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## **The Implications of Sustainable Intensification on Weed Dynamics in the Eastern Gangetic Plains**

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## 2 Executive summary

Conservation agriculture (CA) comprises a package of crop management practices inclusive of minimum soil disturbance, crop residue retention, and crop diversification. CA is currently practiced in over five million hectares in the Indo-Gangetic Plains of South Asia. CASI practices enhance biodiversity and biological processes inside and outside of the soil, contributing to improved soil quality, water use efficiency, and crop production. While there are proven benefits in implementing CASI systems in the Eastern Gangetic Plains (EGP), there are also potential trade-offs. One consistently problematic issue relates to the changing weed dynamics and crop-weed competition, making weed control one of the biggest challenges to CASI implementation. Understanding the weed problems faced and practices used by men and women farmers to manage the changing weed populations in these systems successfully is central to the development of efficient weed management packages. It will facilitate further sustainable and equitable intensification and improved livelihoods for smallholder farmers in the EGP.

While the agronomic implications of changes in weed management have received some attention, socioeconomic issues, including how farmers decide to make changes in weed management or the changing gender relations under changing weed control practices, have been less explored. Knowledge of agricultural practices, beliefs, and perceptions is important for research and development interventions to support CASI's gender-responsive outcomes. Yet, there are limited specific studies on the gendered dimension of the adoption of CASI practices; research on gender implications of changing weed dynamics under CASI systems in the South Asian context is almost non-existent. This project addresses this void in the evidence base and focuses on gendered dimensions of weed management, specifically in the context of CASI systems in the EGP.

With some diversities across EGP owing to different sets of drivers and benefits, this study in general highlights that CASI systems in South Asia appear to be equitable in terms of time savings during crop production, pointing positively to the plans for subsequent scaling out in the region. It can fuel on- and off-farm income-generating activities, leading to farmers' economic empowerment, especially for women. However, it is also important to consider the associated knowledge gap to management and handling of herbicides and technical knowledge around ZT use, prevalent among the male and female farmers, to ascertain a better adoption pathway. Moreover, utilizing the saved time and creating a conducive environment for female farmers as they want to move on to engage in off-farm economic activities and learn and operate farm machinery could be equally challenging, especially in the South Asian sociocultural context.

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## 3 Introduction

The Eastern Gangetic Plains of South Asia (EGP) are home to over 300 million people, characterized by sociocultural diversity and complexity, and predominantly occupied by small-scale marginal farmers. These mixed farming systems and complex sociocultural realities offer a unique set of enabling, or constraining, opportunities and outcomes for different social groups that are intersected by caste, class, gender, and ethnicity (Farnworth and Badstue 2017). The region is densely populated and endowed with rich agrobiodiversity but is also disaster-prone and subject to droughts and floods, which is further exacerbated by unprecedented climate change. These biophysical challenges are coupled with socioeconomic constraints such as high poverty incidence, small landholdings, and widespread landlessness, low economic returns, lack of access to credit, rural-urban migration, the feminization of agriculture, poor extension systems, geographic and infrastructural isolation, and the highly diverse and complex typologies of farmers (SRFSI 2017).

Conservation Agriculture-based Sustainable Intensification (CASI) comprises a series of crop management practices based on minimal soil disturbance through zero or reduced tillage, in situ crop residue retention, and crop rotation and diversification. Conservation agriculture is currently practiced in over five million hectares in the Indo-Gangetic Plains of South Asia (Somasundaram et al. 2020). CASI practices enhance biodiversity and biological processes inside and outside the soil, contributing to maintaining soil quality, water use efficiency, and sustaining crop production. It is a proven technology for climate variability resilience due to the higher soil infiltration that minimizes the impacts of flooding and erosion (Hobbs, Sayre, and Gupta 2008). The implementation of CASI systems in the EGP has formed a key part of ACIAR's Sustainable and Resilient Farming System Intensification (SRFSI) and other projects and has demonstrated a great potential to increase farm system productivity and profitability, and resource conservation of labour, water, energy, and production cost through CASI practices in the EGP (SRFSI 2018).

While there are proven benefits of implementing CASI systems in the EGP, there are also limitations. Some of the limitations are lack of government incentives in support of non-conventional agricultural practices, limited access to and fragmentation of agricultural land, and variable short-term benefits (Harman Parks, Christie, and Bagares 2014; Nichols et al. 2015). One consistently problematic trade-off is changing weed dynamics and crop-weed competition, making weed control the biggest challenge to CASI adoption (Bajwa 2014). Previous ACIAR projects, including the SRFSI (CSE/2011/077) and CSE/2004/033, have also identified weeds as one of the significant problems with CASI systems. For example, the SRFSI 2018 Research Synthesis Report highlights that 75% of the focus group

participants showed weed control as the primary problem under the CASI system (SRFSI, 2018). Implementation of CASI changes weed management due to a lesser number of tillages that are traditionally used to create a clean seedbed. Understanding the weed management problems and evaluating practices used by men and women farmers to manage weeds in these systems successfully will be important components of efforts to develop efficient weed management packages and thereby facilitate the further sustainable intensification of smallholder farms in the EGP.

Changes in farming systems impact men's and women's assets such as land, time, labour, and extension services (Doss and Morris, 2000). However, while the agronomic implications of changes in weed management have received attention, socioeconomic issues, including how farmers decide to make changes in weed management and the consequent alteration in gender relations arising from changing weed control practices, have not been adequately explored. The changing weed dynamics associated with the adoption of CASI technologies, mainly on intra-household differences in knowledge and changing gender roles are an important parameter for equitable and sustainable intensification. There are very few studies on gender dimension of the adoption of CASI practices (e.g., Beuchelt & Badstue, 2013; Farnworth & Badstue, 2017; Halbrendt et al., 2014; Harman Parks et al., 2015), but gender implications in particular in the changing weed dynamics under CASI system in the South Asian context are scanty.

Scholars have started to unravel this unstudied aspect of conservation agriculture in the case of smallholder farmers, but primarily with a focus on Sub-Saharan Africa. In Zambia, for example, Baudron et al. (2017) found that CASI requires more effort in weeding, a task typically undertaken by women (as opposed to land preparation that is traditionally done by men). One of the success factors in CASI adoption has been reported as the herbicide use (Brown et al., 2020). A study conducted in Kenya suggests that time saved by adopting CASI can have a significant impact on women's time allocation, with freed time available to engage in other income generating opportunities (Kaumbutho et al. 2017a). Spaling and Vander Kooy (2019) reported that 71% of surveyed women experienced a decrease in labour required of them. On the contrary to above literature, Giller et al. (Giller et al. 2009) found that extra labour required in place of the purchase of herbicides can lead to increased labour burden for women.

From a labour allocation perspective, it is now accepted that herbicide use may not only save time in land preparation but may also affect household members unequally, yet this is often not explored. Conservation agriculture technology such as zero tillage does reduce the overall labour requirement, but the in-depth gender implications are not often explored, as evident in the study conducted on maize crop by Gouse et al. (2016). Historically in the region, men tended to take the more decision-based roles like deciding on crop choice and

land management while women have been responsible for labour-intensive roles like weeding. In addition to farm roles, women are involved in agricultural preparation activities, livestock, feeding, and caretaking for children and the elderly, and in the absence of men, women are naturally expected to fill the labour share gap (Radel et al. 2012). Yet, there is little exploration of this, particularly from the lived experiences of farmers. In this light, built on the previous SRFSI reports, including the mid-term review (ACIAR 2018), this small research activity (SRA), which was implemented as a supplementary project to SRFSI, documented how male and female farmers in the EGP perceive and address the changing weed dynamics in their farms, and how it implies to their livelihood in general and decision making in relation to CASI implementation in particular.



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## 4 Objectives

The project aims to improve understanding on the response of men and women farmers to changing weed dynamics due to CASI adoption in the Eastern Gangetic Plains of South Asia. It contributes to building the evidence base on gender dimensions of CASI in the context of South Asia, and findings will provide farmers' perspectives on CASI for agricultural research and development professionals and decision makers working to improve livelihoods of farm families in the region through equitable and sustainable intensification of agriculture.

The main objective of this small research activity (SRA) is to document farmers' knowledge, experience and practices around weed management under CASI and analyse its gendered implications for equitable and sustainable intensification in the Eastern Gangetic Plains of South Asia. This objective was explored with the following two sub-objectives.

1. To explore the implications of CASI adoption on male and female farmers in the region, especially with respect to whether zero tillage technology increases women's labour burden in terms of roles, time contribution, and responsibilities, and whether the technology would lead to one of the spouses in a household becoming a knowledge holder for weed management.
2. To document the lived experiences of male and female farmers especially those who have used or consider using herbicides for weed management, and perceptions on how the herbicide use changes labour allocations and responsibilities within the farming households.

## 5 Methodology

### 5.1 Research locations

As a supplementary project to SRFSI, data for this study were collected from SRFSI locations, which includes Sunsari district of Province 1 in Nepal, Cooch Bihar and Malda districts of West Bengal and Purnea district of Bihar in India, and Rangpur and Rajshahi districts in Bangladesh (Figure 1). CIMMYT, with the help of local partners and donor communities, has been working in these areas for a long time, engaging with local communities seeking viable livelihood opportunities for smallholders through conservation agriculture-based sustainable intensification.



Figure 1: Location map, indicated in the world map.

### 5.2 Data collection and analysis

This study adopted a mixed-methods research design and collected data using semi-structured interviews and the collection of photo diaries through the photovoice method. These data collection methods were complemented with a series of field visits and interacting with local community leaders as key-informant to get a better understanding of the field situation. The verbal, text, picture, and voice data collected using different methods were recorded in Kobo Toolbox with due consent of the research participants and exported appropriately for analysis.

#### 5.2.1 Collection of photo diaries

The project used a novel approach to collect data, called photovoice, on the trends of weed emergence in the CASI plots in EGP from respondents who bear the impact of decision making but often cannot express themselves due to lack of literacy and authority.

Observations documented the knowledge of weeds, changing roles, and time required for weeding, and other various implications for male and female members. A total of 50 male and female farmers (from 25 households) participated in the exercise to monitor their respective CASI fields in the first five weeks of seed sowing in the Rabi season of 2019-20. Each week, a field staff visited all the participant farmers and recorded their observations in the specially designed instruments using Kobo Toolbox. The process included developing a user guide, followed by rigorous training to the field staff based on the manual for data collection. The manual was developed into the facilitator's guidebook (Appendix 1), which provides a detailed description of the methods with some examples of the exercise we conducted in the field. The results obtained using this method resulted in a manuscript, which is attached as Appendix 2 in this report.

### **5.2.2 Semi-structured in-depth interviews**

In this research, we also collected data using semi-structured qualitative interviews from 249 households, interviewing the household heads. Within a location, the research participants were selected from different nodes which ranged from relatively high performing nodes, to low performing nodes, and nodes where ZT was out-scaled, in order to ensure diversity in data collection.

The semi-structured interview schedule focused on understanding the drivers, constraints, and farmers' perceptions on ZT adoption. After rigorous discussion among the team members and the field workers, the checklists were prepared to capture narratives of farmer's lived experiences of ZT adoption and simultaneous weed management. The interview schedule was broken down into different ZT aspects to be probed, and one such area of exploration focused on weed management under ZT and under conventional systems. Results of these interviews provided rich narratives on farmers' lived experience and their perceived understanding of ZT use, which eventually feed into several research outputs prepared under this project as well as the larger SRFSI project. The manuscript presented in Appendix 3 has a detailed description of this method.

## 6 Achievements against activities and milestones

The objective of this project was to document farmers' knowledge, experience and practices around weed management under CASI and analyse its gendered implications for equitable and sustainable intensification in the Eastern Gangetic Plains of South Asia. Here is the list of key achievements.

- Limited research exists on the interplay of changing weeds dynamics and its gender implications in a household under CASI.
- Research is peculiarly non-existent in the South Asian context.
- The Weeds and Gender project covers up this significant gap in research.
- Based on a participatory and on-field interaction with farmers, the project collected evidence documenting the knowledge, attitudes, and practices of male and female farmers individually about weed identification, weeds usage, knowledge of herbicides, time saved in a CASI farm, and utilization of saved time, and so on.
- The project has also contributed to the skill-building and capacity development of multiple partners.

Table 1: Activity wise achievements of the project

No.	Activity	Outputs/ milestones	Completion date	Status	Comments
1.1	Meeting stakeholders, SRFSI project partners		May 2019	Complete	SRFSI ARPM (in person in May 2019, virtual ARPM in June 2020 During series of field visits
1.2	Hiring a research assistant		Jul 2019	Complete	
1.3	First field visit		Jul 2019	Complete	
1.4	Developing instruments and protocols for data collection				
1.4.1	<i>Semi-structured interviews</i>		Sep 2019	Complete	Integration in SRFSI instrument
1.4.2	<i>Photo diary exercise</i>		Dec 2019	Complete	
1.4.3	<i>Quantitative survey</i>		May 2020	Incomplete	Drafted and shared with the team, but not revised as the survey had to be cancelled due to COVID-19 restrictions
1.5	Data collection and fieldwork				
1.5.1	<i>Semi-structured interviews</i>		Oct 2019	Complete	
1.5.2	<i>Photo diary exercise</i>		Jan 2021	Complete	
1.5.3	<i>Quantitative survey</i>			Cancelled	Due to COVID-19 restrictions

1.6	Data analysis and write up				
1.6.1	<i>Semi-structured interviews</i>		Feb 2021	Complete	Drafted, will be finalized with inputs from all authors
1.6.2	<i>Photo diary</i>		Jan 2021	Complete	Manuscript, submitted to a journal
1.6.3	<i>Quantitative survey</i>			Cancelled	Due to COVID-19 restrictions
1.7	Project webpage			Under construction	A link in the SRFSI website
1.8	Preparing a research paper		Feb 2021	Complete	Two manuscripts (Appendix 2 and 3)
1.9	Preparing a synthesis report		Jan 2021	Complete	Appendix 4

## 7 Key results and discussions

This report provides two manuscripts as appendices for further reading and more detailed results of the project. In this section, we summarize some of the key findings and learnings. Data show a difference in knowledge between male and female farmers in terms of weed identification. The differences in weed identification skills were more evident in maize than wheat-growing areas. In terms of regional comparison, this difference was more prominent in Bangladesh than in other study locations. Based on the participants' ability to nominate a local name for an identified, there seems to be a considerable knowledge gap. Participants could identify only 27% of all identified weeds; this knowledge gap was found more prominent in maize farming locations (33%) than in wheat farming locations (21%).

In terms of gendered incidence of an inability to nominate a local name, there was no substantial difference between men (29%) and women (25%), but a noticeable difference was observed in Nepal (men 18% to women 35%), meaning women were twice as likely not to attribute a local name than men. The other three locations had minimal difference by gender in the inability to nominate a local name (Figure 2).

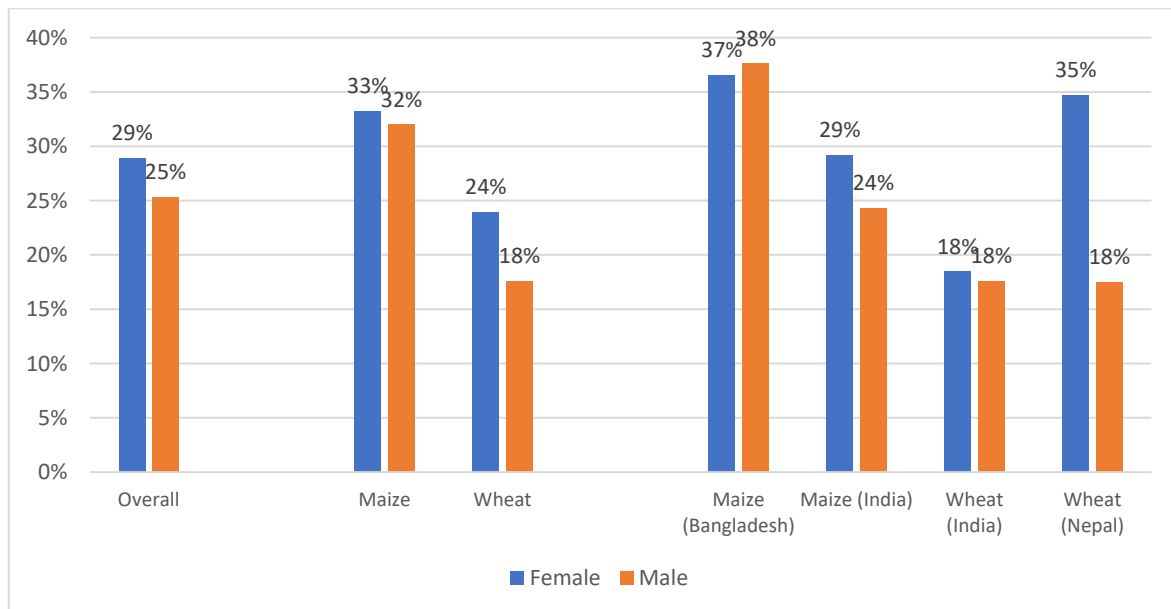


Figure 2: Incidence of an inability to nominate a local name to identified weeds by gender. (Source: Brown et al. 2021)

Another interesting finding of this study is that from the farmers' perspective and under the existing agricultural practices, weeds do not seem to be a problem under conservation agriculture in the research areas. Based on the data collected in the

first five weeks of seed sowing, it is observed that as farmers change their cultivation practice from conventional (CT) to zero (ZT) tillage, the weeding time is significantly reduced (Figure 3). Farmers experienced up to 85% reduction in weeding time, ranging between 45% in the maize system in Bangladesh to almost 99% in the wheat system in India.

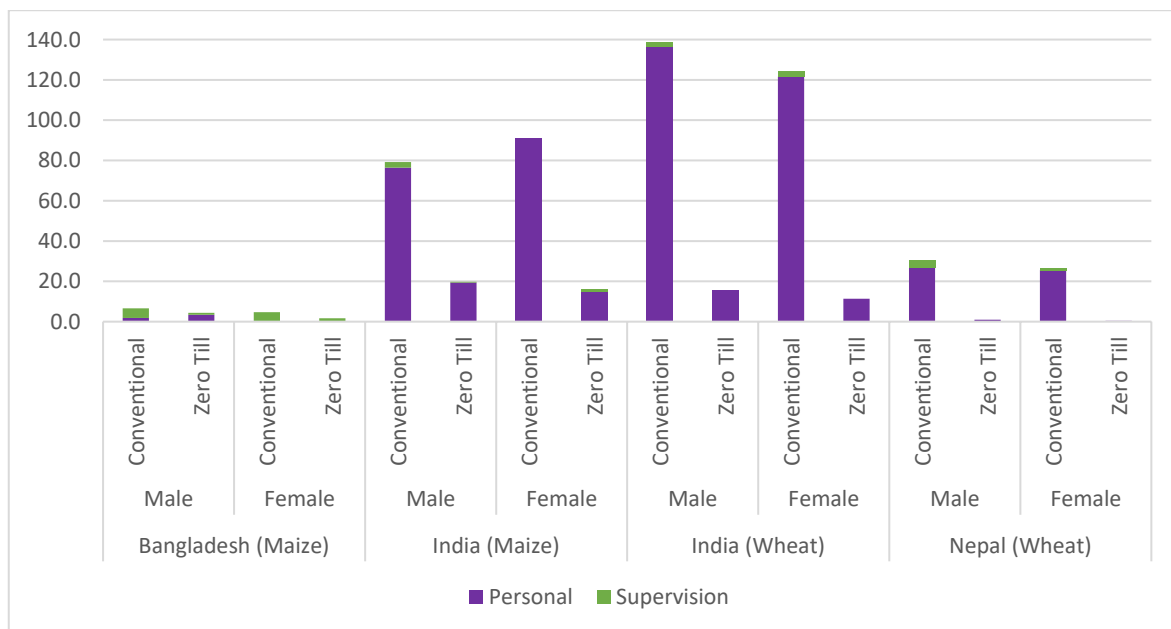


Figure 3: Comparison of total hours spend on weeding related activities in first 5 weeks post planting. (Source: Brown et al. 2021)

Unlike in the earlier agronomic studies indicating weed management as a constraint to CASI uptake (Kaumbutho et al. 2017b; Bajwa 2014), this study indicates that CASI system has positive impacts on how farmers manage weeds in their CASI plots. The results suggest that weed management requires less time under ZT and no reallocation of roles or burden takes place when herbicides are used. The results also contradict with the findings from other regions (especially in sub-Saharan Africa) that ZT adds labour burden to women (Farnworth et al. 2016). The participants of this research rather indicate that ZT saves substantial time in India and Nepal, and more so for women.

As mentioned elsewhere, herbicides control weed emergence and positively contribute to the experience of ZT use. While both users and non-users of herbicides were evident among the research participants, those who expressed negative perceptions on herbicides use appeared to be non-users or those with very little experience with herbicide use. These issues often led to dis-adoption or a lack of

further progression to ZT systems. Farmers raised issues like poor performance of herbicide based ZT, a certain mindset towards preferred weed management method, or simply misinformation and management with respect to herbicides. For those who raised concerns around herbicide performance, observed weed growth and associated management practices as a deterrent to ZT adoption, as expressed by a farmer in Bihar (India): (“there is a problem with two things here. If we do not solve those two problems, then zero-tillage will not succeed here. If the land is not flat, then zero tillage will not succeed here. Second, if there is a weed in the plot, it also creates a problem”- B35. *Source: Suri et al. 2021*). Similar opinions were received from the farmers in Rajshahi (Bangladesh) and Sunsari (Nepal). Mindset related issues pertained to the belief that whatever weed management they practice is the best one. Likewise, misinformation or mismanagement related issues are mentioned as restrictive use of herbicides for food crops, lack of knowledge on herbicide frequency and so on.

On the contrary, herbicide users, often with many years’ experience, were nearly unanimous in their positive response on herbicide, especially related to saved time and cost and reduced farm drudgery. Comparison made between hiring multiple labour against purchasing herbicides was also common (e.g. “Earlier, we had to spend INR 1500-2000 to remove weed with labour for 1 acre, and now we can do it with herbicide for just INR 200 or 300” – B21; approx. 73 INR to USD; *Source: Suri et al. 2021*). This was also related to the drudgery of personal weeding or finding high numbers of laborers, as evident in the following transcripts.

“The hard work has become easy now... There is no weeding work in this system, we just have to apply herbicides. Even if weeding is needed, we only go to the field once. But in the previous method 5 to 7 labours weeding 2 bigha field for 4-5 days did not suffice to pick all the weeds” - J18; Earlier, here we required 2-3 times to remove the weeds. Sometimes 20-25 laborers were required in a bigha land. But in zero tilling, spraying the field once is sufficient” - M27.

*Source: Suri et al. 2021*

Zero tillage has some implications on gender roles and responsibilities in weeding. The research participants identified some contrasting role of women across locations- some actively participated on their own farms, sometimes others’ farms



too, while some were bound by gender norms and did not work beyond their household chores and care work. In some cases, women's involvement was more consistent. In Bihar, it was usual for women to take care of weeding on the bunds which were usually left unsprayed (e.g., "The farmer never sprays on bunds. In this case, women do weeding of bunds"- B12: *Source: Suri et al. 2021*). Some women worked alongside hired labour on their own farm (e.g., "My mother, wife, sister do weeding and transplanting of paddy. They do this work with hired labour."- B12): *Source: Suri et al. 2021*. Sometimes they worked as labour on other people's farms (e.g., "Does your wife come to work on a farm, or used to work as labour on other's fields? Yes, she is going...Work like weeding, sowing of maize, transplanting of paddy"- B44: *Source: Suri et al. 2021*).

Another finding is that spraying of herbicides is becoming the male member's responsibility due to spray tank design and weight. Thus, zero tillage technology usage has had some gender implications. This is more apparent in areas where there is higher tendency of male labour out-migration and that may consequently increase the wage rate of male labour with such 'male-friendly' technologies.

Apparently, herbicide use is normalized in the region and their time, cost and labour-saving benefits are acknowledged by farmers. In developing countries especially that are facing labour shortages in rural areas, use of herbicides has facilitated agriculture intensification by making it economically viable for smallholder farmers (<https://www.iaea.org/projects/crp/d15011>). Moreover, shifting from conventional to conservation agriculture systems involves a change in farmers cultural practices (Wall 2007) and a paradigm shift around management of crops and resources such as soil, water, nutrients, weeds, and farm machinery (Bhan and Behera 2014). Thus, there is a need to establish a systems perspective, a holistic perspective including knowledge transfer, especially around weed identification and better management practices and safe handling of herbicide use (ibid). In support, Erenstein et al. (2012) highlight that scaling up of CA technologies is more about farmer perceptions and mind-set than about the technology itself.

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## 8 COVID-19 Impacts

COVID-19 has left an unprecedented impact on the lives of people across the world. The activities of this project were not refrained from this reality. This resulted in adjustment with respect to field visits and data collection that were planned for 2020. In coordination with the local partners and donor suggestions, we cancelled some activities, including additional field visits, quantitative survey and focus group discussions. However, by utilizing the time to analyse qualitative data that were already collected in 2019, we were still able to deliver the outputs envisioned in the project proposal.

The year 2020 became a virtual year and many researchers indeed conducted telephone survey to accommodate with the changed situation. We also discussed this alternative with our local partners. However, given the sensitivity of information and gender of respondents, the telephone survey would be questioned for the quality and credibility of data. We kept ourselves vigilant about the field situation; but as it did not improve until the time we could plan a field survey, for the safety of our staff, enumerators, and the respondent farmers, we decided to cancel all the remaining field activities and refocused our energy to analyze the data already collected.

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## 9 Conclusions and recommendations

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### 9.1 Conclusions

It is indicated that ZT has substantial benefits in time saving for both male and female farmers in India and Nepal, and that in all study locations there is no shifting of burden in weeding from men to women. The findings show a potential of ZT use to increase on- and off-farm income generating activities, leading to farmers' economic empowerment. However, it is important to consider the associated knowledge gap in terms of management and handling of herbicides and technical knowledge around ZT use, prevalent among the male and female farmers to ascertain a better adoption pathway.

Moreover, knowledge on weeds that grow in ZT fields was limited, which indicates that more extension efforts should focus on weed management and herbicide use as it becomes normalised in the agricultural production systems of the EGP. Moreover, adequate knowledge transfer at the outset of a technology roll out becomes important, as conservation agriculture is complex and knowledge and management intensive and proper agronomic knowledge transfer among farming communities is a crucial lynchpin for adoption.

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### 9.2 Recommendations

While weeds are prescribed as unwanted pests that compete with the main crops in the field, many weed plants could have other economic and medicinal values. Based on further in-depth research on gendered farmer knowledge on herbicide usage, an agronomic literacy on the effective, efficient, and economic management of weeds would help promote ZT technology. Such agronomic literacy programs can be tailored through the existing extension services mechanism prevalent in the region.

Even though herbicide use in the region is not a new phenomenon, the low level of awareness on the safe handling and human health aspects of it cannot be taken for granted. The environmental literacy, comprising safe use of herbicides, health hazards, concerns over air and water pollution, and long-term ecological problems and trade-offs, can be packaged through ZT technology promotion. It will help safeguard farmers' health in any way but also minimize negative impacts on the environment.

The policy environment that promotes equality of opportunities and outcomes may help farmers take up additional economic activities and expanding livelihood portfolios or alternative use of saved time. It may include, for example, affirmative actions like liberating barriers for women in accessing institutional credits to start-up businesses (through group collaterals or linking financial services) and developing business and leadership skills through training on other income-generating activities they are interested in.

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## 10.2 List of publications produced by the project

- Brown, B. Karki, E., Sharma, A., Suri, B., and Chaudhary, A. (2021). Herbicides and Zero Tillage in South Asia: Are we creating a gendered problem? Manuscript submitted to *Outlook on Agriculture*.
- Suri, B., Timsina, P., Brown, B., Karki, E., Chaudhary, A., Sharma, A., Sharma, R., and Gartaula, H. (2021). Farmer's experience of weed management under conservation agriculture: Insights from the Eastern Gangetic Plains. Manuscript under preparation for *Technology in Society*.

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## 11 Appendixes

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### 11.1 Appendix 1: Facilitator's Guidebook, Karki et al. 2021, CIMMYT

Karki, E., Chaudhary, A., Brown, B., Shrestha, M., and Suri, B. (2021) Using photovoice for a gendered understanding of farmers' agricultural knowledge, perception and practice. CIMMYT International, Kathmandu, Nepal.

About the Guidebook: Creating an understanding of smallholder agricultural decision making is complex, and especially creating in-depth understanding from gendered perspectives around knowledge, perception, and practice. This guidebook informs researchers and practitioners on how to implement a different approach towards understanding male and female farmers' perceptions of agricultural practices and subsequent impacts on their household decisions and agency.

This guide provides an outline of collecting quantitative, qualitative, vocal, and visual data using the Photovoice method. The flexible nature of the Photovoice method outlined in this guidebook allows researchers to modify the duration and number of meetings depending on the requirement or objective of the study. The intention is that this can be used as a basis for other studies with similar objectives.

This guidebook uses a participatory study undertaken in the communities in the Eastern Gangetic Plains (EGP) of South Asia as a case study to explore knowledge, attitude, and practice related to the adoption of conservation agriculture-based sustainable intensification (CASI) practices. It incorporates the different steps from preparation to the facilitation of a weeds photo diary study using the Photovoice method. The methodology in this guide were piloted with farmers practicing CASI in communities across Bangladesh, India, and Nepal.

The full Guidebook is attached separately.

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### 11.2 Appendix 2: Manuscript, Brown et al. 2021. Submitted to Outlook on Agriculture

Brown, B. Karki, E., Sharma, A., Suri, B., and Chaudhary, A. (2021). Herbicides and Zero Tillage in South Asia: Are we creating a gendered problem? Manuscript submitted to Outlook on Agriculture

Abstract: Substantial efforts have been devoted to the promotion of Zero Tillage (ZT) as part of a Conservation Agriculture based Sustainable Intensification (CASI) agenda in the Eastern Gangetic Plains of South Asia, yet there is no clear understanding of the gendered implications of the required change in weed management practices. Other geographies have shown evidence that transitioning to ZT may have unbalanced gendered implications

that may lead to CASI being a less than inclusive development pathway. To address this, a targeted in-depth study using quantitative, qualitative, and visual data collection methods was implemented to understand the perceptions, responsibilities, and knowledge of household spouses in the Eastern Gangetic Plains who have adopted ZT systems. Findings indicate that ZT can be considered inclusive based on substantial time savings in India and Nepal, no reallocation or increased burden of roles and responsibilities on women and balanced spousal knowledge of weed management practices in all localities. This research suggests that there may be less concern about inequality in the promotion of herbicide based ZT systems in South Asia than experienced in other geographies.

The submitted manuscript is attached separately.

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### **11.3 Appendix 3: Manuscript, Suri et al. 2021. Under preparation**

Suri, B., Timsina, P., Brown, B., Karki, E., Chaudhary, A., Sharma, A., Sharma, R., and Gartaula, H. (2021). Farmer's experience of weed management under conservation agriculture: Insights from the Eastern Gangetic Plains. Manuscript under preparation for a journal.

Abstract: Conservation agriculture has contributed to farmers' productivity, profitability and saved labour along with offering benefits that go beyond the farm such as strengthened food security, time savings for women, reduced drudgery and stronger resilience systems in South Asia. But it also changes weed population and management which is seen as a reason for its limited uptake and/or negative evaluation. Change in weed management also invariably alters gendered labour arrangements for smallholder farmers, especially owing to herbicide-based weed management. But there is little body of evidence on farmers perception and mindset on changing weed management practices under CA pertaining to the Eastern Gangetic Plains. This paper addresses the key gaps in literature on farmer knowledge and weed management practices within conservation agriculture by exploring their personal experience of using herbicides to manage zero-tillage weeds. This is achieved through semi-structured interviews conducted in Bangladesh, India and Nepal with a focus on their lived experiences, perceptions, gendered labour allocations and weed management responsibilities within households.

The working draft of the full paper is attached separately.



## **11.4 Appendix 4: Policy Brief, CIMMYT 2021**

The key messages from the policy brief:

While farmers in the Eastern Gangetic Plains (EGP) are spending lesser time in weeding with zero tillage (ZT) cultivation system, the lack of comprehensive knowledge of weed control and management in ZT is delaying ZT adoption process.

Though conservation agriculture is currently practiced in about five million hectares in South Asia, its adoption in the EGP has been nominal.

One of the downsides that renders negative evaluation is farmers' lack of in-depth awareness of herbicide usage.

The full document is attached separately.