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COMPREHENSIVE RISK COVER THROUGH REMOTE SENSING TECHNIQUES IN AGRICULTURE INSURANCE FOR DEVELOPING COUNTRIES: A PILOT PROJECT

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ABSTRACT

The paper observes the feasibility of implementing area yield insurance and weather insurance schemes for transferring financial risk and managing production risks. It is believed that these index based schemes are much more efficient than earlier indemnity based insurance schemes. However, implementing both area yield as well as weather index insurance face the huge challenge of inherent risk involved in these mechanisms. The objective of this study included developing a composite insurance product based on NDVI and weather indices via a participatory approach; testing the yield loss estimation accuracy of such a product; and understanding people`s perceptions about the performance of the product. We chose a non-experimental research design and offered the product commercially without popular treatments like issuing of discount coupons. To gain the maximum possible knowledge from the study, the product was offered in regions with great variations in their demographic and geographical characteristics. Despite low sales volumes and weak statistical validity, the inputs gathered from the farmers during the post claims discussion, and the data collected from the limited survey are in sync with the findings from previous studies in the space of weather index insurance conducted in India. A relationship was found between the uptake of insurance and being Above Poverty Line (APL), subject to the buyer having heard about the insurer earlier, expecting a bad cropping season ahead, and having a close friend who has availed of the insurance scheme. To our dismay, very few farmers understand that the product was based on an aerial survey through satellites. Further, many raised concerns about the validity of the claim calculations, since unlike weather insurance, the underlying index was not certified by any government agency. It should be noted that to our knowledge this is the first scheme in India where NDVI and rainfall index were combined. It should also be noted that the product is based on a simple linear regression analysis applied on a limited data set and could be much more accurate if more data on crop yield and corresponding NDVI is available.

INTRODUCTION

With only 52% of the cultivable land being irrigated, a considerable portion of the Indian agriculture sector is dependent on highly erratic monsoons. Weather variations have historically had a calamitous impact on agriculture production. Such unpredictability restricts the agriculture sector players (individuals, corporate agencies, cooperatives, etc.) from planning ambitious ventures, and it limits most of their activities to irrigated geographies (or to areas with less weather variations, or those with sophisticated risk reduction infrastructure).

Since a majority of households in the lowest income quintile are dependent on agriculture, and as the agriculture sector is exposed to various risks, a reliable risk management system would be an important catalyst for the wide spread agri-value chain based models in India. Even the National Agriculture Policy of India (2000) says that "*An endeavour will be made to provide a package insurance policy for the farmers - right from the sowing of crops to post harvest operations including market fluctuation in the price in*

[1] Mangesh was a consultant at Centre for Insurance and Risk Management, Institute for Financial Management and Reseasrch, Chennai.

the agriculture policy". In this paper, we describe our experiences of launching a satellite data based crop insurance scheme as an effort towards having better risk management systems in place. We discuss the experiences we had with various stakeholders for understanding the uptake issues, and in developing an index based agriculture insurance product using satellite imagery. We also discuss the potential accuracy of such products in comparison with the prevalent weather insurance products. Due to the very nature of the pilot, the discussion is specific to the Indian context. But we hope that the learning will prove useful for similar efforts in developing countries across the world.

The various sections in this report discuss the drawbacks of traditional crop insurance in India, the fundamentals of vegetative indices, the broad goals of the project, and methodologies to achieve them. The key outcomes of the effort and the way forward are discussed at the end.

CURRENT INDIAN CROP INSURANCE SITUATION

Crop insurance has existed in India for the past 36 years, and has grown substantially in terms of area covered and perils insured. An account of various insurance schemes implemented in India till date is given in Annexure 1 of this report[2]. Before discussing the pilot insurance product – which is the central topic of this paper - it would be appropriate to first understand why such a scheme is needed at all. Hence we first discuss the challenges in the major agriculture insurance schemes running in India currently, i.e. NAIS and weather insurance schemes.

[2] Based on: Kelkar Ulka, "Adaptive Policy Case Study: Weather Index Insurance for Agriculture in India", Climate Designing Policies, International Institute of Sustainable Development

NATIONAL AGRICULTURE INSURANCE SCHEME (NAIS)

NAIS depends largely on area yield index method for indemnity assessment, except for localized events like hailstorms. The main drawback of this scheme is the fact that the settlement of claims happen through a manual process called Crop Cutting Experiments (CCE) where yield measurements of sample plots need to be done. It is easy to influence or tamper with the results of such experiments. The process of CCE itself is cumbersome and involves huge administrative costs. At times it is possible that the selected sample plots might not represent the overall yield in the given administrative areas[3]. The implementing government agencies have to ensure that the crop cuttings are done at the time of the harvesting which gives rise to monitoring issues. Many times, if the crops are exotic, the population plots themselves could be very small in number, causing a possibility of skewed results. Further, compiling the results of CCEs could be a lengthy procedure and hence the settlement of claims is time consuming – which could be the biggest concern of the farmers with limited liquidity. NAIS also does not score well on the product design front. Though the scheme is envisaged to have actuarially fairer premiums than the earlier insurance schemes, the product relies on the losses incurred in the limited past few years, which has resulted in huge loss ratios, failing to qualify as a financially viable initiative[4]. Naturally NAIS has invited wide criticism and recently a Modified NAIS has been formulated and is planned to be piloted in fifty districts from the Rabi season of 2010-11[5]. In fact this scheme would make available the crop cutting experiments data to the insurers thereby enabling them to venture into area yield index insurance.

[3] The administrative areas are different in different states. One can safely assume that the bigger the area, the bigger is the basis risk faced by the farmers.

[4] Raju SS and Chand Ramesh (2008)

[5] http://www.theindiapost.com/delhi/modified-national-agricultural-insurance-scheme-mnais-approved

WEATHER INSURANCE

As a result of the above described problems in the NAIS, Indian insurers had been looking for an alternative solution which was found in the form of weather index based insurance schemes. In 2003, ICICI Lombard launched the first weather insurance policy in India. Consequently, ITGI and AIC also started to underwrite such policies. It should be noted that claim settlement in weather contracts are based on the parameters recorded at the respective weather stations. Due to this point based nature[6] of weather index insurance, it is essential to have a large number of weather stations for a large area of contract. In reality, poor weather infrastructure has been one of the biggest issues in developing weather insurance contracts in India, as in other developing countries. The density of weather stations in India is low with few private players active in this business. Further most of the older weather stations are owned by public institutions. Though many of them are automated now, most of the historical data has been collected through a manual process and is in the form of hard copies. This gives rise to issues like missing data, inaccuracies, etc. which forces the insurers and reinsurers to add huge uncertainty loading, making the premium prices unaffordable to the farmers. Further, some publicly owned measuring instruments are not capable of recording parameters beyond rainfall. This restricts insurers from designing better indices comprising of parameters like temperature, sunlight, frost, humidity, etc.

When we discuss insufficient weather infrastructure, a discussion on **basis risk** is inevitable. Basis risk relates to the difference between loss estimation and actual loss. It arises due to two reasons – *firstly due to insufficient correlation between modeled weather indices and actual loss, and then due to the distance of the affected farm from the actual weather station*. Unless other factors like soil type, inclination of the land, etc. are considered, the first issue cannot be resolved. With regards to the second issue, a thumb rule followed in the industry is that good weather contracts can be written for places which are within a 20 km radius of a weather station. However, there are many instances where weather contracts are written neglecting this rule. Further, in many places, due to unavailability of older data, pricing of the contract is done as per readings taken from the nearest old weather station[7], and claim settlement is done based on data from the new weather station. To take into account potential inconsistencies in such contracts, insurers and reinsurers end up hiking their prices by adding up loading. This ultimately affects affordability of weather insurance products – the customers of which are usually from the farming community, mostly owning only a few acres of land. As a result, the Indian government is now extending premium subsidies to weather index insurance schemes as well.

It should be noted that in weather index insurance, assessment of weather – which is an agri-input – is done whereas in area yield index insurance assessment of output is carried out. The potential basis risk in area yield insurance can be much lower if the sampling of fields and yield measurements at sample plots are carried out efficiently. This is where remote sensing techniques and satellite imagery can make a difference.

[6] To elaborate what we mean by 'point base nature', the weather contracts are written around a specific weather station. As the distance from a weather station increases, the accuracy of weather data decreases. Thus weather data for a particular region captured by a single weather station is not uniform, and is rather point based.

[7] The practice of estimating weather parameters at a particular location based on the readings from nearby weather stations is known as *kriging*. For more information, refer to Bohling (2005).

APPLICATION OF REMOTE SENSING IN CROP INSURANCE

Reflective remote sensing is the process of obtaining information about an object, which is not in direct contact with the sensor, using the rays reflected from the object. The wavelengths representing the rays could be either in the visible region or in the infra-red region. The process is quite objective in nature, and the data obtained is quantitative. Therefore indices can be developed to observe certain characteristics of remotely sensed objects.

VEGETATION INDICES

Reflective remote sensing could be used for various applications. Vegetation monitoring is one such application. There is an increasing body of knowledge on vegetative indices and their applications in studying agro-ecosystems. In the Indian context, Dadhwal[8] discusses the concept of vegetative indices based on satellite images for tracking crop growth. Normalized Difference Vegetative Index (NDVI) is one such index, calculated using a linear combination of Red and Near Infra Red (NIR) frequency rays emitted through remote sensors[9]. Healthy vegetation absorbs most of the visible light that hits it, and reflects a large portion of the NIR light. Unhealthy or sparse vegetation reflects more visible light and less NIR light. Such reflected light can be measured using satellites like LANDSAT, SPOT, IRS, etc through multi-spectral sensing. NDVI highly correlates with the overall chlorophyll concentration and temporal changes in vegetation and the NDVI values can indicate the status of crop growth. Crop growth is ultimately an indicator of overall productivity from that crop and hence NDVI can be used to indirectly measure productivity of the given crop. This concept can be extended for insurance applications. In a crop insurance contract which uses such indices, a particular index value can indicate a particular level of indemnity – i.e. loss of the production from the given crop.

There could be two ways of designing NDVI based insurance. **A plain vanilla NDVI insurance** product would utilize only NDVI values for pricing as well as claim settlement, whereas **a composite NDVI cum weather index insurance** product will use NDVI as well as other data gathered from various sources. Under the United Nation's Millennium Villages Project associated with the Millennium Development Goals, researchers had considered testing both of these options at a site in Kenya. They tried to build a localized climate impact index based on data from rain-gauges enhanced by NDVI. It was found that the composite index could have identified the worst hit drought years in the region much more accurately compared to individual NDVI or individual Water Stress Index (WSI)[10] models. These experiences indicate that the composite index is much more effective and precise than individual NDVI or individual weather based indices. Of course, where there is no weather data available a plain vanilla NDVI cover would be the only option.

REVIEW OF LITERATURE ON INDEX BASED COVERS IN DEVELOPING COUNTRIES

In the past few years, there have been many initiatives in the space of agriculture risk transfer using index insurance schemes. A variety of products (both crop and livestock) are being tried in geographically diverse areas in an attempt to devise sustainable methods for protecting rural households from covariate risks. Simultaneously, some studies have been performed to understand the uptake issues and

[8] Dadhwal, V. K. "Crop Growth and Productivity Monitoring and Simulation Using Remote Sensing and GIS", *Satellite Remote Sensing and GIS Applications in Agricultural Meteorology: pp. 263-289*

[9] NDVI = (NIR – Red) / (NIR+Red), NIR is an abbreviation for Near Infra Red.

[10] Water Stress Index is usually calculated from ground based weather stations. For detailed discussion refer to Allen et al, FAO (1998).

accuracy of the index insurance contracts. Some of them are described below:

1. One of the first index insurance pilots was tried in Andhra Pradesh in India with the help of the World Bank in 2003-04 where groundnut farmers were offered weather insurance. Since then the Indian weather index insurance industry has grown at an impressive pace with many more states being covered for different crops. In a study carried out for understanding the adoption patterns for this product, Giné, Townsend and Vickery (2008) mention that uptake decreases as the basis risk and income fluctuation increase, and wealthier households are more likely to buy such insurance products. Also, participation is higher in case of families which are familiar with the insurance vendor, or which have their members placed in the local council, or which are closely connected to other buyers. Liquidity constraints may reduce the participation which is in sync with the neo-classical framework. However, surprisingly, uptake was found to decreasing in case of risk-averse families. In a separate study carried out in the state of Gujarat, Cole et al (2009) tried to gauge the difference between the impacts of different media used for marketing and customer education, and the effect of discounting the premium on uptake. This study also confirmed the findings of Giné et al (2008) regarding the negative correlation between risk-averseness and uptake of insurance.

2. Skees and Mahul (2007) briefly discuss the issues faced in increasing the uptake of Index Based Livestock Insurance (IBLI) in Mongolia. The paper notes that the inability of the past livestock insurance products to estimate correct losses has greatly impacted the purchase decision of herders in the pilot region.

3. Boucher (2010) describes an area yield index insurance product in Peru. The product was launched in 2008 with annual cycles, and there have been continuous efforts to study the uptake patterns. However statistically significant results are yet to be derived due to low sales volumes.

4. Hess and Stoppa (2003) compare the performance of weighted rainfall indices with a simple cumulative rainfall index in predicting the yield loss for the Meknes region in Northern Morocco and conclude that the weighted index appears to be a better predictor of wheat yields.

5. Skees, Hartell, Murphy and Collier (2009) and Bryla and Syroka (2009) discuss briefly the experience of introducing weather insurance for groundnut farmers covering drought risks in Malawi. The farmers had obtained loans for seeds and for insurance premiums, and in turn agreed to sell their yield to a particular farmers' association. As most of the farmers did not have any experience with insurance and formal credit, it was difficult to educate them. Further, contract enforcement was a key challenge and many farmers engaged in 'side-selling'. Due to this, the lenders were unable to recover their loans fully.

6. Almost all the studies in this space acknowledge the challenge posed by basis risk, and also recommend alternative arrangements for index building to reduce this risk. NDVI is one such index that can help address basis risk.

Though the concept of developing insurance schemes based on NDVI is comparatively new, a few instances of such schemes in the developed world are found in the United States, Spain, France and Canada. However, in the developing world, instances are fewer, and **no systematic household level study has been undertaken to gauge the response of farmers to such schemes**[11]. In fact, in the latest Global AgRisk

[11] As we write this paper, a new NDVI based scheme is being launched in Kenya led by Dr. Andrew Mude of International Livestock Research Institute. The product is based on the concept that NDVI is a reliable measure of vegetation present in the pastoral lands whereas the existence of good pastoral lands itself is an indicator of low livestock mortality. Thus if one can calculate NDVI for a given region, one can estimate the mortality ratio in a given area and accordingly can pay off the herd owners. The project is being jointly run by the International Livestock Research Institute, BASIS, Cornell

publication, Skees, Collier and Barnett (2010, p.68) categorically state that,

"*To our knowledge, no other buyer response to satellit e-based index insurance products has been conducted.*" Further, few tests have been undertaken to understand the accuracy of such hybrid indices in estimating farm production. The traditional weather schemes have been criticized by the farming community for not being able to judge losses accurately, and hence it would be a worthwhile attempt to study whether it would be wise for insurance companies to invest in the development of NDVI products given their promise of enhanced accuracy.

PROJECT DESCRIPTION

As stated earlier, though NDVI based insurance products were piloted at a few places in India, there was a perceived need to incorporate farmers' views while building such products[12]. Further a need was felt to assess commercial viability of such products. As a first step, accuracy check of such products is extremely essential. Under this project, we tried to address these issues by commercially launching an NDVI based product in ten villages across two states of India. The key hypotheses made before the study began were as follows:

- A composite index made up of NDVI and weather index would perform better in crop production estimation for production-risk prone areas.
- Users will appreciate NDVI based products more than the normal weather index based products.

OBJECTIVES

The main objectives of the study were:

1. To create a composite (weather cum NDVI) index for crop production estimation
2. To test the accuracy of the same vis- à-vis a normal weather index
3. To study the probable and actual acceptability of an insurance scheme based on a composite index vis-à-vis a normal weather index insurance scheme for a given region.

Further we also planned to delve upon:

- Identifying factors which influence or hinder the adoption of such products
- Identifying optimal resolution, or specifically the grid size of NDVI (in terms of the area covered by each grid) to design such products
- Finding suitable channels to disseminate information about this new product

However, not all the objectives were met. Certain goals were compromised at the time of implementation. A detailed discussion of the met and unmet objectives is presented in the later sections of this document.

PROJECT AREA

The project was implemented in a total of four districts in the states of Chhattisgarh and Andhra Pradesh in India[13]. The selection of these states followed discussions with ITGI management based on achieving a good balance between tribal and non tribal populations[14], irrigated and unirrigated areas, and comfort level of the insurer in the regions.

University and Maxwell School of Syracuse University and an ex-ante assessment of the product could be found in Chantarat et al (2009)

[12] In the space of weather insurance, a systematic study has happened to find parameters affecting the uptake. Refer to Barriers to Household Risk Management: Evidence from India, *Harvard Business School Working Paper, 2009*

[13] Refer to Annexure 2 for the location details.

[14] As most of the Indian tribal population is characterized by primitive agricultural practices, special emphasis on such areas was given while selecting the project areas.

Geography[15]

Surguja and **Koriya** are adjacent districts in the north eastern part of Chhattisgarh with their district headquarters at Ambikapur and Baikunthpur respectively. **Nizamabad** district is in the north west of Andhra Pradesh and its district headquarters is the city of Nizamabad. **Kadapa (**also known as **Cuddapah)** is situated in the Rayalaseema region in southern Andhra Pradesh. Its district headquarters is in Kadapa.

Agro climatic features

Located along the Satpuda hills, Surguja and Koriya have relatively high average altitude with long dry summers and short winters. The main crops considered were paddy, wheat, *tuver* (red gram), *moong* (green gram) and *gram* (chick pea). Nizamabad district lies on the Deccan plateau and has negligible hilly areas with tropical wet and dry weather. The temperature is harsh and goes up to 47 degrees Celsius in summers and may fall to 5 degrees Celsius in winters. The district has black and sandy looms soil. The main crops are paddy, sugarcane, maize, groundnut, soya bean and sunflower. Kadapa district has a different geography with a combination of plateaus and broken ranges of Nallamalai, Seshachalam, Palkanda and Veligonda hills. The district receives scanty rainfall with its location being slightly away from the paths of the South-West and North-East monsoons. Thus the rainfall months are extended to two quarters unlike other project areas where rainfall happens only in one quarter. Kadapa has mainly black clay soil – which is considered to be good for cotton - and red sandy clay. Paddy, jowar, bajra, cotton, pulses, sunflower and groundnut are the major crops.

Approximately 80% of the working population in Surguja and Koriya is directly engaged in farming. Kadapa and Nizamabad lag behind slightly, but still have high rural population. This clearly indicates the high dependency on agriculture as a livelihood option[16].

PRE-IMPLEMENTATION PHASE

The study was divided into three phases. Phase 1 dealt with understanding the acceptability and needs of the people regarding the insurance product. Phase 2 involved product and process designing whereas Phase 3 was about understanding the performance of the product.

STUDY VILLAGES

In Phase 1, potential villages were identified for piloting the NDVI-weather hybrid product using snowball technique[17]. Only villages which shared a rapport with IFFCO/ITGI were considered. Five such villages were selected in each district (a total of 20 villages from 4 districts)[18]. Maximum variation with respect to the following parameters was maintained in the selected villages:

1. Distance from the IFFCO centre
2. Irrigation facilities available (individually owned as well as government owned, irrigated and un-irrigated tracts)

This phase sought answers to the following research questions:

1. What are the risks faced by farmers in the given villages?
2. How can the insurance contract (based on NDVI and weather) be designed using the risk profiles

[15] http://www.mapsofindia.com, http://korea.nic.in/english/at_a_glance_scroll.htm and http://sisihyd.gov.in/APProfile/Districts/DistProfiles/KadapaDistrictProfile.pdf

[16] Refer to Annexure 7 for detailed survey findings

[17] Snow-ball technique is a popular way of identifying samples in a non-probabilistic way. We identified the key ITGI staff in the region and asked them to introduce us to the people whom they know and who – as per their opinion – could support us during the pilot. We were able to identify a set of farmers who suggested us the list of possible villages where the pilot could be implemented.

[18] Villages in Nizamabad were later changed during the second phase of the study as a result of no product uptake.

of the farmers? (Considering parameters like grid size for NDVI, choice of weather parameter etc.)

3. What could the concerns of the farmers be regarding such a product? (e.g. understanding the product)
4. How should the product be priced, marketed and distributed?

In every village, both qualitative (PRAs) as well as quantitative (household surveys) research methods were used for data gathering.

For PRAs, snowball technique[19] was used in all the villages to gather groups of at least eight people. Surveys being a part of quantitative research, we used probabilistic sampling up to a certain level. From the resource mapping PRAs, hamlets in every village were identified and were used as the basis for stratification. In each village, 25 household surveys were conducted irrespective of the number of households in the village. From each hamlet, almost equal numbers of households were selected to achieve the total of twenty five. Only those households were considered, in which farming was a key source of livelihood.

FINDINGS

Though some of the villages covered in the study are geographically distant from each other, there were many similarities in the parameters studied – particularly because of similar socio-cultural backgrounds. A state wise and district wise breakdown of some of the aspects studied during the research phase is presented in this report.

Caste Factors

The caste profile of the population in Surguja and Koriya are similar, with a high proportion of tribal people. *It was found from discussions that in general, the non-tribal population was better off, had larger landholding, and exhibited better agricultural practices compared to the tribal population.* They were more inclined to accept the concept of agri-insurance than the tribal population. In the case of Andhra Pradesh districts, tribal population was negligible and no particular distinction was found between different castes of the non-tribal population. However, Muslims were found to be relatively less dependent on the income from agriculture.

Livelihood

In all project districts, most rural people had agriculture as their chief occupation. *Tendu*[20] leaf collection and *Mahua*[21] collection were popular in Ambikapur *tehsil* of Surguja as most villages were surrounded by deep forests. Many of the interviewed people in Surguja were also dependent on fishery. On the contrary, villages in Koriya were not dependent on fishery due to the absence of large water bodies in its vicinity. Ownership of livestock in Surguja and Koriya was very low and therefore commercial dairy farming was scarce, unlike in Nizamabad. As Surguja, Koriya and Kadapa have limited sources of irrigation, very few were able to harvest double crops. Hence, migration after the rainy season was found to be prevalent in these districts. In Nizamabad, migration to Middle Eastern countries was prevalent within the Muslim community, and international remittance was one of the key sources of income for such families. Further, many Muslims were also involved in trading

[19] Similar to the method of selection of the villages, we asked the ITGI and IFFCO personnel to name a few farmers from each of the study village who could prove good interview subject, who in turn helped us to identify a list of farmers who could participate in the discussions and give us valuable information about the farming practices.

[20] Tendu is a forest tree found abundantly in the Central Indian forests. Its leaves are used to make *bidi* - a local cigarette without any filter popular in the poorer section of society.

[21] Mahua is a forest tree found in Indian forests. Mahua bears sweet fruits which are picked by local tribal community. Liquor made from fermentation of such fruits is popular in tribal areas and fetches decent cash.

apart from agriculture. Except for a few families that were relatively better off, almost all the people in Surguja and Koriya stated farm labour and other non-farm labour (e.g. under NREGS) as key sources of secondary income. In Kadapa district, Prodattur, Kadapa and Chennai were popular places for seasonal migration in search of unskilled labour work. Despite this, a major portion of their income was dependent on agriculture[22].

Seasonal Activities

It was essential to understand the season wise activities of locals for planning the regional marketing campaigns. In Surguja and Koriya, *Gangadarshan*, *Tija* and *Karma* are the key tribal festivals. *Gangadarshan Mela* attracts a funfair in May and June, which could be used as a good platform for selling agri-insurance. But a key challenge in selling insurance for Kharif crops could be the money crunch in the months of April, May and June due to traditional wedding and other related expenditure that are incurred during these months. On the other hand, *Dashehra Mela* – a bunch of cultural programmes associated with the festival of *Dashehra* - could be a good opportunity for marketing Rabi crop insurance as most people harvest their Kharif crops during that period. For Nizamabad and Kadapa districts, the seasonal activities are slightly different since the onset of monsoon is late compared to the Chhattisgarh districts. June, August, September and October months provide some free time to farmers. There are instances of people taking vegetables as the third crop in one year in Nizamabad. Kadapa experiences frequent outbreaks of *chikungunya* from April to September and malaria from April to June. Due to the poor healthcare finance mechanisms, financial shocks resulting from disease outbreaks are significant. From the discussions, it was found that this usually created a liquidity crunch, and hence was probably not the best period to sell products like insurance unless it is bundled with credit. Further, liquidity crunch is also faced before sowing of cotton and sunflower in the months of April and May. Labour shortage occurs in both the districts during major crop harvests (paddy in case of Nizamabad, and groundnut and cotton in case of Kadapa). This results in a steep increase in wages for farm labour during these seasons. Comparatively, farmers have a good amount of cash in hand between the months of January and March accumulated from the sales of farm produce harvested during the monsoons. This clearly indicates that April, May and June might not be great months for sales of crop insurance products. However, due to the seasonal nature of the products, they have to be offered in the markets during these particular months.

Cost of Cultivation

Focusing on the key crops of the region, we tried to find the item wise cost of cultivation. Cost of cultivation and expected income were inputs for **designing the strike and notional prices** in the insurance contracts. In Chhattisgarh, cost of cultivation and overall production had a perceived relation with major castes, and the connectivity of the village with amenities like agriculture input and produce markets. Paddy was the only major crop in Surguja and Koriya. Due to similar agro-climatic conditions and market structures, income and expenditure did not vary much across the districts selected in Chhattisgarh. Hybrid seeds were used for cultivation in only a few villages. Though input costs for such seeds were much higher than that of Open Pollination Variety (OPV) or traditional varieties, the production was correspondingly on the higher side. There were many instances where farmers diversified their crop by growing hybrid as well as traditional varieties of rice, as the traditional variety was

[22] It could be possible to study the portfolios of farming community in detail and create a portfolio insurance based on the NDVI and rainfall parameters. However, such effort could have required a panel survey. To keep the project simple, we did not make any effort in that direction and tried to develop insurance for the most important seasonal crop for the farming community.

preferred for personal consumption. For cultivating once acre of farmland, 12 to 14 Kg of hybrid variety seeds was required. The production per acre ranged from 22 to 25 quintals, and it fetched approximately Rs. 20,000 in the local markets. However, very few farmers could reach this level of production, as hybrid seeds demanded a particular method of cultivation. Most of the farmers who used hybrid variety seeds were able to make profits up to Rs. 6,000, whereas most of the local variety growers made very little profit. They sold only the surplus produce, that was over and above their personal consumption requirements, in the markets.

Paddy and soybean were found to be popular crops in Nizamabad. Hybrid varieties of rice were also cultivated. The cost of cultivation was Rs. 8,000 to Rs. 12,000 per acre whereas the remuneration per acre was Rs. 14,000 to Rs. 24,000. Due to the use of hybrid seed varieties, the minimum yield was at least 20 quintals. Though sunflower was the most profitable crop, it faced huge production risks. A few farmers also grew vegetables as the third crop depending upon the availability of water. They considered growing vegetables the riskiest – particularly due to pest problems - but earned handsome profits. Groundnut and sunflower were found to be major crops in Kadapa. For groundnut, the input costs per acre were in the range of Rs. 14,000 to Rs. 17,000, whereas the production worth ranged between Rs. 16,000 and Rs. 18,000. In the case of sunflower, input costs varied between Rs. 9,000 and Rs. 11,000, whereas output was worth between Rs. 12,000 and Rs. 13,000. Thus the profit was still Rs. 2,000 although the investments were less than that of groundnut, as it is a riskier crop.

Market for Agriculture Produce

In Surguja and Koriya, most farmers were found to be selling their agriculture produce in local cooperatives. Agri-inputs were bought from IFFCO or local shops, and the directors of IFFCO had limited influence on the society. In Nizamabad, people preferred selling their produce in the local mills, some of which were run on a cooperative basis[23]. Few farmers also sold a small portion of their produce in the markets of Bodhan and Kotgiri where they received instant cash payments for their produce. Agri-inputs were purchased from IFFCO outlets. The overall role of IFFCO in Nizamabad was quite significant as farmers were dependent on it for both inputs as well as outputs. Thus IFFCO directors enjoyed great respect and were considered influential in the area. In Kadapa, a few villages preferred selling groundnut and sunflower in the local agriculture produce markets (known as *mandi*) whereas a few others preferred selling it to local oil processing units or local traders or agents. Agri-inputs were purchased from markets at Kadapa, Pilimari, Nandimandalam and Venupalli.

Availability of credit facilities

Interestingly, penetration of formal agriculture credit was apparent in all the study villages. Credit from Primary Agriculture Cooperative Society (PACS) and Grameen Bank was preferred in Chhattisgarh. There were hardly any cases where farmers sought credit from national commercial banks as their presence was mostly limited to towns and district headquarters. Although SHGs were present in some villages, they were mostly inactive.

In Nizamabad, commercial banks like Deccan Grameen Bank and Syndicate Bank were present at the *mandal*[24] level, and the interest rates were comparable with that of PACS in the region. PACS was however more popular than the other banks due to its local presence. PACS' management was

[23] Ethonda village has such a rice mill.

[24] A mandal is an administrative unit used in some parts of India. A mandal is smaller than the size of a district and tehsil but bigger than a village.

considered influential in the area. Further, although SHGs were present in the villages, most farmers did not avail agriculture loans from them. Microfinance institutions like Spandana, SKS, Share Microfinance and L&T Microfinance were present in the area and farmers sought petty loans from them. In Kadapa too, Syndicate Bank was a leading bank along with other local cooperative banks and the Regional Rural Banks (known as Andhra Grameen Pragati Bank). State Bank of India, another national level commercial bank was popular for agri-credit in one of the villages. Moneylenders were quite unpopular in the area as their rates were exploitative compared to formal sources of credit. In the long term, credit-linked agri-insurance products would be the key to better penetration. Thus it would be essential to tie up with PACS, Grameen Banks (RRB) and IFFCO agri-input centres in Chhattisgarh for sales and insurance advisory services[25]. Even if the products are not designed as credit linked insurance schemes, there is a lot of scope for marketing the product through these readily available outlets[26]. Interestingly, most Indian MFIs today are willing to provide services other than credit – like jewel loans, insurance, remittance, etc. This opportunity could be easily tapped by agriculture insurers.

Management of Shocks

Through PRAs, various agricultural production risks in the region were first identified, and then the number of people affected by those risks was measured through surveys[27]. Seven different risks were found to be affecting farmers in the four sampled districts: (i) drought, (ii) heavy rains, (iii) hailstorm, (iv)cyclone, (v) fire, (vi) stray cattle, (vii) pests

Nizamabad, being the only highly irrigated district, had a strong drought resistant mechanism in place. In the other districts, droughts were the major risk. Interestingly, Surguja faced severe drought in 2008, whereas Koriya, which is a neighbouring district, did not. Rather, Koriya faced heavy rains in the past twelve months. This explains the high basis risk in these hilly districts. Cyclones and hailstorms were the big shocks for farmers in Kadapa, whereas in the Chhattisgarh districts, no farmer was affected by cyclones. Pests were also among major risks for farmers in Surguja, Koriya and Kadapa.

Migration, savings, and diversification of production resources were found to be the popular ex-ante strategies, although their usage differed across the districts. Most farmers in Kadapa kept aside buffer stocks as it is a drought prone area. Migration was popular in Surguja and Koriya during bad agriculture years, especially due to the tribal nature of the population[28].

We tried to gauge the knowledge level of people about various kinds of insurance. Not surprisingly, most people knew about life insurance, thanks to the wide publicity and tax benefits enjoyed by life insurance schemes in India. Health insurance was often mistaken for life insurance by people in Surguja. In Surguja and Koriya most people were exposed to life insurance, and they had seen payouts being made. Thus they held a level of trust for insurance companies. In Nizamabad and Kadapa, people were familiar with crop insurance as well, but the method of payouts employed by insurance companies was unpopular. This resulted in a trust deficit for insurance companies when compared to the Chhattisgarh districts.

[25] As a step towards such collaboration, ITGI became a formal partner of RRB of Surguja district in February 2010, however this partnership could not be leveraged for the project as the sales had happened way back in 2009.

[26] In fact, for Nizamabad, the product was ultimately distributed as a credit-linked product. The details of the process followed is given in the next sections.

[27] Refer to Table 20 in Annexure 7 for district wise information

[28] In other Indian tribal regions like Southern Rajasthan and Orissa, similar seasonal migration is prevalent.

When we tried to gauge the peoples' inclination towards crop insurance, we found that more people in Chattisgarh felt that crop related insurance would be beneficial for them than in Andhra Pradesh where farmers were not keen on buying insurance (refer to Table 1 below). It could also be seen that there is a geographical preference for different products. It should be noted that in Andhra Pradesh, claim settlements under NAIS are based on village level CCEs. Thus there is a lot of awareness about the process of insurance, pros and cons of area yield, weather index, etc. Due to this, the farmers who participated in focus group discussions were quickly able to understand the benefits of an NDVI scheme. However, post-claims field visits showed little understanding about the exact difference between the treatment product and other insurance schemes.

Table 1: Willingness to Buy

District	Will you buy?	Weather	Satellite based	Satellite cum weather
	Will surely buy	74.4	74.4	74.4
	Do not know	4.8	4	3.2
Surguja	Will not buy	20.8	20.8	20.8
	Will surely buy	96.6	94.1	95.8
	Do not know	2.5	2.5	0.8
Baikunthpur	Will not buy	0.8	0.8	0.8
	Will surely buy	21.6	24	56.8
	Do not know	36.8	36.8	14.4
Nizamabad	Will not buy	7.2	0	24
	Will surely buy	19.2	6.4	39.2
	Do not know	36.8	49.6	42.4
Kadapa	Will not buy	1.6	0	13.6

Farmers in Chattisgarh were very postive about the concept of insurance, whereas farmers in Andhra Pradesh had apprehensions about the same. This also explains why more farmers in Chattisgarh are willing to recommend insurance to others. The farmers in this region showed almost equal preference for all the different insurance products, not being able to gauge the difference, probably due to the novelty factor associated with index based insurance (refer to Table 1). On the other hand farmers in Andhra Pradesh exhibited a preference for NDVI and NDVI composite products over weather products, and hence they were more keen to recommend those to their peers.

A few people in all the districts were aware of crop insurance as it is mandatory when farmers take a loan to cultivate a notified crop[29]. However, most people in Chhattisgarh did not have knowledge about the claim calculation method. They did not know the difference between area yield and weather index insurance methods. Further, some loanee farmers did not even know that their crop was being compulsorily insured. However, in Nizamabad and Kadapa, the scenario was different. The area yield index method is implemented at the village level, and hence people knew about crop cutting experiments. In Kadapa none was aware about the exact rate of premium levied. Whereas in Nizamabad, some people were aware about the exact rate of premiums and were also aware that premiums differed for different crops. Most people in Kadapa perceived credit linked NAIS products to be a burden rather than a risk-management mechanism. The payouts happening through such products were considered windfalls as they were used directly by the bank to write off the loans.

[29] In India, every year, the state government declares certain crops as notified crops in its districts. If a formal loan is taken for cultivation of such crops, a compulsory insurance cover has to be brought in.

In Chhattisgarh when people were asked whether they would like to insure their crops although there were no payouts in the earlier season, most people responded that they would not buy insurance again. On the other hand, in Kadapa, maximum people responded that they would still buy insurance – probably because of the consistent fear of drought in the area (refer to Table 2 below).

Table 2: Willingness to buy in the next season in case of no payouts

In case of no payouts	Surguja	Baikunthpur	Nizamabad	Kadapa
Would not buy	54.4	54.6	36	20
Do not know	0.8	15.1	54.4	28
Would buy	38.4	28.6	6.4	50.4

Specific concerns about the product concept

The qualitative study revealed the following key concerns about agricultural insurance products across all the districts:

- **Poor knowledge about claim settlement methods of crop insurance:** From FGDs it was found that a few farmers were aware of the distinctions between loss estimation methods applied by various insurance schemes. Though the surveys included questions regarding weather and satellite based insurance schemes, it is likely that not many understood the methods of calculating claim payments in detail.
- **Delay in the payouts of government insurance schemes:** Farmers who had availed standalone products earlier were unhappy about the claim settlement time taken by the government insurance schemes.
- **Affordability:** Most of the farmers availed crop insurance just because it was bundled with crop credit. Farmers in Chhattisgarh were not willing to pay more than Rs. 500[30] for insuring one acre of land whereas farmers in Kadapa were not willing to spend more than 6% to 7% of the cost of cultivation as premium. Similarly, in Nizamabad, the FGDs revealed that a product with a premium in the range of Rs. 500 to Rs. 800 would be easily bought by the farmers[31]. The product was priced at Rs. 600. However, at the time of sales, it was too difficult for the farmers to pay this price. Thus, the premium was reduced by Rs. 300 by using subsidies obtained from the marketing budgets. Similarly for Kadapa, the premium was lowered to Rs.300.
- **Apprehensions about the complexity of claim settlement process:** The experience of going through tedious processes for life insurance claim settlements raised concern among some farmers about process glitches. Some were also concerned about the need to open bank accounts as the claim settlements always happened through cheques. In fact, in the post-claims analysis it was found that several of the farmers who received claim benefits in Surguja did not have their own bank account.
- When the NDVI-Weather composite product was discussed with farmers during FGDs, the following issues were raised by them:
    - Size of the grid for settlement – During the FGDs, a few farmers understood the concept of basis risk. However, some of them wanted to have farm level settlement – thinking that high-resolution satellites could easily estimate the production. Upon further research and discussions with GIS professionals, it was found that such products were practically impossible as it required mapping of the farm plots on GIS and also calculating claims at these minute levels.
    - Capability of NDVI to predict yields – As NDVI indicates vegetation, some farmers were concerned whether it would be able to predict

[30] Assuming the cost of cultivation to be approximately Rs. 10000, this turns out to be 5 percent of the investments.

[31] Assuming the cost of cultivation to be approximately Rs. 10000, this turns out to be 5 to 8 percent of the investments.

production for cases where the vegetation and yield are uncorrelated[32].

- Complexity of the product – As the product payout was partially based on rainfall, most did not understand how exactly the quantum of the payouts would be determined.
- Farmers raised the concern of not being able to visualize satellite based indices - unlike rainfall - and hence expressed doubts on validation techniques. Some suggested that it would be helpful if a government agency endorses the data and the insurer makes the index public through village level government bodies like the Gram Panchayat. To address this concern, we distributed claim certificates to the farmers receiving claims[33]. The claim certificates were accompanied by snapshots of an indicative period of the project villages in the particular district (Surguja), clearly depicting NDVI values in each grid of 250m*250m within a village. However it should be noted that the certificates were issued by the insurer, and not by a 'neutral' agency.

- **No event – no payout nature of the schemes:** Many farmers were interested in having a savings component in the premium since most life insurers in India offer such schemes. However the prevailing regulations for **general insurance** in India do not allow such customizations. This also means that similar concerns will exist for other crop insurance covers in the market.
- **Apprehension about availability:** Farmers were keen to have distribution channels in their vicinity. Most did not prefer distant insurance agents or sales force of insurance companies; rather they preferred to buy the products from a known entity (refer to Table 3 and Table 4).

Table 3: Preferred purchase point in Chhattisgarh

Purchase point	Surguja	Baikunthpur
Local farmer in the same village	39.2	2.5
Farmer in nearby village	0.8	14.3
Trader in the village	0.8	0.8
Phone booth operator	22.4	0.8
Temporary shop set up by insurer	27.2	2.5
IFFCO distribution centre	0	8.4
Bank/PACS	0	49.6
Other	6.4	16.0

Table 4: Preferred purchase point in Andhra Pradesh

Purchase point	Nizamabad	Kadapa
Local farmer in the same village	9.6	33.6
Farmer in nearby village	1.6	18.4
Trader in the village	9.6	5.6
Phone booth operator	3.2	0
Temporary shop set up by insurer	4.8	16
IFFCO distribution centre	0.8	1.6
PACS	24.8	0
Bank	38.4	23.2
Insurance agent	2.4	0

- Finally, questions were raised in some villages regarding the assessment of vegetation where sowing dates could be different for different farms. Usually, it was observed that a gap of 15 to 30 days is possible between the first sowing and the last sowing in a typical village. As the vegetation stages would differ according to the sowing stages, farmers were apprehensive about the method of calculating 'mean vegetation'. This concern was not appropriately addressed by the product designed for the study[34]. Instead, average NDVI values **across** the cropping

[32] Ground-truthing of NDVI w.r.t. a particular crop for a particular region is necessary to roll out accurate products.

[33] Refer to Annexure 4 for the templates.

[34] This issue is faced by implementers of many other index insurance schemes. Skees (2009) specifically discusses about the amendments made in the proposed flood index insurance product due to different sowing dates across various districts in Vietnam.

season were utilized, assuming that such averages would compensate for inconsistencies.

PRODUCT PHASE

Based on the inputs from people in the pre-implementation phase, and based on the NDVI and weather data, the products and processes for launching NDVI cum weather index insurance was developed for the study regions.

PRODUCT FEATURES

Typically, any vegetative index based insurance product requires a ground truthing exercise for the best possible accuracy. Ground truthing is a process where the actual crop yield is compared with the vegetation index and certain other parameters like rainfall and soil type, and a correlation between combinations of various parameters is established with the actual yield. For this, CCEs need to be conducted across a few years (similar to that conducted for establishing area yield index). However, conducting CCEs involves huge costs. It should be noted that **for this product, we have not conducted CCEs at the pilot stage, therefore possibly sacrificing accuracy.**

It would be worthwhile to note a few terms pertaining to such products like grid number, productivity factor, index interval and coverage levels[35]. A **grid number** is based on the latitude and longitude range of a given area which corresponds to a grid and helps in the identification of a farm on a satellite image/map. **Productivity factor** is the estimate of the production expected from a particular farm. The provision of productivity factor is based on the assumption that productivity at a particular location may depend upon various factors other than systemic variables like farming practices. **Index interval** indicates various stages in the crop growth. One can choose certain index intervals and exclude certain others, whereas, **coverage level** indicates the threshold limit of payouts.

Certain Adaptations

While designing the pilot product for the given region, we tried to keep the product features as simple as possible, considering that it is targeted at remote rural populations. Hence we did away with the concept of grid number by opting for **village level claim settlements**. This would reduce the hassles in identifying the exact grid location of a particular farm. Further, a general benchmark productivity factor is considered instead of providing a choice to the farmers. As far as the coverage level is concerned, it should be noted that in the NAIS, there is an arrangement to choose one out of three coverage levels. However, it was seen from field observations that these options are rarely exercised and hence this customization was not offered for the pilot. Lastly and most importantly, instead of considering multiple index intervals, we have built the product on a **single index interval** which largely covers the growing and harvesting phases of the given crop in the given area. The reasons for doing this are stated in the data analysis section.

Premium Pricing

Strike and notional values were defined for the particular region based on farm output levels and input costs gathered from the field research. The notional value was dependent on the average market price and average cost of cultivation of the produce. **Burn analysis** was undertaken to understand the probable payouts for the product in the previous years, assuming that the product was capable of predicting the yield correctly. Return on Capital (RoC) was assumed as per the Indian weather index industry standards. Finally, the premium price was calculated considering average payouts, Value at Risk (VaR), and RoC.

35 This is based on the USDA supported standard NDVI products.

Crops covered

Earlier, the plan was to develop an insurance product tailor made for the **paddy** crop for all sampled districts based on primary recommendations from the insurer. **However, inputs received from farmers in Kadapa district indicated that paddy was not a significant crop in their region.** This was because of two reasons. Firstly, paddy was grown only for household consumption needs, and the area under paddy cultivation has decreased considerably over the years due to consistent droughts. Secondly, **groundnut** was considered the major cash crop and livelihood was dependent on groundnut much more than on paddy. Therefore, in Kadapa the insurance product was designed for groundnut whereas the product for the other three districts was specific to paddy.

Cover period

The cover period is highly dependent on the crop, and the location being covered. Accordingly, for Surguja, the cover period for paddy was set starting from the second week of June till the end of September. For Kadapa, the cover period was initially mid July to the end of October. However due to the unprecedented late arrival of monsoons in Andhra Pradesh in 2009, sowing dates were considerably shifted ahead. Farmers were not willing to take up the product before there was an assurance of sowing. Accordingly, the cover period was changed, running from September to end of October. Similarly for Nizamabad, the cover period was changed, starting mid-August till the end of October.

Change in the Pricing of Premiums

The insurance product for paddy in Nizamabad was developed as per the pricing methodology described in the earlier section. People's perceptions were a key input for pricing the products. However, uptake for the product initially launched in Nizamabad was poor, and there was no sale in the first week of launch. Hence it was decided that the price would be reduced, and another product with revised pricing was launched immediately. The subsidy was budgeted from the funds allocated for marketing and sales expenses. Further, foreseeing the same problem in Kadapa district, the price of the premium was reduced through a subsidy allocated from marketing and sales budgets.

Data Sources

The following data was used for product designing:

1. Rainfall data: As the product was to be offered in the Kharif[36] season, only rainfall data, which was considered the key contributor to production, was used. Sources of the weather data were the corresponding rain gauge stations (owned by the respective State governments) and weather stations (owned by IMD).

2. NDVI data: MODIS/Terra vegetation indices of 16 day frequency were used as the NDVI values[37]. The resolution of the data is 250 m * 250 m. Thus the grid size for all the products was 1/16 sq.km. In other words a maximum of 16 different indices can be obtained in an area of 1 sq.km with this data.

This is believed to reduce the basis risk in the product considerably, as the weather data was measured on instruments which were several kilometers away from the actual farm. The remote sensing vegetation data was received from NASA[38]. For historical analysis (or burn analysis), a major rectangle shaped grid was constructed for each district, which would comprise the *tehsils* or *sub-districts* completely. Thus, *a portion of the area outside the project area* was also considered for the historical trend analysis. However, the actual

[36] In Indian subcontinent, farmers usually take two crops in a year. Crops taken in Monsoon season – which coincides late summer, are known as Kharif crops whereas Rabi crops are taken in winter.

[37] The data is freely available at: https://wist.echo.nasa.gov. The data used for this product is labeled as Modis-Terra-Vegetation Indices 16-day L3 Global 250 m SIN Grid V005 under Land section of the database.

[38] The data is publicly available at https://wist.echo.nasa.gov/api/ for free.

claims management is planned with the help of a GIS system which could find the representative village level NDVI values.

3. Yield data: District level yield data collected by the government (based on CCEs) was used for historical analysis.

Data Analysis

For this pilot, to estimate the indemnity, a multiple regression model was constructed with historical productivity as the dependent variable and historical NDVI and rainfall data as the independent variables. Various temporal ranges of NDVI data were tested for their prediction capability, for which correlation between the predicted yield (for historical period) and actual yield (for the same period, as obtained from government agencies) was tested. At the end, average NDVI values for the full crop season were found to be one of the best predictors of production. Rainfall, being the input side parameter, was included for the whole season in summative format. The key point to be noted is that the standard[39] crop water stress index was not used for constructing the model. Further, rainfall or NDVI data for a particular crop growth phase were not considered separately[40]. To clarify, we use the example of the product designed for Surguja. As discussed, the product was designed assuming a linear relationship between the production and NDVI values and rainfall. The first form of the relationship would be:

$$\text{Yield} = f(\text{NDVI, rainfall})$$

It should be noted that due to the assumed linear relationship, the yield would be as follows:

$$\text{Yield} = a + b^{*} \sum \text{NDVI}^{41} + c^{*} \text{rainfall}$$

[39] Allen et al, FAO (1998)

[40] In many weather index insurance products, crop cycle is divided into various stages like sowing and transplanting, flowering, maturity and harvesting.

[41] ∑NDVI indicates NDVI values taken at the intervals of sixteen days from sowing period to harvest period.

The linear relationship is in sync with the assumptions made for most of the weather products. The modified model is to make the product simpler and to increase the legibility. In reality, the production levels have a non-linear relationship with the rainfall and NDVI.

Table 5: Output of the yield prediction models for NDVI weather product Surguja

Surguja	Predicted Yield				
Year	June	June - July	June - August	June - September	Actual Yield
2002		681	784	737	601
2003	755	725	764	894	855
2004	752	693	736	622	633
2005	827	794	725	789	779
2006	731	798	850	801	774
2007	819	766	702	693	831
2008	1038	1066	963	986	1050
Correlation	83.20%	87.20%	60.50%	81.80%	

From the above table (table 5) we understand that for the period of June, June-July, and June-September, the correlation of predicted and actual yield (using NDVI and rainfall as the input variables) is quite high in case of Surguja. We take June to September as the period for analysis purposes since paddy is usually grown in June and is harvested in September in Surguja. After extrapolating the yield estimation data (refer to Table 6 below), we can see that there were instances of losses occurring in the years 1992, 2000, 2002 and 2004, where the yield dropped below the strike. Thus the frequency of losses in the given samples was found to be 20%. Based on this, the average losses for the period 1992 to 2008 was 165.01 Kg (excluding 1997 and 1998 where data was unavailable). Further, the maximum loss amounted to Rs. 1,013.2 (for the year 2002). Though it seems that the sum insured is much higher than the maximum loss, it should be noted that the number of data points in the analysis is too small and hence the pricing was done conservatively.

Using the standard formula for insurance premium calculation which is:

Premium = Historical average loss + Loading factor * (VaR – Historical average loss), the total premium was calculated to be Rs. 341.74. It should be noted that the average loss is based on the strike level set and the historical yield obtained from the government agencies, assuming that the model for predicting the yield to be fairly correct. In the cases where the actual NDVI data would be available for sufficient period, the average yield loss could be based on the predictions from the model.

Table 6: Product designing for Surguja

Year	Predicted yield	Predicted loss[42]	Shortfall below average loss	Strike	300 Kg
1992	292.4	129.2	(35.81)	Notional	Rs. 17/Kg
1993	333.2	0	(165.01)	Sum Insured	5,000
1994	468.4	0	(165.01)	Average	165
1995	370.8	0	(165.01)	Max	1013.2
1996	444	0	(165.01)	VaR	1519.8
1997				Frequency	20%
1998				RoC	8%
1999	318	0	(165.01)	Premium	341.7453
2000	268.4	537.2	372.19	Percentage premium	6.835%
2001	390.4	0	(165.01)		
2002	240.4	1013.2	848.19		
2003	342	0	(165.01)		
2004	253.2	795.6	630.59		
2005	311.6	0	(165.01)		
2006	309.6	0	(165.01)		
	332.4				
2007		0	(165.01)		
2008	420	0	(165.01)		

Data anomalies

Weather data for some of the years was unavailable in the case of all the four products[43]. Further, NDVI data of the given resolution was available only from 2002, whereas weather and yield data was available from the government agencies for a much longer time frame. These factors imposed limitations in creating robust regression models for crop growth estimation because, as a thumb rule, for a good regression analysis, the total number of data points needed is at least 30. Despite this, regression was performed on the limited parameters and correlation between estimated yield and real yield was found out as a method of check. Yield data at *tehsil* or sub-district level was not easily available. Thus, district level data was taken as a proxy for the productivity of the NDVI grid selected for regression analysis. There were some instances in the Andhra Pradesh weather data where rainfall (in mm) was recorded in negative numbers. All such instances were excluded from the analysis.

For Koriya, district level yield data of paddy was obtained from the district government. As highlighted in Table 7 it was observed that productivity of paddy crop remained same in two consecutive years – 2004 and 2005. However, the corresponding weather

[42] Predicted loss = Shortfall of production * Notional loss

[43] Refer to Table 20 of Annexure 5.

parameters and NDVI values were different. Further, as the data points were already less, it was impossible to construct a model with the remaining data points.

Due to these reasons, it was decided not to offer any product in Koriya district

Table 7 : Anomalies in the data of Baikunthpur weather station of Koriya district

	2002	2003	2004	2005	2006	2007	2008
NDVI	5375.5	4954.9	5127.8	4668.6	4905.4	5147.1	4948.1
Rainfall	930.8	1554.6	1094.7	896	930.8	592.2	1540.46
Yield	184	357.2	210	210	288.8	448	662

Process designing

Most people in Surguja and Kadapa considered fellow farmers as the best source of information. Farmers in Nizamabad preferred local leaders who themselves are big farmers (refer to Table 8 and Table 9). Accordingly, the relevant people were contacted and their help was sought in spreading awareness and knowledge about the product. Other than that, people in Surguja and Nizamabad also valued the opinions of bank officers and PACS officers. Converting such institutional entities into marketing channels is a slow process, but we managed to get PACS in Nizamabad to agree. Most of the influential farmers in Nizamabad were on the board of PACS as directors. Interestingly, during PRAs farmers did not talk about the possibility of having agriculture extension officers as sources of information for insurance products in any of the districts. This perhaps indicates a very low reach for government efforts in agriculture extension.

When the concept for the product was explained to bigger farmers in Nizamabad, they found it interesting. However, they found it difficult to explain the product to the villagers without any written information, and hence communication material was printed in the local language (Telugu) to help them disseminate the information in an efficient and effective manner[44].

Their inputs were also taken in revising the pricing of the product. When asked about preferred purchase points, banks and PACS topped the list in Koriya and Nizamabad, whereas the peer group (fellow farmers) were preferred in Surguja and Kadapa. In Nizamabad, not only did PACS partner the marketing and sales activities, but they also linked the product with credit. This was in line with observations from PRAs which indicated that linking insurance with credit would be a good option. However, a similar facility could not be extended to Surguja. There, local farmers and leaders assisted the Bima Sahayaks (the field level employees) in marketing and sales activities. The Bima Sahayaks were imparted product training by the state level officers of ITGI.

Table 8: Preferred information point in Chhallisgarh

Information Point	Surguja	Baikunthpur
Local farmer	39.2	1.680672
Group leader	4	18.48739
Grameen Bank officer / PACS officer	38.4	21.84874
IFFCO Agri Sales Centre	16.8	11.76471
TV/Video films	0	14.28571
Poster	0	3.361345
News paper	0	28.57143
Street plays	0	0

[44] Refer to Annexure 8 for brochures and posters designed for Nizamabad region.

Table 9: Preferred information point in Andhra Pradesh

Information Point	Nizamabad	Kadapa
Local farmer	11.2	48.8
Group leader	36.8	23.2
Bank officers / PACS officers	18.4	5.6
IFFCO Centre Operator	3.2	0
TV / Video film	23.2	0
Insurance agent	1.6	20
News paper	0	0.8
Poster	0.8	0

Sales Experience

Overall, the market response for the product was not encouraging. Surguja district had the highest sales with 25 policies sold, while in Nizamabad only 12 policies could be sold. As explained earlier, the launch of the product in Koriya had to be dropped due to data anomalies. In Kadapa too, the product launch had to be stopped due to political turbulence in the region. In Surguja, in-depth explanation of the product was given to three villages, while two did not receive much awareness. Eventually, in these two villages, the product had to be given on informal credit. In Nizamabad, PACS at Ethonda village in Bodhan mandal was first chosen as the point of sales. However, although PACS officials were convinced about the product, it received poor response from farmers. The product was then sold through PACS at Thadla Rampur village in Morthad mandal of Nizamabad. It emerged later during post-claims discussions that the product design was the key reason for poor response since the **product strike was set too low,** and for most of the years, the farmers thought that they would receive much more yield than the strike. Naturally farmers feared that they would receive payouts only when there is a rarest of rare catastrophic loss. The PACS officials also felt that even if a severe drought occurred, the farmers would be better off by not buying the product. It was found that this problem occurred as the product was based on historical government yield data which did not match with the production on the field. There is also a chance that the reported data was per hectare of land area, whereas the unit used now is acre. Table 10 below gives a snapshot of the offered products and the sales scenario across the selected districts.

Claims calculation

It should be noted that for product development in each district, average district-wide NDVI range and the nearest weather index was used. On the other hand, claims calculation was based on village level average NDVI. This was to ensure that the basis risk remained at a minimal level. It was necessary to find the complete series of 16-day NDVI values for the entire policy period. This data was then superimposed on the village shape files using a GIS application. Once the average NDVI data for the policy period for a given village was found, it was applied in the regression model along with the rainfall data to estimate production. For better understanding, a flow diagram of this process is given in Annexure 3.

We will explain the process with an illustration. We found from NASA that the following 16-day interval data sets were available: 10-Jun-2009 to 25-Jun-2009, 26-Jun-2009 to 11-Jun-2009, 12-Jul-2009 to 27-Jul-2009, 28-Jul-2009 to 12-Aug-2009, 13-Aug-2009 to 28-Aug-2009, 29-Aug-2009 to 13-Sep-2009 and 14-Sep-2009 to 29-Sep-2009.

For Bada Damali village of Surguja, the policy period was from 12th June to 30th June 2009. Hence the data was used to calculate the mean NDVI value. It should be noted that the first 16-day period started on 10th of June, whereas the policy period started on 12th

June. Further the last period ended on 29th September, whereas the policy period ended on 30th September. Such minor overshoots were neglected in the analysis.

It was found that the mean NDVI for the particular village was 0.4617125 for the given period. Rainfall recorded for the period was found to be 595.3 mm.

Table 10: Products offered across two states

District	Surguja	Koriya	Nizamabad	Kadapa
State	Chhattisgarh	Chhattisgarh	Andhra Pradesh	Andhra Pradesh
Proposed crop	Paddy	Paddy	Paddy	Groundnut
Period (from)	12th June 2009	-	15th July 2009	1st September 2009
Period (to)	30th September 2009	-	31st October 2009	31st October 2009
Premium	Rs. 380	-	Rs. 600, later reduced to Rs. 300	Rs. 300
Premium Percentage	7.6%	-	7.06% and 3.52%	4.61%
Strike	300 kg per acre	-	850 kg per acre	325 kg per acre
Notional	Rs. 17 per kg	-	Rs. 10 per kg	Rs. 20 per acre
Sum insured	Rs. 5000	-	Rs. 8500	Rs. 6500
Number of policies sold	25	0	12	0
Number of villages	5	0	4	0
Status	Product launched. Claims received for all the villages.	Product could not be launched due to bad correlation between losses and the index.	Product launched. However none of the villages was eligible for the claims at the end of the agriculture season.	Product could not be launched due to politically disturbed environment

Accordingly the regression model in the policy document was applied to estimate yield, which was 167.56 Kg. This was well below the strike of 300 Kg. The total shortfall was 132.44 Kg, and hence the total final claim amount for this village was found to be Rs. 2,252.

Claims Settlement

To improve the credibility of the claims, (i.e. villages in Surguja) a claims certificate[45] along with images of false-coloured NDVI values for each of the villages were distributed. The payments were in the form of cheques. The claims for Sonbarsa and Taparkela villages were distributed in a small public ceremony. In Nizamabad, there were no claims to be disbursed.

Key challenges faced during claims distribution were:

1. Calculating mean NDVI and printing village wise images representing NDVI values was an expensive effort as it involved skill to superimpose the NDVI data on shape files and remove the data grids protruding out of the boundaries of the village shape files. Calculating mean NDVI values was expensive in this case since it was a one-off task for the GIS agency.
2. Many of the farmers did not have bank accounts. This was a problem since claim settlements had to be made through cheques. Further, due to considerable distance between the issuing bank and the beneficiaries' banks, a processing fee was levied for cheque encashment.
3. In the case of weather insurance, farmers in a considerably large area containing several villages received similar payments based on the readings of the representative weather station. In our experiment, village level settlements were made. A robust

[45] The format of the claims certificate and comparative village level images is given in annexure 5 for reference.

database is necessary in this case so as to avoid confusion arising due to similar names.

4. The comparative analyses of representative images given to the farmers had to be explained in depth as there was some confusion among farmers while comparing multispectral images with NDVI images[46]. The images should have helped enhance the trust level among farmers. However, during the discussions, farmers wanted certification from the government instead.

POST-IMPLEMENTATION PHASE

The post implementation phase comprised of two sub phases where qualitative as well as quantitative data was collected, as in the pre-product phase.

Qualitative sub phase

Qualitative data was collected through FGDs to understand the needs and concerns of the farmers. The participants chosen for the FGDs were a mixed group comprising of buyers as well as non buyers. Points discussed included stocktaking of the situation of the paddy crop for the year, coping mechanisms practiced for mitigating losses, the marketing for the product, product awareness, the farmers' feedbacks and recommendations to improve the product. Further, a face to face interview was conducted with all farmers who purchased the product (24 in Surguja and 12 in Nizamabad). Interviews were also conducted with others who had heard about the product through the marketing efforts, but did not purchase it.

Quantitative sub phase

The quantitative data was collected through a questionnaire based survey. Information on demographics, farming status, risks, agri-credit, insurance experiences and offered product was collected.

Selection of sample households

It should be noted that the research method for this study was non-experimental, and the product was offered commercially. There were two key objectives for the post-product phase: first - to understand the perceptions of the people about the product and second – to understand how the product performs on the accuracy front. For accuracy analysis, a random survey would suffice[47], whereas achieving the first objective requires a more detailed study. Due to low take-up, **instead of a sample survey, a population survey was conducted[48] among the buyers to gauge their reactions to the product**. An initial plan was to look for trends existing among the buyers regarding their income, expenditure on paddy cultivation, landholding, education levels, and relationship with the promoter of the product[49]. Due to the low sales numbers, trends could not be identified. Hence surveying non buyers (studying the counterfactual) was considered essential to understanding why a particular group of people purchased the product. Further, although we wanted to match the takers and non takers based on certain observable characteristics that too seemed to be an ineffective approach as only a few non-buyers knew about the product. For this approach it was essential that even the non buyers had to have made a decision on purchasing at some point in time, for which they should have been aware of the product. Ultimately we randomly selected a sample that was twice the strength of the buying population in Surguja, and observed their characteristics to understand whether the take up was

[46] Refer to Image 6 in Annexure 4.

[47] Each farmer was asked to state the production obtained and the sown area for paddy crop in the pilot season.

[48] We could not reach one of the twenty five policy holders Panna Lal from Taparkela village, in Surguja district.

[49] Some of these variables are historically found to be strongly explaining the take-up in studies of Cole et al (2009), Gine et al (2007), Jain et al (2007).

random or if there was a buying pattern. In Surguja, effort was made to select farmers who were introduced to the product through the marketing campaign, but the final sample also consisted of those who were totally new to the product. In Nizamabad this criteria was not applied since there was no concerted public marketing campaign. Though the IFFCO directors who were apprised of the product discussed it with fellow farmers, the product did not sell well since the strike value of minimal production was too low.

OUTCOMES

The project was reduced to half of its size after the designing phase due to the inability to launch the product in Kadapa and Koriya. Further, due to the low strike value, the product could not be sold in the pre-planned region of Nizamabad, and had to be sold in other regions of the same district, that too only to the PACS directors. This left us with an opportunity to concentrate only on sales in Surguja district. However, for the accuracy analysis, the Nizamabad region was also well covered as it does not require the purchase of an insurance policy to understand the productivity for a certain season.

Accuracy

The key objective of having such a product is to enhance accuracy of insurance payouts. A graph of the village-wise differences between the shortfall and the respective insurance policies is given in Image 4 of Annexure 4. We see that in the case of the villages in Chhattisgarh, the product performs reasonably well, but fails to predict the shortfall correctly in the villages of Andhra Pradesh. Clearly, a better designed product for Nizamabad would reduce the inaccuracy. However it should be noted that the analysis is based on the data gathered for one season. Ideally, a dataset collected over time is essential to comment on the accuracy of the offered product with confidence.

Analysis of uptake

In the context of the low uptake of the product, it becomes difficult to analyze purchase trends. Further, in the case of the Nizamabad product, as it failed to reach the farmers other than the PACS directors, that data was dropped from the analysis. Quantitative analysis was conducted only for the sales data from Surguja. Thus the total data points that were used were limited to 74, out of which 24 were policy customers, whereas the rest were non-purchasers. Due to the low number of data points, a standard logistical regression analysis would not reveal any satisfactory explanatory variable for uptake or non-uptake. Hence, chi square test of independence was used for finding bivariate association between a particular characteristic of the farmer and purchase of insurance. From the independence analysis, the following associations were observed[50]:

1. Keeping the significance level of 95%, it was seen that there could be a relationship between insurance uptake, being above poverty line, and having one of the policy buyers as a close friend. However, it was also found that the uptake and being from a richer family (with relatively higher income level) were independent at 95% significance.
2. After reducing the significance condition to 90%, the possibility of some relationship between insurance uptake, being aware of ITGI, having availed formal credit, and expecting a bad Kharif season could be seen. Most of these confirm to the results obtained from earlier field studies in the index insurance domain.
3. Interestingly there was no association between take up and being a member of Gram Panchayat (the village level administration body), being regarded as a progressive farmer among the contemporaries, being a member of SHGs or cooperatives and being a

[50] A detailed account of all the findings is given in Table 13 of Annexure 4.

frequent visitor of IFFCO society centre. Further no dependence was found between uptake and having seen satellite images on television, having a family with more than 5 members (which could be the approximate national average for the family size), and having an exposure of settling out of the village.

It should be noted that the analysis suffers from the issues that small samples bring about and as many of the explanatory variables have obvious correlations with each other, chi square tests might not reflect the true result.

Interpretations:

The associations between take up and economic status (derived from BPL status) and knowledge about the insurer are in line with traditional beliefs. Relatively progressive farming practices have limited influence on the take up.

The perception analysis – one of the key objectives of the study, revealed the following:

1. When asked about the most attractive feature of the policy, 'claims settlement in the distress year' was found to be the most popular answer. Even in the FGDs, it was clear that the product received positive responses once it was evident that claims were being settled the same year. Most farmers thought that the product would be a great success if it is offered in the next year (Kharif season of 2010) due to the distribution of claims.

2. As much as 96% of the farmers who availed this insurance were ready to recommend this to other fellow farmers, whereas during the 2009 Kharif sales season, the same number was 63%. Of course, this can be highly attributed to the claims distributed during this season.

3. All the farmers in Nizamabad took the insurance on credit. It should be noted that the product was linked with agriculture insurance given under PACS in Nizamabad, whereas in Surguja, in only two of the villages, the product premiums were not collected upfront, and the product was given on credit (46% of the customers purchased on credit).

4. A cause of worry could be the poor knowledge of the farmers regarding the technicalities of the product. The product was found to be much more difficult to understand compared to weather insurance. The statistics show that only 4 farmers in Surguja knew about the fact that there would be payouts in the event of bad vegetation being observed from satellite. The concept of **aerial survey** from satellites was alien to farmers, as was apparent from the post-claims discussions in Surguja. Only 12 farmers in Surguja knew that the product payout was dependent on rainfall measurement as well. This is slightly disheartening given that awareness was generated through FGDs in the same villages before sales. In Nizamabad, the farmers were not aware about the exact mechanism of the payouts. This could however be attributed to the sudden change of sites and the unavailability of sufficient time for awareness generation in that region.

5. Since the sales in Surgujaas well as the Andhra districts was delayed due to the late onset of monsoons, the relationship between being pessimistic about rainfall in the upcoming season and take up was probed. It was found that there was some dependence – though at 90% significance.

6. All farmers who had taken insurance were asked to rate its peculiar features on a scale of one to five. It was found that people favored the availability of insurance at their doorsteps. In Surguja, the amount of insurance was found to be adequate and the price was found affordable. As stated earlier, in Andhra Pradesh the strike value was too low, and hence the insurance was not found to be useful to cover the yield risks even after discounting the premium by half, though the sum insured was adequate in the absolute terms.

7. During FGDs, one of the key concerns raised by the farmers was regarding the validity of the claim

amount. Clearly farmers preferred certification of the claims calculation by a government agency. This feature was absent in the pilot product. Considering the black-box nature of the product, where the farmers simply believed in the claims computation methodology applied by the insurer, this could be critical. Moreover in territories where the insurer does not have the trust of people, or where the product is based only on NDVI rather than a combination of NDVI and weather parameter, this factor can affect sales drastically.

LIMITATIONS

A few limitations of the social research component are listed below:

- The findings of the survey to understand the preferences of people regarding index insurance products cannot be generalized with statistical confidence due to the small sample size. During post-claims research, only a few people were found to be aware of the differences between claim settlement methodologies for various products. Further, the surveyors in Phase 1 were from the same village where surveys were conducted, and they were not monitored directly. Therefore there could be a possibility of bias in the data collection. In order to improve the accuracy of the quantitative data in Phase 3, one to one interviews with all the representatives of the sampled households were conducted, rather than relying on the local surveyors.
- The participation of women was low, and in some villages, no woman participated in the PRAs.
- Language proved to be a barrier since farmers mostly understood only local languages[51]. This necessitated the use of local translators for conducting interviews and FGDs. There could have been points that were lost in translation due to this factor.
- Further, the study was initiated in late March. The monsoons arrive in the study regions in the months of June and July. Thus there was little gap between the actual study, product creation, marketing, and the onset of monsoon. Overall, the planned timelines were found to be aggressive.

On the product front, the major limitations could be stated as follows:

- The accuracy of the pilot product is arguable as no ground-truthing was performed while developing it. The linear regression equation used had only a few data points, well below the benchmark number of 30. If thorough ground truthing is performed, a much better relationship can be established through possibly non-linear models. However such experiments are very expensive.
- As discussed earlier, the best possible product would be one where farm level payouts are made. However, for designing such products and calculating such claims, one needs to have a database of farm level coordinates in the potential sales regions. In India, as well as in most other developing countries, such a database is not yet in place.
- The product was designed using approximate square shaped boundaries of the districts. This implies that the village level risk profile was not considered while determining the price of the premium. Thus there could be some cross subsidization and village level pricing could be applied.
- Major expenditure was incurred on the GIS related work in designing and calculating claims for this product. This might jeopardize the commercial viability of the product.

[51] Telugu and Surguji are the regional languages spoken in the project areas of Andhra Pradesh and Chhattisgarh respectively

WAY FORWARD

It should be noted that although the pilot was a very small experiment, the experiences hold significance for future efforts. We will discuss these here:

1. **Product with ground truthing:** A major drawback of offering a product without ground truthing is that building finer models for crop loss estimation becomes difficult. The bases for modeling were yield and NDVI data. For a good product, NDVI data should correlate well with the yield data from government estimations. NDVI data from NASA consists of data on the overall vegetation, and does not necessarily indicate the vegetation of the particular crops under consideration, as a single area consists of various crops and plants. Further, estimation of yield data depends on the area under consideration for crop cutting. For example in India, such an area is usually an administrative unit like a block. Calculating precise NDVI values for a certain crop for such units is again too cumbersome, unless assisted by GIS. All these reasons make it necessary for insurance providers to consider modeling with ground truthing. However, private insurers might be unwilling to conduct the ground truthing on their own, which highlights the need for the crop cutting experiments data to be made available publicly by the government[52]. From discussions with ISRO[53] it was found that the process of establishing a reasonable model based on farm level crop cutting experiment requires at least two years, which could again dissuade private insurers.

2. **Designing training modules:** From the qualitative research it was first thought that a simple retail model would be successful in Chhattisgarh. However the sales figures contradicted this belief. Further, the post-claims survey indicates that almost no one was sure about the exact claim settlement mechanism. Hence a training module delivered through mass media seems necessary to enhance peoples' understanding of the product. We also had meetings with the field sales officials at ITGI and found that it was very difficult for them to explain the product to the farmers. Hence better training is necessary at this level as well. Further, in Andhra Pradesh the product was appreciated by the farmers who understood the differences between various crop insurance techniques. Hence, strategically it would be advisable for insurers to launch such products in those territories where such farmers are higher in number.

3. **Designing pure NDVI products:** In the case of limited weather data availability in a region, approximate models based only on NDVI data could be built.

4. **Data validation:** From interviews with a few farmers who clearly understood the concept, reinsurers, and the management of ITGI, a need was felt for validation of the NDVI data through a credible agency. Unlike weather index insurance, where most of the processes are automated using electronic weather stations and where index calculation process is comparatively simple, the proposed claim calculation process involved manual intervention for calculating average NDVI using GIS. Thus, validation could be an issue while scaling up such products.

5. **Optimization:** Apart from various departments in the insurance company, the pilot also involved agencies designing the product, measuring weather parameters, and calculating NDVI values and village level claims. A lot of communication was necessary between these teams throughout the project duration. Due to such a complex environment, it would be a challenge for any insurer to create an optimized process for successfully launching such a product.

[52] The currently proposed Modified NAIS (MNAIS) for the winter season 2010-11 is the first step taken towards this. It makes available the crop cutting experiment data to the insurers and thereby attracts them to underwrite area yield index insurance.

[53] Indian Space Research Organization which could be broadly considered as NASA's Indian counterpart.

6. Meso or Macro-level products: From the challenges faced in educating farmers about the composite product during the pilot, we could conclude that it would be advisable to try a pilot policy covering a larger area than a village and understand its advantages over a microinsurance policy. Such products could be useful for covering risks faced by aggregators like agri-lending bodies, producer companies, cooperatives, agro-processors and even regional governments. Due to larger area under consideration, the basis risk would be automatically lowered in such products. Further, it is easier to estimate the claims at meso or macro level. This could also bring in opportunities to try mutual models whereby the individual farm level settlements are handled by the aggregator, whereas the cumulative risk is transferred to the insurer. Of course, this concept is not just applicable to NDVI, but could be tried in case of any index based product in general[54].

This pilot product was envisaged to be an alternative to the prevalent area yield index insurance and weather index insurance. However there could be other alternatives as well. For example, one can think of designing products and settling claims based on rainfall data measured from satellite. Further a combination of area yield index insurance and weather insurance, or a combination of area yield index insurance and NDVI based insurance can also be developed. It would also be interesting to follow the performance of the proposed MNAIS.

[54] A somewhat similar model is already being tried by DHAN Foundation in India.

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Annexure 1: An Account of Agriculture Insurance Products in India

Table 11 : Agricultural Insurance and India –Chronology

Scheme	Since	Approach	Description
Individual indemnity based insurance schemes*	1972	Individual loss assessment	Under this scheme, indemnity was decided by assessing the actual losses of the farms and payouts were given accordingly. Naturally this involved huge administration costs and there is space for moral hazard.
Pilot Crop Insurance Scheme*	1979	Homogene-ous Area	It reached 0.627 million farmers across 13 states, and claims paid were less than the premium collected.[55] The area based approach was a major breakthrough, considering that earlier scheme was based on individual indemnities.
Comprehensive Crop Insurance Scheme (CCIS)*	1985	Homogene-ous Area	This was an extension to the pilot crop insurance scheme. Only loanee farmers could avail this scheme. Further the scheme did not cover many of the crops including horticultural varieties. The scheme suffered severe losses, with loss ratio ranging from 0.88 (wheat) to 20.22 (groundnut). Also the claims were skewed. E.g. the state of Gujarat received almost 58% of the total claims disbursed.
National Agriculture Insurance Scheme (NAIS)	1999-2000	Area yield index	The coverage of this scheme is greater, as compared to CCIS – with almost 23 states covered through this scheme. It can be availed by non-loanee farmers as well. However, loanee farmers are not entitled to 'avoid' this scheme. Further it is available for a larger variety of crops. The problems involved include faulty pricing and adverse selection by non loanee farmers. The scheme is currently running and a modified version of this scheme is planned to be launched in the Rabi season of 2010.
Farm Income Insurance Scheme (FIIS)*	2003-04 Rabi	Area yield, support price	Through this scheme, an attempt was made to cover production as well as price risk. The coverage was low for this scheme, as the scheme was implemented on pilot basis in 18 districts first. The scheme was restricted to wheat and paddy. The scheme suffered very high losses and was discontinued.
Weather Insurance Schemes[56]	2003-04	Weather index	The best part of weather index insurance was less administrative processes, hence low burdens and speedy payouts. Also it did address the challenge of moral hazard. However, the process of designing a weather index insurance contract is dependent upon building weather stations. It is perceived as a profitable insurance venture as any other general insurance is today in India, and has attracted attention of private insurers as well as reinsurers. However, there is a high basis risk involved.

* These schemes are not in practice today.

[55] Jain, Prashad and others, "Report of the working group on risk management in agriculture for the eleventh five year plan 2007-12", Government of India, Planning Commission

[56] All the other earlier schemes mentioned in the table were run by Government of India. Whereas the first weather index insurance was launched by a private insurer – ICICI Lombard. Today apart from ICICI Lombard, Agriculture Insurance Company, which was set up by Government of India after the announcement of Finance Minister in his General Budget speech in 2002-03 and IFFCO TOKIO General Insurance Company sell weather insurance in India. HDFC Ergo and TATA AIG General Insurance Company plan to launch their weather insurance soon. GIC and Swiss Re are the chief reinsurers out of which GIC is a public reinsurer in India.

Annexure 2: Project Area Profile

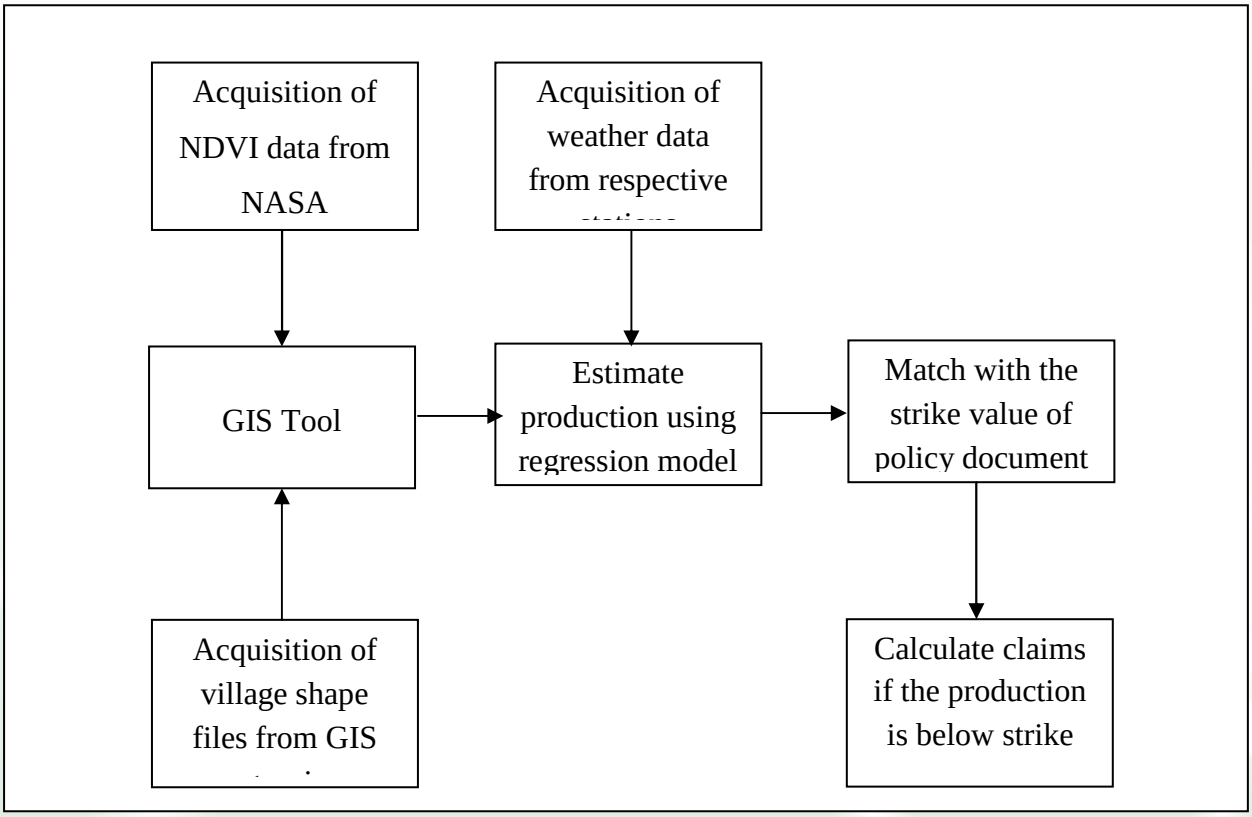
Image 1: Project locations

Table 12 : Area profile of the selected districts				
Parameter	**Surguja**	**Koriya**	**Cuddapah**	**Nizamabad**
Number of households	383217	118828	585987	484588
Percentage Rural Population	93.0	70.2	77.4	81.9
Total Population	1972094	586327	2601797	2345685
Male Percentage Population	50.7	51.4	50.7	49.6
Female Percentage Population	49.3	48.6	49.3	50.4
Scheduled Caste Percentage Population	4.8	8.2	15.7	14.8
Percentage Population of Scheduled Tribes (Tribal population)	54.6	44.4	2.4	7.1
Literate percentage population	44.3	52.3	54.6	44.5
Total work force	982041	279826	1165566	1159606
Main cultivator percentage w.r.t. total working population	37.8	33.3	21.6	26.3
Main agriculture labour percentage w.r.t. total working population	12.2	6.9	25.7	19.6
Marginal worker percentage w.r.t. total working population	38.4	35.0	20.1	16.2
Marginal cultivators percentage w.r.t. total working population	14.2	16.9	2.7	1.0
Marginal agriculture labour percentage w.r.t. total working population	22.6	15.0	13.4	10.1

Source: Indian Census, 2001

Annexure 3: Claim Process

Image 2: Process of claim calculation



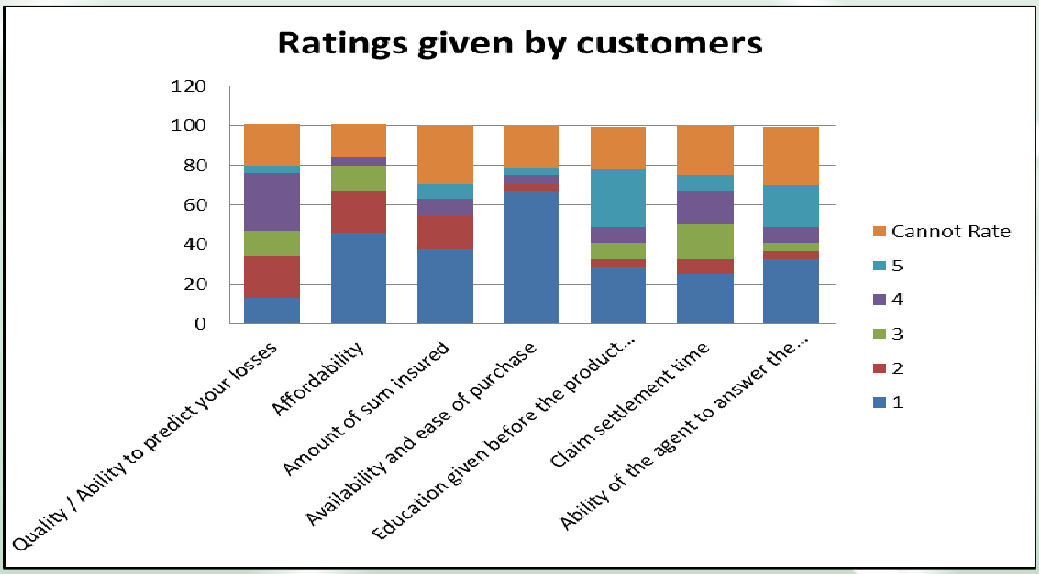
Annexure 4: Key outcomes from Phase 3

Table 13 : Post implementation surveys – Chi Square Independence Analysis

Parameter	p
Sources of Credit (Formal/Moneylender)	0.095534*
Annual Income (Above Rs. 30000)	0.805278
A known progressive farmer buying insurance	0.012797**
Expectation of a bad cropping season	0.095534*
Being Above Poverty Line	0.01064**
SHG/ Coop Member	0.114653
Gram Panchayat Member	0.148117
Visit to IFFCO Shop	0.188814
Progressive Farmer	0.274686
Migrated earlier to other cities	0.655156
Availed formal credit for Kharif 2009	0.098114*
Watched satellite images on television	0.595749
Having family size of bigger than 5 members	0.394968
Being a relatively richer household	0.805278
Heard about ITGI	0.052793
Close friend buying insurance	0.012797*

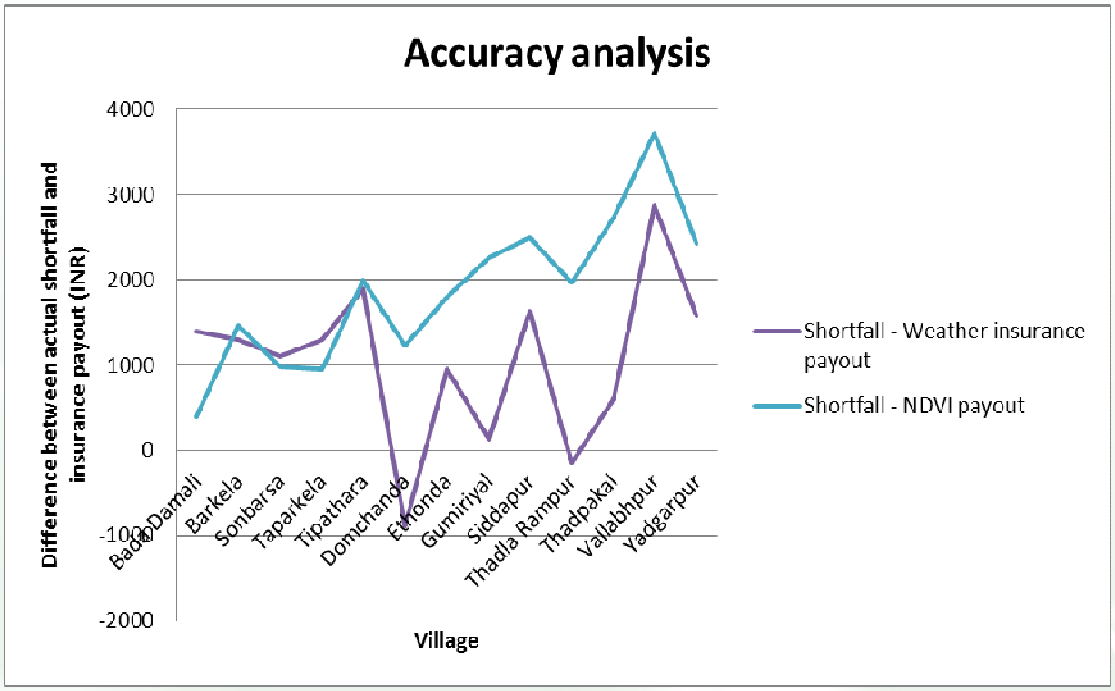
* 90% significance, ** 95% significance

Image 3: Ratings given by customers[57]



[57] Shortfall = % shortfall of production faced in the surveyed field * Sum insured for NDVI or weather policy

Image 4: Accuracy analysis



Annexure 5: Claims Certificate Template for Surguja

Image 5: Certificate template

Barish Bima Yojana with NDVI Cover
IFFCO Tokio General Insurance Company

Name of the farmer: _____

Village: Bada Damali

Average NDVI Value: 0.4617, Rainfall: 595.3 mm

Estimated Production: 167.56 kg per acre (271.5 – 663.5 * NDVI + Rainfall * 595.3 = 167.56)

Strike: 300 kg per acre

Payout: Rs. 2252

_____
Signature of the authorities from IFFCO Tokio

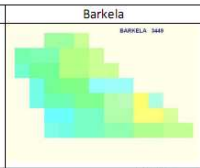
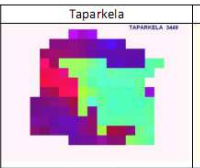
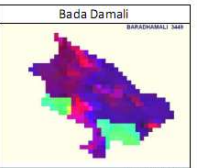
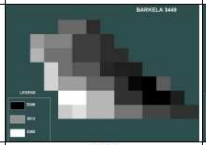
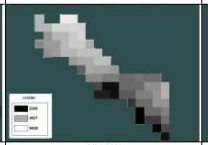
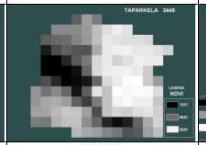
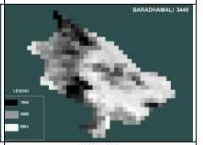
IFMR Research CENTRE FOR INSURANCE AND RISK MANAGEMENT
Research and product design performed by the Centre for Insurance and Risk Management at Institute for Financial Management and Research

microInsurance Innovation facility
Financial support from International Labour Organization's Microinsurance Innovation Facility

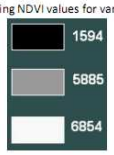
IFFCO-TOKIO GENERAL INSURANCE
Underwriter and insurer of the product

Image 6: Sample sheet of comparison of images given with the certificate

Sample processed images for the period 13th August to 28th August 2009 for some villages in Surguja

Village	Barkela	Sonbarsa	Taparkela	Bada Damali
12 – Band Colour Image				
Grey Scale NDVI Image				
NDVI	0.358	0.383	0.4038	0.4617
Claim	Rs. 1084	Rs. 1371	Rs. 1599	Rs. 2252

Corresponding NDVI values for various shades



Note:
- Dark black shade indicates higher production for given value of rainfall and hence lower payouts.
- White shade indicates lower production for given value of rainfall, and hence higher payouts.
- Grey shade indicates comparatively higher production than white shade but lower production than black shade.

Annexure 6: Rainfall Data Availability

Table 14: Details of historical rainfall data for the project sites

Product area	Rain gauge/Weather station location	Data availability (daily data)
Surguja	Ambikapur	1974 to 2006 (with some missing years)
Koriya	Baikunthpur	1975 to 2008 (with some missing years)
Nizamabad	Mortad	1988 to 2006 (with some missing years)
Kadapa	Kadapa	1975 to 2008 (with some missing years)

Annexure 7: Household survey data – Some key parameters

Table 15: Disasters faced by the households

Type of disaster	Surguja	Baikunthpur	Nizamabad	Kadapa
Drought Last 12 months	50.4	1.7	8.8	45.6
Drought last 5 years	39.2	34.5	11.2	24
Drought last 3 years	60.8	22.7	12.8	28
Heavy rain last 12 months	5.6	84.0	14.4	12
Heavy rain last 3 years	24.8	9.2	11.2	16.8
Heavy rain 5 years	7.2	7.6	8.8	39.2
Hailstorm last 12 months	5.6	4.2	12.8	38.4
Severe pests last 12 months	85.6	12.6	5.6	56.8
Severe pests last 5 years	60	16.0	10.4	72.8
Stray cattle last 12 months	0.8	2.5	8	64
Cyclonic storm last 3 years?	0	0.0	13.6	85.6

Table 16: Ex-ante strategy employed by the farmers

Ex-ante strategy		Surguja	Koriya	Nizamabad	Kadapa
	Never	57.6	7.563025	15.2	45.6
	Sometimes	33.6	73.94958	28.8	31.2
Non farm labour work outside village	Everytime	0	18.48739	48	23.2
	Never	50.4	82.35294	17.6	33.6
	Sometimes	4.8	15.96639	56	32
Children or family labour work	Everytime	0	0	0	0
	Never	25.6	22.68908	30.4	21.6
Diversify production or other	Sometimes	35.2	70.58824	26.4	46.4
activities	Everytime	3.2	6.722689	36.8	34.4
	Never	20	5.882353	17.6	8.8
	Sometimes	15.2	89.07563	44.8	29.6
Saved Money/food grains	Everytime	27.2	5.042017	30.4	64
	Never	33.6	5.882353	16.8	25.6
	Sometimes	24	87.39496	28.8	29.6
Reduced consumption	Everytime	3.2	5.042017	48	52

Table 17: Ex post strategy employed by the farmers

Ex-Post strategy		Surguja	Koriya	Nizamabad	Kadapa
	Never	27.2	5.882353	15.2	40.8
	Sometimes	40	76.47059	33.6	29.6
Migration	Everytime	0.8	16.80672	44	30.4
	Never	28	78.15126	17.6	37.6
	Sometimes	20.8	21.0084	46.4	28.8
Children or family labour work	Everytime	0	0	32	12.8
	Never	8	22.68908	26.4	22.4
	Sometimes	69.6	75.63025	40	40.8
Loan	Everytime	1.6	5.042017	27.2	48.8
	Never	2.4	15.12605	29.6	30.4
	Sometimes	24	77.31092	20	28.8
Spent savings	Everytime	21.6	5.042017	44	43.2
	Never	20.8	73.10924	28	24
	Sometimes	43.2	5.042017	35.2	27.2
MFI/society loan	Everytime	11.2	20.16807	30.4	29.6
	Never	21.6	56.30252	19.2	21.6
	Sometimes	26.4	42.01681	41.6	44.8
Sold livestock/assets	Everytime	0.8	0.840336	29.6	22.4
	Never	24	57.14286	31.2	34.4
	Sometimes	37.6	42.85714	26.4	27.2
Mort/sold house/land	Everytime	0	0	37.6	26.4
	Never	24.8	10.92437	30.4	32
	Sometimes	24	87.39496	40	28
Reduced consumption	Everytime	2.4	1.680672	23.2	35.2
	Never	24	78.15126	23.2	15.2
	Sometimes	36.8	20.16807	36	27.2
Help from Govt	Everytime	1.6	0	33.6	22.4
	Never	24.8	51.2605	22.4	13.6
	Sometimes	31.2	45.37815	40.8	39.2
Help from NGO	Everytime	2.4	0.840336	32	45.6

Table 18: Need for the product

District	Need product	Weather	Satellite based	Satellite cum weather
	Do not need such product	1.6	2.4	2.4
	May need such product	2.4	1.6	1.6
Surguja	Definitely need such product	91.2	95.2	91.2
	Do not need such product	0.8	0.8	0.8
	May need such product	26.9	36.1	35.3
Baikunthpur	Definitely need such product	72.3	62.2	62.2
	Do not need such product	29.6	60	43.2
	May need such product	41.6	39.2	52.8
Nizamabad	Definitely need such product	25.6	0	0
	Do not need such product	24.8	82.4	34.4
	May need such product	12	15.2	61.6
Kadapa	Definitely need such product	61.6	0	0.8

Annexure 8: Brochure and Poster for Nizamabad

Image 7: Brochure for Kothagiri region of Nizamabad

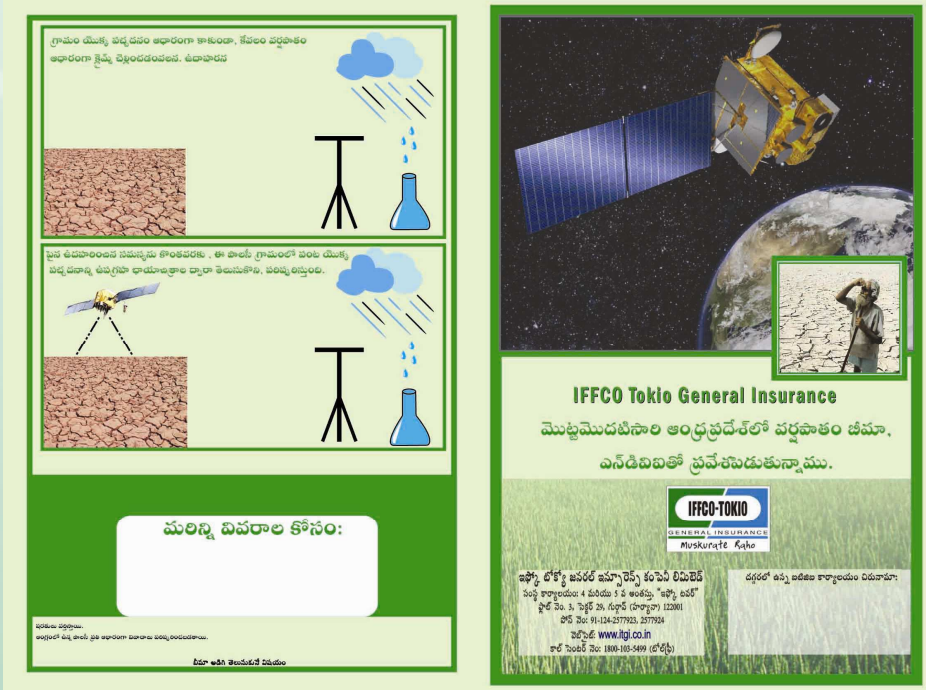
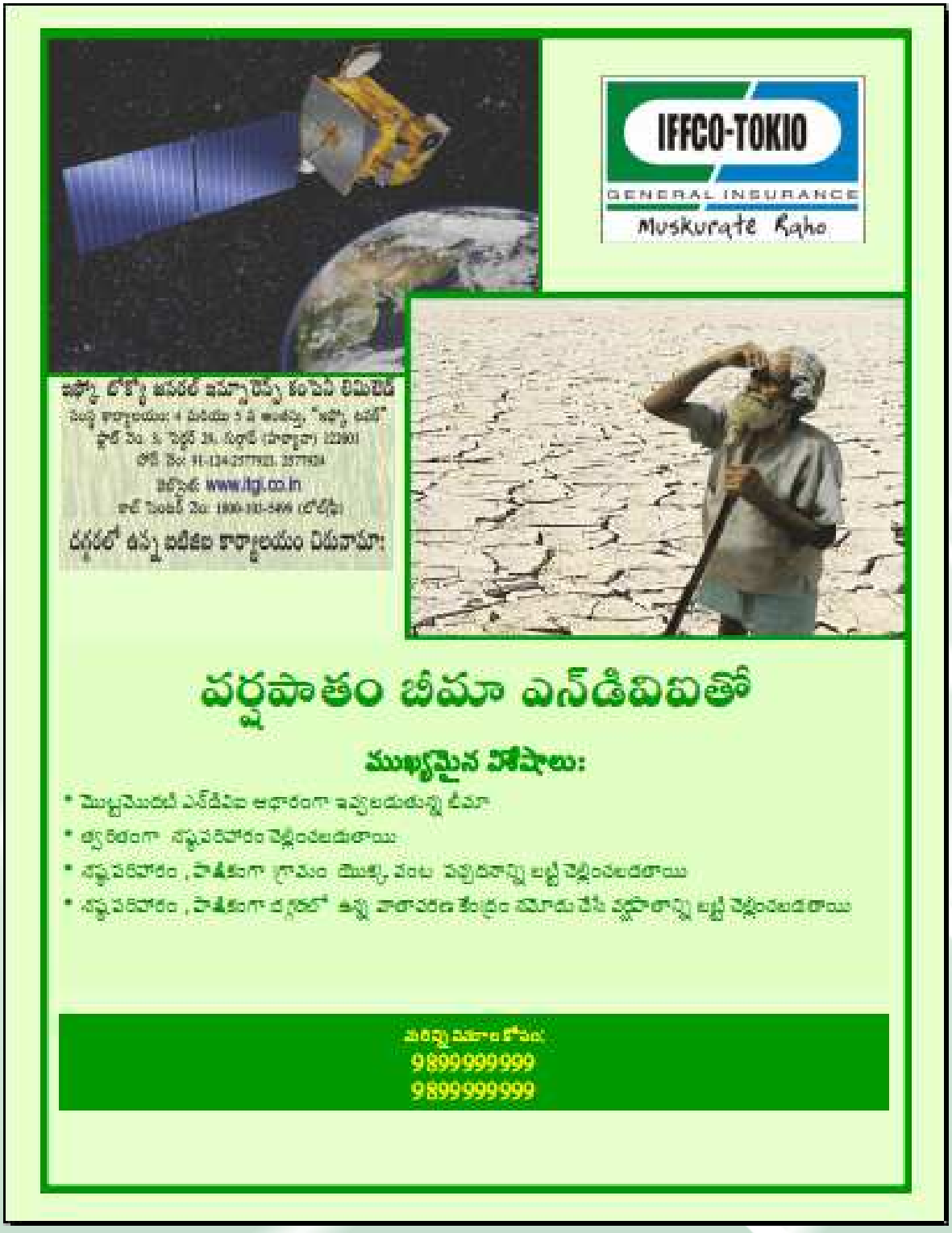


Image 8: Poster design for Kothagiri region of Nizamabad



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