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IMPLEMENTATION ISSUES IN WEATHER INDEX-BASED INSURANCE FOR AGRICULTURAL PRODUCTION: *A Philippine Case Study*

INSTITUTE OF GLOBAL ENVIRONMENTAL STRATEGIES (IGES)
2108-11 Kamiyamaguchi, Hayama, Kanagawa 240-0115, Japan
Tel.: +81 468 553 720
Fax: +81 468 553 709
E-mail: iges@iges.or.jp

SOUTHEAST ASIAN REGIONAL CENTER FOR GRADUATE STUDY AND RESEARCH IN AGRICULTURE (SEARCA)
College, Los Baños, Laguna 4031, Philippines
Tel.: (+63 49) 536 2361; 536 2363
Fax: (+63 49) 536 7097; 536 2283
E-mail: post@agri.searca.org
Websites: www.searca.org; www.climatechange.searca.org

Implementation Issues in Weather Index-based Insurance for Agricultural Production: A Philippine Case Study

Felino P. Lansigan
Professor and Dean
Institute of Statistics
College of Arts and Sciences
University of the Philippines Los Baños

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ACRONYMS

AMS	ASEAN Member States
AWS	automatic weather stations
CC	climate change
CCA	climate change adaptation
CRRM	climate risk reduction and management
DA	Department of Agriculture
ENSO	El Niño Southern Oscillation
Et	evapo-transpiration
GIS	geographic information system
GPS	geographic positioning system
LGU	local government unit
MS	maturity stage
NGO	non-governmental organizations
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Service Administration
PCIC	Philippine Crop Insurance Corporation
PSB	Philippine Seed Board
RS	reproductive stage
PhilCAP	Philippine Climate Change Adaptation Project
SUCs	State Universities and Colleges
TP	total probability
UPLB	University of the Philippines Los Baños
VS	vegetative stage
WIBI	Weather Index-based Insurance
WMO	World Meteorological Organization

EXECUTIVE SUMMARY

Climate variability and weather fluctuations are important risk factors in crop production. They have caused reduced yields and significant reduction in crop production throughout Southeast Asia. As a risk management strategy, crop insurance has been promoted in risk-prone areas in the region to reduce the adverse impacts of climate hazards. However, crop insurance products have not been very popular among farmers and crop growers due to limited coverage amidst high premium as well as apparent subjectivity and bias in crop damage assessment. In recent years, weather index-based insurance (WIBI) products have been proposed to address climate risk more objectively. Issues involved in the implementation of WIBI crop insurance include the determination of appropriate indices in terms of threshold levels, estimation of risk of not meeting the thresholds, and paucity of adequate weather stations from which to gauge or base the threshold values. A case study from the Philippines is presented to determine objectively the threshold levels or index critical in rice production using the water requirements based on rainfall through the cumulative water demand for different phases of crop growth and development, namely: vegetative stage, flowering stage, and maturity stage. Risks of rainfall deficits in rice production for different planting dates for typical rice varieties grown are estimated in selected Philippine provinces, namely, Ilocos Norte, Iloilo, Agusan del Norte, and Laguna. The estimated climate risks based on weekly probabilities of rainfall deficits can then be used in defining and developing WIBI insurance products. They may also be used to determine the low risk-period for growing rice specific for a particular location and climate type. Challenges and issues for the effective and efficient implementation of WIBI in the ASEAN region are then discussed in light of this Philippine case study.

INTRODUCTION

Climate and weather play an important role in crop production. Weather fluctuations and climate variability affect crop growth and development, define crop productivity, and also determine the cropping season (Matthews and Stephen 2007; Lansigan et al. 2007). An objective and science-based assessment of the effects of climate variability on crop productivity provides a systematic evaluation of the vulnerability and risk of crop production due to climate variability (Lansigan 2005). Advances in information and communication technologies as well as in various scientific disciplines in recent years have facilitated the integration of information and the generation of new knowledge using systems research tools such as process-based crop simulation models (Matthews and Stephens 2002; Matthews et al. 1997), geographic information system (GIS), remote sensing (RS), optimisation techniques, geographic positioning system (GPS), and database management. Such advances and developments in Southeast Asia have also provided opportunities to better evaluate the effects of anticipated weather and climate variability on crop production.

Climate variability exhibited by more erratic rainfall distribution and more frequent occurrences of extreme events has profound effects and impacts on crop growth and development. Availability of water from rainfall is crucial especially for rainfed crop production systems. With two-thirds of total arable land in the region planted to paddy rice, the variability of water scarcity is of keen interest to farmers and government (WB 2012). In ASEAN Member States (AMS) such as Indonesia, where 90 per cent of farmers are susceptible to weather risks and 80 per cent of agricultural activity depends on rainfall for irrigation, only 17 per cent of the country's cultivated areas has access to irrigation infrastructure and only 10 per cent are effectively irrigated (IFC 2008). The effects and impacts of historical occurrence of extreme climate events such as the El Niño Southern Oscillation (ENSO) episodes during the last six decades are clearly reflected in the time series of rice and corn production. Rice and corn yields decrease significantly during the severe ENSO events experienced such as in 1997-1998 and also in the 1982-1983 drought episodes.

A number of adaptation strategies to address climate variability in agriculture have been adopted in Southeast Asia. One common approach is changing the planting date or adjusting the cropping calendar, i.e., synchronising the crop growing period to coincide with sufficient rainfall for crop growth and development. Several procedures and indicators are being applied to determine the best time to plant the crops ranging from indigenous knowledge, and rule-of-thumb methods, to more science-based approaches anchored on crop eco-physiology (e.g. Yoshida 1981). However, these procedures have to be adjusted and updated in the light of climate variability. For instance, Yoshida (1981) postulated that rice growing season in an area can start when cumulative rainfall has reached 200 mm during the next 30 days counting from the driest day in the year for a particular area. Rainfall threshold level for corn is less. This postulate has been verified via crop simulation with available historical datasets for Los Baños and other locations in the Philippines (Lansigan et al. 2007).

Another adaptation strategy to cope with the adverse effects and impacts of climate variability is crop insurance which is a risk transfer or sharing mechanism. An innovative local climate risk transfer mechanism in the Philippines is the '*pakyaw*' arrangement between the farmer and the client interested on the crop harvest. Traditional crop insurance provides indemnity to farmers when the crops are damaged or lost. Agri-insurance provided through the Philippine Crop Insurance Corporation (PCIC) has been limited only to major crops such as rice and corn. Crop insurance has not been very popular in the Philippines due to a number of inherent limitations. Meanwhile the rest of the AMS has had difficulty achieving scale in implementing disaster insurance, such as recent efforts by Indonesia at introducing flood index insurance (Bhat and Mukherjee 2013). In recent years, innovative insurance products such as weather index-based insurance (WIBI) have been proposed, and have been implemented in developed and developing countries. Whereas conventional or traditional crop insurance relies on direct measurements of loss or damage, WIBI depends on some weather-related index highly correlated with crop yields such as rainfall and temperature. Thus, WIBI relies on the objective definition of the index and the assessment of the associated climate risks based on such weather index. While WIBI is a novel and objective scheme for climate risk sharing and transfer, there are operational issues to be addressed for its successful implementation in the region. Currently known WIBI implementation or research has been conducted in the Philippines, Indonesia, Thailand with similar index-based disaster risk transfer mechanism piloted in Vietnam and Indonesia (FAO 2011; Bhat and Mukherjee 2013).

The report aims to estimate the climate risk based on probability of cumulative rainfall deficit for crop production focused on annual crops such as rice and corn in the Philippines. It also attempts to present the issues, challenges, and imperatives for the efficient implementation of WIBI in the Philippines and presents implications for the AMS and other Southeast Asian countries. The report presents formulation of weather index-based insurance (WIBI) products using the cumulative crop water requirement for each different phase of crop growth and development, and rainfall distribution during the crop growing season. The development stages of annual crops such as rice and corn, and the water requirement based on evapo-transpiration demand which may be supplied by rainfall are described. Results of estimation and analysis of weekly rainfall deficits are presented to illustrate the WIBI for rice crop grown in selected locations in the Philippines representing varying climate types. The report also discusses the attendant issues and challenges that need to be addressed for the efficient implementation of WIBI agri-insurance products for managing climate risks in crop production in the Philippines and relates these to current efforts in other AMS which are in pre-pilot or pilot stages of WIBI agri-insurance implementation. Some interventions addressing these issues are also recommended.

WIBI as Risk Management Strategy

Traditional or conventional agri-insurance often involves direct assessment of crop loss or damage after the occurrence of climate event or peril. However, measurements and assessments of crop losses and damages are often very expensive and tedious especially when there are many small-scale farmers involved or when the insurance market is still not fully developed (IFAD 2011). Conventional insurance products are often named-peril or multi-peril insurance coverage that provide for indemnity for losses or damages to agricultural crops whenever adverse events or a combination of adverse conditions occur.

There are a number of inherent limitations to the conventional insurance products. These limitations and drawbacks include (Banerjee and Berg 2012; Doherty 2000) (1) the difficulty of controlling moral hazard whereby the insured farmer behave more riskily due to the availability of insurance coverage, (2) inability to control adverse selection wherein more risky farmers seek insurance coverage while less risk-prone farmers ignore the coverage, (3) inadequate and inefficient institutions which make monitoring and assessment of risks of many farmers more costly, and (4) many weather-related hazards are often correlated with each other which make assessment of losses and damages more challenging for insurance providers.

As an alternative to conventional insurance, WIBI products have been promoted by international development agencies with local insurance providers in developing countries in Africa and Asia. Four countries in the ASEAN have either known successful commercial index insurance products (Philippines), small crop weather index insurance pilot programmes (Indonesia and Thailand), or crop weather index insurance pilots designed and are awaiting implementation (Vietnam) (FAO 2011). The WIBI has been piloted by the Philippine Crop Insurance Corporation (PCIC) and MicroEnsure in collaboration with local insurance providers in the Philippines. In Indonesia, disaster insurance has been piloted by private insurer PT ACA and MAIPARK. Previously, private insurer PT Wahana Tata backed by German International Co-operation (GIZ) and Munich-Re failed to achieve commercial scale in introducing a flood index insurance product in Jakarta due to (1) low value proposition, (2) high premium charge, (3) failure to adjust to the preference of the market, and (4) an incomplete understanding of the hydrological context of the area covered (Bhat and Muherjee 2013). In Thailand, Thai Reinsurance Public Company Ltd. and a co-insurance pool of nine other insurance companies have underwritten WIBI products for maize (FAO 2011). Vietnam has designed a pilot for flood cover for rice and drought index cover for coffee and is awaiting implementation. WIBI is an innovative agri-insurance product for climate risk management which can potentially reduce the negative financial consequences of adverse weather events and fluctuations in many developing economies (Banerjee and Berg 2012). However, the feasibility of WIBI depends much on a number of factors including the development of the appropriate weather index as well as the provision of enabling institutional framework for its implementation and operations.

WIBI relies on the objective measure or indicator of risk due to weather such as rainfall and temperature. An example of a commonly used weather index related to crop yield is the cumulative rainfall for each of the crop growth and development stages. Another example is the number of days with temperatures above or below a certain threshold temperature (Banerjee and Berg 2012). In other ASEAN countries, efforts using river gauge data as a proxy for flood damage have been piloted in Vietnam and Indonesia, and are similar in nature to weather-based measurement indices (Bhat and Mukherjee 2013). WIBI can also address moral hazard and adverse selection. Moreover, since pay-outs or payments of indemnities are based on observed weather data from accredited weather gauging stations, costs of monitoring and assessment are minimised (Barnett et al. 2008). Thus, operational cost is low and rapid pay-offs are expected. Nevertheless, WIBI has also some disadvantages related to basis risk, limited hazards or perils, the need to replicate and adjust the index, and inadequacy of available weather data for the cropped areas (IFAD 2011).

WIBI offers an objective and transparent adaptation in agricultural crop production that can complement the suite of measures to cope with climate variability and climate change. It should not be seen though to replace other climate change adaptation measures.

METHODOLOGY

Climate risk is estimated as the probability of cumulative rainfall deficit with respect to three different stages of crop growth and development, namely: Vegetative Stage (VS), Reproductive Stage (RS), and Maturity Stage (MS). Evapo-transpiration (Et) rate for rice crop is assumed to be 6 mm/day (Yoshida 1981). For this study, the traditional rainfed rice variety PSB Rc 82 is considered since it is categorised as a standard variety (Dela Cruz 2013). This variety has similar characteristics as the newer rainfed lowland variety NSIC 282. Rainfall deficit is determined by calculating the cumulative rainfall requirement for each development stage based on Et per day and the phase duration.

Historical sequences of daily rainfall data for selected locations (Batac, Ilocos Norte; Butuan, Agusan del Sur; Iloilo, Iloilo; and Los Baños, Laguna) were collected from the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAG-ASA) and from the University of the Philippines Los Baños (UPLB) Department of Agrometeorology and Farm Structures. Relative frequencies of cumulative rainfall deficits were calculated at weekly planting intervals. The relative frequencies of meeting rainfall requirement for each location are used as estimates of weekly climate risks which will be the basis for formulating the WIBI product.

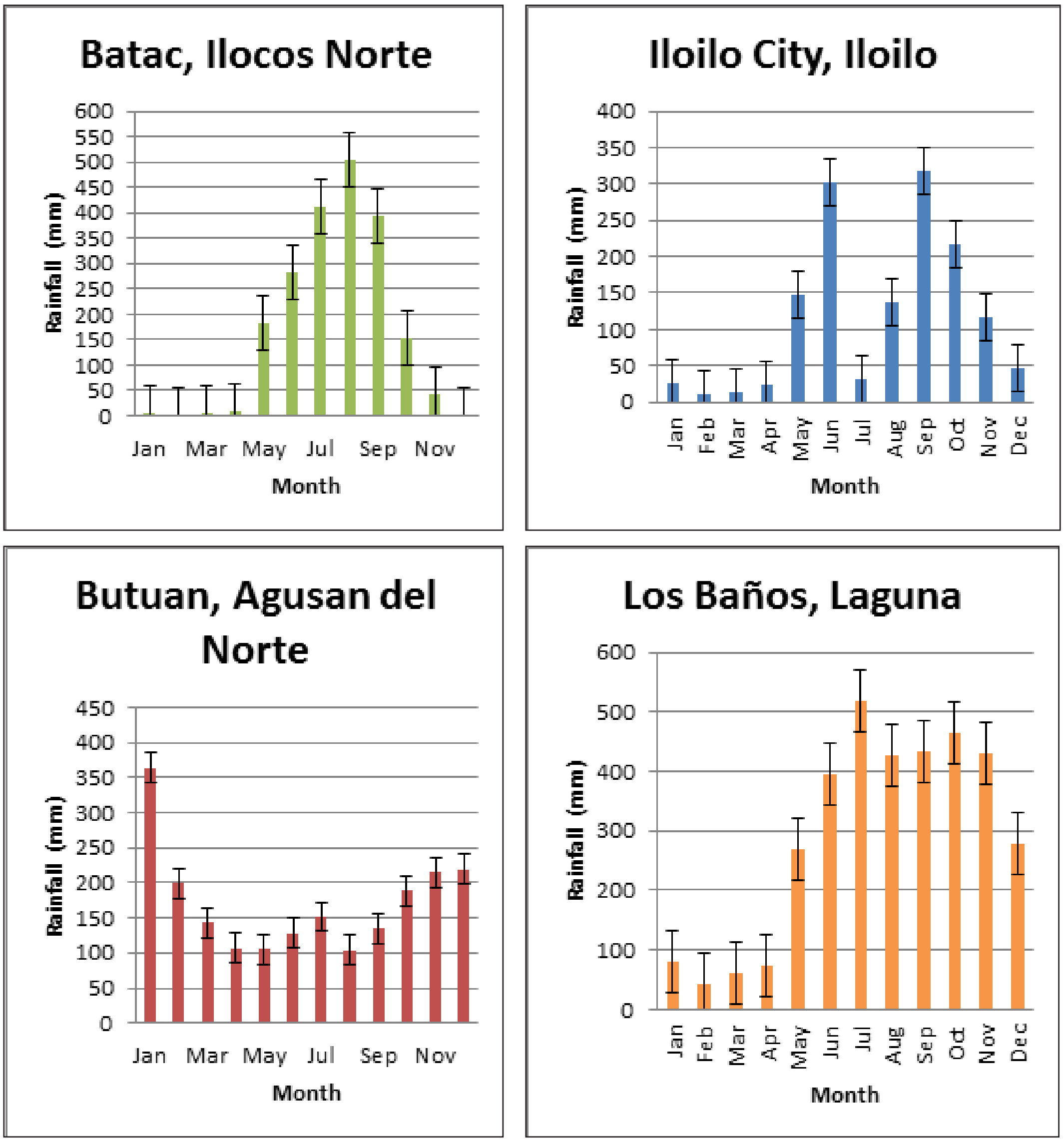
Review and scrutiny of the requirements and procedures of the PCIC were conducted to come up with the issues and challenges besetting the WIBI vis-à-vis the current situations of existing institutions associated with the implementation of the innovative insurance product.

ANALYSIS

Climate Risk Analysis

For this study, four sites in the Philippines were selected considering the major island groups and climatic types as well as the availability of adequate historical weather data. These are Batac (Ilocos Norte), Iloilo City (Iloilo), Butuan City (Agusan del Norte), and Los Baños (Laguna). Figure 1 shows the monthly rainfall patterns for the four locations indicating varying degrees of distinction between the wet and dry seasons within the year. Rainfall distributions in Batac, Iloilo City, and Los Baños exhibit well-defined wet period and dry period. However, rainfall distribution in Butuan City shows no defined dry season.

Figure 1. Monthly mean rainfall (mm) in selected locations (Batac, Iloilo City, Butuan City, and Los Baños) based on available historical weather data



Source of Data: PAGASA (2012)

While the rainfall distributions within the year are different, crop productivity for rainfed rice for these locations is relatively the same but with a wide range of yield variability. Table 1 shows the crop statistics for rainfed rice production in the four locations. Iloilo has the highest rainfed rice production considering it has one of the highest rainfed rice areas in the Philippines. Batac is also reported to have the highest maximum rice productivity among the four locations. But it also has the highest variability in yields like Butuan City.

Table 1. Rainfed rice productivity (mt/ha) and annual rice production (mt) for selected locations in the Philippines from 1980 to 2009

	CROPPED AREA (ha)	AVERAGE PRODUCTION (mt)	STD DEV (mt)	MEAN YIELD (mt/ha)	MAX YIELD (mt/ha)	MIN YIELD (mt/ha)	STD. DEV YIELD (mt/ha)
Ilocos Norte	10,101.93	24,133.63	11,973.00	2.34	4.28	1.02	0.88
Iloilo	133,259.61	277,585.71	12,207.00	2.14	2.98	1.33	0.48
Agusan del Norte	8,583.39	19,585.49	11,187.00	2.22	3.60	0.25	0.80
Laguna	3,210.34	5,691.15	5,874.00	2.23	3.36	0.81	0.56

Source: BAS (2010)

Estimation and Analysis of Cumulative Rainfall Deficit

Implementation of WIBI requires used of weather variables such as rainfall and temperature which are highly correlated with crop yields. For rainfed rice production, cumulative rainfall requirement for the three stages of crop growth and development are considered as index. Duration of development stages varies with respect to crop variety. Table 2 summarises the duration (in days) of phases of crop growth and development of two rice varieties (a standard rice variety IR-64, and a rainfed rice variety PSB Rc 82), which are commonly planted in the Philippines in recent years. While IR-64 is a lowland irrigated variety, it is also planted in lowland rainfed areas in some cases.

Table 2. Duration of crop growth and development stages and corresponding water requirements for a 'standard' rice variety IR64 and rainfed rice variety PSB Rc 82

	RICE VARIETIES					
	IR64 (110 days)			PSB Rc 82 (120 days)		
DEVELOPMENT STAGES	*Vegetative Stage*	*Flowering Stage*	*Maturity Stage*	*Vegetative Stage*	*Flowering Stage*	*Maturity Stage*
Number of days	45	35	30	55	35	30
Amount needed, 6 mm/day (Yoshida 1981)	270	210	180	330	210	180
Amount needed, 7 mm/day (FAO 2004)	315	245	210	385	245	210

Source: Yoshida (1981) and FAO (2004)

The estimated cumulative rainfall requirements for each stage may be estimated based on evapo-transpiration demand using Yoshida (1981) or FAO method (2004). For this study, Yoshida's approach is used assuming an evaporative demand of 6 mm/day for crop growth. Thus, the cumulative rainfall for a development stage (defined as weather index) are 330mm, 210 mm, and 180 mm for Vegetative Stage (55 days), Reproductive Stage (35 days), and Maturity Stage (30 days), respectively. The probability of cumulative rainfall deficit for each stage can be estimated based on the relative frequency of rainfall distribution which can then be used as measures of climate risks associated with each stage.

The plots of weekly climate risks for the different stages of crop growth (i.e., VS, RS, and MS) in selected locations are shown in Figures 2 through 9. The product of these three weekly probabilities gives the estimates of climate risk. Figure 2 shows the estimated probability of not meeting the cumulative rainfall requirements of the crops for the 3 stages in Ilocos Norte. Figure 3, on the other hand, plots the weekly estimated probabilities of rainfall deficit for different planting dates which are obtained as the product of weekly probabilities in Figure 2. Also shown in Figure 3 are the estimated probability of crop failure where crop failure is defined when the yield is below a certain threshold level such as the break-even yield, or the average historical yield in the area.

Figure 2. Estimated risks of rainfall deficit for different stages of growth of PSB Rc 82 rice variety in Batac, Ilocos Norte using 6mm evapo-transpiration (Et) demand, based on historical weather data from 1976 to 2006

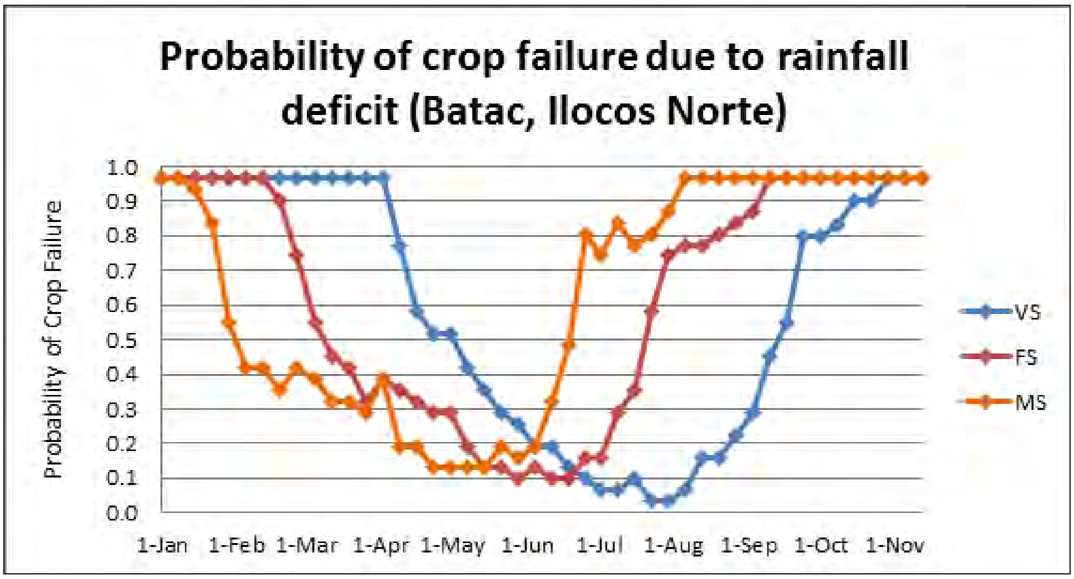
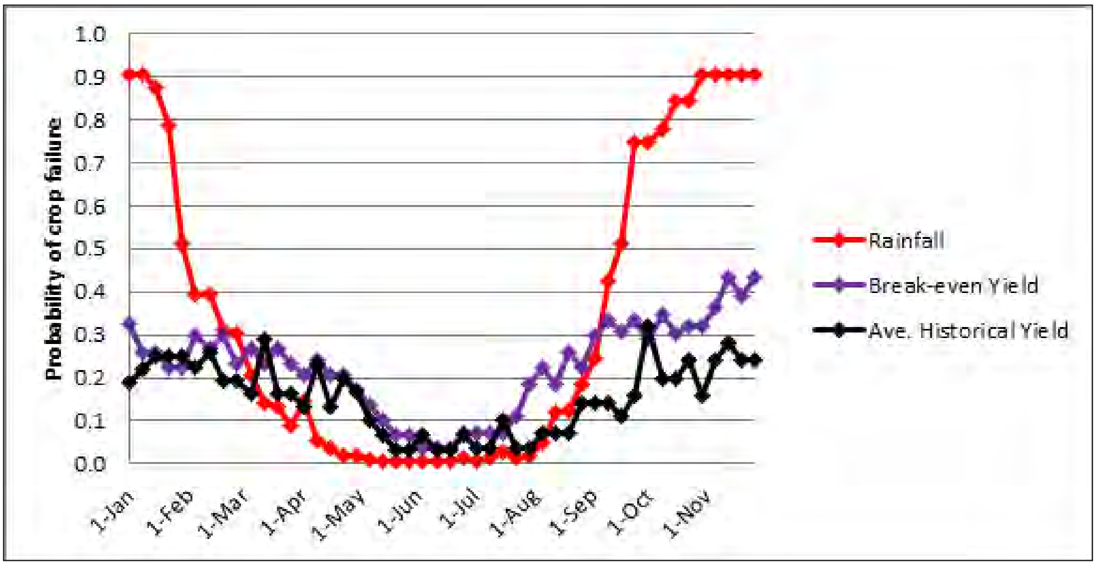


Figure 3. Probability of crop failure of PSB Rc 82 rice variety based on meeting rainfall requirement, break-even yield and average historical yield in Batac using historical weather data from 1976 to 2006



Figures 4 and 5 show the same information for Iloilo City where the probability of rainfall deficit is below 10 per cent from April to later part of August. On the other hand, the estimated probabilities of rainfall deficit in Butuan City are shown in Figures 6 and 7. The plots show the erratic rainfall pattern within the month even if there is sufficient rainfall volume for the month. Nevertheless, the period from October to January has the lowest estimated probability of crop failure which is due to rainfall deficit. For comparison purposes, weekly planting of rainfed rice variety in Los Baños is also considered. The probabilities of cumulative rainfall deficit are calculated and plotted in Figures 8 and 9. The period for low climate risks in Los Baños is from April to September.

Figure 4. Estimated risks of rainfall deficit for different stages of growth of PSB Rc 82 rice variety in Iloilo City using 6mm evapo-transpiration (Et) demand using historical weather data from 1970 to 2009

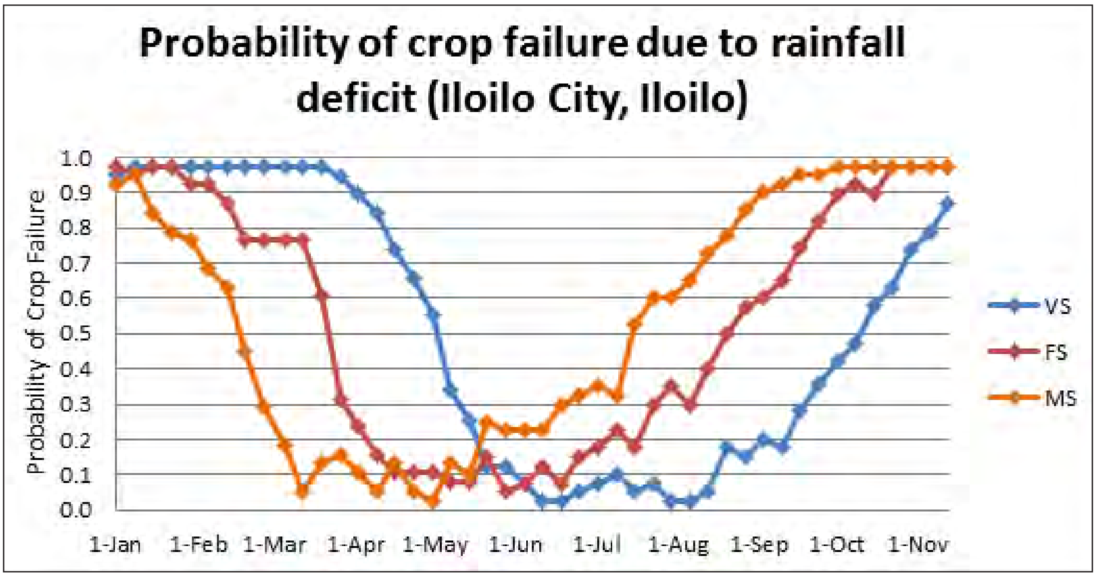


Figure 5. Probability of crop failure of PSB Rc 82 rice variety based on meeting rainfall requirement, break-even yield and average historical yield in Iloilo City using historical weather data from 1970 to 2009

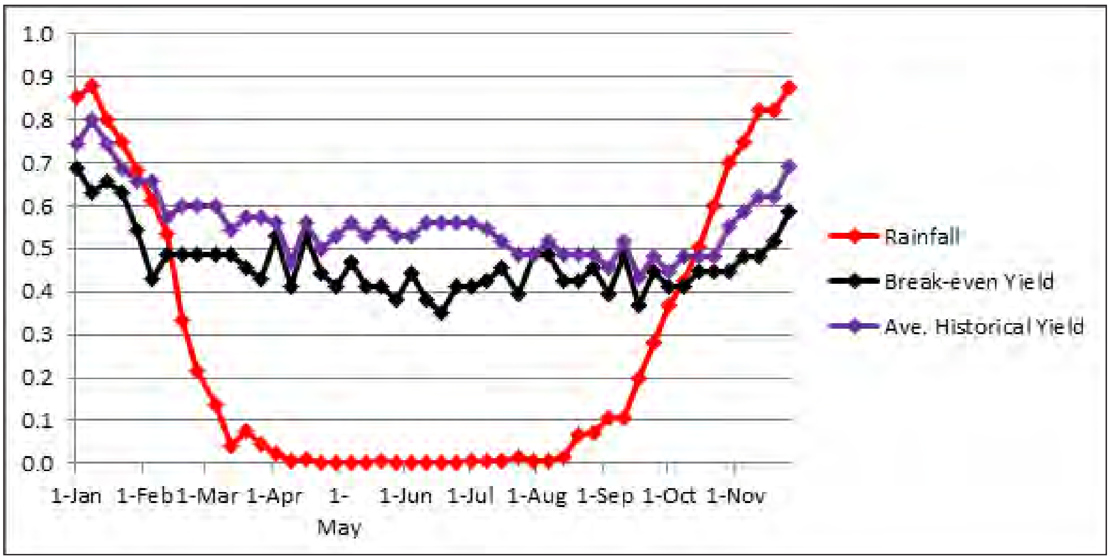


Figure 6. Estimated risks of rainfall deficit for different stages of growth of PSB Rc 82 rice variety in Butuan City using 6mm evapo-transpiration (Et) demand using historical weather data from 1980 to 2009

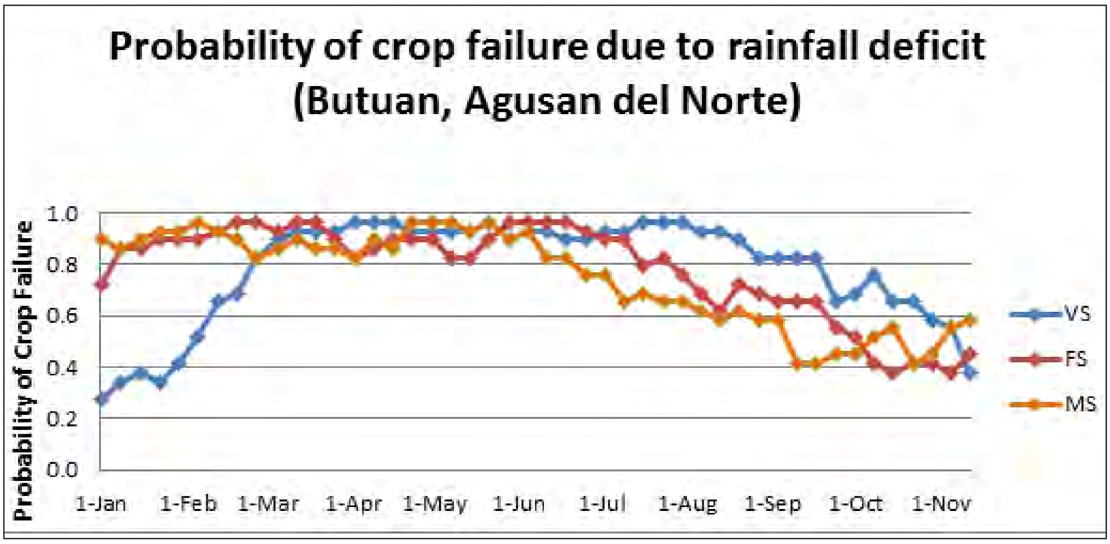


Figure 7. Probability of crop failure of PSB Rc 82 rice variety based on meeting rainfall requirement, break-even yield and average historical yield in Butuan City using historical weather data from 1980 to 2009

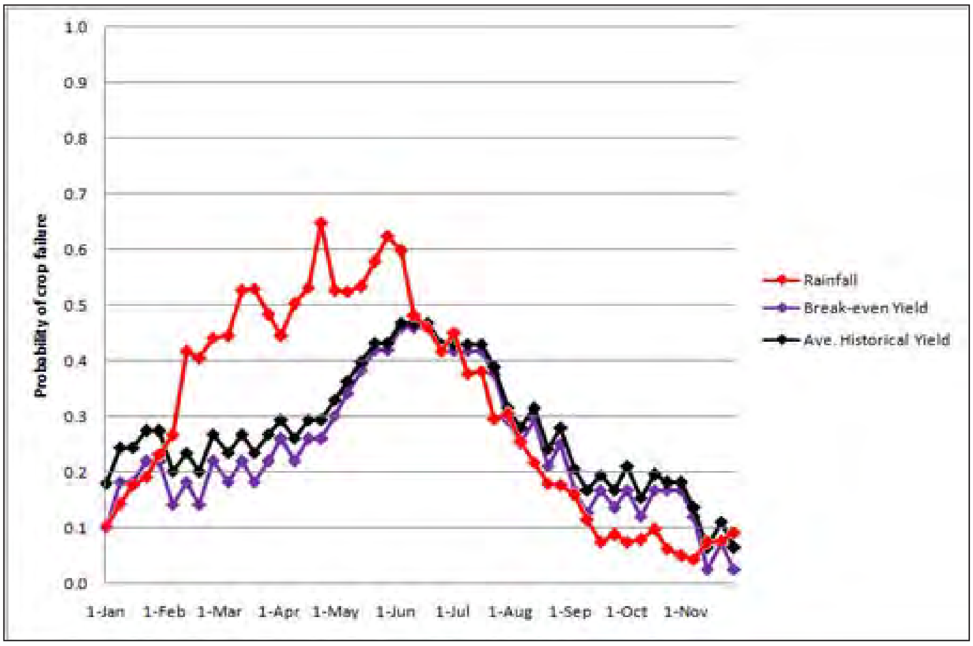


Figure 8. Estimated risks of rainfall deficit for different stages of growth of PSB Rc 82 rice variety in Los Baños using 6mm evapo-transpiration (Et) demand using historical weather data from 1976 to 2009

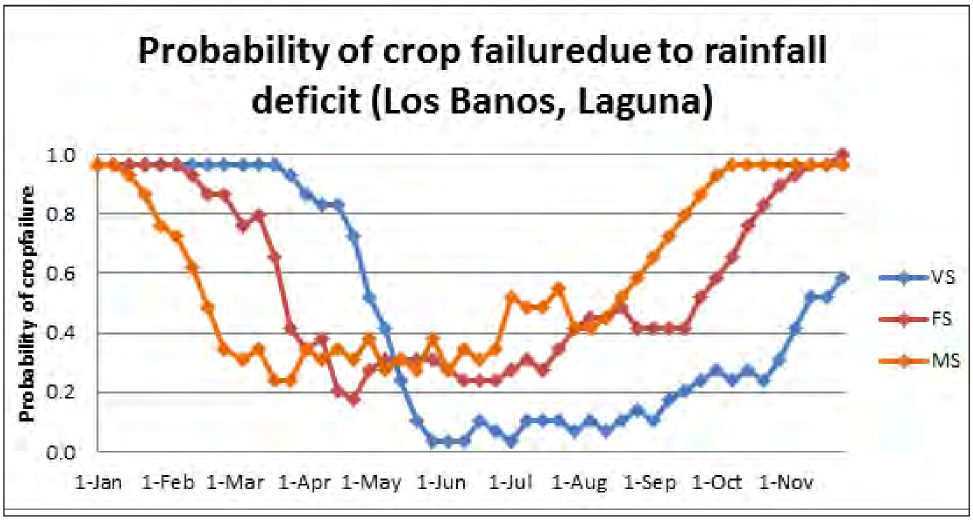
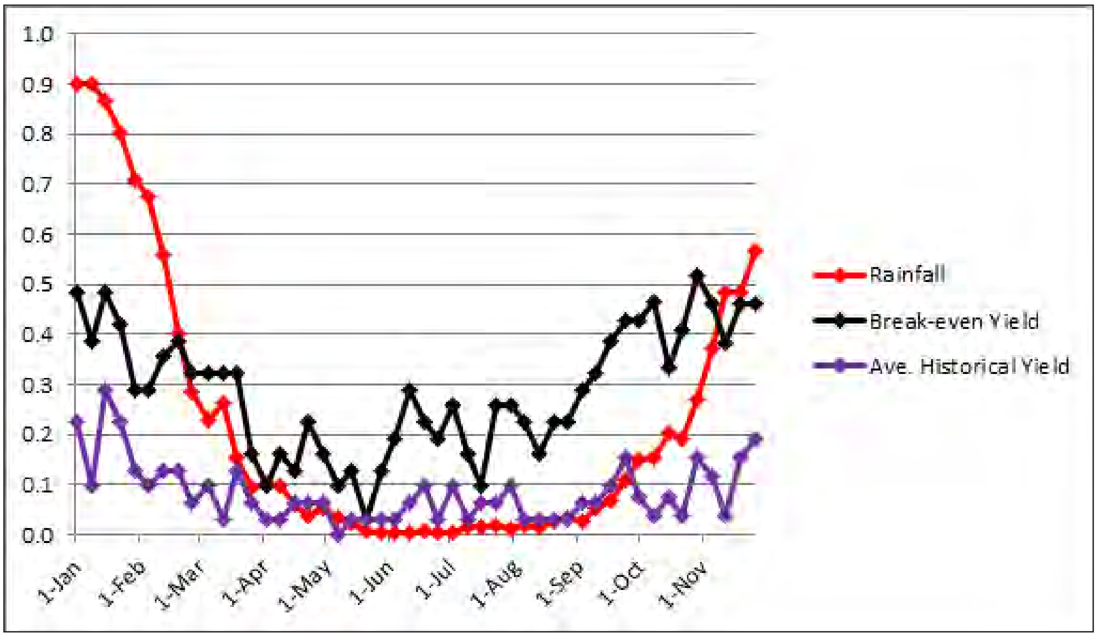


Figure 9. Probability of crop failure of PSB Rc 82 rice variety based on meeting rainfall requirement, break-even yield and average historical yield in Los Baños using historical weather data from 1976 to 2009



Results show the temporal variability within each location of the relative frequency of cumulative rainfall deficit. Probabilities of rainfall deficit are expected to be low during the wet period and relatively high during dry period. Moreover, spatial variability of periods of low rainfall deficit across the different sites is also apparent. This is due to the different climatic types in the areas as reflected in the seasonal rainfall distribution in the different locations. Within each site, the probability of cumulative rainfall deficit is relatively low during the wet season and relatively high during the dry season as expected.

Weekly estimates of climate risks for different stages of crop growth can then be used to formulate location-specific WIBI products for different weekly planting dates. Thus, WIBI insurance provider and the crop grower can now agree on insurance policy based on the estimated risks for the farmer's chosen planting date. As can be inferred, this information (i.e., period of low probability of cumulative rainfall deficit) can also be used as guide to determine the optimal planting dates for rainfed rice production in these areas.

Similar approach to formulating indices or threshold levels based on cumulative rainfall deficit has been used in a study on WIBI as a climate risk management strategy for rainfed rice production in Santa Maria, Pangasinan (Silvestre 2014). Figure 10 shows the monthly distribution of rainfall in Dagupan City, Pangasinan which is the nearest weather station with adequate weather records from 1980-2009. The plot shows a well-defined wet and dry season in the area with adequate precipitation for crop production from May to September. The weekly probabilities of cumulative rainfall deficits for different stages of growth of PSB Rc 14 the area are shown in Figure 11. These probabilities are indicative of the risks involved in planting rice at different planting dates. Thus, these can be used for rainfall-based WIBI product.

Figure 10. Monthly mean rainfall (mm) in Dagupan City, Pangasinan (1980-2009)

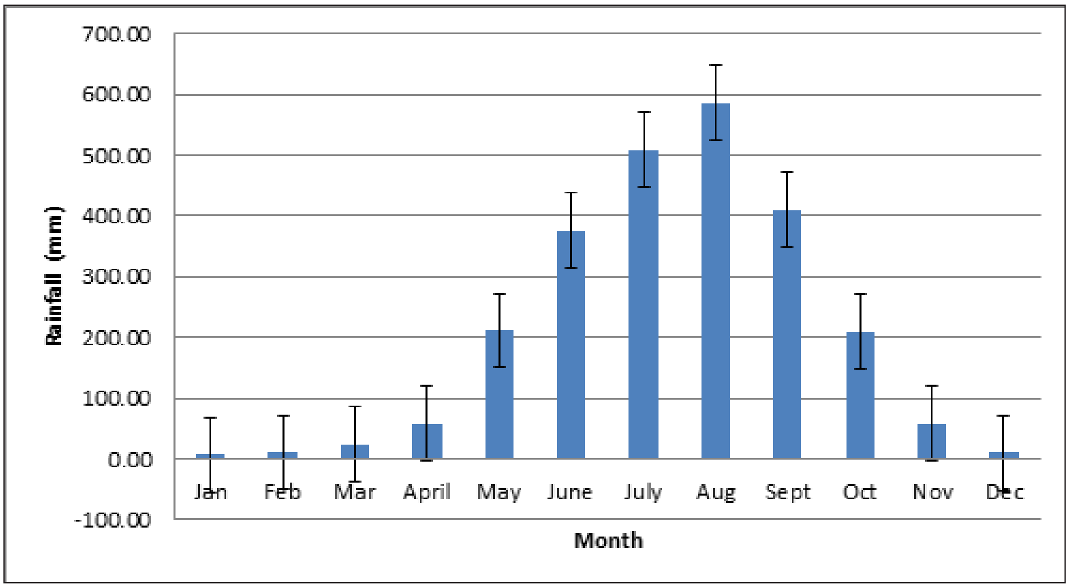
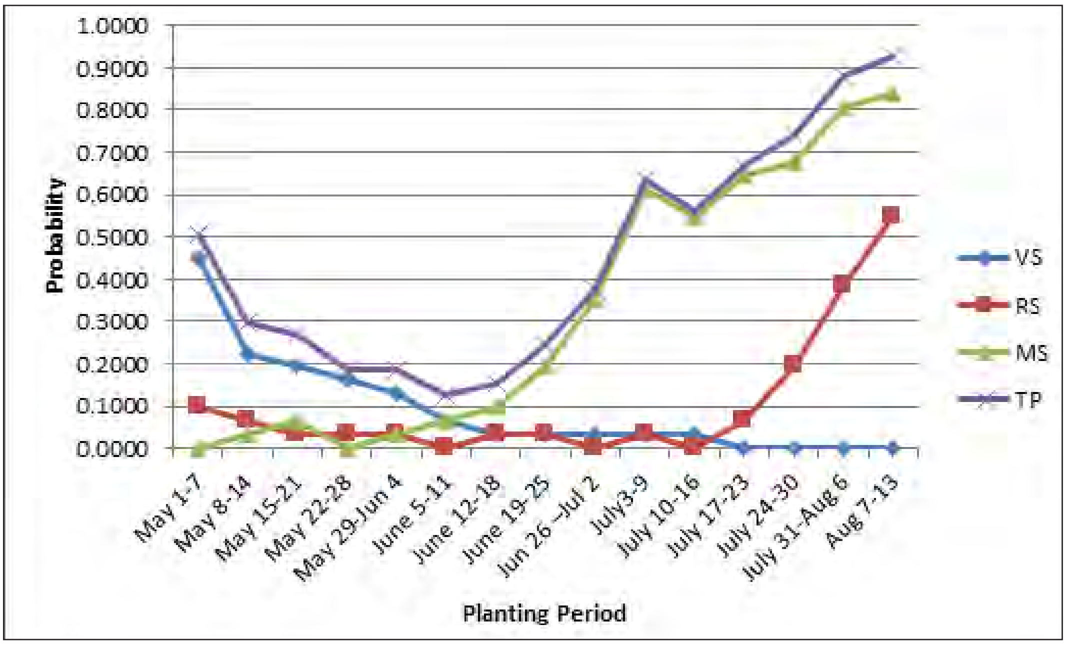


Figure 11. Probabilities of cumulative rainfall deficit (6 mm/day) during the vegetative stage (VS), reproductive stage (RS), maturity stage (MS), and total probability (TP) at different periods of planting rainfed rice in Sta. Maria, Pangasinan



Source: Silvestre (2014)

Other weather-related variables such as temperature and occurrence of typhoons can also be used to define the weather index (or triggering event) for WIBI. Estimation of risks associated with these variables requires reasonably adequate and accurate historical sequences of weather data in the area covered.

ISSUES, CHALLENGES AND IMPERATIVES IN IMPLEMENTING WIBI

The WIBI offers an innovative and objective strategy for climate risk sharing and transfer that minimise the adverse effects and impacts of climate variability in crop production. There are a number of issues that need to be addressed for the effective and efficient implementation and operation of WIBI.

Definition and formulation of weather indices and estimation of risks associated with the indices

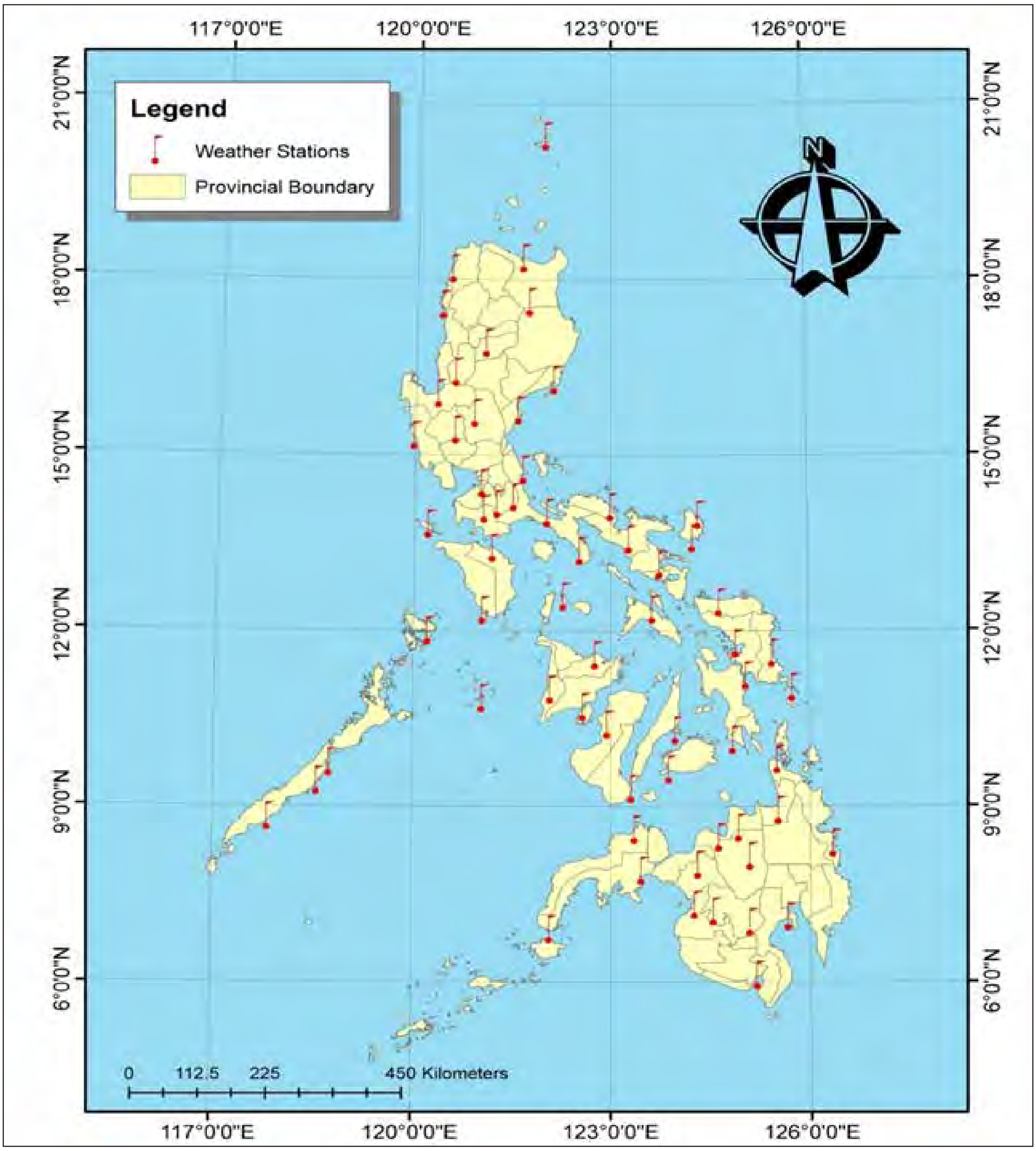
As WIBI promises to be based on objective measures less prone to subjectivity and bias of the assessor, simple indices need to be formulated based on measurable information on weather variables directly related to crop yields. An example of this index is the cumulative rainfall deficits measured during different stages of crop growth and development. Similar indices may be formulated based on observed weather data that are highly correlated to crop growth and yield such as wind speed, intensity of extreme rainfall, and path during the occurrence of typhoon to develop a WIBI for typhoon. In vegetable production areas in some parts of the Philippines (e.g., Atok, Benguet Province) which are vulnerable to frost, WIBI based on the number of days below certain temperature threshold level related to crop damage may be used as index.

Paucity of available weather data for WIBI measurement and monitoring

WIBI products are based on observed historical climate in the area that is highly correlated with crop yield. However, as in the case of the Philippines, considering the geo-spatial variability of climate, WIBI product covers only farms within 20 km radius from accredited representative weather station with reasonably accurate weather records. In the Philippines, PCIC together with local insurance providers, recognises only PAGASA stations with adequate weather data.

PAGASA weather stations are, however, sparsely distributed around the country with roughly only one gauging station per province (see Figure 12). These weather gauging stations are often located near airports and coastal areas primarily for navigational purposes. As per World Meteorological Organization (WMO) standards (Awadallah 2012), PAGASA should have one weather gauging station for every 20 km^2 area. Thus, there is an urgent need to increase the density of weather stations. This can be achieved by installing additional network of weather gauging stations using cheaper but reliable automatic weather stations (AWS) which will be calibrated regularly, and to be accredited by PAGASA. Moreover, local government units (LGUs) may be convinced to invest in additional weather gauging stations by installing AWS, which can be used in LGU climate risk reduction and management (CRRM) as well as in WIBI. There are also existing weather gauging stations operated by other institutions (e.g., SUCs, NGOs, private companies, etc.) whose generated datasets and information can be certified and accredited by PAGASA.

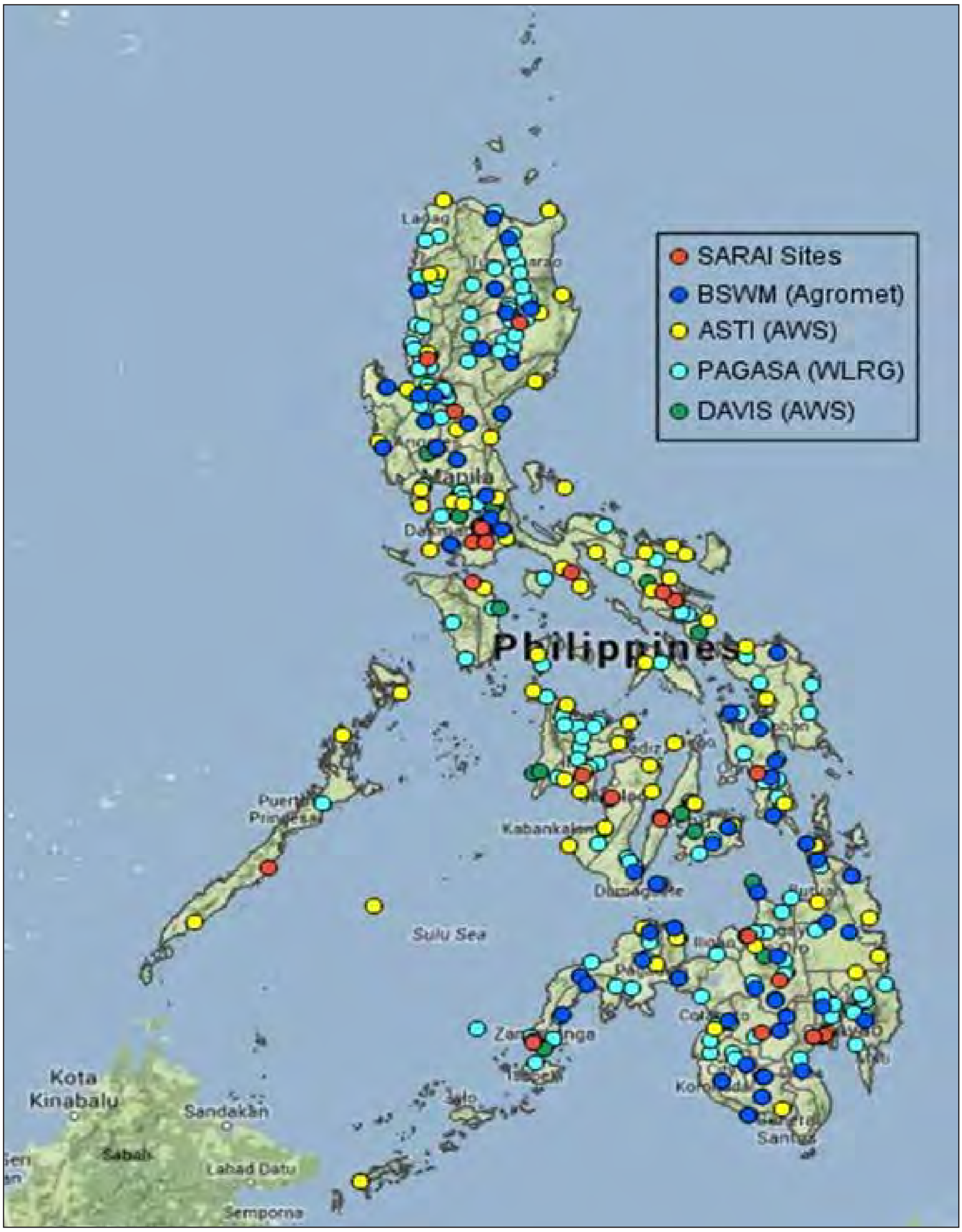
Figure 12. Location map of existing meteorological stations in the Philippines



Source: PAGASA (2012)

Figure 13 shows the location map of existing and AWS being planned by various agencies. While these AWS may provide weather data for WIBI they will have to be calibrated with the PAGASA facility.

Figure 13. Location map of existing and planned automatic weather stations in the Philippines



Source: Project SARAI (2014)

There are considerations in establishing adequate network of weather gauging stations for WIBI implementation, namely: (1) representativeness of location of weather station accounting for topography, land use terrain, elevation, agro-ecosystem, etc.; (2) cost of facility, which varies for different types of weather gauging equipment including the AWS; (3) reliability of weather data which need calibration and certification by PAGASA; and (4) operation and maintenance including security of facility.

High premium for WIBI products

The relatively high premium associated with WIBI products discourages farmers to get insurance coverage. Low subscription rate of crop insurance products by farmers in the Philippines is mainly attributed to high insurance premiums, documentary requirements for agri-insurance coverage, and inadequate operational support and enabling environment for crop insurance in the field. Several strategies may be used to lower the WIBI premium. One approach is to provide subsidy to deserving and qualified farmers. This can be a joint program of the local government units and the Department of Agriculture. For example, the Province of Davao del Norte subsidised the enrollment and premium of up to 2000 ha of farmlands in the province in 2012-2013. Another approach is to impose reduced government taxes on WIBI products to provide some incentives to local insurance providers. Another possible mechanism is to provide incentives to climate risk-prone farmers by acquiring WIBI coverage through reduced premiums for farmers in a cooperative. Farmers in adjacent areas may avail of 'group insurance' coverage which may entail lower premium. It should be noted that providing some subsidy to farmers through payment of reduced WIBI premiums is an investment rather than a cost since this is even cheaper than the cost of rehabilitation whenever catastrophic events occur resulting to crop losses and damages. ***Lack of enabling institutional framework for WIBI implementation***

Agri-insurance is still not a popular climatic risk management strategy in Southeast Asia. There is inadequate policy support and regulatory framework for implementation of WIBI. There is a need to increase the number of subscribers to crop insurance, develop and test innovative insurance such as WIBI products, and conduct massive information campaign and awareness raising. In the case of the Philippines, WIBI may be piloted in selected areas with the support and cooperation of PCIC and other local insurance providers as well as some LGUs especially in crop production areas vulnerable to climate hazards. In recent years, WIBI had been piloted as a development project in selected provinces in the Philippines such as in Davao del Norte (2012-2013), and in Agusan del Norte (2009-2011). The PCIC, in cooperation with the Philippine Climate Change Adaptation Project (PhilCCAP) and the Department of Agriculture (DA), is currently piloting the WIBI products for rice and corn in selected location in Peñablanca, Cagayan Province and Dumangas, Iloilo Province (2013-2015). Results generated and lessons learned from these pilot projects can be used to further improve the development and implementation of the WIBI. Furthermore, WIBI products may be (initially) exempted from government taxes usually imposed on traditional insurance policies. Likewise, LGUs may also consider providing some subsidy to farmers in a cooperative to get WIBI coverage similar to some LGU initiative of providing health insurance to its constituents.

Addressing the aforementioned issues and challenges requires the active and sustained cooperation of different government agencies to work together towards promoting smart approaches to manage climate risks in agriculture. This can be achieved through working together via science-based agricultural extension programs, issuance of joint or coordinated agro-advisories, and promotion of climate resilient and improved technologies that can minimise the adverse effects and impacts of climate risks. Moreover, there is also a need to conduct more pilot projects or field demonstrations with farmers on climate smart agriculture including science-based climate risk management using WIBI.

CONCLUSION

The WIBI is an innovative approach to climate risk management which can help poor farmers. However, implementation of WIBI in the AMS and the rest of Southeast Asia is beset with operational issues and concerns that need to be addressed. While weather index for WIBI can be defined based on scientific knowledge on crop growth and development, and consideration of current weather conditions during the growing season, further studies on developing appropriate indices are imperative. There is also a need to expand piloting and strengthen research into other ASEAN countries. Weather index which is directly related or highly correlated with crop growth or yield should be easy to measure, interpret, and has scientific meaning. The behaviour of weather index reflective or indicative of associated climate risk is location-specific, and also varies in time within location. Cumulative rainfall for different development stages of crop growth can provide a possible weather index related to crop yields. Climate risks associated with cumulative rainfall deficit can be estimated from available historical weather data for a location. However, reliable estimation of climate risks also requires a good network of weather gauging stations that cover the crop growing areas where WIBI will be implemented. While weather-related indices can be readily defined and site-specific WIBI products can be formulated and developed based on these indices, infrastructure such as adequate network of weather gauging stations, and enabling institutional framework, policies, and mechanisms are needed to facilitate its effective and efficient implementation. This requires government interventions and support from the private sector as well as from the local insurance providers. The WIBI program also requires an active partnership between the insurance industry and the academia especially in the context of research and development in developing weather indices and formulating WIBI products.

Governments in the ASEAN, through the local insurance industry, should strategize to promote the increased subscription by farmers to the more objective and transparent insurance products such as WIBI especially in climate risk-prone areas. The successful example of Indonesia's disaster micro-insurance industry should highlight the need to formulate and promote other more objective and attractive insurance products through innovative product distribution channels (Bhat and Mukherjee 2013). Insurance providers should reach out more to the clientele by having an active farm-level promotion campaign; information, education and communication materials; and awareness raising activities in the region. Effective and efficient WIBI implementation in Southeast Asia requires investment of resources towards an adequate network of weather gauging stations, manpower in terms of development of appropriate indices for WIBI products and further research, and communication strategies for agro-technology transfer including the dissemination of knowledge-based climate risk management strategies. There is an important role for ASEAN governments to invest in upgrading national meteorological weather stations, as well as enhance networks correlated to microclimatic variations, and strengthen seasonal crop yield estimation survey procedures (FAO 2011; Bhat and Mukherjee 2013).

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SOUTHEAST ASIAN REGIONAL CENTER FOR GRADUATE STUDY AND RESEARCH IN AGRICULTURE (SEARCA)
College, Los Baños, Laguna 4031, Philippines
Tel.: (+63 49) 536 2361; 536 2363
Fax: (+63 49) 536 7097; 536 2283
E-mail: post@searca.org or kc3@searca.org
Websites: www.searca.org; www.climatechange.searca.org

INSTITUTE OF GLOBAL ENVIRONMENTAL STRATEGIES (IGES)
2108-11 Kamiyamaguchi, Hayama,
Kanagawa 240-0115, Japan
Tel.: +81 468 553 720
Fax: +81 468 553 709
E-mail: iges@iges.or.jp