Remote sensing for crop monitoring, disaster risk management and insurance

Approach, experiences and way forward of a public-private development partnership on the example of the RIICE

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Remote sensing-based
Information and **Insurance**
for **Crops in Emerging Economies**

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CONTENTS

LIST OF ABBREVIATIONS

AICI	Agriculture Insurance Company of India
ASEAN	Association of South-East Asian Nations
ASEAN-SAS	ASEAN Sustainable Agrifood Systems
ESA	The European Space Agency
GISTDA	The Geo-Informatics and Space Technology Development Agency (Thailand)
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Development Corporation)
ha	hectares
IRRI	The International Rice Research Institute
JV	joint venture
MoU	memorandum of understanding
PhilRice	Philippine Rice Research Institute
PMFBY	Pradhan Mantri Fasal Bima Yojana (Agriculture Insurance Programme India)
PPDP	public-private development partnership
PRISM	Philippine Rice Information System
RIICE	Remote-sensing based Information and Insurance for Crops in Emerging Economies
SDC	The Swiss Agency for Development Cooperation
SDGs	Sustainable Development Goals
TNAU	Tamil Nadu Agricultural University
USD	United States Dollar

I. INTRODUCTION

The RIICE project has been working since 2011 to reduce the risks faced by rice smallholders across Asia, by using satellite remote sensing to monitor crops and support decision-making by governments and other agencies. The current document aims to take stock of the achievements to date and obstacles encountered, and to assess lessons learned as well as next steps.

Rice is a staple for most of the world's population and the main source of income for millions of smallholder farmers, especially in Asia. When severe weather events, **natural disasters cause yield losses,** this hits rice farmers and wider society both economically and from a **food-security** perspective. Timely and accurate information on rice crops is essential, whether for responding to disasters or for forecasting and managing future risk.

Remote sensing, specifically using publicly available **satellite imagery,** holds the potential to **provide this information** and **support rice crop management.** One application is **insurance,** which can increase farmers' resilience and livelihood security, and also contribute to agriculture development and food security.

In light of this, in 2011 five public and private actors formed a consortium to support governments and other stakeholders to use remote sensing, and establish monitoring systems based on satellite data. The project is titled **Remote sensing-based Information and Insurance for Crops in Emerging economies, or RIICE,** and is a collaboration between the technology providers sarmap SA and the International Rice Research Institute (IRRI), the international development agencies Swiss Agency for Development and Cooperation (SDC) and German Development Corporation (*Deutsche Gesellschaft für Internationale Zusammenarbeit* or GIZ), and global reinsurer Swiss Re (who replaced the initial reinsurance partner Allianz Re from 2017). Activities have been **undertaken in Cambodia, Vietnam, India, Thailand, the Philippines and Indonesia.**

In the Phase I pilots (2011-2015), RIICE demonstrated the technical feasibility of a remote-sensing based system for rice area and yield mapping and monitoring, as well as yield forecasting. During Phase II (2015-2018) national capacities were established and the operational solution was

developed then scaled up, and its applicability for insurance was tested. In 2016, the project conducted insurance dry tests. These consist of running the data for those crops, calculating the hypothetical pay-outs based on that real-world information, and assessing how an insurance product would have performed in that scenario. Then in 2017, the RIICE data was used by agencies in the southern Indian state of Tamil Nadu to assess crop damage and coordinate government compensation after that year's drought devastated rice crops.

The ongoing Phase III is focused on **institutionalizing the technology with governments and insurance actors.** Depending on the territory, this can consist of building up a service with a hybrid of social and commercial elements, including a range of insurance and related applications. The emphasis is on developing sustainably funded systems that are nationally owned and operated.

Furthermore, the experiences and successes from RIICE will be built on by the India component of SDC's Global Programme on Climate Change and Environment (GPCCE). This will look beyond rice to other crops, and beyond insurance to other applications of remote sensing data.

The RIICE system is gaining traction with national actors in several countries. In **Tamil Nadu,** it is now operated by the Tamil Nadu Agricultural University and used by state authorities to insure farmers against **prevented sowing or crop failure.** In the **Philippines,** it has been integrated into the national rice monitoring system as the **Philippine Rice Information System (PRISM)** under the Department of Agriculture and has been providing monthly rice area data at municipal level. In **Vietnam and Cambodia,** memorandums of understanding have been signed with the respective ministries, and **pilot schemes are due to take place** over the next year.

In figures, RIICE has monitored **more than 15 million hectares of rice cultivated area,** and was used in an insurance scheme **reaching around 1 million farmers in India.** More than 50 trainings have been carried out in addition to numerous workshops, policy dialogues and focus groups, where government staff, insurance stakeholders and farmers have learned about various aspects of the technology, crop monitoring and policy implications, or insurance.

The next stages build on the institutionalization of the RIICE solution. This includes **engagement with partner institutions on the set-up of remote-sensing** units within their public administration for the purpose of crop monitoring, and at **ASEAN level** to **support regulatory frameworks** for the national monitoring systems and insurance schemes.

At country level, in addition to crop insurance applications planned in Vietnam and Cambodia, discussions are progressing in the Indian states of Andhra Pradesh and Odisha, and there have been preliminary discussions with Indonesia about renewing their engagement with the project around monitoring and state-run insurance, as well as expressions of interest from Sri Lanka.

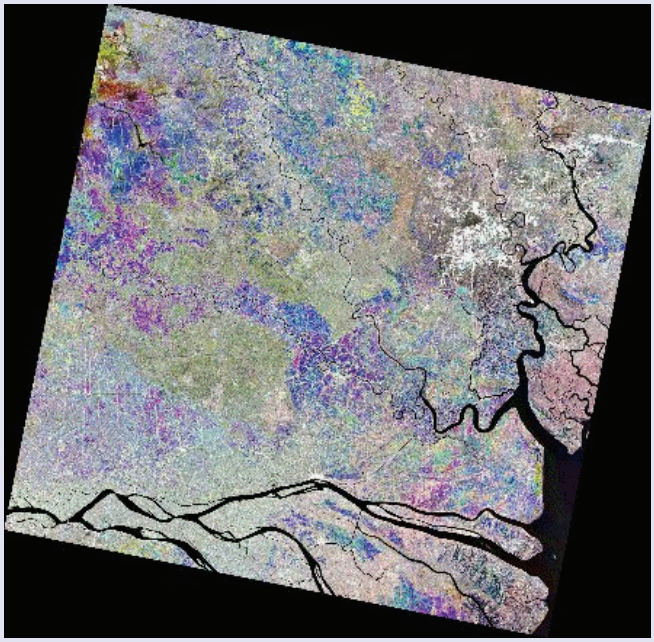
II.HOW RIICE WORKS

Millions of **rice smallholders across Asia are vulnerable to crop losses** from weather incidents and other causes. Governments and other agencies work hard to mitigate these risks using a range of tools. These **include insurance schemes to compensate for lost or failed crops,** as well as forecast models to plan any imports necessary for food security – or exports if yields allow. However, all of these measures face a range of operational challenges, specifically in relation to **timely and reliable data.**

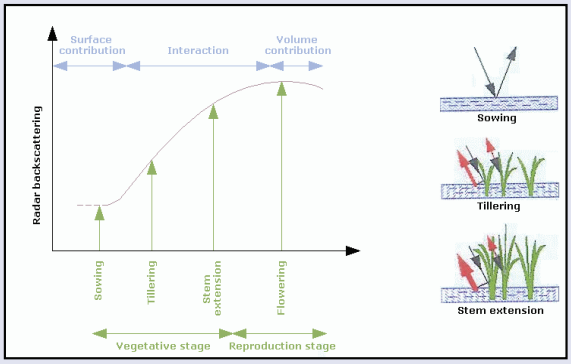
The RIICE project uses data from the European Space Agency's (ESA) satellite system Sentinel. The **Synthetic Aperture Radar (SAR)** on board Sentinel 1 can penetrate dense clouds and allows for monitoring during the monsoon, the main rice-growing season.

The SAR functions by firing an electromagnetic radar beam at the earth. This is absorbed, reflected or scattered in different proportions by the terrain it encounters on the surface. As the satellite is moving, by the time the signal travels to the Earth's surface and back again the satellite is in a slightly different place. The distance between the points where the pulse was emitted and where the echo signal was picked up is included in the calculations to determine various properties about the surface. The patterns of reflected signals and scattering also changes along the growth cycle of a plant, allowing to get indications on the available biomass. This state to biomass is reflected in the so-called Leaf-Area-Index.

Synthetic Aperture Radar – SAR



Ideal rice temporal signature



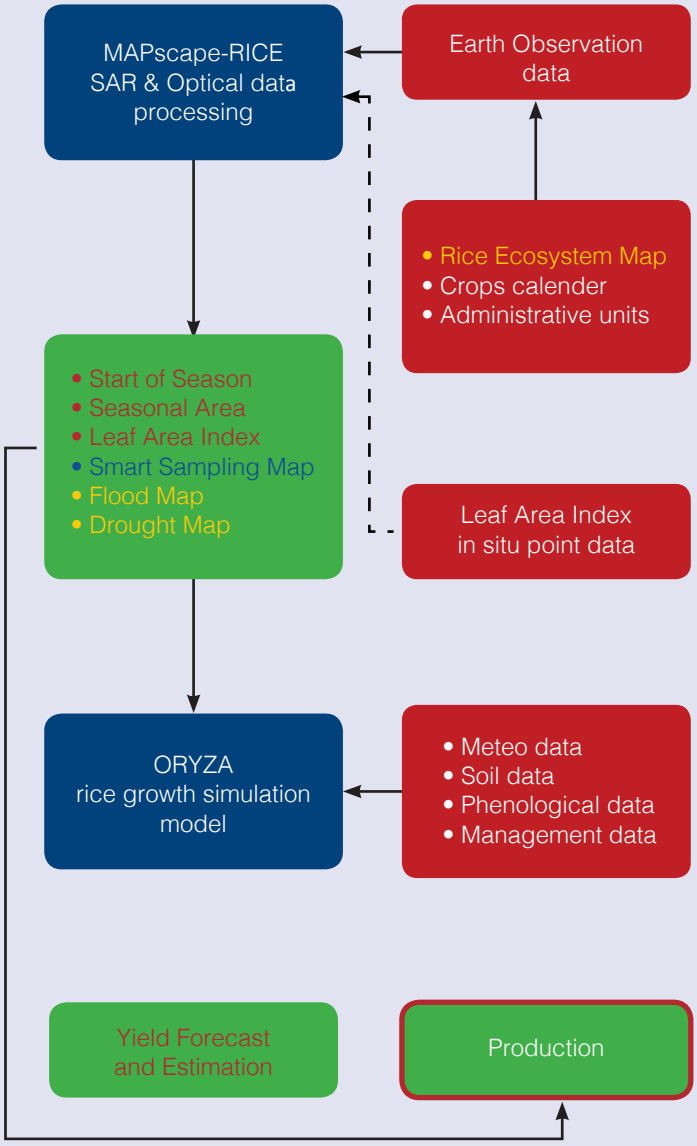
Temporal signature depends on:

- **Field preparation**
- **Crop practices**
- **Crop establishment method**
- **Rice cycle duration**
- **Rice biomass & moisture**

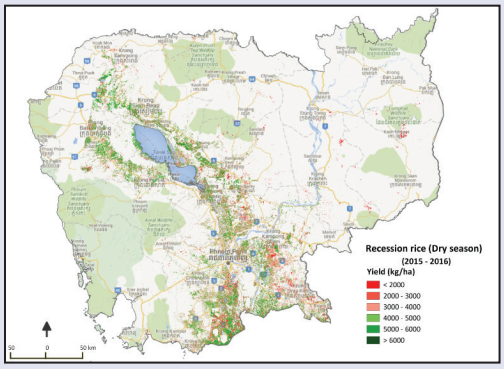
This **SAR data from the ESA** is processed and combined with other information - such as **ecosystem maps and crop calendars** for example - by using a proprietary modelling system that includes the software-based MAPscape (from sarmap) and ORYZA rice growth simulation model (from IRRI), to estimate rice crop area and yield. MAPscape produces map-based information on rice area and the start of season for example, as well as the mentioned **Leaf-Area-Index.** This index is an input into the ORYZA **rice growth model,** which uses **further information from other sources,** including in situ point data on soil, meteorological conditions, plant phenology as well as information on management practices, to **estimate rice yields.**

RIICE uses this to answer three main questions in relation to crops: **Where? When? And How much?** This information is invaluable in helping official agencies or other stakeholders improve the efficiency or effectiveness of their services, or even introduce new ones. This can be useful to manage normal variations in crop yield, or more dramatic events. Crop forecasts that may previously have been based on spot samples several weeks old can be done much faster and more reliably, improving national **statistics reports and food security planning.** And lost yields due to crop failure, prevented sowing or natural disasters can be assessed faster and more accurately, in turn **allowing for faster and more targeted compensation** or relief materials.

The service – Rice Area and Yield

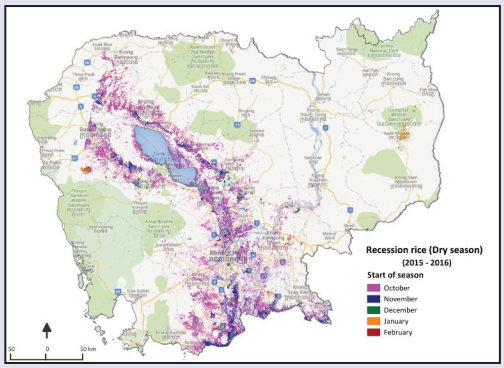


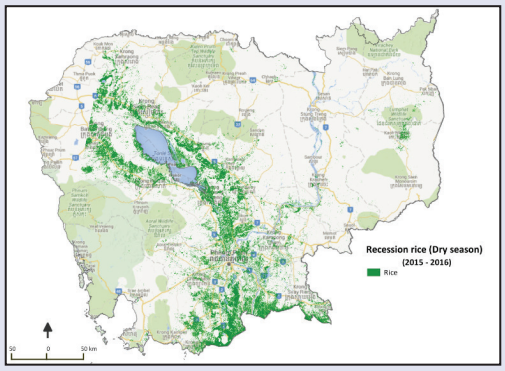
Rice Area, Start of Season, Rice Yield



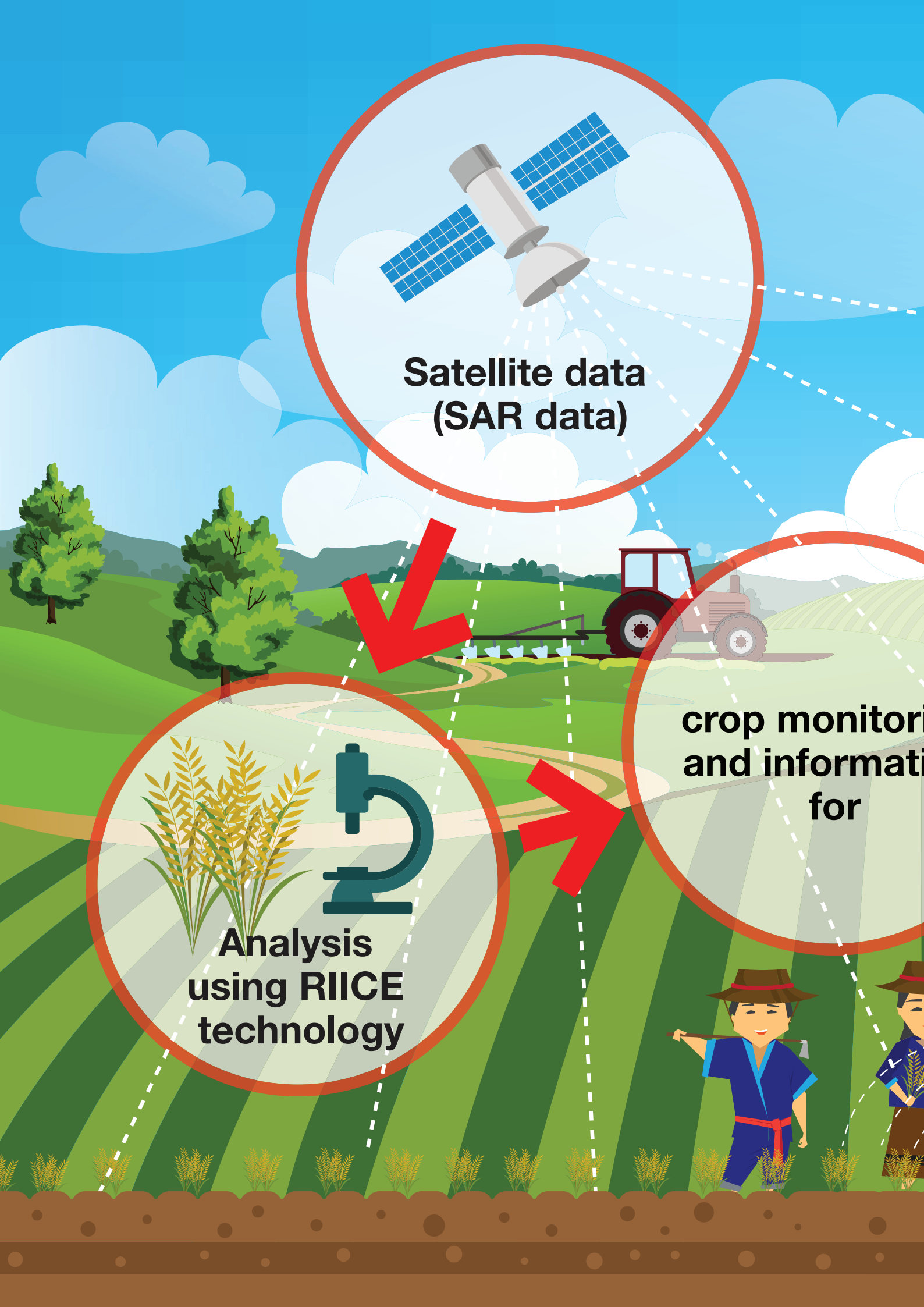
Area

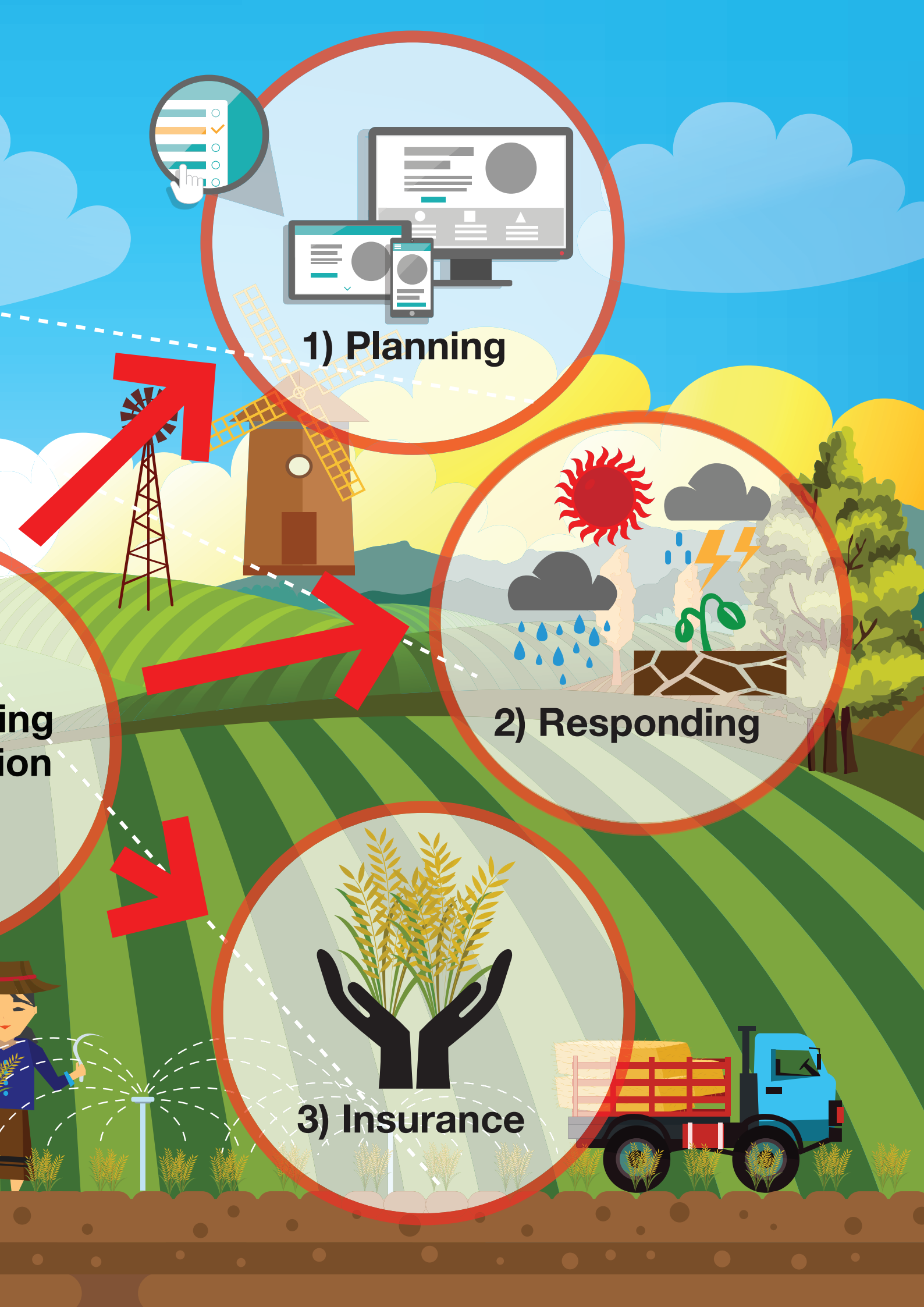
Start of Season





Yield


Satellite data
(SAR data)
Analysis
using RIICE
technology
crop monitori
and informati
for


1) Planning
2) Responding
3) Insurance

III. THE PARTNERSHIP

The RIICE project is implemented collaboratively through a **public-private development partnership (PPDP)** between three public parties and two private companies; the International Rice Research Institute (IRRI), the Swiss Agency for Development and Cooperation (SDC), the German Development Corporation (*Deutsche Gesellschaft für Internationale Zusammenarbeit* or GIZ), software company sarmap SA, and the global reinsurance company Swiss Re (replacing Allianz Re, who were the reinsurance partners until 2017).

sarmap and IRRI jointly **developed and tested the crop monitoring tools**, Swiss Re used the resulting data to develop new **solutions for its insurance** clients to serve previously uninsured smallholders, while SDC provided seed financing as well as the **political advocacy and stakeholder capacity development**, alongside GIZ, to create the necessary political and regulatory frameworks. IRRI, sarmap, and GIZ provided training and capacity building to both farmers and government actors.

In detail, the roles are as follows:

- **sarmap** provides customized earth observation-based products and services, and contributes to capacity building, including through the provision of licensed software MAPscape-RICE and support agreements. The company also provided

training and capacity building to government actors alongside IRRI and GIZ.

- **IRRI** is responsible for the rice yield estimation system (Rice-YES) including the calibration and validation of the ORYZA rice crop growth model. It outreaches to institutional public partners and helps improve the capacity of these organizations. The organization also provided training and capacity building to government actors alongside sarmap and GIZ.
- **Swiss Re** leads the development of insurance products and facilitates business contacts with local insurers who are keen to develop this segment in the long-run. It may also provide reinsurance capacity to further strengthen insurance schemes.
- **SDC** is the key public donor of the programme as well as a convener and facilitator of the partnership. SDC engages in policy dialogue, mainly with the governments of Vietnam, Cambodia and India, to support sarmap and IRRI in the implementation. SDC also promotes the application of RIICE technology for insurance purpose, such as for example in projects in Vietnam and Cambodia;
- **GIZ** engages in policy dialogue with the governments of India, Indonesia and Thailand and supports sarmap, IRRI and Swiss Re in the implementation and application of RIICE technology. GIZ also works with regional actors to advocate for the necessary political and regulatory frameworks. The corporation also provided training and capacity building to farmers and government actors alongside sarmap and IRRI. GIZ's contribution is commissioned by the German Federal Ministry for Economic Cooperation and Development (BMZ), which acts as the other public donor.

The RIICE project also works closely with **partners outside the consortium:**

- **National agricultural government agencies and statistical offices:** Institutionalizing the RIICE technology into the existing government system and ensuring a clear mandate, staff capacity and financial resources are in place to operate a digitized crop information system using the RIICE technology. The project also relies on the technical expertise of the national team, who provide information about rice and its cultivation in a given territory.
- **Public and private insurance companies:** Supporting local, public and private insurance stakeholders who implement crop insurance programmes to use the generated data to strengthen their insurance services and benefits for their clients.

IV. RIICE APPROACH - THE PROJECT PHASES

Phase I - Pilot (2012 – 2015)

Phase I – Pilot centred around **development and demonstration of technical deliverables.**

Thirteen pilot test sites were selected across India, Indonesia, Cambodia, Philippines, Thailand and Vietnam, representing a diverse rice crop environment. A total of 1.6 million hectares of rice were mapped with accuracies ranging from 85 to 95 percent, demonstrating the robustness of the approach in mapping diverse rice systems.

sarmap and IRRI led implementation and 30 technical trainings attended by more than 300 staff of the various partner institutions.

The Philippine government was convinced by the effectiveness of RIICE at an early stage and decided to fully fund a new project, the Philippines Rice Information System (PRISM), developed with the support of IRRI and sarmap.

The Pilot also included exploration of a new crop insurance for strengthening existing programmes, together with key personnel from the Ministries of Finance and in-country primary insurance companies. Insurance dry tests were carried out to model hypothetical pay-outs over one growing season based on RIICE data.

Phase II – Scaling up (2015 – 2018)

Phase II aimed to **scale the delivered technical products to national level, and to secure government commitment to use RIICE in their official production statistics.** This included efforts to make it user-friendly, and easily operational at scale for the intended users.

The area monitored was increased to more than 15 million hectares across six countries. The accuracy of area and yield estimates was 86 to 92 percent, when cross-checked with on-the-ground data.

The RIICE project developed the capacity of national technical partners so that they could take the lead, albeit with ongoing support from sarmap and IRRI. In the Philippines, the PRISM programme was rolled out and has been active since mid-2018, and is fully operated by the Philippine Rice Research Institute. In Tamil Nadu, the project supported the distribution of seeds after a flood in 2015 and the coordination of insurance pay-outs after the drought in 2017. The uses of the RIICE technology in the insurance programme in Vietnam was prepared but delayed by the governmental process to relaunch their pilot crop insurance programme.

Phase III - Institutionalization (2018 - 2021)

Phase III is focusing on setting up **the rice monitoring and its crop insurance application** for smallholder rice farmers, in a way that is sustainable from operational, institutional and financial aspects.

VI. ACHIEVEMENTS

The project so far has demonstrated the effectiveness of RIICE, that the information it produces is reliable and timely, and that its application can bring benefits to a range of areas, including **food security planning, disaster response, and smallholder insurance.**

However, the implementation of the project has also brought to light several complexities and challenges. Different territories have varying needs, not only in terms of the technical requirements of the terrain, but also with regards to existing structures and priorities.

This variation has inevitably meant that progress has been faster in some areas than in others. **The monitoring applications have been well received, notably in the Philippines, and the disaster assessment has been successfully implemented in the Indian state of Tamil Nadu.** However, the development of insurance programmes oriented directly at smallholders has been slower, in particular any that might prove self-sustaining. On the other hand, several opportunities are being explored to use RIICE applications beyond insurance but nonetheless contributing to food security and smallholders' resilience to extreme weather events.

The RIICE project has contributed towards progress on the **Sustainable Development Goals (SDGs)** of the UN's Agenda 2030. By improving the **resilience of smallholders' livelihoods** as well as **food security** at national scale, it addresses some of the targets under SDG 2 Zero Hunger. The use of **innovation and technology** is in line with SDG 9 Industry, Innovation and Infrastructure. The emphasis on preparing for and **recovering from disasters** falls under SDG 11 on Sustainable Cities and Communities and SDG 13 on Climate Action. And the close **collaboration with government agencies, local communities and the private sector** is part of SDG 17 on Partnerships for the Goals.

Ensuring that RIICE supports solutions that effectively meet the needs of smallholders and other stakeholders at national and local level will require further investment of time and other resources. The importance of **securing the input and ownership of those stakeholders, in particular government agencies,** as early as possible has become clearer over the course of the project so far. Greater emphasis will be put on this going forward.

Remote sensing

Achievements:

The technology platform was demonstrated to be effective. More than **15 million hectares of rice cultivated area have been mapped and monitored** across Cambodia, India, Indonesia, the Philippines, Thailand and Vietnam. The accuracy of the area yield estimates was found to be between 86 and 92 percent.

Work in progress:

The technology has **potential to monitor other crops** and water availability. These applications are being developed or negotiated in several existing and new territories.

Challenges:

The system presents some limitations in some specific scenarios. It can detect flood and drought damage with high accuracy, but has not been used to operationally assess wind-damaged crops. Also, the **20-metre resolution** of the publicly available satellite images is effective for assessing wide tracts of land, but does not provide reliable data on the narrow strips and **highly fragmented cultivation that are customary in some areas.** There are higher-resolution data available (3 metres), but on a paid basis. (The Philippines has a budget to purchase this data as necessary for disaster response.)

Information (and institutionalization)

The goal of providing national agencies with information to support their planning was successful. The further goal of **institutionalizing RIICE data into nationally owned processes** has been partially achieved.

Achievements:

RIICE partners in **government agencies and research institutions have learned how to use and process remotely sensed data with RIICE technology**, thanks to around 50 workshops to train more than 300 technical staff. This covers where and how much rice has been planted, how the crop develops and whether there is too much or too little water in the fields.

More than 20 policy-related workshops, dialogues and study trips have also been undertaken, to help decision-makers to exchange and increase their knowledge of **crop monitoring and insurance,** which will in turn **contribute to the formulation of national frameworks.**

Flood maps based on RIICE data have been established in **Vietnam, Cambodia and Tamil Nadu.** In Vietnam, these maps have been used to assess flood risks. In Tamil Nadu they have been used for emergency relief.

In **Tamil Nadu** (India), RIICE data was used to allocate compensation to **farmers for losses during the 2017 draught,** and the system is now operated by local authorities and the Tamil Nadu Agricultural University (TNAU).

Two out of six target countries have committed to use RIICE-based technology and information in some way in their agriculture and disaster risk management operations or insurance schemes.

The **Philippines** in 2018 **institutionalized the Philippine Rice Information System (PRISM),** which relies on RIICE technology.

Memorandums of understanding (MoUs) are about to be signed with national ministries **Cambodia and Vietnam to establish remote sensing-based crop monitoring** in the context of **pilot schemes.**

Several other governments have expressed interest, including Sri Lanka, just as the Indian states of Andhra Pradesh and Odisha have direct projects with IRRI and sarmap. The Indonesian authorities have also renewed their interest in the project after a hiatus in 2014.

A total of **35 partnerships and memorandums of understanding have been established.** Of those, 19 are with **public implementation partners,** including national ministries, universities and meteorology agencies, and the remaining 16 are with **private-sector** partners (see *Insurance* section below).

Work in progress:

In **Vietnam,** the RIICE system is to be integrated into the **government's next crop insurance programme** in 2020.

In **Cambodia,** the government is actively monitoring **several initiatives with private-sector partners** to roll out insurance and associated support mechanisms to farmers.

Through continued **multi-stakeholder engagement** and collaboration with partner institutions at national and ASEAN level, RIICE is working towards **building up institutional capacities and supporting frameworks** for the implementation of national monitoring systems and insurance schemes.

Challenges:

In Thailand and Indonesia, the cooperation has been paused. Indonesia has, at the time of writing, **renewed negotiations** to start working with RIICE again.

In Cambodia and Vietnam, there are question marks over the long-term sustainability of the pricing model.

Insurance

A crucial objective was to support effective insurance for smallholder farmers. **RIICE data has been successfully used in insurance,** but uptake of the RIICE solutions has not been consistent across the region. Various initiatives to tailor the applications are in progress. This allows for each area to **develop the most effective model for the respective circumstances** but has led to longer development periods than anticipated.

Achievements:

RIICE **collaborates with private insurance companies** in the respective countries, amongst others Forte in Cambodia, Bao Viet and Bao Minh in Vietnam, and AICI in India, as well as agricultural banks as potential distribution partners for insurance products.

In total about **1 million hectares of paddy rice fields and more than 1 million farmers in Tamil Nadu** have been covered since 2017 under a RIICE-supported prevented/failed sowing insurance as part of the PMFBY.

After the **2017 drought in Tamil Nadu,** with the help of RIICE data the government was able to immediately **identify the affected areas and insurers released compensations** of an average of EUR 255 to more than 22,500 rice farmers.

Work in progress:

In Vietnam, RIICE will be participating in the pilot of the new crop insurance programme in 2020.

In Cambodia, a pilot is planned for roll-out in 2020 with private-sector partners. These could include linkages between crop insurance and other related support products such as input guarantees, agro-banking and micro-credit services.

Challenges:

The challenges with respect to the insurance applications were largely due to characteristics of the insurance sector or other institutional factors, rather than any shortcomings in the RIICE system.

In the Philippines, the government has moved away from the insurance application of the RIICE solution, and is focussed more on other aspects of planning including crop health.

Despite the many potential advantages from the improved and localized accuracy of RIICE data, application is below expectations:

- Insurers will continue to rely on historical data to calculate premiums. RIICE needs to complement this with its almost-real-time assessments and accurate forecasts, but the integration of this into actuarial models will take some time.
- There are some obstacles to long-term, **unsubsidized market development** in these territories. The governments in target countries often struggle to allocate the budget needed to sustainably operate a nation-wide agriculture insurance scheme and might not feel confident allocating money from their own treasury for necessary support agreements including the software licences.
- The **smallholders** themselves do not represent an end-user **consumer base that could support the market on competitive conditions.** This is partly because there is no perceived need to buy insurance policies, but also partly a question of affordability.

Crops

Achievements:

The RIICE solution has demonstrated its **capacity to map and monitor rice crops,** both for **assessment and forecasting** purposes.

Work in progress:

There is the potential to apply **technologically similar approaches to monitor other crops,** such as wheat, cotton, or chick pea in India, or even water maps and availability.

Challenges:

The **system is not able to assess all aspects of a crop's condition.** It cannot accurately assess wind damage, for example, which can be an important factor in determining yield loss due to a weather event.

Emerging economies

RIICE data has proven itself a valuable tool for emerging economies where rice is a significant contributor to livelihoods, food security and the national economy. Its **adaptability** has helped it integrate the different systems **and requirements of different territories.** However, **the extent of that integration has varied,** and has been most successful **where certain structures and operations were already established** around crop monitoring or insurance services. Outside of the Philippines there has been limited progress in transferring ownership to government agencies. The uptake by the insurance sector has not met expectations, and the business model for the software raises some further questions around financial sustainability.

VI. LESSONS LEARNED

Over the years of the project several observations have been made regarding what worked well, what took longer than expected, and what could usefully have been approached differently. Most of the lessons learned involve the operational dynamics of working with the respective countries on the ground. The following points make up a selection of some of these observations.

The benefits of the RIICE solution are reached much faster when agencies on the ground are willing to take early ownership and integrate it with their institutions. The early and active involvement of key state agencies was a key factor in the rapid and effective uptake in the Philippines and Tamil Nadu. In Vietnam and Cambodia, the deployment of RIICE has had to match the development phases of institutions on the ground.

The flexibility of RIICE has allowed each territory to maximize the benefit for its situation. RIICE has been applied to a wide range of requirements and thus has been customized in each country. Deployment can be delayed while the solution is being adapted and passed through the various administrative steps.

Early input from national agencies saves time. Some of the disconnect from national government partners might be traced back to their more passive involvement with the Phase I piloting. Soliciting more active input at that stage could have helped align the project with national priorities earlier, securing better buy-in from the various country authorities.

Different countries require different solutions and approaches. Bundling six very different territories under the same project makes it challenging to maintain coherence across the project while ensuring that the various needs of national stakeholders are met.

The insurance sector takes time to assimilate new ideas. The insurers were hesitant about some of the opportunities offered by RIICE, even though it offers them improved accuracy, lower operational costs, and new possible products. This is because these would require some innovation at an actuarial level, in a conservative and risk-averse business culture.

VII.THE WAY FORWARD

A need for accurate, transparent and affordable real-time information for monitoring and risk management remains a top priority for agricultural development and farmers' resilience, not only in Asia but across the globe. Climate and weather-related insurance solution can serve as an important cornerstone of a wider sustainable rural development and disaster risk management. For the successful implementation of crop insurance schemes, however, the right technology alone will only go so far. Gaining the much-needed trust and buy-in for the institutionalisation of the technology, finding the right parameters for an adequate business case and figuring out the best way of delivering the solutions are equally important.

In that sense, **the project will continue with the institutionalization of RIICE technology** within its national partners, and will improve implementation processes based on the collected lessons learned. The focus of RIICE operations will be the Ministries of Agriculture and relevant agencies for rice statistics as well as insurers in **Vietnam, Cambodia and India.** The necessary contractual base for such operations has recently been renewed and thus secured.

Furthermore, RIICE technology is planned to be further applied for loss-assessment procedures in **crop insurance programs and pilots** starting early 2020. Finally, RIICE will continue to innovate and coordinate with other projects to leverage their learnings and achievements. In parallel, there are discussions under way for IRRI and sarmap to set up **a joint venture that would be legally able to offer** a range of products to both private and public clients. This approach, together with looking beyond the current scope for applications of RIICE technology, will allow RIICE to tap into arising opportunities in the future in those countries.

In Cambodia, one area being explored next to insurance is the possibility of bundling crop insurance other services such as agri-inputs or agri-loans. It is planned that these pilots are mainly being run in coordination with private-sector partners. Government authorities are being kept in the loop, and it is expected that they may decide to invest public funds to scale up the more successful elements of the pilots.

In Vietnam, RIICE is likely to be deployed in the rice segment of the government's new crop insurance scheme in 2020. The project secured buy-in from national authorities earlier, but implementation was held up by the government's established project cycle. Some re-training was also required following staff rotation among local officials, further extending the timeframe. But the government has now earmarked the equivalent of 30 million US dollars to subsidise insurance products, and RIICE parties are supporting the consultation process for developing a crop insurance product and setting up implementation guidelines.

In India, the RIICE technology is supported by state-level authorities. In cooperation with the Tamil Nadu Agricultural University (TNAU), RIICE is used to assess losses under the government sponsored crop insurance scheme, Pradhan Mantri Fasal Bima Yojana (PMFBY). Further, RIICE pilots are under way in Andhra Pradesh and Odisha coordinated by IRRI and sarmap. Authorities in India are interested in using the remote sensing technology to conduct assessments and forecasts for other crops including chickpea and wheat.

In Indonesia, there have been renewed conversations after national authorities disengaged with the project in 2014, including a meeting with sarmap and IRRI in July 2019. These discussions have so far centred around the cost benefit analysis of using RIICE-based data for ongoing crop monitoring and forecasts. While also **a private company in Sri Lanka has engaged RIICE** in discussions, based on the project's success in improving food security and smallholders' livelihoods in Tamil Nadu.

At a regional level, advocacy efforts will be continuing with ASEAN and other stakeholders to secure the right policy and regulatory framework to develop crop insurance and related products, services and programmes.

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