Assessment of community-based crop micro insurance for climate-related risks offered to smallholder farmers and marginalised communities in India

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About this study

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Summary

Delivery of agriculture insurance through microinsurance is gaining popularity in low and middle-income countries in recent years, as the result of continuous efforts to provide insurance, in addition to microfinance, toward greater financial inclusion of the poor. Consequently, there is growing interest in understanding the factors affecting demand for crop insurance through such schemes, and their impacts. The Swiss Agency for Development and Cooperation, through its project titled “Climate Resilience through Risk Transfer" (RES-RISK), provided funding support to examine this premise in four flood-prone blocks of Bihar (Hajipur, Bidupur and Vaishali blocks of Vaishali district and Meenapur block of Muzaffarpur district). The project was implemented by a consortium led by the Micro Insurance Academy (MIA) working with BASIX Consulting and Technology Services Ltd (between 15th Nov 2014 and 31st Mar 2017). The overall objective of the project was to improve the resilience of vulnerable communities to climate-related risks in selected regions (of two states of India), by introducing and supporting pro-poor microinsurance solutions providing financial protection against three classes of risks that are exacerbated by climate change: human health, crop, and livestock. This study leveraged the implementation model of Community-Based Mutual-Aid Schemes (CBMAS) spearheaded by the Micro Insurance Academy (MIA), the lead partner of the consortium. This study focuses on three key research questions:

- What factors affect voluntary uptake (demand) for agriculture insurance offered to smallholder farmers by community-based mutual-aid schemes (CBMAS, aka microinsurance)?
- Is there a business case for the crop insurance component of CBMAS (CIC) in terms of financial sustainability, scaling, and stakeholders’ interests?
- How effective is the crop insurance component of CBMAS in providing financial protection to insured farmers (timely and adequate payouts in case of losses)?

The study involves mixed methodologies, including both quantitative and qualitative components, with emphasis on quantitative analysis. The total sample size for the study was 1562, of which 430 farmers were offered the CIC and joined, 326 farmers were offered CIC but did not join, and the remaining 806 farmers were not offered the CIC (they were outside the CBMAS scheme).

The analysis of factors affecting enrollment revealed that households belonging to scheduled caste/scheduled tribe (considered as a marginally backward class) were more likely to enroll in the crop insurance component of CBMAS (CIC) compared to other segments of the population. This finding implies that CBMAS is socially inclusive. It is interesting to note that caste played a role whereas religion and the household’s economic status (indicated by access to a savings account and enrollment in other social security schemes e.g. KCC, MGNREGA, PMFBY, and WBCIS) had no significant effect on enrollment. Farmers that cultivate a high proportion of their landholdings are more likely to enroll in the CIC. Trust in the implementing partners and knowledge about the CIC (disseminated through the meetings prior to the enrolment) boosted uptake. It is noted that commercial insurers have, thus far, done almost nothing to enhance clients’ awareness or trust.

The study examined the association between four financial protection indicators and insurance. *The financial loss experienced by farmers in the last year* (caused by insurable risks factors) was not associated with insurance. The second indicator, *borrowing to finance agriculture inputs* gives a mixed message: The treatment subcohort (offered and joined) was more likely to borrow compared to the first control subcohort (offered but not joined) and this result was statistically significant. However, when compared with a larger control group (offered but not joined plus not offered at all), there was no significant difference in borrowing. The third indicator of financial protection (*Income of the household)* offers a more consistent answer: the insured households had higher monthly income than the uninsured households. Finally, *the share of agricultural income in total household income* did not differ significantly between the treatment and control groups.

The premiums and claims data of CBMAS show that there is a clear business case for CIC. In only four seasons of insurance, the external insurer (underwriting the risk) retained 29% of the premiums as surplus and incurred no cost to acquire the business. Also to note that pay-outs through CBMAS could compensate over 70% of the losses (in respect of the cost of cultivation). The CBMAS farmers joined voluntarily even though there was no premium subsidy. CBMAS invested in creating awareness about the risks of climate change and in setting-up the community-managed infrastructure (automatic weather stations) for improved determination of claim payouts. With an initial investment for insurance education and creation of a community-based infrastructure, CBMAS can be scaled-up and made a viable business. Moreover, the cost of acquisition of the business and the cost of settling claims (the two major expenditure items) were almost negligible because the crop insurance component of CBMAS was offered as an additional risk cover to its existing members.

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Acronyms

CBMAS	Community-Based Mutual Aid Scheme
CCIS	Comprehensive Crop Insurance Scheme
CIC	Crop insurance component of CBMAS
FGD	Focused Group Discussion
GVA	Gross Value Added
IDI	In-depth Interview
INR	Indian Rupee
JVSS	Jan Vikash Samajik Sanstha
KCC	Kisan Credit Card
KII	Key Informants Interview
MF	Meenapur Federation
MIA	Micro Insurance Academy
MNAIS	Modified National Agricultural Insurance Scheme
MNREGA	Mahatma Gandhi National Rural Employment General Scheme
NAIS	National Agricultural Insurance Scheme
NO	Not offered
OJ	Offered and Joined
ONJ	Offered but not joined
PMFBY	Pradhan Mantri Fasal Bima Yojana
SDC	Swiss Agency for Development and Cooperation
VASFA	Vaishali Small Farmers' Association
WBCIS	Weather Based Crop Insurance Scheme

1. Introduction

1.1 Background

Agriculture plays a pivotal role in the Indian economy. In 2011-12, more than 50% of the rural population eked out its livelihood mainly from agriculture (National Sample Survey Office, 2014).[1] In 2016-17, agriculture and allied services (including livestock, forestry, and fishing) constituted around 20% of total Gross Value Added (GVA) (Ministry of Finance, 2017).[2] However, Indian agriculture is still heavily dependent on weather conditions, and consequently, farming households face a high degree of uncertainty, which can lead to serious financial hardship and vulnerability. The National Mission for Sustainable Agriculture has recognized Agriculture insurance as an instrument to provide financial risk protection to farmers (Satapathy, Porsché, Künkel, Manasf, & Kalisch, 2011). Some authors claimed that insurance offered to smallholder farmers in rural areas, with little access to the formal insurance schemes or other forms of risk management capacity, could be more successful when operated through Micro-insurance schemes (Zevenbergen, 2014).

Delivery of agriculture insurance through microinsurance is gaining popularity in low and middle-income countries in recent years, as the result of continuous efforts to provide insurance and savings products, in addition to microcredit, toward greater financial access of the poor (Giné, Menand, Townsend, & Vickery, 2010). Consequently, there is growing interest in understanding what factors affect uptake/demand of crop insurance components delivered through these schemes (CIC). The literature contains a few references suggesting that factors affecting enrollment positively include socio-demographic factors of the farmer (like age, education), affordability of premiums, business-related indicators (like land ownership, farm-size), farming practices (adaptation of modern techniques of irrigation, better quality fertilizers etc.) and knowledge and awareness about insurance and the product. The literature dealt with the experience gained in a few countries, including Azerbaijan, Bangladesh, China, Kenya, Philippines, Tanzania and Zimbabwe (Akter & Brouwer, 2007; Balcita, 2015; Daninga & Qiao, 2015; Enjolras & Sentis, 2008; Olila & Pambo, 2014; Rashidpour, 2013; Tsikirayi, Makoni, & Matiza, 2013; Wairimu, Obare, & Odendo, 2016; Wang, Ye, & Shi, 2016).

Rashidpour (2013) reported, based on a household survey in West Azerbaijan, that the factors which positively affected uptake of crop insurance included: price fluctuations of input and outputs (i.e. higher price of inputs and lower price of the product harvested in the next year), socioeconomic position of the farmer (land ownership and income in the previous year), information regarding insurance, government insurance policies and risk perception. Wang et al. (2016) reported that peer effects among the community (what others are doing) played a significant role in the decision to join crop insurance at the initial years in China. In the later years, the farmers started taking a more rational approach, where the yield volatility and education significantly influence their uptake decision. Similarly, (Masara & Dube, 2017) found that in Zimbabwe, information and advice disseminated by non-government organizations led to a higher uptake. Tsikirayi et al. (2013), also reporting on Zimbabwe, concluded that the major focus to enhance

[1] http://mospi.nic.in/sites/default/files/publication_reports/nss_report_554_31jan14.pdf
[2] http://indiabudget.nic.in/es2016-17/estatvol2.pdf

uptake should be on farmers' knowledge and awareness about the relevance of crop insurance.

Two articles dealt with the experience in Kenya. Wairimu et al. (2016) said that education level of household head, farming experience, and size of farmland had a positive influence on the uptake of crop insurance. Olila & Pambo (2014) and Wairimu et al. (2016) reported that lack of knowledge regarding insurance, and lack of access to the agricultural extension services was correlated with a negative enrollment. It was reported that in Bangladesh, willingness to pay for crop insurance was positively associated with household head's primary occupation, land ownership, and size of agricultural farmland (Akter & Brouwer, 2007). Farmers' risk perception and land ownership were significant determinants of demand for rice crop insurance in Philippines (Balcita, 2015).

Even though there exists a handful of literature on the factors associated with the uptake of crop insurance, evidence on the impact of CI on small landholders in developing countries is quite scant. Ashimwe (2016), based on an average treatment effect analysis of a cross-sectional household survey data in Huye district, Rwanda, found that average family income of the treatment households was significantly higher as compared to the control ones. De Nicola, (2015), using a dynamic stochastic optimization model, estimated that weather-based insurance in Malawi had the potential to provide significant welfare gain in terms of increase in consumption for the farmer households. On a similar line, Rathore, Burark, & Jain (2011) performed performance assessment of crop insurance in Udaipur District in Rajasthan, India and revealed that the farm income per family was higher for the insured as compared to the non-insured households. Haruna (2015) found that the impact of weather-index insurance on farming practices was positive and significant in the intensity of fertilizer utilization, but no impact on yield for small farmers in northern Ghana.

In Nigeria, Olubiyo, Hill, & Webster (2009) found that though the insured farmers had used superior farming practices and were more commercially oriented, the non-insured ones were more productive and efficient in resource utilization. Varadan & Kumar (2012) concluded that crop insurance in India had a positive impact on rice farmers' adoption of high-value inputs, which resulted in enhanced returns from farming in Tamil Nadu. Likewise, Gondalia, Khunt, & Vekariya, (2008) concluded that insured farmers in Gujarat were using significantly higher quantity of inputs than uninsured farmers due to the compensation guarantee from insurance. On the other hand, Surminski & Delioma (2013) analyzed 27 insurance schemes that covered the risk of crop losses due to flood in low and medium countries and showed that very few of them exhibited some link between risk transfer and risk reduction.

1.2 Context

Agricultural insurance in India has come a long way since 1972, the year when the first insurance was offered to individual cotton-growing farms. The first insurance scheme providing cover for cereals, millets, pulses, and oilseeds was piloted in 1979 and replicated nation-wide in 1985 as the Comprehensive Crop Insurance Scheme (CCIS). Over the years, the country has witnessed the launch of several schemes such as the National Agricultural Insurance Scheme (NAIS), the Modified National Agricultural Insurance Scheme (MNAIS), the Weather Based Crop Insurance Scheme (WBCIS), the

National Crop Insurance Programme (NCIP) and, in January 2016, the last in this series, Pradhan Mantri Fasal Bima Yojana (PMFBY). Even though every modified scheme entailed more benefits and larger subsidies to premiums than its predecessor, the number of farmers that joined voluntarily was consistently low, contrary to expectations (Aurora & Rachuri, 2016; CSE, 2017). These schemes were thus relevant for those farmers who took bank loans for agricultural production and were required to secure the loans by buying crop-related credit insurance. This practice meant that even though India has floated the largest crop insurance scheme in the world in terms of volume, that Government sponsored crop insurance scheme reached only a small percentage of Indian farmers (Mahul, Verma, & Clarke, 2012).

The Swiss Agency for Development and Cooperation (SDC), through the Embassy of Switzerland in India, decided to provide funding support to examine this premise. The project, called “Climate Resilience through Risk Transfer" (RES-RISK), was implemented between 15th Nov 2014 and 31st Mar 2017 by a consortium led by the Micro Insurance Academy (MIA), working in collaboration with BASIX Consulting and Technology Services Ltd. The overall objective of the RES-RISK project was to improve the resilience of vulnerable communities in selected regions (of two states of India) to climate-related risks, by introducing and supporting pro-poor microinsurance solutions providing financial protection against three classes of risks that are exacerbated by climate change: human health, crop, and livestock. The project leveraged the implementation model of Community-Based Mutual-Aid Schemes (CBMAS) (Dror & Jambhekar, 2016), spearheaded by Micro Insurance Academy (MIA), the lead partner of the consortium. It was fielded in four flood-prone blocks of Bihar (Hajipur, Bidupur and Vaishali blocks of Vaishali district, and Meenapur block of Muzaffarpur district) and in four drought-prone blocks of Maharashtra (Beed, Kaij, Ambajogai and Dharur blocks of Beed district).

Table 1: Initiation of implementations with different partner organisations

Risk	Partner	2014	2015		2016	
Health	NIDAN	✔	✔		✔	
	VASFA		✔		✔	
	MF				✔	
	JVSS				✔	
Livestock	NIDAN		✔		✔	
	VASFA		✔		✔	
	MF				✔	
	JVSS					
			Kharif	Rabi	Kharif	Rabi
Crop	NIDAN		✔	✔	✔	✔
	VASFA		✔	✔	✔	✔
	MF				✔	✔
	JVSS					

The first CBMAS schemes under the project were launched in 2014 in Hajipur and Bidupur blocks (Bihar) among grassroots groups that were associated with NIDAN (our partner organization). In 2014, only health insurance was offered. The second scheme started in 2015 in Vaishali block of Vaishali district (with field partner VASFA). Livestock

and crop insurance components were introduced in 2015. The crop insurance component of CBMAS (CIC) started from the Kharif season of 2015. The pilot was further expanded in 2016, with the launch of two additional schemes, in Meenapur block of Muzaffarpur district, Bihar (with partner organization Meenapur Federation or MF) where health, livestock, and CIC were introduced almost simultaneously. At about the same time, insurance was also launched in four blocks of Beed district, Maharashtra (with partner organization JVSS), only with health insurance. NIDAN and VASFA continued to offer insurance for the three risk categories in 2016. Table 1 presents the year-wise and partner-wise summary of insurance activities.

The community-based bottom-up approach leverages the local population's experience with group activities dealing with finances (mainly membership in Self-Help Groups - SHGs) to introduce insurance to those groups. The high trust level required for insurance, and the more complex nature of insurance compared to savings transactions necessitate conducting iterative discussions among uninsured grassroots communities on demand-side issues (e.g. understanding of the risks they face, and how they reduce the consequences through insurance) and supply-side issues (e.g. design insurance packages that are perceived as affordable). Furthermore, the business process is conceived around the notion that groups mobilize each community's social capital and other resources (e.g. information, talents) to manage and "own" the entire process, which combines skilling of persons that the group selects as key actors of the insurance process. The combination of self-governance of a scheme that is executing decisions/choices of the group, at a price the group considers affordable, entails a very different model of access to insurance than the standard model of individual policy sold by an agent with no role for the insured in package design, pricing or administration of the after-sale services.

The CIC was a weather-based index (parametric) cover underwritten by an external insurer (IFFCO-Tokyo General Insurance), with intensive technical assistance from MIA on the pricing, the term-sheets and simplifying the paperwork, and with setting up weather stations in the covered areas, with financial assistance from the RES-RISK project.

There have been several fundamental differences between the community-based microinsurance (it has been referred to as Community Based Mutual Aids Scheme or CBMAS throughout this document) and the government-sponsored schemes in terms of modus operandi. Participating communities were involved in creating awareness to the value proposition of insurance among their members, in deciding the benefits that would be fully underwritten by the mutual aid scheme, and designing livestock insurance which was underwritten as a quota share arrangement partly by the CBMAS and partly by an external insurer, plus accept the terms for that were negotiated on their behalf by MIA, and fully underwritten by an external insurer without any subsidy support. The conditionality of voluntary and contributory (crop) insurance was being tested for the first time. The farmers that joined were more confident in the scheme as it/they were responsible for enrollments, and the administration of claims submission and processing, and dispute resolution locally. The communities were also implicated in setting-up several automatic weather stations and in maintaining them, to ensure that the weather data was at a suiTable resolution. The CIC was delivered as a group policy held by each community, doing away with individual policies, and entrusting the community with the

distribution of payouts to the insured members that incurred losses. The combination of "composite" multi-risk packages and the unique risk-layering arrangements, coupled with group involvement in the administration of the scheme created a strong relationship of trust of the farmers in their insurance scheme. No farmer had ever experienced such model of insurance before

1.3 Intervention Description and the Theory of Change

The direct impact of insurance is counterfactual ("what could have happened if there was no insurance") and the study of the impacts of an intervention requires a longer period of coverage. We understand that long-term impact of intervention is a change in mindset of the farmers which is reflected in investment in other financial instruments (other insurance products, savings, investment, risk-pooling) borrowing and repayment pattern, utilization of loans, change in farming practices, utilization of land, choice of crops, and investment in agriculture

These changes are expected to contribute to the overall advancement of the family in terms of health-seeking behavior, food security, schooling of children, women's participation in decision making etc. However, the phase-I of the study did not allow us to probe much on these issues mainly because of the shorter duration of the intervention as well as of the study.

This novel experiment with CIC had several important components such as *voluntary uptake* (rather than mandated linkage to agricultural input loans), *contributory* (without reliance on premium subsidies), *demand-driven* (involving farmers in package design), *enhancing gender-equity* (by enable the real cultivator – increasingly women – to become involved in decisions and governance that enabled them to overcome many hurdles to access commercial agri insurance), offering a *holistic insurance solution* (combining health, livestock, and crop insurance, with term-sheets reflecting local climate data for weather index insurance, with operations of all risks handled by a single *"one-stop-shop" local scheme*), and *contextual anchoring of insurance* (in the settings of social, cultural, economic, ethnic, climatic, and risk contexts) through which grassroots groups manage their lives. However, we cannot – without this study – tell what factors could support the scaling of the experiment, its financial sustainability, and its positive impact on insured farmers. We also need to understand whether the CBMAS can offer a cheaper alternative to deliver welfare gains and financial protection to farmers than the publicly financed crop insurance, which has not found favor with farmers. These queries define the focus of this study.

Against this background, we evaluate the effects of CIC schemes offered under CBMAS, on the financial protection of the farmer households insured.

1.4 Monitoring plan

The intervention followed a well-defined model of community-based microinsurance scheme. The model was conceived and promoted by the Micro Insurance Academy (MIA) and thoroughly documented in its Business Process Handbook. The handbook is a published document and available in the public domain. A copy of the handbook may be supplied to 3ie on request. The handbook contains every minute detail of the implementation and its monitoring and supervision strategy. In summary, the model

encourages the formation of local micro-insurance units (MIUs) consisting of claim committees and coordination committees and functioning like de-facto mutual-aid self-insurers. During the period of the study, the model was implemented as a pilot intervention managed by a consortium led by MIA, with BASIX, and with funding support from SDC. There were field managers (overseeing the field operations), thematic experts (health, agriculture, livestock, climate change, MIS), trainers and researchers who were constantly monitoring the intervention locally and from the headquarters office. Staff members of the consortium, posted in headquarters, visited the field locations frequently and there was the system of reviewing field situations with the Heads of the respective organizations at regular intervals.

1.5 Evaluation Questions and Primary Outcomes

This study focuses on the following three key research questions:

i. What factors affect voluntary uptake (demand) for agriculture insurance offered to smallholder farmers by community-based mutual-aid schemes (CBMAS, aka microinsurance)?
ii. Is there a business case for crop insurance component of the CBMAS (CIC) in terms of financial sustainability, scaling and stakeholders' interests?
iii. How effective is CIC in providing financial protection to insured farmers (timely and adequate payouts in case of losses)?

2. Evaluation Design, Data, and Methods

2.1 Research design

The research involves mixed methodologies, including both quantitative and qualitative components, with emphasis on the quantitative analysis. The quantitative analysis draws data from a cross-sectional survey with 3 subpopulations: (i) offered and joined CIC (OJ), (ii) offered and not joined CIC (ONJ) and (iii) not offered to join CIC (NO). To generate comparable treatment and control groups, it has been necessary to apply propensity score matching (PSM) techniques, using socio-economic and demographic characteristics of the households. The qualitative part consists of analyzing information obtained through focus group discussions (FGDs), in-depth interviews (IDIs) and Key Informants' Interviews (KIIs) with farmers groups, CBMAS scheme activists, farmers that were insured, uninsured, and those that dropped-out, as well as agricultural extension service providers.

2.2 Quantitative sampling

The Reference Population: The reference population for this study coincides with the intervention areas of MIA with three implementing partner organizations: NIDAN[3], VASFA[4] and Meenapur Federation[5]. The target groups of the study are located in 278 villages spread over 4 blocks in 2 districts. Location-wise details of the geographical span of the study are provided in Table 2.

Table 2: Geographical dispersion of the target population

Partner Organization	Block	District	# villages in the intervention area	# HHs in these villages as per census 2011	Total population of these villages as per census 2011	# Main + Marginal Cultivators as per census 2011
NIDAN	Hajipur, Bidupur	Vaishali	167	69,276	3,82,767	1,24,029
VASFA	Vaishali	Vaishali	73	38,803	2,43,281	29,980
Meenapur Federation	Meenapur	Muzaffarpur	38	17,342	82,412	5,196
Total	4	3	278	1,25,421	7,08,460	80,469

The reference population for this study consisted of members of Community Based Mutual Aid Schemes (CBMAS) which were described earlier. It is self-explanatory that when new CIC is offered, some households would join, and some others would not join. It is recalled that membership in the health insurance offered by the CBMAS was a prerequisite for eligibility to cover other risks (i.e. livestock and/or crop). Secondly, not all households that joined health insurance are farmers, with interest in crop insurance. Thirdly, not all eligible farmer households who own or lease cultivable land were located within the coverage area (i.e. within 12 km radius of automatic weather stations (AWS); those living further away, for whom the weather data is unavailable, cannot be covered by parametric crop insurance). Fourth, crops insured by the schemes being assessed were limited to paddy, wheat or maize, and not all households grew these crops. Lastly, not all those who cultivated these crops opted for CIC coverage. It is also self-explanatory that the impact of insurance can be assessed only with the insured population. Therefore, it was necessary to segment the study population into treatment and control groups.

[3] Nidan is a non-governmental organization which facilitates empowerment of people employed in the unorganized sector in the states of Bihar, Rajasthan, Delhi and Jharkhand, through community services and pro-poor participative interventions. Nidan was registered in 1996 by its leader Arbind Singh; it now has two head offices, located in Patna and West Vinod Nagar (East Delhi).

[4] Vaishali Area Small Farmers Association (VASFA) was established in May 1971 by Padamshree Krishn Dey Dewan in Vaishali district, Bihar. VASFA is a community based organisation of the farmers, promoting cooperation among its members and their upliftment. The main target area of VASFA is Vaishali, Muzaffarpur, East Champaran, West Champaran, Saran & Patna.

[5] Meenapur SHG Federation in Muzaffarpur, Bihar

Population Segments: The reference study population has been divided into three non-overlapping population segments, as follows:

- households that were offered CIC and joined the scheme for at least one season in the last two years (**OJ** = offered and joined)
- households that were offered CIC but did not join in any of the seasons in the last two years (**ONJ** = offered but not joined)
- The households among the reference population that were not offered CIC at all (**NO** = not offered).

Our NO population segment has been filtered to include only farmer households (non-farming households were removed) because the crop risks are irrelevant to non-farmers. A "farmer household" includes those households that cultivate their own plots, or plot(s) they lease from others[6]. All have an insurable interest in the land they till / cultivate. Table 3 contains a tabulated format of the main criteria for the three non-overlapping population segments sampled.

Table 3: Specific criteria for three non-overlapping sampled population segments

Criterion	NO	ONJ	OJ
Affiliated with one of the partner organizations	✔	✔	✔
Farmer household	✔	✔	✔
Cultivable land falls within the coverage area of automatic reference weather station		✔	✔
Participating in CBMAS health cover		✔	✔
Growing paddy, wheat or maize		✔	✔
Participating in crop cover		X	✔

The first research question deals with two different issues: uptake and demand. The uptake for the CIC scheme is quantified by the size of the population segment OJ. In order to examine the factors influencing uptake, the OJ sub-cohort must be compared with the ONJ sub-cohort. This implies that two independent samples are to be drawn from OJ and ONJ. However, the OJ population is not completely synonymous with demand. It is possible that some households who were not eligible to join under the current conditions would have joined if the restrictions impeding their enrollment would be waived and if crops they cultivated would be insurable. Therefore we also study a sample from the population segment of NO farmers. Their expressed willingness to join the scheme will be taken as a proxy indicator for demand.

Answering the second research question does not really need any sampling per se. It deals with the attributes of the scheme and the financial aspects of including CIC in the CBMAS. The third research question probing the effectiveness of the financial protection (in terms of timeliness and adequacy of payouts) needs a sample from OJ because they are the only ones having experienced payouts from the scheme. Their experience can be compared with two comparators: ONJ and NO sub-cohorts. Here we will apply PSM in order to ensure that the sub-cohorts being compared are indeed comparable in terms of the factors which may affect the impact of crop insurance. The sampling choices are summarized in Table 4.

[6] The system of leasing land is commonly called *batai* in Bihar. These are oral contracts. The consideration for the contract is either paid in cash, in kind or - more commonly - a combination of upfront payment and portion of the yield for the season.

Table 4: Research questions and sample selection

Research Question	Comparators
Factors affecting uptake and demand	OJ, ONJ, NO
Studying the business case	Not applicable
Effectiveness of the scheme	OJ, ONJ+NO

Sample Size: Information on the size of the population segments is given in Table 5. The budgeted sample size for the entire study is 1500 households. The OJ sample included all OJ households, totaling 523 (Table 5, col 6) spread over 93 villages located in the coverage area of reference weather stations. The ONJ sample consists of an equal number of households, drawn from the sub-cohort in each of the three intervention areas. Alternatively, a sample could have been drawn from the combined ONJ population of three locations together, but this is not done because Meenapur has a large number of ONJ households compared to the other two locations, which could lead to a geographically skewed sampling, likely to disturb the balance required for PSM. For an analysis that does not involve PSM, we use suitable weights for every household based on its probability of being selected.

Table 5: Sizes of the reference population segments (oj, onj, no) and sample sizes

Partner Organization (1)	# villages within the coverage area of the weather station (2)	# Farmer HH with Health Insurance (may or may not have crop insurance) in these villages (3)	# HHs with Health Insurance and CIC in these villages (OJ) (4)	# HHs with Health Insurance but NOT CIC in these villages (ONJ) (5)	Sample size from HHs with Health Insurance and CIC in these villages (OJ) (6)	Sample Size from HHs with Health Insurance but NOT CIC in these villages (ONJ) (7)	Number of villages encompassing the NO population (8)	Sample size from NO population (9)
NIDAN	38	319	147	172	147	147	167	
VASFA	27	328	121	207	121	121	73	600
Meenapur Federation	28	1,986	255	1,731	255	255	38	
Total	93	2,633	523	2,110	523	523	278	600

The rest of the sample (1500-523-523=454) is drawn from the NO population. However, since it may not be possible to interview all OJ households (523), we draw a sample of 600 households from the NO population in order to ensure that the total sample for the study is no less than 1500. Sample sizes for OJ, ONJ and NO sub-cohorts from each location are given in columns 6, 7 and 9 respectively of Table 5.

Power calculations for the sample size: It is difficult to estimate the sample sizes based on power calculations for the tests of statistical significance because the distribution of the covariates is not known *a priori*. However, we have checked that the sample sizes of the sub-cohorts specified above (523+523) are adequate to detect an odds ratio higher than 2 with 95% confidence interval and 80% power if the proportion of control with exposures (covariate) is at least 5%. That said, we consider that the power calculations may not be important at this point as the level of significance of the odds ratios will be automatically calculated by the statistical software based on observed distributions of covariates.

Sampling Framework: the OJ sub-cohort is extracted from the list of households who joined CBMAS crop cover. The lists are readily available from the MIA management information system (MIA-MIS) for all three locations. The lists of farming households whose cultivable land is within the coverage area of automatic reference weather stations and have health coverage in all the locations are also available. However, the MIA-MIS system does not capture information about the crops they grow. Therefore, a sampling of the ONJ sub-cohort has been drawn from the household lists, with the caveat that those households which do not meet the criterion of growing the insurable crops were screened out at the point of the survey. This means that when a surveyor met a household that does not grow paddy, wheat or maize, s/he did not interview that household and instead, drew a replacement household from the sample list. The process continued until we reached the desired sample size or all households in the sampling frame were exhausted, whichever was earlier.

The reference population for the NO sample is the entire intervention area of the three partner organizations across 278 villages, irrespective of the distance from the reference AWS. Here, we applied two-stage sampling. In the first stage, 50 villages were selected at random from the list of 280 villages (sampling frame). Since there is no sampling frame for households from the NO sub-cohort, cluster sampling was applied. We drew 12 households (three clusters of 4 households each) from each village selected in the first stage of sampling.

During actual field survey, it was found that many households actually had more than one insurance policy. This was true for the crop as well as health. Since the sampling unit was households, only one questionnaire was filled for the entire household although it might have had multiple policies (for CIC it was farmer-wise and for health insurance, it was SHG member-wise). Thus, the number of samples in the OJ and ONJ groups was considerably reduced from the original plan, with compensation from the NO sub-population. The final total sample size for the study was 1562 households, with a total population of 8672. This is shown in Table 6.

Table 6: Final sample

	OJ	ONJ	NO	TOTAL
# Households	430	326	806	1562
# HH Members	2364	1733	4575	8672

3. Study Timeline

Table 7: Study Timeline.

Activities	Feb'17	Mar'17	Apr'17	May'17	Jun'17	Jul'17	Aug'17	Sep'17
Preparation, designing of study tools	*	*	*					
Field Study				*	*			
Data Entry, Data Cleaning					*	*		
Data Analysis, Report Writing						*	*	*

4. Findings from the Evaluation

4.1 Descriptive Analysis

4.1.1 Household characteristics

- 56% of household members sampled were 18-60 years old (economically-active age group); 6% were below five years old (children); 30% were between 5-18 years (school-going age), and 8% of the total household members were above 60 years of age (elderly).
- 55% of all household members were males and 45% females.
- Average household size was 5.49 for OJ, 5.32 for the ONJs, and 5.68 for the NOs.
- 33% of household members sampled were farmers (34% among the OJ households, 31% among the ONJ households, and 34% among the NO households).
- Overall there were 1.86 farmers per household, with an average of 1.86, 1.63 and 1.94 for the OJ, ONJ and NO households respectively.
- One-third of all farmers in the surveyed households were female.
- 92% of the households were Hindus, and 87% were classified as SC, ST, or other backward classes.

4.1.2 Sources of livelihood

- Agriculture was the main source of income for all households surveyed. This was by default because only farmers' households were selected for the sample. The study also probed on other sources of livelihood in the families.
- 33% of the households had members who worked as non-farm laborers;
- 26% of the households had one or more member working as agricultural laborers (other than on their own lands).
- The OJ households reported fewer farm and non-farm laborers, and the difference with ONJ and NO was statistically significant. This probably implies that more OJ households were engaged mainly or only in farming, compared to the ONJ and NO households.
- 12% of the households had self-employed members, and 10% were salaried.
- 7% of the households depended on livestock rearing as an additional source of livelihood.
- 2% of the households had a pensioner.

4.1.3 Socio-economic status

26% of the families in the total sample lived in concrete houses, 43% in semi-concrete houses and 32% lived in mud houses. OJs had the highest percentage of concrete houses and ONJs had the highest percentage of mud houses. 92% of the families owned the house they were living in. Tubewell was the major source of drinking water (as reported by 90% of the respondents). Open defecation was practiced by 45% of the households and only 12% had proper flush toilet facilities. The rest had either pit latrines or dry toilets.

Electricity was available in 72% of the households for lighting; the rest still depended on kerosene.48% of the households used charcoal and woods as cooking fuel, 38% could afford LPG. 1% of the households cooked with electricity, 1% with biogas and 2% with kerosene. The rest of the families used rudimentary materials like straws, agricultural waste, and dung cakes etc. which were freely available in the environment. Electricity as a source of lighting, flush toilet, and cooking with LPG, which are common indicators of higher socio-economic status, were more visible in the OJ families compared with their ONJ and NO counterparts. The difference was significant for all three indicators implying that OJ households were probably enjoying a relatively higher socioeconomic status.

Overall, in 98% of the households sampled at least one member had access to mobile phone, and in 85% of the households, at least one farmer-member enjoyed this facility. Significant variation was observed between the OJ and ONJ households in respect of access to a mobile phone for the farmers. OJ households had more farmers with access to mobile phone. Overall 49% of the households had at least one member with a PAN card (irrespective of a farmer or not). As far as farmers are concerned, 27% of the farmers in the entire sample had a PAN Card. The highest percentage of PAN card holding farmers were reported by OJ households (34%), compared to ONJs (24%) and NOs (25%); the difference was statistically significant.

4.1.4 Access to financial services, agricultural extension services, and other govt schemes

94% of the households had a bank account. Only 13% reported owning a Kishan Credit Card. OJs had the highest percentage of Kishan Credit Cards - 18% as against 11% in each ONJ and NO households. This difference was statistically significant.

Only 10% of the surveyed households reported to have ever received any agricultural extension services (Krishi Vigyan Kendra, ATMA) in the past 12 months; 67% did not receive any, and the remaining 23% did not even hear of any agricultural extension service. Only 16% of households could effectively utilize the Krishi Sahayaks (agriculture outreach of Panchayat). Only 9% of the households reported having received weather information from the Disaster Management Department of the government. 8% received new seed variety. 2% of the households availed the services of Kisan Call Centre. And only 2% received some kind of training on farming practices from the government. OJ Households were more likely to report receiving extension services from the government or from a scientific institution. The proportion of OJ households, which have received extension service at least once is significantly higher than those from the ONJ and NO households together.

44% of the total respondents participated in MGNEREGA (a government-sponsored employment security scheme). 37% participated in RSBY (government funded hospital insurance scheme) and 16% participated in each PMFBY and WBCIS (the government subsidized crop index insurance). The most cited reason for not participating in the government schemes was lack of awareness about the scheme. When awareness was not an issue, uncertainty about eligibility was mentioned as an impediment. 8% of the respondents who did not participate in RSBY, 7% of those who did not participate in PMFBY and 6% of those who did not join WBCIS complained that it was too difficult to register.

4.1.5 Land ownership

90% of the total respondents own agriculture land. Land ownership was significantly higher among the OJs (98%) compared to ONJs (84%) and NOs (87%) and. Average landholding size, 0.95 acres per household for the OJs, was also significantly higher, compared to 0.79 acres per ONJ household and 0.84 acres per NOs household (average landholding size for the total sample was 0.86 acres per household). Note that with average land holding size of <1 acre, all three groups are considered marginal farmers.

87% of the total respondents had relevant documents to prove their ownership of the entire island. 9% had it for some part of their land and the remaining 4% did not have any documents for any parts of their land.

Farmlands were located both in high and lowlands. Highland farms are characterized by high runoff generation, more favorable for the cultivation of wheat and other crops which do not require inundation. Lowland farms are prone to water inundation during rainy seasons, more suitable for paddy farming.

4.1.6 Total area of cultivation

On average, 84% of the total owned land was cultivated and 4% leased out to someone else or used under the share-cropping agreements. 12% of the total owned land remained uncultivated. The top two reasons for not cultivating land relate to water: 26% of the respondents said that there was no source of water near the land, and another 22% referred to the high cost of irrigation. For 9% of the respondents, the uncultivated land was located far away from the village they lived in.

23% of the respondents were actually share-croppers cultivating another person's land. Cultivating leased land together with owned land was common in the area. The proportion of share-croppers was significantly smaller among the OJs. 18% of the OJ households were share-croppers as against 23% of the ONJs and 25% of the NOs.

4.1.7 Soil quality

56% of the respondents confirmed that they have loamy soil on their farms. 21% had sandy soil and 20% had clay. This indicates that lands in the intervention areas were actually very fertile. 88% of the farmers felt that they had good quality soil. 8% of the farmers got their soil tested to understand the nutritional deficiency of their soil and level of soil moisture. 12% of the OJ farmers got their soil tested as against 7% of ONJ and 4% of the NO farmers. The differences are statistically significant.

4.1.8 Major crops grown in the area

The questionnaire sought detailed information on the experience of cultivation in the last three seasons prior to the survey, namely Kharif 2016, Rabi 2016 and in the remaining part of the year (outside Rabi and Kharif, usually April-June). It was found that paddy, wheat, and maize are the three major crops grown in the area where CBMAS was implemented. Table 8 shows the number of times each crop was reportedly cultivated by three groups of farmers in the entire sample. “Number of times reported” has been interchangeably referred to as “number of cases” in the remaining part of this chapter. 14% of all households had a kitchen garden, mostly grown for subsistence farming.

Table 8: Crops Produced in the CBMAS Intervention Area (Vaishali and Muzaffarpur Districts, Bihar State, India)

Crops	Number of cases				Percentage of cases			
	NO	OJ	ONJ	TOTAL	NO	OJ	ONJ	TOTAL
Paddy	514	367	209	1090	32%	36%	37%	34%
Wheat	635	413	250	1298	40%	41%	44%	41%
Maize	219	118	73	410	14%	12%	13%	13%
Vegetable	119	73	21	213	8%	7%	4%	7%
Pulses	23	15	1	39	1%	1%	0%	1%
Cotton	1	0	0	1	0%	0%	0%	0%
Fruit	49	19	3	71	3%	2%	1%	2%
Oilseeds	11	4	4	19	1%	0%	1%	1%
Millets	1	0	1	2	0%	0%	0%	0%
Fodder	1	2	1	4	0%	0%	0%	0%
Nursery	4	0	1	5	0%	0%	0%	0%
Miscellaneous	8	5	0	13	1%	0%	0%	0%
Total number of cases	1585	1016	564	3165	100%	100%	100%	100%

4.1.9 Area under cultivation for specified crops

Average area under cultivation was 0.63 acre for all three crops combined. The small landholding size (<1 acre) is a key characteristic of the “marginal farmer” population. Intercrop analysis indicates that highest area under cultivation was for paddy (0.77 acres), followed by wheat (0.71 acres) and the least in maize (0.42 acre). The smaller area under maize cultivation matched the qualitative data collected from the same population, in which farmers referred to decreasing trend in maize cultivation due to wild animal grazing. Further analysis shows that paddy and wheat were cultivated once in a year whereas maize was cultivated twice (both in Rabi and Kharif) by some farmers.

Most farmers (96% cases) practiced single cropping. Cultivators of paddy and wheat (98% cases) preferred growing a single crop at a time. Some farmers (7%) did multi-cropping with maize as it was easier to accommodate maize with crops like potato than with paddy and wheat. However, maize too was mostly grown (93% of the cases) as a single crop in the field.

4.1.10 Farming practices

Plowing and leveling: Plowing and leveling were mostly done by a mechanical process. Mechanical plowing was reported in 97% of the cases of paddy, 98% of the cases of

wheat and 95% of the cases of maize. Mechanized leveling has been reported in 91% of the cases (all three crops combined). 97% of ONJ farmers reported using mechanized methods to level the fields as compared to 91% in OJ group. Use of livestock for agriculture has been reported in 13-15% of the cases, mostly by those who owned livestock. However, 24% of those who used livestock hired it from others. Sharing of livestock for agriculture was reported in 3% of the cases.

Seeds: Use of hybrid seeds was reported in 72% of the cases, with 95% for paddy and 93% for maize, but only in 61% of the times for wheat. A hybrid variety of wheat is shorter and hence less prone to lodging, yielding more than a local variety; but short-height wheat generates less husks, which farmers value as fodders. Therefore, farmers preferred a local variety of seeds for wheat even when facing a greater risk of crop loss especially due to heavy wind. 57% of the OJ cultivators used only hybrid wheat seed variety, which was significantly higher than the proportions recorded in two other groups (47% of ONJ, 50% of NO). However, combining all the crops, 69% of OJ and 65% of ONJ reported using hybrid seeds and the difference was not statistically significant.

Treatment of seeds: Farmers do understand the importance of pre-sowing seed treatment to prevent seed-borne disease in plants. Pre-sowing seed treatment was reported in 91% of the cases. In 50% of the cases farmers procured treated seeds from the market; in another 41% of the cases, seeds were treated before sowing by the farmers themselves. In 10% of the cases, untreated seeds were used, with the risk of seed-borne disease assumed by those farmers. The study observed that OJ farmers were more likely to procure treated seeds, whereas more of ONJ and NO farmers preferred to treat seeds by themselves post-purchase than OJ (the differences were statistically significant.

Sowing: Manual sowing of seeds was preferred by more farmers (52% cases) than not (48% cases). Besides being wasteful, non-mechanized planting is done by hand which is usually imprecise and leads to an uneven distribution of seeds, risking lower productivity. The use of a machine (seed drill) can improve the ratio of crop yield (seeds harvested per seed planted) as much as tenfold. However, mechanical sowing entails a cost that many farmers cannot afford. Mechanical sowing was highest for wheat (58%) and lowest for paddy and maize (43% each). No significant difference in practice was observed across the groups.

Irrigation: Dependence on irrigation for farming was quite high. In 84% of the cases, farms were irrigated, most frequently for maize (88%), followed by wheat (86%) and paddy (79%). Paddy requires a lot of water; even though it is grown in the monsoon season, the quantity of rainfall is insufficient to eliminate dependence on irrigation. Maize and wheat require less water and are cultivated in winter (Rabi season) when rainfall is comparatively lesser. Irrigation is required to maintain the level of soil-moisture during dry winter conditions as well as in order to maintain the suitable soil temperature, which could otherwise drop during peak winter months to a level which can harm the root system.

In 92% of the cases, farms were irrigated as and when required throughout the Rabi season. This implies that farmers chose to increase the cost of cultivation in order to maintain the level of yield. In 60% of the cases, the farmers decided on irrigation just by

observing the plant. Soil type, weather parameters such as temperature, rainfall etc. and growth stage of the plants also played a role in farmers' decision to irrigate (reported in 51%, 42% and 19% of the cases respectively). 18% of the farmers simply followed their neighbors in deciding when to irrigate. Deciding on the timing and scale of irrigation according to the type of soil (that requires scientific knowledge on the soil characteristics) was more prevalent among the OJ farmers (reported 59% of the times) than among the ONJs (reported 51% of the times) and NOs (45% of the times). The differences were statistically significant. In 8% of the cases, the level of irrigation was insufficient.

In 88% of the cases, farms were irrigated using Tubewell. In 7% of the cases, the source of irrigation was borewell. Tubewells and borewells were operated with diesel (99% of the cases), and only 1% used Solar or electricity. In 71% of the cases, farmers used rented tube wells. In 26% of the cases, they used tubewells owned by themselves. Only in 1% cases, the source of irrigation was owned by a group. The highest use of owned tubewells was recorded among the OJ farmers (28%), followed by NOs (26%) and ONJs (21%). The difference between the OJs and ONJs in terms of use of owned tubewells was statistically significant.

The method of irrigation used most often was flood irrigation (90% of the cases), which means that water is delivered to the field by ditch, pipe or some other means and simply flows over the ground and the crop. Although flood irrigation is effective, it is certainly not the most efficient method compared to other available options. It is estimated that only half of the water applied with flood irrigation actually ends up in irrigating the crop, with the other half lost due to evaporation, run-off, infiltration in uncultivated areas and transpiration through the leaves of weeds. More precise root irrigation techniques were followed only in 9% of the cases. The highest number of root irrigation cases was recorded for maize (18%). Sprinkler irrigation was used 2% of the times. Use of more efficient modern irrigation techniques (root and sprinkler irrigation) was slightly but significantly better among the OJ farmers compared to the ONJ farmers. This might be a reflection of the better economic status of the OJ farmers. High rent and unfriendly sharing arrangement of pumps were cited as the biggest challenge of irrigation (36% of times). Lack of knowledge (about how much to irrigate and when) came second, reported by 20% of the respondents. Erratic supply of electricity was mentioned by 11% of the respondents. However, 38% of the farmers reported that they did not face any challenges in regards of irrigation.

Fertilizer: 53% of the farmers used both chemical and biofertilizers and 42% use only chemical fertilizers. Use of only chemical fertilizer is significantly higher among the ONJ group than among OJ farmers. Biofertilizers were exclusively used only by 5% of the farmers. Using a combination of bio and chemical fertilizers is an indicator of progressive farming as sole usage of chemical fertilizers not only increases the cost of cultivation but also have adverse effects on the quality of soil and crop yield. Biofertilizers are low-cost and generally comprise cow dung and vermicomposting.

Weed elimination: The process of weed elimination is mostly manual (reported by 88% of the respondents). Use of weedicide has been reported only by 3% of the respondents.

Crop-cutting: Crop-cutting is done manually. Mechanized crop-cutting has been reported only in 10% of the cases. It is observed that mechanized crop-cutting was

applied more for wheat (14% of the times) than paddy (7% of the times) and maize (8% of the times).

Thrashing: The process of separating grains from the plants was also manual most of the times (reported in 51% of the cases). The manual thrashing was more prevalent for paddy (77% of the times) and maize (60% of the times) as compared with wheat. 48% of the wheat growers mostly use thrashing machine to separate grains from the plants.

Transporting: the most common means of moving crops from field to the storage was by humans carrying harvest on their back; reported 46% of the times. Transporting harvest with tractors was reported in 35% of the cases. Rest of the times the harvested crop was transported by bullock carts.

Procurement of inputs: Farmers purchase seeds mostly from the market or village grain bank (reported 87% of the times). Usage of seeds preserved from last year's harvest was reported in 8% of the cases. In 7% of the cases, Cooperatives or the government provided seeds. In 4% of the cases, farmers received seeds from their neighbors. This is noteworthy that seeds are sold at much higher prices in local markets than the price charged by the government.

Inflated price was the biggest challenge in the procurement of seeds, reported by 62% of the farmers (maize: 65%, paddy: 62%, wheat: 59%). Timely (un)availability was another issue, reported by 17% of the farmers. Recent government directives require farmers to pay the market price for inputs (including seeds) even when they buy it from government outlets. Any subsidy that farmers are entitled to would be credited to their bank account later. As often the inputs are not available at the government outlets when needed, farmers have no other options other than to buy inputs from local markets (without expectation of subsidies at all). Consequently, farmers experience an increase in the cost of cultivation. Inability to buy the desired variety of seeds was reported in 14% of the cases and sub-standard quality of seeds was reported in 11% of the cases.

Fertilizers and pesticides are also procured from local markets (reported 88% times). Procurement of fertilizers and pesticides from government outlets was reported only in 5% of the cases. The farmers reported similar challenges in procurement of fertilizers: inflated price, unavailability at the right time, and lack of stock of desired variety.

4.1.11 Source of financing cost of cultivation

79% of the farmers reported that the major source of financing of agricultural costs was their current income and savings. 36% of the respondents said the main source was borrowing, and the borrowed amount represented 52%-60% of the total average cost of cultivation. Dependence on borrowing was more among the OJ farmers (35% of the cases) than among the ONJ farmers (28% of the cases) and this difference was statistically significant. Relatives, friends, and neighbors seem to be the preferred source of borrowing, and they usually charge interest. Borrowing from a bank was reported in 12% of the cases, from money lenders in 9% of the cases, and from SHG and other community groups in 8% of the cases. Selling assets was reported 1% of the times.

4.1.12 Subsistence farming

In 57% of the cases, crops were grown only for self-consumption. Cultivation for the sole commercial purpose was reported by 17% of the respondents. In 25% of the cases, the

purpose of production was both commercial and self-consumption. The study estimates that 55% of the total production was consumed at home. Inter crop analysis shows that paddy and wheat are largely cultivated for self-consumption, whereas maize is mainly grown for sale. The highest percentage of self-consumption was reported for wheat (62%) and the lowest for maize (44%). As for paddy, 59% of the total production is consumed at home. OJ farmers are less prone to subsistence farming than ONJ farmers and the difference is statistically significant.

4.1.13 Market scenario

The study reveals a very dismal picture of the "market" for agricultural products. In 85% of the cases, produce was sold to intermediary traders. Only in 9% of the cases, the farmers themselves took their produce to the market. Selling directly to the government was reported in only 1%. The intermediary traders buy crops from farmers at below the minimum support price (MSP) set by the government. It appears that access to local market and government agencies is slightly better for the OJs than for their ONJ counterparts. 89% of the ONJ farmers sold their produce to intermediaries as against 79% of the OJ farmers and the difference is statistically significant. In general, the intermediary traders are also the local money lenders, and farmers are often obliged to sell their produce to them at a much lower price failing to recover their cost of cultivation. There is a general feeling among the farmers that they do not receive the price they consider worthy of their labor and investment, and that agriculture has become unprofitable nowadays. Farmers unanimously confirmed during the qualitative interactions that it is very difficult to sustain livelihoods on farming alone without any additional source of livelihood in the family. Selling of produce in exchange for some other goods was reported in 5% of the cases.

Table 9: MSP vs Actual selling price

Crop	Median Actual Selling Price to intermediary traders (INR / Kg)	Declared MSP (INR/ Kg)	Cost of Production (INR/Kg)
Paddy	11.00	14.50	14.22
Wheat	15.00	14.50	13.57
Maize	12.00	15.70	12.43

4.1.14 Experience of crop-loss

All three farmers' categories (OJ, ONJ and NO) reported similar crop loss experience, at 53% of the cases in the total sample, with 56% in paddy, 47% in wheat and 64% in maize. No significant differences were found between the OJ, ONJ and NO categories, except in wheat: 43% of the NO farmers reported a loss in wheat while OJs and ONJs each reported loss in 50% of the times. The difference was statistically significant.

The major reason for crop-loss was disease and pest attacks (reported in 32% cases) followed by heat waves/ high temperature (reported in 23% cases), drought (reported in 21% cases), loss caused by animals (reported in 21% cases) and low precipitation (reported in 13% cases). Reasons vary according to crops.

The main reasons for the loss in production of paddy were drought (31%), followed by disease and pest attacks (26%), heat waves/ high temperature (24%), low precipitation (20%) and loss caused by animals (17%). The reasons for wheat crop-loss were heat

waves/ high temperature (23%), disease and pest attacks (22%), loss caused by animals (22%), drought (15%) and low precipitation (9%). Disease and pest attacks were reported to be the main cause of crop-loss of maize (51%), followed by loss caused by animals (25%), heat waves/ high temperature (20%), drought (8%) and low precipitation (7%). OJ and ONJ farmers cited climate-related factors as reasons for crop loss more often than the NO farmers. This may be attributed to their increased knowledge acquired through their exposure to CBMAS campaign on climate-related risks and resilience.

For all crops combined, most losses occurred at the time of planting and during the period of growth of the plants (77%). The incidence of post-harvest loss was comparatively low. The highest frequency of post-harvest loss was reported for wheat.

Table 10: Reasons for crop-loss

Reasons	Paddy		Wheat		Maize		Total Sample	
	Cases	%	Cases	%	cases	%	cases	%
Disease/ pest attacks	153	26%	123	22%	124	51%	497	32%
Heat waves/ high temperature	143	24%	133	23%	48	20%	367	23%
Drought	179	31%	85	15%	20	8%	328	21%
Loss caused by animals	98	17%	126	22%	62	25%	326	21%
Low precipitation	118	20%	49	9%	17	7%	201	13%
Cold waves	17	3%	90	16%	24	10%	162	10%
Untimely rain	19	3%	33	6%	11	4%	83	5%
Poor seed quality	23	4%	29	5%	11	4%	81	5%
Hailstorm	9	2%	46	8%	5	2%	73	5%
Increased precipitation	10	2%	31	5%	4	2%	49	3%
Poor fertilizer quality	10	2%	12	2%	3	1%	37	2%
Poor quality of pesticides/ insecticides	7	1%	5	1%	6	2%	35	2%
Prolonged / continuous rain	4	1%	21	4%	1	0%	27	2%
Insufficient inputs	4	1%	3	1%	4	2%	20	1%
Flood	11	2%	1	0%	1	0%	15	1%
Theft	1	0%	1	0%	2	1%	14	1%
Total Responses	**586**		**567**		**245**		**1574**	

4.1.15 Impact of crop-loss

The major impact of crop loss was reduced food intake and compromised food quality (61%) followed by distress borrowing (39%), dis-saving (29%) and reduced expenditure on health (22%). In 10% of the cases, children's education suffered and in 13% of the cases, the children had to join the workforce to compensate family income. Crop loss also had an impact on women as in 17% of the cases women had to take the additional burden to supplement the family income. In 16% of the cases, loss in one season affected the production of the next season as farmers could not save enough resources for investment in the following season and they reduced their area of cultivation.

Table 11: Impacts of crop loss

	Percent of time reported
Reduced food intake, quality of food compromised	61%
Had to borrow	39%
Dissaving	29%
Reduced expenditure on health	22%
Reduced area of cultivation	16%
Women started working	17%
Children dropped out of school	10%
Children started earning	13%
Sought financial help from relatives	6%
Reduced agri inputs	3%
Family members migrated for longer period	2%
More family members migrated for work	1%
Sold assets	Less than 0.5%

Relatives, friends, and neighbors remained the major source of borrowing (50%). However, in 25% of the cases, farmers had to turn to moneylenders. Borrowing from SHGs was featured 17% of the times and bank 12% of the times. Expectedly, the highest number of loans from SHGs went to the OJ and ONJ farmers. Borrowers from banks mostly belonged to NO category.

4.1.16 Insurance experience

During the 12 months prior to this study, 43% of the respondents insured paddy, 42% insured wheat and 35% insured maize. As could be expected 83% of the OJ farmers insured their crops versus only 16% of the ONJ farmers and 11% of the NO farmers. This clearly indicates that other forms of insurance outside CBMAS did not have many takers. Of all insured cases, CBMAS had a share of 86% (in terms of the number of cases), government scheme (PMFBY) had a share of 15%. In 2% of the cases, the crop was insured under both CBMAS as well as PMFBY, with the notable difference that CBMAS was never linked to loans whereas PMFBY was loan-linked in 67% of the cases.

General reasons why farmers do not insure: Lack of awareness about an insurance scheme was stated to be the major reason (43% of the times) for no insurance. In 30% of the cases, farmers did not know how CIC works, and in 26% of the cases, the farmers thought that they would not suffer any loss. While lack of knowledge about any insurance schemes, lack of knowledge about its functioning and low-risk perception were the top three reasons for not taking insurance, there were other reasons. 6% of the respondents said that the specific crop they grew was not insurable. In 5% of the cases, the insurer was perceived by the farmers as not trustworthy, and in 2% of the cases, the farmers had a bad experience with insurance in the past. 3% of the farmers said they could not afford the premium.

As could be expected, fewer OJ farmers claimed they did not know about any insurance schemes than ONJ farmers (31% and 24% respectively, and the difference is statistically significant). Many more NO respondents (52%) raised this issue. Similarly, “didn’t know how insurance works” was cited by the OJ farmers much less frequently (12%) than by

ONJ and NO counterparts (30% and 32% respectively). The low-risk perception was most prevalent among the OJ and ONJ farmers (32% and 33% respectively) in comparison to the NO farmers (17%).

Table 12: Reasons for no insurance

Reasons	OJ	ONJ	NO	TOTAL
Not aware of any insurance scheme	31%	24%	52%	43%
Don't know how CIC works	12%	30%	32%	30%
Thought that no loss will occur	32%	38%	17%	23%
Did not cover the risk I wanted to cover	9%	11%	2%	5%
Do not trust insurance provider	7%	7%	4%	5%
It was offered too late	12%	5%	3%	5%
Cannot afford the premium	4%	3%	3%	3%
Bad insurance experience	3%	3%	1%	1%
Discouraged by the community	0%	1%	1%	1%

4.1.17 Knowledge about insurance

The study made an attempt to assess overall awareness about the principles of insurance among the respondents. The respondents were asked to answer 11 questions with Yes/No or Agree/Disagree. Each correct answer fetched +1, wrong answer -1 and no answer 0. Mean score for the entire sample was 5.08 (out of maximum 11). Mean score of the OJ and ONJ households (6.45 and 6.19 respectively) was higher than the means of NOs (3.91), a significant difference. Table 13 lists the misconceptions about insurance prevalent among the farmers. The two most common ones are (1) farmers' expectation to get a payout every year, and (2) farmers expected to get their premium back if there was no loss. 82% of the respondents expressed their trust that insurers would pay claims when the loss arises. Positive attitude towards insurers was more visible among the OJs (89%), followed by ONJs (81%) and NOs (78%). The differences between OJs and ONJs and between OJs and NOs were statistically significant.

Table 13: Misconceptions about insurance

Misconceptions	OJ	ONJ	NO	Total
Every year I expect at least my premium back	52%	53%	53%	53%
Every year I should receive a payout	35%	32%	33%	33%
CIC covers all crops I cultivate	12%	24%	18%	17%
Insurance pays loss occurs due to my own fault	13%	18%	16%	15%
Payout is not linked with the terms of the policy	10%	16%	16%	14%
Insurance is no help against financial loss	11%	13%	17%	14%
If I do not claim, I will get the premium back	11%	16%	10%	13%
Insurance covers total loss even when total area is not insured	13%	7%	11%	11%
Renewal of policy does not require further premium payment	7%	6%	7%	7%
Premium can be paid later (not upfront)	2%	3%	1%	2%

4.1.18 CBMAS vs other forms of insurance: difference in experience

55% of the respondents who participated in CBMAS (OJ+ONJ combined) were well aware of the key features of CBMAS. They could say that payout is determined on the

basis of weather readings. 10% gave a wrong answer and the remaining 35% disclosed that they had no idea. As could be expected, OJs were more aware than ONJ respondents, and the difference was statistically significant.

81% of the respondents knew the location of their nearest weather stations. Interestingly, the ONJ farmers were better informed about the location of the weather station (87%) than the OJ farmers (77%). That difference was statistically significant. 70% of the respondents from each - OJs and ONJs – had correct knowledge that their coverage was as part of a group policy.

61% of the respondents (OJs+ONJs combined) stated that they did not face any challenges while participating in CBMAS. The remaining 39% mentioned some issues. 45% of the respondents (OJs+ONJs combined) referred to unavailability of money and busy schedule at the time of enrollment. Interestingly “busy farming schedule at the time of enrollment” as a challenge was cited by 51% of the OJs and 36% of the ONJs, whereas “unavailability of money” was cited by 39% of OJs and 54% of the ONJs. 29% overall – 30% of the OJs and 28% of the ONJs – complained that payout was not received quickly enough. Since ONJs were not part of crop insurance, it seems they were referring to other risks for which they had insurance cover, such as health. 9% overall (11% of the OJs and 4% of the ONJs) claimed that payout received was not as per the terms and conditions. 9% overall (6% of OJs and 13% of the ONJs) admitted that they did not understand weather data very clearly. 1% from each OJs and ONJs mentioned that they did not get assistance from the scheme activists.

Table 14: Challenges faced cbmas and other than cbmas

Challenges Faced	CBMAS		Other than CBMAS	
	#	%	#	%
Payout not received in time	86	29%	4	33%
Payout received not as per the terms and conditions	25	9%	3	25%
Lack of assistance from the scheme activists/Providers	2	1%	2	17%
Response	294		12	
No Response	462	61%	71	86%
Total	756	100%	83	100%

In contrast, there was hardly any awareness among the farmers about any schemes other than CBMAS (what it covered and how payout was determined). 89% of those who had participated in schemes other than CBMAS (in fact, in PMFBY) did not know anything about the risks covered by the scheme. Only 1% of them (1 out of 83) could correctly say that payout of the scheme is determined by yield; 8% (7 of 83) wrongly answered that it is based on the weather reading and the rest had no idea. When asked about the problems faced in the scheme 86% preferred to remain silent and only 14% answered. 17% of those (2 out of 12, who answered this question) did not have a clear idea about the terms and conditions of the policy. 33% (4 out of 12) complained they did not receive a payout in time. 25% (3 out of 12) perceived that payout given was not as per the terms and conditions of the policy.

4.2 Research question 1

What factors affect voluntary uptake (demand) for agriculture insurance offered to smallholder farmers by community-based mutual-aid schemes (CBMAS, aka microinsurance)?

4.2.1 Methods

Participation (of at least one household member) in the health insurance offered by CBMAS was a precondition for eligibility to enroll in the crop insurance. Hence, the analysis of uptake of CIC is limited to OJ and ONJ households. Their eligibility to join CIC was corroborated using the MIA-MIS data for each scheme. Affiliation to CIC was voluntary. Therefore, it is likely that some farming households that are offered to affiliate may not join (ONJ). We estimate the probability of enrollment in crop insurance component (CIC) of CBMAS considering various factors (like the socio-economic indicators, financial profile, farming practices, access to implementing partners, etc.) that are likely to influence the uptake. Since eligibility to CIC was at the household level, we estimate a household-level enrollment specification. Based on these considerations the insurance enrollment status of household *h*, may be written as,

$$CIC = f\,(SES, FIFP, HoH, SS, FARM, ALAND) \quad (1)$$

Where *SES* is a set of variables including religion and caste of the household, its size, the proportion of members engaged in farming, the proportion of migrants, and the household's ranking by using an asset index. The vector FIFP represents the household's profile reflecting financial and formal insurance characteristics (e.g. if a household has a savings account, or a Kisan Credit Card, or the MGNREGA Card, or is enrolled in PMFBY, or in another weather-based crop insurance scheme). The vector HoH captured characteristics of the head of household, e.g. age, years of formal education, employment status, years in farming activity, access to mobile phone, and PAN card). SS (supply side) means access to the NGOs implementing the CBMAS schemes.

FARM expresses farming practices by the sample households, e.g. the number of crops cultivated in the last year (if they practice multi-cropping); methods used for plowing, leveling, sowing, irrigation, weeding, cutting, thrashing and transporting; seeds and fertilizers being used.

The vector ALAND captures whether a household possessed the documents required to prove land-ownership, as well as the information about soil type and proportion of total land under cultivation. Table 15 contains the detailed description of the variables.

Table 15: Description of the Variables Used in Regression Analysis

Variables	Type of variable	Description
Household Socio-Economic Profile		
Religion - Hindu	Dummy	1 if religion is Hindu, else 0
Religion - Non-Hindu	Dummy	1 if religion is Non-Hindu, else 0
Caste - SC/ST	Dummy	1 if caste is schedule caste / schedule tribe, else 0
Caste - Others	Dummy	1 if caste is others, else 0
Household Size	Continuous	No of members in the household
Proportion of members in farming	Continuous	Proportion of family members engaged in farming to total members
Proportion of members in Migrant	Continuous	Proportion of family members seasonal migrant to total members
Asset Index* - Poorest Quintile	Dummy	1 if household belongs to poorest group by Asset Index quintile, else 0
Asset Index* - Poor Quintile	Dummy	1 if household belongs to poor group by Asset Index quintile, else 0
Asset Index* - Middle Quintile	Dummy	1 if household belongs to middle group by Asset Index quintile, else 0
Asset Index* - Rich Quintile	Dummy	1 if household belongs to rich group by Asset Index quintile, else 0
Asset Index* - Richest Quintile	Dummy	1 if household belongs to richest group by Asset Index quintile, else 0
Household Financial Profile		
Savings Account	Dummy	1 if any household member has a savings account, else 0
Kisan Credit Card	Dummy	1 if any household member has a Kisan Credit Card, else 0
MGNREGA	Dummy	1 if any household member has MGNREGA card, else 0
PMFBY	Dummy	1 if any household member has a PMFBY Card, else 0
WBCIS	Dummy	1 if any household member is enrolled in WBCI scheme, else 0
Household Head Characteristics		
Age	Continuous	Average age in completed years
Years of formal education	Continuous	Years of formal education
Engaged in Farming	Dummy	1 if engaged in farming, else 0
Engaged in Non-farm work	Dummy	1 if engaged in non-farm work, else 0
Engaged in not-working	Dummy	1 if engaged in not working, else 0
No of years in farming	Continuous	No of years engaged in farming
Has access to mobile phone	Dummy	1 if has access to a mobile phone, else 0
Has access to PAN	Dummy	1 if has PAN card, else 0
Access to NGOs Implementing CI		
Travel time to the NGOs implementing CI	Continuous	Travel time to the office of partner NGO (in minutes)
Farming Practices		
No of crops cultivated by HH	Continuous	No of crops cultivated in last 1 year

Variables	Type of variable	Description
Type of crop cultivated - Paddy/Wheat/Maize	Dummy	1 if cultivating paddy/wheat, maize (covered under CI), else 0
Practices Multi-cropping	Dummy	1 if cultivates more than one crop in a plot at the same time, else 0
Plowing - Mechanical	Dummy	1 if follows mechanical techniques for plowing, else 0
Levelling - Mechanical	Dummy	1 if follows mechanical techniques for leveling, else 0
Sowing - Mechanical	Dummy	1 if follows mechanical techniques for sowing, else 0
Irrigation Decision - by Soil Type	Dummy	1 if irrigates as per soil type, else 0
Weeding - Mechanical	Dummy	1 if follows mechanical techniques for weeding, else 0
Cutting - Mechanical	Dummy	1 if follows mechanical techniques for cutting, else 0
Thrashing - Mechanical	Dummy	1 if follows mechanical techniques for thrashing, else 0
Transporting Harvest - Tractor	Dummy	1 if transports crop by tractor from field to home/storage, else 0
Farming practices - Seed variety - Hybrid	Dummy	1 if uses hybrid seeds, else 0
Farming practices - Seed treated	Dummy	1 if uses treated seeds, else 0
Farming practices - Fertilizer Type - Chemical	Dummy	1 if uses chemical fertilizer, else 0
Agricultural Land Use		
Document to show land ownership - All	Dummy	1 if has the required documents of land ownership, else 0
Soil Type – Loamy	Dummy	1 if the soil quality is loamy, else 0
Proportion of land under cultivation	Continuous	Proportion of land under cultivation to total land holding
**Asset Index was computing by applying Principal Component Analysis (PCA) on the household's different assets which are, type of house, number of rooms, separate kitchen, ownership of the house, source of drinking water, source of cooking fuel, source of lighting, toilet facility, whether the household have fan, cooler, radio, sewing machine, LPG gas, television, bicycle, two-wheeler, car, tractor, refrigerator, washing machine, mobile phone, water pump, bullock cart, and total landholding by the household members*		

4.2.2 Results

Table 16 contains estimates of household-level marginal effects (estimated dy/dx values), based on a logit specification where the dependent variable is binary (1 = the household is enrolled in CIC, else 0).

Religion has no influence on CIC enrollment in rural Bihar. However, belonging to the socially backward groups is positively associated with uptake; households categorized as SC (scheduled caste) / ST (scheduled tribe) were 10 percentage point more likely to join CIC, compared to other castes (comprising of general caste and other backward castes (OBC).

No association was found between enrollment in CIC and the economic status of the household (expressed as an asset index), or the household's financial profile, the proportion of farming family members, the proportion of migrant family members, or past experience with applying other risk pooling mechanisms (represented by the household savings account, Kisan Credit Card, enrollment status in MGNREGA, PMFBY and other WBCIS).

Formal education of the head of household was positively and significantly associated with uptake: every additional year of the head's formal education represented an increase of 5.5 percentage points in the probability of uptake.[7] Age, occupation, farming experience, access to mobile phone and PAN of the household head were not significant determinants.

Access to the NGOs implementing the scheme was also not a significant predictor of uptake. Households that were engaged in the cultivation of paddy, wheat, and maize were more likely to join CIC compared to those that cultivated other crops. This result is expected as the CIC was offered only to the households cultivating these three crops. Interestingly, households that use mechanical tools to level or weed and thrash their land were 10-26 percentage point less likely to purchase CIC compared to the ones who use traditional methods. Similarly, usage of hybrid and treated seed varieties was associated with reduced probability of uptake by around 12 percentage point compared to using bio and non-treated seeds. In Chapter 3 it was shown that overall, most farmers, both in the OJ and in the ONJ groups, apply modern methods of farming. However, more ONJ farmers than OJ farmers adopted modern farming practices.

Finally, farming households that base their decisions to irrigate on soil testing are around 15 percentage points more likely to join CIC. The proportion of cultivated agricultural land out of household landholding was positively and significantly related to uptake.

Table 16: Marginal Effect Estimates of Probability of Joining in CIC(OJ vs ONJ) using Logistic Specification

Variables	ME Values (dy/dx)	Standard Errors	P Value
Household Socio-Economic Profile			
Religion - Hindu (D) (Base=Non-Hindu)	0.0318	0.077	0.680
Caste - SC/ST (D) (Base=Others)	0.102**	0.049	0.037
Household Size (C)	0.000616	0.014	0.965
Proportion of members in farming (C)	-0.0411	0.105	0.695
Proportion of members in Migrant (C)	-0.0593	0.175	0.734
Asset Index (5) (including land) - Poorest (D) (Base=Middle Quintile)	-0.0152	0.067	0.821
Asset Index (5) (including land) - Poor (D) (Base=Middle Quintile)	-0.00122	0.067	0.985
Asset Index (5) (including land) - High (D) (Base=Middle Quintile)	0.0765	0.061	0.212
Asset Index (5) (including land) - Highest (D) (Base=Middle Quintile)	0.0936	0.067	0.162
Household Financial Profile			

[7] The percentage point calculation follows the formula ((Standard Deviation*100)*estimated coefficient value). Hence here the formula follows is (5.326*100)*0.0103)=5.485

Variables	ME Values (dy/dx)	Standard Errors	P Value
Savings Account - Yes (D)	-0.0477	0.106	0.652
Kisan Credit Card - Yes (D)	0.0432	0.058	0.458
MGNREGA - Yes (D)	-0.0320	0.047	0.497
PMFBY - Yes (D)	0.0657	0.063	0.299
WBCIS - Yes (D)	-0.00256	0.065	0.968
Household Head Characteristics			
Age (C)	0.00164	0.002	0.458
Years of formal education (C)	0.0104**	0.005	0.026
Engaged in Farming (D) (Base=Not working)	-0.156	0.120	0.194
Engaged in Non-farm work (Base=not working)	-0.230	0.151	0.129
No of years in farming (C)	0.00227	0.002	0.290
Has access to mobile phone (D) (Base=No mobile)	0.0583	0.048	0.223
Has access to PAN (D) (Base=No PAN)	0.0433	0.064	0.502
Access to NGOs Implementing CI			
Travel time to the NGOs implementing CI (in minutes)	-0.00213	0.002	0.247
Farming Practices			
No of crops cultivated by HH (C)	0.0150	0.023	0.510
Practices Multi-cropping (D)	-0.0193	0.102	0.850
Type of crop cultivated - Paddy/Wheat/Maize (D) (Base=Others)	0.574***	0.099	0.000
Plowing - Mechanical (D)	0.0965	0.187	0.606
Levelling - Mechanical (D)	-0.257***	0.058	0.000
Sowing - Mechanical (D)	0.0271	0.044	0.541
Irrigation Decision - by Soil Type (D)	0.149***	0.044	0.001
Weeding - Mechanical (D)	-0.125**	0.060	0.039
Cutting - Mechanical (D)	0.0273	0.062	0.661
Thrashing - Mechanical (D)	-0.0970**	0.046	0.034
Transporting Harvest - Tractor (D)	0.0381	0.047	0.417
Farming practices - Seed variety - Hybrid (D)	-0.123***	0.047	0.010
Farming practices - Seed treated - Yes (D)	-0.113*	0.069	0.101
Farming practices - Fertilizer Type - Chemical (D)	-0.0545	0.083	0.510
Agricultural Land Use			
Document to show land ownership - All (D)	-0.0380	0.064	0.550
Soil Type - Loamy (D) (Base=Non-Loamy)	0.0219	0.045	0.627
Proportion of land under cultivation (C)	0.0751**	0.035	0.034
Pseudo R-Square			0.112
Sample size			618

*Note: *** p<0.01, ** p<0.05, * p<0.1*

The Focus Group Discussions (FGDs) conducted with the OJ farmers in one village of Meenapur block revealed that they were aware that CIC entailed paying a premium and in return, receiving compensation in case of adverse events. However, they knew few details about the scheme. They opined that *"Saving or borrowing is not a sustainable*

mechanism for risk mitigation as this led to a vicious circle of payment-repayment of loans. Here insurance can be a good instrument to have financial risk mechanism if implemented transparently. Everyone should take insurance as it provides "some" financial compensation in case of loss". The OJ group agreed that the awareness campaign conducted prior to enrollment enhanced their trust in the implementing partner, and the transparent implementation motivated them to join.

Participants from the ONJ group said that upfront payment was the major reason not to enroll in CIC. One participant in Muzaffarpur said, *"mera paisa ka kya hoga mujhe nahi pata lagega" (what will happen to my money I won't be able to know).* Participants from the ONJ group from Bidupur echoed similar concerns. Some ONJ participants, while aware of the terms and conditions of the health insurance, said that lack of understanding of the CIC was a reason for not joining. These arguments suggest that weak trust in the implementing agency was a factor.

4.3 Research question 2

Is there a business case for crop insurance component of the CBMAS in terms of financial sustainability, scaling, and stakeholders' interests?

4.3.1 Source of data

Data for calculations of the business case were sourced from the Handbook of Statistics on Indian States 2016-17, published by Reserve Bank of India (RBI, 2017). The handbook contains state-wise information on yield, production, and area cultivated under various crops for all Indian states during the past 25 years. We extracted the data on area cultivated for paddy and yield in the state of Bihar.

4.3.2 Developing a hypothetical business case for insurance of paddy[8]

An insurance business has two main sources of income: the premiums received upfront (P) and the interest earned from the investment of premiums (I). An insurance business has two main sources of expenditure: the claims cost (C) and the operating or admin costs (A). In addition, an insurance business may also have other sources of income or expenditure. For example, an insurer may receive subsidies from the government or commission from the reinsurer. Similarly, an insurer may have to pay reinsurance premiums or interest on borrowed capital. We develop the business case keeping in mind the four components of revenue and expense (P, I, C and A). We assume that the capital required for the business would be injected in the form of equity (instead of borrowed capital), at no cost per se, as the equity-holders would expect a return on their investment.

An insurance business is considered viable when (P+I) exceed (C+A). However, there is no guarantee that (P+I) will exceed (C+A) every year. The questions are:

- Will this happen in a finite number of years?
- How should we estimate 'P' (premiums) to make the business viable?
- How does the value of 'P' affect the insured?
- How can we minimize 'A' (admin cost)?

[8] The methodology was developed after reviewing the articles by Vedenov & Barnett, (2004) and Ye, Nie, Wang, Shi, & Wang, (2015).

An insurer must also have clarity on how to invest P to maximize the value of I (interest). We assume a technical rate of interest of 7% per annum, and that it is possible to earn some interest on the excess of premiums over the claims (when this balance is indeed positive). We do not elaborate the question of the management of funds and keep the focus of discussion on the functioning of insurance

How can we minimize 'A' (admin cost)?

Admin or operating costs of the insurer has three major components: acquisition claims processing and routine administrative expenses. Acquisition costs depend to some extent on the farmers' level of insurance education, as it is difficult to sell a complex product like insurance to farmers who do not know what insurance really is. Ideally, the government (or donors) should be responsible to impart general insurance education, and the insurance company should concentrate on promoting its own products. This way, loading of acquisition costs on the premium will be reasonable and competitive.

Acquisition = General Insurance Education + Particular Product Promotion

The second component of admin cost A is the cost of claims processing. There are several ways to estimate crop-loss; first and foremost, by physical verification. Secondly, by using technology such as remote sensing, satellite image, photography etc. The third way is by modeling the covariate risks with independent weather parameters. The fourth way also estimates the loss due to covariate risks, but instead of modeling it with independent weather parameters, the modeling relies on a sample of observations (e.g. crop-cutting experiment). The first two methods are applicable for indemnity-based insurance, the third is weather-based, and the fourth is area-yield based insurance. Farmers are likely to prefer the first method, which is, however, most expensive, time-consuming and prone to moral hazard (=fraud). If all these costs must be factored into the premium, it is likely to be very high. Loading of operating cost will far exceed the cost of risk.

The second method is still being experimented and professionals are yet to reach consensus on its efficacy and effectiveness. However, it does not seem to be less expensive, and the risk of moral hazard is not eliminated. The third (i.e. weather-based) and fourth (i.e. yield-based) types of insurance eliminate the chances of moral hazard completely – at least at the individual level. The CBMAS projects of Vaishali and Muzaffarpur, which are being evaluated in this study, offered weather-based insurance. During the stage of evaluation, we did not record any unhappiness among the farmers about the weather-based model of determining payouts. However, in order to minimize farmers' basis risk, multiple automatic weather stations (AWS) were set-up in the community and there was a cost of maintaining these AWS, which was not included in the premiums of the CIC. Had it been charged, the premium would have been higher. This implies that if the cost of setting-up the weather stations and maintaining them are absorbed by some institutions other than the insurer (like the government or any third party), there would be no need to load that cost on the premium. Moreover, it will bring in more transparency in the system.

Cost cutting experiments cost very much. However, the government routinely conducts the experiments for General Crop Estimation Surveys (GCES) and publishes the results. Under current practice on this issue, insurance companies send their representatives to

witness the experiments in the area they are covering, in order to confirm that the experiments have been conducted accurately and transparently.

In summary of this discussion, the following salient points become clear:

- Indemnity-based crop insurance is costlier for the farmers.
- Weather-based or area-yield-based insurance can be cheaper if the cost of weather-reading or estimating yield is absorbed by some other than insurers, which is usually the case. Then, the cost of claims processing in crop-insurance schemes is small. Weather-based or yield-based insurance generally covers the covariate risks due to extreme weather conditions or some other perils such as pest-attack. The current study reveals that the farmers are more concerned with the covariate risks than with the local perils.
- Protection against local perils may be left to the local community and insurance may not be the best solution for this.
- Weather or yield data should be estimated in the most transparent manner so as to make it acceptable to all stakeholders. Precise estimates should be available at a reasonably low density of geographical units (village level, or at least block level units).

The third component of A is routine administrative costs. No valid data is available to estimate the routine administrative costs. One of the advantages of CBMAS is that it serves as a “one-stop-shop” for all classes of risk, and it is neither possible nor necessary to allot the exact amount of routine administrative cost attributable to CIC, differently from health and livestock insurance components. No administrative cost component was loaded in the premium for CIC under CBMAS. A loading of 10-25% towards routine administrative cost is generally perceived as fair. It may be a bit more in the in the first few years.

Estimating P (premiums)

Pricing of insurance products is a well-kept secret. The government invited bids to roll out its PMFBY insurance from multiple insurers, apparently to introduce competitiveness. First of all, the details of the bids submitted by the insurers for a particular cluster are not made public, and there is no way for independent researchers to examine whether the premium bids are actuarially fair for each cluster. Secondly, as each cluster is awarded to only one insurer (based on the lowest premium quoted), the formation of a cartel the insurers cannot be ruled out. The lack of transparency due to the absence of evidence makes it difficult to prove or disprove the independence of each bid. Many people concerned with this business were not convinced that the level of premiums charged by the insurers under PMFBY was actuarially fair. For instance, the Centre for Science and Environment estimated that all insurance companies together generated a surplus of premiums over claims to the tune of INR 9,929 crores in one season of Kharif 2016. Such results beg an answer to the question: how does the public know that the premiums charged (and heavily subsidized with public funds) were actuarially fair?

Figure-1 shows the actual yield of paddy in Bihar over the past 25 years (from 1990-91 to 2014-15). The best fitted trend-line with 25 years’ data is a fourth degree polynomial

$$y = 0.0176x^4 - 0.5861x^3 + 4.4246x^2 + 27.892x + 986.11$$

where y is the yield and x is the time; R-squared = 0.4536.

If we always estimate the future yields from the best-fitted trend-line, the predictions are expected to be better. However, we need to revise the trend-lines every year following the inclusion of new actual observations in the dataset. Hence, we do it with the trend-lines of the simplest form (a straight line) and examine the results.

We assume that insurance business started in the year 2000-01 and that we have only 10 years' data in hand at the present time. We predict the following years' yields based on the best-fitted straight line trend with all available data from the past. We also assume that the ratio of standard deviation to mean (coefficient of variation) remains unchanged. This is not a non-controversial assumption, but it is fair to assume that as mean increases, variation also increases and this assumption results in more conservative estimates for the insurers. We estimate yield-variance for the following years based on the de-trended values of the yields of the past years. Table 17 shows the actual yield and equations of the trend-lines we have used in each year to predict the next year's yield. We notice that R-squared values are much lower when compared with the estimated trend based on the fourth-degree polynomial. But the R-square values for the straight line trends increase steadily until the outlier yield of the year 2004-05 pushed it down close to zero. This implies that R-squared values will improve if the outlier yield of the year 2004-05 is excluded.

Table 17: Actual yields and predicted yields based straight line trend

Year	Actual Yield (Kg/ Ha)	Prediction Formula (based on previous years' yields)	R-square	Predicted Yield (Kg/ Hectare)	Estimated SD (Kg/ha)	mean -1 sd (Kg/ha)	mean -2sd (Kg/ha)	Sum Assured (mean-1sd) as % of Expected Yield	Exit Point (mean-2sd) as % of Expected Yield	Liability of the insurer (Kg/ hectare)
1990-91	1,218									
1991-92	932									
1992-93	806									
1993-94	1,295									
1994-95	1,297									
1995-96	1,318									
1996-97	656									
1997-98	1,395									
1998-99	1,331									
1999-00	1,450	y=35.94x + 972.13	0.16							
2000-01	1,489	y=41.46x + 950.04	0.25	1,367	291	1,076	785	79%	57%	291
2001-02	1,465	y=42.13x + 947.14	0.31	1,448	294	1,154	860	80%	59%	294
2002-03	1,419	y=39.63x + 958.81	0.33	1,495	289	1,206	917	81%	61%	289
2003-04	1,523	y=39.9x + 957.47	0.39	1,514	281	1,233	952	81%	63%	281
2004-05	792	y=20.8x + 1059.33	0.11	1,556	277	1,279	1,001	82%	64%	277
2005-06	1,075	y=13.8x + 1098.98	0.06	1,392	301	1,092	791	78%	57%	301

Year	Actual Yield (Kg/ Ha)	Prediction Formula (based on previous years' yields)	R-square	Predicted Yield (Kg/ Hectare)	Estimated SD (Kg/ha)	mean -1 sd (Kg/ha)	mean -2sd (Kg/ha)	Sum Assured (mean-1sd) as % of Expected	Exit Point (mean-2sd) as % of Expected Yield	Liability of the insurer (Kg/ hectare)
2006-07	1,486	y=16.79x + 1081.05	0.09	1,334	293	1,041	747	78%	56%	293
2007-08	1,237	y=14.22x + 1097.31	0.08	1,383	294	1,090	796	79%	58%	294
2008-09	1,599	y=17.88x + 1072.95	0.13	1,368	286	1,082	797	79%	58%	286
2009-10	1,120	y=13.44x + 1104	0.09	1,431	292	1,139	847	80%	59%	292
2010-11	1,095	y=9.66x + 1131.74	0.05	1,386	286	1,100	815	79%	59%	286
2011-12	2,155	y=19.27x + 1058.04	0.15	1,344	279	1,065	786	79%	58%	279
2012-13	2,282	y=27.76x + 990.15	0.25	1,501	339	1,162	823	77%	55%	339
2013-14	1,759	y=28.79x + 981.6	0.29	1,656	389	1,267	878	77%	53%	389
2014-15	1,948	y=31.06x + 961.86	0.34	1,701	390	1,311	920	77%	54%	390

Statistical lemma suggests that most of the variation occurs within three-sigma limits from the mean (sigma stands for standard deviation). But in reality, it looks catastrophic if the actual yield goes below 1-sigma limit from the mean. We assume that farmers bear the loss up to 1-sigma. Insurance kicks in when the yield falls below 1-sigma line and remains in force up to 2-sigma line from the mean. If the yield falls further down (below the 2-sigma line), the reinsurance mechanism takes over.

Sum assured is often declared as a % of predicted yield. This practice is not necessary, and may at times be misleading. It is more important to see this limit in terms of its absolute value. In 2001-02 insurance kicked in when the yield went below 80% of the predicted yield. The absolute value of the yield at this point was 1154 kg/ha. In 2014-15 a pay-out is promised if the yield goes below 77% of the predicted yield. Apparently, it seems that insurers' liability has reduced. But the fact is that in 2014-15 the threshold for pay-out has risen to 1,311 kg/ha, which is higher than the level applied in 2001-02. The insurers' liability actually remains the same; it is 1-sigma.

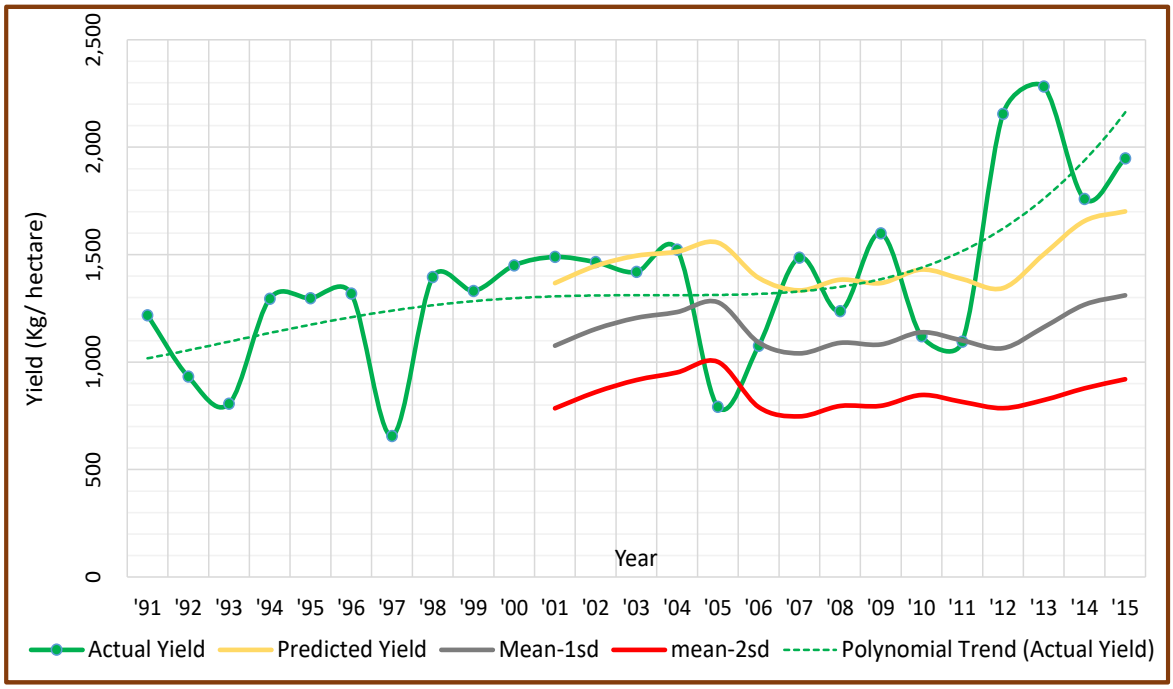
When the actual yield is higher than the predicted yield, it is indeed good for both the farmers and insurers. However, it is legitimate to query whether the farmers see any benefits from insuring their crop in such a case? Let us examine the sum-assured in the first five years (2000-01 to 2004-05) and last four years of the business (2011-12 to 2014-15). The yield has steadily increased. This means good production in one year is expected to give more protection in the following year. However, the reverse is also true. Yield lower than the predicted value is likely to give a lesser protection in the following year. There is another issue. If the actual yield differs in a given year – either way - from the predicted yield, indicating increased variance, the insurer's liability will increase. If the negative trend continues over several consecutive years (which is very unlikely), Insurance may be unable to cope and some other measures may be needed.

The conditions explained above (loss up to 1-sigma to be borne by the farmers, between 1-sigma and 2-sigma by the insurers and beyond 2-sigma by the reinsurer or the government) lead to the following results:

The probability of loss for an insurer in any year is 16%. This means that insurers will suffer a loss once in six years on average. In our real-life example of the business case, the insurer has suffered a loss four times in 15 years, i.e. a little more than the expected number of times.

The expected value of the loss is 0.0748 times sigma. This implies that if variance increases, the expected loss, and hence the premiums, increase. On the other hand, if the actual yields come closer to the predicted yields, the premiums should decrease.

Figure 1: Actual Yields vs Predicted Yields and Sum Assured



The premium is expressed in terms of yield. For example, if the estimated standard deviation is 390, then the premium is 0.07448 x 390 = 29 kg/ hectare. This means that farmers have to pay the equivalent of 29 kg of paddy as premium per hectare of insured land. This result has several far-reaching implications. In order to compute premiums in monetary terms, it is necessary to multiply by any rate, so long as it is one-and-the-same for every insured unit. However, the same rate is applicable for computation of sum assured as well. Stated differently, the rate can be fixed arbitrarily – it may be the cost of production or minimum support price (MSP) or anything else. Profitability of the insurer does not change. However, this rate matters if the premium is subsidized. If the rate is high, the government has to pay a higher subsidy.

In weather-based index or yield-based insurance, there is no conditionality that each policyholder has an insurable interest. This situation challenges basic insurance principles. However, insurers may find this acceptable because of the way the product is designed. Those, who do not have any insurable interest, will probably be not interested in buying such products because pay-outs will be declared only when many farmers suffer a loss. It will help those who have insurable interest but do not have documents of land-ownership (sharecroppers, those who cultivate unauthorized land).

Table 18 shows what would have been the rates of premiums in every year and surplus or loss of the insurer following the method of calculations we have discussed above. We assume that

- The rate for conversion of the premium from yield to its monetary value is INR 14 per kg (this is close to the declared minimum support price of paddy, but could be any value)
- Every parcel of land used for paddy (in Bihar) is insured
- There was no initial capital and
- The premium received upfront does not earn interest (i.e. I=0).

We observe the following from Table 18.

- Actuarially Fair Premium (AFP, also known as Pure Risk Premium) varies between 1.62% and 2.30%.
- The insurer did not suffer any loss in the first four years. In fact, in the first four years, the insurer generated a surplus to the tune of INR 435 crores.
- It suffered losses in four years (2004-05, 05-06, 09-10, and 10-11). However, except in one year (2004-05), the total loss was always less than the total premium received in the corresponding year.
- The amount of loss in 2004-05 was so high that it took nine years to recover. In spite of INR 435 crores in hand at the end of the fourth year, the insurer could not pay all the claims in the next nine years.
- But ultimately at the end of 15th year, it has again generated a surplus of INR 210 crores.

Table 18: Operating results of the insurer (without initial capital and interest income)

Year	Actual Yield (Kg/ Hectare)	Area sown under paddy ('000 ha)	Sum Assured (Kg/ ha) (mean -1 sd)	Premium (Kg/Ha)	Pure Risk Premium as % of sum assured	Rate to be protected (INR/Kg)	Total Premium ('000 INR)	Loss (Kg/ ha)	Total Loss ('000 kgs)	Total Loss ('000 INR)	Excess of Premium over Claims ('000 INR)	Cumulative Excess of Premium over Claims ('000 INR)
1990-91	1,218	5,390										
1991-92	932	5,100										
1992-93	806	4,517										
1993-94	1,295	4,718										
1994-95	1,297	4,855										
1995-96	1,318	5,037										
1996-97	656	5,068										
1997-98	1,395	5,112										
1998-99	1,331	5,087										
1999-00	1,450	5,002										
2000-01	1,489	3,656	1,076	22	2.03%	14.00	1,115,621	0	0	0	1,115,621	1,115,621
2001-02	1,465	3,552	1,154	22	1.90%	14.00	1,092,751	0	0	0	1,092,751	2,208,372
2002-03	1,419	3,585	1,206	22	1.79%	14.00	1,085,892	0	0	0	1,085,892	3,294,264
2003-04	1,523	3,578	1,233	21	1.70%	14.00	1,052,575	0	0	0	1,052,575	4,346,839
2004-05	792	3,123	1,279	21	1.62%	14.00	907,361	277	866,177	12,126,480	-11,219,119	-6,872,280

Year	Actual Yield (Kg/ Hectare)	Area sown under paddy ('000 ha)	Sum Assured (Kg/ ha) (mean -1 sd)	Premium (Kg/Ha)	Pure Risk Premium as % of sum assured	Rate to be protected (INR/Kg)	Total Premium ('000 INR)	Loss (Kg/ ha)	Total Loss ('000 kgs)	Total Loss ('000 INR)	Excess of Premium over Claims ('000 INR)	Cumulative Excess of Premium over Claims ('000 INR)
2005-06	1,075	3,252	1,092	22	2.06%	14.00	1,024,084	17	53,843	753,795	270,288	-6,601,992
2006-07	1,486	3,357	1,041	22	2.11%	14.00	1,030,702	0	0	0	1,030,702	-5,571,290
2007-08	1,237	3,573	1,090	22	2.02%	14.00	1,099,276	0	0	0	1,099,276	-4,472,014
2008-09	1,599	3,496	1,082	21	1.97%	14.00	1,045,710	0	0	0	1,045,710	-3,426,303
2009-10	1,120	3,214	1,139	22	1.92%	14.00	982,406	19	60,123	841,716	140,689	-3,285,614
2010-11	1,095	2,833	1,100	21	1.94%	14.00	848,024	5	15,574	218,040	629,983	-2,655,631
2011-12	2,155	3,324	1,065	21	1.96%	14.00	972,706	0	0	0	972,706	-1,682,925
2012-13	2,282	3,299	1,162	25	2.18%	14.00	1,171,463	0	0	0	1,171,463	-511,462
2013-14	1,759	3,131	1,267	29	2.30%	14.00	1,276,468	0	0	0	1,276,468	765,006
2014-15	1,948	3,263	1,311	29	2.23%	14.00	1,334,796	0	0	0	1,334,796	2,099,802

These observations lead us to conclude the following:

The insurers should be given the opportunity to spread the risk over time. This is not the situation at present. Private insurers were allowed to participate in the government schemes only under PMFBY which started in 2016. Crop insurance is so much under government control in terms of policy constraints, that the insurers do not know whether they will get a chance to recover the loss in future years. Under such circumstances, the insurer will tend to generate as much surplus as possible in each and every year. [*The insurers should also be given the opportunity to spread the risk across geography as well as crops. All the states and all the crops did not suffer the similar loss in the same year. Time and resources did not allow us to examine the pattern of loss if it spreads across geography and crops. But we strongly feel it is worth investigating and it will provide better opportunities and flexibilities to the insurers.*]

The business has to start with an initial capital in order to prevent situations when insurers fail to pay legitimate claims of the insured. But the question is what should be the amount of this capital and what will be its effect on the premium if we want to ensure a return on investment?

There is no one simple answer to this question and it really depends on the business strategy of the insurer. If a credit line is available to the insurer as and when required, then no initial capital is required and it has the least impact on the premium. On the other hand, if the insurer can start the business with zero capital, why should it be entitled to draw a profit? Ideally, it should be a judicious mixture of equity and borrowing. Again there is no clear answer to what should be the ideal ratio of borrowing to equity. It depends on the expected level of equity participation, cost of borrowing and most importantly, the outlook of the insurer. The rule of thumb is: the higher the borrowing, the higher is the impact on the premium. We examine here an extreme case: the total initial capital comes as equity and the premiums in excess of claims are invested earning an interest @7% per annum.

We estimate that an initial capital of INR 368.8 crores is required to write off the negative balances at the end of the year that we observed in Table 3 if the excess of premiums over claims earns an interest @7% per annum. A sensitivity analysis suggests that it requires a loading of 20% on the premium. Table 19 shows the cash-flows in the business over a period of 15 years. An initial capital of INR 368.8 crores will grow to INR 1,584 crores in 15 years, implying a compound annual growth rate (CAGR) of 10.20%. An initial capital less than this (INR 366.8 crores) is not sufficient. A capital more than this is indeed good for the business, but the return on investment will be less than what has been estimated above. A smaller percentage of loading on the premium has two impacts. First, it necessitates additional initial capital and secondly, it reduces the return on investment. For example, if no loading is allowed on the premium, the minimum initial capital required is estimated as 461.5 crores which will grow @6.98% per annum.

Impact on the Farmers

The minimum and maximum rates of premiums over the past 15 years when expressed as additional expenditure per kg of production were INR 0.22 and 0.30 respectively (denominator = expected yield per hectare). Even if we allow a margin of 20% on the final rate of the premium (equivalent to loading of 25% on the base value) to accommodate routine admin cost, the minimum and maximum rates of premium are estimated as INR 0.28 and INR 0.37 per kg respectively, which the farmers can afford if they are able to buy the inputs and sell their produce at the right price. During 2016-17 the median selling price for paddy was INR 11 per kg when the declared minimum support price (MSP) was INR 14.70 per kg. This implies that in order to motivate farmers to buy insurance, an essential step is to ensure MSP by eliminating the intermediaries. If the selling price is less than the cost of production, the farmers consider it as unprofitable and restrain themselves from incurring any additional expenditure which can be avoided. Insurance is such expenditure.

Table 19: Cash Flows (with Initial Capital, Earned Interest and Loading on Premium)

Year	Premium as % of sum assured	Initial Capital ('000 INR)	Total Premium ('000 INR)	Total Loss ('000 INR)	Excess of Premium over Claims ('000 INR)	Closing balance at the end of the year before interest	Interest Earned ('000 INR)	Closing Balance at the end of the year after interest ('000 INR)	Compound Annual Growth Rate
2000-01	2.43%	3,688,000	1,338,746	0	1,338,746	5,026,746	351,872	5,378,618	45.84%
2001-02	2.28%		1,311,301	0	1,311,301	6,689,919	468,294	7,158,213	39.32%
2002-03	2.15%		1,303,071	0	1,303,071	8,461,284	592,290	9,053,574	34.90%
2003-04	2.05%		1,263,090	0	1,263,090	10,316,663	722,166	11,038,830	31.53%
2004-05	1.95%		1,088,833	12,126,480	-11,037,647	1,183	83	1,265	-79.72%
2005-06	2.47%		1,228,900	753,795	475,105	476,371	33,346	509,716	-28.10%
2006-07	2.53%		1,236,843	0	1,236,843	1,746,559	122,259	1,868,818	-9.25%
2007-08	2.42%		1,319,131	0	1,319,131	3,187,949	223,156	3,411,106	-0.97%
2008-09	2.37%		1,254,852	0	1,254,852	4,665,958	326,617	4,992,575	3.42%
2009-10	2.30%		1,178,887	841,716	337,171	5,329,746	373,082	5,702,828	4.46%
2010-11	2.33%		1,017,628	218,040	799,588	6,502,416	455,169	6,957,585	5.94%
2011-12	2.36%		1,167,247	0	1,167,247	8,124,832	568,738	8,693,570	7.41%
2012-13	2.62%		1,405,756	0	1,405,756	10,099,326	706,953	10,806,278	8.62%
2013-14	2.76%		1,531,761	0	1,531,761	12,338,040	863,663	13,201,703	9.54%
2014-15	2.67%		1,601,755	0	1,601,755	14,803,458	1,036,242	15,839,700	10.20%

Table 20: Premium for Catastrophic Loss

Uncovered loss	209	kg / ha
Area sown	3,123	'000 ha
Total uncovered loss	653,175	'000 kg
Rate	14	INR per kg
Total uncovered monetary loss	9,144,447	'000 INR
Total actual production in 15 years	75,400	thousand tons
Loss/ kg	0.12	INR per kg
Average are cultivated (over 15 years)	4,005	'000 ha
Loss amortized over 15 years	152	INR / ha

As we have just discussed, the government should first and foremost ensure that the farmers get the declared MSP for their produce and also buy the inputs at the right price. A number of problems could be solved just by meeting these two requirements. However, from the business point of view, the government has one more task to do. Let us look at the yield of the year 2004-05 which was 792 kg per hectare and it falls below the 2-sigma limit from the mean. The mean and 1-sigma and 2-sigma limits from the mean in that year were estimated as 1556, 1279 and 1001 kg per hectare respectively. The actual yield was far below the 2-sigma limit and it is really not possible to deal with a loss of this extent without any provision of reinsurance. In fact in the hypothetical business case we have set up in this chapter, the insurer didn't take any responsibility below 1001 kg/hectare. There is still a loss of 209 kg/ hectare. Multiplying this loss by the area cultivated under paddy in that year (3,123 thousand hectares) and rate per kg (INR 14), the total loss for the year (after the insurer pays what was due to them) is estimated as INR 914 crores. But this happened only once in 15 years and if the total loss is amortized over a period of 15 years, it comes INR 152 per hectare or INR 0.12 per kg (Table 20). Instead of paying subsidy on the premium is it not much better to build a reserve which will accumulate @ INR 0.12 per kg of production in every year? If we assume that the reserve earns some interest (which is definitely true), the value will be even smaller. Instead of receiving premium subsidy it is much more attractive for an insurer to receive this assurance that catastrophic loss will be taken care of by the government. We have shown that per unit cost of this assurance is very small and can be borne even by the farmers.

4.4 Research question 3

How effective is the crop insurance component of CBMAS in providing financial protection to insured farmers (timely and adequate payouts in case of losses)?

Various stakeholders, including governments, researchers, the development community, and think tanks, are often interested in finding the impact of projects like CBMAS, as these are implemented with a promise to deliver welfare gains for an underserved group of the society. The evaluation which is required should answer the key questions for evidence-based policy making: what has worked (and what has not), why, for whom and at what cost. In view of the low insurance penetration among small landholders of crop

insurance provided by commercial players with heavy subsidies from the government, it is essential to examine all the relevant alternatives, notably the crop insurance component (CIC) of Community-based Mutual aid schemes in India.

The CIC of CBMAS has been operational for only two years (since 2015) in Bihar. This study is therefore limited in the scope and length of insurance coverage, and it is recalled that the impact of insurance is usually becoming more pronounced as the insurance scheme matures (maturity in insurance is considered to occur after about 10 years of operation). Therefore, this analysis of the impact of CIC on the enrolled farmers must be viewed as only indicative of what could still develop into more pronounced trends with time. The analysis is limited to four indicators of financial protection that can be measured:

The financial loss experienced by the farmers in last one year

We posit a hypothesis that the OJ farming households experience lower financial loss at the end of the harvest (due to issues like disease or pest attack, cold/heat weaves, increased/low precipitation, excess/untimely rain, flood, drought, hailstorm, poor quality of inputs, etc.).

Borrowing to finance agriculture inputs

The underlying assumption is that the OJ farmers are more inclined to invest in better-quality of inputs because they can potentially take a higher risk which is insured, which the ONJ cannot take. Moreover, OJ farmers may have easier access to credit, because moneylenders seek to capture higher returns with limited risk, and OJ farmers are less risky than ONJ.

Income of the household

The ultimate goal of CIC is to reduce the risk of large fluctuations in the income of farmer households (measured by monthly per capita household income). We examine the hypothesis that OJ households will have a more stable income, and perhaps also a higher income, compared to ONJ households.

The share of agricultural income in total household income

We also hypothesize that CIC will increase the share of income from farming to total income, particularly in the short run, for the OJ households.

In this chapter, we'll analyze the impact of CIC offered under CBMAS on the above-mentioned indicators of financial protection, by comparing OJ to ONJ and NO households.

4.4.1 Methods

In this study, the analysis of the effectiveness of CIC on financial protection has been conducted on two different samples:

Offered-and-joined vs Offered-and-not-joined (OJ vs ONJ):

It is recalled that households that had at least one member covered under the health insurance offered by CBMAS were eligible to purchase the CIC. As the enrollment in CIC was restricted by enrollment in health insurance, we limited our first analysis to the OJ & ONJ groups, comprising a total of 756 households (430 in OJ and 326 in ONJ). In this analysis, the OJ households are the "treatment" group (with crop insurance) and the ONJ households are the "control" group (without crop insurance).

Offered-and-joined vs Offered-and-not-joined and Not-offered (OJ vs ONJ+NO)

The second part of this analysis examines the outcomes related to financial protection discussed earlier between the OJ group ("treatment") and the entire sample that was without crop insurance, composed the ONJ & NO group ("control"). The total sample of 1562 households was used for the impact analysis in this stage, with 430 OJ households (treatment) and 1132 ONJ+NO households (control).

The concern in this comparative analysis is to ensure that the treatment cohort (OJ) should be comparable to the control cohorts. As many differences were observed which could constitute selection bias, we applied propensity score matching (PSM) methods to condition the observable variables (Smith & Todd, 2005) to eliminate the selection bias between the treatment and control groups.

To analyze the difference in the outcome variable between the treatment group (those who actually received the benefits of crop insurance) and the control group, we applied the average treatment effect on the treated (ATT) on the matched sample. The underlying assumption of the ATT method is that the distribution of the outcome variables is the same for the treatment and control groups (Becker & Ichino, 2002).

The ATT estimation follows the following model specifications:

The propensity score, defined by Rosenbaum & Rubin (1983) as the conditional probability of receiving a treatment based on a set of observable indicators, can be presented as:

$$P(X) = Pr\,(D=1 \mid X) = E\,(D \mid X) \qquad (6.1)$$

Where D represents the treatment status (1 if received the treatment, else 0) and

X is the vector of observable indicators of the household. Hence P(X) represents the estimated propensity score.

Given this, the average treatment effect (ATT) can be calculated by

$$\begin{aligned} ATT &= E\,\{Y_{1i} - Y_{0i} \mid D_i = 1\} \\ &= E\,[\,E\,\{Y_{1i} - Y_{0i} \mid D_i = 1, P\,(X_i)\}\,] \\ &= E\,[\,E\,\{Y_{1i} \mid D_i = 1, P\,(X_i)\,\} - E\,\{Y_{0i} \mid D_i = 0, P\,(X_i)\,\} \mid D_i = 1] \end{aligned} \qquad (6.2)^{9}$$

Where the overall expectation is over the distribution of $P(X_i \mid D_i = 1)$ and Y_{1i} and Y_{0i} are the possible outcome variables in the counterfactual situations of treatment and control respectively.

The analysis used both the nearest neighborhood method (matching treatment and control households that are closest in terms of propensity scores as matching partners) and stratification method of the propensity score matching (matching the treatment and control households within mutually exclusive strata based on their propensity scores) (Austin, 2011; Becker & Ichino, 2002). The propensity scores were estimated as a

[9] (Becker & Ichino, 2002)

parametric logit model and the common support requirement of PSM was used to discard the unmatched observations from the analysis. The balancing property of the PSM was satisfied using the Student's t-test, i.e. households with the same propensity score had the same distributions of all covariates for the sample.

4.4.2 Results

The variables that were used to conduct the PSM and ATT analysis were selected based on the findings from the analysis of uptake of the CIC of CBMAS (refer to Table 18 and Table 21).

Analysis of impact on OJ vs ONJ: From the descriptive statistics, presented in Table 21, we can see that there is no significant difference between the loss experience of the OJ and ONJ groups (binary variable with 1 if the experienced loss, else 0).

Regarding borrowing in the previous year to buy inputs (binary variable with 1 if the household has borrowed, else 0), the treatment households (OJ) reported around 6 percentage points higher incidence rate than the control (ONJ), and this difference was statistically significant. Also, the monthly per capita income of OJ households was more than INR 300 higher than that of ONJ households. However, the share of income from agriculture to total family income was about the same in both treatment and control cohorts.

Table 21: Descriptive Statistics of Mean and Standard Error of Mean (SE Mean) of the Outcome Indicators, OJ vs ONJ

Indicator	OJ		ONJ		Diff. (OJ-ONJ)	P-value (t-test)
	Mean	SE Mean	Mean	SE Mean		
Experienced loss in the previous year	0.585	0.025	0.561	0.034	0.024	0.564
Borrowing to buy inputs	0.322	0.024	0.263	0.029	0.059	0.060
Income - monthly per capita (INR)	1842	112	1533	101	308	0.063
Share of agriculture to total income	0.374	0.018	0.391	0.023	-0.018	0.543

Table 22 presents the results of the ATT analysis for OJ and ONJ; it points to no significant difference between the OJ and ONJ groups in loss experience in farming during the last year. However, the ATT values reveal that the OJ households were significantly more likely to borrow in order to buy inputs compared to the ONJ households. The result was significant at 10% level when the stratification matching method was applied.

There were also no significant differences in monthly per capita income of the household and in the share of income from agriculture to total family income.

Table 22: Average Treatment Effect on Treated (ATT) of CIC on Financial Protection, OJ vs ON

Indicator	PSM – Method	N - Treatment	N - Control	Average Treatment Effect (ATT)	Standard Error	t-Value	P-value
Loss	Nearest Neighbor	388	128	-0.063	0.067	-0.935	0.175
	Stratification	387	225	0.000	0.051	0.009	0.504
Borrowing to buy inputs	Nearest Neighbor	388	133	0.062	0.062	1.001	0.159
	Stratification	387	225	0.071*	0.047	1.503	0.067
Income - monthly per capita	Nearest Neighbor	388	133	206	250	0.823	0.205
	Stratification	387	225	185	202	0.917	0.180
Share of agri to total income	Nearest Neighbor	388	133	-0.01	0.047	-0.214	0.415
	Stratification	387	225	-0.025	0.038	-0.667	0.253

*Note: *** p<0.01, ** p<0.05, * p<0.1*

Analysis of impact on OJ vs ONJ+NO: When the "Control" cohort is composed of the ONJ and NO groups, the descriptive Table (Table 23) reveals that the OJ households experienced around 6 percentage point more incidence of loss in farming during the previous year than the control group. However, the difference in borrowing to purchase inputs has disappeared. And, the OJ households had significantly higher monthly per capita income (of INR 226) than the control group. Furthermore, the share of income from agriculture in total family income was now significantly lower (by 3.2 percentage point) in the OJ group compared to the combined ONJ+NO cohort.

Table 23: Descriptive Statistics of Mean and Standard Error of Mean (SE Mean) of the Outcome Indicators, OJ vs ONJ+NO

Indicator	OJ		ONJ+NO		Diff. (OJ-ONJ+NO)	P-value (t-test)
	Mean	SE Mean	Mean	SE Mean		
Experienced loss in the previous year	0.585	0.025	0.521	0.018	0.064	0.049
Borrowing to buy inputs	0.322	0.024	0.315	0.016	0.007	0.791
Income - monthly per capita	1842	102	1616	110	226	0.042
Share of agriculture to total income	0.354	0.012	0.386	0.012	-0.032	0.051

When the analysis was done using ATT method, no significant effect of the CIC was recorded on the loss experience of the households. Similarly, the earlier findings that OJ households borrowed more to buy inputs than uninsured households disappeared. And, the monthly per capita household income of the insured households was now significantly higher than the control. The finding was applicable for both the types of PSM method (nearest neighborhood and stratification matching).

Following the same trend, the share of income from agriculture out of total income was also higher for the OJ group. However, the result was statistically significant at 10% only, when nearest neighborhood method of PSM was applied.

Table 24: Average Treatment Effect on Treated (ATT) of CIC on Financial Protection, OJ vs ONJ+NO

Indicator	PSM – Method	N - Treatment	N - Control	ATT	Standard Error	t-Value	P-value
Loss	Nearest Neighbor	388	239	0.027	0.047	0.560	0.288
	Stratification	386	838	0.029	0.034	0.832	0.203
Borrowing to buy inputs	Nearest Neighbor	388	248	0.031	0.043	0.712	0.238
	Stratification	386	838	0.029	0.032	0.893	0.186
Income - monthly per capita	Nearest Neighbor	388	248	280**	157	1.783	0.038
	Stratification	386	838	185*	141	1.313	0.095
Share of agriculture to total income	Nearest Neighbor	388	248	0.043*	0.033	1.323	0.093
	Stratification	386	838	0.014	0.024	0.584	0.280

Note: *** p<0.01, ** p<0.05, * p<0.1

Other important differences became apparent: 45% of the people who experienced a loss from the OJ group reported of taking a loan, compared to 37% from the OJ+ONJ group (Table 22, a significant difference). The average amount payout by CBMAS (applicable to OJ) was INR 760, comparable to INR 1085 and INR 4400 for the ONJ & NO group respectively, paid by other crop insurance schemes. Finally, the average time waiting period for payouts was much shorter for OJ (123 days), compared to other insurance schemes (232-245 days).

Further probing on adequacy and timeliness from secondary data: Table 25 shows that on average, the lag period between end date of CBMAS crop insurance policy and claim settlement is 80 days. It is important to note that payout amount is delivered at the doorstep of the farmer household within 5 days subsequent to claim settlement by the insurance company. Thus, farmers get payout money in cash within the duration of 85 days from the policy end date. However, the season-wise analysis shows that maximum TAT (turnaround time of claim settlement) was for the Rabi season 2017 (98 days) whereas minimum TAT was for Kharif 2016 (63 days) in both the locations. The analysis shows that in the CIC, efficient timing was maintained in claim settlement and payout dispersal in comparison to PMFBY. As per various news reports and documentation of independent agencies, the TAT in PMFBY ranges from 7 months to 1 year.

Table 25: Turn around time (CBMAS)

Location	Season	Crop	Coverage End Date	Claim Settlement Date	TAT* (Days)
Vaishali	Kharif 2015	Paddy	23-Oct-15	8-Jan-16	77
Vaishali	Kharif 2015	Maize	13-Oct-15	8-Jan-16	87
Vaishali	Rabi 2015-16	Wheat	30-Apr-16	13-Jul-16	74
Vaishali	Kharif 2016	Paddy	10-Nov-16	12-Jan-17	63
Vaishali	Kharif 2016	Maize	7-Nov-16	12-Jan-17	66
Vaishali	Rabi 2016-17	Wheat	28-Mar-17	4-Jul-17	98

Location	Season	Crop	Coverage End Date	Claim Settlement Date	TAT* (Days)
Vaishali	Rabi 2016-17	Maize	1-Apr-17	4-Jul-17	94
Muzaffarpur	Kharif 2016	Paddy	10-Nov-16	12-Jan-17	63
Muzaffarpur	Kharif 2016	Maize	7-Nov-16	12-Jan-17	66
Muzaffarpur	Rabi 2016-17	Wheat	28-Mar-17	4-Jul-17	98
Muzaffarpur	Rabi 2016-17	Maize	1-Apr-17	4-Jul-17	94
Average					**80**

Table 26 shows season wise payout paid and estimated loss incurred in various season during CBMAS crop cover. The maximum payout was released by the insurance company during Rabi season of the year 2015-16 (INR 62.96/Kattha) followed by the payout of INR 44.53/Kattha in Kharif 2015. In order to check the adequacy of the payout, yield loss of both the crops in respective seasons was estimated. Paddy and wheat Yield data was referred from Department of food and public distribution and RBI (Reserve Bank of India, Government of India. Maximum loss in the Table is defined as the maximum of estimated losses of last fifteen years (2000 to 2014-15) whereas loss is estimated as a difference of actual yield of a particular year and moving average of last five years of yield. Analysis for maize crop was not done due to unavailability of the data. Estimated yield loss is in line with the amount of payout paid to the farmers and in both the season 71%-72% of loss was covered by the payout. In qualitative data, OJ farmers responded that they find CBMAS payout more adequate than the payout calculated in other crop insurance schemes. The further probe showed that post-payout dispersal, OJ farmers of CBMAS were updated about the details of payout calculation by scheme activists. This resulted in the transparency within the scheme and also enhanced the understanding of the OJ farmers about the comparison of yield loss and payout amount.

Table 26: Estimating Loss Compensated by Pay-outs

Location	Season	Crop	Claim Paid (INR/ Kattha)	Maximum Loss/ Khatta[1] (INR/ Kattha)	% estimated loss compensated by payout
Vaishali, Bihar	Kharif 2015	Paddy	44.53	63.12	71%
Vaishali, Bihar	Kharif 2015	Maize	27.38		
Vaishali, Bihar	Rabi 2015-16	Wheat	62.96	87.40	72%
Vaishali, Bihar	Kharif 2016	Paddy	19.64		
Vaishali, Bihar	Kharif 2016	Maize	2.61		
Muzaffarpur, Bihar	Kharif 2016	Paddy	26.77		
Muzaffarpur, Bihar	Kharif 2016	Maize	0.00		
Vaishali, Bihar	Rabi 2016-17	Wheat	4.08		
Vaishali, Bihar	Rabi 2016-17	Maize	-		
Muzaffarpur, Bihar	Rabi 2016-17	Wheat	6.51		
Muzaffarpur, Bihar	Rabi 2016-17	Maize	9.33		

5. Implications of study findings

5.1 Implications for the intervention

The analysis of factors affecting enrollment has revealed that households classified as scheduled caste/scheduled tribe (i.e. considered as marginally backward social groups) were more likely to enroll in the CIC of CBMAS compared to other segments of the population. This finding points that CBMAS is socially inclusive. It is interesting to note that caste played a role when religion and the household's economic status (indicated by holding of a savings account and enrollment in other socio security schemes e.g. KCC, MGNREGA, PMFBY, and WBCIS) had no significant effect on enrollment. This factor may be more pronounced in Bihar, and it would be interesting and worthwhile to examine whether it recurs in other places where the demographic composition is different.

The education level of the household head positively influences uptake. Age, work status, experience in agriculture, access to mobile phone and PAN card (a proxy of financial literacy), were not significant factors for uptake of crop insurance.

Farmers that use some modern farming techniques (to perform functions such as leveling the land, weeding, thrashing etc.) are less likely to enroll in crop insurance. This seems surprising at first sight, but less so when we recall that a clear majority of the farmers use modern farming methods but the incidence of applying traditional farming practices was higher among the OJ than among the ONJ groups. Farmers do not need to be innovators on all fronts to appreciate crop insurance. What seems more pertinent is that farmers that cultivate a high proportion of their landholdings are more likely to enroll in CIC of CBMAS. As the efforts to encourage farmers to cultivate much of their landholdings are independent of insurance, it seems legitimate to surmise that those efforts produce, as a collateral benefit, the potential to scale enrollment in CIC of CBMAS.

Other factors that positively affect uptake of the CIC component of CBMAS include access to a savings account, access of the household head to a mobile phone, and access to other weather-based crop insurance. All three factors allow optimism that uptake is bound to continue to grow, because the number of savings accounts is on the rise in rural India[10], pursuant to the government's drive to achieve more financial inclusion; and because mobile phones can nowadays be found in about 75% of households, and projected to reach more than 85% of households by 2030, with much of the growth in rural households[11]. In fact, mobile phones are gradually replacing TV as the main communication device, and smartphones gradually replace simpler mobile phones. This development would be useful for communicating to farmers more elaborate advisories about crop insurance and related information.

[10] 'Bank account penetration set to increase in country' The Hindu, August 19, 2016. Accessible at: http://www.thehindu.com/news/national/karnataka/%e2%80%98bank-account-penetration-set-to-increase-in-country%e2%80%99/article14578561.ece

[11] Janaki Padmanabhan: Mobile Phones – The Pathway to Rural India. Euromonitor, 12 May 2016. Accessible at: http://blog.euromonitor.com/2016/05/mobile-phones-the-pathway-to-rural-india.html

Technology is however not everything. The positive role of conducting iterative discussions at community level – an established practice of CBMAS – is also instrumental for uptake. The qualitative findings from the FGDs with OJ and ONJ groups corroborated that trust in the implementing partners and knowledge about the CIC(disseminated through the meetings prior to the enrolment) boosted uptake, and lack of awareness or trust were detrimental to uptake by ONJ participants. It is noted that commercial insurers have, thus far, done almost nothing to enhance clients' awareness or trust.

The premiums and claims data of CBMAS show that there is a clear business case in the CIC. In only four seasons of insurance, the external insurer retained 29% of the premiums as surplus without spending any amount in acquiring the business. Also to note that pay-outs through CBMAS could compensate over 70% of the loss (in respect of the cost of cultivation). In the hypothetical business case we have developed in chapter-5 we have shown that private insurers can gain substantially without any subsidy from yield-based insurance schemes if they are given the opportunity to spread the risk across time and if a re-insurance mechanism exists. The question is: can CBMAS be replicated to this scale? In order to answer this question, we need to understand the difference between CBMAS and available other insurance schemes. In CBMAS there was no premium subsidy and the farmers joined voluntarily. CBMAS invested in creating awareness about the risks of climate change and in setting-up the community-managed infrastructure (automatic weather stations) for determination of claim payouts. As a result, no disputes have been reported in CBMAS in regards to claims settlements – either from the farmers' side or from the external insurer's side. However, the risk was underwritten by an external insurer. With a similar arrangement, there are no reasons why CBMAS cannot be replicated to the scale and made a viable business. It needs to be mentioned that the cost of acquisition of the business and the cost of settlement of claims (the two major sources of expenditures) were almost negligible because crop-insurance in CBMAS was offered as an additional risk cover to its existing members. It did not require any additional investment except in awareness building and in setting up the automatic weather stations. But this was only one-time cost and it is possible to amortize the cost over a certain number of years. In summary, we emphasize on the following:

- It is possible to create a captive market for crop insurance anywhere just by one-time investment in insurance education and setting up the community-based infrastructure through CBMAS
- It is possible to motivate the farmers to join crop insurance schemes voluntarily without any expectations of subsidy through CBMAS
- It is possible to make the business viable by underwriting the risk by an external insurer and by introducing a reinsurance mechanism

We can now discuss the information relating to the third research question about the impact of CIC on financial protection of the insured farmers. The impact has been measured by comparing OJ farmers (treatment group) to two control groups: Offered-and-not-joined (ONJ), comprising a total of 756 households; and ONJ + Not-offered (ONJ+NO) comprising 1132 households. Four indicators of financial protection have been considered:

The financial loss experienced by farmers in the last year (due to issues like disease or pest attack, cold/heat waves, excessive/ insufficient precipitation, untimely rain, flood, drought, hailstorm, poor quality of inputs, etc.). This indicator does not reveal any significant difference between the treatment and control groups in loss experience.

The second indicator, of *borrowing to finance agriculture inputs* gives a mixed message: calculations of the differences using one method and one comparator group led to a result that the treatment households (OJ) was more likely to borrow than the control (ONJ), and this result was statistically significant. It was corroborated, at 10% level (when the stratification matching method was applied) when the calculation was done applying the ATT method. When the calculation was repeated, this time by reference to the larger control group (ONJ+NO), there was no difference in borrowing.

The third indicator of financial protection (*Income of the household)* offers a more consistent answer: the OJ households had higher monthly income than ONJ households (INR 300 more). Notwithstanding that differences in monthly per capita income of the household were indistinguishable when a different calculation was applied (ATT method), the difference was reconfirmed to be significant (and amount to INR 226) when OJ was compared to ONJ+NO. Considering the very short period of insurance coverage, and the multiplicity of methods used, we submit that this impact should be retained and considered valid.

Finally, *the shares of agricultural income in total household income have remained about the same for all groups, or marginally lower* among OJ, according to the method and comparator used.

In summary, the analysis leaves sufficient room to entertain the thought that we are on the right track in examining the impact of CIC on financial protection of the insured farmers. As a minimum, the results suggest that such impact cannot be discarded. The small size of the groups compared, and the short period of insurance cover during which the differences could have materialized are uncontested. Therefore, these hypotheses would have to be re-examined after a longer period of insurance coverage, and maybe also when the degree of cover is increased.

It is noted that the average payout by CBMAS (applicable to OJ) was INR 760, comparable to INR 1085 and INR 4400 for the ONJ & NO group respectively, paid by other crop insurance schemes. Finally, the average waiting period for CBMAS payouts to OJ was much shorter (123 days) compared to about double that time it took (232-245 days) for other insurance schemes to pay to ONJ.

Conclusions: The aggregate quantity of land insured through the crop insurance component of CBMAS schemes has increased 4.5 times, from 81 acres in the 2015 Kharif season to 361 acres in the 2016 Kharif seasons, and 3.4 times from 97 acres in the 2015 Rabi season to 327 acres in the following 2016 Rabi season. It reached a total of 865 acres over this short period. This represented a premium volume of INR 6,34,581 and aggregate claims payouts of INR 4,53,502 or 71.5% of total premiums. In passing, we note that during the first two seasons the payouts exceeded the premiums, and during the following two seasons the aggregate results have been balanced to a perfectly desirable cumulative claims ratio. These results can be viewed as encouraging for farmers, insurers and policymakers alike.

100% of the crop-risk written by the CBMAS has been ceded to an external insurer, in recognition that the weather risk was mostly covariate, and thus unfit for mutualization at a narrow geographical area. The CBMAS was the local platform which made it feasible for farmers to take up crop insurance, which was otherwise either unavailable to them (because of administrative hurdles most often). Therefore, it is fair to say that the CBMAS activities have been instrumental in catalyzing demand for (this kind of) crop insurance.

Considering that the crop insurance component of CBMAS was paid for by the farmers in full (under a regime of zero subsidies to premium), and considering the high cost of public funds paid to insurance companies as premium subsidies, we submit that the pilot of CBMAS that was operated by MIA represents an interesting potential to generate very large savings (spent today on premium subsidies) which can be better used to support the rollout of MIA's CBMAS model on a much larger scale, in more locations, and applies to more crops.

An initial attempt has been made to analyze the business case of the crop insurance component of CBMAS. The analysis of the viability and sustainability of the business model of CIC is useful and meaningful for policy purposes only when it can be compared to the business case of the alternative delivery channels of crop insurance by commercial insurers, at a considerable and growing cost of public funds in the form of subsidies. This study has laid the ground for such comparative analysis. Much more research effort would be required to take this topic to the stage where policymakers could be satisfied that all aspects of this complex conundrum are reflected. This reserve notwithstanding, the analysis presented in this study points that the cost of subsidies influences the sustainability issue much more than the agricultural risk per se, or the administrative costs of operating a transparent and participatory mutual aid scheme that can catalyze trust in the process and therefore uptake of crop insurance.

The experience of collaboration between a commercial insurance company and MIA to work out fair term-sheets and more farmer-friendly administrative processes has been very positive. The insurance company has been keen to work with MIA on simplifying the paperwork, accepting a single group policy, zero acquisition costs, zero agent commissions to pay, and entrusting the role of redistributing the payout among the insured members to their community. The insurance company was not involved in MIA's other efforts to develop the new community-centric business process. Ultimately, the community consolidates solvent demand and speaks for its members to represent their interests. The insurance company represented its interests as the supplier of insurance, and this focus was not cluttered by the fact that the premiums were not subsidized. And MIA acted as the market-maker, bringing both demand and supply to agree on terms of their transaction.

The role of the market-maker should neither be overlooked nor underestimated. MIA could act as benevolent market-maker because its operating costs were funded by a grant from a development agency. Its technical assistance to the community (to understand the risks and how to mitigate them through insurance) and to the insurance company (to develop fair term sheets to underwrite the crop risk) was essential in bringing the parties to transact. Price was not the main or only determinant of the value proposition. as the transactional, This enabled MIA to be accepted as an honest broker

that promotes insurance even though it will not take a commission from any party to the insurance transaction.

These details suggest that the proposition to enhance voluntary uptake of crop insurance is viable when rolled out through CBMAS. As for the business case of this activity, we have established a hypothetical case with real data from Bihar, and have shown that CBMAS actually provides the evidence that it is possible to bring farmers do join crop insurance on a voluntary basis, without linkage to loans, to other forms of compulsion, and without any expectation of subsidy. The CBMAS (and its technical assistance backstopper MIA) has invested efforts to design and implement proper insurance education. We distinguish between insurance education (which is lacking outside CBMAS) and product promotion (the usual manner in which the insurance companies work). We understand the key problems the farmers are facing: increasing costs of cultivation, and reduced prices for their agricultural products. Crop loss due to climate change is an additional issue aggravating their woes. Farmers are very keen to reduce their reliance on intermediaries (that are now ingrained in all the phases of the agricultural production chain).

We have also demonstrated that the business case of CBMAS could allow it to reach scale and sustainability, provided that the good intentions of the government will enable the CBMAS to grow their activities, combining insurance education, capacity development at local level, and customized solutions for crop insurance as an extension to other community-based mutual aid activities. In the short term, these activities can produce a positive impact on the financial protection of the insured, which would encourage more farmers to join. In the longer term, it could reduce the burden of premium subsidy and enable the government to raise more resources for agriculture than ever before.

This will also provide level-playing fields for all insurers introducing transparency and competitiveness.

5.2 Implications for further research

Sustained impacts of insurance could not be probed through this study. As described in the section Theory of Change, insurance is expected to bring a change in the mindset of the farmers and motivate them to take greater risks in terms of increased land use and increased agricultural investment which will ultimately bring financial stability to farming households. It is definitely worth studying whether insurance has that potential to change the agricultural landscape of the country. This requires an intervention of longer duration. However, crop insurance in India is controlled by the government and the schemes introduced by the government are ever-changing. Private insurers introduced insurance products on an experimental basis, but those were short-lived. Organisations like MIA have implemented community-based insurance schemes, but the continuation of such implementation depends on donors' motivation. Hence, the impact of insurance on the farmers are to be assessed irrespective of any particular intervention. We have elaborated our views and proposed our methodologies, which we feel, are best fitted for such study in the proposal for phase-II.

6. Major challenges and lessons learned

Obtaining ethical approvals from institutional review boards, where applicable – We did not face any problems in obtaining ethical approvals from our institutional review board. The members of the institutional review board suggested some changes and we revised our tools following their valued suggestion.

Obtaining approvals from the relevant government department to run the implementation and/or evaluation – This was not required and hence not applicable to us.

Engaging with key stakeholders at various stages of the study – The field researchers did not face any problems in engaging the farmers during the interview session. However, at times it was felt that the questionnaire used for the quantitative study could have been shorter. So far as implementation was concerned, we faced some challenges. Creating awareness on insurance requires an initial investment. It cannot be loaded in the premium. Secondly, farmers do not constantly remain under insurance. They may join the scheme intermittently. There was initial confusion at the time sampling which of the two groups - farmers continuously under insurance in four seasons or those who joined the scheme at least once – should be considered as the treatment group. Finally, the farmers who joined the scheme at least once were included in the treatment groups (referred to as OJ in the analysis). A third challenge of the intervention was that many farmers did not join the health insurance offered by CBMAS but were insistent on joining the CIC. As per the design of the intervention, they were not allowed to join the CIC. Otherwise, enrolment under CIC would have been better.

Developing technologies (if any) used in the intervention – Developing technology was not imperative for the study and hence, it is not applicable.

Motivating and/or incentivizing the health workers, especially those in the government, to participate in the intervention – Health workers were not involved in this study. This is not applicable.

Monitoring and understanding the fidelity of the programme roll-out (implementation fidelity, e.g., monitoring and evaluation capacity of the implementing agency) – The intervention was very well monitored (elaborated in the Monitoring Section). Some farmers in the sample were found to have joined both the CBMAS and the government subsidized PMFBY schemes. We do not consider it as infidelity as no such restriction was imposed in the intervention. Farmers' experience of CBMAS and of schemes other than CBMAS were asked in two separate sections in the quantitative questionnaire.

During data collection- Farmers were unable to provide accurate information on yield and cost of cultivation. It is clear that they do not keep any records of transactions and cannot recall the information when asked later (if the recall period is too long). Estimates of yield and cost of cultivation we obtained from the study were unrealistic and hence excluded from the findings. A different approach is needed if it is required to collect accurate information on yield and costs. We, therefore, have suggested a very different approach in the phase-II.

During data analysis- Did not face any major issues in data analysis.

Adhering to the planned timeline- Did not pose any great threat. Uncertainty over the continuation of the intervention delayed data collection. However, it was well-handled by the field supervisors. Delay was made-up by engaging additional surveyors. Data cleaning took than expected time.

Appendix

Table A1: Results of Balancing Test following PSM between OJ & ONJ group

Indicators	Mean in treated	Mean in Untreated	Standardised diff.
Religion - Hindu (D) (Base=Non-hindu)	0.93	0.90	0.09
Caste - SC/ST (D) (Base=Others)	0.22	0.17	0.13
Household Size (C)	5.53	5.34	0.11
Proportion of members in farming (C)	0.42	0.43	-0.04
Proportion of members in Migrant (C)	0.05	0.06	-0.02
Asset Index (5) (including land) - Poorest (D) (Base=Middle Quintile)	0.16	0.21	-0.14
Asset Index (5) (including land) - Poor (D) (Base=Middle Quintile)	0.15	0.19	-0.10
Asset Index (5) (including land) - High (D) (Base=Middle Quintile)	0.23	0.19	0.12
Asset Index (5) (including land) - Highest (D) (Base=Middle Quintile)	0.27	0.17	0.25
Savings Account - Yes (D)	0.96	0.97	-0.03
Kisan Credit Card - Yes (D)	0.20	0.14	0.16
MGNREGA - Yes (D)	0.46	0.50	-0.09
PMFBY - Yes (D)	0.22	0.20	0.07
WBCIS - Yes (D)	0.24	0.23	0.04
Age (C)	48.27	46.79	0.12
Years of formal education (C)	5.95	4.29	0.32
Engaged in Farming (D) (Base=Not working)	0.75	0.72	0.07
Engaged in Non-farm work (Base=not working)	0.21	0.27	-0.14
No of years in farming (C)	19.93	17.45	0.19
Has access to PAN (D) (Base=No PAN)	0.37	0.27	0.22
Has access to mobile phone (D) (Base=No mobile)	0.87	0.83	0.13
Travel time to the NGOs implementing CI (in minutes)	22.21	24.20	-0.16
No of crops cultivated by HH (C)	2.46	2.26	0.20
Practices Multicropping (D)	0.06	0.05	0.04
Type of crop cultivated - Paddy/Wheat/Maize (D) (Base=Others)	1.00	0.98	0.15
Ploughing - Mechanical (D)	0.96	0.98	-0.13
Levelling - Mechanical (D)	0.89	0.96	-0.26
Sowing - Mechanical (D)	0.53	0.55	-0.03
Irrigation Decision - by Soil Type (D)	0.60	0.50	0.21
Weeding - Mechanical (D)	0.16	0.20	-0.11
Cutting - Mechanical (D)	0.13	0.12	0.01
Thrashing - Mechanical (D)	0.65	0.70	-0.11
Transporting Harvest - Tractor (D)	0.36	0.30	0.13
Farming practices - Seed variety - Hybrid (D)	0.46	0.56	-0.19
Farming practices - Seed treated - Yes (D)	0.91	0.93	-0.08
Farming practices - Fertilizer Type - Chemical (D)	0.93	0.94	-0.05
Document to show land ownership - All (D)	0.86	0.88	-0.07
Soil Type - Loamy (D) (Base=Non-Loamy)	0.62	0.56	0.12
Proportion of land under cultivation (C)	1.59	1.50	0.14

Table A2: Results of Balancing Test following PSM between OJ & ONJ+NO group

Indicators	Mean in treated	Mean in Untreated	Standardised diff.
Religion - Hindu (D) (Base=Non-hindu)	0.93	0.95	-0.09
Caste - SC/ST (D) (Base=Others)	0.22	0.19	0.08
Household Size (C)	5.53	5.61	-0.05
Proportion of members in farming (C)	0.42	0.44	-0.07
Proportion of members in Migrant (C)	0.05	0.06	-0.06
Asset Index (5) (including land) - Poorest (D) (Base=Middle Quintile)	0.16	0.20	-0.11
Asset Index (5) (including land) - Poor (D) (Base=Middle Quintile)	0.15	0.21	-0.15
Asset Index (5) (including land) - High (D) (Base=Middle Quintile)	0.23	0.19	0.10
Asset Index (5) (including land) - Highest (D) (Base=Middle Quintile)	0.27	0.18	0.20
Savings Account - Yes (D)	0.96	0.91	0.19
Kisan Credit Card - Yes (D)	0.20	0.12	0.20
MGNREGA - Yes (D)	0.46	0.42	0.09
PMFBY - Yes (D)	0.22	0.13	0.24
WBCIS - Yes (D)	0.24	0.12	0.33
Age (C)	48.27	48.78	-0.04
Years of formal education (C)	5.95	5.20	0.14
Engaged in Farming (D) (Base=Not working)	0.75	0.80	-0.12
No of years in farming (C)	19.93	20.28	-0.02
Has access to PAN (D) (Base=No PAN)	0.37	0.31	0.13
Has access to mobile phone (D) (Base=No mobile)	0.87	0.80	0.18
Travel time to the NGOs implementing CI (in minutes)	22.21	26.33	-0.39
No of crops cultivated by HH (C)	2.46	2.27	0.17
Practices Multicropping (D)	0.06	0.05	0.02
Type of crop cultivated - Paddy/Wheat/Maize (D) (Base=Others)	1.00	0.97	0.24
Ploughing - Mechanical (D)	0.96	0.96	0.02
Levelling - Mechanical (D)	0.89	0.89	-0.01
Sowing - Mechanical (D)	0.53	0.56	-0.05
Irrigation Decision - by Soil Type (D)	0.60	0.49	0.22
Weeding - Mechanical (D)	0.16	0.17	-0.03
Thrashing - Mechanical (D)	0.65	0.70	-0.10
Transporting Harvest - Tractor (D)	0.36	0.34	0.04
Farming practices - Seed variety - Hybrid (D)	0.46	0.56	-0.19
Farming practices - Seed treated - Yes (D)	0.91	0.89	0.06
Farming practices - Fertilizer Type - Chemical (D)	0.93	0.92	0.04
Document to show land ownership - All (D)	0.86	0.87	-0.03
Soil Type - Loamy (D) (Base=Non-Loamy)	0.62	0.55	0.14
Proportion of land under cultivation (C)	1.59	1.46	0.21

Table A3: Reuslts of Balancing Test following PSM between OJ & ONJ group

Variable	Mean			t-test		V(t) /	
	Treated	Control	%bias	t	p>t	V(C)	
Religion - Hindu (D) (Base=Non-hindu)	0.92526	0.95876	-11.9	-2	0.046	.	
Caste - SC/ST (D) (Base=Others)	0.22423	0.2268	-0.6	-0.09	0.932	.	
Household Size (C)	5.5284	5.6778	-8.6	-1.2	0.229	1	
Proportion of members in farming (C)	0.41881	0.36554	22.6	3.41	0.001	1.55*	
Proportion of members in Migrant (C)	0.05313	0.04436	7	1.03	0.301	1.58*	
Asset Index (5) (including land) - Poorest (D) (Base=Middle Quintile)	0.15979	0.20876	-12.6	-1.76	0.079	.	
Asset Index (5) (including land) - Poor (D) (Base=Middle Quintile)	0.15206	0.15722	-1.4	-0.2	0.843	.	
Asset Index (5) (including land) - High (D) (Base=Middle Quintile)	0.23454	0.22938	1.3	0.17	0.865	.	
Asset Index (5) (including land) - Highest (D) (Base=Middle Quintile)	0.26546	0.24485	5	0.66	0.511	.	
Savings Account - Yes (D)	0.95876	0.94845	5.4	0.68	0.495	.	
Kisan Credit Card - Yes (D)	0.19845	0.20876	-2.8	-0.36	0.722	.	
MGNREGA - Yes (D)	0.45876	0.57216	-22.7	-3.18	0.002	.	
PMFBY - Yes (D)	0.22423	0.26804	-10.7	-1.42	0.157	.	
WBCIS - Yes (D)	0.24485	0.30928	-15.2	-2.01	0.045	.	
Age (C)	48.273	46.389	15	2.07	0.039	1.22	
Years of formal education (C)	5.9485	5.5412	7.8	1.05	0.294	1.08	
Engaged in Farming (D) (Base=Not working)	0.74742	0.77577	-6.4	-0.93	0.355	.	
Engaged in Non-farm work (Base=not working)	0.20619	0.20361	0.6	0.09	0.929	.	
No of years in farming (C)	19.925	19.085	6.3	0.85	0.397	1.18	
Has access to PAN (D) (Base=No PAN)	0.37113	0.40979	-8.3	-1.1	0.27	.	
Has access to mobile phone (D) (Base=No mobile)	0.87113	0.87113	0	0	1	.	
Travel time to the NGOs implementing CI (in minutes)	22.211	21.682	4.3	0.59	0.557	0.66*	
No of crops cultivated by HH (C)	2.4613	2.5232	-6.1	-0.81	0.42	1.34*	
Practices Multicropping (D)	0.0567	0.07474	-8.1	-1.01	0.311	.	
Type of crop cultivated - Paddy/Wheat/Maize (D) (Base=Others)	0.99742	1	-2.6	-1	0.318	.	
Ploughing - Mechanical (D)	0.96134	0.99485	-20.3	-3.21	0.001	.	
Levelling - Mechanical (D)	0.8866	0.94072	-20.3	-2.69	0.007	.	

Variable	Mean			t-test		V(t) /	
	Treated	Control	%bias	t	p>t	V(C)	
Sowing - Mechanical (D)	0.53093	0.52062	2.1	0.29	0.774	.	
Irrigation Decision - by Soil Type (D)	0.60309	0.61598	-2.6	-0.37	0.713	.	
Weeding - Mechanical (D)	0.16237	0.13144	8	1.22	0.224	.	
Cutting - Mechanical (D)	0.12629	0.09278	10.1	1.49	0.135	.	
Thrashing - Mechanical (D)	0.65206	0.64691	1.1	0.15	0.881	.	
Transporting Harvest - Tractor (D)	0.36082	0.37113	-2.2	-0.3	0.766	.	
Farming practices - Seed variety - Hybrid (D)	0.46134	0.39948	12.4	1.74	0.082	.	
Farming practices - Seed treated - Yes (D)	0.90979	0.84536	23.7	2.75	0.006	.	
Farming practices - Fertilizer Type - Chemical (D)	0.92784	0.95103	-9.3	-1.35	0.176	.	
Document to show land ownership - All (D)	0.86082	0.87113	-3.1	-0.42	0.674	.	
Soil Type - Loamy (D) (Base=Non-Loamy)	0.61856	0.60567	2.6	0.37	0.713	.	
Proportion of land under cultivation (C)	1.5865	1.5849	0.3	0.04	0.972	0.99	
* if variance ratio outside [0.82; 1.22]							
Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
0.069	74.12	0	8	6.4	62.8*	1.37	44

Table A4: Reuslts of Balancing Test following PSM between OJ & ONJ+NO group

Variable	Mean			t-test		V(t) /	
	Treated	Control	%bias	t	p>t	V(C)	
Religion - Hindu (D) (Base=Non-hindu)	0.92526	0.9433	-7.4	-1.01	0.311	.	
Caste - SC/ST (D) (Base=Others)	0.22423	0.24485	-5.1	-0.68	0.499	.	
Household Size (C)	5.5284	5.7139	-10.4	-1.44	0.151	0.86	
Proportion of members in farming (C)	0.41881	0.40204	6.8	1.01	0.314	1.16	
Proportion of members in Migrant (C)	0.05313	0.04086	8.8	1.4	0.162	1.35*	
Asset Index (5) (including land) - Poorest (D) (Base=Middle Quintile)	0.15979	0.19588	-9.4	-1.31	0.189	.	
Asset Index (5) (including land) - Poor (D) (Base=Middle Quintile)	0.15206	0.15979	-2	-0.3	0.767	.	
Asset Index (5) (including land) - High (D) (Base=Middle Quintile)	0.23454	0.22423	2.5	0.34	0.733	.	
Asset Index (5) (including land) - Highest (D) (Base=Middle Quintile)	0.26546	0.25773	1.9	0.24	0.807	.	
Savings Account - Yes (D)	0.95876	0.96649	-3.1	-0.57	0.571	.	
Kisan Credit Card - Yes (D)	0.19845	0.17784	5.6	0.73	0.463	.	
MGNREGA - Yes (D)	0.45876	0.46134	-0.5	-0.07	0.943	.	
PMFBY - Yes (D)	0.22423	0.22423	0	0	1	.	
WBCIS - Yes (D)	0.24485	0.25773	-3.4	-0.41	0.679	.	
Age (C)	48.273	48.036	1.8	0.25	0.803	1.01	
Years of formal education (C)	5.9485	5.4536	9.1	1.29	0.198	1.12	
Engaged in Farming (D) (Base=Not working)	0.74742	0.68299	15.4	1.99	0.047	.	
No of years in farming (C)	19.925	19.969	-0.2	-0.04	0.968	0.77*	
Has access to PAN (D) (Base=No PAN)	0.37113	0.32732	9.3	1.28	0.201	.	
Has access to mobile phone (D) (Base=No mobile)	0.87113	0.87887	-2.1	-0.33	0.745	.	
Travel time to the NGOs implementing CI (in minutes)	22.211	21.878	3.1	0.4	0.693	0.83	
No of crops cultivated by HH (C)	2.4613	2.3995	5.6	0.79	0.427	1.25*	
Practices Multicropping (D)	0.0567	0.07474	-7.9	-1.01	0.311	.	
Type of crop cultivated - Paddy/Wheat/Maize (D) (Base=Others)	0.99742	1	-1.9	-1	0.318	.	
Ploughing - Mechanical (D)	0.96134	0.96907	-3.9	-0.59	0.557	.	
Leveling - Mechanical (D)	0.8866	0.86598	6.5	0.87	0.384	.	
Sowing - Mechanical (D)	0.53093	0.5567	-5.2	-0.72	0.472	.	

Variable	Mean			t-test		V(t) /	
	Treated	Control	%bias	t	p>t	V(C)	
Irrigation Decision - by Soil Type (D)	0.60309	0.59021	2.6	0.37	0.715	.	
Weeding - Mechanical (D)	0.16237	0.16753	-1.4	-0.19	0.847	.	
Thrashing - Mechanical (D)	0.65206	0.62371	6.1	0.82	0.412	.	
Transporting Harvest - Tractor (D)	0.36082	0.39433	-7	-0.96	0.336	.	
Farming practices - Seed variety - Hybrid (D)	0.46134	0.47165	-2.1	-0.29	0.774	.	
Farming practices - Seed treated - Yes (D)	0.90979	0.93557	-8.6	-1.34	0.179	.	
Farming practices - Fertilizer Type - Chemical (D)	0.92784	0.93557	-2.9	-0.43	0.67	.	
Document to show land ownership - All (D)	0.86082	0.8067	15.8	2.03	0.043	.	
Soil Type - Loamy (D) (Base=Non-Loamy)	0.61856	0.64433	-5.2	-0.74	0.457	.	
Proportion of land under cultivation (C)	1.5865	1.5305	9	1.29	0.197	1.21	
* if variance ratio outside [0.82; 1.22]							
Ps R2	LR chi2	p>chi2	MeanBias	MedBias	B	R	%Var
0.03	32.28	0.646	5.4	5.2	41.2*	0.85	33

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