Potential Impacts and Demand for Picture-Based Crop Insurance

Qualitative research findings from Haryana State, India

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Abstract

This report summarizes results from qualitative research on a picture-based insurance solution to improve agricultural risk management. We conducted focus group discussions with 122 male and 77 female members of farming households in the state of Haryana in India. Participants perceive horticulture crops like tomato as high-risk, high-return investments. Excess rainfall, hail, and pests are considered key risks for both wheat and paddy farming, while disease and hail are identified as more important risks for tomato production. Respondents distrust insurance and there is widespread use of informal credit as a risk coping strategy. Female household members not involved in production have limited knowledge about investments in and returns from crops but are aware of price and production shocks as well as the coping strategies in response to these. In addition, households do not show sufficient knowledge of crop insurance as a coping mechanism. Smartphone penetration and use was found to be high among interviewed households, but women rarely own smartphones and rely instead on younger members of the household. Given households' familiarity with credit and their distrust of insurance, credit and insurance bundles are a potential mechanism to encourage adoption of smartphone-based insurance solutions. Moreover, additional research is needed about female financial knowledge, attitudes towards risk and risk coping, and households' demand for insurance.

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Section 1: Introduction

Smallholder farmers in India are increasingly exposed to climate change and extreme weather events (Porter *et al.*, 2014). The increased exposure to risk and resulting agricultural income losses discourage farming households from investing in both productivity-enhancing innovations and human capital, affecting growth prospects for existing and future generations (Cole, et.al., 2017; Karlan et al., 2014). Market-oriented solutions to improve agricultural risk management, such as formal insurance, are not available at scale due to a range of supply and demand side factors (Hazell, 1986). Indemnity insurance products suffer from high transaction costs and information asymmetries, while index-based products are prone to high basis risk and poor farmer engagement, perpetuating low levels of trust in insurance, and insurance demand and coverage (Cole, et.al., 2013; Mobarak and Rosenzweig, 2012). Additionally, most large-scale insurance programs focus mainly on livestock and cereals, whereas there are relatively few programs that offer coverage for high-risk, yet potentially high-return horticultural commodities such as tomatoes.

Agricultural research-for-development has been testing and studying a range of innovative risk-management strategies to improve demand for affordable crop insurance and to reduce the financial burden of climate change on Indian farmers. One such strategy - Picture-Based Crop Insurance (PBI) - aims to deliver affordable and easy-to-understand crop insurance using farmers' smartphone pictures (Ceballos, Kramer, and Robles, 2019). Farmers take crop pictures using their own smartphones, thereby reliably documenting damage before, during, and after any loss suffered. This brings down the costs of loss verification and delivers visible plot-level assessments of damage, reducing key barriers in the demand for existing index insurance products including basis risk, trust, and understanding. The solution is being tested in partnership with HDFC Ergo, a leading private sector insurance provider in India.

This report describes results from a qualitative study on agricultural risk management in Haryana, a state in the northwestern part of India. Through focus group discussions, the study aimed at addressing the following objectives:

1. To inform the current theory of change, product design, and the design of a quantitative survey tool that was being developed for an impact evaluation of picture-based crop insurance products.

2. Understand key demand factors for the insurance product and assess whether individual characteristics, especially gender, affect risk aversion, perceptions of crop risk, and risk coping strategies.

This report describes the study's research methods and findings, focusing on key points arising from the analysis of the focus group discussions (FGDs). Section 2 introduces the FGD tool. Section 3 discusses findings regarding crop calendar, crop investments, returns, crop-wise risk analyses, risk coping strategies, and differences between male

and female responses. The concluding section, Section 4, lays out key recommendations for the theory of change.

Section 2: Methods

The study was implemented by the International Food Policy Research Institute (IFPRI) and the Borlaug Institute for South Asia (BISA) in two districts in Haryana: Kurukshetra and Karnal. The FGDs were held with approximately 100 households, separately with female and male heads of each household, resulting in a total coverage of 199 individuals (including 77 female respondents and 122 male respondents).

The selection of the sample proceeded as follows. First, within the two districts, two blocks per district were deliberately selected to cover areas where tomatoes are grown. For each of these blocks, two villages were randomly selected to conduct the FGDs. In these villages, discussions were held with village leaders to list eligible farming households. Eligible farmers included a mix of larger land-owning farmers, marginal farmers with up to 2.5 acres of land, and landless farmers. They were growing three crops – wheat, paddy, and tomato. Among eligible households, we selected participants and potential replacements. Overall, out of the targeted 200 participants, 199 participants were reached from 16 villages across four blocks in the two districts - Karnal and Kurukshetra.[1]

Table 1 presents descriptive statistics for the sample that participated in the focus group discussions. While the number of male participants is well balanced between the two districts, we were able to recruit relatively more women in Kurukshetra, a relatively poorer district where women have higher mobility. Men are on average slightly older than female participants, and they are more likely to have completed a post-graduate or university degree. The average household has about 6 household members, and women report smaller landholdings than men, both in terms of owned land and land that has been leased-in. Leasing land out is very uncommon among the sample. Women also report significantly fewer years of farming experience than men.

Not all individuals own and use smartphones, and smartphone ownership is significantly lower among women than among men (28.6 versus 67.2 percent, respectively). Nevertheless, every household we met had at least one family member, usually an older child or the head of the household, who owned and used a smartphone. In most instances, heads of households took help from their children in using smartphones for purposes such as taking pictures or browsing the internet. The higher smartphone adoption among younger age groups together with the low cost of data in India compared to other parts of the world, opens potential options to engage farming households directly through youth.

[1] Invited farmers were not always able to attend and particular challenges were faced recruiting female participants from households. The typical farmer in Haryana is male, with female household members largely restricted to household work. Limited female mobility and knowledge about farming sometimes made male farmers reluctant to permit their wives to join group discussions. However, these issues were largely addressed by carefully explaining the research objectives.

FGD Tool

The FGD incorporated a mix of close- and open-ended questions with participatory exercises to chart key crop calendars and risks. This allowed us to facilitate consensus and triangulate responses in a group format, while also ensuring that we elicited responses from diverse types of participants. Figure 1 presents the key modules and discussion flow.

Discussions would start with a mapping of crop calendars to understand cash flow processes and bottlenecks and the timing of insurance needs. Aside from helping the facilitation team understand the timing of critical activities, which was important in informing the planning of insurance activities and product design, the calendar served as a strong memory tool for subsequent sections, for instance for helping farmers recall costs and describe when specific risks had affected their crops.

After compiling the crop calendar, the discussion continued with a listing of crop-wise expenses and revenues to assess profitability and optimal coverage amounts for potential insurance products. Next, groups would identify key production risks, and rank these in order of what they felt posed the highest threat to their crops. Facilitators were instructed to probe to see whether farmers were indeed reporting risks that occurred most regularly, rather than those that were suffered most recently. To prevent farmers from simply repeating the rank order suggested by whoever spoke first, facilitators ensured that different people were brought into the discussion and prompted them to surface any concerns or hesitation around the rank ordering of risks.

The group concluded with a discussion around coping mechanisms for these risks, experiences with insurance, and a demo of satellite-based and picture-based insurance. After demonstrating these insurance products, we elicited participants' willingness to pay for these products, which is discussed in a separate study report (Kramer et al., 2017).

Section 3: Findings

Crop Calendar

As discussed above, the first activity in the FGD involved farmers collectively indicating crop-specific key farming activities on a calendar. Crop cycles for the studied crops are given in Figure 2. There is minimal variation in crop cycles for paddy and wheat. Typically, the state government would provide a fixed date for specific events such as transplanting of paddy (usually in late June) in line with weather conditions. There is slight variation in planting seasons of paddy depending on variety (hybrid vs basmati). However, most farmers had shifted from basmati to hybrid varieties due to a negative price shock to the '*basmati*' variety in the previous season.

The crop calendar for horticultural crops depends on the grown variety as well. Farmers can choose to grow tomatoes during two periods, allowing them to stagger their labor input with wheat requirements. One possible period starts in August and September, a

month before wheat planting starts, with a second period starting in February, a month before the onset of wheat harvesting. The tomato harvesting activities often stretch over two months because farmers pick tomatoes as and when the fruit emerges, which does not occur at once for the entire plot. Therefore, harvesting can be done in several cycles within one season alone.

Resources

Figure 3 provides block-wise average and median costs for wheat, paddy, and tomato. There are pronounced differences between average and median costs, suggesting the presence of outliers, particularly for tomato cultivation. The large discrepancies between average and median costs are in part due to differences in costs of different tomato varieties and partly due to one outlier village in Nilokheri, which was growing tomato vines and reported significantly higher investments. Whereas ground-trailing tomato varieties require little infrastructure, bamboo support structures for tomato vines can be expensive.

Differences in costs and profits by block and crop can be seen in Figure 4. Tomato was not grown in Pehowa block at the time of the study. Wheat and paddy are largely considered basic crops, for which farmers can estimate their investment and earnings without difficulties. In the case of horticultural crops like tomato and cash crops like sugarcane, however, there is more variation in returns due to significant price volatility, making it more difficult for farmers to predict their profitability. Most farmers perceive the cultivation of tomatoes to be a high-risk, high-return activity. “It is like an expensive gamble”, commented a farmer in Nilokheri. Furthermore, farmers, especially in Karnal, complained about having faced losses with their tomato crop in the last season, because of a sharp price drop during the second and third harvest periods.

However, it is clear from the chart that not all farmers planned their investment in tomato in a similar way. Specifically, in one particular village in Nilokheri block, farmers invested substantially in infrastructure (listed as miscellaneous in Figure 4c), comprising bamboo structures for vine growing tomatoes. In other villages, a ground trailing local variety was grown (Indri and Ladwa blocks). While our findings indicate the ground trailing tomato variety as overall more cost effective (particularly with effective soil management and correct tilling and solarization, see graph for Indri block), this may be confounded by the fact that weather conditions in 2018 may not have been optimal to recover the higher investment in vine-growing infrastructure. . The impact evaluation will assess whether insurance leads to increased investments in infrastructure for tomato cultivation and verify whether these investments lead to improved returns, aggregating over multiple seasons to average out years in which the investment does not pay off.

Female Knowledge of Farm Profitability

In the districts where the FGDs were held, female household members rarely contribute directly to farming. Overall, we only came across a few women who had taken up a direct role in farming. Part of this is because in Haryana, there are strong gender norms

restricting women's movements outside of the house, limiting women's mobility. Moreover, women are discouraged from mingling with people outside their families.

Another reason for the lack of women interviewed in the FGDs participating in farming is that in recruiting participants we balanced the representation of farmers with and without land. Being generally more poor, landless households depend more heavily on income from agricultural labor activities. Since the FGDs were conducted around the time of the paddy planting season, during which farms rely more intensively on hired female labor, it is possible that the wives of non-landowning farmers were busy as laborers and could thus not attend this activity.[2]

As a result of the small amount of female participants familiarized with farming activities, we did not get many female responses on detailed costs of cultivation. However, many could report rough estimates of the total investment per acre. Where this was the case, participants generally reported consistent numbers across male and female FGDs. Likewise, the small number of women who were involved in farming were unable to give accurate estimates of returns, but most women did report estimates of losses due to price shocks in tomato. This is perhaps due to price shocks being more salient in household discussions around farm returns and profitability.

In some cases, women indicated a larger number of vegetables being sown and cultivated than their male counterparts. For example, in Nilokheri Block, we came across capsicum (bell peppers), bitter gourd, and okra as additional vegetables, but these vegetables were not always reported by males. This could be because these vegetables are "kitchen garden" crops and not yet grown at scale for marketing.

Risk and risk coping strategies

Risk ranking **-** Farmers were asked to rank six risks (low rainfall, excess rain, hail, pest, disease and winds) in terms of how much these risks worried them, and to identify any 'other risks' if relevant for the ranking. The only 'other risks' identified in discussions were low and high temperature in two of the villages. We use these rankings to generate the heatmaps presented in Figure 5 to visualize the priority risks for each crop.

In the case of wheat, excess rain, hail, and wind are the highest-ranked risks. In the case of tomato, the highest-ranked risks are disease, hail, and excess rain. For paddy, the highest-ranked risks are pests, excess rain, and disease.

We do, however, observe some variability across districts. While hail, excess rain, and wind are the key perceived risks for wheat in both Karnal and Kurukshetra, we observe differences across the two districts for tomato. In Karnal, farmers prioritised disease,

[2] There were some district-level differences in the involvement of women in farming. As we moved away from Karnal into Kurukshetra, which is generally a poorer district than Karnal, we found more women reporting detailed costs and involvement in farming.

excess rain, and hail as the 1st, 2nd and 3rd risk, respectively, whereas farmers in Kurukshetra generally ranked hail as a more worrying risk than excess rain and disease.

Key risky periods – The FGDs also asked participants to report the most vulnerable period for their crops to various risks. Participants reported the spring period between March and April as the most vulnerable period for both wheat and tomato (in terms of both weather risk and diseases affecting the crops). For paddy, August and September were reported as the most vulnerable times around the time of flowering.

Visible damage - For horticultural crops such as tomato and potatoes farmers reported that most damage related to hail, excess rain, and disease resulted in visible damage, which was an important consideration for the viability of a picture-based insurance model. As stated by a farmer in Mukhali: *"We can make out pests and diseases easily in tomato. It may get black patches. The skin of tomato shows every distress – too much rain, wind - it shrivels. We can see it immediately."*

Risk coping methods **–** Access to credit, mostly informal loans through local traders and moneylenders, was reported as the most common approach to managing risk both by females and males. The standard fee that farmers pay when taking out such an informal loan is INR 2 per one hundred rupees borrowed, or a 2% interest rate per month on tenures ranging from 6 to 12 months (equivalent to 24% per annum). However, farmers must pay the full fee even if they return the loan ahead of time. For example, if farmers repay within four months, they will still have to pay the 6-month or one-year interest charge. Although different crops are prone to different risks, farmers did not use different risk coping strategies depending on the crop. Instead, they described risk coping in general terms, and mostly reported that they managed risk by taking out loans.

Generally, access to formal credit was limited to landowning farmers. Most landowning farmers reported taking loans under a government scheme either directly or through an agricultural bank or cooperative. The interest rate on these formal loans varied around 5-7% annually depending on whether a subsidized lending rate was applied and if the farmer was perceived by the lender to be at a low risk of default.

Other approaches to cope with risk included sale of assets such as gold and land at times of extreme stress. Among landless farmers, assets such as gold are used as collateral to raise informal credit. Alternatively, they may seek credit in exchange for their future labour contribution to a landowner. None of the farmers explicitly stated insurance as a risk coping mechanism, although many were already covered by insurance through the Prime Minister Fasal Bima Yojana (PMFBY), as will be discussed in Section 4.

Gender considerations in risk and risk coping – Female responses were generally consistent with regards to the mechanisms through which their households were coping with agricultural production risk. They were aware of informal options for loans, but not so much about formal sources, even though a considerable number of the female participants had formal bank accounts.

However, unlike men, women emphasized shifts in household expenditure and consumption as a key mechanism to cope with shocks to agricultural incomes. Many reported that sources of protein and vitamins like paneer (local cottage cheese) or vegetables would be curtailed when the household did not have much cash in hand. Some reported that the request for needs relating to for instance children's education or visiting relatives were often turned down during such periods, leading to tension within the household. "*You can imagine that the man's blood pressure goes up during times of stress*." said one woman in Sura village in Nilokheri block. She continued to express that most women would be the first to bear the brunt of heightened tensions at the domestic level. However, by and large, women reported that when it came to children's health and education, external shocks to farming did not affect what needed to be done.

In some villages, female responses tended to rank crops on an overall household income risk scale versus ranking specific risks on a crop-by-crop basis. For example, they would report that wheat is the main crop, and if something would go wrong in wheat production, then things would start to affect basic expenses like food or education. Paddy was not generally perceived as a high-risk crop, although in some villages both wheat- and paddy-related risks were highlighted. Tomato, on the other hand, was considered a high-risk crop both from the perspective of weather and pest-related damage, and price volatility. "*Getting a good return on tomato is a bonus. We know from the beginning something is going to go wrong with tomato so our expectations are in line with that*." (Female respondent, Dudhi Village Ladwa Block).

Other risks - Although the FGDs focused on production risks, farmers in both districts reported overall price volatility as the most important perceived risk, particularly for tomatoes, but also for certain varieties of paddy. As picture-based crop insurance is not a solution to hedge against price shocks, the FGDs did not focus on this aspect of the discussion. Another risk highlighted by farmers was the lack of access to markets for tomato particularly due to the price of transportation. This risk was closely related to price risk, though, as the farmers tried to reach a more profitable yet more distant market when prices were lower in the local market.

Attitudes towards insurance and buying insurance:

Farmer awareness of insurance **-** Most male and female respondents would first identify life insurance (particularly, the Life Insurance Corporation) and vehicular insurance (for tractors and motorcycles). As such, the concept of insurance was understood at some level. Respondents, however, had varying exposure to crop insurance with almost no women having heard of crop insurance.

Is insurance available to all? – The national crop insurance scheme, PMFBY, was the only available insurance policy and was only available to landowning farmers who had taken loans through a formal financial institution. Here, the premium was bundled with the loan. While farmers were aware that they were paying a certain premium (approx. INR 400) with their loan installments, they were not clear about specifics around coverage

amounts, or about the terms and conditions relating to payouts. Farmers working on leased land reported being unable to qualify for PMFBY coverage, as this is area yield index-based insurance, and loss assessment requires that there be clear information on the size of land. In reality, however, leasees can obtain loan and insurance coverage with the landowner's approval.

Experience and attitudes towards crop insurance – Most farmers had an extremely negative attitude towards crop insurance. In a few villages in Karnal (in both Nilokheri and Indri), farmers had suffered losses to wheat or paddy due to excess rains. Since the PMFBY insurance is bundled with credit, it only covers the full credit amount, resulting in farmers being under-compensated for losses as farmers do not usually take loans to cover all plots or their full production cost. Additionally, in the perception of some farmers, the PMFBY loss assessment methodology does not account for microclimates. "They require a large area to suffer consistent losses and do not visit enough villages to obtain crop samples to estimate losses," according to a farmer in Gangar village, Nilokheri, Karnal.

As a result, most farmers were complaining about the lack of payouts or low payouts from the scheme. At the same time, because the scheme is bundled with loans, and because farm loans have a high market penetration among landowning farmers due to a subsidized credit scheme which charges prime lending rates, almost 100% of the participants who owned land and qualified for formal loans were covered under the PMFBY. If the insurance product were effective, a loan-linked insurance scheme would be be preferred by farmers compared to one where they have to pay the premium separately. In particular, farmers seem tto appreciate that the premium is bundled with the loan, allowing them to pay it off in instalments, rather than upfront as a standalone lump sum.

However, loan-linked schemes can come with their own issues. One particularly extreme case was reported during an FGD in the Ladwa block of Kurukshetra. Farmers who took out loans were covered under PMFBY and suffered a significant loss during wheat production. The payout was supposed to be settled directly with the bank since farmers had taken out loans. For some reason the payout was delayed. The bank, therefore, suspended farmer credit lines, affecting the ability of farmers to invest in the next crop, which was paddy. From the farmers' perspective, the payout was never meant for them and never reached them; they paid the insurance premium but the bank benefitted from their insurance coverage instead of the farmer. Timing is essential when the turnaround from one crop to the other is quick, and in this case, farmers decided to use the platform of their local farmer organisation to negotiate with the bank for reopening their credit line.

Other factors of interest

Technology adoption – While not all individuals own and use smartphones, every household had at least one family member, usually an older child or the head of the household, who owned and used a smartphone. In most instances, heads of households

took help from their children in using smartphones for purposes such as taking pictures or browsing the internet. The higher smartphone adoption among younger age groups together with the low cost of data in India (when compared to other parts of the world) opens up potential options to engage farming households directly through youth.

Hidden investments in managing resources – Most female participants mentioned that they could not stop working. For instance, a participant in a female FGD in Indri Block said: “Life has gone by in serving others and we cannot stop until we die.”. Women bear the burden of housework and generally work between 9-10 hours every day. This burden can increase if women tend cattle at home or need to provide tea and sometimes even bookkeeping services for external labor.

Additionally, the forced sale of assets traditionally owned by women (such as gold) can have a significant adverse effect on their safety nets. Women in Haryana typically have very few assets– most of the women participating in the FGDs reported that the only assets they truly owned were the savings in their account and their jewellery.

Section 5: Conclusion and Recommendations

Recommendations can be categorized into those that have implications for the design of the insurance product and related services and those that highlight research gaps. Both these types of recommendation have an implication for the theory of change. For product design it would be useful to test models bundled with credit versus unbundled models of PBI to see whether and how uptake could vary between them. As awareness and attitudes regarding crop insurance can adversely affect willingness to pay, bundling this product may facilitate its adoption more widely. However, with bundled products, particularly in a context where banks already perceive farmers as high-risk borrowers, it would be important to ensure that insurance payouts are timely and bank credit policies and flows do not get affected by delays or failures in payouts.

There is widespread use of informal credit to smooth consumption and invest in crops (particularly when the household faces a weather or price shock). On the other hand, most farmers were reluctant to report whether they had any savings (respondents typically underreport savings).[3] Given the demand for consumption credit and learning from digital credit models emerging elsewhere globally, the picture-based insurance program could potentially offer an opportunity to learn about bundling credit with insurance.

In cases where farmers do not actively own and use smartphones, it may be beneficial to see if some form of motivation can be offered to children in the household to “help” their parents with picture-based insurance. This may not need to be of high monetary value

[3] This could be because households do not want to disclose their income or savings to researchers, or it could be that the range of money management strategies that low-income households use are not all perceived as ‘savings’ by them. See for example Collins *et al.* (2009).

but could relate to some tangible engagement such as a points program redeemable with airtime.

One key area where a research gap was found relates to gender and the demand for insurance. Studies that discuss and analyse the key drivers for insurance demand, uptake, and usage by gender are limited. There remains a large evidence gap, for example, about how female attitudes towards risk and risk coping, their willingness to pay and, more broadly, their financial knowledge and behaviours, affect their demand for insurance.

Similarly, there is more to learn about both the economic and non-economic outcomes of insurance uptake and usage. This qualitative study highlights that while insurance may not be able to exert a direct positive effect on female household drudgery it would be useful to see how female labour gets re-allocated with income smoothening. One mechanism could be if insurance leads to expansion of labor-intensive crops, which could have implications for women's workload. Similarly, it will be useful to track whether the forced sale of female assets like gold reduces with insurance. On non-economic outcomes, a future research direction is to track whether improved insurance decreases household conflict or tensions and improves consumption smoothing, particularly in relation to dietary diversity implications.

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Figures and Tables

Table 1: Descriptive statistics of the qualitative sample

	Female		**Male**	
	Mean	**Std. dev.***	**Mean**	**Std. dev.***
District				
– Karnal	45.5		49.2	
– Kurukshetra	54.5		50.8	
Age	43.1	(11.0)	46.1	(11.4)
Highest level of education				
– Primary or less	49.4		40.2	
– Secondary	39.0		39.3	
– More than secondary	11.7		20.5	
Number of family members	5.73	(2.35)	6.11	(2.60)
Size of land (in acres)				
– Acres owned	6.72	(9.87)	9.10	(10.8)
– Acres leased-in	2.90	(5.88)	4.76	(9.30)
– Acres leased-out	0.11	(0.91)	0.08	(0.91)
Years of farming experience	3.51	(10.3)	24.7	(11.5)
Is a smartphone user	28.6		67.2	
Has PMFBY	32.5		51.6	
Number of observations	77		122	

Note: * Standard deviations not provided for binary variables.

FIGURE 1: TYPICAL DISCUSSION FLOW

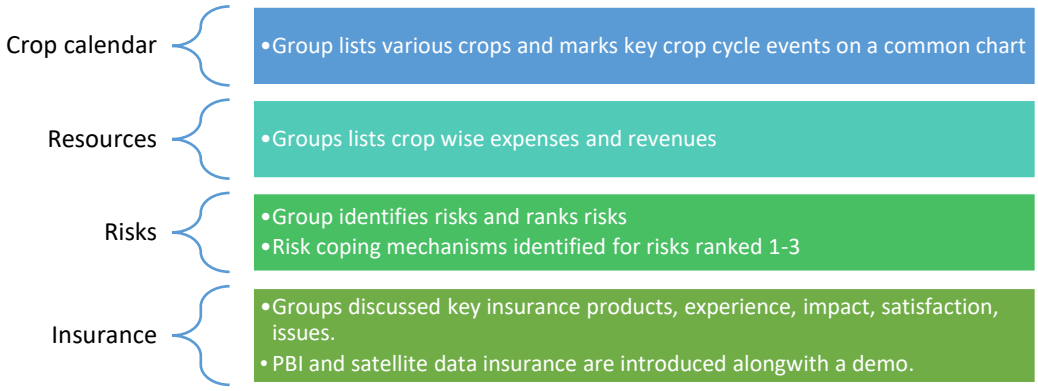
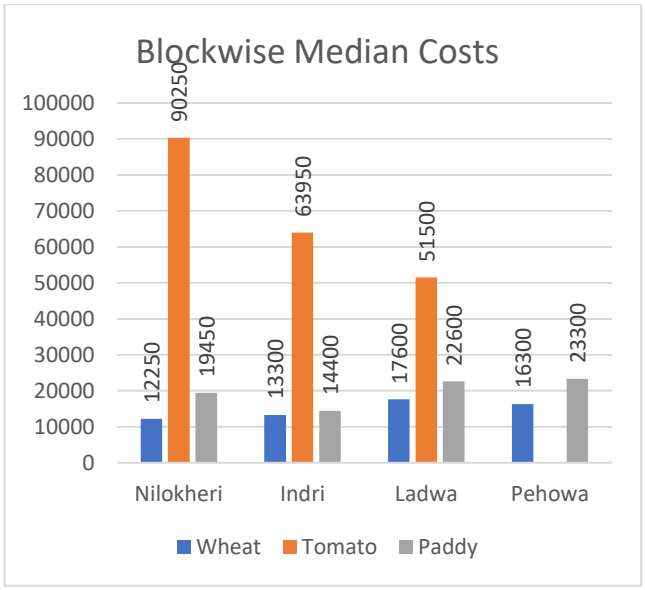


FIGURE 2: CROP CALENDAR

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wheat		4		5&6						1&2	3	
Paddy						1&2	3	4	5	6		
Potato		5	6							1&2	3&4	
Mustard	5	6								1&2	3	4
Tomato 1	1	2	3	4	5	6						
Tomato 2			6					1&2	3		4	5
Tomato 3	2	3	4		5	6						1

1- Land preparation
2- Planting starts
3- Planting ends
4. Flowering
5. Harvesting starts
6. Harvesting ends

Figure 3: Average and Median Costs by Crop



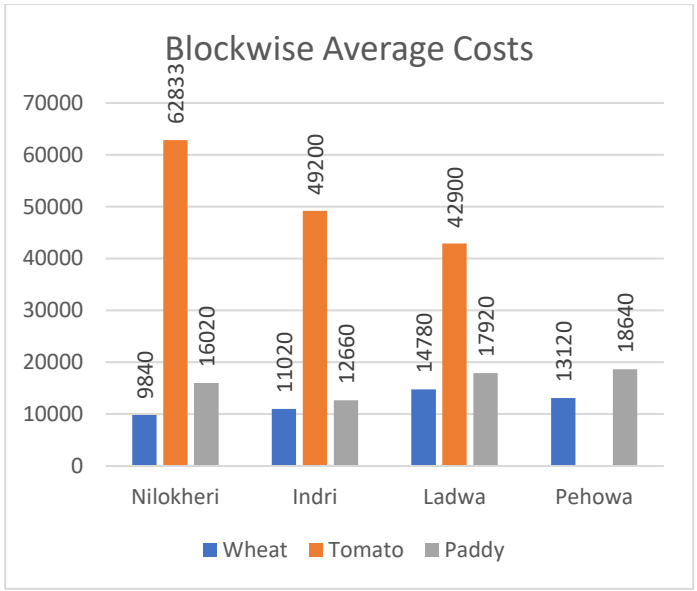
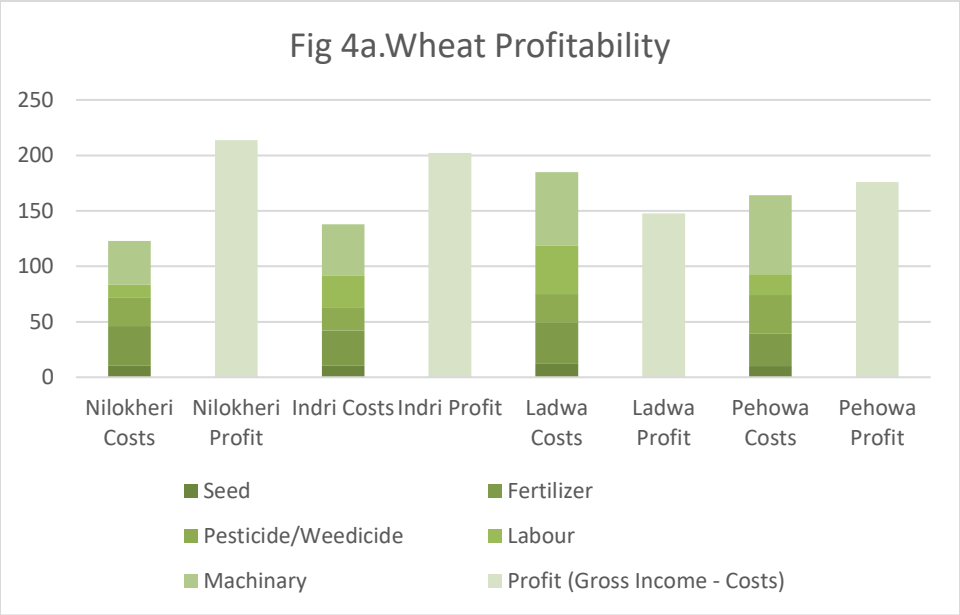
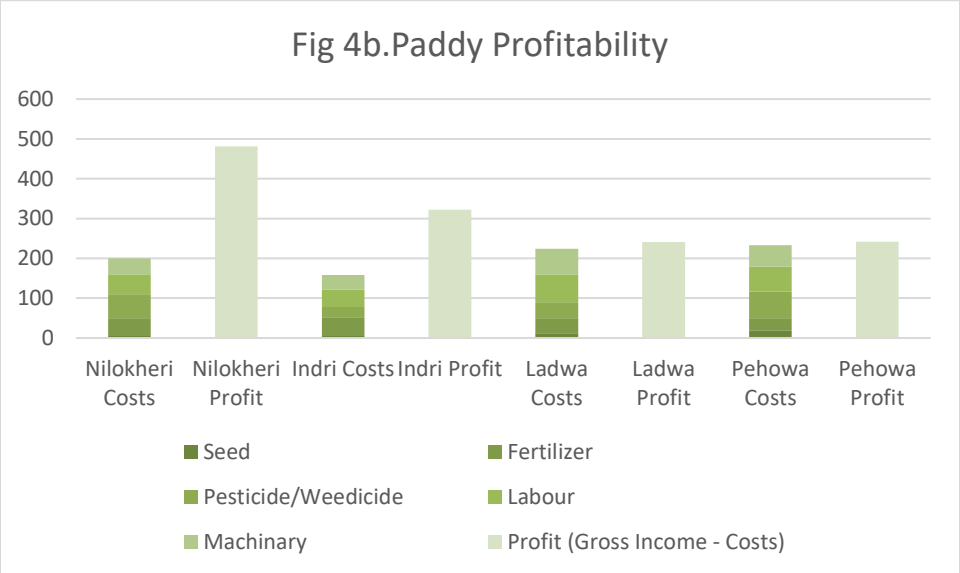


Figure 4: Costs and Profit from Wheat, Paddy, and Tomato Farming





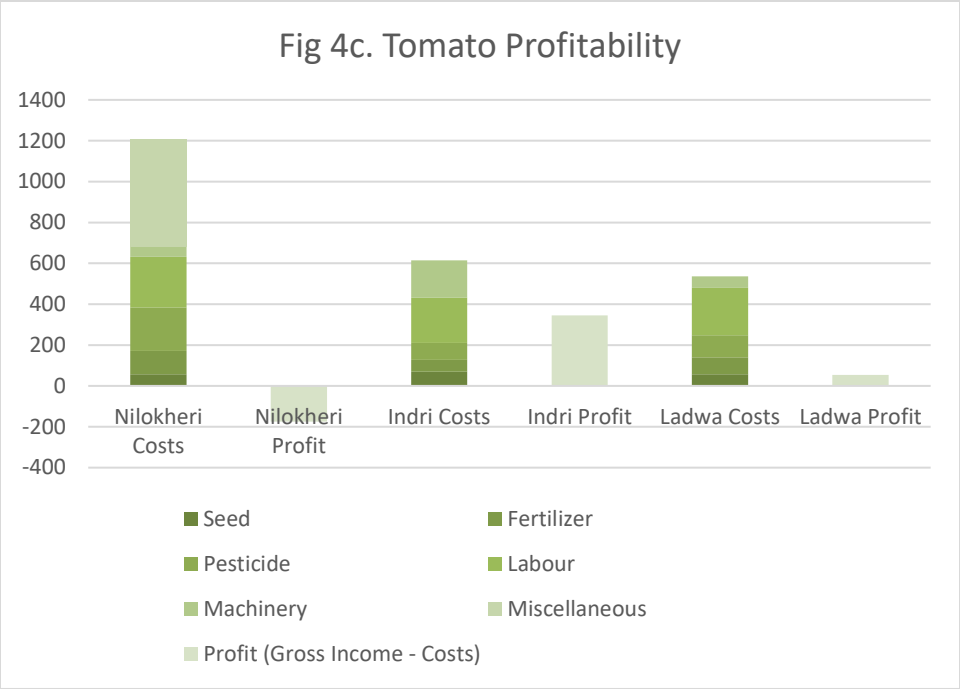


Fig 4c. Tomato Profitability
1400
1200
1000
800
600
400
200
0
-200
-400
Nilokheri Costs
Nilokheri Profit
Indri Costs
Indri Profit
Ladwa Costs
Ladwa Profit
Seed
Fertilizer
Pesticide
Labour
Machinery
Miscellaneous
Profit (Gross Income - Costs)

FIGURE 4: RISK HEATMAP FOR WHEAT

Wheat	Less Rain	Excess Rain	Hail	Pests	Diseases	Winds
Nilokheri Block						
Koer	6	1	5	4	3	2
Ghaggar	6	1	2	5	4	3
Takhana	6	1	2	5	4	3
Manak Majhra	6	1	5	3	4	2
Ladwa Block						
Dudha	6	5	1	4	3	2
Dudhi	6	2	1	4	5	3
Kheri Dabdlan	6	3	1	4	5	2
Sura	6	4	1	2	5	3
Indri Block						
Mukhali	6	3	1	4	5	2
Rajepur	6	2	5	1	4	3
Khera	6	1	3	4	5	2
Raitikhana	6	1	4	5	3	2
Pehowa Block						
Chajjanpur	6	1	3	4	5	2
Jhakwala	6	1	3	2	5	4
Naisi	6	1	2	4	5	3
Khizrpura	6	1	3	2	4	5

Risk gradation	High Risk					Low Risk

FIGURE 5. RISK HEATMAP FOR TOMATO

Tomato	Less Rain	Excess Rain	Hail	Pests	Diseases	Winds	Other	
							High temp	Low temp
Nilokheri Block								
Koer	6	1	5	4	5	3		2
Ghaggar	6	2	3	4	1	5		
Takhana	6	2	3	4	1	5		
Manak Majhra	6	3	2	5	1	4		
Ladwa Block								
Dudha	6	2	4	5	1	3		
Dudhi	6	4	1	5	2	3		
Kheri Dabdlan	6	3	1	5	2	4		
Sura	6	3	1	5	2	4		
Indri Block								
Mukhali	7	3	1	5	4	2	6	
Rajepur	6	2	4	5	1	3		
Khera	6	3	2	5	1	4		
Raitikhana	6	2	3	1	5	4		

Risk gradation: High Risk … Low Risk

FIGURE 6: RISK HEATMAP FOR PADDY

Paddy	Less Rain	Excess Rain	Hail	Pests	Diseases	Winds
Nilokheri Block						
Koer	3	6	5	1	2	4
Ghaggar	4	6	5	1	2	3
Takhana	4	6	5	1	2	3
Manak Majhra	2	6	5	1	4	3
Ladwa Block						
Dudha	6	2	5	4	1	3
Dudhi	6	1	5	4	2	3
Kheri Dabdlan	6	5	3	1	2	4
Sura	6	4	5	3	1	2
Indri Block						
Mukhali	6	5	2	4	1	3
Rajepur	5	6	4	3	1	2
Khera	6	1	4	3	5	2
Raitikhana	6	2	5	3	1	4
Pehowa Block						
Chajjanpur	6	2	5	1	4	3
Jhakwala	6	1	3	2	5	4
Naisi	6	1	5	4	2	3
Khizrpura	6	1	4	5	3	2

Risk gradation	High Risk					Low Risk