

GENDER TECHNOLOGY ASSESSMENT

Appropriate Scale Mechanization Consortium

CAMBODIA: SERVICE PROVISION FOR CONSERVATION AGRICULTURE

Maria Jones¹, Vira Leng², Socheath Ong³, Makara Mean³

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¹University of Illinois at Urbana Champaign, ²Department of Agricultural Land Resources Management, Conservation Agriculture Service Center, ³Royal University of Agriculture, Phnom Penh

The USAID funded Appropriate Scale Mechanization Consortium led by the University of Illinois at Urbana-Champaign develops and promotes appropriate agricultural mechanization technologies for smallholder farmers in Cambodia, Bangladesh, Burkina Faso and Ethiopia. ASMC's 'eco-system of innovation' approach includes the development of local Innovation Hubs comprised of relevant stakeholders to promote and enhance suitable, sustainable, and scalable mechanization. In Cambodia, Innovation Hub leaders and key implementers are Faculty of Agricultural Engineering at the Royal University of Agriculture, Phnom Penh, The Conservation Agriculture Service Center, Department of Agricultural Engineering at the Ministry of Agriculture, Forestry and Fisheries and CIRAD.

SUMMARY

Agricultural technologies can improve economic productivity and reduce time spent on agricultural production, processing, and transporting. Men and women have similar propensities to use technologies. However, women are less likely to have access to them compared to men. Ensuring women have better access to agricultural technology, inputs, and information can help lessen the gender gap in agricultural productivity and increase agricultural output globally by 2.5-4% (FAO 2011). The Appropriate Scale Mechanization Consortium (ASMC) project conducted a Gender Technology Assessment of ASMC Cambodia's service provision for conservation agriculture. This report identifies gender barriers and enablers to adoption of conservation agriculture, understands intra-household gender norms and women's roles in household technology adoption. The report concludes with strategies for better design, dissemination, and adoption of the service provision.

Key Findings:

- Conservation Agriculture (CA) service provision is critical to the adoption of CA practices. Therefore, the service provision design and delivery needs to be robust.
- Women play integral roles in the household decision-making in adopting technologies, especially in the paying for technologies, negotiating with and paying service providers. Women need tailored CA trainings that cater to financial reasons to adopt CA. Trainings need to be accessible in time, location and medium of instruction.
- Men and women collectively negotiate adoption of new technologies, or methods such as CA.
- CA for vegetable production can increase women's labor and time in weeding and mulching. Hand tools combined with consistent technical assistance can help lessen the impact.

CAMBODIA COUNTRY PROFILE

Cambodia is a lower middle-income status country that ranks 146 out of 189 countries on the Human Development Index. Between 1990 and 2018, Cambodia's HDI value increased from 0.364 to 0.552, an increase of 59.9 percent (UNDP, 2018). Cambodia's economy has sustained an average growth rate of 7.7 percent, primarily driven by garment exports and tourism (World Bank, 2019). The poverty headcount declined from 53 percent in 2004 to 18 percent in 2012, lifting four million people out of poverty. More than 60 percent of poverty reduction was a result of positive developments in the agriculture sector where, higher rice prices stimulated the larger rice production that increased farm wages (Eliste & Zorya, 2015). However, about 90 percent of the poor live in the countryside with around 4.5 million people remaining near-poor, vulnerable to falling back into poverty when exposed to economic or other external shocks (World Bank, 2019).

In Cambodia, the agriculture sector accounts for 27 percent of GDP and is a major employer and livelihood option for the population. Cambodia's small-scale family farms range from being rain-fed and few inputs to utilizing high yielding rice varieties under irrigation systems. In the flood plains and upper sandy terraces, farmers utilize local jasmine rice seed varieties (Pkha Rumdoul) and in the uplands with commodities such as maize and cassava, farmers purchase seeds from the market. Typical farm sizes tend to be less than four acres and 41 percent of the population farm on less than two acres of land (UNCDF, 2016). Majority of these farms (58 percent) produce just only rice, and 26 percent of farms produce two crops. In 41 percent of rice farms, the household consumes all of the harvest (ibid). A 2017 report by the Ministry of Agriculture, Forestry, and Fisheries (MAFF) stated that in 2017 only 40 percent of population worked in farming, which is down from 80 percent in 1993 (Open Development Cambodia, 2015). The World Bank also records a downward trend in the net output of agriculture, forestry and fishing sector from 34.5 percent of GDP in 2011 to 23.4 percent of GDP in 2017 (World Bank, 2018).

Rice, which is Cambodia's primary crop in the uplands, contributes 60 percent of agriculture's contribution to the national GDP. The government instituted the "White Gold" policy, which targets lifting rice production to 1,000,000 tons for export by 2015 (Open Development Cambodia, 2015). In 2017, rice exports were only 538,396 tons. China was Cambodia's largest market in 2018, buying 27 percent or 170,154 tons (ibid). The country also has a strong fisheries sector producing 802,450 tons in 2016. Freshwater fisheries are an integral part of the country's culture, economy, and food security, and is a vital source of food for rural people (FAO 2015). Cambodia exports fish, prawns, crabs, and other seafood to China, Japan, Russia and some ASEAN countries. Yields for most crops increased by 4 percent during 2004-2012, driven by the use of new technologies and quality fertilizers, expanded irrigation, and better access to mechanized services and markets. (Eliste & Zorya, 2015).

The Cambodian government has prioritized agriculture as a key sector for development through the Rectangular Strategy. The third version of the strategy aims to push agricultural investment beyond strengthening rural incomes, into improved technology, research and development, crop diversification and promotion of commercial production and agro-industries. The 2010-2016 Strategic Plan for Agricultural Engineering in Cambodia, developed by the General Directorate of Agriculture and the Royal University of Agriculture's (RUA) Department of Agricultural Engineering (DAEng), aimed to increase mechanization in rice production to 46 percent by 2016. The strategy promoted farm machinery, which

was cheaper, more efficient, versatile and user-friendly for small farms (CSAM, 2014). DAEng has calculated that 68 percent of the mechanization target can be achieved by promoting multiple uses of the power tiller and planter, by adding implements for planting, weeding, fertilizer application and other post-harvest operations.

Gender: The Women's Empowerment in Agriculture Index (WEAI) scores Cambodia at 0.98, reflecting high levels of women empowerment (Malapit, et al., 2014). The Royal Government of Cambodia's (RGC) specific commitments to promote gender equality through its institutions, policies, and practices have contributed to Cambodia's progress in reducing the gender gap in terms of political, economic, health, and education measures. More women occupy political positions, are leaders in civil society organizations and there is no gender gap in enrollment at the primary and lower secondary levels of education (although gaps persist at higher levels). Maternal and child health indicators have improved significantly in recent years and more women have access to skilled birth attendants (USAID , 2016). Women run 65 percent of all businesses, most of which are microenterprises. Though women's businesses are less profitable than businesses run by men, women are benefiting from great access to financial services forming over 80 percent of the clientele of microfinance institutions (ibid.).

Cambodian women have the highest labor force participation rate in the region at 79.7 percent, but a gender gap remains (the male rate is 89.1 percent). The three sectors that account for 89 percent of all women's employment are agriculture, forestry, and fisheries at 66.3 percent; wholesale and retail trade and services at 12.7 percent; and manufacturing at 10.3 percent (ADB, 2014). Women are active both in self-employment and wage employment in the agricultural sector and 22 percent of small-scale agricultural households are female led. Women participate in all phases of the cropping cycle, play the lead role in food processing and are responsible for feeding their families; however, gender inequalities in access to productive resources, services and markets remain widespread (ibid.). FAO's country programming framework also notes that the lack of gender-disaggregated data hampers informed decisions on how to optimize the development contribution of the female labor force in the agricultural sector. The Asian Development Bank calls for addressing productivity constraints in agriculture – the sector in which most Cambodian women work (ADB, 2014).

Although literature broadly states that agricultural mechanization serves to reduce women farmers' workload and increase their productivity, it is beyond the reach of women farmers in Cambodia. National statistics indicate significant differences between female and male farmers' access to agricultural tools and farming equipment in Cambodia. Male-headed agricultural households are seven times more likely to have access to hand tractors and more than twice as likely to have access to a water pump compared to female-headed agricultural households (MAFF, 2006).

Rural migration is contributing to reducing the growth rate of the sector as the average age of farmers' increases and the availability of rural labor decreases. A 2012 report on migration found that 90 percent of villages had experienced a reduced population as a result of out-migration (MOP, 2012). Migration also has strong gender dimensions, as family and community structures are altered. In many instances, women become de facto heads of household when the male head of household migrates. This may offer greater leadership opportunities and autonomy, but poses additional burdens and limitations on women's time (USAID , 2016). Nearly 60% of rural migrant women move to Phnom Penh (ADB, 2015). Women migrants have lower average earnings and send more money home than their male counterparts. Women migrants

tend to work in the garment industry, as self-employed business owners, services or as domestic workers (ADB, 2015).

Migration is also common amongst youth who do not view agriculture as an attractive future and seek better prospects in other sectors, in the cities and in neighboring countries, particularly Thailand (FAO, 2016). Cambodia has the largest youth and adolescent population in Southeast Asia, with 50 percent of the population below the age of 22. There is a need to engage youth and invest in their skills and capabilities to offset the challenges of un/underemployment and increasing urban poverty (USAID, 2016) (FAO, 2016). The FAO's country strategy also recommends making agriculture and the related value-chains more profitable and creating off-farm employment opportunities in rural areas (FAO, 2016).

Conservation Agriculture: Over the last two decades, the Cambodian uplands has seen increased agricultural intensification which has had negative impacts on soil fertility, land degradation, and resulted in loss of biodiversity. One of the focus areas for the World Bank's investment in Cambodia includes improving agricultural productivity and diversification, and strengthening the sustainable use of natural resources (World Bank, 2019). Conservation agriculture (CA) is beneficial in strengthening the environmental sustainability of agricultural production. It operates on three technical principles: minimum soil disturbance through minimum tillage or no tillage, soil cover with organic crop residues and diverse crop rotations (Kassam, et al., 2009). CA practices have demonstrated potential agronomic benefits such as preserved or increased soil fertility, improved soil productivity, greater resilience to climate change and increased yields (Hok L., et al. 2015; Le, K.N. et al. 2018; Pheap, S., et al. 2019; Wall, 2007). Furthermore, CA could serve as a pathway for smallholder farmers to increase profitability, decrease labor burdens, reduce production costs and enhance household food security (Derpsch, et al., 2010).

In Cambodia, the General Directorate of Agriculture (GDA), Department of Agricultural Land Resources Management, and CIRAD (the French Agricultural Research Center for International Development), co-designed CA cropping systems. CA activities in Cambodia have been implemented since 2004 through the French Agency for Development (AFD) in Kampong Cham province. Activities were also implemented in the pioneer front of Battambang from 2010 to 2014 under the USAID funded Sustainable Agriculture and Natural Resources Management (SANREM) CRSP. Since 2014, the GDA, the Conservation Agriculture Service Center (CASC) and CIRAD have promoted CA activities through different projects and sources of funding including the USAID funded Feed the Future Innovation Lab for Sustainable Intensification.¹

CASC, CIRAD and the DAEng have promoted CA through innovation platforms. The innovation platforms operate through experimental fields (e.g. assessing agronomic performances); on-farm demonstrations; and forming a pre-extension network (e.g. data on farmers' adoption and adaptation of machinery, assessing economic performance). CA-based cropping systems have been developed for both the upland (Battambang, Kampong Cham) and lowland (Kampong Thom) regions.

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ASMC CAMBODIA

Developing appropriate scale mechanization is an essential R & D dimension of CA for smallholder farmers. Within the Appropriate-scale Mechanization Consortium (ASMC), partners CASC and DAEng have focused on two complementary dimensions: 1) identifying the right mechanization for sustainable CA cropping systems; 2) and mechanisms to make mechanization accessible and affordable for all types of field crop producers (Chan, et al., 2017). Since 2016, through ASMC, a rice no-till planter has been developed by DAEng and tested in the lowlands and uplands of Battambang. The project has also developed six prototypes of the seed planter, seed broadcaster and bucket scrapper, which can be operated with a power tiller and tractor.

CA Service Provision: In order to make mechanization accessible, ASMC has worked to identify mechanisms to engage local service providers in the provision of CA services. For instance, in the upland region of Battambang, CASC has been providing farmers service for no-till sowing of maize, advising farmers on crop management (maize, pulse crops, cassava), and supporting farmers in producing seeds for cover crops since 2014. ASMC built on CASC's existing work to provide support to design and test the no-till planters, and strengthen farmers groups in different agroecosystems (uplands and lowlands). A study conducted by Vernet helped establish the demand for no-till services. By 2018, cultivated area under no-till was at 150 ha/planter per cropping season. Although no-till planting service was offered at \$35/ha (which is more than planting costs for conventional maize planter at \$25/ha), farmers were willing to adopt no-till planting if the service was available (Vernet, 2018). This also highlighted the central role of local service providers as a key change agent in enabling CA transition. The demand for service providers is expected to be high for at least the next 10 years until land concentration increases, which would increase the need for agricultural machinery to be owned by individual or larger farms (ibid). A key challenge in engaging service providers to provide CA services is the financial investment required to purchase implements such as no-till planters. Implements can range from \$7,000 to \$10,000 based on crops. Furthermore, service providers tend to earn more with conventional tillage as they provide two to three ploughing services per field, in comparison to a no-till planter, which requires only one operation (See box 1 for more information).

In 2018, the Conservation Agriculture Services with a Fee (CASF, USAID Cambodia) project brought together several partners to engage the private sector in enabling service

Box 1: Service Providers for CA

In 2008, CASC identified that farmers were not interested in purchasing the no-till planter with the power tiller due to high labor and time required to perform no-till sowing operation. Instead, farmers preferred to pay for the service of no-till planting.

However, a typical four rows, no-till planter from Brazil costs \$14,000, which was beyond the financial capacity of local service providers to purchase. Additionally, there was no sufficient evidence of farmers' demand for no-till planting and access to clientele within a radius of eleven km (Vernet, 2018).

In 2012, CASC purchased a no-till planter from a Thai manufacturer at half the price at \$7,000. However, adaptations were needed such as lower weight and improved seed distribution function. Furthermore, it was difficult to promote the no-till planter, as specific skills were required to build connections between agricultural machinery manufacturer, service providers and farmers.

This led to the CASC team, since 2014, playing the role of a service provider offering service for no-till sowing of maize and providing free technical support to farmers.

providers to transition to CA practices in both the upland and lowland regions of Battambang. Partners included RUA and the Center of Excellence on Sustainable Agricultural Intensification and Nutrition (CESAIN), GDA and the Dep. of Agricultural Land Resources Management (DALRM/CASC), DAEng, CIRAD, and Swisscontact. CASC and Swisscontact provide support to local manufacturers and importers, identify farmers' demand, build connections between manufacturers and local service providers and between service providers and farmers.

GENDER TECHNOLOGY ASSESSMENT

Technologies/Mechanization can improve the timing of tasks, reduce drudgery, make labor more efficient; and improve the quality and quantity of food, feed, and fuel. However, they are not inherently gender neutral (Manfre, Nordehn, & Rubin, 2017). Developers need to ensure that new technologies will benefit both men and women farmers. Closing the gender gap in women's access to agricultural technology is considered a key strategy for rural women's economic empowerment (FAO 2011).

Methodology

The ASMC project conducted a Gender Technology Assessment (GTA) of CA service provision of no-till planting to understand the gender dynamics that can affect access to CA service, and thereby adoption of CA practices. The GTA aimed to understand gender barriers and enablers to adoption of CA service provision; understand intra-household gender norms and identify women's roles in household technology adoption; and identify strategies for better dissemination and adoption. The GTA methodology was adapted from the Technology Assessment toolkit developed by Cultural Practice, LLC within the INGENAES project (Manfre et al., 2017) and the Guidance for Inclusive Irrigation Interventions tool developed by IFPRI-REACH project (Theis et al., 2018). The GTA was conducted over a period of seven days, which included a two-day workshop to train 12-member team (DAEng, CASC team, ASMC staff and 2 RUA faculty and students), four days of data collection and one day of group analysis to organize key findings and develop recommendations.

Key informant interview were conducted in two villages in Battambang province. Site selection was based on CASC field staff's experience and prioritized availability of higher density of service providers of CA and conventional farming (CT). Three categories of respondents were targeted: farming households using CA Service Providers, farming households not using CA Service Providers, farming households not using CA practices but using conventional farming methods and hiring service providers. The team also interviewed service providers, community leaders and the CASC team. Data was collected through semi structured qualitative interviews. In total 22 households in Ratanak Mondol (upland) and 16 households in Banan (lowland) were interviewed producing maize and rice. Additionally, six households in Banan were interviewed for vegetable farming. Interviews were conducted in Khmer, and translated into English when needed. The next section of the report discusses agricultural production and access to service provision along three key areas of inquiry: Time & Labor, Income & Assets, and Intra-household gender norms.

Time & Labor

Agricultural production activities are gendered, with men primarily involved in activities related to the field and women engaged within the sphere of the household. Male respondents mentioned being

responsible for multiple tasks along rice production from land preparation to harvesting. Specific agricultural tasks men perform include tillage activities (plowing, furrowing), application of herbicides, pesticides, and fertilizer, irrigating fields and transporting crops to market. In certain tasks, sons or son-in-laws assisted with land preparation (harrowing), application of fertilizers or pesticides and transporting paddy to mills. In one instance, a male respondent said that if his son in law was not available, he hired labor.

While men are primarily responsible for activities in the field, women's roles in the domestic sphere are integral to the Cambodian farming system. Female respondents assisted their husbands in the field in broadcasting seeds, weeding, preparing fertilizer or pesticides, irrigation and harvesting. Some male and female respondents pointed out that women were responsible for manual weeding. Multiple female respondents stated that they prepared and brought food for their husbands or hired laborers working in the fields. Women were primarily responsible for household activities such as washing, cooking, cleaning and childcare. Women also managed household vegetable gardens, raised small livestock, managed household finances (see [Income & Assets](#) section), and marketed and sold maize and rice.

Agricultural machinery such as four-wheel tractors or power tillers were operated only by male members of the family. Some respondents mentioned that men had greater physical strength to handle the agricultural machinery, or carry backpack sprayers for pesticides or fertilizer application. Although women helped in preparing the solutions, it was perceived as men's task.

Income & Assets

Both men and women respondents stated that women were primarily responsible for managing household finances. Activities done by women included budgeting household expenses, paying back loans, allocating income from crop production, marketing and selling the maize and rice production. Multiple women respondents owned and operated local grocery stores and managed money from the stores. Women determined the price for different products. In some households, women inquired of market prices from middlemen, and negotiated price with buyers. Decisions on selling were discussed by both the husband and the wife. Women stored money from the sale of crops and paid for household consumption expenses. A male farmer said, "[when] I receive cash from a sale and give it to my wife." However, major purchases such as machinery or land were decided by men in discussion with their wives. A male respondent mentioned that he was happy with his wife managing the household money.



A women farmer who also owned and operated a local grocery store

In Cambodia, there are several ways to obtain land: (1) redistribution from former KR generals as part of the reintegration of the KR beginning in 1996; (2) purchase from former KR soldiers and others; (3) inheritance from either the husband's or wife's parents; (4) renting land; and (5) "managing" land. Joint ownership is mandated under the 2001 Land Law, defining ownership rights so they are shared equally between a husband and wife and land is confirmed as marital property. The law is designed specifically to assist women secure tenure and control over land, although women may not make decisions on how the land is managed (Sumner, et al. 2016).

According to UNCDF, in Cambodia, about 60 percent of farmer households are in possession of documents of ownership for their land, while 54 percent report having title deeds for the land on which they farm.

Formal and informal sources of credit are available to farmers. Thirty-six percent use formal credit and 15 percent use informal credit (UNCDF, 2016). Sumner et al. (2016) mentions five main sources of credit available to smallholder farmers in the Ratanak Mondol region: (1) moneylenders; (2) micro-finance institutions; (3) savings groups sponsored by international NGOs; (4) family members; and 5) middlemen. During interviews, common sources of credit mentioned by respondents were individual money lenders and ACLEDA bank. Credit was accessed to purchase inputs such as chemical fertilizers, motorcycles. One female respondent accessed credit to help her daughters business. Some farming households belonged to savings group lead by Green Trade, a rice milling company.

Multiple respondents mentioned owning motorcycles. UNCDF states that 71 percent of people own motorcycles in comparison to 19 percent who own an agricultural vehicle. Respondents saved for and bought motorcycles for their children to travel to school or pursue higher education. Mobile phones and televisions are also popular with 72 percent of the population having access to a television, and 62 percent accessing media on mobile phones (UNCDF, 2016).

Intra-Household Gender Norms

Negotiations and dynamics within the household can affect the dissemination of agricultural technologies and management practices, including CA (Doss 2001, 2013). While the farming household is not a homogenous unit, men and women's roles in decision-making within the home and field are not independent and, in fact, are interrelated in multiple ways.

Within agricultural production, male respondents mentioned making most decisions. This included seed selection, herbicides used, cropping system to follow. Men also proposed investment ideas such as purchasing machinery, but discussed with their wives prior to making the decision. While women did not participate in decision making on herbicides used, women respondents track expenses within the farm, pay debts, negotiate prices for laborers and prepare financially for the next season. Women played critical roles in selling. One female respondent said, *"I gather information,*



Female Service Providers:

Cheng Chum is a multi-faceted farmer who owns seven hectares of land, operates a local grocery store and runs conventional farming service provision business with a tractor. Her father and brother owned tractors, which was a motivation for her household to purchase a tractor.

She initiated the discussion to purchase a tractor with her husband, and they mutually decided to purchase it with their savings. Cheng charges farmers \$27.5/ha to provide tractor services, and pays the driver \$2.5/ha. Within six months of purchase, she had a net profit of \$1200 with which she purchased a motorcycle for her son to pursue his education.

Both men and women (in a ratio of 10:3) contact her to hire tractor services. New customers contact her because of the word-of-mouth promotion from existing customers.

and then we discuss together and decide [on selling].” A female respondent said she did not have money saved because she had to “pay for the next season and take care of household expenses”. Furthermore, female respondents also mentioned that they propose new activities for the farm, and decide on the amount of crops to be sold. One women stated, “I decide to keep 2 ha of rice out of 9 ha for my household’s consumption.” Another man said, “I bring the idea of selling the crop to a buyer, but she [wife] is the main decision maker.”

This intra-household dynamic can also be seen in hiring conventional or CA service providers. Some respondents mentioned that men look for service providers and select laborers for plowing, planting and harvesting. However, the men bring money from their wives to pay the service providers. Many female respondents said that they paid for hired labor, such as harvesters, but mutually decided with their husbands on whether to hire or not.

With respect to purchasing agricultural machinery or new technology adoption, respondents mentioned that husbands propose the idea but discuss with their wives. Husbands may take the final decision on purchasing machinery after discussing with their wives. Only one female respondent said she was a key decision maker on buying new machinery such as tractors. As Sumner et al. discusses, “power-laden negotiations occur and link the field to the household in multiple ways... women’s decisions about household finances (in)directly affect decisions about the choice of farm inputs” (Sumner, et al. 2016). Some farming households said that adult children purchased and encouraged parents to try new technologies such as power tillers.



Gender Dimensions Framework

Key areas of inquiry: Time & Labor; Income & Assets; Intra-Household Gender Norms

GENDER CONSIDERATIONS WITHIN TECHNOLOGY ADOPTION

Technologies are not inherently gender neutral, and there is a need to understand the needs of users – both male and female. Sophie This mentions, “Technology adoption is not only about how well-suited the technology is to a user’s needs, but also about overcoming the constraints to learning about, investing in, and using the technology, which are gendered processes.” This section explores CA service provision adoption and broadly, adoption of CA (for cash crops and vegetable production) by men and women through the four stages of technology adoption: design, dissemination, adoption, and use (see figure below). For this report, we do not address ‘use’ because CA Service Provision for no-till planting is still in its early stages.

Design

Although the application of CA's three principles (no-till, soil cover and diversified cropping pattern) brings about agronomic sustainability of farmers' practices, experience across many countries has shown that the adoption and spread of CA requires a change in commitment and behavior of all stakeholders. CA is management and knowledge intensive, and complex to practice, requiring more planning than tillage-based systems (Derpsch, 2008; Friedrich & Kassam, 2009). CA Service Provision with no-till planting provides a big advantage in reducing the labor involved and thus critical in CA adoption. However, the assessment team identified the following gaps in the service design and delivery that could negatively affect CA adoption:

- **Timeliness:** The time range for planting and harvesting is a short window where farmers need on-time service. Lack of timely service provision for no-till planting or harvesting of cover crops lead to farmers discontinuing CA practices. This was further exacerbated by field location, where farmers who were interested in adopting CA practices, could not access service provision for their farms due to the location. While this gap between demand and supply can be attributed to growing pains of an early-stage business model, it points to a key element of the service provision business that farmers expect (and will continue expect) if they utilize CA practices.
- **Cost:** Although overall farmers might profit from CA, farmers could not afford access to CA service provision due to higher up-front costs of \$35 (in comparison to \$25). Farmer's inability to pay may worsen with uninformed price increases. Furthermore, male and female farmers mentioned lack of access to credit. Farmers defined lack of access to credit as early payback time, high interest rates, and lack of collateral needed such as ownership of land. Examples from the literature highlight that without access to credit and other financial capital, CA and other sustainable natural resource management practices are unlikely to be accepted (Jones, 2002).
- **Increased women's time and labor:** With respect to CA vegetable production, utilizing CA practices reduced the overall time and labor associated with land preparation, which is perceived as men's responsibility and shifted it to women in the task of mulching, which is seen as a women's task. Farmers also cited increased weed pressure with the adoption of CA practices. Since women are primarily responsible for weeding, women's multiple responsibilities and limited amount of time to spend in the field could impede the success of CA. Furthermore, multiple female farmers mentioned problems with the drip irrigation system provided as part of the CA vegetable system which increased their time and labor as they manually irrigated their farms.

In order to address the challenges and promote better design and service delivery, CA service provision needs to be timely, available for farmers when they need it (both planting, harvesting). The cost of service provision should be affordable for farmers or better access to credit needs to be provided.

Women's time and labor requirements can be simplified by continuing to provide hand tools for CA vegetable production. Multiple female respondents said that the tools provided by the project helped in reducing manual labor and effort. Equipment such as the drip irrigation system need to be fixed or technical assistance needs to be provided. Herbicides or cover crops can compensate for increased weed pressure and reduce women's labor burden related to manual weeding (Sumner, et al. 2016).

Design Recommendations:

- **Offer credit or link with credit lending institution** (promoting NRM) to enable farmers to utilize CA service provision. Consider pay back during harvest.
- **Provide assistance** in obtaining straw or production of mulch in order to reduce women's labor requirements.
- Transform gender roles by **encouraging men** to grow cover crops or assist in production of mulch

Dissemination

Through interviews, we identified that farmers learned about new technologies or new techniques from seeing neighbor's plots, word of mouth, lead farmers, and demonstration plots. Secondary sources of learning and information was through trainings conducted by extension workers or CASC. There was also an increasing prevalence of younger farmers learning through Facebook groups and videos. A female service provider said she wanted to *"...see other farmers, if they using no-till planter and the rate of seeding"* before switching to CA practices.

Both men and women viewed extension events and trainings conducted by CASC as important sources of information. However, to attend the training, farmers are invited by households. Only one member per household attends a training and it is usually men. This is due to multiple factors such as perception amongst men that, *"men and women have same chance to get the knowledge about the technology, but men are better in implementation"*; and perception amongst women that, *"my husband has more education than me. He can understand the training."* Furthermore, lack of transportation to training sites and timing of the trainings (which were held between 8 – 11 am when women were busy with household tasks such as cleaning, childcare and cooking lunch) were cited by women respondents as barriers in attending trainings.

Despite these beliefs, in multiple households wives attended the trainings if the husband was busy: *"whoever is available attends the meeting."* When women attended the trainings, they shared the information they learned with their husbands. However, the husbands did not necessarily share the information they learned at the trainings with their wives.

Women's exclusion from training events is an unintended consequence of household gender dynamics. In fact, the FAO states that women receive only 10 percent of extension services, and have less access to information and relevant technological resources (FAO 2010). There is a need to tailor trainings that meet women's practical needs and strategic interests (Cambodia Gender Assessment 2014, Sumner, et al. 2016). Through interviews we identified that women do not make the sole decisions on purchase of technologies, however, they are a part of the household discussions (see [Barriers & Enablers to Adoption](#) section). Therefore, women should be included in tailored CA trainings that address financial reasons to adopt CA.

Dissemination Recommendations:

- Have **separate CA trainings** for men and women
- Hold trainings at a **convenient time** for women, preferably in the afternoon after lunch when household responsibilities are done
- Ensure convenient training location for women to attend. If location is inconvenient, provide **transportation assistance**.
- Cater to **lower literacy** of women training by using pictures, videos, visuals and discussion
- **Tailored training content** for women should include actual costs savings and profit generation to farmers, which can enable women to champion adoption of CA.

Barriers & Enablers to Adoption

Adoption and spread of CA requires a change in commitment and behavior of all stakeholders. For this section, we interviewed farmers who had practiced CA but resorted back to conventional farming to understand barriers in adoption.

- **Lack of availability of planting service when needed.** Currently, there are a small number of available planters and few service providers. Lack of timely service provision is a critical barrier to CA adoption as seen by a male farmer who said, *“I wanted to start working with the project, but I could not wait for the planter to come sow the maize seed.”*
- **Lack of continued technical assistance.** Conventional farmers who had tried CA and switched back during changes in CASC’s service provision model in 2013 reported higher weed pressure and problems with pest control especially mice. This might be due to limited understanding of CA principles and points to the need for continued extension and technical assistance to farmers applying CA.
- **Lack of financial incentive for growing cover crops in off-season.** Farmers are cash strapped and often use credit to purchase inputs. Farmers prefer to grow cash crops twice a year instead of cover crops because of the short-term financial gain. Furthermore, some farmers did not want to grow cover crops in the off-season because neighbors’ cows graze on the land.
- **Challenges for female-headed households.** Multiple female-headed household interviewed had sick or disabled men, men who had immigrated, or men who had taken up monkhood. Such households face numerous challenges in adopting CA due to increased labor and management needs.
- **Exclusion of landless farmers.** Multiple landless farmers within the CA group in Banan, Veal Kropou village who are renting farmland said they were excluded from CA training because they did not meet the criteria for selection. The currently selected farmers owned land and were suggested by village chiefs and sub-chiefs. This selection criteria could be pose a barrier when scaling up. Additionally, there are concerns with landowners raising rental fees and pushing for higher crop intensification.

In addition to barriers, it is important to identify enablers of technology adoption. In this assessment, the team observed that women are the financial managers or “banks” of the household controlling household expenses. While decisions to purchase major items like technologies are made by men, women are integral to the discussion process and paying for these technologies. Additionally, women played an

integral in contacting service providers, negotiating prices and paying for service provision. As mentioned in the dissemination section, women need to be provided CA training tailored to their needs.

Adoption Recommendations:

- Provide **consistent and long-term technical assistance** to farmers implementing CA. This can avoid farmers jaded by CA principles and who discourage others from adopting CA principles.
- Provide **financial incentive to grow cover crops**. Some farmers reported being able to sell cover crops seeds, which served as a financial incentive to grow cover crops during the off-season. Furthermore, when multiple farmers practice growing cover crops simultaneously, there is collective understanding of benefits of cover crops and protecting them from grazing cows. Farmers can also grow cover crops that serve a dual benefit of soil management and cow fodder.
- Engage the community with **community development plan** (collective action / bottom-up approach) to addressing potential issues surrounding growing cover crops.

CONCLUSION

CA is both management and knowledge intensive and complex to practice. It cannot be reduced to a technology package, adoption requiring both change and adaptation based on experiential learning (Derpsch, 2008; Friedrich & Kassam, 2009). Fee-for-service arrangements have made mechanization needed to implement CA principles more accessible to smallholder and resource-constrained farmers who no longer need to purchase capital-intensive machinery. Appropriate machinery options can help farmers to reduce their own labor and drudgery, as well as expenditures on hired labor. Conversely, farmers who own machinery can benefit as rural entrepreneurs who offer machinery to farmers on an affordable fee-for-service basis (Baudron, et al., 2015).

In conclusion, we have identified two main insights: Firstly, CA service provision is critical to the adoption of CA practices. Therefore, the CA service provision design and delivery should be robust. This includes better financial models (out of pocket expenses and incentives), consistent technical assistance, and timely service provision. Secondly, women play integral roles in the household decision-making process in adopting technologies and hiring service providers as household financial managers; and hence should be targeted with tailored CA training. This includes accessible training (time, location, method), tailored content (financial reasons to adopt CA). Women should also be provided financial resources (access to credit) and resource list of service providers. To be effective, programs promoting CA must recognize the multiple spaces of the farming household and challenge the assumption that CA and other agricultural activities are solely a field management decision controlled by men (Sumner et al 2016).

Suggested Next Steps

- ASMIH Cambodia should better engage households - both men and women as farmers and service providers, in order to enable CA adoption. This can be done through collective learning processes, and through trainings that consciously engage both men and women. Additionally, trainings should be geared for men and women catering to their respective roles within households.

- Since CA service provision is critical to adoption of CA, accessibility to mechanized tools such as the no-till planter needs to be improved. This includes timely availability and diverse payment options.
- 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 household labor. The goal of CA programs should be to reduce overall production costs and increase net profits for farmers that will contribute to better livelihoods. Additionally, technical assistance and capacity building should encourage farmers to persevere through failure and continue learning.
- Focus on early adopters and youth farmers. This assessment did not take into account youth farmers.

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Contact Person: Maria Jones mjones10@illinois.edu

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