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Transforming Weather Index-Based Crop Insurance in India: Protecting Small Farmers from Distress

Status and a Way Forward

ICRISAT
INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

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- Mission India for Transforming Agriculture (MITrA)
- Transforming Agricultural Marketing in India: Linking Farmers to a National Gateway and E-Markets, Current Scenario and a Way Forward;
- Soil Health Mapping and Direct Benefit Transfer of Fertilizer Subsidy;
- Digital Agriculture; and
- Self-sufficiency in Pulse Production.

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Transforming Weather Index-Based Crop Insurance in India: Protecting Small Farmers from Distress

Status and a Way Forward

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1. Executive Summary

- Index-based weather insurance uptake has not achieved the envisaged numbers in India despite its theoretical benefits. While pricing is one of the key determinants, financial literacy is a major constraint in the rural environment where the individual farmer's familiarity with the framework and confidence in the insurance seller is paramount to the product's success.
- The current crop loan insurance, which is largely tied to the institutional loan, favors farmers with irrigation. This is because more than half of the cropped area in India is dependent on rains, and any aberrations in rainfall or in its distribution can adversely impact crop yields.
- A review of related case studies underlines the need for a Weather Index-Based Crop Insurance Scheme (WIBCIS) to provide additional value to the client beyond the financial protection provided by the insurance. As a stand-alone product, it may not find much favor with poor smallholders who face a variety of risks and productivity constraints in addition to weather risks and may even see it as an unnecessary cost.
- Insurance is invariably more appealing when linked to an existing development program that targets these constraints or when linked to other market opportunities. One obvious linkage could be seasonal credit, but could be further enhanced when a package of credit and inputs is provided.
- WIBCIS can find widespread favor with farmers, if efforts go into educating them about it.
- Crop insurance is subject to structural design and financial issues. Coordinated efforts by agencies and organizations involved in crop insurance programs could lead to effective implementation. Support is needed for the long-term development of improved products that aim to minimize basis risk.
- A comparative statistical analysis of different insurance products as well as enhanced consumer protection legislation for indexed insurance products are required. Research on methods to combine information from different indices should be promoted so that farmers can rely on timely claim payments during bad years.
- While this paper was in print, the Government of India has made a formal announcement of launching a new scheme, Prime Minister's Fasal Bhima Yojana, in its annual Budget Speech 2016-17. Details are included.

2. Situation Analysis

2.1 Current Scenario

In India, agriculture contributes 14% of the GDP and employs 54% of the workforce (NCAER 2013). It accounts for 8.56% of the country's exports. Despite agriculture's steady decline in share in the GDP, it remains the largest economic sector and plays a significant role in the country's overall socioeconomic development. However, agriculture is fundamentally a risky economic activity, particularly for small and marginal farm households because the climate risks, including aberrant rainfall, and natural calamities and input risks have a significant impact on yields. Low investment potential combined with poor coping ability render farming households vulnerable to debt and poverty traps in the face of adverse weather shocks. It is estimated that about 60% of the variation in yield can be attributed to various weather-related shocks. Since 70% of crop production in India is subject to the vagaries of the monsoon, crop insurance has been in existence through many public sector insurance companies for decades. Different agricultural insurance products have been tried out on a limited, ad-hoc and scattered manner.

Crop insurance schemes have been introduced in the past three decades and have been modified as and when required to address operational issues. Delays have occurred in the payment of claims because of anomalies in data on insured area, insured crops, and estimated yield of insured crops. Inconsistencies in information on insured crop area and the area reported to be under a crop in a particular season have also posed problems. The major agricultural insurance schemes implemented in India include: Individual Approach Scheme; Pilot Crop Insurance Scheme; Comprehensive Crop Insurance Scheme (CCIS); National Agricultural Insurance Scheme (NAIS); Modified National Agricultural Insurance Scheme (MNAIS); Pilot

Where we stand	Why change	Options	Preferred option and players
• WIBCIS is intended to provide insurance protection to the cultivator against adverse weather incidence. • It currently covers only about 15% of farmers and 17% of cropped area. • Since the product is based on the adverse macro weather patterns rather than actual loss, processing time for claims is reduced as damage assessment processes are bypassed. • The Scheme has succeeded only where it has been compulsorily bundled with loans as an alternative to the traditional area-based yield insurance. • Against the backdrop of a change in the policy landscape in cognition of climate change, weather-based indices offer better protection against covariate risks like drought and floods. • The market has a minimum credible number of weather-index based products; farmer literacy is the key hindrance. • Investment in human capital development for delivering agriculture extension services is lacking; efforts to strengthen the system are required.	• A shift from a social crop insurance program with ad-hoc funding from the Government of India to a market-based crop insurance program with actuarially sound premium rates and product design is needed. • The 'indirect' approach might sometimes overlook actual individual losses, one of the reasons why farmers are still reluctant to trust the product. • Dedicated efforts to make farmers understand the medium to long-term benefits of this 'costlier' instrument would induce them to adopt these products. • An improved product and the active involvement of private sector insurance markets are expected to lead to significant benefits such as faster settlement of claims, a more equitable allocation of subsidies, and lower basis risk for farmers. • Pro-poor products need to be introduced as a large chunk of insurance buyers are small and marginal farmers. • Insurers and government must experiment with cost-effective ways of increasing outreach. Government should provide equal opportunity for all insurers participating in WIBCIS.	• Special Purpose Vehicle (SPV) to provide agriculture extension services. • The product and active involvement of private sector insurance markets may significantly benefit farmers in terms of faster claims settlement, a more equitable allocation of subsidies and lower basis risk. • Establishing pilots with quality automatic weather stations representing several farmers' fields in one village or a cluster of villages is the key to weather index-based insurance. • The Farm Livelihood Obligation Fund (FLO-F) would envisage creating an initial pool for public sector insurance companies to enable premium payments. • It is recommended that WIBCIS and the electronic platform facilitating transactions in the National Agricultural Market be integrated.	• Special Purpose Vehicle to strengthen extension services with the help of FPO/PC, and public and private agencies. • The Farm Livelihood Obligation Fund to overcome financial obligations along with financial institutions. • The National Agricultural Market electronic platform will be used to pay farmers for the produce sold. • The farmer database may be made more comprehensive and integrated with banks and financial institutions to maintain loan data. • Regular capacity building of farmers and FPOs through existing national level skills development corporation.

Weather Index-Based Crop Insurance Scheme; Pilot Coconut Palm Insurance Scheme; and National Crop Insurance Program.

1. **National Agricultural Insurance Scheme**: This scheme was introduced during the late 1990s to increase the coverage of farmers, crops, and risk management. It covered all the food crops, oilseeds, and annual commercial/horticultural crops. The scheme continued till *kharif* 2013. The total area insured under the scheme till *rabi* 2012-13 was about 314 million ha; the largest area being in Madhya Pradesh (69 million ha), followed by Andhra Pradesh (44 million ha), Rajasthan (31 million ha), Gujarat (31 million ha), and Uttar Pradesh (30 million ha). Nearly 50 million farmers have benefited from its implementation, with the ratio of claims to sum insured being just 0.03.

   The Modified National Agricultural Insurance Scheme implemented since *rabi* 2010-11 in 17 states covers 4.58 million farmers for a premium of ₹ 108,800 lakhs against claims of ₹ 86,400 lakhs until *rabi* 2012-13. The total area insured was 4.68 million ha (Government of India, 2014). Similarly, the Pilot Coconut Palm Insurance Scheme has been implemented since 2009-10, encompassing 51,108 farmers covered for a premium of ₹ 167.69 lakhs against ₹ 214.05 lakhs claims paid till December 2013 with a total insured area of 25,938 ha (Government of India, 2014).

   Crop insurance is subject to structural, design and financial problems. Given problems of asymmetry of information, moral hazard and adverse selection and co-variability that are more pronounced in crop insurance, schemes based on the area approach were introduced in the 1980s. Since insurance schemes are currently based on weather and adopt an area approach by involving several agencies and organizations, coordinated efforts are critical for their effective implementation.

2. **Weather Index-Based Crop Insurance Scheme:** This scheme implemented by the Agriculture Insurance Company of India Limited (AIC) and private companies, has been in operation since 2007. It has been piloted across India to explore its effectiveness as an alternative to the NAIS, and provides insurance protection to the cultivator against weather incidence, such as deficit and excess rainfall, frost, heat, relative humidity, etc., which adversely impact rabi crops. The insurance is linked to credit, and farmers are required to obtain credit.

Introduced as an alternative to yield-based crop insurance, WIBCIS is implemented by both public and private companies (AIC, ICICI Lombard, and IFFCO-Tokio) in 18 major states, and coverage has expanded over the years. Between the years 2007-08 and 2012-13, the scheme covered 47 million farmers, i.e., 30.2 million during *kharif* and 16.8 million during *rabi* seasons, with a total area insured of 63.2 million ha. Annually, an average of about 7 million and 9.5 million hectares were covered under the scheme. The highest coverage of 30.28 million farmers and 42.05 million ha was in Rajasthan, followed by Bihar with about 8.8 million farmers covering 9.41 million ha. In all states except Chhattisgarh and Uttarakhand, the amount of claims was less than the amount of premium received (Table A-1). Moreover, the average loss cost (claims as a % of sum insured) is about 6.7–5.8% during *kharif* and 7.5% in *rabi* seasons (Figure 1).

The claims payout was ₹ 5,286 crore against the premium received of ₹ 7,519 crores. The amount of claims was less than the amount of premium in all the 13 seasons, except for *rabi* 2012–13, when it was marginally higher. For the entire period (2007-08 to 2012-13), the claims ratio was 0.70 and the loss cost was 7%. Both these ratios are significantly lower for WIBCIS than that for CCIS and NAIS, indicating better financial viability (Government of India, 2014). However, whether WIBCIS addresses yield risk adequately for farmers is a question that requires more in-depth analysis.

Interestingly, groundnut has a claims ratio of 0.71 and loss cost of 7%. This is significantly different from the experience with groundnut crop in the case of MNAIS and other schemes. Fruits/plantation crops and pulses have claims ratios greater than 1. Banana has the highest claims ratio of 2.55 and loss cost of 30% followed by gram with a claims ratio of 2.20 and loss cost of 18%.

Private WIBCIS are available in India through two main insurance providers: ICICI Lombard and Indian Farmers Fertiliser Cooperative (IFFCO) Tokio General Insurance Company (ITGI). Their products are distributed through multiple channels including rural cooperative banks, input suppliers, and contract farming companies (Annexure I, Table A-2). ICICI-Lombard employs a mix of distribution strategy based on geography.

2.2 Enabling Environment

a) Parameters covered

WIBCIS provides insurance coverage and financial support to farmers in the event of crop failure due to adverse weather incidence and subsequent crop loss. If a farmer does not insure the crop under MNAIS and they are damaged due to adverse weather conditions, he/she can still claim insurance with this component. In 2010-11, over 9 million Indian farmers held WIBCIS policies.

The adverse weather incidences leading to crop loss and subsequent indemnity under WIBCIS are: (a) Rainfall – deficit rainfall, unseasonal rainfall, excess rainfall, rainy days, dry-spell, and dry days; (b) relative humidity; (c) temperature – high temperature (heat), low temperature (frost); (d) wind speed; (e) a combination of the above; and (f) hailstorms and cloudburst.

The various indices used include: (a) Total seasonal rainfall index; (b) Weighted rainfall index; (c) Multiple phase weather indices; (d) Consecutive Dry Days (CDD) index; (e) Excess / Untimely Rainfall index; (f) Low temperature or frost indices; (g) High temperature indices; and (h) Weather indices for pests and diseases. The scheme covers cereals, millets and pulses, oilseeds, and commercial/horticultural crops. Crops are selected and notified by various State Governments.

b) Methods and tools used

MNAIS was implemented in 50 select districts of India on pilot basis in place of NAIS in September 2010. Under MNAIS, if 'Actual Yield' (AY) per hectare of insured crop for insurance unit (calculated on the basis of requisite number of Crop Cutting Experiments) in the insured season falls short of the specified 'Threshold Yield' (TY), all insured farmers growing that crop in the defined area will be deemed to have suffered a shortfall in yield of similar magnitude. MNAIS seeks to provide coverage against such contingency[1].

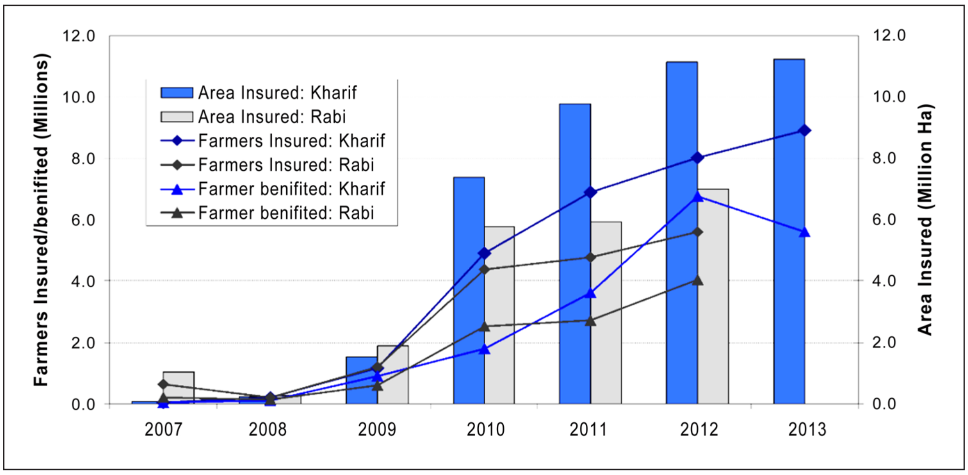


Figure 1. Farmers insured and beneficiaries of WIBCIS in kharif *and* rabi *seasons in India (2007-2013).*

1 Claim is calculated as per the following formula: [(Threshold Yield - Actual Yield) × Sum Insured] / Threshold Yield, where threshold yield for a crop in a notified insurance unit is the average of past seven years (excluding calamity year(s) as notified by the State Government/UT) multiplied by the applicable indemnity level for that crop.

The indemnity level is 90% in low risk areas, 80% in medium risk areas and 70% in high risk areas as notified by the State Government/UT for a particular crop at a particular level (sub-district/district/region). The insurance company decides the indemnity level applicable based on risk categorization, and the methodology used is made available to GOI.

This scheme is available to all farmers, big or small; loanee or non-loanee; landholders, sharecroppers or tenant farmers. Loanee farmers, i.e., those who have taken farm loans from financial institutions, are covered compulsorily. The scheme gives the farmer the freedom to choose the insurance company. Panchayati Raj Institutions (PRIs) are encouraged to play a role in its implementation.

MNAIS uses an "area approach," where the sum assured is pre-defined, as opposed to an "individual approach" adopted by WIBCIS, where the claim assessment is made for every individual insured farmer who has suffered a loss. For the purpose of compensation, a Reference Unit Area (RUA) is defined by the State Government as a homogeneous unit of insurance. The RUA can include the Village, Panchayat/ Revenue, Circle/Mandal/Hobli/Block/Tehsil, etc., as defined by the State Government. The Sum Insured (SI) for each notified crop is pre-defined as per a formula which is based on the 'cost of production' and is the same for loanee and non-loanee farmers and all companies. The State Government notifies the RUA before the commencement of the season and all the insured cultivators of a particular insured crop in that area will be deemed to be on par in the assessment of claims. Each RUA is linked to a Reference Weather Station (RWS), on the basis of which current weather data and claims are processed. Adverse weather incidences, if any during the current season, entitle the insured to a payout, subject to the weather triggers defined in the 'Payout Structure' and the terms and conditions of the scheme.

The premium is decided by the insurance companies on RUA level and there is a cap on maximum premium as with MNAIS. Farmers are eligible for premium subsidy and the difference between actuarial rates and the premium paid by the farmers is borne by the Government (both Centre and State governments concerned on 50:50 basis).

c) Agencies involved

The first ever crop insurance program in India was started in 1972 on H 4 cotton in Gujarat and was extended to a few other crops and states. This was followed by the Pilot Crop Insurance Scheme (1979–1984) and Comprehensive Crop Insurance Scheme (1985–1999). The NAIS began operations in India from *rabi* 1999-2000, providing coverage to approximately 35 different types of crops during the *kharif* season and 30 during the *rabi* season. NAIS covers about 20 million farmers annually, making it perhaps the world's largest crop insurance program in terms of the number of farmers covered[2]. In India, multi-peril crop insurance programs are being implemented, considering the overwhelming impact of nature on agricultural output and its disastrous consequences on society in general and farmers in particular.

Table 1 summarizes the financial performance of crop/weather insurance programs in India. Farmer coverage increased significantly from the early 1970s to 2010-11. However, it fell during the subsequent two years. The claim ratio has improved significantly over a period of time. Both MNAIS and WIBCIS have shown similar efficiency trends during recent times.

2.3 Global Trends

a) East Africa

The Agriculture and Climate Risk Enterprise (ACRE) is the largest index insurance program in the developing world in which, the farmers pay a market premium. It is also the largest agricultural

2 There are several private insurance companies such as IFFCO Tokio General Insurance Company, ICICI Lombard General Insurance Company, Tata AIG General Insurance Company, HDFC Ergo General Insurance Company, Cholamandalam MS General Insurance Company and Future General India Insurance Company, International Reinsurance and Insurance Consultancy and Broking Services Private Limited.

Table 1. Financial performance of crop/weather insurance programs in India, 1972–2013.

Schemes	Period	Farmers covered (lakhs)	Premium (in crore ₹)	Claims (in crore₹)	Claim ratio
Individual approach	1972–78	0.03	0.05	0.38	1:7.6
Pilot Crop Insurance Scheme	1979–84	6.23	1.95	1.56	1:0.8
Comprehensive Crop Insurance Scheme (CCIS)	1985–1999	763	404	2303	1:5.7
National Agricultural Insurance Scheme	1999 to *kharif* 2010-11	1700	6213	20437	1:3.3
Modified National Agricultural Insurance Scheme	*Rabi* 2010-11 to *kharif* 2011	15.72	335	184	1:0.55
Weather Index-Based Crop Insurance Scheme	*Kharif* 2007 to *rabi* 2012-13	376	6093	3308	1:0.55

insurance program in sub-Saharan Africa and the first agricultural insurance program worldwide to reach smallholders using mobile technologies. ACRE has shown rapid scaling-up in East Africa, and is projected to reach 3 million farmers across 10 countries by 2018. In the year 2013, the sum insured reached US$12.3 million, the recorded insurance payout was US$370,405 and the average cost of insurance was 5-25% of the harvest value.

One of the strengths of ACRE is that indices used for its products are based on several data sources, allowing experimentation with new technologies without corrupting trust and its baseline of users. Data sources include 130 solar-powered automated weather stations, satellite rainfall measurements, and government area yield statistics. Indices have been developed for maize, beans, wheat, sorghum, millet, soybeans, sunflowers, coffee and potatoes. In Rwanda, more than 37,000 low-income smallholder farmers were able to purchase a satellite-based index insurance product.

b) Ethiopia and Senegal

The R4 Initiative developed in Ethiopia in the year 2009, was initially called the Horn of Africa Risk Transfer for Adaptation (HARITA) project. It is deliberately targeted at poor smallholder farmers who were previously considered to be uninsurable due to a combination of poverty, lack of education, data limitations and remoteness. In 2014, an option of paying for insurance through a combination of cash and labor called "Insurance-For-Work" (IFW) was introduced to give farmers the opportunity to graduate from the IFW programs. In addition to providing a means of insuring the poorest households without resorting to direct premium subsidy, the approach is also designed to complement other R4 strategies. For example, the IFW programs employ farmers in community drought risk reduction activities identified through local participatory planning processes.

Since ground-based weather stations are extremely sparse in the R4 project area, several other data sources were used in index design and validation. The R4 index is based on ARC2 satellite rainfall estimates, which were validated and backstopped by a combination of other satellite rainfall and vegetation estimates, water-balance satisfaction indices, rainfall simulators and statistical tools that interpolate data from nearby stations. As with any weather-based index, reducing and appropriately communicating basis risk is also a challenge, especially as there are several non-drought perils faced by farmers in the region (such as insects or heat stress). Risk assessment and context analysis have been keys to facing this issue, which has taken time and meaningful investment by project partners. There has also been significant research with scientific partners into regions with recurrent basis risk, leading to current efforts to design hybrid index insurance products using a combination of satellite rainfall estimates and vegetation indices.

c) Brazil

SEAF is a Federal Government of Brazil's compulsory crop credit insurance program for smallholder farmers who access seasonal production credit from PRONAF (National Program for the Strengthening of Family Agriculture – Programa Nacional de Fortalecimento da Agricultura Familiar). Automatic cover is available for beneficiaries of PRONAF Seasonal Credit. Multi-Peril Yield Shortfall Policy indemnifies growers by the amount of actual crop revenue that has fallen short of the sum insured. A wide range of crops are identified under the agricultural zoning program (zoneamento agricola), including rainfed and irrigated cereals, legumes, oilseeds, fiber crops, root crops (cassava), grapes and tree fruits. Insured perils include drought, excess rain, frost, hail, excess variation in temperature, strong winds, cold winds, crop pests and diseases, which are uncontrollable either technically or economically (Foretell and ICRISAT 2013).

The sum insured is based on the amount of seasonal production credit loaned to the farmer, plus the interest due on the principal, plus up to 65% of the estimated net revenue of the crop, subject to a maximum of Rs 2,500 per farmer. The estimated gross and net revenue are determined by the bank and the crop inspector at the time of policy issuance. The premium is fixed at 2% and paid by the insured for each insured crop. The Government pays a 75% premium subsidy on the SEAF program. Losses must exceed 30% of the expected gross revenue for the crop in order to qualify for an indemnity.

d) Best practices

Best global crop insurance practices are mentioned below (Table 2).

The basic characteristics of index-based insurances around the world are shown in Table 3. In case of Malawi, the index-based insurance developed for groundnut worked well with strong credit linkage support. This was later extended to tobacco. The pooling of various insurance schemes has reduced their capital costs. In Mexico, the disaster index insurance has protected farmers well, and it works out cheaper than if the government had to pay disaster relief directly to farmers. On the other hand, the rainfall and temperature insurance in Ukraine did not take off and in Brazil, area-yield index insurance saw sluggish take-up because of high dependency on government funds.

Table 2. Best global crop insurance practices.

Country	Best practice	Stakeholders involved	Supporting policies
Bangladesh	Design, piloting, and product evaluation of WIBCI especially for small and marginal farmers, supported by ADB	International insurer, public insurer, private insurer, NGOs, MFI, farmer cooperatives	Govt. of Bangladesh provided subsidies on WIBCI products to encourage farmers to purchase them. Capacity of staff enhanced IDRA framework was established
India	Pilot weather-based crop insurance schemes in 18 states from 2007-08 to 2012-13 using an area approach and reference rain gauges.	PACs, MFIs, NGOs and nationalized banks are identified for implementation under the Modified National Agricultural Insurance Schemes (MNAIS)	No specific encouragement is given to farmers during that time. The limited weather insurance portfolio and high claim ratios seem to be the key deterrents for insurers to sustain investments in weather insurance. WIBCIS policies are covered under Service tax.
USA	Crop insurance is subsidized by the Government but administered by private companies. Both adverse selection and moral hazard are not a problem.	USDA	Multi-peril insurance is subsidized by the government and implemented by private companies, a significant improvement over previous years.

Continued

Table 2. Best global crop insurance practices *continued.*

Country	Best practice	Stakeholders involved	Supporting policies
Canada	Initially administered through an 'area approach', which was found inequitable and inefficient. Developed satellite imagery insurance based on satellite images. Also developed lack of moisture insurance to estimate soil moisture before the season begins.	Agricultural Financial Service Corporation (AFSC)	Was encouraged as voluntary rather than mandatory crop insurance. The mandatory policy introduced and implemented in Canada reduced the adverse selection problem.
Mexico	AGROASEMEX, a government insurance company set up in 1991 does reinsurance of private companies and 200 mutual insurance funds. In 2001, weather indices based on temperatures and rainfall were developed, working well in the country.	BANRURAL, AGROASEMEX	Promoted as a voluntary scheme in the country. Catastrophic Agricultural Insurance (CAI) was also developed to protect smallholder farmers from weather aberrations with 70% contribution from the federal government and 30% from the local government.
Uruguay	Spanish insurance companies have advised the Uruguay government in developing insurance law.	State Insurance Bank	The law is encouraged to pay up to 60% of the subsidies in the premium.
Japan	After being criticized for using 'village level yields', they shifted to individual plot level yields.	-	The government made crop insurance compulsory.
Brazil	A credit-linked crop insurance scheme is in existence. One of the merits of Brazil's policy is that it envisages a future transfer of federal programs to state agencies and private insurance companies.	PTTS	The main constraint is the program's high dependency on the government. Delay in payouts have deterred scaling up.
South Africa	A subsidized multi-peril crop insurance scheme was offered for some time, but no subsidy has been given in the past 15 years.	-	This country's experience serves as an example of how a private company can offer insurance to a wide range of farmers and how the policy was sustained even after withdrawal of subsidies.
Malawi	In 2005, WIBCIS for groundnut were developed based on the experience of pilots conducted in India. They provided secured loans that allowed the banks to expand their lending portfolio in rural areas.	National Smallholder Farmers' Association of Malawi (NASFAM), OIBM, IAM and MRFC	No regulatory impediments and high potential for reinsurers paved the way for the expansion of groundnut production in the country and its exports. Pooling together insurance schemes resulted in significant savings in capital requirements.
Ukraine	Rainfall and temperature index insurance was developed to protect farmers from crop losses.	-	The pilot scheme failed because of lack of government support and subsidy. Lack of exposure and cooperation among farmers and the absence of weather infrastructure were also reasons for the low turnover.
Morocco	Crop insurance scheme piloted in early 1995. Later, the World Bank attempted to pilot weather insurance schemes in the country.	MAD	The traditional crop insurance was subsidized by 50% on premiums. The weather insurance did not take off because of a downward trend in rainfall and high premiums.

Table 3. An overview of Index Insurance case studies around the world.

Country	Type of insurance	Since	Delivered by	Sum insured, farmers covered	Role of government	Re-insurance	Linked to credit
Malawi	Rainfall index insurance	2005	Banks: OIBM&MRFC Insurer: IAM Farmers: NASFAM TA:WB&SECO	2005: Sum insured: US$ 35,000 900 farmers 2006: 3000 farmers US$ 110,0003	None (no subsidy or government support)	No	Compulsory for smallholder farmer taking loan
Mexico	Disaster index insurance	2003	Disaster relief: federal & local government Reinsurer: AGROASEMEX	2006: Sum insured: US$ 131.9 million 2007: 650,000 farmers 800,000 farmers	Agricultural reinsurance through AGROASEMEX Catastrophe insurance protection for smal lholderfarmers:100 %subsidized	Yes	No
Ukraine	Rainfall and temperature index insurance	2005	Insurer: Credo-Classic Partnership with: IFC&CRMG	2005: 20,000 farmers	None (only subsidy support for the other agricultural insurance)	No	No
Brazil	Area-yield index insurance	2001	Insurer: PROAGRO Partnership: SAA, Banrisul, PROCERGS, Agro Brasil Seguros	2007: 26,071 farmers 2008: 14,893 farmers	Subsidized and initiated by government (Subsidy:90% of the premium)	Yes	No

2.4 Issues and Advantages

2.4.1 Key issues

In spite of the theoretical benefits of the schemes, and partially field-proven instances globally, index-based weather insurance uptake has not achieved the envisaged numbers. Pricing is one of the key determinants, and studies have shown that a reduction in premiums would lead to a proportional increase in enrolments. Lack of financial literacy is a major constraint in the rural environ where an individual farmer's familiarity with the framework and confidence in the insurance seller is paramount to the product's success.

- Since the product is not based on actual loss but rather on adverse macro weather patterns, processing time for claims is reduced as damage assessment processes are bypassed.
- However, this 'indirect' approach might overlook the actual individual losses, which is one of the reasons why farmers are still reluctant to trust the product. Solutions to this lie in policy design such as policy payouts on global catastrophe indices and cumulative rainfall (as opposed to continuous rainfall), dynamic start dates, and phasing the design to local cropping cycles among others.
- Presently, WIBCIS has succeeded only where it has been compulsorily bundled with loans as an alternative to the traditional area-based yield insurance. For the same reason, highest coverage under all types of crop insurance coverage (see Table A-4) is for oilseeds (40%) and paddy (25%) and high cost and high risk crops have low coverage, like e.g., sugarcane (4%), fruits (1%), and vegetables (11%). Even low cost but lifesaving crops, particularly in the drylands like coarse grains (12%) and pulses (20%) coverage levels are low. Some of the farmers' suicides, which occurred in 2013-2015, could have been averted if these coverage levels were high in dryland farming areas.
- For climate change, weather-based indices offer better protection against covariate risks such as

droughts and floods. However, farmers still opt for traditional schemes that focus only on localized eccentric patterns of weather and do not cover the aforementioned larger risks.

- It is our conclusion that the market now has the minimum credible number of weather-index based products, and farmer literacy is now the key hindrance to adoption. Therefore, dedicated efforts are needed to make farmers understand the medium to long-term benefits of this 'costlier' instrument, thus, making them more inclined to adopt these products.
- Heavy investments in developing a workforce for delivering agriculture extension services are needed. This is important if new technical developments such as drip irrigation, precision farming, etc., and institutional innovations such as credit guarantee and interest subvention schemes are to be communicated to and implemented by the farmer.
  - A shift from a social crop insurance program with ad-hoc funding from the Government of India to a market-based one with actuarially sound premium rates and product design would be a major step forward.
  - The improved product and active involvement of private sector insurance markets are expected to lead to significant benefits for farmers, including faster claims settlement, a more equitable allocation of subsidies and lower basis risk.
  - Lack of pro-poor products and cost effectiveness: Pro-poor products need to be introduced as a large chunk of insurance buyers are small and marginal farmers. Insurers and government must experiment with cost-effective ways of increasing outreach. Government should provide equal opportunity for all insurers participating in WIBCIS.

2.4.2 Advantages

- Trigger events such as adverse weather (rainfall, temperature, relative humidity, etc.) can be independently verified and measured
- Allows for speedy settlement of claims, say within 45 days from the end of the insurance period
- All cultivators – irrespective of loanee or non-loanee; small/marginal or others; owners or tenants/ sharecroppers can buy WIBCIS
- Government is subsidizing the premium; hence, the premium payable by the cultivator is affordable
- WIBCIS provides transparent, fully objective, efficient and direct payouts for adverse weather incidences and thus, it is an effective risk mitigation tool against weather risks
- The insured is not required to submit a claim form or other documents as proof of loss
- Claim payout is automatically calculated on the basis of weather data collected from the Reference Weather Station at the Tehsil/Block level
- Since the weather data decides the compensation, the insured retains the incentive to put in extra effort to obtain better yields.

2.4.3 Challenges

However, technical challenges exist in designing weather indices and also correlating weather indices with yield losses.

- Cultivar coefficients for popular varieties of major crops are still not very dependable for use in crop-growth simulation models, to develop indices.
- While historical weather data (up to 25-30 years) was considered essential, it is now considered in the industry that down-scaled daily observed weather for last 10 years is more relevant given climate change.
- By offering claim payments based on weather at a contractual weather station, weather indexed insurance offers little protection against localized events such as hailstorm or cloudburst, and may not capture some aggregate events that affect a whole area, such as an outbreak of pest or disease. For such localized losses, one will need a validation process based on photos from smart phones that are geographically and temporally stamped that are complimented by high resolution imagery to assess extend and area affected.

- The imperfect correlation between the index and a farmer's loss, which can result in the farmer receiving no claim payment despite having experienced a severe crop loss, is known as *basis risk*, and can deter demand. Indeed, arguments[3] against crop insurance reveal that "given the nature of agricultural production, India should stop investing in crop insurance schemes and replace these with a comprehensive Agricultural Calamity Compensation Fund, shared between the Center and States, for meeting a part of crop losses faced by farmers".
- Need crop specific and area specific products design. Development of new products for uncovered crops and areas.
- Tasks of appraising and approving the design of weather insurance products to capture reasonable risk/perils by regulatory agencies and designated expert committees.
- Enhancement of weather infrastructure and establishment of centralized data center.
- Benchmarking of weather insurance product before providing government support.
- Designing of web portal for administration of crop insurance, covering national, state and district level information and linking this with all government records, banking database and insurance agencies database.
- Extensive awareness, publicity through different media and capacity building programs.
- Implementation of compulsory coverage for all loanee and government subsidy availing farmers by financial institutions/banks/government agencies.
- Capturing of individual farmers insurance coverage details for each crop season and synchronising/comparing it with the government records. Database of these records have to be updated every season. Then, sample verification by bankers and village officials on a timely manner.
- Evaluation and monitoring for proper implementation and further planning and policy decision, grievance redressal mechanism.
- Effective coordination among all stakeholders – various government agencies, banks, insurance agencies, village level officials, technology providers.
- Strict adherence of seasonality discipline in crop loan sanction and disbursement along with pre-fixing the cut-off dates before occurrence of risk.

Table 4 compares the two main agricultural insurance types in India -- weather index insurance and area-yield insurance. There are several studies that evaluate NAIS insurance and the proposed weather index insurance as more effective alternatives for smallholder farmers. Yet some other studies propose clubbing both to gain the advantages of both while overcoming the challenges these risk management strategies face. None of the studies completely dismisses crop insurance as a risk management strategy, although multiple studies underline the importance of an integrated livelihood perspective, in which insurance is part of a broader risk management package.

A majority of studies on both types of insurances cite basis risk as a main concern, i.e., when the outcome for the insurance is not in line with the outcome for the farmer, meaning a farmer experiences a loss without payout or vice versa. This is mainly due to the poor density of weather stations and the lack of real time weather data for weather index insurance and the inefficiency of crop yield estimation (area estimation differs from the actual yield of the individual farmer) for area yield insurance. Furthermore, both types also face delays in payment which could be due to differences in the availability of weather data and infrastructure in the different areas under study. In terms of costs, weather index insurance needs relatively high start-up costs (i.e., weather stations), whereas yield area insurance has no high initial investment, but rather high administrative and transaction costs throughout the provision of the insurance. Also, area yield insurance is hindered by information asymmetry (moral hazard and adverse selection) while weather index insurance has fewer of such problems.

3. Ramesh Chand and Sumedha Bajar 2015. "Drop the crop insurance plan", *Financial Express, 25 June 2015.*

Table 4. Challenges, opportunities and scope for improving weather index and area yield insurances.

	Weather index insurance	Area yield insurance
Main challenges	Basis risk	Basis risk
	Infrastructure Lack of real time weather data	Inefficiency in crop yield estimation
	Delay in payment indemnities	Delay in settlement indemnities
	High start-up costs	Large manpower and transaction costs
	Reliance on historical data	Moral hazard and adverse selection
	Complex contract index design	Limited coverage (only production risks are covered)
Main opportunities	Lower moral hazard and adverse selection	Available for all crops, where yield data is available
	Quick claim settlement	Combines individual and area approaches
	Low transaction costs (no field visits or yield estimation)	Relatively low start-up costs
Scope for improvement	Investment in weather stations and satellite imagery (radar)	Simplified procedure
	Raise awareness among farmers	Wide publicity for creating awareness
	Wider coverage (pre-sowing and post-harvest)	
	Reduce insurance unit	
	Combine different insurance products	
	Risk packaging; integrated risk management strategy (insurance as part of broader strategy)	

3. Goals and Objectives

Goal: To enable all farmers to adopt risk mitigation measures in crop related activities using modern technology and e-governance mechanisms promoted by the government and private agencies in India.

Objectives:

a. To develop a robust and simple method to adopt weather index-based crop insurance widely across India for risk mitigation in crop related activities.
b. Review and adopt best insurance practices from private and government agencies in other countries.
c. Design improved methods for piloting the new schemes and scale up based on learnings from the pilots.
d. Develop and adopt effective monitoring and learning mechanisms.

4. A Way Forward

4.1 Technology

Drones to measure crop status

In recent years, more states of India have adopted modern technology to assess crop losses, in a more qualitative and quicker manner. For better verification of crop losses, the Maharashtra Government under the Rashtriya Krishi Bima Yojana, will use two drones in drought-hit Osmanabad district to survey crop losses due to water scarcity. The data will be used to determine the compensation to be paid to the farmers. A private company is responsible for this survey and the economics works out to be $1 per farmer. Also, at 1000 pictures every 5 meters, it translated to around 800,000 pictures per acre, which is very good granularity. It is expected that drones will now be used during both *kharif* and *rabi* season crop harvest. If this technology proves to be economical and authentic, existing manual surveys and approximate assessments may be a thing of the past.

In October 2015, the Government of India launched KISAN (meaning farmer), a project that will use space technology and drone-based imaging for efficiently estimating crop yield. KISAN will use geo-informatics system along with high resolution data from UAV/drone-based imaging for better yield estimation and planning 'crop cutting experiments' which are needed for crop insurance programs. Under the project, a pilot study is proposed to be launched in one district each of Haryana, Karnataka, Madhya Pradesh and Maharashtra during the current *kharif* season and in two districts each of these states during the *rabi* season of 2015-16.

It also launched an Android App, designed by Indian Space Research Organisation, the country's space agency, to assess real time data on hailstorm occurrences to figure out crop loss in affected areas[4]. Both these technical support systems will help the government in effectively running the crop insurance schemes and disbursing compensation to farmers.

In USA, the use of drones for crop surveillance has shown increase in farm crop yields while minimizing the cost of walking in the fields or airplane fly-over filming. Using precision imaging system has enabled viewing composite video showing the health of crops. It can find potentially yield limiting problems in a short time. With the help of integrated GIS mapping, it can draw field borders for flight pattern. For the first time, agriculture drones will legally be able to gather widespread data across an entire growing season, allowing companies to test their business models and technologies together for the first time—and ideally make a profit in the process.

Source. http://www.precisiondrone.com/testimonials/14-08-2015

Index-based insurance: Most of the experience in weather index-based insurance has been with micro-level applications and rainfall deficit (drought). To date, many initiatives have been piloted, but a market-based scaling-up of weather index-based insurance has taken place only in India. The WIP and IFAD (2010) review of 36 index insurance case studies yielded the following lessons on sustainability and scalability:

- Create a value proposition for the insured and offer insurance as part of a wider package of services;
- Build the capacity and ownership of implementing stakeholders;
- Increase client awareness of index insurance products;
- Graft onto existing, efficient delivery channels, engaging the private sector from the beginning;
- Access international risk transfer markets;
- Improve infrastructure and the quality of weather data;
- Promote legal and regulatory frameworks; and
- Monitor and evaluate products to promote continuous improvement.

One of the key messages from the case study review is that weather index-based insurance must provide added value to the client, beyond the simple financial protection provided by insurance. As a stand-alone product, it may be seen as an unnecessary cost and have little demand from poor smallholders who face a variety of risks and productivity constraints in addition to weather risks. Insurance is often more appealing

4. The KISAN project will be implemented by Mahalanobis National Crop Forecast Centre (MNCFC) in collaboration with ISRO Centres (Space Applications Centre, Ahmedabad & National Remote Sensing Centre, Hyderabad), India Meteorological Department, CCAFS, state agriculture departments and state remote sensing centres. Source: Times of India, 5 October 2015.

when linked to an existing development program targeting these constraints or when linked to other market opportunities. One obvious linkage relates to seasonal credit, but it can be further enhanced when a package of credit and inputs is provided.

To date, most practical experiences with the development of weather insurance index have been with deficit and excess rainfall and have relied on data collection from weather stations. However, a wide range

Table 5. Weather parameters and their application in weather index insurance.

Rainfall deficit	High	Rainfall is the main, but not only, contributor to low yields from drought Drought is difficult to insure by traditional insurance (MPCI or named peril), especially for small farmer systems - Most frequently used parameter for weather index for agriculture - Not possible to index rainfall for irrigated crops Other variables (especially soils and temperature) affect transpiration and water balance, but drought indexes have so far been limited to rainfall as a single peril - Key period of risk: crop establishment and crop flowering, but also vegetative stage
Rainfall excess	Medium	- Causes problems of inability to harvest or assess loss of mature crops - Complex effects influenced by soils and drainage impact may be flood - Not widely developed as weather index peril - Key period of risk: maturing and harvest
High temperature	Medium	- Most important impact is in combination with lack of rainfall and high evapotranspiration during drought - Drought indexes so far have been limited to rainfall deficit and do not incorporate temperature - Key period of risk: high temperature can impact any growth stage, but particularly crop establishment and flowering
Low temperature	Medium	- Complex effects according to season: • winter freeze (medium length event) • autumn and spring frost (sudden event) • insufficient growing degree days (long length event) - Short-term frost events difficult to index (heavy dependence on exact growth stage) - Local basis risk from microclimate and topography - Yield loss from spring frost (lack of flowering) or quality loss in autumn (fruit) - Winter freeze damage can depend on snow cover - Growing degree days important in crops such as cotton, especially if growing season is limited - Key period of risk: spring frost in flowering in fruit and nuts; autumn frost in fruits; cool temperatures in maturation; mid-winter freeze in cereals
High wind speed, wind direction	High (macro index) and low (micro index)	Impact of high wind (especially cyclones) is very complex at the local level (high basis risk) Cyclones associated with variable amounts of rainfall and high rainfall can occur under low category cyclones Impact is very widespread Currently macro indexes have been developed for cyclone winds, feasibility for micro application are now being researched
Sunshine hours	Low	Some vegetable crops require a combination of sunshine and high temperature to mature Low sunshine hours (overcast) can lead to lack of maturity and maybe difficult to index

of weather risks are indexable, and Table 5 draws out the main features of insuring different weather risks using index products. Additionally and especially given the lack of weather monitoring systems, there is growing research on the use of alternative data sources and risk modeling.

In order to address these challenges and promote effective and sustainable markets, we propose the following innovations for sustainable implementation of the project.

- Innovations in low-cost automated weather stations: These are providing increased opportunities for deficit and excess rainfall coverage, as the cost of denser networks is falling.
- Satellite imagery coupled with computer models has the potential to measure risks in new regions. For instance, the normalized differential vegetation index (NDVI), which uses satellites to measure a plant's ability to absorb sunlight, can be used to proxy major droughts in certain parts of the world. NDVI is already being used in indexation of pasture growth for insurance in Spain and North America, and is under development in Kenya.
- Specialized satellite imagery and computer models can be used to model flood risk and to show areas inundated by water (and also to monitor inundation periods). The type of flood strongly impacts the feasibility of flood index insurance. An index may be more applicable to river inundation flooding affecting large geographic areas, more challenging in coastal flood, and not possible for flash floods. Flood index insurance would be very challenging to implement but may be technically feasible at the macro/ meso levels (World Bank 2011).

Innovation-1

- Collect historic weather, crop, area, production, yield information from available weather stations from the pilot districts/sites. This applies to historical records of the chosen weather parameter(s) for underwriting and pricing purposes and to record parameter(s) for payout calculations during the period of insurance. It also applies to historical yield data to assess risk, design, and price the product, if the weather index is to serve as an accurate proxy for loss. For weather index insurance, a long and high-quality time series of meteorological data are required (minimum 30 years of daily data).
- To make the assessment, the Indian Meteorological Department (IMD) concerned will need to share its data from potential pilot areas. Additional questions can also be asked at this stage. Usually, the following should be collected and ensured:
- Recorded weather parameters (rainfall, temperature, solar hours, wind speed, etc.)
- Type of equipment used (automated versus manual stations)
- Availability of historical time series (approximately 30 years are needed but the last 10 years are critical and most relevant)
- Missing data per weather station
- Sufficient quality standard of data and access (data cleaning, reporting, etc.)
- Location of stations and radius of coverage, plus whether they were relocated during the period
- Are the weather stations reasonably close to potential customers?
- Are the weather stations secure from tampering?
- The Commercial Market Assessment Approach: This approach applies a market demand assessment technique similar to that used by commercial insurers. The key question is whether there is a business case for the product. This can be assessed by pursuing some or a combination of all the following analyses:
    - Existing cropping pattern, yield levels and socioeconomic conditions of the farmers
    - Past and existing levels of insurance coverage
    - Farm structure: number of farmers, distribution of land holding sizes, subsistence versus commercial farming, and so on
    - Credit coverage and gaps where insurance may help unlock more credit
    - Interest from agribusinesses and agricultural banks

- Install automatic weather stations and develop information technology to provide weather risk information to surrounding area.
- Construct the index with collected weather and agricultural data using crop model output (WRSI/DSSAT) and pretest with farmer and local expert interviews
- Design and rate prototype agricultural insurance products with riders attached
- "Dry running" or "piloting" itself is treated as an empirical demand assessment. This entails:
    - Farmers being provided with real prototype insurance products
    - Provision of educational and marketing sessions
    - Real purchasing decisions being made
- Create the Index: Develop an insurance portfolio model to assess the potential exposure of stakeholders (farmers, local insurance companies, government) to natural disasters
    - Quantify potential yield losses associated with particular weather risks at various stages of the crop cycle
    - Demonstrate how efficient the index is at providing a proxy for yield. A complementary approach to selecting a weather index is to utilize farmer or local expert's recollection of difficult years
    - Generate models of expected hazard frequencies for weather variables
    - Quantify the immediate fiscal impact of the weather risk on farmers
    - Structure an insurance contract
    - Determine the price of contract by underwriting
- Test, determine the marketability and implement the contract at pilot sites
- Obtain clearance from the insurance regulator
- Check regulatory issues
- Market the product
- Prospective Delivery Channels: Identification of the primary product delivery channel at an early stage is preferable. Depending on the legal framework, product design, institutional capacity, and interest in any given country, the delivery channels could be:
    - Department of Agriculture and allied divisions
    - Insurance companies
    - Insurer intermediary
    - Local bodies/agents
    - Financial institutions
    - NGOs
- Hire and train sales staff and print and distribute marketing materials
- Identify scheduled sowing and harvesting times of crops for indemnity payouts
- Create awareness among the farmers through mass media and lead farmers.
- Conduct monitoring and evaluation studies and publish half yearly/annual reports.

Innovation-2

The Normalized Differential Vegetation Index (NDVI), an index of plant "greenness" or photosynthetic activity, is one of the most commonly used vegetation indices. Vegetation indices are based on the observation that different surfaces reflect different types of light differently. Photosynthetically active vegetation, in particular, absorbs most of the red light that hits it while reflecting much of the near infrared light. Vegetation that is dead or stressed reflects more red light and less near infrared light. Likewise, non-vegetated surfaces have a much more even reflectance across the light spectrum.

Since plant photosynthetic activity, total plant cover, biomass, plant and soil moisture, and plant stress affect NDVI values, NDVI is correlated with many ecosystem attributes of interest to researchers and managers (e.g., net primary productivity, canopy cover, bare ground cover). Since it is a ratio of two bands, NDVI helps compensate for differences both in illumination within an image due to slope and aspect, and differences between images due to factors like time of the day or the season when the images were acquired. Thus, vegetation indices like NDVI make it possible to compare images over time to look for ecologically significant changes.

4.2 Institutions

4.2.1. FPO/PC-led Special Purpose Vehicle (SPV) to provide agriculture extension services - Public Private Partnership (PPP)

India has about 750 extension workers per million farmers as compared to 2500-3500 in China and Vietnam. Owing to the structural complexities of index-based weather insurance that ensures long term sustainability of these models, it is essential to pay special emphasis on education and awareness if the insurance is to find widespread favor with the farmers (Table 6).

Farmer Producer Organizations (FPOs)/Producer Companies (PCs), the Ministry of Agriculture, State Agriculture Departments and Agri-Insurance providers could pool resources to create a SPV that would:

- Provide training and certification to Business Correspondents/Extension Workers/ NGOs.
- Provide training and certification to farmers to make them eligible for additional benefits.
- Be a central repository of extension services being offered by the government, private sector and institutions across the country.

How does it help India: India has a strong network of collaborative community structures in the form of FPOs and PCs that provide extension services to their respective members. A greater degree of cohesiveness is required between them.

Table 6. Micro, meso and macro levels of application of weather index-based insurance.

Policyholder	Sales or distribution model	Potential benefit(s) of weather index-based insurance
	Micro	
Farmers Households Small businesses	Farmers buy insurance as part of a package (e.g., credit and other financial services, technology, agricultural information) or occasionally as a stand-alone product Note: FSPs, farmers' associations, processors, input suppliers or NGOs can also act as a distribution channel for micro products retailed to individual farmers	Weather index-based insurance payout can: Allow farmer to avoid default and restart production Compensate for additional livestock feed costs Provide income support in lean periods Supplement other sources of household income that may be disrupted Facilitate access to credit Encourage investment in higher quality inputs
	Meso	
FSPs Processors Input suppliers Farmers' associations NGOs	Meso-level institutions buy weather index-based insurance policies (e.g., portfolio or group insurance) to protect their own exposure, and may create payout rules that directly or indirectly benefit farmers	Weather index-based insurance opens access to a new client base and helps manage mass defaults caused by weather shocks Meso-level actors can develop innovative linkages along the supply chain (e.g., contract farming, packaging of credit and inputs) to help manage their risk and open market opportunities
	Macro	
Government (or relief agencies)	Government or relief agency is reinsured	Government receives early liquidity following disasters; relief agency is able to fund operations

Source: Based on IFAD and WFP (2010).

Example: Farmer Associations' in high-income and low-income countries

Farmer Associations (FAs) play an important role in all economies, taking on a range of opportunities and cross-finance between them, such as processing, and bulk handling of outputs and inputs to generate funds for research, extension and training.

FAs in Europe

Denmark: Two main farmers' union organizations with some state financial support.

France: A variety of unions and cooperatives coordinated by a national association co-managed by the state and farm industry and chaired by a farmers' representative.

Finland: Services run by the farm industry with 50% subsidy by the state.

Sweden: Services run by farmers make up two-thirds of the services available to farmers with the rest provided by the state.

FAs in developing economies

In developing countries, farmer associations are usually associated with a particular crop, although some of these tend to diversify into a more general rural development focus. To take advantage of economies of scale, the public sector and NGOs jointly establish training facilities, or field extension programs with large-scale commercial farmers' association to extend services to small-scale farmers.

Initial scale: This scheme would benefit at least 1 million farmers across the country by inducing channelized investments into upgradation of infrastructure as well as the technical skill sets of individual farmers. Jammu & Kashmir, Himachal Pradesh, Uttarakhand and northeast India could be chosen for the pilot, with a focus on FPOs involved in horticulture/fruits and vegetables (See Section 4.5 for more details on supporting pilots).

Required steps: a) Devise a project Vision, Mission and Deliverables; b) Develop an operational strategy; and c) Execute the project in 5 years.

Partners: FPO/PC, Ministry of Agriculture, State Agriculture Department, Agri-Insurance company, Donor agency/Development Bank, local NGO, institutional procurer/buyer, private sector procurer/buyer, financial sector.

4.3 Better Governance

Since several agencies and organizations are involved in crop insurance programs, coordinated efforts are critical for the effective implementation of schemes. A comparative statistical analysis of different insurance products, enhanced consumer protection legislation for indexed insurance products, and research on better methods to combine information from different indices are required.

A Committee[5] appointed by the Government of India to examine the various issues related to crop insurance recommended the following measures:

- Developing a web portal to make data on land records for all states available to financial institutions.
- Revisiting MNAIS premium rates.

5. *Report of the Committee to Review the Implementation of Crop Insurance Schemes in India*, *2014*, submitted by a four-member Committee headed by Dr PK Mishra, former Secretary, Department of Agriculture and Cooperation. This was constituted in September 2013 to examine the loopholes in the implementation of the Crop Insurance Schemes.

- The Reserve Bank of India (RBI) and National Bank for Agriculture and Rural Development (NABARD) should effectively monitor the compliance of their circulars on compulsory crop insurance for loanee farmers.
- Insurance companies and banks should play a proactive role in ensuring effective implementation of schemes.
- State Governments should ensure the use of GPRS-enabled and camera-fitted mobile phones, while conducting crop cutting experiments.
- Developing an Atlas of critical weather elements for different agro-climatic regions.
- Formulating an Agricultural Insurance Act to cater to specific needs of crop insurance and agricultural insurance.
- Shifting from a social crop insurance program with ad-hoc funding from the Government of India to a market-based crop insurance program with actuarially sound premium rates and product design.
- The improved product and active involvement of private sector insurance markets are expected to lead to significant benefits for farmers, including faster claims settlement, a more equitable allocation of subsidies and lower basis risk. For the product to be pro-poor, small and marginal farmers must purchase the MNAIS product voluntarily, and insurers and government must experiment with cost-effective ways of increasing outreach.

A study by the CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) (De Nicola et al. 2011) concluded that the key to success is effective engagement with the private sector and efforts to address knowledge needs of the sector, with clear and quantifiable development outcomes. The use of latest technology such as GPRS-enabled and camera-fitted mobile phones may be used to implement crop insurance schemes more effectively. A comprehensive program of capacity building – in line with the needs of stakeholders such as State Government functionaries, insurers and Central Government agencies associated with crop insurance schemes should be organized. Programs for creating awareness and insurance literacy among farmers should be prepared by insurance companies and banks, in collaboration with the concerned State Governments.

4.4 Monitoring and Evaluation Indicators

Monitoring indicators	Agency responsible	Frequency	Source
List of insurers (loanee and non-loanee)	State-level committee	Half yearly, annually, and at completion of the project	Bank and lending institutions, Department of Agriculture
Establishment of geographical coverage area	State level committee and Department of Agriculture	Half yearly, annually, and at completion of the project	Department of Agriculture
List of beneficiaries (bank-wise & geographical area-wise) Number of farmers enrolled in WIBCIS Number of farmers enrolled in other schemes Number of policies (acres) Number of hectares/heads/policies	State-level committee	Half yearly, annually, and at completion of the project	Bank and lending institutions
Weather data Number of weather stations installed Number of weather stations upgraded	State-level committee, IMD and Department of Agriculture	Daily, monthly, yearly and at completion of the project	IMD
Number of distribution models to offer WIBCIS models Number of established linkages with lending institutions, rural banks, cooperatives	State-level committee	Half yearly, annually, and at completion of the project	Insurers
Losses in farm income due to climate and disaster risk reduced Losses (%) in farm income due to climate and disaster risk reduced	State-level committee	Half yearly, annually, and at completion of the project	Impact evaluation and baseline data report
Marketing and distribution Growth ratio Coverage ratio Participation ratio Renewal ratio Persistency ratio Farmers to agents ratio	State-level committee	Half yearly, annually, and at completion of the project	Insurers
Customer satisfaction Time to payout	State-level committee	Half yearly, annually, and at completion of the project	Insurers, customer satisfaction survey
Capacity building Number of farmers trained on weather-based insurance products Number of agents trained Number of agricultural staff and banking staff trained Number of weather station staff trained Number of competence training and awareness/customer communication	State-level committee	Half yearly, annually, and at completion of the project	State-level committee

Note: See Annexure I for more details.

4.5 Support Pilots

Considering the complexities of implementing WIBCIS, it is proposed (Figure 2) to have a few pilots representing major crop growing states like Punjab (wheat), Haryana (wheat), Rajasthan (mustard), Uttar Pradesh (rice), Gujarat (groundnut), Madhya Pradesh (soybean), Odisha (rice), Maharashtra (*rabi* jowar), Karnataka (pigeonpea), Andhra Pradesh (rice, groundnut and mango) and Tamil Nadu (rice and groundnut). Baseline surveys should be conducted to collect 15-year data on the area, yield and production at Taluk/Mandal and village levels to understand productivity variability under varying weather conditions.

Detailed and location-wise agroclimatic analyses based on historic weather data will help to identify abiotic factors limiting sustainable crop yields; identify critical periods, and quantify factors limiting promising crop varieties using calibrated and validated crop-growth simulation models. These will enable the derivation of weather risk indices that need to be validated under real field conditions for a few seasons. Crop acreage and health monitoring are to be taken up using high resolution and multi-temporal and multi-spectral satellite data along with ground measurement of weather data using Automatic Weather Stations. Crop losses due to weather aberrations will be estimated and proper policy guidelines and compensation needs to be worked out to pay to individual farmers.

A weather index can be constructed using any combination of measurable weather variables like temperature, rainfall, humidity and wind speed, over any period of time. The trigger level determines

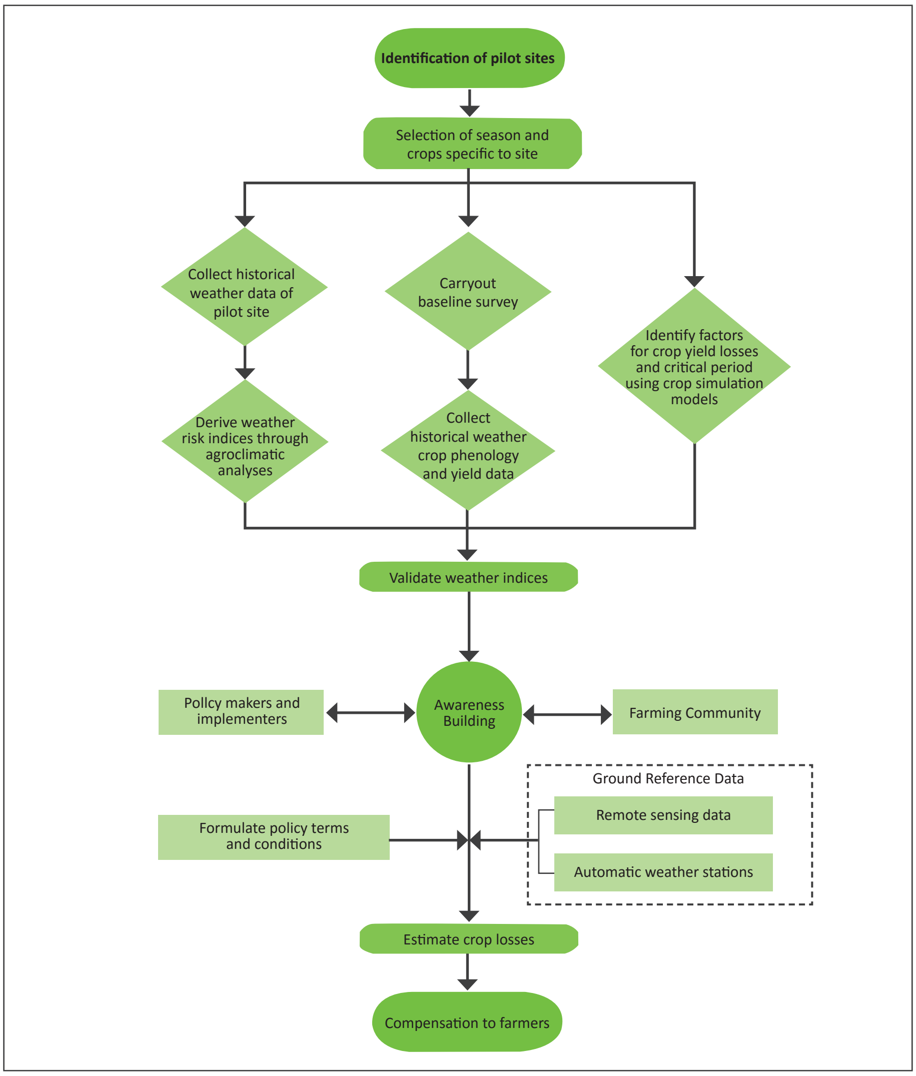


Figure 2. Proposed flow chart for the process of piloting weather index-based insurance.

the level at which compensation would begin for the farmer and the exit level determines the level at which the farmer would receive a maximum payout. A payout rate per crop-growing stage needs to be determined. A good index must account for the susceptibility of crops to weather factors during different stages of development.

Crop acreage and health monitoring should be taken up using high resolution and multi-temporal and multi-spectral satellite data along with ground measurement of weather data using Automatic Weather Stations. Crop losses due to weather aberrations will be estimated and through proper policy guidelines and accurate compensation needs to be worked out to pay the individual farmers. Establishing a price for the weather risk management instrument is essential and the premium charge could be defined as:

Premium = Expected Loss + Risk Margin + Administrative Costs

In addition to identifying delivery channels to reach the farming community, assessing the marketability of insurance products and monitoring pilots, it is important for the insurance products to be customized to local legal and regulatory frameworks.

The presence of high quality automatic weather stations representing several farmers' fields in one village or a cluster of villages is the key to weather index based insurance. The weather data must adhere to strict quality control with regard to sensors, maintenance and reporting procedures. Ideally, there must be a process of daily reporting to the World Meteorological Organization (WMO) and hourly/daily to National Meteorological Agencies like IMD.

Data generated by satellite-based rainfall measurements like Tropical Rainfall Measuring Mission (TRMM) and Global Precipitation Measurement (GPM) mission are mainly used for forecasting floods, droughts, crop yields, and for monitoring freshwater resources. For the operational WIBCIS, ground-based weather measurements are essential and possible by setting up self-recording rain gauges at the village level and Automatic Weather Stations for a cluster of villages. A self-recording rain gauge with GSM Modem communication (Telemetric rain gauge) costs about ₹50,000 while a complete Automatic Weather Station is about ₹4,50,000. Though there are limitations to index-based weather insurance contracts (since they cover only a portion of farm risks), they will be most effective and ultimately more sustainable and increase farm income.

4.6 Enabling Policy Framework

The vulnerability of resource-poor farmers and landless agricultural laborers is aggravated by the dominance of uninsured risks under conditions where opportunities for full-insurance are absent. Agricultural shocks are further amplified in rural areas where the markets for land, labor and credit are interlocked. Policy initiatives are urgently needed to protect small and marginal farmers from yield losses, floods, droughts, hailstorms and high temperatures. Among a few measures suggested are the following:

b. There are huge coverage gaps in terms of farmers benefitted and crops being covered under the state-sponsored and heavily subsidized MNAIS. A multi-peril, area-based crop insurance scheme is required that mandatorily covers all loanee farmers in the country.

c. The crop yield insurance scheme has been plagued with low coverage, high claims to premium ratio, and problems with both the design and implementation. To be a meaningful policy risk management tool, crop insurance would have to reach out to a majority of farmers, and not merely 15% of the farmers and 17% of cropped area as is the case now.

d. Universal coverage of farmers under crop insurance should be pursued aggressively alongside the goal of financial inclusion. Excluding non-loanee farmers who account for more than 50% of the total farmer base in India from access to cheaper institutional credit is a double penalty as they are largely left out of the majority of government programs.

e. Increasing the number of perils in a WIBCIS is not a constraint for insurers as they have demonstrated in the case of policies for horticultural crops that require risk coverage for more complex weather events and parameters in addition to rainfall and temperature. The quality of coverage under a peril is more important than the number of perils being covered.

f. The critical need to minimize basis risk by proper coverage of weather stations is underlined by the fact that more than three-fourth (77%) of respondents from the farmer beneficiary sample are not satisfied with the location of the weather station. It is time for India to invest heavily on the generation of comprehensive weather databases across locations and crops.

g. A weather insurance product is similar to a black box, with weather data as an input and a term-sheet as an output. While it continues to remain a mystery even for seasoned personnel dealing in sales and marketing of weather insurance, it is even more baffling for farmer customers who may not find it easy to unravel the technicalities in the design of weather insurance. Therefore, a more understandable, transparent mechanism needs to be developed to bring more awareness among farmers in the country.

h. Owing to the practically limitless number of designs possible for weather insurance, the task of exploring a diverse portfolio of designs and their contextual suitability is a specialized task that has unfortunately not attracted the level of attention and technical rigor that it deserves. There is a need for a taskforce of resource persons with expertise in the field to identify such diversity in design. A systematic and proper validation mechanism is needed before offering policies to farmers.

i. The density of Automatic Weather Stations and IMD observatories holds the key to better pricing of risk products over time, enabling the introduction of weather insurance based on other parameters. A warehouse of daily rainfall data for weather insurance is also important for disaster management as well as weather advisory service. The growth of high-density weather station networks across the country has been haphazard and devoid of a coordinated approach and integrated planning.

j. Insurance coverage should be made mandatory for all crops to minimize adverse selection. Bringing in the private sector would minimize the problem of moral hazard. Similarly, the component of subsidies to WIBCIS should be enhanced to encourage more farmer participation and rapid penetration. The Service tax on WIBCIS should be removed immediately for greater accessibility to small and marginal farmers.

k. Stakeholders in the crop insurance space are now looking at remote sensing technologies, which are witnessing rapid advancement. Till such time as such a technology becomes so reliable and cost-effective that it can be utilized for loss assessment of existing insurance units, the crop insurance sector in India will go through a transitional phase wherein NAIS and WIBCIS can play the role of either complements or alternatives, but not substitutes.

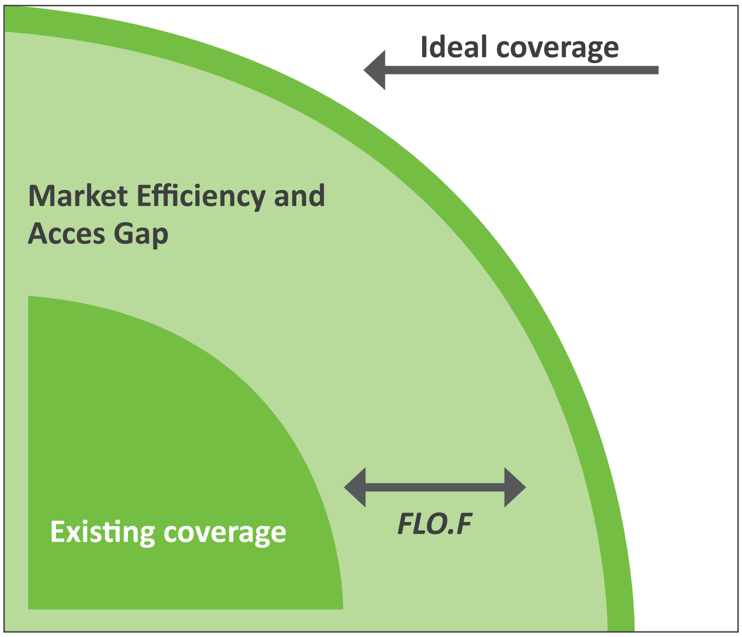
l. While this paper was in print, we learnt that, the recent Budget Speech 2016-17 of Government of India has clearly indicated that under Prime Minister Fasal Bima Yojana, Rs 5500 crores has been allocated to focus on crop insurance scheme[6]. The Prime Minister of India had launched this scheme in January 2016 with the following key features:
   - Biggest-ever government contribution to crop insurance
   - Farmers will pay the lowest-ever premium rate
   - The government will bear the remaining financial burden – even if the government's share exceeds 90%.
   - There will be only one premium rate for each crop season for all foodgrains, oilseeds and pulses – removing all variation in rates across crops and districts within a season – 2% in *kharif* and 1.5% in *rabi*.
   - Farmers will get full insurance cover. There will be no "capping" of the sum insured and consequently, claim amounts will not be cut or reduced.

6 The Budget Speech 2016-17 of the Government of India (Point no. 31) presented on 29th February, 2016. Www:finmin.nic.in/29-03-2016/6pm.

- For the first time,
  - Inundation has been included under localized risk cover.
  - Post-harvest losses arising out of cyclones and unseasonal rain have been covered nationally.
  - Emphasis has been given to mobile and satellite technology to facilitate accurate assessment and quick settlement of claims.
- This scheme will be implemented from the forthcoming kharif-2016 season.

5. Financing

5.1 Farm Livelihood Obligation Fund (FLO-F) for Agricultural Markets/ Mandis



Currently, premium payments remain a challenge for public and well as private agri-insurance companies due to a large number of claims. The Farm Livelihood Obligation Fund (FLO-F) (akin in principle to the Universal Service Obligation (USO) fund) would envisage creating an initial pool for Public Sector Insurance Companies to enable premium payments. The possible revenue streams for the fund can be: a) Budgetary allocation, b) cess, duty or taxes, and c) CSR fund channelization.

How does it help India: Currently, only about 20% of farmers in India are insured. Of the un-insured, 46% were found to be aware but not interested; while 24% said the facility was not available to them. As the most populated democracy in the world, it is important to protect the farmers' livelihoods and have a sustainable insurance ecosystem in place.

5.2 Corporate Social Responsibility (CSR) Funds for Farmer Groups/Individuals

Without significant subsidy from the government, index-based (or even other) insurance models have not seen much success. India already bears more than ₹ 4000 crore per year as premium subsidy and compensation packages. It is not entirely correct to surmise that premiums are high because of inadequate coverage. Rates are usually determined on loss data of previous years, and are independent of low penetration.

The real cost of agriculture insurance to the government also arises from the subsidies it bears in premiums. However, studies have suggested this trend to continue, with subsidy levels of 75% to be jointly borne by the Centre (50%) and State Governments (25%).

CSR funds can contribute towards reducing this burden on the exchequer. The combined prescribed amount for CSR spend for public and private sectors stood at almost ₹ 6500 crores for 2014-15, out of which about ₹ 5000 crores were spent. It is also interesting to note that public sector companies spent only 66.7% of what they had to spend in the year ended 31 March while private companies spent 82% of the prescribed spend in the first year of mandatory CSR spending.

This fact demonstrates that sufficient funds exist in theory to channelize finance for agriculture insurance. Under the present law (Schedule VII, Companies Act, 2013), it is 'indirectly' possible to contribute towards agri-insurance in some manner.

However, to derive any meaningful impact, it is imperative that Agriculture Insurance is specifically defined as a distinct subset of the CSR Law, as is the case with Agroforestry, which falls under Point 4 of Schedule VII, of the Companies Act, 2013.

In addition to insurance premiums, the CSR allocation could also include:

- Investments in drone technology
- Investments in capacity building and/or remuneration for business correspondents/ rural agents

5.3 Financial Concerns

i. Inadequate coverage of weather stations and the lack of confidence in the installed stations is an issue. Given that this is a capital intensive activity, it is recommended that private entrepreneurs be invited to set up weather stations in designated locations (at a distance of 25 kilometer from each other), capable of transmitting data on real time basis. Based on a cost plus approach, the investor may receive an annual pay off from the insurance company that receives a premium for WIBCIS. Viability gap funding may also be built in the scheme, if necessary. In order to gain the confidence of the farmer population, a national level agency may be set up (or a division established within the IMD) to institute a system of accreditation, certification and quality monitoring of weather stations to ensure accuracy and standardization of sensors and the integrity of data collected from these stations.

   Given the inadequate coverage of farmers, the pilot scheme underlines one challenge – a dedicated scheme could cover an average of just 8% of the farmer population. It is recommended that the entire farmer population should progressively be covered under an insurance scheme; it may even be WIBCIS.

   Though compulsory coverage has been challenged in multiple courts, the Government may review the situation and effectively contest these cases, so that this issue is put to rest. Meanwhile, it is recommended that pilots be taken up in select districts of the country, with the districts well spread out. The pilot projects should endeavor to cover the entire population of the district, so that WIBCIS is made universal in that area.

ii. The Committee set up by the Department of Agriculture and Cooperation, Government of India to Review the Implementation of Crop Insurance Schemes in India has recommended that financial institutions should ensure that loan accounts are related or linked to land records, through the web portal to be set up by the state government concerned. Further, a software interface between banks and insurers has also been recommended.

   With the setting up of a National Agricultural Market gaining acceptance, it is recommended that WIBCIS and the electronic platform facilitating transactions in that market be integrated.

   The National Agricultural Market electronic platform would collect and maintain farmer data to enable payments to them for the produce sold. This database may be made more comprehensive and integrated with banks and financial institutions, so that loan data is maintained. With WIBCIS and other insurance schemes becoming universal and loan data being captured in the database, it would be possible to directly discharge the loan taken out of the insurance proceeds if a payout happens. If the crop does not suffer any stress, sale proceeds realized can be used to discharge the loan.

   This seamless integration of lending, insurance and marketing will alleviate the problems faced by farmers to a large extent.

iii. Farmers view insurance premium as an avoidable additional cost, rather than as offering them protection against adverse situations. This calls for intensive and extensive stakeholder education. Premium affordability and more targeted subsidy should be looked into. Maybe, differential premiums, like farmers in irrigated areas paying more premium to cross-subsidise premium paid by farmers in non-irrigated areas can be considered.

iv. Banks and financial institutions lending to farmers could be advised to take a more proactive approach to insurance. Considering that the insurance policy is critical for them to realize the loans advanced, it is in their commercial interest to actively promote WIBCIS. The RBI and the IRDA could jointly work out the details in this regard.

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Annexure I

Table A-1. State-wise details of the WIBCIS in various states of India, Kharif 2007 to Kharif 2013.

State	Farmers insured (in lakhs)	Area covered (in lakh hectares)	Sum insured (in crore ₹)	Gross premium (in crore ₹)	Claims (in crore ₹)	Farmers benefitted (in lakhs)
Andhra Pradesh	28.40	45.03	11236.00	1130.00	992.00	21.78
Bihar	88.86	94.08	21588.00	1870.00	1369.00	68.82
Chhattisgarh	2.14	3.89	746.00	60.00	62.00	1.55
Gujarat	4.98	4.13	224.00	22.00	9.00	1.71
Haryana	2.67	4.27	1334.00	122.00	50.00	1.44
Himachal Pradesh	0.89	10.00	434.00	50.00	48.00	0.60
Jharkhand	3.58	3.42	656.00	58.00	40.00	2.94
Karnataka	8.12	10.28	1364.00	148.00	104.00	5.84
Kerala	0.81	0.57	173.00	18.00	13.00	0.44
Madhya Pradesh	9.42	16.62	3563.00	318.00	172.00	7.87
Maharashtra	5.91	6.79	2112.00	253.00	180.00	4.44
Odisha	3.16	4.57	1178.00	57.00	32.00	2.16
Punjab	0.10	0.30	1.00	0.00		
Rajasthan	302.80	420.46	34577.00	3237.00	2114.00	166.92
Tamil Nadu	1.27	1.85	308.00	30.00	18.00	0.52
Uttar Pradesh	4.47	2.99	1014.00	100.00	33.00	2.03
Uttarakhand	0.84	1.90	264.00	32.00	36.00	0.44
West Bengal	1.03	1.15	179.00	18.00	14.00	0.56
Total	469.45	632.30	80951.00	7523.00	5286.00	290.06

Source: Report of the Committee to Review the Implementation of Crop Insurance Schemes in India, Department of Agriculture and Cooperation, Government of India, 2014.

Table A-2. Coverage of NAIS in India.

Crops	Area covered (%)	Claims/ premium ratio	Premium/ sum assured (%)	Claims/sum assured (%)	Farmers benefitted / covered (%)	Sum assured as% of value of crop output
2007-08						
Paddy	18.21	3.87	2.43	9.41	15.55	9.81
Wheat	13.20	5.96	1.51	9.00	28.01	17.43
Groundnut	51.59	0.19	3.47	0.66	2.52	4.38
Potato	31.08	0.89	4.61	4.09	15.77	10.75
Cotton	3.77	0.03	7.61	0.24	0.80	69.00
2008-09						
Paddy	14.91	5.11	2.37	12.14	25.22	9.88
Wheat	13.99	3.19	1.52	4.83	16.84	13.83
Groundnut	52.98	9.06	3.47	31.45	53.26	3.23
Potato	21.16	4.35	7.39	32.17	78.87	6.60
Cotton	4.99	0.10	10.22	0.98	6.77	49.20
2009-10						
Paddy	26.02	3.79	2.47	9.36	31.73	5.12
Wheat	12.30	1.39	1.50	2.08	16.41	17.00
Groundnut	69.88	6.99	3.48	24.36	59.90	1.87
Potato	13.87	0.13	7.67	1.00	3.93	8.10
Cotton	5.53	0.58	7.28	4.20	15.04	27.08

Source: Report of the Committee to Review the Implementation of Crop Insurance Schemes in India, Department of Agriculture and Cooperation, Government of India, 2014.

Table A-3. Weather-based insurance in India.

Agricultural year	Farmers insured	Sum insured (in million US$)	Commercial premium volume (in million US$)	Claims paid(in million US$)	Claim payments as multiple of commercial premiums
2003-04	1,000		<0.1	<0.1[2]	
2004-05	11,300		0.2	0.1[2]	
2005-06	112,500		1.6	0.2[2]	
2006-07	181,900		1.6	1.0[2]	
2007-08[3]	678,425	398	33.1	23.9	72%
2008-09[3]	375,100	208	18.6	14.2	77%
2009-10[3]	2,278,407	1,093	99.9	62.0	62%
2010-11[3]	9,278,000	3,174	258.9	125.0	48%

1 Commercial premium includes both farmer premium and government premium subsidies.
2 Kharif season only.
3. WIBCIS only.
Source: Clarkeetal.(2012).

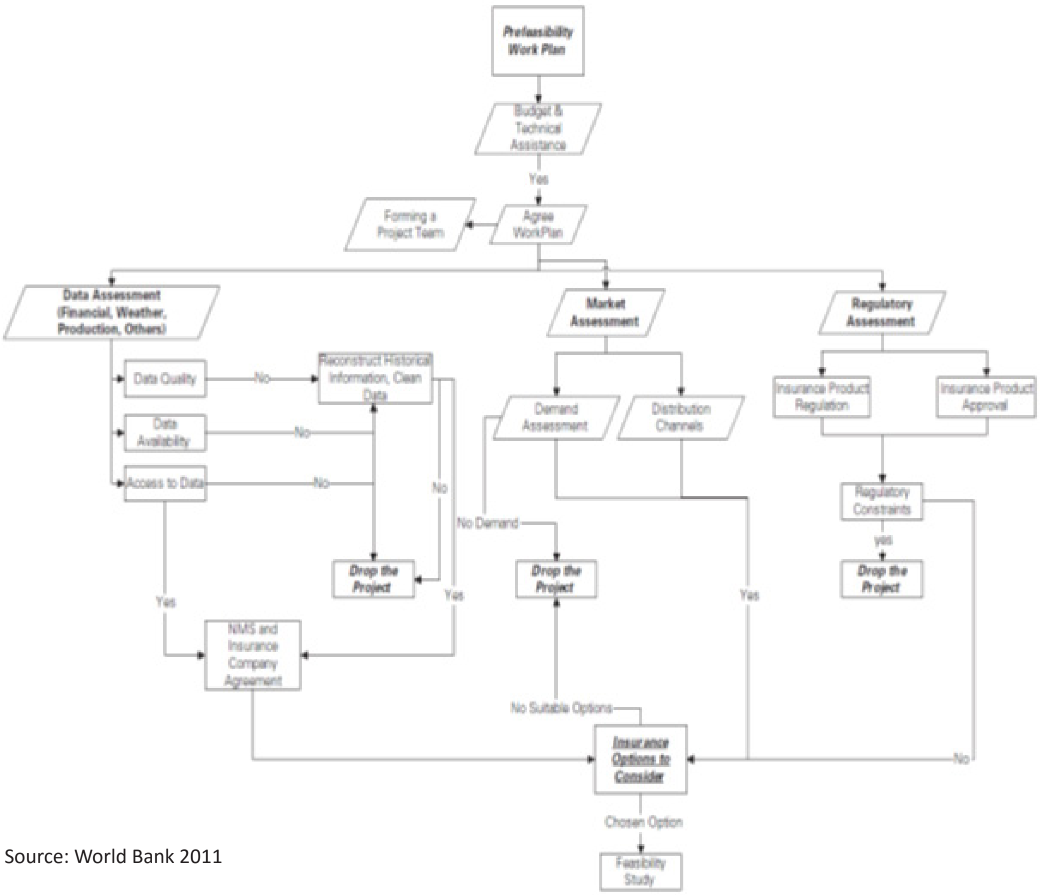
Table A-4.Crop coverage in all Schemes in 2013-14.

Sl.No.	Crop	Gross area sown (Lakh Ha)	Area Insured (Lakh Ha) NAIS	MNAIS	WBCIS	TOTAL	% Coverage
1	Paddy	434	36.15	38.71	33.58	108.44	25
2	Wheat	290	46.35	7.18	6.51	60.04	21
3	Coarse Grains	270	9.26	16.74	13.85	39.85	12
4	Sugarcane	47	0.26	1.70	0.00	1.96	4
5	Cotton	110	7.92	0.28	6.75	14.96	14
6	Jute & Mesta	10	0.00	1.71	0.00	1.71	17
7	Oilseeds	270	68.55	25.09	14.94	108.58	40
8	Pulses	240	21.90	15.71	9.22	46.82	20
9	Vegetables	170	1.81	12.30	5.28	19.39	11
10	Fruits	90	0.05	0.02	0.89	0.97	1
11	Grand Total	1922	192.25	119.45	91.02	402.72	21

Source: Ministry of Agriculture and Farmers Welfare, Government of India, 2015.

Annexure II

Process map decision tree for a pre- feasibility study.



Source: World Bank 2011

Annexure III

Crop simulation models

Decision Support System for Agrotechnology Transfer (*DSSAT*)

Crop simulation models can be used as valuable tools in assessing sustainability of cropping systems. Some of the methodological challenges in assessing sustainability both temporarily and spatially can be addressed using crop simulation models. The major components of the model are vegetative and reproductive development, carbon balance, water balance and nitrogen balance. It simulates crop growth and development using a daily time step from sowing to maturity and ultimately predicts yield. Genotypic differences in growth, development and yield of crop cultivars are affected through genetic coefficients (cultivar-specific parameters) that are inputs to the model. The physiological processes that are simulated describe the crop response to major weather factors, including temperature, precipitation and solar radiation and include the effect of soil characteristics on water availability for crop growth. Wherever required information like crop genetic characters and phenotype are not available, simulations of yield parameters and weather parameters will be carried out either with proxies or simulation packages like CRYSTAL Ball.

Model inputs

The minimum data sets required to simulate a crop for a site include site location and soil characteristics, daily weather and agronomic management data. The model also needs input of cultivar-specific parameters (genetic coefficients) that distinguish one cultivar from another in terms of crop phenology, growth and partitioning to vegetative and reproductive organs and seed quality. The soil-profile data for the study sites can be obtained from the profile characteristics data published NBSSLUP, Nagpur else we need to develop soil profile specific to site.

Water Requirement Satisfaction Index (WRSI)

Studies by the FAO have shown that WRSI can be related to crop yield deviations, and these water-balance crop growth models have been extensively tested in many climates. Indeed the WRSI model was initially developed for use with weather station data to monitor the supply and demand of water for a rainfed crop during the growing season. The model is also currently used by the Famine Early Warning Network (FEWS-NET) to monitor agricultural areas around the world for signs of drought on a near-real-time, spatial, and continuous basis using a combination of satellite-derivative rainfall estimates and rain station data to compute WRSI values. These models also form the backbone of most crop production early warning systems run by government agencies in non-humid tropics, particularly in Africa.

Technical Details

The WRSI measures crop performance based on the balance between water supply and demand during the growing season. The WRSI is computed as the ratio between evapotranspiration and the water requirement of the crop. If "actual evapotranspiration" a function of water availability in the soil, is identified as AET and the "water requirement" a function of atmospheric conditions and plant growth phases as WR, WRSI is determined by the following relationship: $WRSI(i) = 100 * AET(i) / WR(i)$

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