An Assessment of climate-indexed insurance contracts as a climate change adaptation strategy for Sri Lankan smallholder agricultural producer.

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1. Introduction

One of the under-investigated themes related to climate change adaptation is climate finance. Climate financing opportunities can make direct impacts on the success of adaptation practices. In low income settings where farming is the main livelihood, climate change has presented significant threats to the livelihoods. Farmers use various responses to climate induced shocks, but the relative efficacy of the conventional responses has been poor and these options have not generated sufficient safeguards. In the absence of suitable risk management options, farmers tend to adopt unsustainable and environmentally hazardous practices such as overuse of agrochemicals, misuse of water resources and use of hazardous postharvest treatments on agricultural produce as coping strategies to climate risks (Panda et al. 2013). Insurance and other risk-pooling mechanisms are viable options under adaptation finance. Among these, weather-indexed insurance instruments moderate the yield and income risks of farming resulting from climate and weather variations.

In this study, a choice experiment methodology is adopted to investigate the factors contributing to farmers' adoption of climate-indexed insurance. Especially, the study attempts to understand the effectives of climate-indexed insurance as a climate change adaptation strategy in smallholder agriculture in Sri Lanka. A sample of 300 respondents to cover perennial and annual crops from five agroecological regions was targeted as potential respondents of the choice experiment after calculating the sample size needed to match the dimensions of the choice experiment.

1.1. Background to risk and insurance

The coping strategies of the farmers as individuals, households and communities are contextual and numerous. Such strategies vary widely in terms of their effectiveness. Still, the exposure to risk even at the subsistence to low income smallholder level (setting aside the agribusiness operator's case) is too large to ignore. In a survey based analysis, Rosenzweig and Binswanger (1993)[1] found that smaller and poorer farmers in a semi-arid region in India sacrificed 27% of their expected income to reduce risk. Further evidence on the limitations of traditional risk management tools can be witnessed in the long standing poverty traps in smallholder agriculture. While poverty traps are not created entirely due to risk in farming, they are indirectly perpetuated by the inadequacy of traditional risk mitigation methods.

History of risk mitigation instruments in agriculture is limited by the presence of documentation. As per the literature, the earliest recorded incidences come from Western Europe. Crop-hail insurance was offered in Germany as early as the 1700s, livestock insurance was offered in Germany, Sweden and Switzerland by 1900. Early implementations were single peril type products. Federal crop insurance in USA was first authorized in Agricultural

[1] Rosenzweig, M. R. and Binswanger, H. P. (1993): Wealth, weather risk and the profitability of agricultural investment. Economic Journal, 103, pp. 56–78.

Adjustment Act of 1938. The Federal Crop Insurance Act of 1980 (USA) made crop insurance the primary form of catastrophic protection available for farmers (Glauber et al 2002). Japan implemented a multiple peril crop insurance program in early 20th century that provided nationwide coverage for paddy rice, wheat, barley and mulberries (Yamauchi 1986). A number of public sector multi-peril crop insurance (MPCI) schemes were established in Latin America (for example, Brazil, Costa Rica, and Mexico) and Asia (India, the Philippines), often linked to seasonal production credit programs for small farmers (Kerer, 2013).

1.2. Climate change adaptation: The role of insurance

Adaptation to climate change in agriculture can happen through different approaches. At the level of the farmer, one potential approach is to introduce financial strategies that can help mitigate output and price risks. A key policy issue is how such risk mitigation strategies are financed. The government interventions often come in the form of subsidies for adaptation technologies and compensation for climate induced harvest losses. In either case, the cost of intervention is borne by the tax payer, essentially indicating that there are welfare losses. In contrast, privately-financed insurance schemes can be considered as market solutions to risk mitigation.

Climate indexed insurance (CII) schemes solves key problems related to traditional indemnity based insurance substantially, making the transaction costs of CII considerably low relative to traditional insurance (Tadesse et al., 2015). This makes CII schemes attractive to private insurers. From the client (farmer) side, CII are more transparent than the traditional insurance.

Climate adaptation finance channeled through an insurance instrument as opposed to a direct subsidy will strengthen the market orientation of small-holder agriculture sector while reducing the fiscal burden that subsidies entail. The instrument will directly contribute towards the national climate change adaptation strategy of Sri Lanka formulated in 2010, in strengthening its fourth and fifth priorities, namely, improving Climate Resilience of Key Economic Drivers and Safeguarding Natural Resources and Biodiversity from Climate Change Impacts.

Further to its direct role in managing risk and uncertainty, insurance instruments will help smooth the agricultural household income. The role of indexed insurance as a consumption smoothing tool for farmers and other stakeholders of the agricultural sector falls in line with the identified policy priority in the 2010 national strategy formulation on “Supporting climate-change adaptation strategies with incentives, where possible”.

1.3. Agro insurance in Sri Lanka

In Sri Lanka, the first experimental crop insurance scheme was established in 1958 as a pilot project covering rice cultivation only. The scheme was legislated under the Crop Insurance Act No. 13 of 1961. The scheme covered 26,000 acres of paddy in five districts. The experience during the first 15 years period was quite favorable. By 1973, 16% of the total area cultivated with paddy was insured by this scheme in both seasons (Sandaratne, N, 1974). The penetration of insurance has fallen since then to an overall 4% according to government statistics. In terms of paddy area under voluntary insurance as a percentage of area cultivated is recorded at 1% by the agricultural insurance board of sri lanka (figure 1.1)

Marking the second stage of agricultural insurance, the crop insurance board was established in 1973 under the Parliamentary Act No. 27 of 1973 (Agricultural Insurance Law No. 27 of 1973) to operate a comprehensive agricultural crop insurance scheme, covering all major crops and livestock. In case of rice and other crops, insurance protection was provided against lack of water, drought, excessive water, floods, diseases, insect infestation, and damage by wild animals and losses due to non-adherence to approved methods of farming (i.e. Department of Agriculture recommendations). This scheme was partially subsidized with the administration costs being borne by the State. Other objectives were to stabilize farm incomes thereby promoting agricultural production, and also to undertake research for the promotion and development of Agricultural Insurance. Other crops like green gram, cowpea, chilli, soya bean and even livestock, especially cattle and poultry came under the program by 1985. The total area under insurance cover increased to 200,000 acres. A large percentage (85%) of the total acreage insured is paddy and other crops that received agricultural credit. The institutional framework was further expanded by the Agricultural and Agrarian Insurance Board (AAIB) Act No. 20 of 1999 (Agricultural and Agrarian Insurance Act No. 20 of 1999) which operated under the objective of running the scheme on a self-financed basis.

Although paddy insurance is compulsory under section 11 of the Agricultural Insurance Law, insurance subscription remained effectively voluntary, participation by farmers has ranged around 10%. Further changes followed suit. Area under crop insurance was only about one percent of the total paddy lands in 2005 as reported by the (Annual Reports of AAIB). The direct focus of the Amendment to the act in 1999 Agricultural Insurance Act was making provisions for the private sector involvement in crop insurance. The results however have not been satisfactory due to the fact that there had been no entrants from private sector except for one general insurance company.

In Sri Lanka, insurance is mainly targeted at the staple crop of the country: rice. Paddy/rice insurance covers total or partial loss of yields due to flood, drought, plant diseases, pest damages, damages by wild animals. Period of insurance cover spans from planting up to the date of harvest of the crop. Coverage and premium vary depending on the risk level and the land class (as under major irrigation, minor irrigation and rain fed). Three tiers of risk exposure are classified and premium rate of low risk is set to 5% of the coverage, medium risk as 7.5% of the coverage and high risk as 10% of the coverage. Calculation of indemnity was based on cost of cultivation under each land class. Under the major irrigation schemes, insurance coverage ranged between LKR 10,000 to LKR 15,000 per acre and premium rates varied between LKR 500 to LKR 750 per acre.

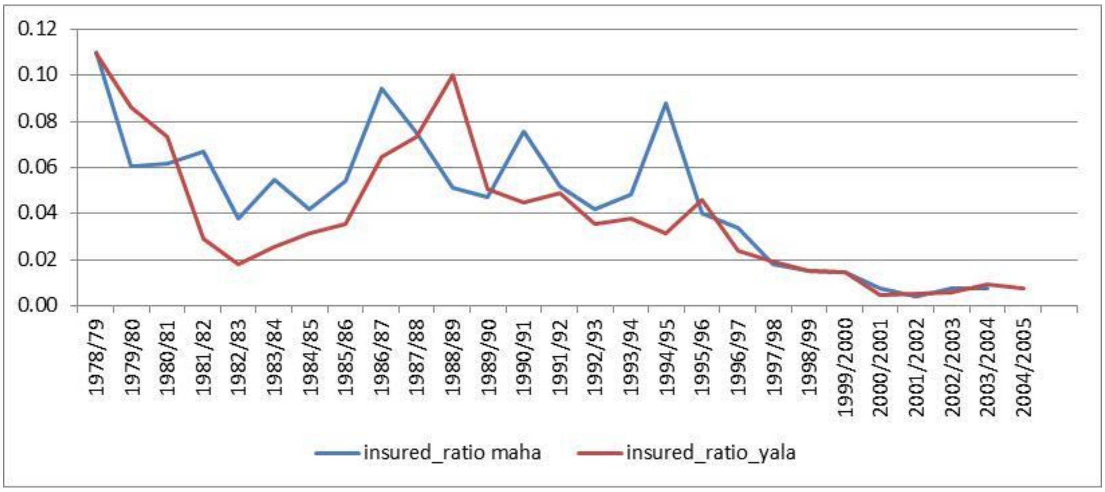


Figure 1.1 : insurance penetration (percentage of the paddy cultivated area) in two cultivation seasons: *Yala* (may to september) and *Maha* (november to february)

2. Literature Review

Crop insurance is not a new topic in the development discourse. However, insurance schemes are novel in most low income country settings owing to structural characteristics of the relevant economies. Even when insurance options are present, the uptake by poor farmers is minimal. In traditional insurance schemes aiming to cover crop losses due to climate related damages, an insured farmer receives compensation for the verifiable loss at the end of the growing season (Barnett and Mahul, 2007). The most significant downside is the verifiability and the delay in processing the claim. In a climate indexed insurance setting, the scope of insurance is certainly limited to climate induced losses compared to a general crop insurance, but there is a clear advantage with respect to verifiability and promptness of claim settlement.

Over 100 countries in the world have various types of agricultural insurance. A World Bank assessment (Mahul and Stutley 2010) regarding the extent of usage of agricultural insurance around the world, carried out in 2007, estimated that 104 countries had some form of agricultural insurance in place that year. However, the same study reports that 88 percent of the value of premiums was collected in high-income countries (mostly in North America and Europe), while lower-middle income and low-income countries accounted for only 7.5 percent. In terms of premium value by each country, USA, Canada, Mexico, and Spain dominate the global crop insurance market. In terms of premium value to farm-gate value, there is wide variation across different regional of the world: North America (69 %), Western Europe (21 %), Latin America (5 %), Asia (3 %), Australia (1%) and Africa (1%) (Roberts, 2005).

Given the inadequacy of traditional tools and clear evidence of financing gaps, one wonders as to why insurance is not adopted in agricultural sector in parallel to its extensive use in other areas of economic activity. Insurance is a market-based instrument with important economic and behavioral properties necessary to a modernized agricultural sector. For long years, the lack of adoption of insurance, especially in smallholder agriculture has been discussed as a concern which needs attention by policy and business community alike. To understand the role that insurance can potentially play in smallholder agriculture, it is crucial to consider insurance in the broader context of financial management in smallholder agriculture. The insurance markets do not function in isolation in agriculture. The role of insurance is linked to the function of credit closely. Farm households, especially smallholders do not make adequate investments due to difficult to access credit from formal institutions (i.e. banks). This in turn, limits the ability of the smallholder to link to other financial tools such as insurance. On the other hand, those who do have access to insurance are unwilling to seek credit because the collateral requirements would expose them to further risk. Thus, under-developed insurance markets are a vicious cycle of under-investment, poor productivity and rural poverty (Boucher et al. 2008).

To directly observe how farmers respond to certain changes in the design of a climate indexed insurance scheme is impossible in the rural setting even when some forms of climate insurance is in operation. The rates of adoption are low and general payout rates are high. In almost all cases these schemes function as part of a larger package of farmer support. Therefore, it is impossible to collect observational data with suitable variations in insurance contracts. As an alternative, choice experiments can be conducted to analyse preferences for hypothetical contract features.

Several examples of choice experiments have been used to examine farmer attitudes towards climate insurance in high income countries (Liesivaara and Myyrä, 2014). These studies consider the insurance premium , deductible , type of verification, level of expected indemnity as attributes. The focus on deductible is motivated by the EU legislation on caps on deductibles in the light of high subsidization of crop insurance premiums. According to the results, both the deductible and the expected indemnity had a major effect on the willingness of farmers to pay for crop insurance. Other key determinants identified in the literature include trust (Cole *et al.,* 2013), client group size effects in collective insurance purchase (Wollni and Fischer, 2015), information of payment trigger mechanism in the case of climate insurance (Elabed *et al.,* 2013).

Indexed insurance products use publicly observed and exogenous signals to provide coverage for covariate risk. Linking indemnity payments to external indicators avoids the need to verify claims, which is costly in low income farming environments. When clients are having low or modest assets as it is the case with a small-scale farmer community, the act of not linking payments to realized losses mitigates the incentive issues of traditional insurance products, i.e. moral hazard and adverse selection . Based on the above understanding, indexed based insurance is promoted in the context of small holder agriculture and fisheries.

Climate-indexed insurance as a method of mitigating production and price risk is founded on the literature on agricultural insurance. Indexed insurance has a long history in crop insurance where specific periodic drought can affect the lifecycle of the total crop. (Hill *et al.,* 2013). An indexed insurance contract makes the agreed payout to beneficiaries whenever the data source indicates that the index reaches the insurance activation level. Unlike traditional insurance, which makes payouts based on separate assessment of individual client claims, index-based insurance pays based on an external indicator that triggers payment to all insured clients within a geographically-defined space (Chantarat *et al*. 2013).

The strategy of index-based insurance has clear advantages as discussed before. However, in order to have a substantial adoption rates by smallholders, the insurance package needs to be designed in a locally-relevant and an incentive compatible manner (Marr *et al.,*2016; Wairimu *et al.,*2016*)*. Such an analysis should take into account the potential trade-offs between the attributes and levels in the eyes of the farmer. Failure of previous trials of farmer insurance is mainly due to the poor design (i.e. lack of customized packages) and targeting of the insurance schemes.

3. Methodology

Discrete choice experiments (DCE) have an analytical advantage over contingent valuation methods due the ability to quantify the utility trade-offs of the respondent between different attributes of the choice. Therefore, in order to analyze the adoption behavior of climate-indexed insurance, this study proposes the discrete choice analysis framework.

Research sites imposed on agro-climatological map of Sri Lanka

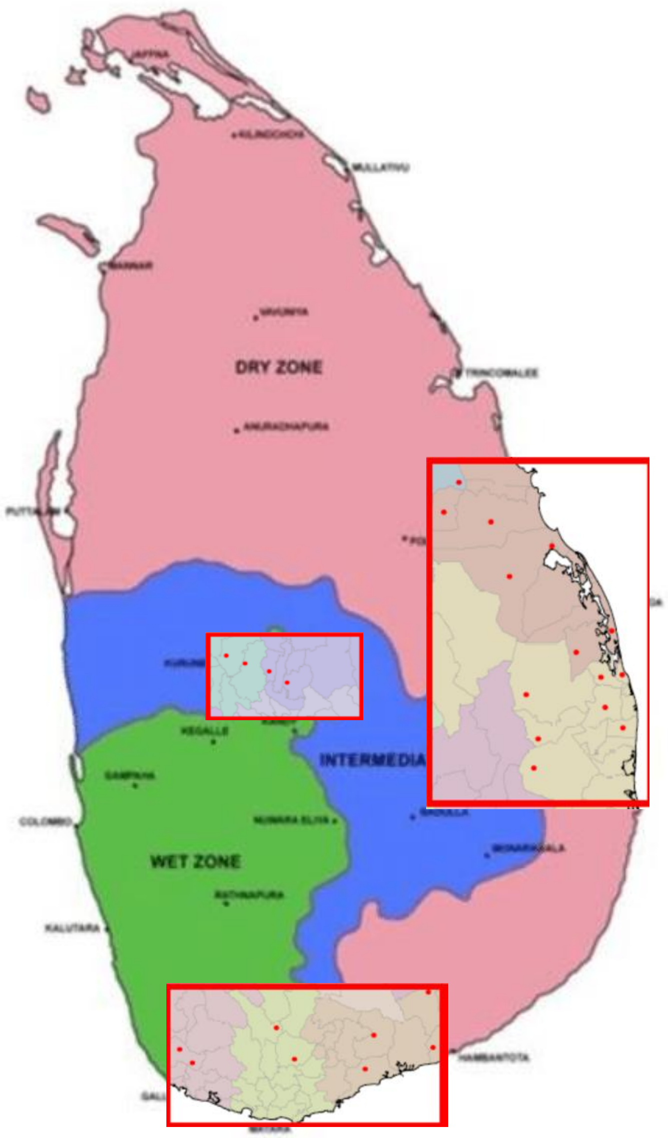


Figure 3.1 : agro climatic zones and sample distribution

In order to plan the Discrete Choice Experiment (DCE), a preliminary literature survey and a series of focused group / key informant interviews was carried out to validate the relevant attributes and their levels proposed. A key element of an index-based insurance package is the measurement of climate indicators relevant as the triggers of the payout. The sample sites for carrying out the study were chosen after considering the agro-climatology of the location and land use patterns. The following geographical locations were the primary study locations based on agro-climatology[2] and land use: Polonnaruwa, Ampara, Batticoloa, Hambanntota in Dry Zone, Matara, Kurunegala in Intermediate Zone, Galle and Matale in Wet Zone. A total sample of 300 farmers was targeted.

Four Attributes of an insurance scheme were tested in the discrete choice experiment:

a. Premium
b. Reference area for evaluating Climate /weather indicator
c. Method of calculating compensation
d. Institutional authority managing the insurance scheme

The above attributes were assigned levels based on feedback from Focused group discussions and key informant interviews. Premium was set at three levels of 200, 400, and 600 LKR. The range is motivated by the subsidized rate applicable to insurance bound to the fertilizer subsidy. There was no precedent to standard insurance premium in the Sri Lankan context. The insurance program attached to the fertilizer subsidy is active at a payment of 350 LKR and applicable for a maximum compensation up to 10000 LKR per acre.

The weather index selected was the rainfall index which is the most used indicator of claimate variability in tropical settings. The choice of levels referred to the size of the reference area for which the weather index calculated . the smallest unit was the Grama NIladari Division, corresponding the command area of the local government administrative officer. This is typically coverage of approximately 1500 individuals in Sri Lanka. In the historical social organization , this is area covered by one or two villages. The second size was the Divisional Secretary area which is an administrative service area catering to approximately 50,000 individuals. In land area, this is approximately a small township within 5-8 km from the centre . the largest reference area type is the administrative district , which has no natural or social boundary but usually comprises of around 10 DS areas within it. However, in the public administration setting of Sri Lanka , this is the functional unit for administrative and policy decisions.

A compensation determination in insurance typically follows an indemnity approach in general insurance. When index insurance is introduced , the determination of insurance has to take an alternative basis. The third attribute refers to the method of determining maximum compensation.

Final attribute considers the type of institution that is managing the indexed insurance. The levels included the government (usually the Agrarian insurance board, or the department of agrarian services), agribusiness company or the bank. The public has experience of all three parties in providing indemnity based insurance.

Experimental design included a four by three design generating 81 choice alternatives .Implementation of the experiment followed a fractional factorial design in order to reduce the cognitive burden of the respondent while maintaining adequate degrees of freedom for estimating the main effects . The number of choice scenarios was thus reduced to nine.

[2] Three main climatic zones are present in Sri Lanka, demarcated mainly based on annual precipitation: Dry Zone (less than 1000 mm); Intermediate Zone (between 1000mm and 2500mm) ; wet Zone (above 2500mm)

3.1. Sample Selection and Data collection

Farmers were selected randomly after stratifying over the agro-climatic risk exposure and crop coverage. The sample area covers paddy/rice cultivation and to a lesser degree, other field crops. The type of cropping activity was mainly categorized as annual/short term mono-crops, perennial mono-crops, and mix of crops but respondents were not targeted based on this criteria once the site was selected based on crop land use pattern.

The study considered a data collection framework covering the varying agro-climatic conditions as broadly as possible since the main objective is to test the acceptance of climate indexed insurance product with wider agro ecological relevance in terms of accuracy and farmer coverage. Therefore, a sampling procedure mainly focused on dry land short term cropping system, intermediate rain fed short term crops and wet perennials were implemented. The sample selection represented all the three main agro-climatic zones of the country.

Table 3.1: summary statistics of key variables

Variable	Obs	Mean	Std. Dev.	Min	Max
gender (female=1)	287	0.26	0.44	0	1
age	287	52.74	12.08	19	85
education level	287	3	1.02	1	6
monthly income	284	32741.37	25185.87	750	300000
acreage cropped	287	2.41	2.33	.125	15
Ownership private	287	0.79	0.40	0	1
Distance to market	244	6.45	7.97	0	60
Early planting	285	0.23	0.42	0	1
early harvesting	286	0.16	0.37	0	1
Irrigation availability	287	0.41	0.49	0	1
weather insurance knowledge	287	0.66	0.47	0	1
Insurance exposure	287	0.41	0.49	0	1
climate change impact	287	0.75	0.43	0	1

3.2. Distribution of key indicators of farmer behavior over the five agro-ecological regions in the sample

In obtaining the sample of respondents, we targeted the most dominant agro ecological regions of the country in order to be generalizable. Sri Lanka is divided into 3 climatic zones (Wet , Dry and Intermediate) and the total land area was delineated into 24 Agro ecological regions[3]. Each agro ecological region represents a particular combination of climate (mainly rainfall), soil and relief (Panabokke, 1996)[4]. We considered five of the most agriculturally dominant agroecological regions, namely DL1 and DL2 in the dry zone, IL1 in the intermediate zone and WL3, WL4 in the wet zone. The agricultural suitability of these zones lie mainly in the pattern of

[3] There was reclassification into 46 Agroeconological regions in 2003 after subdividing some of the initial agroecological regions in the 24 part classification.

[4] Panabokke C.R. (1996). Soils and Agro-ecological environments of Sri Lanka. Natural Resources Series – No 2. Natural Resources , Energy and Science Authority, 47/5, Maitland Place, Colombo 7.

precipitation and topography. DL1 and DL2 are low lying area of dry zone that receive highest precipitation. Compared to other regions of dry zone both flat topography and intense monsoon exposure enables paddy and other field crop cultivation at least in one season of the year. On the other hand , WL3 and WL4 are the drier regions of low lying lands of the wet zone. Other wet zone areas receive rainfalls exceeding the levels suitable for paddy and other field crops. IL1 , again, is the more widely spread low lying part of the intermediate zone enabling rainfall based cultivation in at least one season. The differences within are mainly differences in soil types. For instance, the difference between the DL1 and DL2 is based on soil type : DL1 is dominated by reddish brown earth and DL2 by non-calcic brown soils.

3.2.1. Adaptation behavior in terms of date of planting and harvesting

One of the noticeable examples of adaptation to climate induced shocks, mainly rainfall related irregularities, in open-field cultivation context is change of timing of planting. Further, whenever it is possible, change of timing of harvest is also practiced by certain farmers. Since these two decisions are symbolic of risk perception and adaptation, we enumerated these two decisions by agroecological region considered in the sampling methodology.

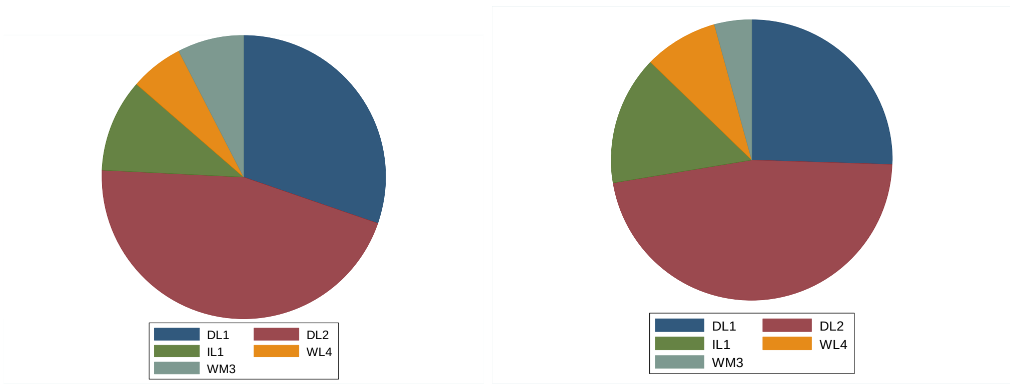


Figure 3.2: Early planting (left) and early harvesting (right) decision by agro ecology

3.2.2. Degree of resilience to climate shocks

One aspect of the perception and willingness to purchase insurance is the farmer's expectation of the recovery from a climate shock. Therefore, the survey enumerated the experience of the speed of recovery after a climate related shock. There was no visible difference between the agroecological location of the farmer and the speed of recovery from a climate related shock among farmers who declared the ability to recover within one year and farmers who declared the ability to recover within two years.

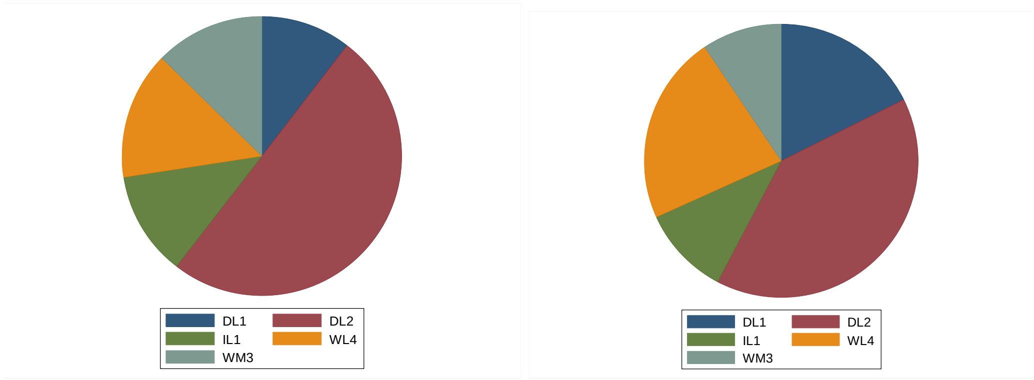
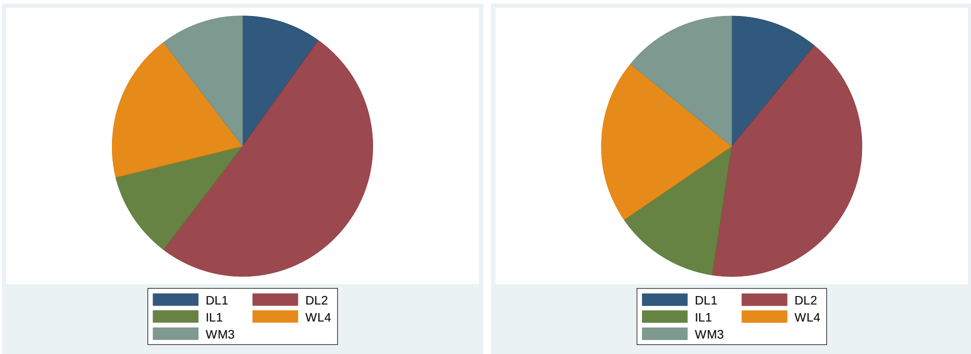
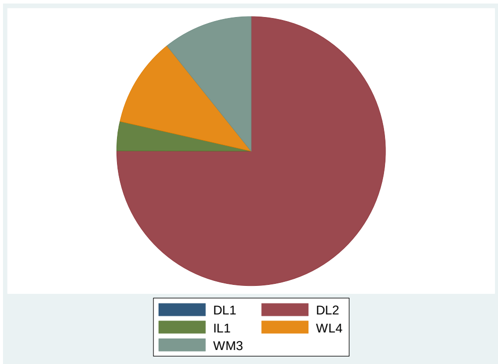


Figure 3.3: Recovery from climate related crop loss within one year (left) and between 1-2 years (right)

3.2.3. Familiarity to insurance solutions as adaptation choices



A (agricultural insurance as a priority) B (weather indexed insurance as a priority)



C (insurance as priority tool for adaptation)

Figure 3.4.: Importance of agri insurance (A), weather indexed insurance(B), and selection of insurance as priority adaptation mechanism (C) by agroecological region

4. Descriptive and Analytical results

4.1. Land use characteristics of the sample

The respondents that will potentially benefit from a risk mitigating insurance framework are predominantly smallholders which are often sidelined in terms of formal financial services. Since the sample selection was random within selected agroecological areas, we conducted an analysis to see the land holding size of the farmers who participated in the experiment. Figure 4.1a plots the distribution of acreage cultivated by farmers. Mean value of land size 2 acres.

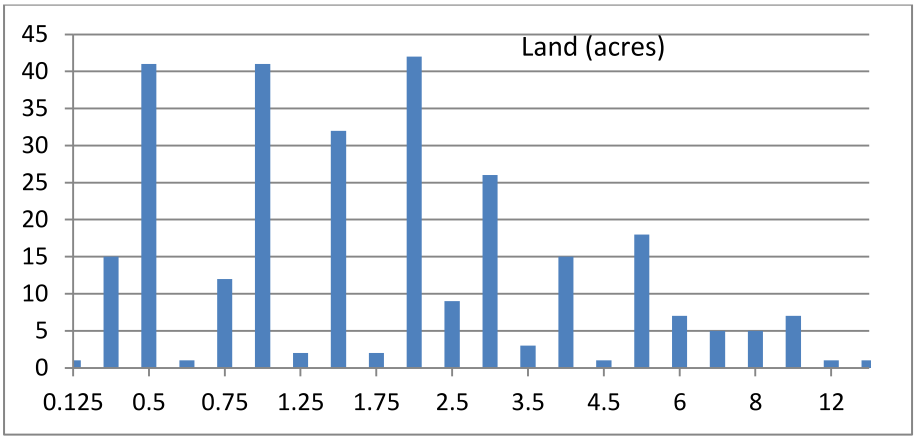


Figure 4.1a: land holding size (in acres)

The figure 4.2b looks at the mean land size by agro ecological region. The low land dry zone has mean land size of 3 acres while the mean land holding is approx. 1 ac in the intermediate and wet zone where pressure on land by other land uses are high.

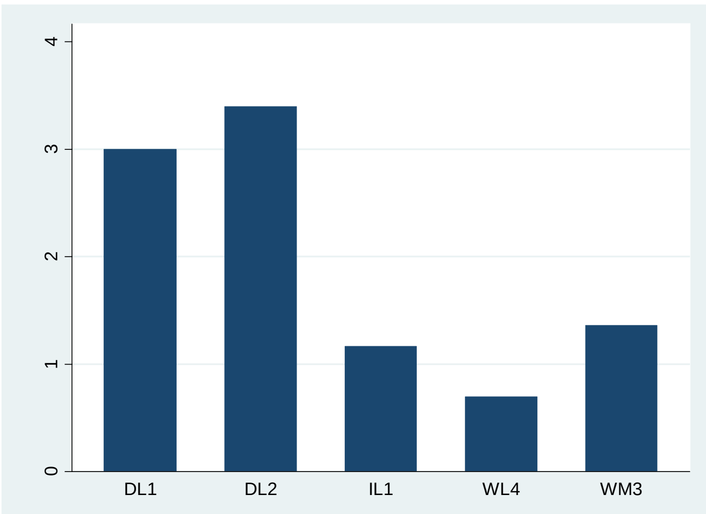


Figure 4.2b: average landing holding size by agroecological region

The land holdings referred to above were not necessarily privately –owned land. Table 4.2a displays the breakdown of ownership of the cultivated land. Majority of the farmers were cultivating their own holdings while a significant portion of the sample were either renting land or cultivating on government owned land.

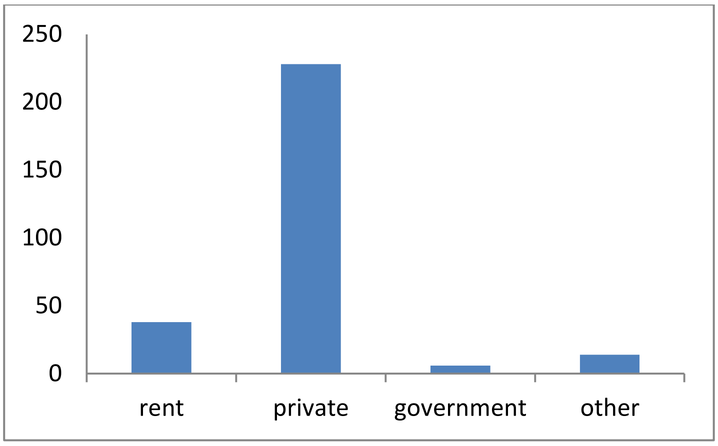


Figure 4.2a: Nature of land ownership

Similar to the observation related to the mean land holding size, we observe that higher pressure from land uses in the wet and intermediate zones has resulted in a better property rights regime in the wet and intermediate zones characterized by significantly higher incidence of private deeds on agricultural land (figure 4.2b).

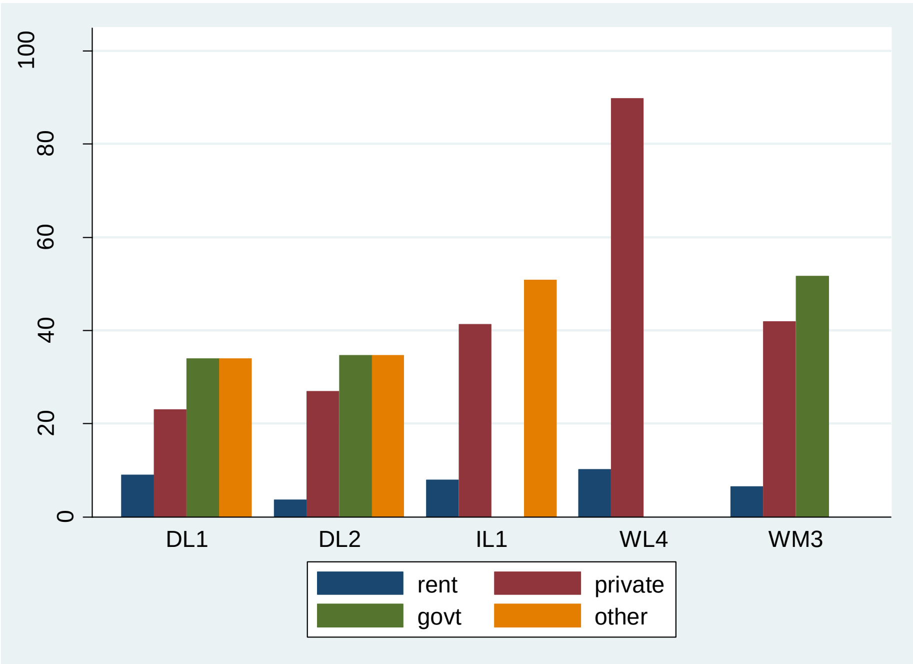


Figure 4.2b: Land ownership status by Agroecological region

A wide variety of crops cultivated were observed even though predominantly paddy cultivation was targeted by insurance schemes. Except in the Dry zone area , home garden based vegetable cultivation was observed. The crop distribution in the sample is displayed in figure 4.3.

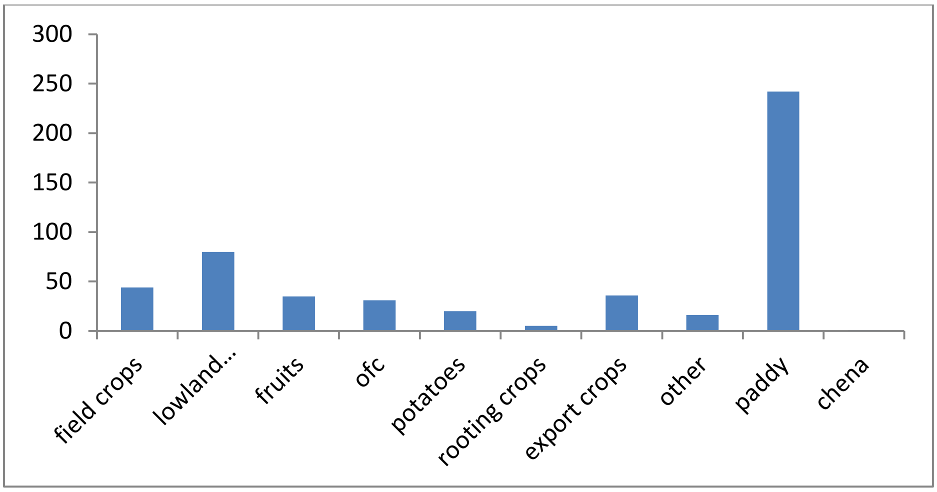


Figure 4.3: main types of agriculture activity

4.2. Socio economics of the respondent farmers

Respondents were varied in their occupational identity from fulltime farmers to part timers who were practicing agriculture as a side income generation method or as a family food support strategy. Figure 4.4 displays the time and vocational commitments of the respondents to the choice experiment.

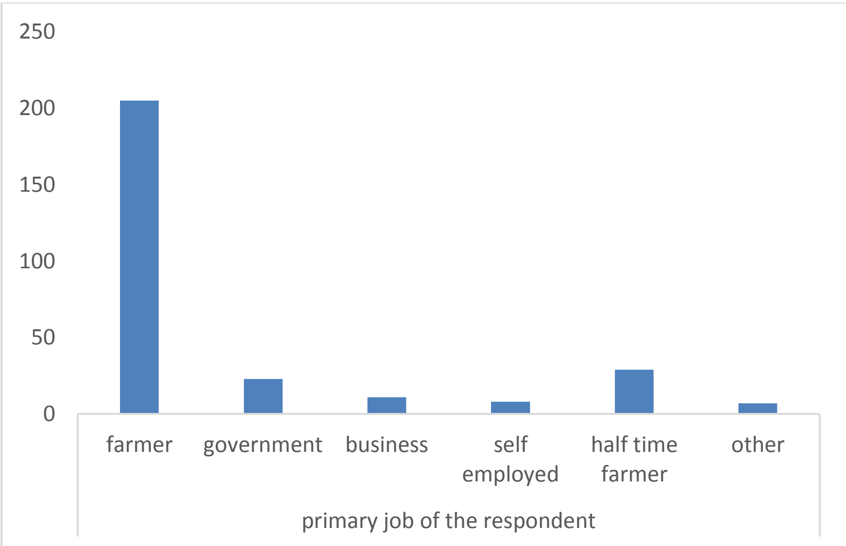


Figure 4.4: occupational identity of the sample

The household survey enumerated the agricultural income of the respondents based on self-reported values. Varying levels of income were observed with no central tendency. However 90% of the sample had a monthly income less than 50000 lkr (approx. 300 USD). Figure 4.5a displays the distribution of income in the sample.

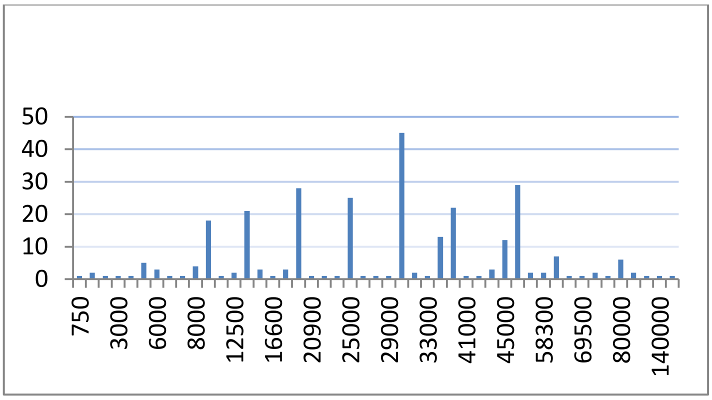


Figure 4.5a.: Monthly Agricultural Income variation among the respondents (LKR)

The survey enumerated household finances in detail by asking about incomes , expenses and savings at different points of the questionnaire. The evidence shows farming household operate on a balanced budget and managing household finances is not different across various agroecological regions. On average, dry zone farmers reported higher revenues from farming (figure 4.5b)

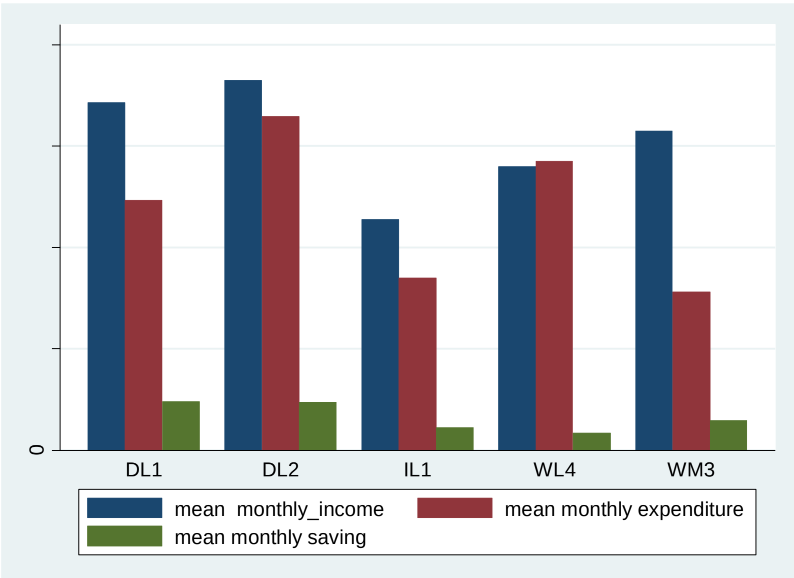


Figure 4.5b: Monthly Agricultural Income variation among the respondents (LKR)

4.3. Financial penetration

Financial exposure of the farmers is a key variable of interest to the validity and relevance of the present study. We surveyed the source of capital for agricultural investments made by each farmer. The results are summarized in Figure 4.6a. The majority used their own saving for capital needs. Second most common source were lending from banks and other financial institutions. The third category was investments made by agribusiness companies under forward contracting arrangements with the farmer. Though forward contract agreements are widely observable in the field, the evidence reveals that they do not carry a significant investment component from agribusiness company. Even when inputs are provided by agribusinesses, it is on credit basis which is eventually recovered by the firms. Therefore, the forward contracts are largely produce buying agreements for farm output.

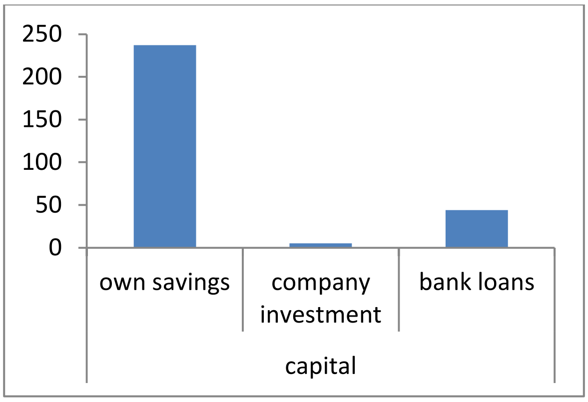


Figure 4.6a : Source of funds for agricultural investment

When we disaggregate the source of funds by agroecological zone (figure 4.6b), agribusiness investments are exclusively observed in the dry zone setting . In wet and intermediate zones , own capital and loans are the main sources.

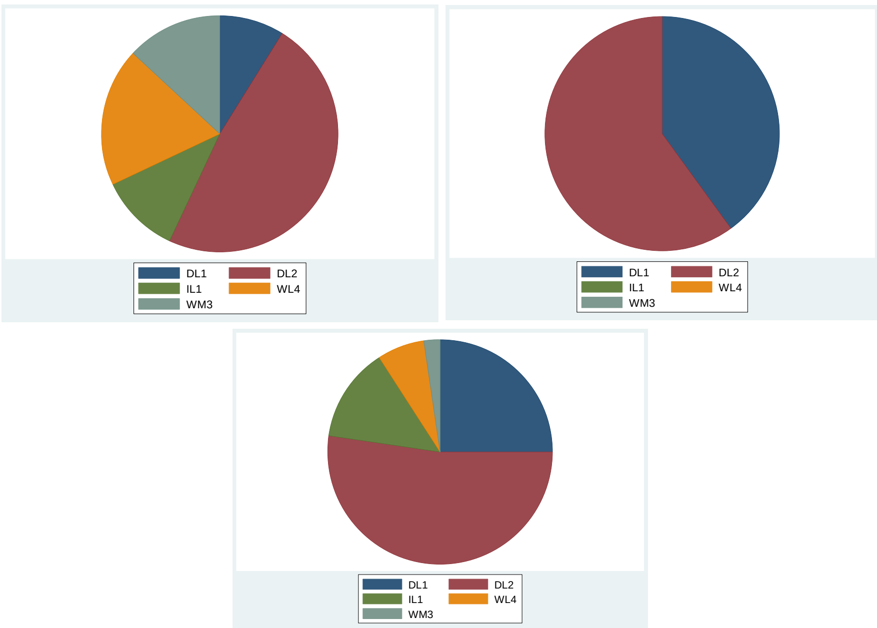


Figure 4.6b :Capital from savings (upper left), agribusiness company investment (upper right), loans (lower) by ag ecological region

Next, we looked into the variation (Figure 4.7) in levels of savings to obtain an understanding of depth of capital generated. There was wide variation but the almost all annual savings were below 250,000 LKR (approx 1600 USD).

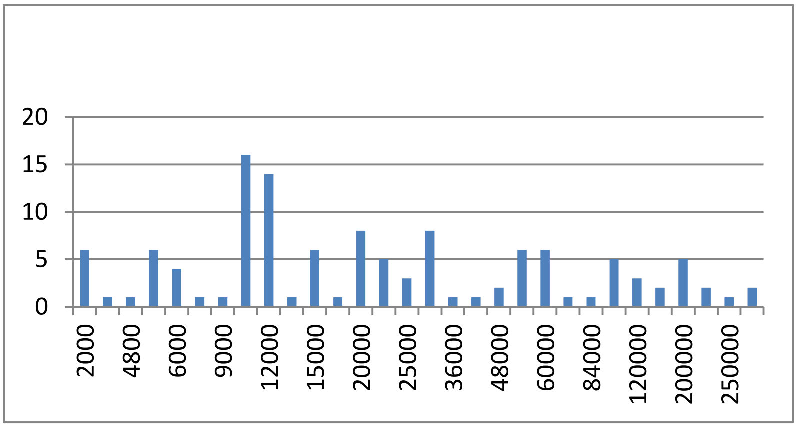


Figure 4.7 : variation of savings levels among respondents (LKR)

4.4. Exposure to insurance

The household survey specifically enumerated the penetration of agricultural and general insurance in order to evaluate the financial literacy of the respondents in terms of the ability to easily comprehend the nature of a proposed insurance scheme. Figure 4.8 shows the prevalence of life insurance in the sample, followed by coverage of other types of insurance (figure 4.9).

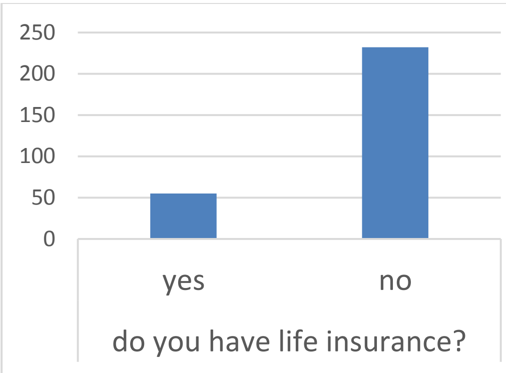


Figure 4.8: exposure to life and health insurance

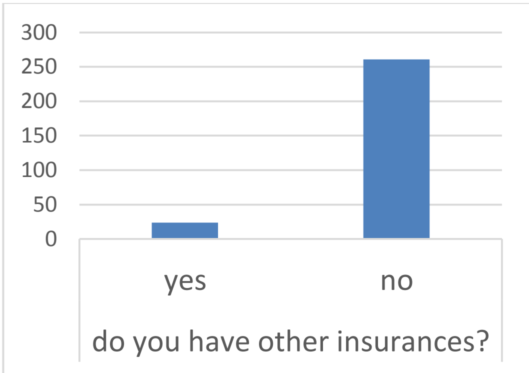


Figure 4.9: exposure to other insurance

While a majority of the sample claimed lack of experience with insurance, a substantive proportion of the sample agreed that agricultural insurance was important in their opinion. (figure 4.10).

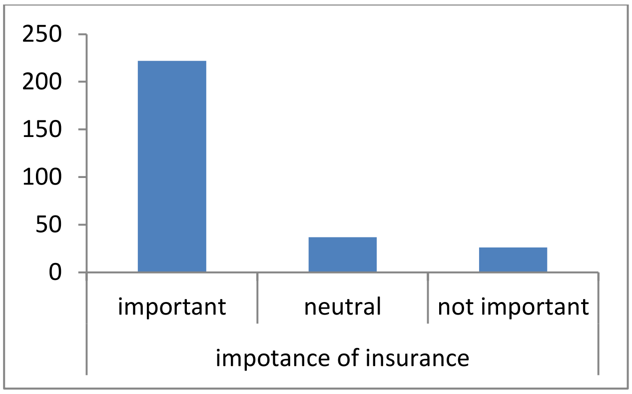


Figure 4.10: Attitude and opinion on the importance of agricultural insurance

4.5. Agricultural Risk Perception and preferences for adaptation

As was planned in the study design , we attempted to capture a representative sample that includes all types of farming settings varying across different types of water availability. The three main agricultural water sources (namely, large tanks, village tanks, rain-fed) were equally distributed among the respondents (Figure 4.11). Given the balanced exposure to water availability seen in figure 4.11, we enumerated the perception of farmers towards to adaptation to climate related risks giving several options to choose as relevant to their own circumstances.

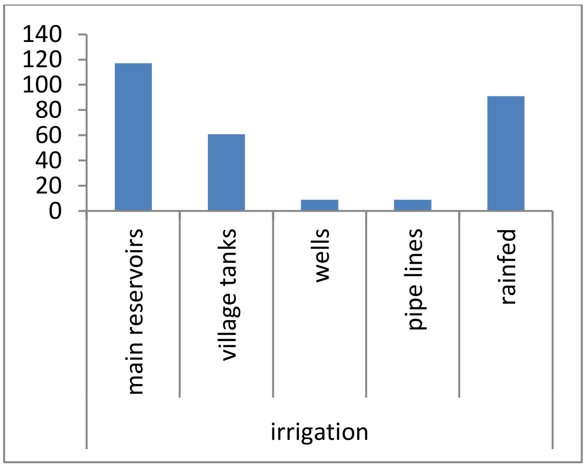


Figure 4.11: variation in water availability by source

The four optional paths to adapt to climate risk listed in the survey were choosing crops with low irrigation needs, short term crops, efficient irrigation technologies, and finally the option of insurance purchase to cover the risk. The sample was dominated by preferences for all the four types, however the preference for insurance was the least frequent choice. (figure 4.12). We further assessed how each farmer obtained information on adaptation methods in the event of floods and droughts to shed further light on their preference for adaptation instrument. In this instance four options were given to choose from, namely, changing the crop, early or late crop establishment, consulting farmer organization (FO) and consulting field extension officers (see figure 4.13). Responses indicate that all these options are equally significant among the respondents.

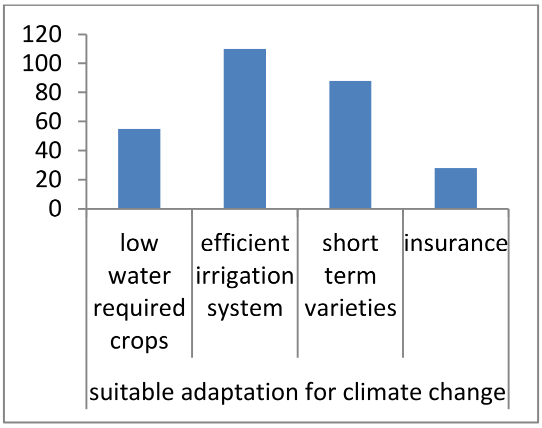


Figure 4.12: preference for adaption instruments

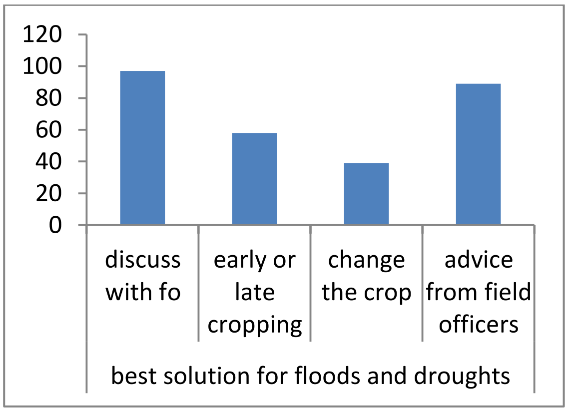


Figure 4.13: preference for adaption instruments

4.6. Estimates from the Discrete Choice Model

Table 4.14 outlines the conditional logit model results for choice data. The village is the base level for spatial reference are for the climate index. Accordingly, data supports a negative willingness by farmers for weather indices benchmarked at larger administrative areas, namely divisional secretary area and district boundary. In terms of management of insurance scheme there is overwhelming support for government managed programs (base preference) against private company or commercial bank managed schemes. In terms of how the compensation is calculated, the respondents have negative wiliness for fixed compensation schemes (where the maximum payout is predetermined or fixed at the beginning of the contract) . However, there is statistically significant positive willingness towards a potential (or forgone) revenue-based compensation scheme. The base choice level for the analysis for this attribute was the compensation calculation based on cost of inputs. We obtain estimates for rate of premium which is significantly negative, indicating the expected sign for the price attribute.

Table 4.14: results of the conditional logit estimation

	coef	se(coef)	Z	p
Alternative Specific Constant	4.181	0.310	13.470	< 2e-16
Index reference-Divisional secretary area	-0.673	0.205	-3.280	0.001
Index reference-District area	-1.872	0.287	-6.520	0.000
Bank managed scheme	-0.111	0.196	-0.570	0.571
Company-managed scheme	-1.041	0.146	-7.120	0.000
Revenue-based compensation scheme	0.324	0.146	2.220	0.026
Fixed compensation scheme	-0.416	0.111	-3.730	0.000
Price/Premium	-0.001	0.001	-1.900	0.058

Table 4.15 outlines the marginal willingness to pay values estimated for each of the above levels calculated in terms of LKR. The calculations refer to the base scenario of village level indexed, government managed, cost based compensated scheme.

Table 4.15. Marginal WTP calculated

	Marginal WTP (in LKR)
Index reference-Divisional secretary area	-678.9
Index reference-District area	-1889.1
Bank managed scheme	-112.2
Company-managed scheme	-1050.5
Revenue-based compensation scheme	326.9
Fixed compensation scheme	-420.1

The attribute level choice probabilities were calculated based on the responses generated in the experiment. Leaving out the base levels of each attribute, figure 4.16 displays the partial probabilities of selection or rejection. The selection probabilities highlight the divergence of preference for certain attribute level vis-a-vis others. For instance, the preferences for private company managed insurance diverge significantly whereas insurance managed by a bank is nearly equally preferred and rejected by the respondents. Similarly, farmer preferences for compensation based on inputs /outputs and for indices based on small local administrative reference area are significantly higher according to the probabilities.

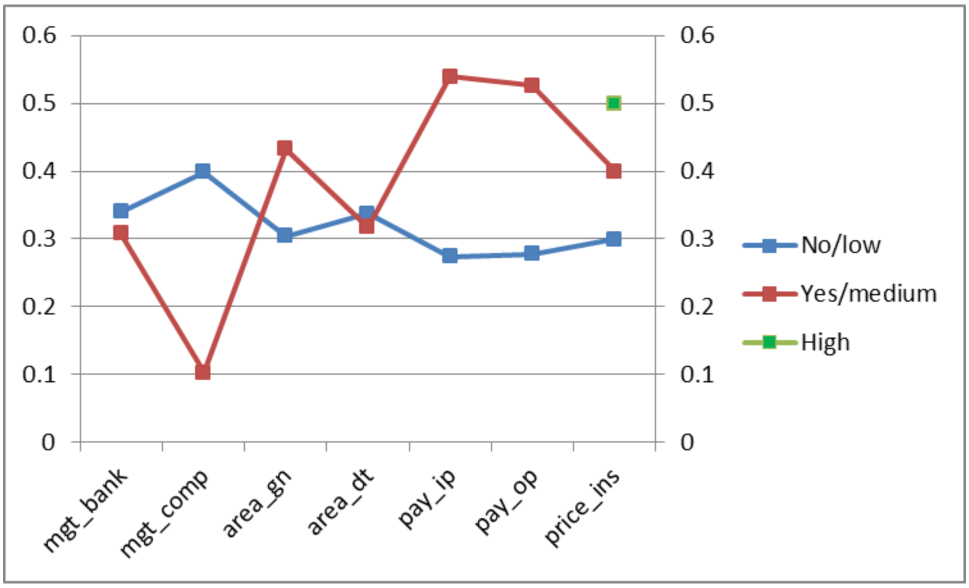


Figure 4.16: relative probabilities for levels of attribute variables in the mixed logit model (base levels of categorical variables are omitted)

4.6.1. Farmer specific variables and attribute choice

In this section, we look at the multinomial choices of each level of the attribute in terms of the predictive relationship to farmer specific variables. The objective of the analysis is to identify the farmer specific variables that significantly associate with the preference of each level of the attribute. We discuss only the statistically significant results. With respect to demographics on the choice of institution managing the indexed insurance, females have a negative preference for agribusiness company. The aged and the more educated have a negative preference for agribusiness company administration. In contrast, high income farmers have a negative preference to the government and the bank administrated option. Acreage of the farm and distance of the farmer to the market do not display any significant association to the choice of an institutional type (table 4.17) .

Table 4.17. :Logit estimates of respondent specific variables on insurance management framework

	(1) mgt_government	(2) mgt_bank	(3) mgt_company
Gender(female=1)	-0.085	-0.166^{*}	-0.169
Age	-0.001	-0.002	-0.019^{***}
education	0.009	-0.020	-0.103^{**}
monthly_income	-0.001^{**}	-0.001^{**}	0.000
acres	0.011	-0.013	-0.038
distance	-0.005	0.004	-0.007
N	2187	2187	2187
ll	-1.5e+03	-1.4e+03	-957.281

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

The second set of attribute levels relate to the choice of admin area for measurement of the climate index. For disaster management purposes the government uses the administrative district as the relevant unit. District is considerably large , sometimes, spanning over 2500sq km. (Sri Lanka is divided into 25 admin districts over a total country land area of 65610 sq km). The respondents were given a choice of District boundary, DS boundary (approx. 10 DS areas constitute a District) or the GN boundary (this is the smallest administrative unit and approximately five GN divisions make a DS division). In terms of partial coefficients of logistic model , the negative preferences for District as reference area for climate index measurement by females are distinctly observable. There were no positive coefficients with reference to area boundaries with respect to farmer specific factors. Higher acreage is associated with preference for DS division but the coefficient is not statistically significant. Similarly, the more distance the farmer is from the market, there is higher preference for the small local area of GN division but the coefficient is not significant.

Table 4.18 :Logit estimates of respondent specific variables on index area coverage

	(4) area_GN division	(5) area_DS_division	(6) area_DISTRICT
Gender	-0.022	-0.121	-0.313***
Age	-0.007**	-0.006*	-0.005*
Education	-0.043	-0.010	-0.047
monthly_income	-0.000	-0.001*	-0.000
Acres	-0.005	0.002	-0.030
Distance	0.004	-0.005	-0.006
N	2187	2187	2187
Ll	-1.4e+03	-1.4e+03	-1.2e+03

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Third attribute is on how the compensation is calculated. The levels that were stated varied from fixed rate, input cost based compensation and output price based compensation. Significant negative preference relationships from farmer specific variables were recorded for fixed payout option.

Table 4.19: Logit estimates of respondent specific variables on compensation method

	(7) Fixed payout	(8) Input cost based payout	(9) Output price based payout
Gender	-0.232**	-0.101	-0.111
Age	-0.007**	-0.005*	-0.005*
Education	-0.049	-0.022	-0.026
monthly_income	-0.000	-0.001*	-0.000
Acres	-0.072***	0.007	0.021
Distance	0.002	0.000	-0.008
N	2187	2187	2187
Ll	-1.2e+03	-1.4e+03	-1.4e+03

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Relationship of farmer specific variables on the premium was also investigated . The logit model estimates reveal that with higher education the willingness to pay premium increases while the same declines with higher monthly income of the farmer.

Table 4.20: Logit estimates of farmer specific variables on premium

	(10) Insurance premium

Gender	-0.017
Age	0.005
Education	0.080**
monthly_income	-0.001***
Acres	-0.020
Distance	0.007
N	2187
Ll	-2.8e+03

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A second series of logistic models were estimated to see the connection between management decisions of the respondent and the attribute level preferences. Similar to the previous analysis, we regress attribute levels using a set of variables regarding the management practices of the farms. The variables considered include incidence of subsidies to the farm, private ownership of land, reported early planting and early harvesting decisions, familiarity with government insurance scheme for paddy, stated choice of percentage of subsidy for Insurance premium, incidence of output losses attributed to climate change impact.

Table 4.21 lists partial coefficients of the above variable on type of insurance administration preferred. The statistically significant relationships are as follows. The subsidy recipients dislike agribusiness company managed insurance but prefer bank managed schemes. Private land owning farmers show aversion to the government and agribusiness companies. Previous familiarity with government managed insurance has a positive association to a private company management. Farmers who have reported climate change related losses prefer government managed insurance programs.

Table 4.21:Logit estimates of farm management decisions on insurance management

	(1) mgt_government	(2) mgt_bank	(3) mgt_company
Subsidies receipt	0.058	0.209*	-0.383**
Ownership_pvt	-0.629***	-0.278	-1.850***
Early_planting	-0.043	0.102	-0.015
early_harvesting	0.006	-0.058	-0.099
Familiarity (govt_ins)	-0.110	-0.242*	0.376*
Insurance_subsidy_%	0.055	-0.024	-0.000
loss_cc_impact	0.274**	-0.184	0.032
N	1836	1836	1836
Ll	-1.3e+03	-1.2e+03	-822.738

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Regarding the preference for size of reference area for index measurement, none of the above variable displays interesting relationships. Estimated coefficients are displayed in table 4.22.

Table 4.22:Logit estimates of farm mgt decisions on index coverage area

	(4) area_GN division	(5) area_DS divisoin	(6) area_DISTRICT
Subsidies receipt	0.046	-0.023	0.034
Ownership_pvt	-0.458**	-0.961***	-1.082***
Early_planting	0.037	0.036	-0.038
early_harvesting	0.007	-0.103	-0.015
Familiarity (govt_ins)	-0.203	0.037	0.006
Insurance _subsidy_%	-0.013	0.045	0.004
loss_cc_impact	0.076	0.062	-0.006
N	1836	1836	1836
Ll	-1.2e+03	-1.2e+03	-1.0e+03

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Farmers who want a higher rate of premium subsidy distinctly prefer fixed payouts and private land owners show negative preferences for all suggested the compensation calculation methods. (table 4.23.)

Table 4.23 :Logit estimates of farm mgt decisions on method of compensation and premium

	(7) Fixed payout	(8) Input cost based payout	(9) Output price based payout
Subsidies receipt	-0.073	0.083	0.033
Ownership_pvt	-1.382***	-0.549**	-0.628***
Early_planting	0.158	0.021	-0.120
early_harvesting	-0.046	-0.098	0.033
Familiarity (govt_ins)	-0.028	-0.196	0.055
Insurance _subsidy_%	0.098**	-0.014	-0.031
loss_cc_impact	-0.089	0.164	0.048
N	1836	1836	1836
Ll	-1.1e+03	-1.2e+03	-1.2e+03

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.7. Limitations

Marginal willingness to pay results reveal a potential issue regarding the structure of the levels of premium. Except for the input cost based, output price based compensation, attribute levels have negative willingness to pay..

The price attribute were given equally spaced levels of 200, 400 and 600 at the outset. However, during the course of the study , a country wide policy was introduced to cover paddy lands for a compensation of 40,000 LKR per acre for a subsidized premium of 650 LKR. Since this was widely advertised , the relevance of the range of premiums that were incorporated in the choice experiment may not have had a significant impact in the farmers decisions on the cost of insurance. It is difficult to conclude that the range of levels was redundant given the fact that there is very low penetration of insurance, but the cognitive response to the value posted in the experiment may not have communicated a significant trade-off among the three levels.

5. Conclusions and implications.

Given the current lack of understanding on why uptake of insurance is poor or why there is a lock of supply of insurance products targeting climate risks in Agriculture, this study contributes to empirical evidence on factor determining choices and utility associated with climate-indexed insurance in the context of small-holder faming. It sheds light on the key factors that determine such adoption in terms of behavioral and socio-demographic characteristics.

Smaller administrative division (in contrast to larger administrative boundaries) is preferred by respondents as reference area for weather-index calculation. Government (vis-à-vis the bank and the agribusiness company) is preferred as the management authority. The revenue-based compensation approach (vis-à-vis cost-based approach and fixed compensation) is statistical significantly preferred as the method of calculating compensation.

The average negative marginal willingness-to-pay (MWTP) for medium and larger reference areas are -678 and -1,889 LKR (1USD=150LKR) respectively. The MWTP for insurance administered by a private company is -1050 LKR. The MWTP for a revenue-based approach is 326 LKR and the MWTP for the currently-practiced fixed compensation schemes is -420 LKR.

Given the limitations on liquidity of farmer finances in the event of climate-based disasters, the introduction of appropriate insurance tools would help mitigate short-term liquidity issues. The credibility of indemnity-based insurance, which is the conventional type of insurance, has long suffered due to lapses in damage assessment and timeliness of compensation payment. The weather-indexed insurance provides a viable alternative if targeted using above willingness to pay estimates.

6. References :

- Barnett, B.J. and Mahul, O., 2007. Weather index insurance for agriculture and rural areas in lower-income countries. American Journal of Agricultural Economics 89(5), 1241-1247.
- Boucher, S., Carter, M. and C. Guirkinger. 2008. Risk Rationing and Wealth Effects in Credit Markets: Implications for Agricultural Development. American Journal of Agricultural Economics 90 (2): 409–423.
- Chantarat, Sommarat, Andrew G. Mude, Christopher B. Barrett, and Michael R. Carter. 2013. "Designing index-based livestock insurance for managing asset risk in northern Kenya." Journal of Risk and Insurance 80, no. 1: 205-237

- Cole, S., Giné, X., Tobacman, J., Topalova, P., Townsend, R., Vickery, J., 2013. Barriers to household risk management: Evidence from India. *American Economic Journal: Applied Economics* 5(1), 104-135.
- Elabed, G., Bellemare, M.F., Carter, M.R., Guirkinger, C., 2013. Managing basis risk with multiscale index insurance. *Agricultural Economics* 44(4-5), 419-431.
- Glauber, J. W., Collins, K. J., & Barry, P. J. (2002). Crop insurance, disaster assistance, and the role of the federal government in providing catastrophic risk protection. *Agricultural Finance Review*, *62*(2), 81-101.
- Hill, Ruth V., John Hoddinott, and Neha Kumar. 2013 "Adoption of weather-index insurance: learning from willingness to pay among a panel of households in rural Ethiopia." Agricultural Economics 44.4-5 : 385-398.
- Kerer, Jan (2013) Situation of Agricultural Insurance in Kenya with Reference to International Best Practices, GIZ/ MoA (ACCI), Nairobi, 2013.
- Liesivaara, P. and Myyrä, S. 2014. Willingness to pay for agricultural crop insurance in the northern EU. *Agricultural Finance Review* 74(4), 539-554.
- Marr, A., Winkel, A., van Asseldonk, M., Lensink, R. and Bulte, E., 2016. Adoption and impact of index-insurance and credit for smallholder farmers in developing countries: A systematic review. Agricultural Finance Review, 76(1), pp.94-118.
- Mahul, O. and Stutley, C. J. (2010): Government support to agricultural insurance: Challenges and options for developing countries. Washington DC: World Bank.
- Panda, A., Sharma, U., Ninan, K.N. and Patt, A., 2013. Adaptive capacity contributing to improved agricultural productivity at the household level: empirical findings highlighting the importance of crop insurance. Global Environmental Change, 23(4), pp.782-790.
- Roberts, R. A. (2005). *Insurance of crops in developing countries* (Vol. 159). Food & Agriculture Organization.
- Sandaratne, N., (1974), "Using Insurance to Reduce Risks in Peasant Agriculture", The Agricultural Development Council, U.S.A.
- Tadesse, M.A., Shiferaw, B.A. and Erenstein, O., 2015. Weather index insurance for managing drought risk in smallholder agriculture: lessons and policy implications for sub-Saharan Africa. Agricultural and Food Economics, 3(1), p.26.
- Wairimu, E., Obare, G. and Odendo, M., 2016. Factors affecting weather index-based crop insurance in Laikipia County, Kenya. Journal of Agricultural Extension and Rural Development, 8(7), pp.111-121.
- Wollni, M. and Fischer, E., 2015. Member deliveries in collective marketing relationships: Evidence from coffee cooperatives in Costa Rica. *European Review of Agricultural Economics* 42(2), 287-314.
- Yamauchi, Toyoji. 1986. Evolution of the Crop Insurance Program in Japan. In P. Hazell, C. Pomerada, and A. Valdez, eds. Crop Insurance for Agricultural Development: Issues and Experience. Baltimore: Johns Hopkins University Press: pp. 223 –239.