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How profitable climate smart agricultural practices are? Voice of farmers from rice-wheat ecologies

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ABSTRACT

Farm record keeping can provide a look into the health of farm business, its profitability, and a snapshot in time of its present equity. However, farmers in developing country seldom maintain written records of farm operations. In many cases, farmers consider it worthless exercise. They feel overwhelmed by record keeping because it takes time, a change in behavior and for some, the requirement to learn a new skill. This study assesses the role of record keeping, particularly among women and youth using data collected in afarmers participatory research undertaken under the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Farmers (both male and female) in climate smart villages (CSVs) of Haryana were acquainted with farm *Lekha Jokha* (farm budgeting) booklet designed by CIMMYT-CCAFS partners and training to fill the information was given by the field staff including male and females (CIMMYT-CCAFS 2014). The study was undertaken during 2014-15 and 2015-16. Based on the data recorded through *Lekha Jokha*, the study also estimated the adoption and economics of different climate smart agricultural practices (CSAPs). The farm budgeting found to be very effective tool for increased awareness among women and men farmers especially youth which lead to accelerated adoption of CSAPs. With adoption of CSAPs proven reduced climatic risk was observed in terms of yield penalty, income and distress. The results identifies a platform for social inclusive development in agriculture to promote evidence based informed policy decisions for investment prioritization.

Key words: Climate risk adaptation, Climate smart village, Decision making, Farm Budgeting, Gender, Youth

Farming has become a very complex business in recent years with expected climate change effects and requires careful planning. In this situation, farm record keeping practice not only help in proper planning but also allows one to determine the most profitable alternatives and combinations of enterprise and the best methods to use in production (Winkler 2008). Information about the cost incurred and profitability earned from the different enterprises in the past helps in identifying suitable enterprise and also in deciding the mid-course correction (Rutto *et al.* 2016). Record keeping has a great potential to retain youth and also helps small holder farmers to overcome climate related challenges as several climate smart agricultural practices (CSAPs) have been developed which can be now easily compared by keeping record for increasing profitability and productivity (Aryal *et al.* 2016, Sapkota 2017, Jat *et al.* 2013, Gathala *et al.* 2015, Krupnik *et al.* 2014). Despite of showing potentiality, the adoption of CSAPs has not taken place as expected due to number of factors such as age, gender, education, risk taking behaviour, land ownership, family size etc. (Kumar Ajay *et al.* 2016, Aryal *et al.* 2016). However, none of them has studied the importance of farm record keeping in informed decision making in technology adoption and comparison of difference in area under CSAPs with respect to men and women record keeper.

In spite of equal involvement of men and women in agriculture activities, decision making is largely controlled by men (Kumar *et al.* 2016, Chand *et al.* 2011). It is now widely recognized that for agriculture to grow substantially role of women is indispensable as women provides more than 50 percent of agriculture workforce (FAO 2011).Under-estimating women's roles in agriculture is dangerous and hence gender incorporation in agriculture programs will lead to better outcomes and also for optimal use of available resources to ensure economic, sociological and physiological development (Quisumbing *et al.* 2014). The study of farm record keeping was conducted with aim to assess overall adoption pattern of CSAPs, to identify the role of record keeping in socio economic conditions of household with special emphasis on empowerment of farmwomen and youth and to assess the impact of CSAPs in climate related risk. The major hypothesis tested in the study are: record

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keeping helps in attracting youth in agriculture, enhances income of farmers and support technology application by informed decision making.

MATERIALS AND METHODS

The state of Haryana contributes significantly to the national food security as 7.66% of major cereals (rice and wheat) are produced in this state (GOI 2018). The state has a severally distressed male: female ratio and mainly dominated by men. As per Census 2011, the sex ratio in the state is 877 (GOH 2012). The decision making in farming are also dominated by men. CGIAR in collaboration with national and local research (ICAR, SAUs) and developmental (State Department of Agriculture, Govt. of Haryana) partners launched CCAFS climate smart village (CSV) program in Haryana in 2012. This program has been working to enhance farmer's ability to adapt climate change, manage climate risks and build resilience through climate smart villages (CSVs). It also aims to bring the inclusiveness through building capacity of both male and female farmers and upscaling these technologies among farming households (Hariharan *et al.* 2018).

As an activity of climate smart village, during 2013-14 a farm budgeting booklet *Lekha Jokha* was distributed to respondents in 28 climate smart villages (CSVs).The booklet includes all the vital information like type, amount and cost of seed and fertilizer used, time of sowing and harvesting, type, cost and return of technologies used, etc. Out of 28 CSVs 108 households in 19 CSVs of Karnal district (Haryana), *viz*. Barana, Anjanthali, Pujjam, Sandhir, Ganger, Narayana, Nadana, Shambli, Sagga, Beernarayana, Dahha, Unchasamana, Kutail, Bastada, Kartarpura, Kalsora, Badarpur, Chandsam and and Dabkoli Kala filled *Lekha Jokha.* Field staff (including male and female staff) also imparted trainings before entering the information required in the booklet. Trainings were imparted through farmer's group discussions as well as individual contact method. Thereafter, season wise data was collected during 2014-15 and 2015-16 (both the seasons) from the farmers to whom *Lekha Jokha* distributed. Data were analyzed using simple tabular analysis as well as graphical presentation using STATA 14. Besides, correlation and regression analysis was also carried out using MS-Excel. The increase in area and profitability were the indicators used for assessment of impact of record keeping and CSAPs.

RESULTS AND DISCUSSION

Adoption pattern of Lekha Jokha

It was found that smallholders farmers in particular do not maintain written records in the study area due to small size of holdings, lack of skills in record keeping, etc. which is similar to study conducted by Minae *et al.* (2003). However, study revealed that if proper guidance is given, farmers could willingly adopt record keeping practice as sufficient numbers of trained specialists in farm management are not available in the country who could help farmers maintain records. With the increased penetration of mobile phones and digital technologies, development of web–enabled decision tools could help the farmers in informed decision-making.

Results revealed that out of 100 booklet distributed among men and women of different households 50 households participated in record keeping during *rabi* 2014-15 and 35 farmers continued the record keeping in succeeding year (2015-16). Besides, additional 15 household filled the *Lekha Jokha* during *rabi*-2015-16. In *kharif* season, out of 100 household to whom *Lekha Jokha* were distribute, 50 household (17 men and 33 women) continued record keeping in both the years. Seven households continued the record keeping in all the seasons. It indicated that if proper skills are developed, the record keeping can be promoted among the farmers.

Adoption of climate smart agricultural technologies and their impact

On analyzing adoption pattern of CSAPs by record keeping farmers in *rabi* season during 2014-15 and 2015-16, it was found that adoption of turbo happy seeder (THS) remarkably increased by 124% and area under conventional tillage and broadcast seeding of wheat decreased by 93.6% during the corresponding period. However, no significant effect on area increase under nutrient expert and green seeker was observed.Although, consumption of urea significantly decreased with increase in DAP consumption indicating towards balance use of fertilizers. Also, It is

Table 1 Adoption pattern of different technologies in the study area

Season	Crop	Technology	Area under technology (ha/household)					
			2014-15			2015-16		
			<40 years	>40 years	Diff.	<40 years	>40 Years	Diff.
Rabi	Wheat	Turbo happy seeder	2.33 (32.60)	2.24 (31.40)	0.09	4.92 (73.80)	3.65 (69.40)	0.09
	Wheat	Conventional tillage	4.00 (48.00)	1.91 (21.00)	2.09	1.40 (2.80)	1.00 (2.00)	2.09
Kharif	Rice	Direct seeded rice	1.17 (16.60)	1.51 (19.60)	-0.34	0.60 (7.80)	0.62 (5.60)	-0.34
	Rice	Conventional tillage	2.94 (108.60)	3.61 (101.10)	-0.67	3.18 (66.80)	4.01 (80.10)	-0.67
	Rice	Nutrient expert	0.93 (8.40)	1.20 (7.20)	-0.27	1.81 (27.20)	1.25 (13.80)	-0.27*
	Rice	Green seeker	1.49 (19.40)	1.67 (20.00)	-0.18	2.14 (47.00)	3.00 (54.00)	-0.18*

Where; * indicated level of significance at 10%

Table 2 Gender based technology adoption and profitability analysis

Technologies	Year	Area covered (in ha)			Yield (t/ha)			Net return (₹/ha)		
		M	F	Dif.	M	F	Dif.	M	F	Dif.
Broadcasting	2014-15	5.83 (40.8)	1.76 (28.2)	4.07**	4.90	4.62	0.28	50186	44177	6009**
	2015-16	1.40 (2.0)	1.00 (2.0)	0.40	4.86	5.13	-0.27	51412	56913	-5501
	Dif.	-4.43	-0.76		-0.04	0.51**		1226	12736**	
Turbo happy seeder	2014-15	2.30 (9.2)	2.28 (54.8)	0.02	5.03	5.19	-0.16	55506	55127	379
	2015-16	6.10 (48.8)	3.63 (94.4)	2.47	5.37	5.45	-0.08	59777	60123	-346
	Dif.	3.8	1.35*		0.34	0.26***		4271	4996***	

Where; *, **, *** indicated level of significance at 10%, 5% and 1%.

worth mentioning that in *rabi* 2014-15 there was untimely rainfall during the grain filling stage due to which there was yield loss of 16% and 8% in conventional till (CT) wheat and conservation agriculture (CA)-based wheat system, respectively (Aryal *et al.* 2016). Record keeping farmers could clearly see this yield differencealong with difference in net revenue as given in Table 2. The positive and high correlation between technology adoption and yield (0.54) as well as net returns (0.56) further strengthen the hypothesis that record keeping helps in increasing income of the farmers. Grisham and Gillespie (2018) also studied that Louisiana dairy farmers who were adopters of record keeping were larger producers and were adopters of new technologies in dairy farming.

During *kharif* season the major CSA technologies considered were direct seeded rice (DSR), transplanted rice (TPR) with nutrient expert (TPR+NE), transplanted rice with green seeker (TPR+GS) sensor based nitrogen application. Results showed that area under TPR + NE and TPR+GS technology increased by 163% and 156% respectively, whereas area under DSR and TPR decreased in *kharif* 2016 compared to 2015. Decrease in area under DSR is possibly due to the fact that farmers are adopting GS and NE technology in TPR practice to get maximum yield benefits as TPR is ease and need not required much care.When the technology use was regressed on cost of cultivation, sowing cost and net returns, it was observed that DSR technology significantly decreases sowing cost but the cost of weed management could not compensate the reduction in total cost of cultivation and hence net returns were less than the TPR which was the main reason of unacceptance of this technology. Various studies also showed that farmers have reported weed as the main constraint in DSR (Rao and Chauhan 2015, Dhakal *et al.* 2015, Chauhan and Johnson 2011).

However, costs to society in terms of high extraction of water and carbon emission due to TPR has not been taken into account and need to be considered in DSR. The technology is further important from the viewpoint of scarcity of labor, particularly in the state of Haryana. Rao *et al.* (2007)opined that hand weeding is at least five times more expensive than herbicides for weed control in DSR, especially under labor-scarce or high labor cost environments. Therefore, it is believed that proper record keeping will enable farmers to keep monitored weed records which in turn will ensures timely weed management so that they can fetch more profit out of DSR technology.

Farm record keeping has a positive effect of farm income on record-keepers. By keeping farm records they can know how much they are earning from different technology. It was observed that farm income increased by 32% and 18% respectively among men and women record keepers during *rabi* 2014-15 and 2015-16, whereas in *kharif* season, farm income among men and women record keepers increased by 10.4% and 16.9% respectively (Fig 1).

Role of youth in technology adoption

To know how record keeping can help the youth in better decision-making and retain them in farming, technology adoption across the age group was seen by grouping the respondents into two age groups, i.e. youth (<40 years) and old (>40 years).Results showed that youth increased more area under climate smart technologies like THS compared toold farmers (Table 1). The decrease in area under conventional-tillage wheat during *rabi* 2015-16 compared to previous year was more pronounced among youth farmers (96%) than old farmers (90%). Our results are in line of our hypothesis, that youth involvement certainly affect adoption of all technology (Choudhary Vikas, ypard.net 2016).Youth devoted more area under nutrient management practices with PTR during 2015-16.Wilson *et al.* (2014) also found that younger farmers of northwest Ohio place a great emphasis on environmental stewardship while older farmers place great emphasis on profits.

Role of women in technology adoption and risk management

With the *Lekha Jokha* intervention women showed spectacular interest as area under THS significantly increased

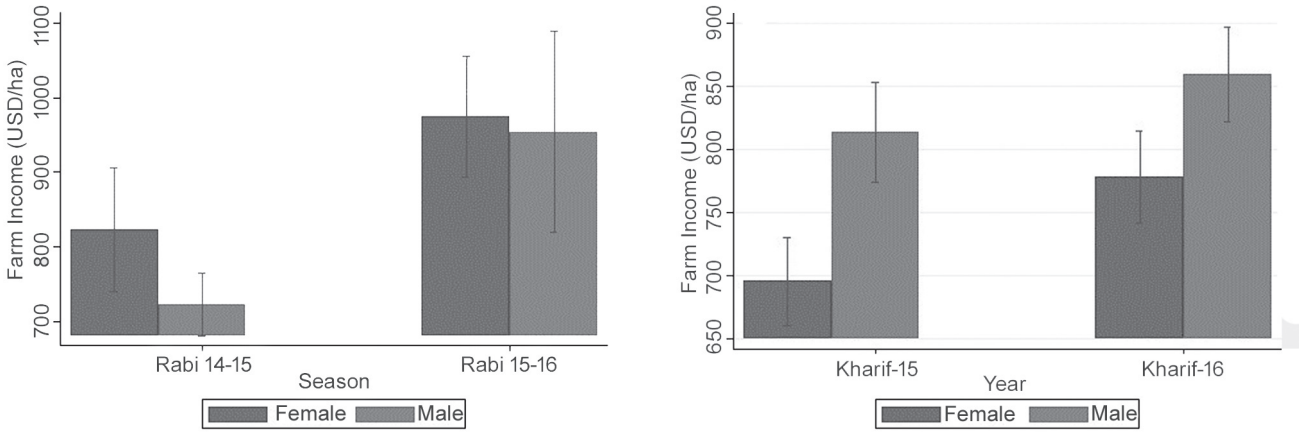

Fig 1 Impact of *Lekha Jokha* on farm income (USD/ha) during *rabi* and *kharif* season 2014-15 and 2015-16.

from 2.28 ha in 2014-15 to 3.63 ha in 2015-16 (Table 2). The absolute area under CSAPs such as THS by women record keepers increased from 54.8 ha to 94.4 ha, whereas men record keepers increased their THS area from 9.2 ha in 2014-15 to 48.8 ha in 2015-16. Study further found that women record keepers decreased total area under CT- based seeding through broadcasting of seeds from 28.2 ha to 2 ha and the men record keepers from 40.8 ha to 2.4 ha (Table 2). A significant increase in productivity as well as net return was observed in case of women farmers. Targeting women groups over individuals tends to lead to better technology adoption and resource utilization, enabling enhanced decision making capacity leading to improved livelihoods (Hariharan *et al.* 2018).

Considering *rabi* 2014-15 as a bad year for wheat production due to untimely excess rains at grain filling period, it was observed that record keepers who adopted THS experienced less yield penalty and increased their wheat yield by 13% in 2014-15 compared to non-adopter women record keepers (Fig 2). Whereas, men record keepers (adopters) increased their yield by 3 percent compared to men farmers who opted for broadcasting wheat. In 2015-16, which was a normal year, the yield gap between adopters and non-adopters of THS was 5.8% for women farmers and 9% for men adopters and non-adopters (Fig 2). Aryal *et al.* (2016) also found in his study that magnitude of yield loss in wheat during bad year was less in CA wheat than CT wheat and hence CA wheatcan serve as a climate risk adaptation measure irrespective of farm size.

Similar results were also reported by many workers (Krishna and Veettil 2014, Keil *et al.* 2015, Aryal *et al.* 2016). Results also showed that women record keepers who adopted THS for wheat sowing increased their net returns by 9% while menby 8% during both the years. Women record keepers who opted broadcasting method for sowing decreased their net returns by 20% compared to women THS adopters in 2014-15 (bad year), whereas in 2015-16 the decrease was only 5% (Table 2). Similarly, men record keepers decreased their net returns by 10 and 14% in 2014-15 and 2015-16 respectively. Direct seeded rice (DSR) however did not showed any significant association with gender but showed positive correlation with gender and technology adoption. Women record keepers reduced the area by 60% whereas men by 69% in 2016. Though, area under transplanted puddled rice decreased by 31% and 28% in case of women and men record keepers respectively.

The results from the study significantly highlights farm record keeping as an efficient tool for increased adoption

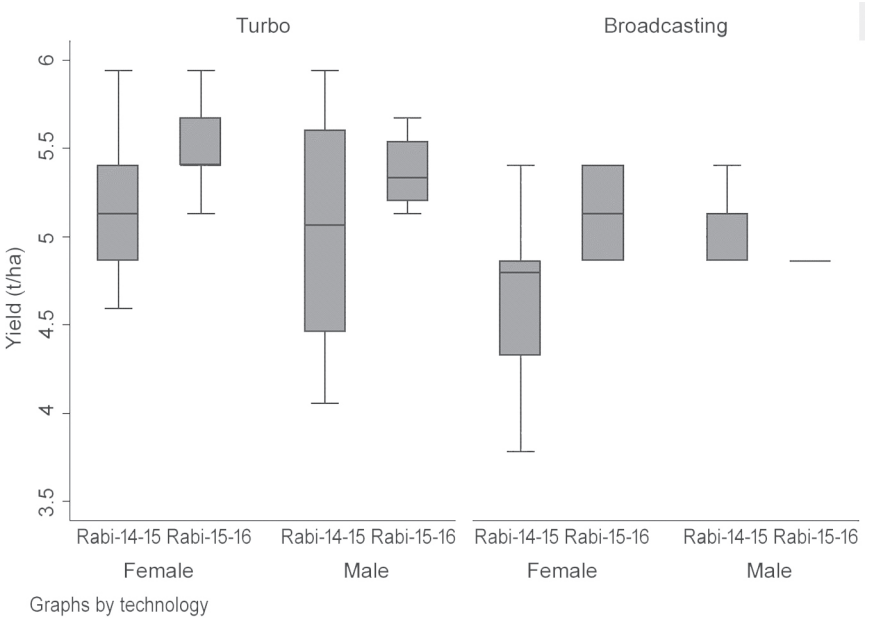

Fig 2 Gender based adoption pattern of DSR and TPR technology during *kharif* 2015 & 2016

of climate smart agriculture practices. Although this tool was rolled as pilot activity in climate smart villages (CSVs) of Haryana, it demonstrated high impact on increased awareness among farming community. Specifically, the tool highlighted the significance of budgeting among rural youth for persuading them with socio- economic and environmental benefits of CSAPs. Addressing improved household livelihood, increased role of women in decision-making plays vital role, where providing access to women on farm budgeting has illustrated their high involvement in scaling CSAPs. The response rate of farm *Lekha Jokha* have motivated government developmental department in Haryana to scale out and thus incorporated its usage exclusively by women in its project on addressing climate change through mainstreaming CSVs. The outputs and learnings will further be useful for the policy makers in developing models for inclusive development.With the increased penetration of mobile devices and digital technologies, development of web–enabled decision tools could help the farmers in informed decision-making. Blending CA technologies with ICTs can help in motivation and retaining youth in agriculture.

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