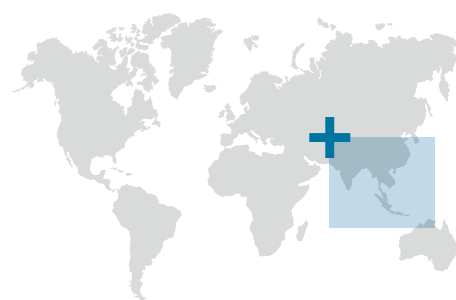# INNOVATION & TECHNOLOGY

## SUBJECT

The high transaction costs of serving low-income clients in developing and emerging market economies demand innovative approaches and technological advancements. Challenges that inflate operational costs include data collection, processing and management, premium payment mechanisms as well as claims verification and settlement. Index insurance products, mobile payment devices or more accurate weather and agricultural-yield information based on satellite data are examples of innovative approaches that can help to overcome these challenges.

## CHALLENGES IN ASIA

Rice is the most important food crop for the poor: more than 3.5 billion people depend on it worldwide. Particularly in Asia, many small-scale farming households grow rice for consumption and income. These farmers are frequently impacted by natural catastrophes such as floods, typhoons, and droughts. In order to protect the livelihood of these poor households, agricultural insurance schemes have been developed in various Asian countries.

Traditional insurance schemes that require physical loss verification, such as multi-peril crop insurance (MPCI), are difficult to deliver to smallhoder farmers. Instead, the focus in recent years has been on index-based insurance through either weather data based products or products based on vegetation indices. Both products have technical limitations:

- Weather data index: Due to the low density of weather stations, most insurance schemes use satellite-generated weather data. There are however major challenges concerning the accuracy of this technology and the difficulty of predicting farm output as a direct result of weather factors. The occurrence of basis risk is a major concern for insurance programs, as it often leads to customer dissatisfaction and low demand for insurance.

- Vegetation index: Satellite-based optical observations of vegetative growth have been used for insurance based on Normalized Difference Vegetation Index (NDVI). This type of product is most suited for larger areas, in particular grasslands, but not for smallholder farmers. For crop production, the relationship between vegetation vigour during the growing season and final crop production is not as simple. In addition, cloud coverage obstructs the view of the vegetation below.

## SOLUTIONS

### Use of radar technology to observe crop growth

To overcome the technical limitations of weather and vegetation index products, RIICE, in partnership with Allianz Re, the International Rice Research Institute (IRRI), and Sarmap has developed a radar-based monitoring and yield estimation system for rice.

**Configure radar technology to detect rice growth.** Compared to optical satellites that are used for vegetation index products, radar waves are not obstructed by cloud coverage. Synthetic aperture radar (SAR) data is obtained from the ESA satellites Sentinel-1a and Sentinel-1b that were launched in 2014 and 2016, respectively. The satellite provides data every 12 days with repeat frequency at a resolution of 20 meters. All remote sensing data is stored, processed and analysed on the cloud. One advantage of this data source is that it is free of charge until 2030. Even though the RIICE system is configured on ESA's Sentinel satellites, it is able to work with different satellites.

**Estimate rice yields from radar data.** Radar-based remote sensing technology can determine the extent of rice cropping, monitor the rice growth, estimate (to some extent) biomass and identify crop damages and losses caused by droughts and floods. The radar technology was used to develop a crop information system. Based on historic satellite observations, rice-growing areas are delineated and monitored. The observation data is fed into a rice crop growth model (Oryza2000) developed by IRRI that calculates projected rice yields during mid-season. This yield estimation allows for insurance payouts even before harvest if production is lost due to severe flooding during crop growth.

**Calibrate remote sensing data through field work.** During the development of the technology and for the validation of remote sensing data, the system required extensive fieldwork, for example measuring the Leaf Area Index (LAI) for randomly selected locations as a form of ground truthing. The LAI is defined as the one-sided green leaf area per unit ground area in broadleaf canopies of rice. RIICE trained over 300 representatives of government-mandated agricultural institutes to enable them to conduct the fieldwork, process and interpret satellite-based information and run crop simulation models by themselves. All field data was collected by mobile phone, and was sent to the cloud over mobile or Wi-Fi network.

## LESSONS LEARNED

The RIICE system is a promising application to monitor the production of rice. The data is sufficiently accurate and can be used for different purposes, e.g. food security planning by the government and area-yield insurance by the insurance sector. Unfortunately, the radar technology only works with specific crops such as wetland/lowland rice that have a particular growth pattern: wetland/lowland rice is grown on unobstructed fields that are flooded at the beginning of the season. Therefore, the radar technology is not suited to capture the growth of some other types of crops, e.g. fruit crops.

The use of technology significantly reduces the cost of monitoring crop growth. But it does not completely eliminate the need to have field staff to validate results, at least during the establishment phase. An excellent understanding of local crop practices and production conditions is required to calibrate the system and to ensure that the monitoring tool accurately measures rice production in the fields. But recent analysis shows that field work and ground truthing can be greatly reduced after the first two years.

Despite the high accuracy of the satellite data (20-meter resolution), the system does not have the technical ability to monitor crop growth on individual small plots. The system produces monitoring results for small geographical locations, such as villages. This allows for the development of area-yield index insurance (AYII) products.

The active involvement of national partners is key. The information produced by the RIICE system is politically sensitive as it touches upon issues such as food safety and farmer welfare. Therefore, national governments have a strong interest that rice production and loss data is published by national institutions appointed by them. In addition, the various outputs produced by RIICE (the radar observation tool MAPscape-RICE, the crop growth model Oryza, and the field protocol for ground truthing) have greatly benefitted from the inputs provided by national partners.

## OUTCOME

RIICE is still in an experimental stage. No insurance system has been installed using the technology but the proof of concept has been delivered. The accuracy of the system for mapped rice area and yield is over 90%.

The crop monitoring system has many different uses apart from insurance. The system also helps to identify areas that are affected by natural disasters. In 2013, after typhoon Haiyan RIICE submitted post-disaster information on rice crop losses to the Department of Agriculture of the Philippines within a few days. In November 2015, after Tamil Nadu witnessed heavy rainstorms the RIICE partners were able to deliver a flood assessment report within 2 days. This information is used to provide disaster relief in a timely manner.

**Name of programme:**
Remote sensing-based Information and Insurance for Crops
in Emerging economies (RIICE)

**Duration:**
February 2012 – December 2017

**Programme area:**
Asia (Bangladesh, Cambodia, India, Indonesia, Philippines,
Thailand, Vietnam)

**Cooperation partner:**
Allianz Re, Deutsche Gesellschaft für Internationale
Zusammenarbeit (GIZ) through the program develoPPP.de
on behalf of the German Ministry for Economic Cooperation
and Development (BMZ), International Rice Research
Institute (IRRI), sarmap, Swiss Agency for Development
and Cooperation (SDC)

**Target group:**
Agricultural policy-making institutions and public bodies
that are interested in better rice crop information for food
security policy purposes. Furthermore, the target groups are
rural financial institutions and insurance companies that serve
smallholder farmers as the key beneficiary of this program

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