Gendered Impacts of Conservation Practices for Vegetable Production: A Case Study of Four Communities in Nepal

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Nepal's agricultural economy is shifting as migration, primarily of men, to find alternative employment becomes more common. This trend has produced a feminization of agriculture, whereby women's share of agricultural labor is increasing. The country's extreme topography, increasing demand for land resources and intensive tillage regimes all contribute to erosion and soil fertility losses that constrain agricultural productivity. Conservation agriculture is one possible erosion mitigation strategy for small-scale farmers. When applied to vegetable cropping systems, conservation practices also have the potential to reduce weed pressure, increase soil organic matter and increase water infiltration. These potential benefits have been shown to reduce time and labor burdens in certain contexts

iDE, a non-governmental organization, is conducting a trial to learn more about the effects of conservation practices in smallholder vegetable production. Women farmers in four communities have been implementing the trial for two years. Using a qualitative technology assessment methodology, farmers who were both users and non-users conservation practices were interviewed during August 2016.

Farmers using the conservation practices reported increased yields following adoption. Increased vegetable supply allowed many farmers to either consume more vegetables at home or sell more vegetables, some for the first time. Time spent managing vegetables shifted from cultivation and irrigation to mulch collection, with a reduction of total time spent in vegetable production over the course of the season. Finally, women farmers participating in the trial were, in many cases, able to control the income derived from vegetable production, or make decisions jointly with other family members. While there are few adopters of conservation practices outside of the iDE trial to date, many farmers expressed an interest in adopting during the next season as a result of observing trial outcomes for themselves.

In the case of the iDE trial, conservation practices seem promising as a mechanism for improving vegetable production, reducing women's time and labor burdens and conserving soil resources in the smallholder context. Further research would be needed to understand whether similarly positive results are possible outside of the iDE network.

Introduction

Nepal is a country in transition. The diverse landscape is being reshaped by changing agricultural production systems and a variety of natural resource intensive industries. Countless poverty reduction efforts have made significant progress over the past few decades, however, Nepal remains one of the poorest countries in the world, particularly due to rapid population growth (CIA World Factbook, 2015). The economy, formerly dominated by agriculture, is shifting due to an influx of remittances from Nepali's migrating abroad to seek alternative employment. The population that remains is largely self-employed in agriculture (70% of total employment), typically managing small rain-fed landholdings (DFID, 2013). However, insufficient profit margins still force many households to make difficult tradeoffs between agricultural livelihoods in rural, isolated areas and migrating to find alternative employment in Kathmandu or abroad.

Migration of men has led to a feminization of agriculture, with women performing a significant portion of agricultural labor. Women manage livestock and vegetable production almost exclusively. Many smallholder farmers still produce at a subsistence level, and those that do market their crops may only do so for staples like rice and wheat, growing vegetables just for home consumption. Commercial crop production is becoming more common as a strategy for small-scale growers to increase on-farm incomes (Brown and Shrestha, 2000). Extreme topography, increasing demand for land resources and intensive tillage regimes (multiple times per year) contribute to erosion and soil fertility losses that can constrain agricultural productivity. Conservation agriculture is one possible erosion mitigation strategy for small-scale farmers. When applied to vegetable cropping systems, conservation practices also have the potential to reduce weed pressure, increase soil organic matter and increase water infiltration.

Working to close gaps in women's access to productive resources and knowledge, and ensuring that agricultural technologies do not place additional burdens on women's limited time and labor, will also be critical to improving food security and on-farm incomes (FAO, 2011). Learning from men and women about adoption barriers and vegetable management experiences is an important step to understanding the potential of conservation practices to positively impact livelihoods, nutrition, and empowerment.

In this paper, I will first review literature relevant to conservation agriculture generally, and the Nepal country context, with attention to agricultural production and women's status. Then I will describe the conservation practice trial conducted by the non-governmental organization iDE. Next, I will detail the methods used in the qualitative assessment of these practices and the locations where the survey was conducted. I will then explore the findings of the assessment and discuss their significance. Finally, I will present recommendations based on the key lessons learned from the assessment.

Review of Literature

Background on gender in agriculture

Gender is a social and cultural construct that creates expectations about how people of a particular biological sex should behave. Gender roles also mediate interpersonal interaction and dictate individual performance both publically and privately. The way individuals engage with agricultural labor, decision making and income generation/expenditure is impacted by their gender identity.

Women in farming households often have competing responsibilities in the productive (agricultural or business related), reproductive (domestic or childcare related) and community spheres. This is referred to as the "triple burden" on women's time and labor. These responsibilities include, but are not limited to, collecting water for home and agricultural use, gathering fodder for animals, collecting firewood for cooking, caring for children or other family members, and preparing meals. In most cases women's responsibilities are in the domestic sphere and do not generate income. Women may also participate in farmer groups or savings groups. In many cases, women's time and labor burdens are unacknowledged or underestimated. Women, even those heavily engaged in on-farm businesses lack access to inputs, land, resources and credit which could otherwise increase their productivity or profitability.

The perception of who is and can be a farmer is also linked to gender. Most commonly, the term farmer refers to either the landowner, the farm income earner, the head of household, or some combination therein (Manfre, 2013). In many countries, these are designations held by men, tying the idea of "farmer" to men almost exclusively. Expanding the idea of "farmer" to anyone responsible for performing agricultural labor can help to recognize women's contributions and increase their self-confidence about accessing resources and training targeted to farmers.

Background on conservation agriculture

Increasing pressure on soil and water resources has motivated researchers to test a range of reduced cultivation techniques that preserve soil structure, while maintaining agricultural productivity. Depending on the crop and region, cultivation methods vary widely, but are typically grouped into a loosely defined set of practices called conservation agriculture (CA). The Food and Agriculture Organization most recently defined CA as a combination of three specific practices: (1) minimum soil disturbance through reduced/conservation tillage, (2) implementation of a diverse crop rotation and (3) maintenance of semi/permanent organic soil cover (Hobbs, 2008). While the initial motivation for CA development and promotion was agronomic in nature, there is also mounting evidence that CA may also be able to reduce smallholders' labor burdens.

The 1930's dust bowl instigated the promotion of CA in the United States, with the goal of reducing soil disturbance from tillage. However, similar sets of practices have existed in cropping systems around the world with different names for much of agricultural history. In the 1970's conservation tillage was tested in Brazil and throughout West Africa. By the 1990's CA began to spread rapidly across the developed and developing world, with regional leaders such as China, Zambia, Argentina and Canada attracting the attention, and investment of major research institutions (Friedrich et al, 2012).

CA has been shown to improve water infiltration and soil structure, increase soil organic matter, reduce erosion, foster beneficial insect populations, and minimize weed pressure (Giller, Kassam, 2009). Due to the nature of CA as a package of practices with interacting modes of action and impact, it can be difficult to isolate observed benefits to prove causation to any one practice (Giller, 2009). The extent of observed benefits also varies by region and cropping system. In some systems, there are reported drawbacks including initially reduced yields in the first few years following implementation, increased pest pressure, increased weed pressure if herbicides are not used, and difficult crop establishment in residues (Hobbs, 2008).

CA has been shown to impact time, labor and gender equity, with results varying by region and cropping system. Women practicing CA in Malawi experienced reduced labor burdens as intensive mulching decreased weed density. Additionally, their involvement in decision-making at the household level increased, and they could decide whether to sell or consume crops produced under the CA system (Concern Worldwide, 2015). A study done by Norad in Zambia, also found that CA reduces women farmer's overall workload and decreased the amount of times they needed to collect water (Maal, 2011). However, Halbrendt et al (2015) found that in maize, millet and legume systems in Nepal, shifting from traditional cultivation to CA increased women's proportion of labor.

Despite demonstrated benefits, there are numerous barriers which have prevented widespread adoption (Friedrich et al, 2012). The cost of implements, insufficient access to resources and lack of understanding about potential benefits can all constrain adoption. Gendered division of labor can also be a significant constraint to adoption. In many cases, women are responsible for weeding and increased weed pressure during the first years after adoption (Maal, 2011) means women have to spend more time weeding the same land area. Learning that weed pressure may increase as a result of using CA could discourage these women from adopting.

Gendered knowledge of soil may have an impact on the willingness of farmers to adopt conservation practices. For example, in a study of two communities implementing CA in the Philippines, researchers found that differences in women's and men's perceptions of soil quality differed based on their agricultural responsibilities. Women, who grow garden vegetables and prepare meals, talked about soil in terms of what it produced, while men discussed quality based on texture and ease of cultivation due to their role in plowing land. These differences impact the understanding of soil management and consequently mediate the decision-making process to adopt CA. The other significant constraints to adoption were lack of access to secure land tenure, capital and training, which were more limiting for women. Benefits from CA may take up to 4 years to manifest, so lack of land tenure can discourage farmers from adopting because the initial costs (Parks & Christie, 2015).

There is a high degree of local specificity to the subset of CA practices that will be most effective in a given region. No universal combination is guaranteed to produce similar outcomes. Although patterns across regions exist, some barriers to adoption may vary by location as well (Brouder & Gomez-Macpherson, 2014). Investigation into the local agricultural, climatic, cultural and socio-economic context is necessary to determine practice suitability and potential for impact.

Nepal country context

The country has three main geographic regions, each with unique social and agricultural systems: the Himalayan mountains in the north, the mid hills, and the terai (plains) to the south. Most of the population is concentrated in the hill and terai regions. These are also the regions with the most agricultural production (WFP and NDRI, 2010). Hill communities are typically more remote, may lack basic infrastructure and have higher rates of poverty rates than those in the terai.

In many communities, off-farm employment opportunities are limited in the local area and when available are low paying. In response to a lack of job opportunities, especially for youth (the youth unemployment rate increased from 7.6% to 13% between 1998 and 2008), men's rate of migration has increased dramatically. In the terai especially, migration to India for at least part of the year is very common amongst men (Upadhyay et al, 2005). The Department of Foreign Employment reported that as of 2014, more than 500,000 foreign labor permits were issued to migrant workers from Nepal, a 100% increase since 2008 (ILO, 2014). Of the permits issued, 95% were issued to men, and remittances were valued at 29% of national GDP

(World Bank, 2016). These permits (which don't include the significant portion of men who travel to India to work, due to visa-free access for Nepali's) were primarily issued for Malaysia, Qatar and Saudi Arabia (ILO, 2014). Total migration has been estimated as high as 1.92 million individuals (about 7% of the population) (2011), 37.6% of which are in India (ILO, 2014).

Status of women in Nepal

Nepal is a patriarchal society where social dynamics are strongly influenced by gender, caste, and ethnicity. Women tend to be disempowered as compared to male counterparts (WHO, 2009). Women provide much of the agricultural labor but are disadvantaged in their ability to access markets. Further, inequitable allocation of already limited resources within the household places additional burdens on women.

Baseline data from the Women's Empowerment in Agriculture Index (WEAI)[1] indicates that women in Nepal score a 0.80 out of 1 (higher scores represent greater empowerment). In the countries where the WEAI has been used so far, scores range from a high of 0.98 in Cambodia to a low of 0.66 in Bangladesh. In Nepal, the WEAI domains in which women were least empowered were community leadership, time allocation, production decision-making and access to productive resources (USAID, 2014).

Men's out migration has led to a feminization of agriculture. In 2011, 84% of women's employment was in the agriculture sector (CBS, 2011). Women's participation in agricultural value chains is limited to primary levels as producers or sellers of non-timber forest products.

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[1] The Women's Empowerment in Agriculture Index (WEAI) was developed by USAID to measure the empowerment, agency and inclusion of women in the agriculture sector, particularly to compare women's status before and after program implementation. The WEAI is made up of two sub-indices, one that measures women's engagement in five domains (production decision making, productive resource access, time use, income control and community leadership), the second compares women's empowerment relative to men in the same household (USAID, 2014).

Their participation also does not necessarily translate into equitable accrual of benefits, as it often does for men (Coles & Mitchell, 2010). Shifting gendered divisions of labor, due to male migration may increase women's workloads and present challenges. For example, tasks such as plowing are considered to be culturally inappropriate for women (Lokshin & Glinskaya, 2009) presenting a dilemma in how to maintain production in the absence of a male farmer. The expectation that women purchase agricultural inputs from a male neighbor is also common (Adhikari, 2008).

Women contribute significantly to vegetable production under drip irrigation systems and their total labor time in hours greatly surpasses their male counterparts. In a 2003 study of vegetable producers by iDE, women were found to play the dominant role in all aspects of production (estimated 88% of total labor) except for seed bed preparation and in some cases, sowing. They concluded that the use of drip-irrigation can have a pro-woman bias in generating opportunities for labor force participation (Upadhyay et al, 2005). Women do not necessarily have control over their earned income and the act of earning does not necessarily improve their status within the patriarchal Hindu-dominated society (Adhikari, 2008). As women increase their share of agricultural labor and income, they (usually) continue to function within traditional cultural roles as subordinate to men (Adhikari, 2008). This means that income control is not guaranteed. Women are more likely to have full or partial control over income when engaged in culturally appropriate activities such as vegetable production where they provide the majority of labor (Adhikari, 2008). Researchers conducting a study of drip irrigation in Nepal also found that as women's crop production activities became more lucrative, men's share of domestic responsibility increased (Upadhyay et al., 2005). This suggests that increasing income from vegetable production can shift men and women's labor divisions and power related to agriculture.

Migration can also complicate labor divisions when a new income stream is introduced. Remittances have been shown to negatively impact women's labor market participation (Lokshin & Glinskaya, 2009). In a context dominated by subsistence production, men's and women's labor may be substitutes (tasks are completed by one or the other, rather than completed jointly). Therefore, male migration would increase the value of the woman's labor, decreasing her likelihood of engaging in off-farm employment (Lokshin & Glinskaya, 2009). De facto women headed households may also experience reduced dependence on remittances as vegetable production commercialized (Upadhyay et al., 2005).

The agricultural extension system is still largely male-dominated and women receive little or no information on improved agriculture and new technology (Upadhyay et al, 2005). This is compounded by the fact that women do not see it as part of their cultural role to access new information, often deferring to men to gain information, especially in the case of technology. The feminization of agriculture trend may positively or negatively impact women who become de facto household heads, by increasing labor burdens and/or decision-making power (Gartaula et al., 2010). In should be noted that even in cases when the absence of men heads of household does increase women's decision-making power at home or in family businesses, this may not translate to similar increases at the community level.

Conservation agriculture in Nepal

In Nepal, smallholder farming systems typically relay or intercrop, which increases tillage frequency and places additional stress on soil resources. Tillage is used not only for bed preparation, but also water and weed management (water is redirected through dug channels, and weeds are tilled under). As farmers are risk averse and believe that traditional tillage practices maximize production in the short-term, traditional tillage regimes continue to dominate hill regions of the country (Bajracharya, 2001). Most farmers in Nepal use hand plow or animal draught methods for agricultural land preparation. Plows and hand implements are fabricated locally. In the hill regions, steeply sloping terrain has precluded widespread adoption of mechanized land preparation technologies, requiring farmers to employ labor-intensive techniques, especially to maintain terraces. Additional tillage in combination with low levels of soil organic matter, compound the already high risk of soil loss and degradation in hill regions (Bajracharya, 2001).

While land holdings are very small, usually less than one hectare, families typically manage a host of species within that area with little to no division or parceling of land for separate purposes (Pratap, 2002). Home gardens are especially significant in Nepal as they buffer food-deficit households by supplying a diversity of edible plants as well as timber, fodder and medicine. The wide variety of types of home gardens blurs the division of foods grown solely for home consumption and crops with a marketable surplus. Throughout Nepal, as much as 50-90% of households produce vegetables and fruit in home gardens for direct consumption. Many of these households will also sell vegetables and fruits from their home garden to supplement income if markets are accessible (Pratap, 2002). Households growing produce to sell tend to grow annual varieties, while those growing solely for home consumption may have more perennial varieties. Vegetable farming in western Nepal has been shown to be economically viable when drip irrigation is used (Upadhyay et al, 2005). Households with access to irrigation commonly grow seasonal and off-seasonal vegetables such as cauliflower, tomato, cabbage, cucumber, bitter gourd and French beans (Upadhyay et al, 2005). Due to their perishability, vegetables tend to be grown in regions that are closer to urban centers, as compared with storable staples like rice and pulses (Fafchamps & Shilpi, 2003). Similarly, the extent of agricultural input use is a function of distance from cities and markets. Fertilizer use is highest in areas that are within two hours from a market, and usage drops off sharply outside of that range, presumably due to transportation costs (Fafchamps & Shilpi, 2003).

Across the Indo-Gangetic plains, including Nepal, conservation tillage is practiced in wheat-rice cropping systems, but rarely full-fledged CA and rarely for crops other than rice and wheat. However, low rates of adoption do not necessarily reflect a lack of interest. Low adoption may be due to interveners' and extension agents' lack of understanding about farmer incentives and preferences. While time and labor savings are commonly touted benefits of CA, Halbrendt et al. (2015) found that labor reduction was the least important factor for both men and women's adoption decision. Instead, yield, income or soil fertility improvements were reported as reasons why both men and women farmers unanimously preferred CA systems that utilized intercropping and strip tillage over standard cultivation systems. A study by Reed et al. (2014) found that soil quality was identified as the most important factor affecting long-term household income, indicating that practices to improve soil quality would be of great interest to farmers in these areas.

Despite the common perception that incomes can be increased through adoption of CA, increases to income are only realized in situations where sufficient off-farm employment opportunities exist (i.e. time/labor not spent on agricultural production can be used for other income generating activities). Often, men are able to find off-farm employment or migrate to work, while women are unable to earn supplemental income due to a lack of culturally acceptable opportunities. This means that any time saved through use of CA may not translate into increased incomes for women, unless appropriate income generation activities for women are locally available. Alternatively, overall household income may increase if divisions of labor between men and women shift, and women take on additional agricultural responsibilities that free up men's time for alternative work. The opportunity cost of both men's and women's labor should be included when analyzing potential benefits of CA (Lai et al, 2012).

Intervention Description

While the literature reviewed here illuminates the factors impacting adoption of CA in agronomic systems, little is known about how these findings apply in the context of vegetable production systems in Nepal. Over the past two years, iDE, an international non-governmental organization, has conducted a trial on CA appropriate for Nepali smallholders, with support from the Feed the Future Horticulture Innovation Lab, funded by the United States Agency for International Development (USAID). The trial was conducted in four districts: Lalitpur (Central), Surkhet (Mid-West), Banke (Mid-West) and Dadeldhura (Far West). At the outset of the trial, women farmers volunteered to participate and received start up supplies and training from iDE field staff on practice implementation and monitoring procedures. The women farmers compared conservation practices versus standard farmer practices in the production of tomatoes and bitter gourd over two years (see details below). The formal trial ended in December 2016, and iDE plans to expand training on conservation practices to other communities where they have ongoing activities.

The set of conservation practices being implemented for vegetable production is intended to reduce soil erosion, increase soil fertility, conserve water and improve vegetable productivity. The set of practices includes three components:

1. Reduced tillage through the use of a "holemaker." Tillage disrupts soil structure and can increase runoff and soil erosion. Reducing tillage can increase soil fertility and water holding capacity by maintaining soil structure over time. A holemaker is a handheld auger used to dig small holes into which transplants, compost, and fertilizers are placed. Typical tillage practices involve hand hoeing the entire plot, a task that is most often performed by men. While there are an array of tillage reduction strategies and tools, the holemaker can be made locally for about $20 U.S.D. and is promoted by iDE for use in vegetable systems. Holemakers are shared informally amongst trial participants.
2. Mulching practices intend to keep soil covered, preserving soil moisture and reducing weed pressure. Fertility increases as mulches break down over time. For best results, it is recommended that mulch is at least 3 inches thick around plants. Mulching materials are selected based on what is locally available including living and dead leaves, grasses, rice straw, and leaves or vegetative byproducts from other crops (if not damaged by pests or disease).
3. Drip irrigation. The drip irrigation system includes a 55-gallon drum and plastic drip tape. In typical farmer practices, women collect water each day and water plants by hand. Trial participants were provided with subsidized drip irrigation systems (50% of the cost covered by iDE, 50% by farmers).

Crop diversity or rotation is also a tenet of CA, and in the Nepali context this is a given. Most smallholder farmers grow a diverse array of crops on small land areas and rotate crops both season-to-season and between fields. This assessment did not consider crop diversity a new practice under the umbrella of conservation training for vegetables. For this reason, the subset of practices assessed are referred to as conservation practices, rather than CA.

Survey locations

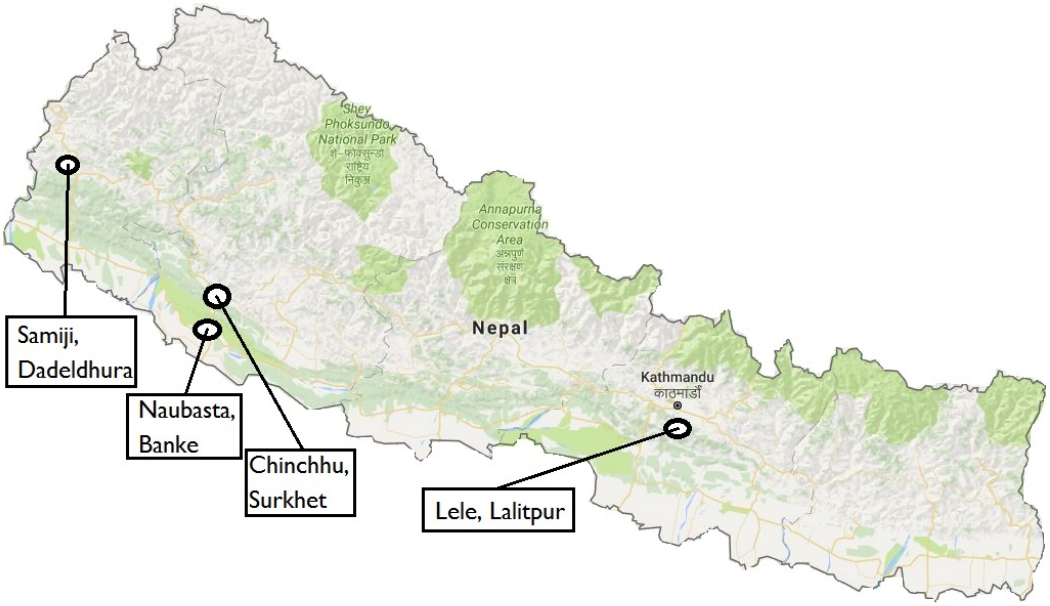

Figure 1: Map of iDE Trial Locations

The community of Lele in Lalitpur is situated in the hills at the edge of the Kathmandu Valley. Gently sloping rice terraces are common and markets in the capital are easily accessed. Lele is about 5000 feet above sea level with annual rainfall of 67 inches. Naubasta, Banke is close to the city of Nepalgunj in the Terai region. The area is adjacent to the India border and cereal production is common in this region due to the flat terrain. Naubasta is 500 feet above sea level and considered to be one of the hottest places in Nepal with average summer temperatures rising to110 degrees Fahrenheit or higher. Annual precipitation in Banke is about 40 inches. Chinchhu, Surkhet is a few hours north of Nepalgunj in the mid-hills, 2,083 feet above sea level. Farmers in this region are known for their ginger production and steeply sloping vegetable terraces. Annual precipitation is around 65 inches. Samiji, Dadheldhura is very-isolated in the mid-hills of the Far-West region, nearly 6,000 feet above sea level. While the community is close to the district center, the closest market is a few miles away. The area receives about 55 inches of rainfall annually, but it is highly seasonal, with most precipitation occurring during the summer monsoon season (Government of Nepal, 2017). Water scarcity is a major concern for farmers in this area.

In each community, iDE staff provide training and resources to farmer groups, that are either men's, women's or mixed. In some cases, farmer groups were established prior to iDE involvement. In some communities, like Dadeldhura for example, iDE helped to organize the creation of a new vegetable-farming group. Groups meet monthly to coordinate their activities, meet with extension agents to voice concerns or receive new information. If farmers desire, they can sell vegetables at community collection centers (established by iDE in 2014 and 2015) on a weekly basis. These facilities are managed by marketing committees that operate separately from farmer groups, though there is some overlap in membership. Collection centers aggregate all vegetables from a community at one location, so growers can tap into bigger metropolitan markets. After aggregation, it is delivered to buyers typically using public transportation. There are collection centers in Lalitpur, Surkhet and Banke, but not in Dadeldhura, where farmers sell at a small local market.

Each district also has a Community Business Facilitator (CBF) who supports farmer groups in securing seed, biopesticides, fertilizer, drip line, and other inputs from suppliers. CBFs attend group meetings to take orders for inputs and hear farmers' concerns, which are then communicated to local extension agents and iDE staff. iDE provides additional training to CBFs on production and marketing.

Methods

A technology assessment methodology was used to investigate the gendered impacts of conservation practice adoption on agriculture and nutrition outcomes. The assessment consisted of a qualitative survey to learn about user and non-user experiences with vegetable production. Survey questions were developed by INGENAES (Integrating Gender and Nutrition within Agricultural Extension Services) project partners. The set of baseline questions was piloted in in both Zambia and Bangladesh and later revised to suit the Nepali context with support from iDE staff.

While the methodology is designed to study impacts of a technology, it is informed by a broad understanding of what constitutes a technology. Even tools typically thought of as just hardware, are coupled with accompanying behavior change, complementary knowledge and complementary resources, in package of “hardware” and “software” (Leeuwis, 2013). This set of conservation practices is coupled with accompanying software in the form of knowledge about how to adapt practices to different crops over time, and with changing resource availability. The social enabling environment mediates perceptions about whether tools or practices are acceptable for farmers, particularly women, to use. The idea of coupling recognizes all of these aspects as a part of the innovation package. Survey questions were adjusted in an attempt to capture nuances of the set of complementary practices, as well as the impacts of both hardware technologies (drip irrigation, holemaker) and associated software.

The main objective of the survey was to gather information about adoption barriers and gendered constraints and opportunities to use. Farmers also shared some general observations about practice effectiveness that can contribute to existing iDE studies on the production impacts of conservation practices. A copy of the survey questions is included in the Appendix.

Data collection occurred in the Lalitpur, Surkhet, Banke and Dadeldhura districts of Nepal during August 2016. Staff from iDE Nepal coordinated individual and group interviews, as well as provided support in translating questions and responses. Responses were recorded in written form.

Both users and non-users of the conservation practices were interviewed. Users included men and women farmers who are growing vegetables using conservation practices. In some cases, there were farmers using one or more practices, but not the entire set. 20 women users and 4 men users were interviewed individually. While most users were trial participants, some users had partially adopted practices based on observation or learning from those who were participating in the trial. Land area in Nepal is typically measured in ropani, one ropani being the equivalent of 500 square meters (about 8 ropani in 1 acre). Of the users interviewed, land holdings varied between less than 1 to 20 ropani. 11 users had less than 5 ropani, 6 users had between 6 and 10 ropani and 9 users had more than 11 ropani.

Non-users are farmers who were growing vegetables but not using conservation practices. All users and non-users were members of at least one farmer group. Group interviews were conducted that were mixed users and non-users. In total, 56 women and 6 men participated in the group interviews. Of those, 21 had either tried mulching practices or used them regularly and 12 used drip irrigation.

Interview Respondents	Full set of practices	Mulching Only	Drip Only	Holemaker Only	Do not use practices
Farmers' group member and trial farmer	20 Women 4 Men	0 Women 0 Men	0 Women 0 Men	0 Women 0 Men	0 Women 0 Men
Farmers' group member and non-trial farmer	0 Women 0 Men	23 Women 10 Men	17 Women 0 Men	0 Women 0 Men	13 Women 2 Men
Not a member of farmer's group or trial	0 Women 0 Men	0 Women 0 Men	0 Women 0 Men	0 Women 0 Men	16 women 0 men

Table 1: Total Number of Interview Respondents by Category

Additionally, 16 women non-users from a microfinance group were interviewed. All cultivated a small area of vegetables for home consumption, but none of them were members of a farmer group or had heard of the conservation practices. This indicates that knowledge of commercial vegetable production and conservation practices may be very limited outside the iDE network.

Discussion of findings

Smallholder farmers in Nepal tend to grow a wide variety of vegetables for home consumption, even when their primary production may be in cereals such as rice or wheat. Vegetables in many cases are the responsibility of women, thus more women than men farmers were interviewed in this survey. However, many women respondents reported that labor is shared within the family. Men from farming households often have off-farm employment, especially in Lalitpur and Banke, which are close to city centers. In these cases, husbands would help with vegetable cultivation before or after work. Five women said their husbands had migrated to find alternative employment.

Farming households are not a homogenous decision making unit, and targeting adoption at the household level may obscure interpersonal dynamics that mediate the decision-making process. If, hypothetically, a woman becomes aware of a technology that she is interested in adopting, but her husband controls the income/resources necessary to purchase or use it, he acts as a gatekeeper to implementation. Most women users said either they made the decision to join the trial themselves, or that they made a joint decision with other family members. While the survey questions may not reveal the extent to which inherent power dynamics within households play into the decision-making process, and whether there is bias in reporting whether a man or woman made the adoption decision for the family, it can be reasonably assumed that this is a more complex process than solely an individual decision to adopt. Each of the farmers was asked about their individual adoption decision, but there was also communication amongst community members, and within farmer groups, to collectively trial innovations and observe results before adopting or rejecting. This scenario still involves an individual decision-making process, however collective trial and risk abatement has the potential to remove barriers to entry and equip smallholders to adopt technologies they may not otherwise have access to.

Many members of the farmer groups who were not users of the practices said that they were interested in implementing the practices based on the results of trial farmers' experiences. Even for those that had adopted, the innovation-decision process occurred over more than two years, as farmers were curious to find out the cumulative results of the trial before deciding to continue implementing the practices beyond the required term. In part, this can be attributed to the existence of tacit knowledge about the use of practices. Tacit knowledge "exists in the background of our consciousness, enabling us to focus our conscious attention on specific tasks and problems," (Gertler, 2003). It is hard to communicate through training and may often not be realized until the practices are physically implemented. The skills required for successful use of an innovation are developed, in part, through implementation and cannot be completely transmitted (Compagni et al., 2014). In the case of users who were also trial participants, they implemented the practices with the continued support of iDE staff over the course of two years. Most users interviewed said that it took them at least one growing season to learn the practices sufficiently and to feel confident about their use. By initially implementing with the support of experts, there are favorable conditions for transferring tacit knowledge and ample opportunities to share knowledge and skills tailored to new users' specific needs (Compagni et al., 2014).

After knowledge was transferred from the iDE extensionists to the trial participants, their positive feedback increased other farmers' willingness to adopt. This is known as discursive persuasion, or "the propensity of exemplary users to actively disseminate positive accounts of their experiences among peers and powerful constituents," (Compagni et al., 2014).

The results of surveys with users and non-users revealed that in many cases partial adoption of only one or two practices, rather than the whole package, is common. This may be due in part, to farmers possessing in-depth "how-to" knowledge[2] about practice implementation but insufficient principles-knowledge[3] about why and how the practices accrue benefits. This gap may prevent adaptation of alternative strategies that work toward the same goals. Reduced tillage, for instance, can be achieved through a variety of means, however most of the farmers interviewed exclusively associate it with the use of the holemaker. If the holemaker is unavailable, they will not use other strategies to produce the same effect, rather they will use the standard soil preparation practice of hand tilling the whole field. An understanding of the how-to knowledge about the set of practices alone, limits the potential for reinvention of the practices to fit changing circumstances, and adopters may lack patience for delayed benefits, which may not manifest until after multiple rounds of adoption. Principles-knowledge about why the practices work effectively allows the adopter to update and adapt the system as needed.

This logic extends to individuals that are only able to use innovations in certain seasons depending on availability of resources, or other time-sensitive responsibilities such as harvest or animal rearing. Although in many cases packages of innovations may function best when implemented in tandem, farmers who are resource-constrained and risk-averse may only be able to adopt one part of an innovation package at a time. While the conservation practices are

[2] How-to knowledge is understanding how to utilize an innovation correctly (Rogers, 2010).
[3] Principles-knowledge is a type of knowledge described as an understanding of the functioning principles of how and why an innovation works (Rogers, 2010).

ideally implemented as a package with compounding and interrelated benefits, farmers may be unable to adopt all the practices at once.

Complex agricultural systems are inextricably linked to the dynamic, natural environment, meaning that technology cannot be static. Thus reinvention, and the provision of principles-knowledge necessary to adapt, are required for successful application of conservation practices in each of the different regional topographies. Reinvention manifested in three modes: translation, modification and adaptation (Bui, 2013). Translation is the way in which innovations spread across an organization and are applied to unique local contexts. In this case, conservation practices were disseminated amongst the farmer groups and translated into locally appropriate applications that utilized mulching materials available in each microclimate. While consistency of the system was largely maintained due to the need for trial replication, there were some modifications to the set of practices in terms of mulching materials. Also, users adapted the practices to meet other needs. For example, using the holemaker to dig postholes for tomato trellises. Each of these modes of reinvention was encouraged by iDE staff during initial training and continued support for implementation.

Gender Analysis

To understand the potential gender and nutrition impacts of the conservation practices, interview data was analyzed in three dimensions: food availability, quality, and safety; income and assets; and time and labor. Due to their complementary nature, the conservation practices will be discussed as a whole, unless otherwise specified.

Food availability, quality and safety

Nearly all users and non-users said that they cultivated some amount of vegetables for home consumption prior to the onset of the trial. Only one respondent had never grown vegetables. Growing a home vegetable garden is common in many communities in Nepal, particularly in the hill region, where poor transportation infrastructure may restrict access to markets where vegetables can be purchased. Some women users reported that they grow vegetables at home because it is more affordable than buying them.

One of the critiques of CA generally is the lag time between start of implementation and measureable accrual of benefits. Often yields may initially decline or stagnate, before increasing a few years after adoption. This may mean that the adopter needs to continue using the technology for multiple seasons, before they are convinced of its effectiveness. Survey respondents did not report any yield reductions during the transition, and in fact observed higher yields under conservation management as compared with farmer practices. However, there are additional benefits to CA practices that may take multiple seasons of continued use to accrue, such as improvements to soil structure and fertility which change slowly relative to crop production cycles.

Survey responses indicate that increased vegetable supply for farm households is linked to both increased production and sale of vegetables. Of 24 total users, 21 observed increased yields in plots managed with conservation practices in the first two seasons after adoption. Nineteen users said that they consume vegetables grown under conservation practices at home. Ten of the users (8 women and 2 men) who do consume vegetables at home, or about 40% of all surveyed users, said that they were consuming more vegetables than before adopting the conservation practices. Both women and men users said they prioritize home consumption of vegetables over sale, meaning that they would sell if there were extra vegetables available after meeting at-home demand. Some women users also indicated that adoption of conservation practices increased their dietary diversity, as selling excess vegetables gave them an opportunity to purchase vegetables they were not growing themselves.

Seven women users reported that vegetable quality, especially fruit size, was improved using conservation practices. The remaining women users and all men users said that vegetable quality was the same or noticed no difference between farmer practices and conservation practices. There were some environmental factors, which negatively impacted users' perceptions of the growing season and the overall availability of vegetables, but were not specifically associated with the conservation practices. In Lalitpur, intense pest pressure from Tuta absoluta, also known as tomato leaf miner, devastated many of the tomato transplants. Farmers were in the process of replanting tomatoes at the time of data collection. They reported that pest pressure was the same across both plots (conservation practices and farmer practices). They did state that based on the previous years' experience that they still preferred the conservation practices. A few women users in Lalitpur also expressed a desire to grow vegetables organically. They perceive that growing vegetables without the use of pesticides increases produce safety. However, the pest pressure means that they are unable to avoid use of pesticides at this time.

Time and Labor

Women and men users said they spent less time managing vegetables using conservation practices than using farmer practices, with regard to soil preparation, watering, and weeding. An iDE survey conducted in 2016 also found that farmers spent the same amount or less time on vegetable production using conservation practices than farmer practices. The amount of time spent preparing soil before planting was reduced by the holemaker, which allows users to only dig where planting, versus hand plowing the entire area. However, only a few holemakers are available to be shared amongst an entire farmer group, so farmers were often forced to wait to prepare soil until the tool was available. None of the farmer groups has a formal system for how the holemakers would be shared amongst the group.

In some cases, the holemaker also changed women's perception of their ability to prepare soil. Eighteen women non-users had an opportunity to try the holemaker, but did not use it regularly due to the difficulty of accessing the tool when they needed it. Seven of these women said that they hire someone (typically a man) to prepare soil using standard plowing practices and would be interested in using the holemaker if it meant they could prepare beds themselves. These women were willing to spend additional time preparing beds themselves, as opposed to hiring someone to hand plow the plot. While less time overall would be spent using the holemaker, more of the women farmers' time would be required for soil preparation, but this was desirable so they would not have to spend money to hire someone. While plowing in many cases is seen as men's work, the introduction of the holemaker as a new tool gives women an opportunity to take on this responsibility if they so choose, provided that the holemaker is available for use.

In part, time and labor savings can be attributed to disadoption of practices. For example, standard farmer practice for soil preparation is informed by cultural norms, i.e. that women should not be responsible for plowing. Not only does implementing a reduced tillage regime require modifying this assumption, but tillage *reduction* inherently involves fewer tasks on part of the farmer. They have to disadopt standard hand tilling practices in order to adopt soil preparation techniques consistent with the conservation practices (e.g. use of the holemaker).

Within the reduced amount of time spent managing vegetable production, time and labor also shifted between tasks, which occur at different times throughout the season. Time and labor shifted from being spent mostly on land preparation to mulch collection. Mulching is the only practice out of the three trialed that increased time and labor allocation. The type of mulching material differed by district based on what was locally and seasonally available. The diversity of mulching sources and methods for application represents an ability of users to reinvent the practice to best suit their context. iDE training encourages this reinvention as it increases utilization. There are many different types of appropriate materials such as living tree branches, rice straw, crop residues, dried leaf matter from forest floors and other shrubs. The most commonly cited reason for not using mulch by those who had heard about mulching practices was a lack of materials during at least some portion of the year. The impact of mulch collection on time and labor varies widely depending on the proximity of the forest to their home. In the hill regions of Dadeldhura and Surkhet, users often live close to forest areas where they can collect mulch in just a few hours. In Banke and Lalitpur, which are closer to cities and further from forests, access to mulch is a challenge.

Ownership of forest areas also impacted mulch access and availability. Users who own forested land themselves did not identify mulch supply as a barrier to use. Users who don't have access to privately-owned forest, must walk to a community forest area to collect mulch. Women farmers often travel on foot for many hours to gather mulch. Community forests also have rules associated with use. For example, use of forest materials including mulch may be seasonally restricted or closed to the public on certain days. Each community forest user group, the management entity for these forest areas, has autonomy in setting restrictions, which makes barriers to access site-specific. Rules are well intentioned, as conservation of forest areas is a priority in Nepal. Smallholders depend on forest areas for food, medicinal plants, fodder and firewood. Were restrictions not in place, forest areas would quickly face a tragedy of the commons scenario, reducing the sustainability of resources. Unfortunately, these restrictions create difficulties for farmers accessing community forests for mulch allocation and may limit adoption of mulching practices to certain seasons.

Limited supply may also skew mulch use to certain crops, for example in Chinchhu, Surkhet where ginger and turmeric production is common, there were many users of mulching practices who did not use either drip irrigation or the holemaker. Traditional ginger and turmeric production methods use thick mulch layers to protect plants and retain water. While users reported many benefits of using mulches in root crops, they did not know about using mulches in other vegetables. In this case, adoption may be easier than in other regions because knowledge already exists about how the practices would be implemented, where to access the materials and what the benefits or challenges might be. While most farmers had never conceptualized the application of mulching to vegetable crops specifically, they already had some of the complementary knowledge and resources that could made the adoption decision easier. For the trial users, this posed a resource competition issue as they may have a limited supply of mulch to be spread across multiple cropping areas. This forced them to prioritize where mulch would be applied. In many cases this meant using it in ginger first, and only applying to other crops such as vegetables, if there was extra. Another seasonal shift in mulch application was between the dry season and the rainy season. In the rainy season, mulch supply is limited.

Livestock ownership also created competing demand for mulch. Livestock rearing is common amongst smallholders, and most farmers interviewed owned at least one animal. Mulching materials, such as rice straw and fresh fodder, are commonly used as animal feed. This means that farmers with more livestock had to make tradeoffs between using straw and leaves for mulch or as fodder.

Both men and women users perceived that the drip irrigation system decreased time and labor as compared with watering by hand. In June 2016, iDE surveyors also found that farmers reported using about 50% less time in irrigation activities when using conservation practices compared to farmer practices. In this specific drip irrigation system, most users still have to collect water by hand to fill the irrigation drum, which is typically done by women. In one instance, a user had a rain water catchment system that gravity fed the irrigation drum, so manually carrying water was not necessary. Once the irrigation drum is filled, farmers turn on the spigot and watering happens automatically. In the farmer practice, they were watering each plant individually which takes much more time. This reduction in time spent watering is important, as women are typically responsible for this task. The potential of the drip irrigation system to alleviate women's labor burdens, however slightly, is positive. While they still spend time gathering or transporting water for agricultural use, it may occur less frequently (water can be stored in the irrigation drum between watering events), whereas in the farmer practices they would be transporting it at every watering event. Water sources varied between communities, some having access to a central water pump that was shared between houses, others having personal pumps. Some homes had large water collection tanks that stored water until use. Women users reported the amount of water needed for vegetable production using conservation practices was half the amount required using the farmer practices. This is primarily due to mulch coverage, which increases infiltration and limits evapotranspiration. Additionally, the drip system allocates water more precisely to plants than watering by hand, meaning less water is wasted.

Those who claimed that the conservation practices decreased time spent producing vegetables said they used the additional time to care for animals, tend to other crops, collect fodder or perform household tasks. One woman said she was able to participate in a collective farming group because she spent less time managing vegetables.

Income and Assets

While nearly every user stated that they continue to prioritize home consumption, in many cases demand for vegetables was already being met by home production before the adoption of conservation practices. This means that increased yields did not always increase home consumption, but rather, enabled women and men users to sell vegetables more often or in larger quantities than they had prior to adoption. Some women farmers said that the trial allowed them to sell vegetables for the first time, especially in Naubasta where flat topography favors cereal production and vegetables are only grown in small quantities, if at all, for home consumption. In Chinchhu and Lele vegetable production for both home consumption and marketing is common, but most users said they were able to sell more vegetables after conservation practice adoption in response to increased yields. Men and women sell vegetables either at community collection centers or local markets, which are located within walking distance from their homes. In a few cases produce was sold to customers directly from their homes.

Women, who in many cases do not have other income generating activities, said they felt good to be contributing to household income. Of the 20 women users interviewed, 16 stated that they had some control over income generated from vegetable crop production under the conservation practices. Three women users said they did not have any control over how income was spent, and that their husbands or fathers instead controlled the money. Of the five men users interviewed, only one claimed independent control over income, the other four said that even when they contributed to production or marketing of vegetables, their wives controlled the income or they made decisions together. In some cases, men were responsible for the delivery or sale of vegetables, but women users still controlled income or shared in decision making about purchases. Of the women who claimed independent control of their income from vegetable production, most said they would choose to spend money on small purchases such as tea, sugar or other food goods. For large purchases, women said that they make decisions jointly with their spouse or other family members. Many women, especially in Lalitpur, said that income derived from vegetable production allowed them to participate in savings groups. Women also mentioned that they used their incomes to pay for children's school fees, weddings, and other ceremonies.

Recommendations for future applications

Support from iDE staff and infrastructure such as collection centers and farmer groups, mean that these communities are extremely well connected, especially relative to their remote locations. Survey respondents were members of farmer groups which provided them access to training, markets and networks of input suppliers. Their positionality is such that they are better equipped to adopt new innovations. This differentiates them significantly from farmers in other communities without organizational support, who were growing vegetables for home consumption but had not heard of the conservation practices. Farmers who had heard of the practices but were not participating in the trial have also been hesitant to use conservation practices due to a lack of understanding of potential benefits. Many non-users did however, express interest in adopting during the next season after seeing the positive outcomes of the trial. Further investigation would also be required to determine if adoption of practices outside the iDE network is linked to similarly positive outcomes.

Increasing awareness of conservation practices outside of the iDE network is a precursor to widespread farmer adoption. The idea of discursive persuasion through the sharing of adopter experiences, can help to reduce uncertainty by answering potential adopter's questions about possible benefits or challenges of implementation. Adopters can prevent dissemination of narratives that question benefits or emphasize difficulties that might negatively impact diffusion. While this may increase initial excitement about an innovation, it can also lead to instances where positive reports obscure potential problems, as users may be eager to report success than admitting failures they encounter with the new practices. Especially when early adopters have apparent success, those with unsuccessful experiences may be reluctant to discuss problems to avoid appearing incompetent (Compagni et al., 2014). This is an important consideration that grounds positive feedback received from trial farmers and the reported interest of non-users to adopt in the future. Conducting interviews in the presence of NGO staff who typically provide access to resources and training for farmer groups may lead to this positive slant in reported user experiences.

Further explanation of underlying principles-knowledge for each of the practices could also increase adoption. This is especially true in the case of tillage reduction, which men and women users and non-users exclusively associated with the use of the holemaker. Despite sufficient interest, those outside the trial do not practice reduced tillage when the holemaker is unavailable. Demonstration of alternative methods, such as strip tilling, or digging holes for transplants with other tools, coupled with testimonies from users, could bolster confidence about adoption. Similarly, sharing ideas about different types of mulch that are commonly used in different districts may be a useful part of continued training efforts. Improving farmer's understanding of the full range of appropriate materials may help to close the gap in unmet demand for mulch. This is particularly important in cases where competing demand for mulching materials due to use for livestock or other perennial crops exacerbates supply shortages.

Both women and men users perceived that conservation practices improve yield and reduce time spent on vegetable production. Women's significant involvement in vegetable production positions them to benefit the most from both income and labor improvements. User experiences indicate that in the case of the iDE trial, adoption can increase women's income control and decision-making power. These income effects are specific to vegetable production, which have higher market value than staple grains. The observed increases in income differed significantly from findings about potential income generation from implementing conservation practices in grain and legume systems, which were only possible in cases where off-farm employment was available (Halbrendt et al., 2015).

Reported time and labor savings are consistent with existing research studies on the benefits of conservation agriculture. However, further research would be needed to determine whether time is saved with regard to marketing specifically, especially for those who are selling vegetables for the first time. By freeing up time normally spent managing vegetables, conservation practices can potentially ease women's time and labor burden, one of the most significant constraints on empowerment. Women may also have increased opportunity to participate in community-level activities such as collective farming or savings groups.

The positive outcomes of conservation practices for iDE farmers emphasize the importance of training and education for successful implementation. Not only do the practices have the potential to improve agricultural productivity and home consumption of vegetables, but can also positively affect gender roles in farm management and community participation. The results are contextual and cannot speak to outcomes in different locations or cropping systems, but can be shared amongst organizations in Nepal that are working with vegetable commercialization or conservation agriculture. Finally, the results do provide promising, supporting evidence for iDE's ongoing organizational efforts to scale up training on conservation practices across Nepal.

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Appendix

Technology Assessment Survey Questions

Extension Officer/Dissemination Agent Questionnaire

•We are conducting research about how men and women farmers use new technologies to improve their farms and farming businesses.
•We would like to talk to you about your experiences disseminating technologies to farmers.

Individual Details			
Name			
Sex		Age	
Location			
Years of schooling		Number of contact farmers responsible for	
Name of the technology		Targeted crop(s)	

Section 1

1. How do you decide which problems to address?
   Prompt:
   Directions from the Ministry/NGO/project
   Consultation with farmers
   Recommendations from input supplier
   How do you decide whose problems to prioritize?
2. For example, if some farmers are experiencing problems with a weed and others with a virus, how do you decide whose problems to address?
   Prompt:
   Directions from the Ministry/NGO/project
   Consultation with farmers
   Recommendations from input supplier
3. How do you decide what technologies to promote?
   Prompt:
   Directions from the Ministry/NGO/project
   Consultation with farmers
   Recommendations from input supplier
4. How do you decide to whom you target specific technologies? For example, if you have a new seed variety, how do you decide which farmers to inform?
   Prompt:
   Directions from the Ministry/NGO/project
   Consultation with farmers

Recommendations from input supplier

Section 2

1. What are the advantages of the conservation agriculture?
2. Are there specific advantages for women farmers?
3. Are there specific advantages for men farmers?
4. What are the disadvantages of conservation agriculture?
5. Are there specific disadvantages for women farmers?
6. Are there specific disadvantages for men farmers?
7. What methods do you use for training farmers on conservation agriculture?

    Prompt:
    Farmer Field School
    Face-to-face
    Mobile phone
    Demo plots
    Other
8. Are you using different training methods to reach women farmers than you use to reach men farmers on conservation agriculture? If so, why? If not, why not?
9. What farm or farmer characteristics do you prioritize when selecting participants for group activities (e.g., training, FFS)[4] for training on conservation agriculture?

    Prompt:
    Age
    Sex
    Size of plot
    Choice of crop
    Location
    Degree of market-orientation

[4] If the informant mentions multiple training methods under question 8, ask about the preferred farm or farmer characteristics for each type of training method. Only ask about one training method at a time.

Technology Users and non-Users Questionnaire

•We are conducting research about how men and women farmers use new technologies to improve their farms and farming businesses
•We would like to talk to you about your farming business and have a set of questions for you.

Individual Details			
Name			
Sex		Age	
Location		Name of association (if applicable)	
Years of schooling			
Name of the technology		Targeted crop(s)	

<u>Section 1 (All informants)</u>

1. Are you familiar with conservation agriculture? (*Prompt individually: Reduced tillage? Mulching? Drip irrigation?*)

   <u>Prompts:</u>
   How did you hear about it?
   Have you seen it being used?
   If so, by whom?

2. What have you heard about the benefits of conservation agriculture?

   <u>Prompts</u>
   Reduces time spent performing the task
   Reduces difficulty of work
   Increases yield
   Improves quality of the product
   Improves sale price
   Conserves soil or water resources

3. Have you tried using conservation agriculture practices? *(<u>Prompt individually:</u> Reduced tillage, Mulching, Drip irrigation*)
   a. If no, has anyone else in your household tried conservation agriculture practices?
      i. If yes, move to section 2.
      ii. If no, move to section 2.
   b. If yes, are you still using it? (Move to Section 3)
   c. If yes for some practices and no for others, start with those they are not using and then move to the ones they are using.

<u>Section 2 (Non-users)</u>

1. Why have you not tried conservation agriculture? (*Prompt for each practice individually*)

Prompts:
Too many inputs/labor required
Not within sphere of decision-making
Not convinced it will help / work *(in short term or long term?)*
Lack of money
Not appropriate (Please elaborate for example, plot to small, inappropriate for men/women, too difficult)
Haven't learned to use it
Not available in the area
Concern about production losses

2. What would encourage you to use it?
3. How much total cultivated land does your household have?
4. How much land (e.g., hectares, acres) is under the cultivation of targeted crop(s)?
5. In your household, how much of that do you manage?[5]

Thank you for your time.

Section 3 (Users)

1. Please describe how to use conservation agriculture practices.
2. How did you learn to use conservation agriculture?
   Prompts:
   (Method) A training, demonstration, or farmer field school?
   (From whom) Family member? Neighbor?
   Self-taught?
3. How much time did it take you to learn how to use it? (If a participant, was the training sufficient?)
4. How long have you used conservation agriculture practices? (*Prompt for individual practices, if applicable*)
5. Were you involved in the decision to start using conservation agriculture practices?
6. Who first implemented conservation agriculture practices on your farm?
   Prompts:
   Self?
   Other?
   Implemented as part of a project?
7. Are you able to access the [targeted technology] whenever you need?
   Prompts:
   a. Does someone else use it when you want it?
   b. Do you have to ask permission to use it?
8. Has the amount of time you spend on tasks changed as a result of using conservation agriculture practices?
   Prompts:
   Soil preparation
   Planting

[5] Clarify with interviewer what management means.

Weeding
Irrigating
Scouting for pests
Gathering resources
Harvesting
Overall production

If increased, how has the additional time affected your ability to perform other tasks? (e.g., child or elder care, leisure, other income-generating activities, food preparation)
If decreased, how are you spending your time differently?

9. Has using conservation agriculture made growing vegetables harder?
    a. Easier?
    b. If so, in what ways?
10. Was someone else responsible for the tasks contributing to vegetable production before you started conservation agriculture? (*Prompt for individual tasks: soil prep, weeding, irrigating, harvest, marketing etc.*)
    a. If so, who?
11. What advantages have you experienced as a result of using conservation agriculture practices?

    Prompts:
    Reduces time spent performing the task or frequency of events (weeding/watering)
    Reduces difficulty of work
    Increases yield (If so, by how much?)
    Improves the safety of food
    Improves quality of the product (in what ways?)
    Improves quality of plot/land
    Improves sale price (If so, by how much?)
12. What are the disadvantages of using conservation agriculture?

    Prompts:
    Availability of inputs/too many inputs required
    Skills-required to use the technology
    Access to the tools
    Problems with maintenance – drip irrigation
    Health problems
    Yield reduction
    Increased pest pressure
13. Has the amount of vegetables available for home consumption changed as a result of conservation agriculture practices?

    Prompts
    Has the amount of vegetables you store changed?
    Has the amount of vegetables you have when you need it changed (e.g. at planting time)?
14. Are you consuming more nutritious food as a result of using these practices (e.g. more diverse foods such as dairy, meat, vitamin-rich foods)?

    Prompts

Eating more vegetables or selling them?

15. If you are consuming more nutritious foods, where do they come from?

    Prompts

    a. From own production?

    b. From purchases?
16. Has the amount available for sale changed as a result of conservation agriculture practices?
17. Has the use of conservation agriculture changed how much income is received from sale of vegetables?
18. Do you control the income from the sale of the product?
    a. Is this different than before you started using conservation agriculture?
19. Would you recommend conservation agriculture to others? And why?
20. How much total cultivated land does your household have?
21. How much land (e.g., hectares, acres) is under the cultivation of targeted crop(s)?
    a. In your household, how much of that do you manage?[6]

Thank you for your time.

[6] Clarify with interviewer what management means.

Group Interview Questionnaire with Technology Users

1. Please describe how you use the technology.
2. What advantages have you experienced as a result of using the conservation agriculture?
   Prompts
   Reduces time spent performing the task or frequency of events (weeding/watering)
   Reduces difficulty of work
   Increases yield (If so, by how much?)
   Improves the safety of food
   Improves quality of the product (in what ways?)
   Improves quality of plot/land
   Improves sale price (If so, by how much?)
3. What are the disadvantages of using conservation agriculture?
   Prompts
   Availability of inputs/too many inputs required
   Skills-required to use the technology
   Access to the technology
   Problems with maintenance
   Health problems
   Yield reduction
   Increased pest pressure
4. Would you recommend the technology to others? And why?

Thank you for your time.