US, EU, Africa, and Asia were introduced to farmers and tested to identify which are appropriate, best, and effective in the farming. Time and labor savings have been considered as keys for adaptation of the hand tools in the commercial vegetable production. Some of the tools tested were handy twine knife, over the shoulder harvesting bucket, section garden hoe, single tine cultivator, cape cod weeder, 3 tine cultivator, short single tine cultivator, push pull hoe, long batwing hoe, collinear hoe and digging tool.

About 30 vegetable production farmers in Battambang are implementing CA commercial vegetable home garden. Schematically, the activities are designed into innovation platforms embedding three main scales: (i) experimental fields (agricultural engineering, assessing agronomic performances, vegetal diversity), (ii) on-farm demonstrations (performances and abilities of the systems to match the means and goals of the farmers), and (iii) pre-extension network (analysis of farmers' adoption and adaptation of machinery and cropping systems; detailed record of costs, labor requirements and economic performances of a sub-sample of representative farms). All scales are not currently established on each location (Kampong Thom: Santuk district and Battambang: Banan and Rattanak Mondoul districts). The following tables emphasized



the number of households involved in a transition towards conservation agriculture in the lowlands (Table 2) and in the uplands (Table 3).

### 3.2.3 Identifying mechanisms to engage local service providers into a CA transition

The price of the no-till seeder (rice, fodder) and planter (maize, pulse crops, sunflower) is high when compared with conventional rice seeder and maize planter. However, based on surveys with service providers and smallholder farmers, the agricultural equipment is making suitable for large land holders, service providers who will offer service to small-scale farmers and agricultural cooperatives which are already engaged in providing services to their members or communities. As in other countries from the region, small scale farmers would have to access to the planter through service providers. However, engaging service providers into a CA/SI transition is challenging because of the investment but also because they raised their concerns about the demand from the farmers. Another challenge is the availability of imported no-till planters and/or the lack of trust of users on the designed seeder. The limitations are expected to be addressed by the on-going project Conservation Agriculture Services with a Fee (CASF). In connection with DALRM/CASC & CIRAD, Swisscontact liaises as the private sector engagement experts and various demand creation activities are being conducted working also on the availability of the implements especially for the no-till planters. Swisscontact is also providing support to a medium manufacturer to promote the seed and fertilizer broadcaster. Swisscontact has developed the 4S<sup>1</sup> technology market segmentation model and will be deploying this model with the Noeurn workshop to promote the seed broadcaster technology.

### 3.3 Capacity building and youth engagement

ASMC Cambodia conducted activities for youth engagement, capacity building of stakeholders,

operators and smallholder farmers, and for knowledge sharing and networking.

#### 3.3.1 Youth engagement

To improve the overall educational experience for the students, steps were taken to improve the educational degree and to build capacity of the faculty staff. In order to improve practical study of the students the mechanic workshop of FAE was equipped, and field visits were organized for the students to gain practical experience. Additionally, the students were provided with internship opportunities to get hands-on experience.

#### To improve educational degree and to build capacity of the faculty staff

There is a need to improve the education degree that is offered by Faculty of Agricultural Engineering (FAE) and to build capacity of the faculty staff. To identify the issues in the undergraduate curriculum of Agricultural Engineering and to discuss the needs for improvement of the degree, a consultation workshop was conducted on June 30-31, 2017. There were 35 participants (7 female) which included lecturers, faculty members and international advisors. The lecturers suggested that upgrading the workshop and lab equipment would help for the practical part of their course. To further the discussion, FAE organized a meeting on June 10, 2019 with 13 faculty members and lecturers. The meeting was aimed at collecting feedbacks from the lecturers and to identify strengths, weaknesses, opportunities and threats (SWOT) of the current curriculum. The output from this meeting, will be the basis for Professor Ting Kuan Chong, University of Illinois at Urbana-Champaign who has been assigned with reviewing and further development of the curriculum. In addition, FAE has been in discussion with Swisscontact to improve the curriculum through possibly collaborating with University of Bern, Switzerland. Additionally, e-learning modules on machinery for conservation agriculture are being developed by the ASMC team as another pedagogical resource for the students to access

<sup>1</sup> The 4S model, a product of Swisscontact, is a four-step marketing strategy which uses farmer segmentation and target

marketing to effectively promote agriculture technology. The 4S consists of 4 stages: Search, Set-up, Service and Showcase.



and to learn on different combined and integrated ways (<http://e-learning.rua.edu.kh/>).

### To improve students' practical study

As recommended by the faculty in the consultation workshop, lab equipment was purchased and installed at FAE's mechanic workshop. Some equipment that were bought include motorized round bending machine, metal welding, shop press, hydraulic hand pallet machine, air compressor, battery charger, electricity analyzer, and other supplies as well as spare parts of machinery. The equipment has allowed lecturers and students, from year 2 and year 3, to do practical experiments in courses such as Agriculture Machinery, Materials and Science and Mechanic Workshop for students. The equipment was also used by year 4 students and workshop staff for thesis researches and other assignments.

RUA-FAE organized field visit for students to 3 target provinces of Battambang, Kampong Thom and Siem Reap including Bos Khnor Research Station located in Kampong Cham province. The aim of the field visits was to demonstrate to the students the link between the classroom study and practical research in the field. For year 2 students, the objective of the field visit was to familiarize them with the farming systems in the target project sites. The students learned about conservation agriculture for vegetables and about the various technologies and technique being demonstrated at the Technology Parks in Siem Reap and Kampong Cham provinces. For year 3 students, the objective of the field visits was to practice the use of various implements for land preparation, crop establishment, laser land leveling, rice grain drying, milling and storage. The students were taken to Battambang province to the Don Bosco Vocational Agricultural Training Center. They also visited the project sites of DALRM/CASC & CIRAD in Banan district and Ratanak Mondul district, Battambang to learn CA practices for rice and upland crops.

### To improve students' practical experience: Internship and Research

Internship opportunities were provided to 4 undergraduate students of RUA. One student interned with DALRM/CASC team in Rattanak Mondul district, Battambang for 3 months. At the end of his internship, he was offered a full-time

position with the team. Another student interned at Tuol Samroang Agricultural Engineering Research Station in Battambang for one month. During his internship, he learned about maintenance and use of agricultural machinery and collected data of experimental research for broadcast seeder testing on rice production. The third student interned at a local manufacturing workshop for broadcast seeder manufacturing in Kampong Thom province for one month. The fourth student interned two months with a service provider that provided laser land leveling services to farmers. He also conducted his thesis research on the laser land leveling testing and service provision. As a result, he was selected as an interpreter for a German researcher to conduct a survey of laser land leveling service providers in Battambang and Banteay Meanchey province for two weeks.

To improve the employability of the students, Swisscontact is supporting FAE to upgrade the internship program. The 1<sup>st</sup> cycle of internship program has started in July 2019 and students are interning with one of MIGIP partners, Larano. The internship is designed in a way where students receive training once a week in the first month on the following topics: Soft Skill, Business Management,



*FAE/RUA students during their internship with Larano Workshop*

Marketing (4S model), Communication and Swisscontact's Inclusive Markets approach.

The project provided opportunities to students to conduct research as part of their undergraduate/graduate thesis. Eight students were selected from FAE/RUA to conduct research as part of their



undergraduate thesis. Five students conducted tests on the newly developed prototypes in cooperation with DAEng, DALRM/CASC and CIRAD. Three students conducted research on other technologies recommended by the Innovation Hub for Madjipump irrigation and Sunbucket in collaboration with ASPIRE Cambodia project. Six students were selected from UBB to conduct research as part of their masters (3) and undergraduates (3) degrees. These students, out of which 50% were female, were conducted research on the vegetable hand tools and looked for ways to help commercial vegetable producers. All the research findings were shared through national and international conferences, and trainings organized by ASMC Cambodia. Three of them received best presentation awards. One student from UBB received Best Presentation Award in the UNICAM Conference 2018. Two students, from RUA and UBB, received Best Presentation Award in the 5th National Conference on Agriculture and Rural Development, celebrated in Cambodia in 2018.

### **3.3.2 Capacity building for stakeholders, operators and smallholder farmers**

As part of capacity building to other stakeholders, operators and smallholder farmers, short term training courses and field days were organized.

#### **Short-term training course**

Over the course of the project period, the implementing institutions of ASMC Cambodia have organized 19 short-term trainings to various stakeholders which includes – government officials, members of the civil society including NGOs, private sector including service providers and small holder

farmers. The trainings courses included concepts of CA, machinery in CA, operation and maintenance of the prototypes, technical drawing, quality check, safety, business management, demonstration of CA technologies and machinery.

A regional training was also organized on May 6-9, 2019 in Siem Reap and Bos Khnor research station. This Regional Training on “Appropriate Scale Mechanisation for Conservation Agriculture” was organized by GDA with the support from CSAM/UN-ESCAP, CIRAD and Swisscontact. 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.

#### **Field days training**

The ASMC implementing institutions, including DALRM/CASC, CIRAD, DAEng and RUA, organized 48 field demonstrations for relevant stakeholders such as producers, government, private sectors, and civil society at national and international events. During the 4 years project, 371 producers (116 female), 224 government officials (32 female), 26 private sectors (10 female), 567 civil society (172 female), and 154 student participants (53 female) attended the on-farm demonstrations. In some demos, students from nearby high school were invited to join to stimulate their interest to study agriculture. In the fourth year, training on gender awareness was organized for the project team as well as other stakeholders. With the support from Ms. Maria Jones, Gender Specialist from the University of Illinois at Urbana-Champaign, the team conducted gender assessment of CA technologies in Battambang province. Later, the assessment was expanded to other target provinces (Kampong Thom, Siem Reap,



*FAE/RUA organized field trip for the 3rd year students to visit the project sites and practical field learning*





*The Oggun tractor training was provided by Faculty of Agricultural Engineering to students and lecturers of the faculty.*

Banteay Meanchey, and Battambang) for conventional technologies.

### **3.3.3 Knowledge sharing and networking**

ASMC Cambodia implementing institutions established links with various institutions such as Swisscontact, Don Bosco Vocational Training School in Battambang, CamSID Australian funded project, CSAM/UNESCAP, among others. ASMC organized Mechanization Webinar where Swisscontact presented on *Enhancing Private Sector Commercialization of Agricultural Machinery in Cambodia*. The ASMC Cambodia team including DAEng, UBB and Swisscontact presented various topics including: Testing the Oggun Tractor for Conservation Agriculture Production System in Cambodia; A Comparison of Direct Seeding in Conservation Agriculture and Conventional Seeding for Paddy in Cambodia; Identifying the best tools for Conservation Agriculture Commercial Vegetable Homegarden Production System; and Overcoming the Valley of Death: Linking Research and the Private Sector.

### **Website and Facebook content**

Information and events organized under ASMC support were published on website and Facebook. The content was published on ASMC's website [asmc.casaenet.org](http://asmc.casaenet.org), managed by RUA, is part of the [www.casaenet.org](http://www.casaenet.org) website which is managed by DAEng. Contents such as articles of events, technical documents, photo and video of mechanization were published on the website as well as two Facebook page (@khmerfarmmachinery and @ASMCProjectCambodia). There have been 4,510 visitors on the website and 2,137 likes on the Facebook page. In addition, educational resources and a number of testimonies are available on the Youtube Channel [Soil is Life](https://www.youtube.com/channel/UC...) (>3,050 subscribers) that is managed by DALRM/CASC and on RUA's e-learning website (<http://e-learning.rua.edu.kh/>).

### **Women Farmer Network formed**

In Banan, Ek Phnom, and Sangkae districts of Battambang province, 50 conservation agriculture commercial vegetable home gardens with drip irrigation were established. The 50 women farmers



were formed as “Women Farmer Network.” Farmers’ knowledge and technologies would be shared through the “Women Farmer Network”. To improve farming practices for the commercial vegetable home gardens utilizing drip irrigation with conservation agriculture practice management, market-available tools brought from abroad, and modified tools were introduced to partner farmers. The farmers were interviewed to get feedback of tool preference. The team also tested efficiency of each tool for work efficiency.





#### 4. Lesson Learned





Hub Advisory Committee meeting has been a useful platform for sharing knowledge among the members as well as receiving feedback and suggestions on the project direction. Due to the involvement of various stakeholders, and specifically private sector, the Innovation Hub brings perspective and areas of collaboration that is essential to move towards sustainable intensification, to engage different market segments to promote and make available appropriate scale mechanization. The HAC also recommend topics for trainings, field days, findings from the field work and share knowledge about demand and supply side.

The involvement of the lecturers and staff of FAE in the meetings to discuss the improvement of curriculum was essential to understand the need of the faculty and the need of the faculty staff. The faculty and students benefitted from the curriculum development. The students appreciated the improvements and their feedbacks were as follows: they preferred practical training as they can learn in different combined and integrated ways (see, touch, practice and listen). They can design using computer software and construct the prototype using the equipment from the mechanic workshop which was provided with the support of the project.

The gender assessment of CA technologies, conducted by Ms. Maria Jones, in Battambang province revealed that women are unintentionally being excluded from training events. Usually for training events, one member per household is invited. Among the household members, men/husbands are the ones to attend the training, but they are less likely to share

information from the trainings and events than women/wives. Women attend training only if men are busy. Another constraint for women to attend the training is timing. The trainings conducted usually tend to start at 8 or 9 am. The timing between 8-11 am is not a suitable time for women as they are busy with household tasks such as cleaning, childcare, and cooking lunch. Lack of transportation is another barrier for some women to attend training events. Additional recommendations were emphasized with:

- (i) targeting a better engagement of households both men and women as farmers and service providers, in order to enable CA adoption,
- (ii) service provision is critical to adoption of CA and accessibility to mechanized tools such as the no-till planter needs to be improved (i.e., availability, payment options, at the time needed by farmers),
- (iii) there is a need to explore innovative cropping systems which take into account technical details such as land preparation, pest management, cover crop growth and labor/market needs such as input payments, and availability of households, and
- (iv) technology adoption and new techniques should include youth farmers actively.

In terms of knowledge sharing platforms, website is quite useful to store documents and organize it, but Facebook page is more powerful for sharing and promoting technical tips, demonstration of prototypes as more people can see, particularly the Cambodian farmers, service providers, students, among other with limited knowledge in English and accessing websites.



## 5. Future Direction





### Policy dialogue and role of the Hub advisory:

Innovation is still considered by development practitioners and states as a matter of adoption of a new technology. But the intrinsic qualities of a practice do not guarantee its broad scale dissemination and impact. Many constraints related to multi-scale and multi-sector dimensions of the innovation have limited the impacts of long-term development efforts so far. There is a need to bring under a more systematic way technical, economic, environmental, and organizational-based evidence to policymakers. The ASMC Innovation Hub will operate in close connection with CAMTA (Cambodia Agriculture Machinery and Technology Association) and with CASIC (Consortium of Conservation Agriculture for Sustainable Intensification Cambodia) that will be the place in the future for policy and inter-sectoral dialogues. The main objective of the ASMC hub will be to capitalize research-based knowledge informing agricultural policies, to bring together different stakeholders (public, private, higher education) to support the changes of agricultural mechanization in the field of Sustainable Intensification.

**Synergy with other projects:** To give continuity to the activities on CA and to address some of the challenges, the project Conservation Agriculture Services with a Fee (CASF, USAID), was launched in July 2018. CASF aims at engaging the private sector in the uplands and lowlands of Battambang province. Several partners are involved with RUA, CE SAIN, KSU, Illinois Urbana-Champaign, DALRM/CASC, DAEng, CIRAD and Swisscontact. Swisscontact, specializes in private sector engagement, implemented several activities to involve the private sector. Swisscontact engaged with a local manufacturer and importer, provided support to identify farmers' demand and built the relationship between manufacturers and service providers, and between service providers and farmer communities. The activities implemented by ASMIH were also key to strengthen the national dynamic on sustainable intensification. In this regard, in the coming months, through the support of Swisscontact and CIRAD, the Cambodia Conservation Agriculture based Sustainable Intensification Consortium (CASIC) is expected to be launched along with the establishment

of a Center of Excellence CA for SI (CE CA4SI) at the Bos Khnor Station (GDA). Synergy will be sought with CAMTA as well.

### Additional technology, test and demonstration:

additional tests are required for the rice seeder (both CT and CA) for 4WT, bucket scraper for laser land leveling and seed broadcaster for 4WT and for 2WT. Economic models for these prototypes should be developed as well as train local manufacturers, consumers, students and relevant stakeholders. The effort to demonstrate and promote planters and seed broadcasters with farmer communities, cooperatives and service providers must be pursued in through the support from DALRM/CASC, CIRAD, ASMC partners and Swisscontact.

**Reinforce education:** FAE has been in discussion with Swisscontact to improve the curriculum through possibly collaborating with University of Bern, Switzerland. Swisscontact is also supporting to develop a better structured internship program for the FAE students. In this internship program, the students will be better prepared for the internship, and FAE will improve their network with private sector so that FAE is better able to find intern placements for the student.

**Reinforce training programs:** Training programs should be reinforced for different target groups (i.e., agricultural engineers, students, manufacturers, service providers). Steps should be taken to develop economic models for the different agricultural equipment, to train local manufacturers, service providers and to intensify on-field technical training both for local service providers and farmers. Special focus needs to be given to encourage women and youth to contribute and participate in the design, test of machinery and their use on farm.

**Engaging with the private sector:** Making no-till planters available to smallholder farmers constitutes an increasingly relevant opportunity in both lowland and upland areas of Cambodia. Service providers play a major role in smallholder farmers' access to tractor services, and thus, to the intensification of cropping systems while at the same time contributing to the soil fertility depletion through plough-based management. There is an opportunity to engage them



into a process to facilitate farmers' access to mechanization that enables transition towards conservation agriculture and sustainable intensification. However, for a service provider, investing in a no-till planter may not necessarily be an obvious decision. Challenges are identified at both the supply and demand side of the no-till planters' market in Cambodia. Importers are not confident to sell no-till planter as tractor owners (tilling service providers) are not convinced that farmers will buy no-till services from them. Farmers report interest in no-till but are risk-averse and unsure no-till planters will increase productivity. Hence further interventions are proposed to overcome the problems in the demand and supply of the no-till services:

- (i) increase adoption of no-till planters,
- (ii) diversify tractor owner service offering to include no-till planters services,
- (iii) improve the supply chain for no-till planters, and
- (iv) strengthen the relationship of institutions working on Conservation Agriculture.

Surveys conducted with 35 service providers (26 in upland and 9 in lowland areas) from Battambang province (Samlout, Banon and Rattanak Mondoul districts) emphasized that over 65% of their net income come from non-conservation mechanized operations (Vernet, 2018; Vernet et al., 2019). Supports to service providers should also take into account their diversity. We identified four main categories of service providers for whom the strategy differ with:

- (i) focus on own farm and provide services to their communities,
- (ii) focus on service provision,
- (iii) intensive use both on farm and for service provision, and
- (iv) low performance on service provision with under-used equipment.

The interests and capacities of service providers to invest into a no-till planter differed between categories. Actions to support the increased use of no-till planters can focus on triggering farmers' demand (e.g., thanks to demonstration fields bringing together service providers and farmers) and enhancing the environment of service providers. This could include making sure that no-till planters and spare parts are

available on the market, either thanks to import or to local production. It could also entail building capacity of service providers in terms of operation and maintenance of no-till planters. Our study emphasized the relevance of offering support in priority to rice seeders and for versatile no-till planters in the uplands. Land use in uplands is quite dynamic and farmers located in uplands have changed several times of crops over the past two decades. In the lowlands, agronomic constraints make it difficult for farmers to produce other crops than rice, so farmers' demand for no-till seeders would be much more stable.

Support can take different forms. Public policies can also impact the profitability of custom hire services. On the one hand, rigid and restrictive policies in terms of taxes or import regulation can lead to increased investment and operating costs (Diao et al. 2016). On the other hand, financial support from public institutions through subsidies or tax exemption can help providers' acquisition of new equipment (Sims and Kienzle 2017). However, past records of these types of support are usually disappointing (Groot et al. 2018). There is thus a need to define subsidies that support but do not distort the market for mechanization services (Baudron et al. 2015). Support to create the demand and to build the connections in both side (i.e., manufacturer – service provider and service provider – farmers) should be targeted and this is the work currently implemented by Swisscontact and other partners through the CASF project.

Finally, farmers' demand is not only uncertain at the present, it may also evolve. This demand may increase in the future once farmers see the benefits of using a no-till planter, or because the planters enable to sow a large diversity of crops during a wide period throughout the year. However, this demand could also decrease in the upland area as a consequence of farmers shifting to fruit tree plantations. Support action could help service providers developing robust strategies. For instance, the demonstration and analysis of the profitability of versatile (but more expensive) no-till planters could be done with the service providers located in the uplands and who have high investment capacities.



## 6. Aggregated Results

693



Number of Producers  
**30% FEMALE**

398



Number of Government  
**15% FEMALE**

124



Number of Private Sector  
**17% FEMALE**

1,111



Number of Civil Societies  
**26% FEMALE**

333



Number of Students  
**28% FEMALE**

14



Number of Students  
in Research

4



Number of Students  
in Internship

15



Number of  
Prototypes Developed

2,291



Number of Hectares  
the prototypes tested on

18



Number of Workshops

19



Number of Trainings

48



Number of  
Field Demonstration



## 7. List of Scholarly Outcomes

During the project, several scholarly works have been produced and presented in various workshops, training, conferences which have been compiled and listed below.

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## 8. Conclusion





In brief, the following activities are highlighted:

- Surveys were conducted to identify for the main agroecosystems the agricultural machinery and equipment used and produced locally, to assess their cost, efficiency and practicability for farmers.
- A process of collective learning and adaptation has been promoted through the events organized and regular meetings from the Hub Advisory Committee. These events provided opportunities for smallholder farmers, service providers, manufacturers, importers to meet, share ideas and propose changes on the agricultural machinery set developed.
- Agricultural machinery and equipment set designed and developed is currently demonstrated and in use outside the initial targeted areas.
- Local authorities, smallholder farmers, local manufacturers of agricultural machinery and service providers expressed their wishes to have access to a larger range of equipment, that are produced locally, easy to adapt to a diversity of conditions, affordable with facilities in place both in terms of maintenance and availability of parts.
- Supports need to be identified to strengthen medium manufacturers for the production of appropriate-scale mechanization that match with the principles of sustainable intensification. This is a key issue that has to be targeted along with supports to local service providers.

**Future interventions:** will help promote a sustainable service provision in Battambang – a high-potential pilot market in Cambodia – by working on the demand and supply side of the market. The support from a phase 2 of ASMC will help in starting up the initiative to promote the commercial relationship between the company, tractor owners and the farmers. To sustain a market-based solution the intervention seeks to achieve the following business objectives:

- (i) demonstrate market-based incentives to tractor owners to establish no-till service provision and
- (ii) attract private sector investment in no-till planters' manufacturing and/or import. There is still a need to work on the efficiency of the farming system, reducing production costs while increasing productivity and profit. The first steps towards planting green technology, implemented by DALRM/CASC and CIRAD, are promising

and must be strengthened in case that a second phase is implemented. If the project were to extend, DAEng would like to continue to develop a bucket for laser land leveling by studying and producing a larger-sized of bucket with 2.5 meters long and 3.2 meters wide; to continue to develop a direct seed planter for conservation agriculture by conducting research and production trials. 1) Direct seed planter for single-grain rice and 2) Direct seed planter for rice and other crops such as corn and bean.

**Good synergies between implementing institution:** The synergies between the various implementing institutions was very encouraging as each one is moving towards the sustainable intensification of Cambodia agriculture with appropriate scale mechanization.

**Organization for private sector engagement helped:** Although not part of the project design, including Swisscontact as an implementing institution was an important and strategic move on the project's part. As the other institutions are research-oriented organization, the project needed someone that understood private sector engagement and Swisscontact played this part. As emphasized in the report, Swisscontact will also provide support to the secretariat of CASIC and CAMTA.

**Demand based internship (engaging the private sector):** There is much work that is still needed in the internship design for FAE. Swisscontact has a model to improve the internship process and is working with FAE and it would be good to support to scale this. Through the work conducted by DALRM/CASC and CIRAD essential connections are made with service providers and farmer communities. Those links must be valued as a support for training and for the interns. In addition, involving interns into field activities allow developing complementary studies to inform the changes in appropriate-scale mechanization for sustainable intensification.

**Organization for project management helped:** The project has also realized the need of having an organization that has experience in project management. Bringing Swisscontact helped as they have experience in management, which gave other



institutions, specializing in research, the opportunity to concentrate on their research work. This would benefit all the implementing institutions and add to the synergy. Swisscontact also understands the importance of research for technology commercialization and their understanding of the valley of death has been instrumental in the private sector thinking. This should be part of the design in the next phase if it comes. RUA has been instrumental in the engagement of youth and for the overall research on development of appropriate scale of agricultural machinery and equipment for Cambodia.





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