IRRI

Annual Report 2017-18

Increasing Productivity of Rice-based Cropping Systems and Farmers' Income in Odisha

Development of Agriculture in collaboration with the International Rice Research Institute

Increasing Productivity of Rice-based Cropping Systems and Farmer's Income in Odisha
(IRRI Ref. No. A-2016-48)

Annual Report

submitted to the

Department of Agriculture and Farmers' Empowerment,
Government of Odisha

June 2018

Alvin Poncin
Head, Portfolio Management Office
Telephone: +63 (2) 580-5600 ext. 2747; Direct: +63 (2) 580-5621; Fax: +63 (2) 812-7689 or 580-5699
E-mail address: pmo@irri.org / drpc-irri@irri.org Mailing address: DAPO Box 7777,
Metro Manila, Philippines
Courier address: 10th Floor, Suite 1009, Security Bank Center, 6776 Ayala Avenue
Makati City 1226, Telephone: +63 (2) 891-1236, 891-1303

Rice Science for a Better World

The International Rice Research Institute (IRRI) was established in 1960 by the Ford and Rockefeller Foundations with the help and approval of the Government of the Philippines. It is supported by government funding agencies, foundations, the private sector, and nongovernment organizations. Today, IRRI is one of 15 nonprofit international research centres that is a member of the CGIAR Consortium (www.cgiar.org). CGIAR is a global agricultural research partnership for a food-secure future. The work described here was undertaken as part of the on-going, Government of Odisha funded project '**Increasing Productivity of Rice Based Systems and Farmers' Income in Odisha'.** The responsibility for this publication rests with the International Rice Research Institute.

Mailing address:
International Rice Research Institute
Odisha Project Office: 340/C. Sahidnagar, Bhubaneswar, Odisha.
IRRI-India Office: 1st floor, Office Block, NASC Complex, DPS Marg, Pusa New Delhi 110012
Ph.: +91-11-66763000

Headquarters: DAPO Box 7777, Metro Manila, Philippines
Phone: +63 (2) 580-5600 Fax: +63 (2) 580-5699
Email: info@irri.org; Web: www.irri.org

Rice Knowledge Bank: www.knowledgebank.irri.org

Courier address: Suite 1009, Security Bank Center 6776 Ayala Avenue, Makati City, Philippines Tel. +63 (2) 891-1236, 891-1174, 891-1258, 891-1303
Suggested citation: Annual Progress Report. **Increasing Productivity of Rice Based Systems and Farmers' Income in Odisha (2018).** India Office, International Rice Research Institute. 123 P

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Preface

The Government of India is pursuing initiatives for Doubling Farmers' Income since 2016. The push for ushering a second Green Revolution has also made good progress in the Eastern Indian region, with concerted efforts to disseminate successful technologies in rice, pulses, and oil seeds (BGREI, NFSM). Strategies must recognize and accommodate the agro-biological, technological, socio-economic and institutional dimensions of the various rice-based production and livelihood systems to contribute to enhanced incomes. That was the raison d'être for the Government of India's support to the project on 'Increasing Productivity of Rice-based Systems and Farmers' Income in Odisha' which completed its second year of operation in March 2018.

Rice is the most important food crop in Odisha. However, it experiences excessive or deficient water conditions and salinity that depress yields in inland and coastal regions. A number of submergence-, drought-, and salinity-tolerant varieties developed by the International Rice Research Institute (IRRI) and the National Agricultural Research Systems, supported by policy initiatives to enable the cultivation of these varieties released across national boundaries like Bangladesh and Nepal, among other countries have proven to be useful. Several varieties including Bina Dhan 11, released in Bangladesh and found suitable in Odisha conditions, are finding increased acceptance among farmers in the State. The IRRI-Odisha project has made significant progress in building capacity to accelerate good quality seed multiplication and dissemination of stress-tolerant rice varieties after comparative analysis of their performance in head-to-head trials led by women and men farmers. Large variations in soil fertility characteristics necessitate appropriate site- and region-specific management methods for increased nutrient efficiency and reduced cultivation costs. The Rice Crop Manager, a computer- and mobile phone-based tool that gives site-specific recommendations to farmers based on target yields, is being fine-tuned to be used in rain-fed stress-prone areas. Cropping systems research is facilitating farmers to benefit from integrating pulses in rice systems. Using advanced remote sensing and geo-spatial analysis, extrapolation domains are being developed using which contextually-relevant cropping systems including varietal combinations can be recommended. Satellite-based monitoring of rice in kharif and rabi seasons is in progress that helps deliver near real-time estimates of the net cropped area and yield at desired resolutions to help the government in assessing crop losses due to extreme weather events and to assist farmers in getting the timely payout of compensation against such losses. Enriching the knowledge base with locally valuable content, creating enabling conditions for farmers to adopt new technologies, and empowering women farmers to take the reins of farm management are other positive changes the project has strived to deliver. These processes are gaining traction and receiving support from various stakeholders including the Department of Agriculture. It is hoped that in the years to follow, the fruits of research would not only reach the needy farmers but also fulfil the objective of raising their income levels satisfactorily.

Ranjitha Puskur

Acknowledgement

The project on 'Increasing Productivity of Rice-based Cropping Systems and Farmers' Income in Odisha' was implemented by IRRI with the support of the Department of Agriculture and Farmers' Empowerment (DAFE) in the Government of Odisha. To bring about the needed transformations in the rice sector, then Principal Secretary of DAFE Shri Manoj Ahuja and his successor, Dr. Saurabh Garg, provided all necessary support to plan and execute the project activities across the state and guided the team to work with the Directorate of Agriculture (DoA) and its functionaries in different districts to implement the activities as envisaged in the second year plan. Without their constant encouragement and support, the project objectives would not have been realised by IRRI's efforts alone. Shri Hari Ballav Mishra and subsequently Dr. M Muthu Kumar, Director of the Directorate of Agriculture & Food Production, Government of Odisha, facilitated the implementation of the project activities by providing necessary linkages with various stakeholders including the Odisha State Seed Corporation (OSSC), Odisha State Seed Organic Products Certification Agency (OSSOPCA), Orissa Space Applications Centre (ORSAC), Institute on Management of Agricultural Extension (IMAGE), and also the state administration whose permissions were sought for specific interventions in farmers' fields (e.g. the use of drones for crop mapping). The active role played by the directors of the OSSC and OSSOPCA in prioritizing the production and certification of stress-tolerant rice varieties is also thankfully acknowledged.

The formation of coordination committees for regular interactions at the district level and the participation of women officers of the DoA, Assistant Agriculture Officers (AAOs), and other staff in training programmes and workshops greatly helped IRRI in organizing the Training of Trainers in Quality Seed Production and Storage, Rice Crop Manager, Season-Long Training programmes, and the Leadership Programme for Women in Agriculture. Shri Ashok Mohanty, Joint Director for Special Programmes, was instrumental in establishing the linkages that ensured seamless information flow between IRRI and DoA for various operations. Dr Rajesh Das, Nodal Officer of the Pradhan Mantri Fasal Bima Yojana (PMFBY), regularly interacted with the crop insurance team, connected the team with agencies like ORSAC and helped IRRI fine-tune the satellite-based monitoring of rice area and yield estimates. His active role in project implementation is thankfully acknowledged. The committee constituted by the DoA to monitor the implementation of the project also made helpful suggestions to facilitate the processes. Liaison by Sri Saroj Kant Chand and Tarun Chotoray, officers of DAFE, was very helpful in the periodical reporting of the physical and financial progress of the project at defined intervals. IRRI would like to put on record their invaluable contribution.

Many institutions lent their support in the implementation of this project. Research partnership with the Orissa University of Agriculture and Technology (OUAT) and its associated Krishi Vigyan Kendras in different districts, the Indian Council for Agricultural Research – National Rice Research Institute (ICAR-NRRI), and the ICAR – Central Institution for Women in Agriculture (CIWA) provided the much needed support in evaluating the performance of stress-tolerant rice varieties, crop and nutrient management systems, and organizing workshops and training programmes. The proactive roles of Dr. Surendranath Pasupalak, Vice Chancellor, OUAT; Dr. Himanshu Pathak, Director, NRRI; and Dr. Jatinder Kistwaria, Director, CIWA, in facilitating these activities are thankfully acknowledged.

Evidence Hubs in different districts were established with the guidance of the Deputy Directors of Agriculture who also regularly visited the on-farm research sites and demonstrations and helped in the evaluation of technology, assisted in organizing the activities through non-government organizations, AAOs, and Krishak Sathis and reported the outcome to the DoA as needed. Their active role in project implementation was invaluable. Last but not the least, the thousands of farmers, village-based seed dealers, and the women self-help groups who worked with the IRRI team through the season to successfully operationalise the project activities in their fields deserve a special mention. Their contributions are thankfully acknowledged.

Introduction

Field crops, especially rice, continue to dominate the agricultural landscape of India at large and the state of Odisha in particular. Despite the higher productivity and production of rice in recent years, there appears to be no equitable growth in farmers' income owing to increased cost of cultivation against stagnant and low prices of the produce which lead to poor returns on investment. The disparity between farm income and non-farm income has also widened in recent years with higher wages realised by workers in the non-farm sector. Anthropogenic climatic changes have profoundly compounded the existing constraints with recurrent adverse weather events depressing both production and productivity. While scientific exploration into the effects of climate change is still ongoing, IRRI recognizes two universal trends predicted by all climate change models: a) that temperature will increase, resulting in more heat stress and rising sea levels and b) that there will be more frequent and severe climate extremes. At present, about 20 million hectares of the world's rice-growing area is at risk of occasionally being flooded to submergence level, particularly in major rice-producing countries such as India and Bangladesh. Major flooding events are likely to increase in frequency with the onslaught of climate change, making rice-growing areas currently not exposed to flooding vulnerable to experiencing floods. Saline water intrusion further inland will expose more rice-growing areas to salty conditions. The intensity and frequency of droughts are also predicted to increase in rainfed areas, with the drought conditions possibly extending further into the water-limited areas. Rainless days for a week in upland rice-growing areas and for about two weeks in shallow lowland areas can significantly reduce yields.

The resilience of farmers and farming systems to multiple challenges posed by abiotic and biotic stresses needs to be carefully developed with appropriate technological interventions while the inequity in farmers' income has to be addressed with pro-active policy initiatives in the post-production sector. IRRI, with its strong regional focus, is working with NARS and state governments to bring in the desired changes in rice-based production systems, thereby addressing a host of issues that threaten to jeopardize the recent advances in production trends. The inherent diversity of land types in which rice is grown in Odisha and the various hydrological regimes demand sustained interventions that are specific to each region, district, or even block to steadily increase and stabilize production, productivity, and profitability. Although productivity gains and resource use efficiency and reduction in the cost of cultivation of rice and rice-based cropping systems are the major focus of these interventions, better returns on investment and reduction of distress are also avowed targets of the IRRI-Odisha project.

The second year of the project on 'Increasing Productivity of Rice and Rice-based Cropping Systems and Farmers' Income in Odisha' has been completed. The IRRI-Odisha project has made a strong beginning that promises to produce major impacts to achieve the project's objective of increasing productivity with recent technological breakthroughs for less favoured environments. This include the newly released drought-, submergence-, and salinity-tolerant varieties befitting the crop duration of existing commercial cultivars, their testing in the different districts based on specific requirements, the comparative evaluation of the stress-tolerant rice varieties (STRVs) in farmers' fields under their own management, the conduct of cluster demonstrations by seed dealers and other partners linked to seed production, and the emphasis on the training of participating farmers on quality seed production and storage. The training programmes were structured to develop master trainers at the district/block level who would further impart training to village-level workers and farmers to take up quality seed production.

There is a strong case for the transition in seed provisioning from the public to the private sector with the increasing demand for quality seeds in place of farm-kept seeds. Increased commercialization of agriculture has, however, differentially influenced this behaviour as seen from the higher seed replacement rate (SRR) observed in the neighbouring states of Andhra Pradesh and West Bengal compared to Odisha, possibly due to the higher percentage of rice area under the irrigated ecosystem in the two states. SRR does not ensure high productivity if the variety is old and has developed susceptibility to biotic stresses. Varietal replacement rate is as important as SRR. While the process of seed delivery and adoption is being accelerated, IRRI is mindful of the need to match the increasing seed demand for STRVs with adequate supply of seeds facilitated through the public, private as well as informal seed systems. During the kharif season in 2017, demonstration linked seed production of STRVs was facilitated in about 500 ha of private farms with seed certification from OSSOPCA and buy-back of the certified seed by the OSSC.

Farming practices and risks vary among farmers and fields. Since farmers need quick and easy access to information that matches their specific field conditions and needs, the site-specific nutrient management (SSNM) principles were used to develop web- and app-based decision tools at IRRI. One of these is the Rice Crop Manager (RCM) which is a comprehensive decision support tool that provides farmers operating on irrigated and rain-fed ecosystems with location-specific crop management recommendations to increase their production and income. RCM, evolved on the principle of SSNM, addresses the nutrient requirement of individual farmers' fields to realise targeted yields in tune with the type of varieties grown, soil type, and hydrology. RCM can maintain or enhance crop yields while providing savings for farmers through the more efficient use of costly fertilizer inputs and, in the process, reduce both damage due to pests in certain cases and the carbon footprint. The program was adapted and evaluated for use in Odisha in 2012-15 under the Cereal Systems Initiatives for Southeast Asia funded by the Bill & Melinda Gates Foundation and implemented in 2016 under the IRRI-Odisha project in seven districts. Dissemination of RCM recommendations was accelerated with the establishment of RCM Kendras in 14 districts in 2017, training of trainers, and the active involvement of field-level functionaries of the DoA and NGO partners.

Increasing cropping intensity in fallow lands could substantially improve food production and enhance the livelihoods in the state of Odisha. With the availability of new drought-, flood-, and salt-tolerant rice cultivars and short-duration pulse crops, along with improved agronomy and water management, better chances of bringing significant numbers of potential rice-fallows to double crop systems are assured. Moreover, there is considerable scope to improve the productivity of rice-based systems by adjusting varietal characteristics (e.g. by planting shorter-duration rice, stress-tolerant rice, hybrid rice, etc.). Potential crops for rice-fallows include greengram, blackgram, chickpea, and mustard, among others. To efficiently target these potential fallows, a detailed characterization of the resources is needed (e.g., salinity, submergence, inundation depth, groundwater availability, etc.) to systematically analyse the potential opportunities and constraints. IRRI worked to develop domain maps of fallows with potential for double cropping by integrating remote sensing and GIS mapping with logical decision tree approach and following it up with on-farm trials and demonstrations of pulses after rice in different locations.

Farmers rely on fellow farmers, dealers, farmers' fairs (Kisan melas), and Kisan Call Centres for obtaining farming-related information including varietal choices, availability of seeds, fertilizer recommendations, and advice on pesticides/ insecticides. Technical backstopping needs to be provided through appropriate dissemination pathways for STRVs and management practices. This entails training of local functionaries of the DoA on rice ecosystem-specific domain knowledge and extension services. The IRRI-developed digital extension service, the Rice Knowledge Bank (RKB), provides practical knowledge solutions specialized for small-scale farmers in developing countries. The RKB initiative for Odisha aims to provide ready-to-use district-level content available in different formats (factsheets, training manuals, and videos) in Oriya. This will enable farmers to realise higher net incomes from their farming enterprise on a sustainable basis by using relevant technological information. It will create awareness about the availability and cost of inputs and tools, marketing facilities, prices etc. Applying the available information will enhance their skill to share the knowledge to others. Building the capacity of extension functionaries of the State DoA, NGO partners involved in rural livelihood programmes and sister institutions like the Odisha Livelihoods Mission are the planned 'next steps' to institutionalize the process of knowledge sharing and dissemination.

Majority of rural women in India can be considered as 'farmers' in some sense, either working as agricultural labourers or as unpaid workers in the family farm enterprises, or a combination of the two. Their role in rice farming spans seed preparation to sowing, raising nurseries, transplanting, weeding, applying fertilizers, harvesting, threshing, cleaning, and storage. Mechanization has brought about a modest reduction in their drudgery and time shared on farm activities but decision making and the control and sharing of resources continue to be vested in the menfolk. With a view to instil self-confidence in women and enhance their access to productive assets, knowledge, and skills, the project took up a number of pro-women programmes to encourage them to become leaders in their communities, mentoring women entrepreneurs in agri-business and enhancing the strength of women extension personnel through capacity building.

Information and Communications Technology (ICT) sector is considered one of the key drivers of economic growth as, for example, mobile services facilitate communication not restricted by distance, volume, medium, and time. With this, access to smart phones in rural areas is increasing. According to the Telecom Regulatory Authority of India, currently there are 499 million mobile subscribers in rural India as of June 2017, of which 109 million users own smart phones. About 50 million also use mobile internet. The IRRI-Odisha project is leveraging on this prospect, focusing on app- and web-based information services through a number of interventions in the area of seed provisioning (SeedCast), nutrient management (RCM), and rice pest management (Rice Doctor). The uptake of information by farmers and its impact on productivity is also being monitored in the case of RCM which was launched in 2017 and is reaching more than 50000 farmers in one year. Similar exercises will follow for other services but such services/solutions are only complementary to other infrastructural/ research support programmes and would need refinement, updating, and integration to enable farmers to fully benefit from ICT-enabled platforms. The development of a single integrated ICT gateway or knowledge portal with content reviewed by the DoA and assisted by the Orissa University of Agriculture and Technology and the Indian Council for Agricultural Research – National Rice Research Institute (ICAR-NRRI) will ensure convergence and appropriate dissemination of information among the agricultural stakeholders.

Several studies have indicated an inverse relationship between climate change and farm income. Low farm income reduces the adaptive capacity of farmers to withstand climate shocks, thereby increasing their vulnerability. Low income and high climatic vulnerability lead to extreme distress, necessitating efforts to support such disadvantaged regions. The PMFBY provides comprehensive crop insurance from pre-sowing to postharvest against non-preventable natural risks at a low premium rate of 2 percent for kharif crops, 1.5 percent for rabi crops, and 5 percent for horticulture and commercial crops. The remaining premium is subsidised by the central and state governments together. Though the scheme has witnessed increased coverage in the last few years, there are also a number of challenges delaying claim settlements of farmers. The biggest challenges are the conduct of crop cutting experiments (CCEs), possible fudging of CCE to estimate yield losses, and the delay in reporting and payout of compensation. In addition, conducting CCEs is resource-intensive. The use of technology such as mobile devices and remote sensing to estimate crop losses has been limited. IRRI has developed substantial expertise in delivering satellite technology-supported monitoring systems which was implemented in Odisha as part of the project. Synthetic Aperture Radar (SAR) imagery is highly suitable for detecting rice areas, especially in the tropical region where pervasive cloud cover in the rainy seasons limits the use of optical imagery. The satellite-based rice monitoring system uses multi-temporal X-band and C-band SAR imagery and field observations to classify rice in multiple locations across the state and assimilate the information into the ORYZA Crop Growth Simulation model to generate high-resolution yield maps. The resulting cultivated rice area maps had classification accuracies above 85% and yield estimates were within the 81-93% agreement against district-level reported yields. Along with a robust monitoring system, studies on the socio-economic factors that affect the uptake of insurance policies by loanee and non-loanee farmers were also taken up through farmer group discussions, structured interviews, and surveys.

The outputs from the five major interventions under the project on seed system improvement, crop resource management, rice fallow management, knowledge management, and crop insurance are presented in the following sections. The results presented here relate to the work accomplished during the 2017-18 kharif season and progress of activities in the rabi season up to March 2018.

Executive summary

Interventions in key thematic areas that could influence economic decisions and bring about system level changes included (a) innovations in the seed sector, (b) better utilization of rice fallows to improve the cropping intensity (c) making effective management decisions for the crop, especially on investments in fertilizers and plant protection products (d) knowledge management with localization of content and capacity building with inclusivity and (e) the ability to predict and prepare for climatic adversities better. Salient findings from the interventions made are summarised below:

Seed System Improvement:

Twenty-eight Evidence Hubs (EHs), one in each district including two at NRRI and OSSC (Puri) and two managed by women self-help groups (SHGs), were established with two sets of drought- and submergence-tolerant varieties to evaluate their performance in different agro-climatic conditions and to select the desirable ones based on stakeholder selection (extension officials, NGO partners, farmers) and yield. Extension officials were more discerning in their ranking of genotypes as they perceived the requirement of the entire district, prioritizing the varieties based not only on yield and yield-contributing traits but also on other traits such as duration fitness, stature, and grain type, among others. Several new entries were identified as having potential and were ranked higher across locations, among them Bina 17 and BRRI dhan 70, 71, and 75 for drought-prone areas.

Farmers' perceptions during Head-to-Head (H2H) trials indicated that most farmers favoured STRVs, with 67% of the 550 farmers interviewed finding a distinct edge of STRVs over farmers' varieties, whereas 24% did not find any difference between STRVs and the currently grown varieties. Since many H2H plots were not affected by stress, the lack of difference between Swarna and Swarna Sub 1, for example, was expected.

About 15000 farmers from 1032 villages/470 Gram panchayats (GPs) of 109 blocks benefited from cluster demonstrations which covered more than 5518 ha during the kharif season. DRR 39 and CR 405 were identified as promising salinity-tolerant varieties that can replace varieties like MTU 1010 in the rabi season in the coastal zone.

Three classes of genotypes were identified: varieties specific to the submergence-prone areas (Swarna Sub1, CR 1009 sub 1), drought-prone areas (Sahbhagi dhan, DRR 44, BRRI series), and a few such as Binadhan 11 and Bina 17 which had high scores and yield across coastal and inland areas obviously due to their resilience to different growing conditions.

Seed and input dealers have a key role to play in disseminating seed and farming-related knowledge to farmers. Demand creation through awareness raising benefits the dealers. About 500 seed dealers distributed approximately 40 tons of seed of 5 varieties to 7900 farmers during the year. Analysis of seed demand for the next cropping season through these dealers would be monitored to measure the acceptance of the varieties among the farmers.

SeedCast, a digital platform developed to forecast the demand and supply of seeds, is an effective mode of demand aggregation benefiting all stakeholders in the supply chain management including public and private seed producing/supplying agencies on the one hand and farmers on the other. The first version of the web-based/ mobile app is under pilot testing.

Thirty-eight percent of the more than 15000 farmers involved in seed system improvement work in 2017-18 were women. Training for skills development of women farmers through SHGs for quality seed production and their involvement in the EHs, H2H trials, and cluster demonstrations linked to seed production were helpful in developing income-generating opportunities for women.

Rice–Fallow System:

Spatial distribution and extent of rice fallow, current fallow, and spatial-temporal changes of rice fallow in last 10 years were analysed using Principal Component Analysis-based remote sensing methodology through processing time series remote sensing datasets (Optical and Microwave) of different seasons/years. Analyses of seasonal spatial-temporal profiles of satellite data revealed that nearly 1.6 M ha area remained fallow in the rabi season in 2016-17.

Village-level mapping of the flood inundated area in the coastal districts of Odisha using high-resolution SAR data revealed that 1.43 and 1.04 lakh hectare of rice area were affected by flash floods in 2016 and 2017 respectively. A soil moisture-based 'integrated drought stress index' is also being developed to understand the spatial variability and drought dynamics in the state. The flood inundation and drought indices would help in precisely targeting flood/drought-tolerant rice varieties for the state.

Spatio-temporal profiles of soil moisture availability during the rabi season were analysed to precisely target and utilize the short residual moisture window to cultivate short-duration pulses in the rice fallow areas. The identification of areas having low, optimum, and excessive soil moisture profiles during the rabi season helps to determine the cropping window, type, and duration of the pulse varieties, and the monthly average moisture availability for the crop from germination to pod formation.

Based on rice fallow maps and associated information, demonstration using four green gram (IPM 2-3, IPM 2-14, Virat, and PDM 139) and three black gram (PU 31, VBN 8, and Azad) varieties were conducted in 2095 ha covering 6020 farmers from 499 villages in 22 districts.

Nano-materials of iron and zinc and a root growth promoting material improved the vegetative growth of the drought-tolerant varieties Sahbhagi dhan and CR Dhan 205 and contributed to significantly higher yields compared to sprays of zinc sulphate and iron sulphate in a field experiment conducted at a research farm (NRRI, Cuttack). The effect of nano-materials on the growth promotion of green gram was also tested and compared with hydrogel and a bio-agent (*Trichoderma*). Previous year results indicated that all three treatments with standard fertilizers and practices improved the grain yield of green gram compared to farmers' practice. The combination of nano solution and hydrogel over the line-sown crop with seed treatment of fungicide+insecticide+rhizobium and the recommended dose of fertilizers recorded 29.4% higher yield in the green gram variety IPM 2-3.

The Rice Pulse Monitoring System (RPMS), launched in May 2017 for the state of Odisha, is a customised application in an open-source platform that works online or offline to collect and store geo-referenced information. The capability of the system has been improved by adding information on 1.7 million registered farmers of Odisha and options to view or overlay remote sensing data. The upgraded version of RPMS will be ready for pilot testing shortly.

Rice Crop Manager:

The climate-informed RCM service was provided to more than 50000 farmers in 11 districts during kharif 2017 through two primary channels i.e., printed recommendations and phone advisories. Field functionaries of the DoA and NGO partners operating the kiosks or kendras were trained by IRRI staff in a series of training of trainers to establish the kiosks, interview farmers, and generate recommendations. A total of 91 kendras were set up during the project period. A total of 1636 participants from 11 districts were oriented on the operation and use of RCM and on troubleshooting problems associated with the use of RCM during kharif and rabi seasons.

Crop advisories were sent out to around 6000 farmers during kharif 2017 through SMS and voice calls in collaboration with IFFCO-Kisan and Precision Agriculture Development. RCM and farmers' fertilizer practices were compared in 4340 demonstrations, 370 of which were compared with crop cuts in both practices. Field days were organized along with crop cuts in farmers' fields where RCM and non-RCM plots were compared. The advantages of RCM were explained with an analysis of its costs and benefits.

Farmers using RCM harvested an additional yield of up to 1 t/ha (yield advantage of 26%) and could save on the use of phosphatic and potash fertilizers. Yield targeting based on Geographic Information System and RCMs' interactive farmer-based yield targeting were compared, with the former having an accuracy level of 74% with an average saving of Rs. 1882/ha over the farmer-based target yield.

Experiments have been initiated to evaluate better crop and nutrient management practices to help develop decision trees for rain-fed environments.

Knowledge Management:

Contextualized content development for RKB in the form of fact sheets, videos, and training manuals is in progress. Standard operating procedures or package of practices for rice under various stress conditions are in the process of development as well.

The Rice Doctor app, a mid-season diagnostic tool for about 80 different rice diseases, insect pests, and nutritional problems was modified for Odisha conditions. The beta version of the app for Odia will be field tested with about 250 farmers during kharif 2018.

A baseline survey with about 300 farmers to quantify the occurrence, intensity, and spread of pest problems in different rice systems in Odisha was conducted, along with a workshop for extension officials to assess the awareness, management, and intervention needs for Integrated Pest Management (IPM) and a pilot testing of IPM modules during kharif and rabiseasons.

Season-long training programmes organized at the Badashahi and Rasgobindpur blocks of Mayurbhanj during kharif and at Brahmagiri (Puri district) provided hands-on training on modern crop management methods to a group of women farmers and extension functionaries, respectively.

A series of workshops, training programmes, and hands-on exercises were undertaken to help conceive, develop, implement, and lead entrepreneurial projects and businesses with women farmers along the rice value chain and also to support the professional development of women scientists and extension/social workers.

Science-based Crop Insurance:

Three tracks of multi-temporal Sentinel 1A imageries covering Odisha (January to December 2017 for discrimination of land cover types in the ecosystem map and June to November 2017 for start of the kharif season, rice area and leaf area index maps) were processed. Landsat 8 and Sentinel 2 images were used to cross-check and verify SAR data.

District-wise rice area was estimated and consolidated for the state after validating SAR signatures with ground data for rice and non-rice points. The kharif rice area was estimated at 35.26 lakh ha with an overall accuracy of 87.75%. Start of rice season estimates revealed that about 28% of rice seeding/transplanting was completed from June to mid-July, 57% from mid-July to mid-August, and the rest during the latter half of August (13%) and early September (2%).

Kharif rice yields were estimated using the ORYZA crop growth model and rice yield estimation system with inputs on SAR data, weather data, varieties, soil hydrology, crop establishment, and nutrient management information.

Risk attitude of farmers and the factors influencing it are important policy pointers to strategize risk mitigation measures. Risk preference elicitation experiments with rice growing farmers in 15 districts revealed that majority of farmers (51%) were completely risk averse, with most of them being small and marginal farmers. Focus group discussions (FGDs) conducted in villages representing different climatic risks and farmers having varied socio-economic characteristics revealed that most of the farmers were not aware of or were misinformed about the provisions of the PMFBY scheme. Lack of access to insurance to share croppers, problems in yield loss estimation, delayed payout of compensation, and farmers' inability to cope with mitigation without government interventions were highlighted in the FGDs.

Stakeholder meetings with department officials revealed the need to increase coverage with additional crops under crop insurance, digitize land records, bring share croppers and non-loanee farmers under the scheme, and remove moral hazards that adversely affect the yield estimation process. Delay in getting cropped area and yield estimation, lack of information on the sum insured, ambiguities in land records, and lack of standard methods of premium estimation were the constraints flagged by insurance agencies.

Cognitive behavioural experiments to evaluate different ways of integrating technologies have been planned to make insurance policies attractive and acceptable to the stakeholders.

Subproject 1: Strengthening seed systems of stress-tolerant rice varieties through innovative demonstrations and extension approaches in Odisha

This subproject aims to mitigate the effects of recurring abiotic stresses through the enhanced adoption of STRVs by replacing existing varieties which are susceptible to several abiotic and biotic stresses. In order to empower farmers to better deal with drought, submergence, and saline conditions, different approaches to popularize and diffuse STRVs were successfully demonstrated and efforts made to strengthen the formal and informal seed delivery systems.

Component Goal

To improve the access to and availability of quality seeds of STRVs in the risk-prone (floods and drought) areas of Odisha for improving and stabilizing rice productivity.

Objectives: The major objectives of the five-year project are:

- To identify the best approaches in improving informal seed dissemination and adoption of STRVs;
- To develop suitable strategies for sustainable seed production, promotion, and delivery of STRVs to the farmers through demonstrations;
- To develop the knowledge base, capacity, and awareness in the varietal selection process for scaling up through evaluation of STRVs in participatory mode;
- To promote and create awareness on the role of STRVs in rice-based cropping systems; and
- To conduct an impact evaluation of the adoption of STRVs

The subproject on seed systems is planned to promote suitable STRVs with the involvement of key stakeholders in the seed value chain. IRRI, in collaboration with the Government of Odisha, demonstrated different STRVs through diverse extension approaches such as the establishment of EHs, H2H trials, and cluster demonstrations. This was followed by awareness creation, training of trainers and, training the farmers including women-led groups on quality seed production and storage. The process was facilitated by the officials of the DoA in different districts, NGO partners, dealers and field staff of IRRI located strategically in the western, northern, southern, and coastal eastern regions. The activities taken up during kharif 2017 and the following rabi season are summarised in Tables 1.1 & 1.2.

Table 1.1: Progress summary of seed component for 2017-18

SN	Activity		Unit	Physical Targets			Achievements	Remarks
				Districts	Blocks	Area/No	Total	
Kharif 2017-18								
1	Demonstrations	Demonstrations (5 ha each)	Ha	30	109	5518	5,518	Area covered is 5518 ha in 109 blocks of 30 districts
		H2H Trials	No	30	109	2180	2,500	AAOs, NGOs, Farmers, Dealers
		Demos through OSSC Dealers	No	30	109	1090	1090	OSSC dealers, Krishak Sathis, OSSC. &7913 farmers reached
		Evidence Hubs (Crop Cafeteria)	No	30		28	28	DDAs, OSSC, KVK, Dealers & Farmers
		Client Oriented Crop Cafeteria	No	2	2 in state	2	2	NRRI, OSSC
2	Trainings	QRSP Trainings for farmers (25 per training)	No	30	109	2725	2730	DDAs, IRRI, KVKs, OUAT, NGOs
		TOT on QRSP and Management Practices	No			2	2	NRRI, OUAT, KVKs, IRRI, completed 22-23 and 25-26 September
3	Workshops Meetings	District-level Seed Meetings	No	30	Dt level	30	30	DDAs, KVK, OSSC, AAOs, Dealers
		Formation of women-led seed groups	No	30	30	30	8 SHGs formed, 22 under process	NGOs, SHGs, DDAs
		Awareness creation meetings (2/season) 100 farmers each	No	30	109	218	218	DDAs, NGOs, Farmers
4	Research Support	Pilot SeedCast	No	10	30		1 (under process)	DDAs, AAOs, Dealers, PACS, OSSC outlets, OSSC
Rabi 2017-18								
5	Demonstration	H2H trials	No	9	21	210	Crop cutting is in progress	
		Cluster demonstration	Ha	9	21	520	Crop cutting is in progress	
		Crop Cafeteria	No	9	21	5	Crop cutting is in progress	5 cafeteria: Puri, Kalahandi, Sonepur, Bargarh and Bhadrak

Table 1.2: District-wise demonstration details

S N	District	Cluster Demonstration			H2H demonstration		Dealers' demonstration		STRVs demonstrated	NGO Partner
		Seed Quantity (Kg)	Area in ha	No of farmers	No of H2H trials	Area in ha	Minikits (5Kg Each)	No of dealers participated		
1	Angul	8128	162.57	636	61	6.1	1125	15	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	SSSS, FES
2	Balasore	9260	185.20	535	79	7.9	1500	20	Bina dhan 11, CR 1009 sub 1, Swarna sub 1	BSSS
3	Bargarh	5250	105.00	277	60	6	1120	15	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	SSSS
4	Bhadrak	7490	149.80	378	57	5.7	1090	15	Bina dhan 11, CR 1009 sub 1, Swarna sub 1	BSSS
5	Bolangir	7665	153.30	249	60	6	825	11	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	Lutharan, Global Green
6	Boudh	7500	150.00	267	60	6	1125	15	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	Palli Seva Sansad
7	Cuttack	5801	116.03	288	48	4.8	705	6	Bina dhan 11, CR 1009 sub 1, Swarna sub 1	Lutharan, SHDA
8	Deogarh	5040	100.80	263	40	4	1125	15	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	SSSS, CSDR
9	Dhenkanal	5195	103.90	326	48	9.5	750	10	DRR 42, DRR 42, Bina dhan 11, Sahabhagi	FES
10	Gajapati	6713	134.26	325	73	7.3	450	6	Bina dhan 11, DRR 42, DRR 44, DRR 46	ISARA
11	Ganjam	10183	203.66	352	30	3	1720	24	Bina dhan 11, Swarna sub 1	ISARA
12	Jagatsinghpur	7450	149.00	396	60	6	1235	15	Bina dhan 11, CR 1009 sub 1, Swarna sub 1	Utsarga, Pallivikash
13	Jajpur	11540	230.80	535	73	8.2	1355	17	Bina dhan 11, CR 1009 sub 1, Swarna sub 1	Netaji, Bidhata, SEED
14	Jharsuguda	10007	200.13	516	86	8.6	1595	18	Bina dhan 11, DRR 39, DRR 42, DRR 44, DRR 46, Sahabhagi	SSSS, SEWA
15	Kalahandi	16450	375.08	812	205	20.5	2560	32	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	S CARE, Harsha Lutharan, Lok Sebak

S N	District	Cluster Demonstration			H2H demonstration		Dealers' demonstration		STRVs demonstrated	NGO Partner
		Seed Quantity (Kg)	Area in ha	No of farmers	No of H2H trials	Area in ha	Minikits (5Kg Each)	No of dealers participated		
16	Kandhamal	6488	131.20	656	70	8	1135	12	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	CARE, Harsha Trust
17	Kendrapada	5013	100.26	363	44	6.5	850	14	Bina dhan 11, CR 1009 sub 1	Lutharan, Sophy
18	Keonjhar	15468	309.36	951	243	24.3	1980	25	Bina dhan 11, DRR 42, DRR 44, DRR 46, Sahabhagi	BSSS, FES, Lutharan, CSDR
19	Khurda	1250	25.00	68	22	4.4	750	10	Bina dhan 11, CR 1009 sub 1, Swarna sub 1	AID
20	Koraput	12113	504.84	1291	221	23.8	2220	22	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	Harsha Trust, Pragati
21	Malkanagiri	3910	89.00	276	64	11.1	700	10	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	Parivartan, Harsha Trust
22	Mayurbhanj	15272	305.44	1096	121	12.1	2010	26	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	BSSS, SPARDHA
23	Nabarangpur	9885	197.70	664	63	6.3	1380	19	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	Harsha Trust, CARE
24	Nayagarh	9750	199.80	712	80	8	1480	12	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	BOJBP, SAHAYA
25	Nuapada	8075	161.50	354	59	5.9	1245	13	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	Lutharan, Bharosa
26	Puri	14971	299.41	993	114	11.4	1710	18	Bina dhan 11, CR 1009 sub 1, Swarna sub 1	Lutharan, Wisdom
27	Rayagada	2835	113.40	244	159	17.1	1550	22	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	Harsha Trust, Pragati
28	Sambalpur	13135	262.70	507	100	10	2025	26	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	SSSS, ADARSA
29	Subarnapur	7480	149.60	211	60	6	1500	20	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	Global Green, KKM
30	Sundergarh	7510	150.20	471	40	4	750	5	Bina dhan 11, DRR 42, DRR 44, Sahabhagi	DISHA
	Total	**256827**	**5518**	**15012**	**2500**	**268.5**	**39565**	**488**		

Innovative extension and demonstration approaches to strengthen the formal and informal seed systems for STRVs

Evidence Hub (EH)

The Evidence Hub—an innovation in demonstration—is essentially a replicated trial to assess the performance of suitable STRVs in a particular agro-climatic region where a range of region-specific varieties is grown and assessed in comparison with local popular varieties. About 15-20 varieties were planted at staggered intervals according to their growth duration to ensure synchronization of flowering, thus making varietal comparison easy for all stakeholders who play a pivotal role in the seed diffusion system. Participatory observation and assessment of varieties are key features of the EH which inevitably provides inputs to the DDAs to advocate for the most suitable varieties for the upcoming cropping season.The EH is ideally put up in a government farm at district level with due consultation and joint planning with the DDA. In some districts where a DDA farm was not available, the EH was established in fields voluntarily provided by the farming community.

Taking a cue from the success of the EH at Cuttack in 2016-17, the coverage was extended in 2018 to include 28 districts. Of these, two EHs – one managed by NRRI (Cuttack) and the other by OSSC (Puri) – had the complete set of submergence-, drought-, and salinity-tolerant varieties with the underlying purpose to engage different stakeholders of the formal seed system that have larger roles to play in the state's seed strengthening system. The intention was to showcase to seed companies and their dealers all the available varieties and provide them with the opportunity to select the preferred varieties for scaling. In Jajpur and Jharsuguda, where a DDA farm was not readily available, farmers were mobilized to establish EHs in their plots. This has expanded the opportunities for farmers to experience demonstrations and their outcomes closely.

This project has always envisaged to recognize the power and contribution of women in agriculture. This year, two EH in two districts were established and managed by women's groups. *Maa Thakurani*, a vibrant SHG of 12 women, displayed encouraging management and leadership skills by successfully establishing the EH at Kalahandi district. Another dynamic SHG, *Swarna Laxmi*, effectively managed the EH in Deogarh district. This paves the way for women to increase their knowledge, skills and leadership.

Important outcomes achieved through the establishment of EHs were (a) collective varietal evaluation by the District Agriculture Officers (DAOs) led by the DDA; (b) reflection on field observations from EHs by all participants to further analyse the performance of different varieties vis-à-vis existing old varieties; (c) creation of a unique platform where a range of varieties is showcased to allow selection of the most suitable ones; and (d) enhancement of farmers' decision-making ability while potentially creating demand for those varieties.

Photo 1.1 Evidence Hub conducted at various locations in Odisha

Photo: Bonth, Bhadrak

Photo: Bhamhagiri, Puri

Photo: Bhamhagiri, Puri

Photo: Jatni, Khurda

Varietal assessment by DDAs

For each standing crop at maturity, a score is given to each variety by the team of agriculture officers headed by the DDA. This assessment was based on several visible parameters such as stress tolerance (when stress is present), grain type, duration, crop height, tillering ability, yield, and incidence of diseases and pests. These attributes are usually considered important for choosing the best-suited variety over others. All the STRVs showcased in the EHs were scored on a ten-point scale. Variety-wise average scores are presented in Figures 1.1 & 1.2.

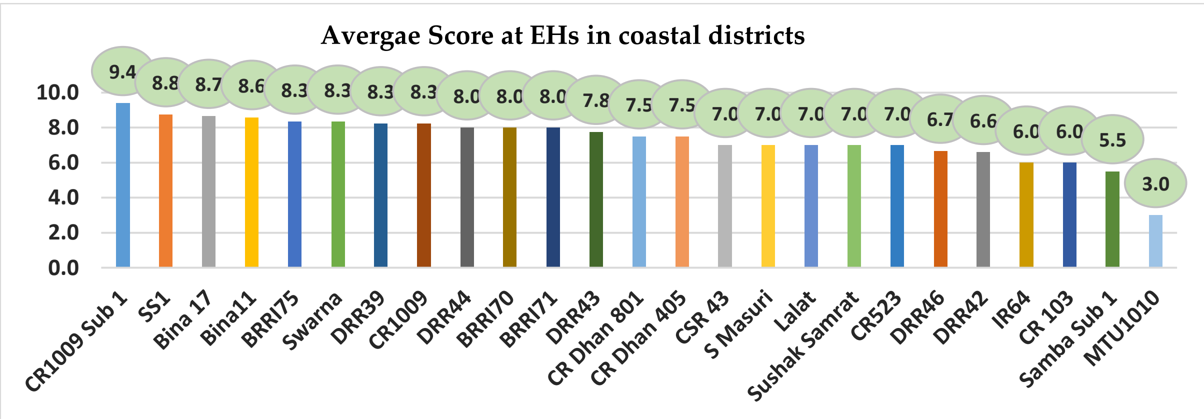


Figure 1.1: Average score of varieties at EHs (Coastal)

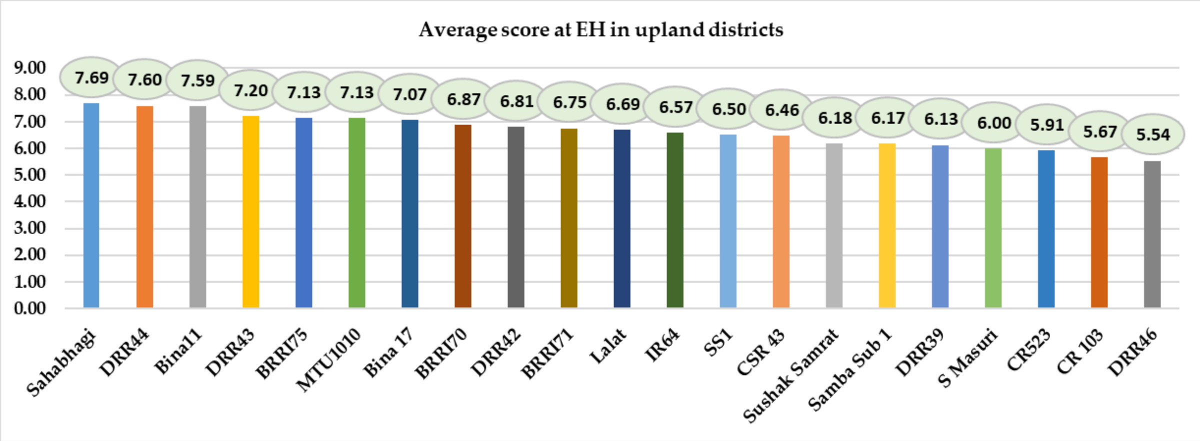


Figure 1.2: Average score of varieties at EHs (Inland)

Out of all varieties demonstrated in the different EHs across two main agro-ecological zones (submergence-prone and drought-prone), CR 1009 sub-1, Swarna, Swarna Sub 1, Bina dhan 11, Bina 17, and DRR 44 were the top-rated varieties in the coastal areas. In the upland districts, DRR 44, Bina dhan 11, Sahbhagi dhan, BRRI 70, BRRI 71, and BRRI 75 were some of the varieties given a high score. Varieties in the series of BRRI (70, 71, and 75) also came with huge promise and potential particularly in the upland districts, making them highly recommended to be released through appropriate channels for further exploration and adoption.

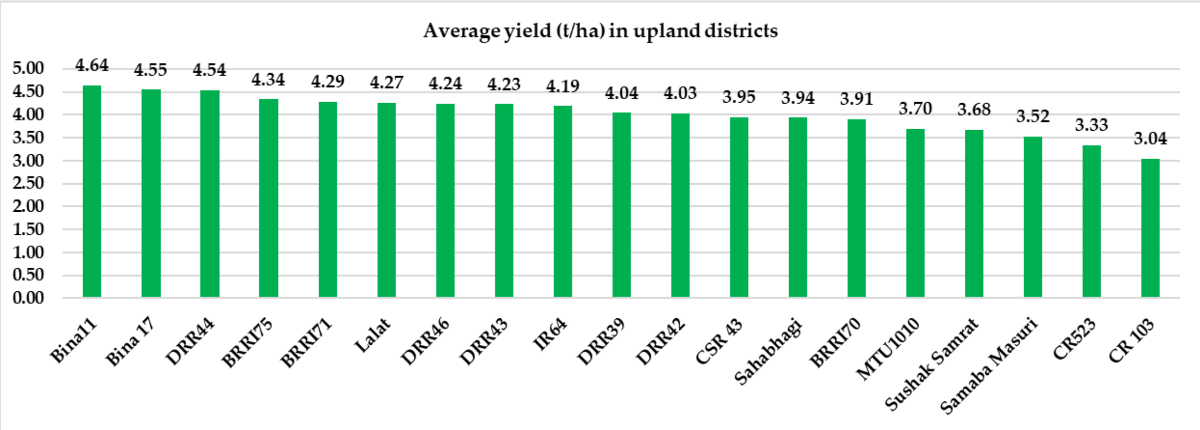


Figure 1.3: Average yield at EHs in upland districts (20)

In the inland districts, the average yields of Bina dhan 11, DRR 44, DRR 43, DRR 42, BRRI 71, BRRI 75, Lalat, and Bina 17 were found to be high, further reinforcing the earlier recommendation to diffuse these varieties in the upland ecology.

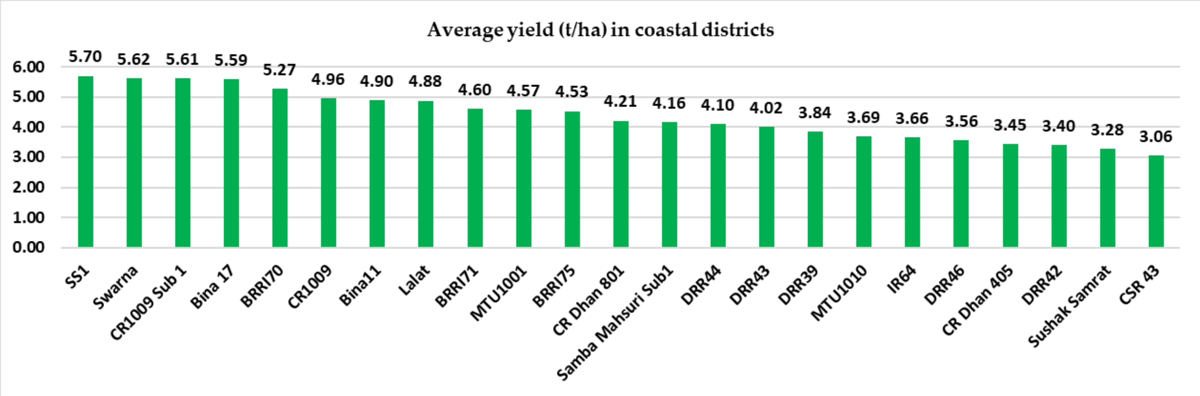


Figure 1.4: Average yield at EHs in coastal districts (8)

For the coastal dstricts, the varieties CR 1009 sub 1, Bina 17, Swarna, Swarna Sub 1, Bina dhan 11, MTU 1001, and BRRI 75 were found to be producing good yield. This suggests the need to further step up efforts to enhance their availability and accessibility in these districts. Repetition of such demonstrations in subsequent years will corroborate the idea of popularizing these varieties in farming communities in suitable areas. In the EH, a variety is demonstrated in a 5 x 5 square metre plot with three replications. These average yields are obtained through crop cutting in all three replications.

While selecting a variety to plant, a farmer considers many other factors apart from productivity. The variety's duration, plant height, grain size, tillering ability, resistance to pest and disease, and tolerance to stress are some of these factors. DDAs at different EHs rated varieties based on these parameters. The following table (1.3) presents the top-rated varieties of the different districts based on this scoring exercise. The assessment was done before the crop was harvested and evaluators included "expected yield" as one of the parameters. The yield was finally calculated with actual crop cuts and embedded in the overall evaluation process to complete the scoring.

Table 1.3: Top three varieties according to score (on a 10-point scale)

Most preferred varieties	Lowest score	Highest score	Mean score
Coastal districts			
CR 1009 sub 1	9	10	9.40
Swarna Sub 1	8	10	8.80
Bina 17	8	9	8.70
Bina dhan 11	7	10	8.60
Upland districts			
Sahabhagi	6	9	7.69
DRR 44	5	9	7.60
Bina dhan 11	5	9	7.59

Head-to-Head Trials

Under H2H trials, two different varieties (one STRV and the other farmers' own variety) were evaluated under the same farmer management conditions, preferably on the same field (half each of at least 500m^2) or on two adjoining fields. The idea was to create an opportunity for the participating farmer and other farmers in the community to observe and assess the advantage of STRVs over their regular varieties. This has a unique feature of demonstrating varietal advantage at the farmers' site under their own management. It proved to be a strong mechanism to create a demand for STRVs. The H2H trials were conducted in all 30 districts. Varietal performances in these trials are directly evaluated by farmers during field days and crop cutting. The differences in the yield were clearly seen and compared by the participating farmers.

In the reporting year, 2500 H2H trials were conducted against the target of 2180, undertaken in 109 blocks in all 30 districts. Each participating farmer was given 5 Kg seeds of STRVs to grow in a plot adjacent to the plot planted to the local variety. When crop cut yield data was analysed, the varieties SS 1, CR 1009 sub 1, and Bina dhan 11 were found to be giving good results in the coastal areas, whereas Bina dhan 11, DRR 44, DRR 42, and Sahbhagi had comparative yield advantage over the farmers' own variety in the upland districts (Tables 1.4 & 1.5).

Table 1.4: Average yield of STRVs across different ecologies in the Head-to-Head trials

STRV	Average Yield (ton/ha)	No of observations	Min Yield	Max Yield
Coastal				
Bina dhan 11	4.91	47	2.60	6.48
CR 1009 Sub -1	5.41	29	3.46	7.40
Swarna Sub 1	5.03	84	1.84	6.69
Upland				
Bina dhan 11	4.26	52	1.88	6.32
DRR 42	3.80	58	2.05	6.44
DRR 44	4.43	54	2.16	6.92
Sahbhagi dhan	3.93	42	1.81	5.88

Table 1.5: Ecology-wise yield comparison between STRV and adjacent variety

STRV	STRV yield (ton/ha)	Adjacent variety	Adjacent Variety Yield (ton/ha)	Yield difference (ton/ha)
Coastal				
Bina dhan 11	5.80	Binapani	5.40	0.40
Bina dhan 11	5.04	Kuber	4.49	0.56
Bina dhan 11	5.07	Lalat	4.21	0.86
Bina dhan 11	4.84	Lohata	4.00	0.84
Bina dhan 11	5.38	MTU 1001	5.46	-0.08
Bina dhan 11	2.97	Naveen	2.73	0.24
Bina dhan 11	4.97	Otara	4.94	0.04
Bina dhan 11	5.36	Padmini	3.90	1.46
Bina dhan 11	4.88	Pratikshya	4.16	0.72
Bina dhan 11	4.20	Sahabhagi	3.56	0.64

STRV	STRV yield (ton/ha)	Adjacent variety	Adjacent Variety Yield (ton/ha)	Yield difference (ton/ha)
Coastal				
Bina dhan 11	6.75	Samrat	5.63	1.13
CR 1009 Sub -1	6.40	Bankei	4.00	2.40
CR 1009 Sub -1	4.96	CR-1009	3.88	1.08
CR 1009 Sub -1	5.40	CR-1018	4.30	1.10
CR 1009 Sub -1	4.95	Pooja	4.49	0.46
CR 1009 Sub -1	5.91	RGL	4.80	1.11
CR 1009 Sub -1	6.30	Sarala	5.00	1.30
Swarna Sub 1	5.92	Dhani	5.80	0.12
Swarna Sub 1	6.24	Ganjamgedi	5.70	0.55
Swarna Sub 1	1.84	Ghuntha	1.72	0.12
Swarna Sub 1	3.52	HMT Sona	3.40	0.12
Swarna Sub 1	3.61	MTU 1001	3.37	0.24
Swarna Sub 1	4.64	Nali Bhutia	4.04	0.60
Swarna Sub 1	5.16	Pooja	4.79	0.36
Swarna Sub 1	5.94	Pratikshya	5.35	0.59
Swarna Sub 1	5.23	Rani	4.72	0.51
Swarna Sub 1	6.88	RGL	5.72	1.16
Swarna Sub 1	5.19	Swarna	4.67	0.52
Swarna Sub 1	5.47	Swarna Masuri	4.94	0.53
Upland				
Bina dhan 11	2.16	Baidhyanath	1.58	0.58
Bina dhan 11	4.00	Balaram	3.20	0.80
Bina dhan 11	4.10	Bhagyabati	3.00	1.10
Bina dhan 11	3.40	Bhuvan	3.33	0.07
Bina dhan 11	4.72	Kanak	4.64	0.08
Bina dhan 11	5.60	Kanicha	4.80	0.80
Bina dhan 11	3.17	Khandagiri	2.52	0.65
Bina dhan 11	4.72	Lalat	4.07	0.65
Bina dhan 11	4.85	Lohata	4.52	0.33
Bina dhan 11	4.06	MTU 1001	4.47	-0.41
Bina dhan 11	6.26	MTU 1010	5.60	0.66
Bina dhan 11	3.63	Naveen	3.23	0.40
Bina dhan 11	4.62	Pratikshya	3.83	0.79
Bina dhan 11	3.89	Sahabhagi	3.17	0.72
Bina dhan 11	4.56	Shubhadra	3.84	0.72
DRR 42	3.30	Bhuvan	3.21	0.09
DRR 42	4.34	Lalat	3.86	0.48
DRR 42	3.36	MP 3	2.48	0.88
DRR 42	5.16	MTU 1001	3.92	1.24
DRR 42	4.50	MTU 1010	4.13	0.37
DRR 42	3.47	Naveen	3.21	0.26
DRR 42	2.05	Pathara	1.02	1.03
DRR 42	3.28	Pratikshya	3.01	0.27
DRR 42	4.51	Sahabhagi	3.71	0.80
DRR 42	2.42	Silky	3.95	-1.53
DRR 42	2.12	Soma	1.97	0.15
DRR 44	2.90	Bhagyabati	3.20	-0.30
DRR 44	2.78	Bhuvan	2.65	0.13
DRR 44	4.72	Dhanraj	4.40	0.32
DRR 44	5.60	Ganga	5.00	0.60
DRR 44	3.20	Ghuntru	2.80	0.40

STRV	STRV yield (ton/ha)	Adjacent variety	Adjacent Variety Yield (ton/ha)	Yield difference (ton/ha)
		Coastal		
DRR 44	5.28	Kanicha	4.56	0.72
DRR 44	4.37	Khandagiri	3.31	1.06
DRR 44	4.84	Kranti	4.12	0.72
DRR 44	4.97	Lalat	4.29	0.69
DRR 44	4.70	Local	4.34	0.36
DRR 44	5.16	MTU 1001	4.04	1.12
DRR 44	4.34	MTU 1010	3.76	0.59
DRR 44	3.92	Naveen	3.48	0.43
DRR 44	4.68	Pratikshya	4.64	0.04
DRR 44	5.88	Sahabhagi	5.62	-0.26
DRR 44	4.04	Sarubhajni	3.60	0.44
DRR 44	2.96	Silky	1.24	1.72
DRR 44	4.56	Surendra	4.28	0.28
Sahbhagi Dhan	3.70	Bhuvan	3.34	0.36
Sahbhagi Dhan	5.20	Bikrant	3.80	1.40
Sahbhagi Dhan	5.08	Butura	5.40	-0.32
Sahbhagi Dhan	5.34	Dhani	3.50	1.84
Sahbhagi Dhan	3.10	Ganga	2.76	0.34
Sahbhagi Dhan	4.68	Gold	5.56	-0.88
Sahbhagi Dhan	4.48	Khadika Kuchi	3.40	1.08
Sahbhagi Dhan	2.95	Khandagiri	2.47	0.48
Sahbhagi Dhan	4.55	Lalat	4.02	0.53
Sahbhagi Dhan	3.92	MTU 1010	3.84	0.08
Sahbhagi Dhan	3.55	Naveen	3.18	0.37
Sahbhagi Dhan	3.14	Pratikshya	2.27	0.87
Sahbhagi Dhan	2.92	Silky	2.48	0.44
Sahbhagi Dhan	5.24	Surendra	4.68	0.56

Note: The yields are average of replicates obtained through crop cutting (in 5 x 5 sq.m.)

Farmers' perception about STRVs in Head-to-Head Trials

A sample survey involving 550 farmers attempted to capture the perception of farmers with respect to IRRI-introduced varieties in the H2H trials. Of the sample farmers, 67% found the STRVs to have a distinct edge over the other varieties grown while 24% could not perceive any difference between the STRVs and adjacent varieties and 9% did not prefer STRVs and rated these lower than their own varieties.

In the reporting year, severe stress (flood or drought) was not experienced and the incidence of flood was negligible. However, demonstrations in a few districts were affected by drought that occurred for around 10-20 days at different stages of plant growth. With a sample study under the H2H trials, the performance of STRVs was measured vis-à-vis farmer's own variety in drought condition.

Table 1.6: Yield advantage of STRVs in stress conditions

STRV	STRV yield (ton/ha)	Farmer's variety yield (ton/ha)	Yield advantage (ton/ha)
DRR 44	2.87	2.4	0.47
Sahabhagi Dhan	3.04	2.54	0.50

Photo 1.2 Head to Head trial fields in Odisha

Photo: Nektideul Sambalpur

Photo: Bhrahamgiri, Puri

Photo: Bhrahamgiri, Puri

Photo: Naugaon, Jagatsinghpur

Cluster Demonstrations

The demonstrations using various STRVs were conducted in an area of 5518 ha in 1032 villages of 470 GPs in 109 blocks covering all the 30 districts. A total of seven STRVs viz. Swarna Sub 1, Bina dhan 11, DRR 39, DRR 42, DRR 44, DRR 46, and Sahbhagi dhan were demonstrated for submergence, salinity, and drought tolerance conditions. Bina dhan 11 was evaluated and demonstrated in all the districts for its submergence tolerance, shorter duration, yield potential, and grain preference. The maximum area was covered by Bina dhan 11 followed by Swarna Sub 1 to replace Swarna in the coastal areas and other varieties in other ecologies. In upland districts, the maximum area was covered by the drought-tolerant varieties DRR 44 followed by DRR 42 and Sahbhagi dhan. Yield estimation was done through crop cutting experiments conducted along with field days to create awareness among the farmers. The details on area and yields are given in the following tables.

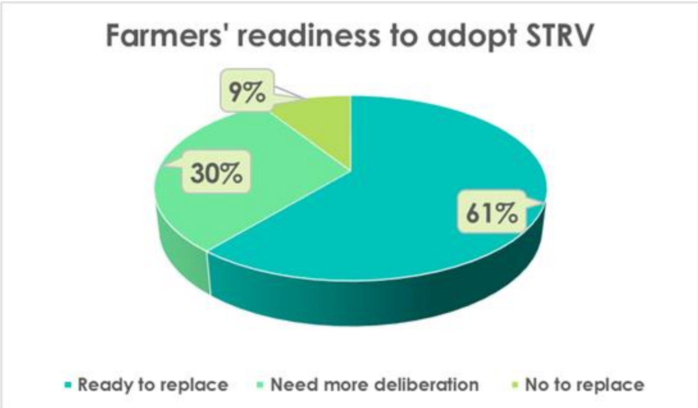


Table 1.7: Variety-wise area (ha) covered by different varieties under cluster demonstrations

SN	District	DRR 42	Bina dhan 11	DRR 44	DRR 46	Sahbhagi Dhan	Swarna Sub 1	Grand Total
1	Angul	17.3	47.2	55.7		42.4		162.6
2	Balasore		30.0				155.2	185.2
3	Bargarh	14.0	33.0	40.8		17.2		105.0
4	Bhadrak		50.0				99.8	149.8
5	Bolangir	24.4	49.8	51.5		27.6		153.3
6	Boudh	21.0	52.4	57.6		19.0		150.0
7	Cuttack		20.4				95.6	116.0
8	Deogarh	14.8	34.6	34.2		17.2		100.8
9	Dhenkanal	34.3	19.7	19.6		30.2		103.9
10	Gajapati	21.0	31.2	36.5	45.6			134.3
11	Ganjam		9.6				194.1	203.7
12	Jagatsinghpur		48.6				100.4	149.0
13	Jajpur		130.2				100.6	230.8
14	Jharsuguda	29.4	68.6	54.3	4.8	41.1	0.8	200.1
15	Kalahandi	69.2	133.9	108.8		63.2		375.1
16	Kandhamal	32.6	36.0	40.0		20.6	2.0	131.2
17	Kendrapada		40.0				60.3	100.3
18	Keonjhar	72.0	81.5	82.7	0.3	72.3	0.6	309.4
19	Khordha						25.0	25.0
20	Koraput	120.2	168.2	128.1		88.3		504.8
21	Malkanagiri	13.5	26.1	33.5		11.3	4.6	89.0
22	Mayurbhanj	43.1	108.1	77.1		77.2		305.4
23	Nabarangpur	26.2	67.9	69.4		34.2		197.7
24	Nayagarh	50.3	54.0	52.5		42.9		199.8
25	Nuapada	28.5	46.6	61.4		25.0		161.5
26	Puri		75.4				224.0	299.4
27	Rayagarda	23.9	41.5	33.1		14.3	0.6	113.4
28	Sambalpur	67.2	58.5	72.1	26.6	36.9	1.4	262.7
29	Subarnapur		53.6	54.6		41.4		149.6
30	Sundergarh	25.5	51.4	47.8		25.5		150.2
	Grand Total	**748.4**	**1668.0**	**1211.3**	**77.3**	**747.7**	**1065.0**	**5518.9**

Table 1.8: Average yield of STRVs in the cluster demonstrations (ecology-based)

STRV	Average yield (ton/ha)	No of Observations	Min Yield	Max Yield
Coastal				
Bina dhan 11	4.95	39	1.56	6.24
SS1	5.20	111	2.12	6.68
Upland				
Bina dhan 11	4.37	136	2.72	6.56
DRR 42	4.18	79	1.68	6.50
DRR 44	4.05	149	1.80	6.24
Sahabhagi	4.22	71	1.70	6.60

Photo 1.3 Cluster demonstrations

Photo: Pipli, Puri

Photo: Kuliana, Mayurbhanj

Demonstrations through Dealer's Engagement

IRRI has explored another innovative approach of engaging seed dealers in the awareness and diffusion process for STRVs. The strategy focused on encouraging the seed dealers to promote STRVs using the demonstration plots of their potential customers so that farmers, who are also regular customers and could directly provide feedback about the featured varieties. In this case, however, there was no effort to capture the yield advantage because the farmers' interest in the new varieties would be reflected in their seed demand in the next season. Seed dealers work as key mediators in spreading information and promoting STRVs among farmers because the new business prospects (when demand is created) act as an incentive for them. With this concept, about 480 dealers were engaged in popularising new varieties through their networks. More than 7000 demonstration plots were managed by the seed dealers to create awareness and to promote the seed demand process for sustainable seed supply. The details of these interventions are given in Table 1.9.

Photo 1.4 Dealers demonstrations

Photo: Nimapada, Puri

Photo: Khandapada, Nayagarha

Table 1.9: Dealers' demonstrations in 30 districts

SN	Districts	No of Blocks	No of Dealers	Seed Quantity In Kg	No of Farmers Covered
1	Angul	3	15	1125	225
2	Balangir	2	11	825	165
3	Balasore	4	20	1500	300
4	Bargarh	3	15	1120	224
5	Bhadrak	3	15	1090	218
6	Boudh	3	15	1125	225
7	Cuttack	2	6	705	141
8	Deogarh	3	15	1125	225
9	Dhenkanal	2	10	750	150
10	Gajapati	3	6	450	90
11	Ganjam	4	24	1720	344
12	Jagatsingpur	3	15	1235	247
13	Jajpur	4	17	1355	271
14	Jharsuguda	4	18	1595	319
15	Kalahandi	6	32	2560	512
16	Kandhamal	4	12	1135	227
17	Kendrapara	3	14	850	170
18	Keonjhar	5	25	1980	396
19	Khurda	2	10	750	150
20	Koraput	4	22	2220	444
21	Malkangiri	4	10	700	140
22	Mayurbhanj	6	26	2010	402
23	Nabarangpur	5	19	1380	276
24	Nayagarh	3	12	1480	296
25	Nuapada	3	13	1245	249
26	Puri	4	18	1710	342
27	Rayagada	6	22	1550	310
28	Sambalpur	5	26	2025	405
29	Subarnpur	4	20	1500	300
30	Sundargarh	2	5	750	150
	Grand Total	**109**	**488**	**39565**	**7913**

SeedCast – an app to assessthe demand and supply of seed

To strengthen the current seed system by reducing the information gap between the demand and planning the supply in an informed way, IRRI has developed a digital platform (mobile and web-based app) for forecasting seed demand. This app called "SeedCast" is a quick and effective way of demand aggregation and information sharing across all concerned stakeholders in a dynamic mode. It will help in bringing together government, private, and other stakeholders in the seed chain to forecast the seed demand for STRV more accurately, thus, facilitating the better planning for STRV supply by the OSSC. SeedCast provides users information about the availability of STRVs with different dealers. Varietal information and the basic management practice of STRVs are other important features of this app. The data on seed demand collected through SeedCast can be used by the DoA and OSSC.

Following the formal launch of this app on 18 May 2018, government officials from DoA, OSSC, and seed dealers were oriented on the app's features, benefits, and process of usage. Feedback from this orientation program were collated to help further refine the app. In the coming kharif season, this app will be piloted with dealers to assess how effectively it works. The app will be updated based on feedback received.

Figure 1.5 Dr. Saurabh Garg, Principal Secretary, Department of Agriculture and Farmers' Empowerment (Government of Odisha) is addressing the Seedcast launch program

Women Farmers in the Seed Delivery System

IRRI creates and promotes various platforms to encourage women participation for them to realise their potential as farmers and be recognised as such. Interventions such as the EH, H2H trials, and various capacity and skills building programs promoted by IRRI provide opportunities for women farmers to evaluate and analyse new technologies and be a part of the decision-making process. Because women actively participate in all the operations of rice farming and play an important role in many farming-related decisions including varietal selection and adoption, creating awareness about new varieties through their social networks helps speed up the adoption of new varieties through the informal seed system. IRRI provided training programmes for the skills and capacity building of SHGs on quality seed production and storage practices. The production of quality rice seeds helps in increasing their annual income, creating sustainable agricultural livelihood opportunities for them, improving their skills and capabilities, and enhancing their managerial capabilities. A total of 907 women farmers participated in H2H trials, making up 36% of the total farmers reached by this demonstration. For the cluster demonstrations, 5704 (38%) of the total 15012 participating farmers were women.

Photo 1.6. Encouraging women participations and recognising their efforts in agriculture sector, Maa-Tarini SHG, Bhwanipatna, Kalahandi, Odisha

Table 1.10: Participants of Head-to-Head trials in 30 districts

SN	District	No of Villages	No of GPs	No of Blocks	No of participants		Grand Total	% Female	% Male
					Female	Male			
1	Angul	14	7	3	28	33	61	46	54
2	Balangir	6	6	3	4	56	60	7	93
3	Balasore	25	16	4	25	54	79	32	68
4	Bargarh	15	4	3	14	46	60	23	77
5	Bhadrak	14	13	3	25	32	57	44	56
6	Boudh	21	16	3	5	55	60	8	92
7	Cuttack	12	8	2	4	44	48	8	92
8	Deogarh	8	4	3	24	16	40	60	40
9	Dhenkanal	4	2	2		48	48	0	100
10	Gajapati	26	9	3	2	71	73	3	97
11	Ganjam	15	11	4		30	30	0	100
12	Jagatsinghpur	24	3	3	41	19	60	68	32
13	Jajpur	20	10	4	8	65	73	11	89
14	Jharsuguda	15	8	4	29	57	86	34	66
15	Kalahandi	46	28	6	121	84	205	59	41
16	Kandhamal	8	6	4	70		70	100	0
17	Kendrapara	16	12	3	6	38	44	14	86
18	Keonjhar	48	23	5	17	226	243	7	93
19	Khordha	9	8	2		22	22	0	100
20	Koraput	59	26	4	149	72	221	67	33
21	Malkangiri	13	7	4	2	62	64	3	97
22	Mayurbhanj	46	26	6	29	92	121	24	76
23	Nabarangpur	10	7	5	63		63	100	0
24	Nayagarh	43	24	3	11	69	80	14	86
25	Nuapada	21	16	3	9	50	59	15	85
26	Puri	33	12	4	79	35	114	69	31
27	Rayagada	32	15	4	108	51	159	68	32
28	Sambalpur	20	7	5	10	90	100	10	90
29	Sonepur	17	17	4	4	56	60	7	93
30	Sundargarh	8	8	2	20	20	40	50	50
	Grand Total	**648**	**359**	**109**	**907**	**1593**	**2500**	**36**	**64**

Table 1.11: Sex-disaggregated details of Cluster Demonstrations in 30 districts

SN	Districts	Female	Male	Grand Total	% Female	% Male
1	Angul	191	445	636	30	70
2	Balasore	93	442	535	17	83
3	Bargarh	129	148	277	47	53
4	Bhadrak	46	332	378	12	88
5	Bolangir	71	178	249	29	71
6	Boudh	82	185	267	31	69
7	Cuttack	47	241	288	16	84
8	Deogarh	135	128	263	51	49
9	Dhenkanal	34	292	326	10	90
10	Gajapati	42	283	325	13	87
11	Ganjam	83	269	352	24	76
12	Jagatsinghpur	90	306	396	23	77
13	Jajpur	56	479	535	10	90
14	Jharsuguda	99	417	516	19	81
15	Kalahandi	672	140	812	83	17
16	Kandhamal	656		656	100	0
17	Kendrapada	55	308	363	15	85
18	Keonjhar	100	851	951	11	89
19	Khordha	7	61	68	10	90
20	Koraput	861	430	1291	67	33
21	Malkanagiri	64	212	276	23	77
22	Mayurbhanj	222	874	1096	20	80
23	Nabarangpur	614	50	664	92	8
24	Nayagarh	252	460	712	35	65
25	Nuapada	26	328	354	7	93
26	Puri	366	627	993	37	63
27	Rayagarda	229	15	244	94	6
28	Sambalpur	157	350	507	31	69
29	Subarnapur	12	199	211	6	94
30	Sundergarh	213	258	471	45	55
	Grand Total	**5704**	**9308**	**15012**	**38**	**62**

Capacity Building and Awareness Creation: District-wise coverage

Generating varietal awareness and building the capacity of trainers and farmers have been major key interventions since the beginning of the project. This year, around 22000 farmers have been reached with a set of activities that effectively created awareness about location-specific STRVs and their availability. This was done through H2H trials and cluster demonstration meetings with farmers and organizing field days and seed committee meetings, among others. The following table summarizes the various awareness generation activities that were conducted.

Photo 1.7 Awareness creation and dissemination activities at various locations in Odisha

Photo: Rasagobindpur, Mayurbhanj

Photo: Marshaghai, Kendrapada

Photo: Jajpur

Photo: Koksara, Kalahandi

Table: 1.12 District-wise capacity building and awareness activities

District	No of block level QSP organized	Awareness Meeting					Seed Committee /Coordination meeting	EH	Client based EH
		Field day	Seed Distribution	H2H	Demonstration	Crop Cafeteria			
Angul	3	3	3	1	6	1	1	1	
Balasore	4	4	4	1	5	1	1	1	
Bargarh	3	3	3	1	3	1	1	1	
Bhadrak	3	3	3	1	4	1	1	1	
Bolangir	4	4	4	1	2	1	1	1	
Boudh	3	3	3	1	3	1	1	1	
Cuttack	2	2	2	1	3	1	1	1	1
Debgarh	2	2	2	1	3	1	1	1	
Dhenkanal	2	2	2	1	3	1	1	1	
Gajapati	1		1	1	3		1		
Ganjam	2		2	1	4	1	1	1	
Jagatsinghpur	3	3	3	1	4	1	1	1	
Jajpur	4	4	4	1	5	1	1	1	
Jharsuguda	4	4	4	1	5	1	1	1	
Kalahandi	6	6	6	1	8	1	1	1	
Kandhmal	4	4	4	1	7	1	1	1	
Kendrapada	3	3	3	1	4		1		

District	No of block level QSP organized	Awareness Meeting					Seed Committee /Coordination meeting	EH	Client based EH
		Field day	Seed Distribution	H2H Orientation	Demonstration	Crop Cafeteria			
Keonjhar	6	6	6	1	10	1	1	1	
Khurda	1		1	1	1	1	1	1	
Koraput	7	7	7	1	13	1	1	1	
Malkangiri	3	3	3	1	3	1	1	1	
Mayurbhanj	7	7	7	1	11	1	1	1	
Nabrangpur	3	3	3	1	7	1	1	1	
Nayagarh	4	4	4	2	7	1	1	1	
Nuapada	4	5	4	1	4	1	1	1	
PURI	5	5	5	2	10	1	1	1	1
Rayagada	4	4	4	1	2	1	1	1	
Sambalpur	5	5	5	1	5	1	1	1	
Sonepur	3	3	3	1	2	1	1	1	
Sundergarh	2	2	2	1	5	1	1	1	
Total	**107**	**104**	**107**	**32**	**150**	**28**	**30**	**28**	**2**

Table 1.13: Participation in block-level quality seed production

District	No of block level QSP organized	Participation	District	No of block level QSP organized	Participation
Angul	3	63	Kandhmal	4	81
Balasore	4	145	Kendrapada	3	303
Bargarh	3	60	Keonjhar	6	213
Bhadrak	3	135	Khurda	1	25
Bolangir	4	80	Koraput	7	121
Boudh	3	57	Malkangiri	3	61
Cuttack	2	151	Mayurbhanj	7	123
Debgarh	2	71	Nabrangpur	3	29
Dhenkanal	2	121	Nayagarh	4	25
Gajapati	1	25	Nuapada	4	26
Ganjam	2	177	Puri	5	124
Jagatsinghpur	3	105	Rayagada	4	78
Jajpur	4	94	Sambalpur	5	111
Jharsuguda	4	107	Sonepur	3	61
Kalahandi	6	111	Sundergarh	2	76
			Total	**107**	**2959**

Seed production

Seed production is the process of multiplying a particular class of seed (breeder, foundation, and certified) from a specific class of seed up to the certified seed stage. The introduction of quality seeds of new varieties alone, wisely combined with other inputs, has the potential to increase yields up to 15%.

The success of a seed programme is based on the choice of a proper seed multiplication model. The availability of a sufficient quantity of seed basically depends on the seed multiplication ratio and the total seed demand. The seed multiplication agency should decide how quickly the farmers can be supplied with the seed of newly released varieties after the breeder and foundation seed stock has been handed over to the concerned agency so that it may replace the old varieties.

Commercial quantity of seed is produced after a series of multiplication steps. The plant breeder or the organization entrusted with the maintenance of the nucleus seed of new varieties produces breeder seeds and supplies the same to different seed corporations. The breeder seed is then multiplied as foundation and certified seeds. The certified seed is the commercial seed made available to farmers.

Breeder seed material of the newly released varieties was sourced from the breeder and other agencies. A total of 21.5 quintals of the breeder seeds of three STRVs viz., DRR 44, Bina 11, and CR 1009 sub 1 were supplied to the OSSC for further multiplication into foundation seeds.

Photo 1.8 Quality seed production training programmes in Odisha

Photo: Rajgangpu, Sundergarh

Photo: Remuna, Balasore

Photo: Rasoolpur, Jajpur

Photo: NRRI, Cuttack

Table 1.14: Breeder seeds supplied to the OSSC for multiplication

Breeder seeds supplied to OSSC			Breeder seeds utilized by OSSC for multiplication				
SN	Variety	Total Quantity (q)	Name of the grower	Location	Supervising SPO	Quantity (q)	Area Covered (ha)
1	DRR 44	1.2	SPOCuttack	Cuttack	Cuttack	1.2	2.4
2	BINA-11	20	Barpali farm	Bargarh	Bargarh	3	6
			Mudghat farm	Bolangir	Bhawanipatna	3	6
			Dhanei farm	Berhampur, Ganjam	Berhampur	3.3	6.6
			D. Baral, Pvt.grower	Resinga, Pipli, Puri	Bhubaneswar	3	6
			S. Swain, Pvt grower	Puri	Bhubaneswar	0.6	1.2
			U.K Tripathy, Pvt grower	Nimapada, Puri	Bhubaneswar	2.1	4.2
			M.R das, Pvt grower	Kanas, Puri	Bhubaneswar	1.5	3
			B. Khatei, Pvt grower	Satyabadi, Puri	Bhubaneswar	1.5	3
			Kuliposh farm	Sundergarh	Sundergarh	2	4
3	CR-1009 SUB-1	0.3	D. Baral, Pvt grower	Resinga, Pipli, Puri	Bhubaneswar	0.3	0.6

Seed production through private seed companies

The seeds of new varieties are made available to farmers through multiplication and sale through private seed companies in Odisha. The foundation seeds of Bina 11 and DRR 44 were supplied to seven seed companies in four districts. 125 ha was covered with the seed supplied which, in turn, can produce approximately 375 MT of certified seeds. The seeds can cover 7500 ha of these new STRVs in the next season.

Table 1.15: Seed multiplication through private companies/foundations

Dealers/variety	DRR 44 (q)	Bina dhan 11 (q)	Total Quantity (q)	Total Area Covered (Ha)	Total multiplication (ton)
Reliance India Foundation, Bolangir	12	9	21	42	126
Sri Sai Krishna Seeds, Sambalpur	7.5	7.5	15	30	90
Gopaljee Seeds, Sonepur	5	5	10	20	60
Annapurna Seeds, Subarnapur	2.5	2.5	5	10	30
Orissa Seeds, Sambalpur	2.5	2.5	5	10	30
Sai Ram Seeds, Sambalpur	2	0	2	5	15
Bhulaxmi Seeds, Bargarh	4	0	4	8	24
Total	**35.5**	**26.5**	**62**	**125**	**375**

Demonstration plot registered as seed production plots

During kharif 2017, as part of the demonstration activity, IRRI supplied foundation seeds of the STRVs Swarna Sub 1, Bina 11, Sahbhagi dhan, DRR 42, and DRR 44 from different sources.

These demonstration plots were used as seed production plots by registering with the OSSOPCA.

A total of 522 ha of demonstration plots from 26 blocks in 11 districts were registered with OSSOPCA for the seed certification process. Four STRVs viz., Swarna Sub1, Bina 11, DRR 46, and Sahbhagi dhan were registered with 1244 beneficiaries by forming 82 farmer cluster groups. The registered area of 522 ha is expected to produce 1500 MT of seeds (@3MT/ha) to cover 30,000 ha for the next season.

Table 1.16: Seed multiplication from the demonstration plots

SN	Districts	No. of Blocks	No. of farmers cluster	No. of beneficiaries covered	Registered Area in ha	Varieties	Total multiplication (ton)
1	Balasore	2	5	77	27	Swarna Sub-1	81
2	Bargarh	1	1	20	8	Bina-11	24
3	Bhadrak	3	15	239	99	Swarna Sub-1	297
4	Cuttack	2	10	139	62	Swarna Sub-1	186
5	Gajapati	1	5	51	30	DRR-46	90
6	Jagatsinghpur	2	7	96	43	Swarna Sub-1	129
7	Jajpur	3	9	67	58	Bina-11	174
8	Koraput	3	3	55	23	Bina-11 and Sahabhagi dhan	69
9	Nayagarh	3	7	174	45	Sahabhagi dhan	135
10	Puri	4	18	276	107	Swarna Sub-1 and Bina-11	321
11	Sonepur	2	2	50	20	Bina-11 and Sahabhagi dhan	60
	Grand Total	**26**	**82**	**1244**	**522**	**4**	**1566**

Training of Trainers on Quality Seed Production

As many as 75 key people ranging from AAOs, DAOs, seed growers, dealers, and representatives from partners were invited in two batches to a two-day Quality Seed Production Training held at Cuttack with technical support from NRRI scientists. Upon successful completion of the training, these master trainers took lead roles in orienting farmers on the same subject matter at block level through training sessions organized by local partners with hands-on support from IRRI staff.

Table 1.17: Participant's details engaged in quality seed production

Batch No	Date	Agriculture department	NGO partner	Seed Grower	Total
1	22-23 September, 2017	11	16	11	38
2	25-26 September, 2017	13	15	8	36

Activities during Rabi 2018

For the rabi season in 2018, interventions in 22 blocks spread across nine districts were implemented. These districts and blocks have been chosen carefully considering assured irrigation facilities throughout the crop growth period. Two salinity-tolerant varieties (CR Dhan 405 and DRR 39) and Bina dhan 11 were the varieties evaluated for this season in cluster demonstrations and H2H trials. Local NGO partners included BSSS, Netaji, SEEDS Adarsha, Global Green, Loksebak, and Wisdom to cover 500 ha for both types of trials. About 26 tons of seeds have already been distributed to participating farmers who were selected by our NGO partners on the basis of a set of criteria. Partner organizations have been oriented on the process and methods of demonstration. Transplanting was completed by mid-March in various districts. Due to its comparative yield advantage and non-lodging character as experienced in previous seasons, Bina dhan 11 was the variety of choice to be demonstrated in large-scale both in coastal and inland districts.

Table 1.18: Plans for the Rabi season in 2018

Name of the District	No of Target Blocks	Intervention Block	NGO Partners	Seeds distributed in Quintal			Area covered in Ha		
				Bina-11	DRR 39	CR Dhan 405	Bina-11	DRR 39	CR Dhan 405
Balasore (CD)	2	Jaleswar, Sadar (CISA)	BSSS	15			30	0	0
Bhadrak (CD)	1	Tihidi	Netaji	5			10	0	0
Mayurbhanj	1	Bengriposhi, Kuliana, Badoshai	BSSS	5			10	0	0
Jajpur (CD)	4	Binjarpur, Dharmashala, Jajpur	SEEDS,Netaji	15			30	0	0
Puri	3	Brahmagiri, Pipli, Satyawadi	Wisdom	77	8	25	154	16	50
Bargarh (N.D)	1	Attabira	IRRI-Direct Implementation	16			32	0	0
Sambalpur (N.D)	2	Maneswar, Jamankira	Adarsha	15			30	0	0
Subarnapur (N.D)	3	Sonepur, Binika, Dumripali	Global green	39			78	0	0
Kalahandi (S.D)	5	Kesinga, Bhawanipatna, Kalampur, Golamunda, Dharmagarh	Lok Sebak	40			80	0	0
Total	**22**			**227**	**8**	**25**	**454**	**16**	**50**

Apart from the H2H trials and Cluster demonstrations, EHs were established in five districts—Puri, Bhadrak, Kalahandi, Bargarh, and Sonepur. In Bargarh and Sonepur, private seed growers were invited to participate in the EH, which will again help assess the effectiveness of engaging private dealers in the mainstream extension program.

Table 1.19: Evidence Hub details in Rabi season

District	Partner	EH Location	No of varieties
Puri	Wisdom	Brahmagiri	21
Bargarh	Bhulaxmi Seeds	Padhanpali, Barpali Block, Bargarh	15
Kalahandi	Loksebak	Bhwanipatna	16
Sonepur	Gopal Seeds	Dungaripalli	15
Bhadrak	Netaji	Bhandaripokhari	15

The main varieties under trial at the Crop Cafeteria (EH) are IET 4876 (Shatabdi), CSR 43, IR 64, CR Dhan 801, BRRI 71, BRRI 75, DRR 39, DRR 42, DRR 43, DRR 44, Bina dhan 11, Bina 17, MTU 1001, MTU 1010, Bina 8, Bina 10, and DRR 78.

Monitoring, supervision, and evaluation of interventions

Throughout the year, the project has exerted all efforts to ensure that all activities are undertaken with proper supervision and monitored efficiently. A strong network of 31 local partners who, with technical inputs from IRRI, rolled out several interventions. The field officers and research technicians of IRRI have extended regular support to these partners through technical orientation, beneficiary selection, demonstration management, data collection and documentation. Continuous and close hands-on support was critically important to successfully complete the planned activities.

For all major interventions (H2H trials, cluster demonstrations, Quality Seed Production training, etc.), the project's approach was to first orient a cadre of partner staff who, in turn, trained participating farmers. This was primarily done by field officers and technicians with support from IRRI specialists. With adequate orientation, selected farmers conducted several activities which were again closely monitored by the project officers.

Data on project activities received from partners were first checked by field staff and another round of data standardization at specialist level was conducted before those cleaned data were used for analyses, documentation, and report preparation. Periodic reports generated were shared with the DoA and the DDAs.

Lessons Learned and Recommendations

Evidence Hub—an innovative participatory varietal assessment

The disconnect among farmers, extension specialists, and researchers is the main reason for the slow uptake of new technology. On-field demonstration is an effective tool to popularize and disseminate new rice varieties in a farming community. A range of well-planned demonstrations is helpful in showcasing varietal qualities in order to increase the rate of adoption of these varieties by farmers. These demonstrations are usually conducted with the participation of farmers and the engagement of government officials. Varieties are displayed until maturity so that farmers can see, understand, evaluate, and decide on adoption. This is supposed to create demand for chosen varieties.

Such approach is hypothesized to facilitate awareness creation among farmers about a particular variety and address the demand aspect of the seed delivery system. However, it is not sufficient to augment varietal replacement as it does not involve all interrelated stakeholders who are critically important in translating the farmers' demand for a variety into a robust supply mechanism which, in turn, ensures the availability of preferred varieties. Because of this, the demand of farmers who are well aware of a particular variety remains unmet.

Government officials, particularly at block and district levels, also need to be exposed to varietal performance demonstrations in order to advocate for well-performing varieties in particular geographies. This emphasizes the need to formulate and implement a demonstration model where all improved varieties are systematically displayed and officials who are actively involved in the seed dissemination process join together on a particular day during crop maturity to observe varietal performances and scale the results based on a list of relevant parameters (e.g. yield, duration, height, tillering, etc.)

This year, IRRI under the Odisha project executed a well-planned and participatory model of demonstration called "Evidence Hub" in 28 districts. This unique approach is put up at every district preferably in government farms in consultation with and participation of DDAs, DAOs, and AAOs. It is a participatory process where all officials sit and plan right from the plot selection through crop management, field days, and yield observations in replicated fields to rank and prioritize good genotypes from around 20 high-yielding varieties evaluated in a particular ecosystem. The important feature of this model is to help government officials identify the potential of high-yielding varieties which they will popularize through advocacy using state machinery. Thus, it facilitates the supply side of varieties found appropriate by DDAs and others for a particular district.

The positive impression from this year's large-scale EH demonstration resolutely suggests the replication of this model in subsequent years to validate current varietal selections. This will further concretize varietal recommendations in different ecologies.

Seed production through private seed players

The role of private seed growers in the seed value chain, particularly in the seed diffusion network, is often underestimated and not fully realized. However, long-standing experience and findings of several studies strongly support inclusion of private dealers along with other key actors in the seed delivery system.

Despite being quite aware of improved rice varieties, farmers in Odisha are often confronted with the issue of disrupted supply of seeds in time. Even though farmers want to adopt a new variety of their choice, they may not have easy access to seeds as these may not be readily available. The most important reason for such a constraint is reported to be a supply side issue. OSSC, the nodal seed supply body, also faces many problems along the supply side. To address this, IRRI experimented with selected private dealers and with OSSC and provided them with breeder seeds of STRVs which the dealers multiplied into foundation and certified seeds that can cover around 7500 ha.

The experiences and learnings from such interventions revealed that there is a pressing need to engage private dealers in seed production activities. However, their involvement must be well planned jointly with the DoA in order to meet the strategic ends of this innovation. When the seed production and multiplication potential of both OSSC and private dealers are harnessed optimally, supply constraints will naturally be mitigated, thus, the adoption of the varieties by the farming community will be enhanced. The project, therefore, warrants the greater involvement of duly diligent private dealers in seed multiplication activities. Choosing such dealers in different zones meticulously and decentralizing seed processing initiatives can also potentially resolve transportation issues.

Giving it back to the system: Seed multiplication by farmers

Supply constraints of STRVs are well-known bottlenecks that impede the adoption of suitable varieties in the different agro-ecological zones of Odisha. Any player in the seed system, including farmers, can contribute to the production of STRV seeds to eliminate shortcomings in supply. This year, the intervention involving farmers for seed multiplication produced quite promising results, evidently suggesting that, given appropriate opportunities in a conducive framework, the farming community too can be a strong and key player in sorting out seed supply issues.

This strategy not only prepares participating farmers as seed growers or partners of OSSC but also provides an array of facilities with which farmers will be more capacitated on knowing about and cultivating STRVs. Therefore, more direct strategic engagement with farmers is recommended for seed multiplication.

Women participation

Since the beginning of the project, the engagement of women in the interventions has been a priority. IRRI as an organization attaches special importance to gender equity. This year, two women SHGs were tapped to establish and manage EHs in their farm in two districts. Surprisingly, these EHs were the most efficiently managed among the 28 EHs established. This emboldens to repose even more confidence in women when rolling out other demonstration models. The district administration, in recognition of the efforts of the women, awarded one of the SHGs in Kalahandi for their excellent role in the demonstrations.

In other forms of demonstration, the participation of women farmers was in the range of 36 to 38%. One distinct qualitative revelation showed that demonstration activities managed with direct involvement of women were much more systematic and organized. The following years will see a greater participation of women SHGs in every possible way to promote STRVs through trials and demonstrations.

Increasing uptake of varieties selected under EH

Boosting seed uptake through popularizing selected varieties directly among farmers is effective but slow due to the enormous number of farmers to be reached in a short period of time. It involves year-on-year trials and a great deal of exploratory evaluation in different agro-ecologies. However, with the evaluated performance of STRVs in the past two years, a trend can be deduced to narrow down on varietal recommendations and replacement. The initial trend from all forms of demonstrations suggest that STRVs such as Bina dhan 11, CR 1009 sub-1, and Swarna sub1 are to be promoted in coastal districts. On the other hand, the varieties Bina dhan 11, DRR 42, DRR 44, and Sahbhagi dhan yielded good results in the upland districts that could trigger their adoption by farmers. Thus, the formal extension system is advised to focus on further trials and on the promotion of these varieties.

In the Crop Cafeteria, experiments were conducted with non-released varieties such as BRRI 70, 71, 75, and Bina 17. These STRVs delivered extremely well and found fit as assessed by the DDAs and farming community, thereby calling for initiating steps to make procedural arrangements to get these varieties released and be made available to farmers.

Annexure

Table 1.20: Details of Head to Head demonstrations in Kharif 2017

SN	District	No of Villages covered	No of Gram panchayats covered	No of Blocks covered	No of H2H trials conducted
1	Angul	14	7	3	61
2	Balangir	6	6	3	60
3	Balasore	25	16	4	79
4	Bargarh	15	4	3	60
5	Bhadrak	14	13	3	57
6	Boudh	21	16	3	48
7	Cuttack	12	8	2	40
8	Deogarh	8	4	2	48
9	Dhenkanal	4	2	2	73
10	Gajapati	26	9	2	30
11	Ganjam	15	11	2	60
12	Jagatsinghpur	24	3	3	73
13	Jajpur	20	10	4	86
14	Jharsuguda	15	8	4	205
15	Kalahandi	46	28	8	70
16	Kandhamal	8	6	4	44
17	Kendrapara	16	12	2	243
18	Keonjhar	48	23	6	22
19	Khordha	9	8	1	221
20	Koraput	59	26	6	64
21	Malkangiri	13	7	2	121
22	Mayurbhanj	46	26	6	63
23	Nabarangpur	10	7	2	80
24	Nayagarh	43	24	4	59

SN	District	No of Villages covered	No of Gram panchayats covered	No of Blocks covered	No of H2H trials conducted
25	Nuapada	21	16	3	114
26	Puri	33	12	5	159
27	Rayagada	32	15	4	100
28	Sambalpur	20	7	5	60
29	Sonepur	17	17	4	40
30	Sundargarh	8	8	2	60
	Grand Total	**648**	**359**	**104**	**2500**

Table No 1.21: Variety details in Head to Head demonstrations in Kharif 2017

SN	District	Bina 11	CR 1009 sub 1	DRR 42	DRR 44	DRR 46	Sahabhagi dhan	Swarna Sub 1	Grand Total
1	Angul	13		16	16		16		61
2	Balangir	6		45	3		6		60
3	Balasore	26	26					27	79
4	Bargarh	11		11	23		15		60
5	Bhadrak	20	19					18	57
6	Boudh	13		15	14		18		60
7	Cuttack	12	14					22	48
8	Deogarh	11		11	9		9		40
9	Dhenkanal			48					48
10	Gajapati	32			37	4			73
11	Ganjam							30	30
12	Jagatsinghpur	19	21					20	60
13	Jajpur	26	26					21	73
14	Jharsuguda	30		23	16		17		86
15	Kalahandi	37		26	93		48	1	205
16	Kandhamal	13		8	35		14		70
17	Kendrapara	19	25						44
18	Keonjhar	69		43	53	2	76		243
19	Khordha	7	7					8	22
20	Koraput	44		79	42		56		221
21	Malkangiri	20		8	16		20		64
22	Mayurbhanj	37		28	30		26		121
23	Nabarangpur	5		11	29		18		63
24	Nayagarh	20		20	20		20		80
25	Nuapada	15		12	14		18		59
26	Puri	41	43					30	114
27	Rayagada	19		16	54		70		159
28	Sambalpur	46		9	28		17		100
29	Sonepur	2		38	14		6		60
30	Sundargarh	10		10	10		10		40
	Grand Total	**623**	**181**	**477**	**556**	**6**	**480**	**177**	**2500**

Table No 1.22: District wise Head to Head average yield comparison (STRV Vs Farmers' variety)

District	STRV	Yield (ton/ha)	Adjacent Variety	Yield (ton/ha)	Yield difference (ton/ha)
Angul	Bina dhan 11	5.1	Lalat	3.8	1.3
Angul	Bina dhan 11	3.7	Naveen	3.2	0.5
Angul	Bina dhan 11	4.3	Sahabhagi	2.7	1.6
Angul	DRR 42	4.2	Lalat	3.5	0.7
Angul	DRR 42	5.2	MTU1010	3.9	1.2
Angul	DRR 42	3.7	Naveen	3.1	0.6
Angul	DRR 42	3.5	Sahabhagi	2.5	1.0
Angul	DRR 44	3.7	Khandagiri	2.1	1.6
Angul	DRR 44	3.3	Naveen	2.3	1.0
Angul	Sahbhagi dhan	3.3	Naveen	2.6	0.8
Balasore	Bina dhan 11	6.4	Lalat	5.3	1.1
Balasore	Bina dhan 11	5.8	Swarna	6.0	-0.2
Balasore	CR 1009 Sub -1	6.0	Swarna	5.5	0.5
Balasore	Swarna Sub 1	5.7	Pratikshya	5.6	0.1
Balasore	Swarna Sub 1	5.3	Rani	4.8	0.5
Balasore	Swarna Sub 1	5.4	Swarna	4.6	0.8
Bargarh	Bina dhan 11	3.7	Lalat	2.5	1.2
Bargarh	DRR 42	2.5	Silky	4.4	-1.9
Bargarh	DRR 44	4.9	MTU-1010	4.7	0.2
Bhadrak	Bina dhan 11	5.5	Khandagiri	4.8	0.7
Bhadrak	Bina dhan 11	3.9	Swarna	3.8	0.2
Bhadrak	CR 1009 Sub -1	3.5	Swarna	4.0	-0.5
Bhadrak	Swarna Sub 1	4.0	Swarna	3.8	0.3
Bolangir	DRR 44	5.0	MTU-1010	4.0	1.0
Boudh	Bina dhan 11	4.1	Bhagyabati	3.0	1.1
Boudh	Bina dhan 11	3.3	MTU 1001	3.8	-0.5
Boudh	DRR 42	3.1	Khandagiri	2.9	0.2
Boudh	DRR 42	3.1	Naveen	2.5	0.6
Boudh	Sahbhagi dhan	2.5	Naveen	2.4	0.1
Cuttack	Bina dhan 11	3.8	Lalat	3.1	0.7
Cuttack	Bina dhan 11	2.6	Naveen	2.0	0.6
Cuttack	CR 1009 Sub -1	5.1	MTU 1001	4.4	0.7
Cuttack	CR 1009 Sub -1	5.0	CR-1009	3.9	1.1
Cuttack	Swarna Sub 1	5.0	Swarna	4.5	0.5
Dhenkanal	DRR 42	3.6	Lalat	3.4	0.2
Ganjam	Swarna Sub 1	3.3	MTU 1001	3.1	0.2
Ganjam	Bina dhan 11	5.0	Kuber	4.5	0.6
Jagatsinghpur	Bina dhan 11	5.1	Otara	4.7	0.5
Jajpur	Bina dhan 11	5.6	Khandagiri	4.6	1.0
Jajpur	Swarna Sub 1	6.2	Pooja	5.6	0.6
Jajpur	Swarna Sub 1	6.2	Pratikshya	5.1	1.1
Jajpur	Swarna Sub 1	5.9	Swarna	6.1	-0.2
Jharsuguda	Bina dhan 11	3.4	Bhuvan	3.3	0.1

District	STRV	Yield (ton/ha)	Adjacent Variety	Yield (ton/ha)	Yield difference (ton/ha)
Jharsuguda	Bina dhan 11	3.7	Pratikshya	3.7	0.0
Jharsuguda	DRR 44	2.8	Bhuvan	2.7	0.1
Jharsuguda	Sahbhagi dhan	3.8	Bhuvan	3.5	0.3
Kalhandi	Bina dhan 11	6.3	MTU 1010	5.6	0.7
Kalahandi	DRR 42	5.8	Lalat	4.7	1.0
Kalahandi	DRR 42	4.9	MTU 1010	4.2	0.7
Kalahandi	DRR 44	5.1	Khandagiri	4.5	0.6
Kalahandi	DRR 44	6.9	Lalat	6.2	0.7
Kalahandi	DRR 44	4.9	MTU 1001	3.2	1.7
Kendrapara	Bina dhan 11	5.0	Pratikshya	4.0	1.0
Keonjhar	Bina dhan 11	4.8	Lalat	4.3	0.4
Keonjhar	DRR 44	5.3	Lalat	4.4	0.9
Keonjhar	DRR 44	4.0	Naveen	2.9	1.2
Keonjhar	Sahbhagi dhan	5.2	Lalat	4.9	0.4
Keonjhar	Sahbhagi dhan	5.4	Naveen	3.2	2.2
Khurda	Bina dhan 11	6.8	Samrat	5.6	1.1
Koraput	Bina dhan 11	4.2	MTU 1001	4.3	0.0
Koraput	DRR 42	4.5	MTU 1010	4.6	-0.2
Koraput	DRR 44	4.8	Kranti	4.1	0.7
Koraput	DRR 44	4.7	Pratikshya	4.6	0.0
Mayurbhanj	Bina dhan 11	6.0	Lalat	5.2	0.8
Mayurbhanj	Bina dhan 11	3.7	Naveen	3.5	0.2
Mayurbhanj	DRR 42	4.5	Lalat	4.4	0.1
Mayurbhanj	DRR 42	4.3	Naveen	3.8	0.4
Mayurbhanj	DRR 44	5.3	Kanicha	4.6	0.7
Mayurbhanj	DRR 44	4.8	Lalat	4.1	0.7
Mayurbhanj	DRR 44	4.6	Surendra	4.3	0.3
Mayurbhanj	Sahbhagi dhan	3.2	Khandagiri	2.9	0.4
Mayurbhanj	Sahbhagi dhan	5.0	Naveen	4.7	0.3
Mayurbhanj	Sahbhagi dhan	5.1	Lalat	4.8	0.3
Nabarangpur	DRR 42	5.4	Khandagiri	5.1	0.3
Nayagarh	Bina dhan 11	5.4	MTU-1001	5.5	-0.1
Nayagarh	DRR 42	5.9	MTU-1001	6.1	-0.2
Nayagarh	DRR 44	6.0	Naveen	5.6	0.4
Nayagarh	Sahbhagi dhan	4.4	Kudrat	3.9	0.5
Puri	Bina dhan 11	4.9	Lalat	4.1	0.7
Puri	Bina dhan 11	4.9	Otara	5.1	-0.1
Puri	Bina dhan 11	4.5	Swarna Masuri	4.2	0.3
Puri	CR 1009 Sub -1	4.9	Pooja	4.5	0.5
Puri	Swarna Sub 1	6.2	Ganjamgedi	5.7	0.5
Puri	Swarna Sub 1	5.0	Pooja	4.7	0.4
Puri	Swarna Sub 1	6.7	Swarna	6.0	0.7
Puri	Swarna Sub 1	6.8	Samba Masuri	6.1	0.7
Rayagada	Bina dhan 11	4.9	Lohata	4.5	0.4
Rayagada	Bina dhan 11	6.3	Pratikshya	4.3	2.0

District	STRV	Yield (ton/ha)	Adjacent Variety	Yield (ton/ha)	Yield difference (ton/ha)
Rayagada	Sahbhagi dhan	4.0	Naveen	3.9	0.2
Sambalpur	Bina dhan 11	4.5	Lalat	3.8	0.7
Sambalpur	Bina dhan 11	3.5	Naveen	3.3	0.2
Sambalpur	Bina dhan 11	5.1	Pratikshya	4.7	0.4
Sambalpur	Bina dhan 11	4.6	Shubhadra	3.8	0.7
Sambalpur	DRR 42	3.4	Lalat	2.6	0.8
Sambalpur	DRR 42	3.4	MTU 1010	3.3	0.1
Sambalpur	DRR 42	3.1	Naveen	3.2	-0.1
Sambalpur	DRR 42	3.4	Pratikshya	3.3	0.1
Sambalpur	DRR 42	3.0	Swarna	2.5	0.5
Sambalpur	DRR 44	3.1	MTU 1010	2.6	0.6
Sambalpur	DRR 44	2.2	Naveen	1.8	0.4
Sundargarh	DRR 42	3.9	MTU 1010	3.1	0.8
Sundargarh	DRR 44	4.3	Naveen	3.0	1.2
Sundargarh	Sahbhagi dhan	3.5	Pratikshya	2.8	0.6

Table No 1.23: Variety wise number of demonstrations conducted in Kharif 2017

SN	District	DRR 42	Bina dhan 11	DRR 39	DRR 44	DRR 46	Sahbhagi Dhan	Swarna Sub 1	Grand Total
1	Angul	106	137		239		154		636
2	Balasore		72					463	535
3	Bargarh	40	79		115		43		277
4	Bhadrak		132					246	378
5	Bolangir	39	50		109		51		249
6	Boudh	40	106		98		23		267
7	Cuttack		60					228	288
8	Deogarh	51	95		80		37		263
9	Dhenkanal	110	72		61		83		326
10	Gajapati	50	88		93	94			325
11	Ganjam		10					342	352
12	Jagatsinghpur		113					283	396
13	Jajpur		298					237	535
14	Jharsuguda	57	198	1	136	12	110	2	516
15	Kalahandi	156	263		254		139		812
16	Kandhamal	163	180		200		103	10	656
17	Kendrapada		155					208	363
18	Keonjhar	267	247		243	1	192	1	951
19	Khurda							68	68
20	Koraput	327	402		339		223		1291
21	Malkanagiri	53	78		95		42	8	276
22	Mayurbhanj	148	424		277		247		1096
23	Nabarangpur	102	218		231		113		664
24	Nayagarh	182	171		208		151		712
25	Nuapada	71	95		138		50		354

SN	District	DRR 42	Bina dhan 11	DRR 39	DRR 44	DRR 46	Sahbhagi Dhan	Swarna Sub 1	Grand Total
26	Puri		227					766	993
27	Rayagarda	46	74		88		35	1	244
28	Sambalpur	120	122		145	55	63	2	507
29	Subarnapur		72		78		61		211
30	Sundergarh	95	173		134		69		471
	Grand Total	**2223**	**4411**	**1**	**3361**	**162**	**1989**	**2865**	**15012**

Table No 1.24: Average yield of STRVs in Cluster demonstrations (District wise)

District	Variety yield (ton/ha)					
	Bina dhan 11	DRR 42	DRR 44	DRR 46	Sahabhagi	Swarna Sub1
Angul			2.72		2.35	
Balasore	4.94					6.18
Bargarh	2.8	2.32	2.72		2.56	
Bhadrak	5.19					6.79
Boudh	3.9	2.42	3.22		2.9	
Cuttack	3.11					4.57
Debgarh	5.27	4.99	4.85		4.44	
Gajapati	3.2		3.32	3.8		
Ganjam						3.41
Jagatsinghpur	5.34					6.88
Jajpur	5.26					4.25
Jharsuguda	3.31	3.32	3.47		3.76	
Kalahandi	5.36	4.72	5.28		4.11	
Kendrapada	5.11					6.13
Keonjhar	5.39	4.59	5.11		5.31	
Khordha						4.88
Koraput	5.89	5.04	5.47		4.97	
Malkangiri	3.77	3.74	3.81		3.58	
Mayurbhanj	4.62	3.66	3.88		3.38	
Nabarangpur	7.2	5.67	4.75		4.27	
Nayagarh	4.78	4.07	4.41		4.4	
Nuapada	3.12					
Puri	5.03					5.56
Rayagada	5.34	6.7	5		5.29	
Sambalpur	3.85		3.38			
Sonepur	3.68		3.2		2.48	
Sundargarh	4.19	3.98	3.87		4.03	

Subproject 2: Targeting rice-fallows: a cropping system-based extrapolation domain approach

A substantial area of potentially productive cropland in Odisha remains fallow during the winter (Rabi) season after the monsoon (Kharif) rice crop due to three major factors: (1) lack of irrigation water, mostly in the plateaus and tablelands; (2) stagnant water causing water logging in the coastal low land areas; and (3) high soil or water salinity in the coastal zone. Late harvest of the Kharif crop or excessive soil wetting after rice harvest leads to late planting and low productivity of the Rabi crop. Increasing the productivity and profitability of these low productive areas is a major challenge for the state.

The traditional single-layer characterization method may not be adequate for assessing cropping system suitability in these multi-stress areas where resource profiles vary both spatially and temporally. Any single improved practice may not be suitable for all areas and technologies should be targeted to the most appropriate places. Advanced remote sensing-based targeting methods like "extrapolation domains" can facilitate precise targeting and accelerate the dissemination of improved technologies in fallow areas in a fast and cost-effective manner. IRRI has developed considerable expertise in delivering geo-spatial solutions (integration of remote sensing and GIS through logical decision tree approach) through "extrapolation domains" for STRVs and improved cropping systems.

Objectives: This component of the project aims

- To develop, test, and validate innovative cropping systems to target rice-fallows;
- To identify the land use requirements of tested cropping systems and develop decision rules;
- To develop extrapolation domain maps using geospatial modeling and decision tree approach for targeting improved technologies (STRVs and innovative cropping systems) in rice-fallows;
- To demonstrate different tested technologies (STRVs and cropping systems) at farmers' fields guided by Extrapolation Domain Analysis (EDA) for accelerated dissemination; and
- To disseminate project outputs, maps, or reports to national partners, government officers, and agriculture extension through various applications, e.g., open access web-GIS system, mobile applications, atlases, and research papers

Characterizations of rice-fallow area

Rice-fallow scenario in Odisha: Rice-fallows are areas which remain fallow during the Rabi season after the kharif rice crop is harvested. Rice-fallow lands constitute a significant portion of the total underutilized lands in South Asia, more specifically in eastern India. To intensify cropping in rice-fallow lands by targeting water-efficient crops like pulses, the spatial distribution and extent of the rice-fallow system area need to be mapped. Using improved remote sensing methods, IRRI has carried out a study to identify the spatial distribution and extent of rice-fallow and current fallow as well as the spatial-temporal changes of rice-fallow in the last 10 years. Remote sensing data and geo-spatial techniques were used to identify rice and corresponding fallow areas to target suitable improved cultivars and technologies.

A standard approach and methodology was prepared for processing and analysing the time series remote sensing datasets (Optical and Microwave) of different seasons/years to identify the cropping patterns during kharif and Rabi seasons. Intensive ground truth survey was conducted for validation of the remote sensing outputs. A land use/land cover map (Fig 2.2.) of Odisha State for the year 2016 was generated by analysing the multi-temporal remote sensing data of different cropping seasons. Land use categories such as water bodies, settlements, forests, and vegetation are very important for accurately calculating the area of other agricultural classes (e.g. rice and rice-fallow).

The study identified nearly 1.6 M ha of rice-fallows in Odisha in 2016-17. Major causal factors for lands to remain fallow include lack of irrigation, the use of long-duration rice cultivars, non-availability of good quality seeds of short-duration rice and pulses, and lack of knowledge along with the customary practice of cattle open grazing during the dry season. The Landsat OLI and Sentinel-1 (SAR) data were used to identify the rice during kharif and the corresponding fallow areas during Rabi. The study area was covered by 14 Landsat tiles (i.e., Worldwide Reference System-2 tile) (Fig. 2.1a) and 12 Sentinel-1 tiles (Fig. 2.1b). The Landsat OLI and Sentinel-1 SAR data were downloaded from the National Aeronautics and Space Administration (NASA) (https://search.earthdata.nasa.gov/) and the European Space Agency (ESA) (https://scihub.copernicus.eu/) websites, respectively. The Landsat OLI data covered the annual crop calendar (i.e. June to May) of Odisha in 2015-16 and 2016-17. Scene-wise numbers of Landsat tile count in each calendar year are provided in Table 2.1. Cloud contamination is a major problem for acquiring good quality data. Therefore, a criterion – cloud coverage of <10% – was followed to obtain good quality data. The Sentinel-1 data covered only the Kharif season (i.e. June to October) since high-cloud coverage affects the availability of good quality optical data (i.e. Landsat OLI). Scene-wise details of Sentinel-1 tile count in each calendar year are provided in Table 2.2 In addition, time-series Normalized Differential Vegetation Index (NDVI) (having 100 m spatial and 10 days temporal resolution) from Proba-V was downloaded for the same period from the ESA website.

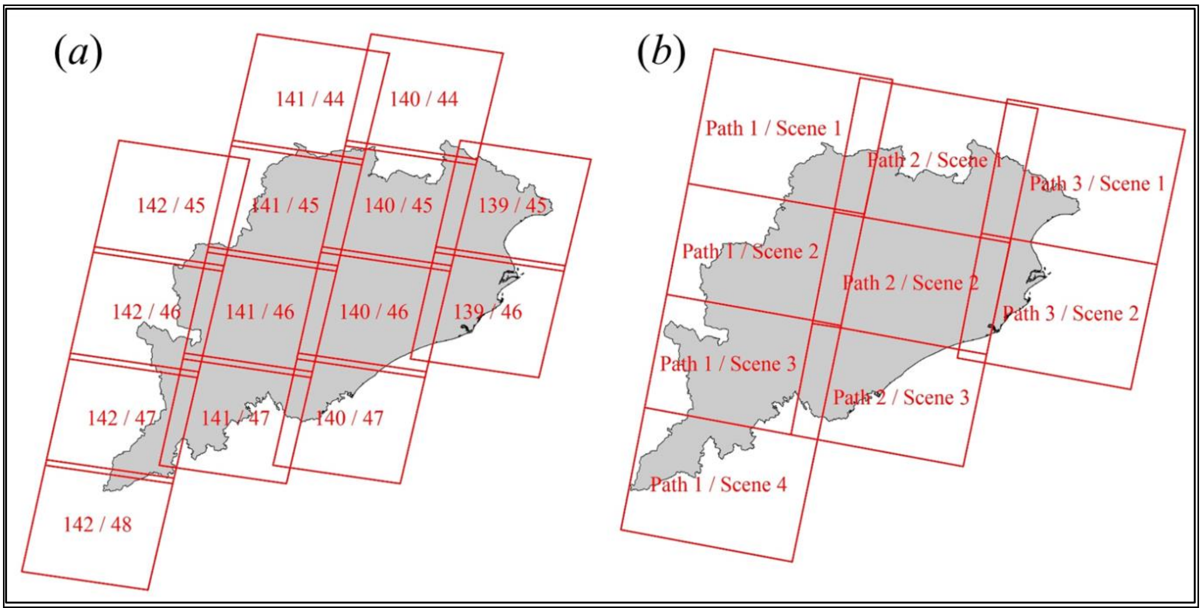


Figure 2.1: The tile coverage of (a) Landsat OLI and (b) Sentinel-1

Table 2.1: Details of tile-wise Landsat OLI and Sentinel-1 data count for 2016-17

Landsat OLI			Sentinel-1		
SN	**Path / row**	**No. of dates**	**SN**	**Path / scene**	**No. of dates**
1	139/45	11	1	Path 1 – Scene 1, 2, 3, 4	6
2	139/46	9	2	Path 2 – Scene 1, 2, 3	6
3	140/44	14	3	Path 3 – Scene 1, 2	6
4	140/45	13			
5	140/46	12			
6	140/47	12			
7	141/44	14			
8	141/45	12			
9	141/46	10			
10	141/47	9			
11	142/45	10			
12	142/46	11			
13	142/47	9			
14	142/48	15			

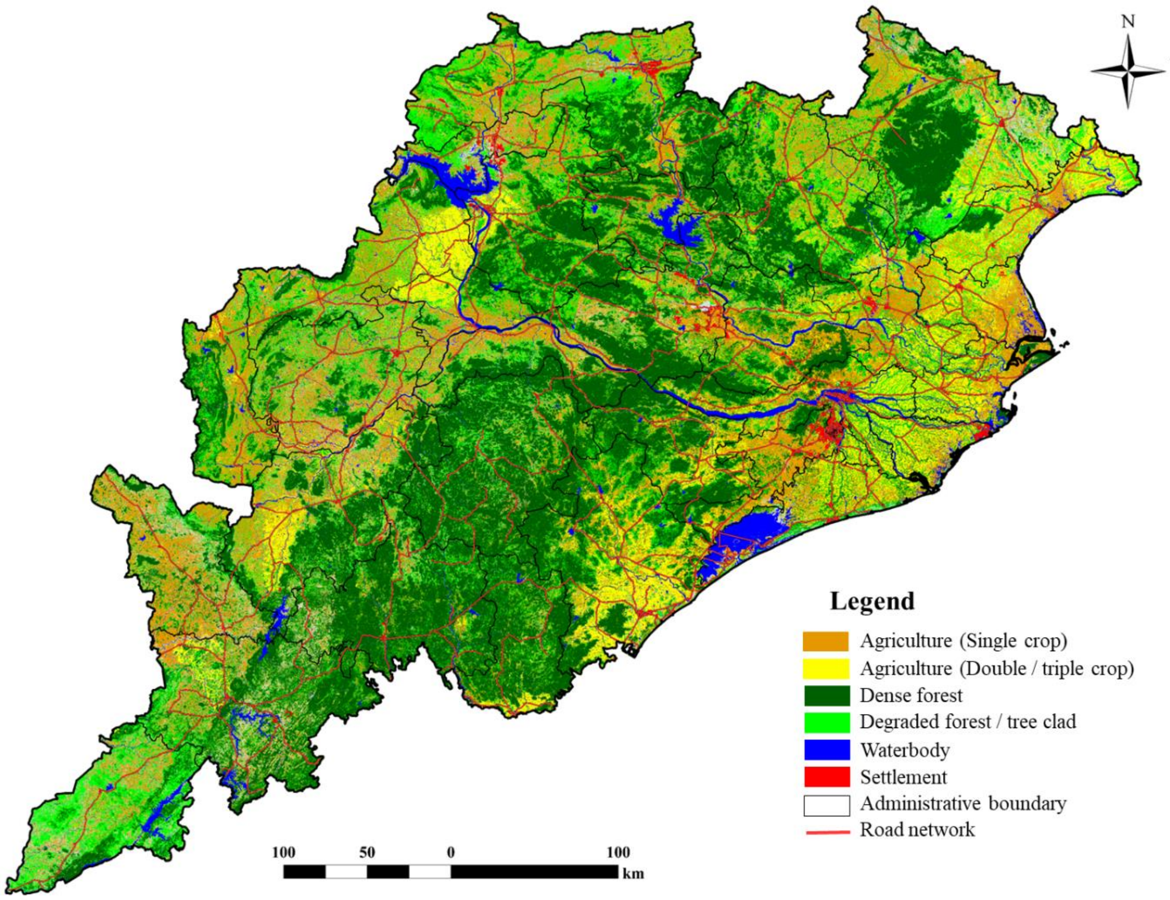


Figure 2.2: Spatial distribution of major land use and land cover classes in Odisha in 2016-17

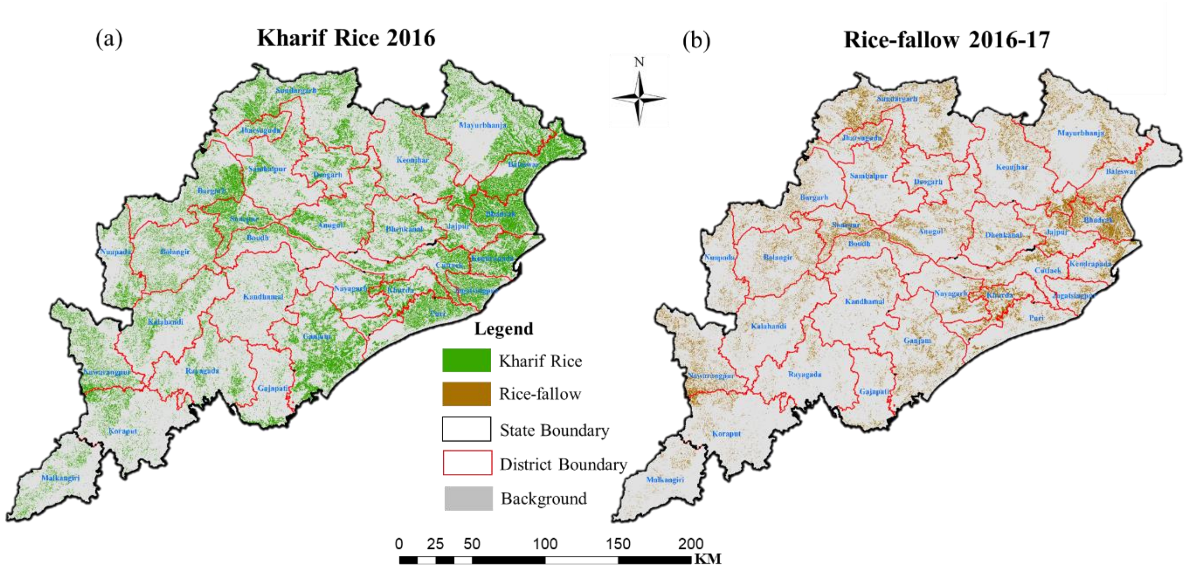


Figure 2.3: Spatial distribution of (a) Rice area during Kharif 2016 and (b) Rice-fallow area during Rabi 2016-17

Table 2.2: Distribution of district-wise rice-fallow area for 2016-17

SN	District	Rice-fallow area during 2016-17 (in ha)	SN	District	Rice-fallow area during 2016-17 (in ha)
1	Angul	120261	16	Kandhamal	22891
2	Baleswar	57646	17	Kendrapada	37956
3	Bargarh	82163	18	Keonjhar	86545
4	Bhadrak	101972	19	Khurda	61388
5	Bolangir	88665	20	Koraput	38202
6	Boudh	33354	21	Malkangiri	31422
7	Cuttack	41667	22	Mayurbhanja	117030
8	Deogarh	20319	23	Nawarangpur	74563
9	Dhenkanal	39375	24	Nayagarh	36736
10	Gajapati	13297	25	Nuapada	23265
11	Ganjam	78984	26	Puri	27039
12	Jagatsingpur	16728	27	Rayagada	18919
13	Jajpur	47124	28	Sambalpur	67618
14	Jharsuguda	32973	29	Sonepur	42365
15	Kalahandi	59733	30	Sundargarh	115541
Total Rice-fallow area = 1635741 hectares					

Ground Truth Data Collection: Field surveys were conducted during the Kharif and Rabi seasons to collect the ground truth data to determine land use/land cover including irrigation source, crop intensity, and crop extent from 24 out of the 30 districts (Fig.2.4.). Rice-based cropping systems information was obtained through interaction with farmers. Among all the ground truth data, only 40% of the clear rice field plots (i.e. GPS location collected in the middle of the rice field) were used for standard time 'rice base' preparation which was further subjected to use for multiple microwave backscatter coefficient-based threshold identification. The remaining samples were further used for validation purpose.

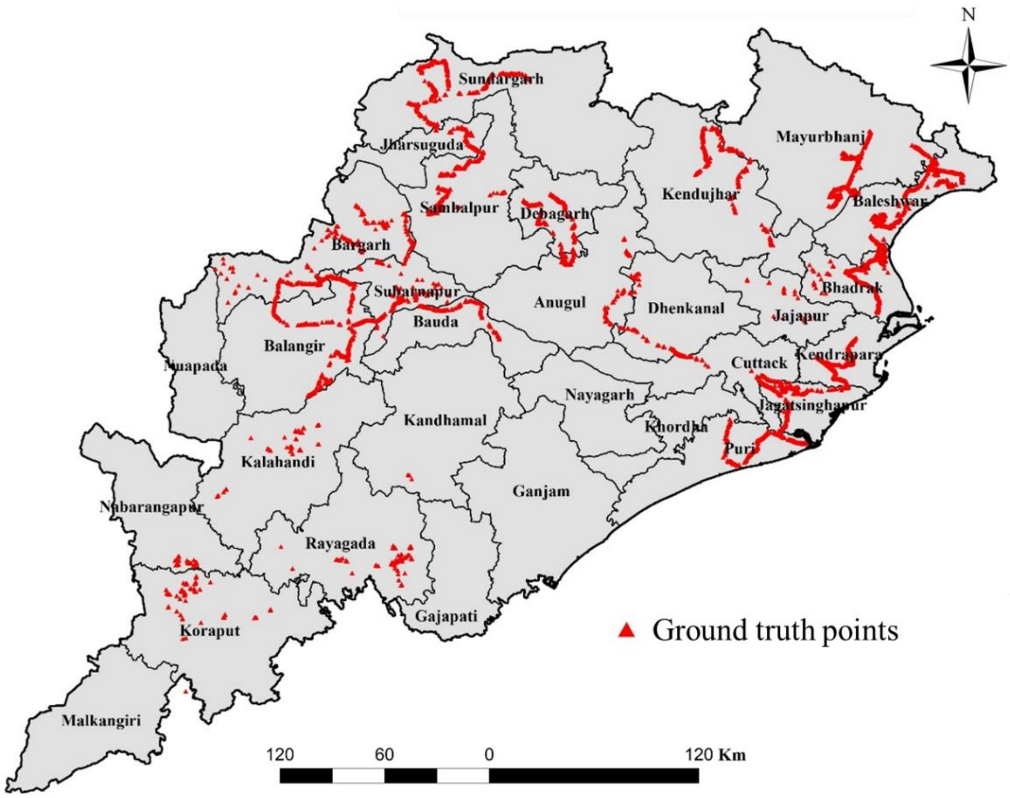


Figure 2.4: Distribution of ground truth points collected during Kharif 2017 and Rabi 2017-18 seasons

Analysis of soil moisture for targeting pulses in rice-fallow area: Targeting of water-efficient crops (e.g. pulses) in rice-fallow areas not only intensifies the cropping system and enhances crop diversification but also contributes to soil fertility. In areas that lack irrigation facilities, timely seeding that taps the residual moisture of the previous rice crop as well as relay cropping or surface seeding of legumes could offer potentially cost-effective options for resource-poor farmers. Residual soil moisture content in these deep alluvial soils after rice is often sufficient to raise short-duration pulses (55-75 days) and oilseed crops in rainfed rice-fallow cropping systems. A detailed analysis of the spatio-temporal profiles of soil moisture availability and duration during the Rabi season is required to precisely target and utilize the short residual soil moisture window (varies from 10-20 days, depending upon land types). An analysis of the long-term average of spatio-temporal soil moisture profiles can assist in identifying the areas having low, optimum, and excessive soil moisture during the sowing period during Rabi. It also provides the information needed (1) to identify the areas where soil moisture is retained for a shorter or longer period after initial germination, and (2) to determine whether adequate soil moisture can be available up to the pod formation stage of the crop. This information can significantly help to decide the type and duration of the cultivars to use as well as sowing time to target the pulse crop in the rice-fallow cropping system. The spatial distribution of monthly average soil moisture during the Rabi season (November to April) for 2015-16 (drought year) and 2017-18 (normal year) in comparison with the long-term monthly average extracted using ASCAT Soil Water Index are presented in Figure 2.5 and the temporal progress of soil moisture in different districts of Odisha during same period is presented in Figure 2.6.

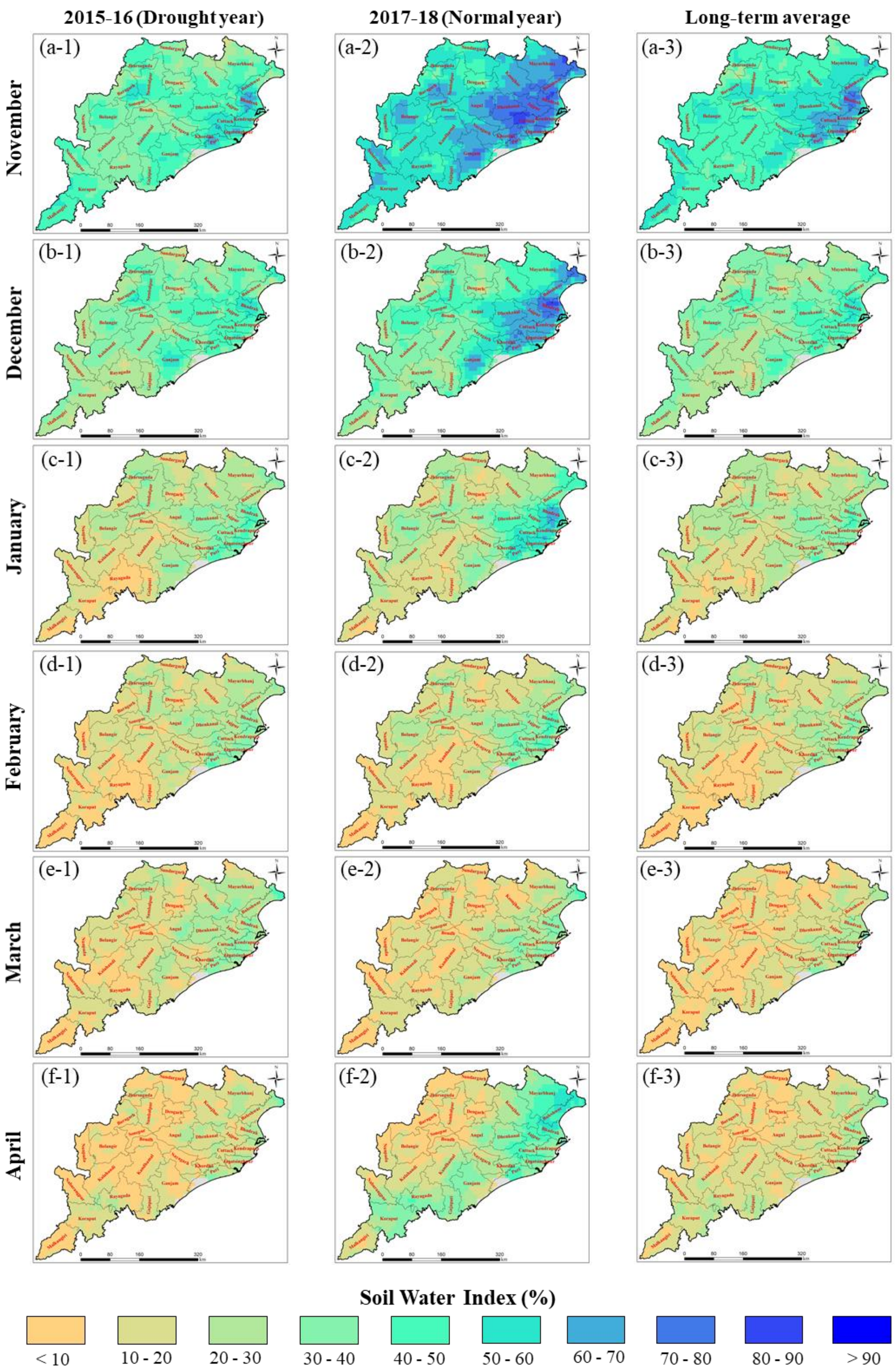
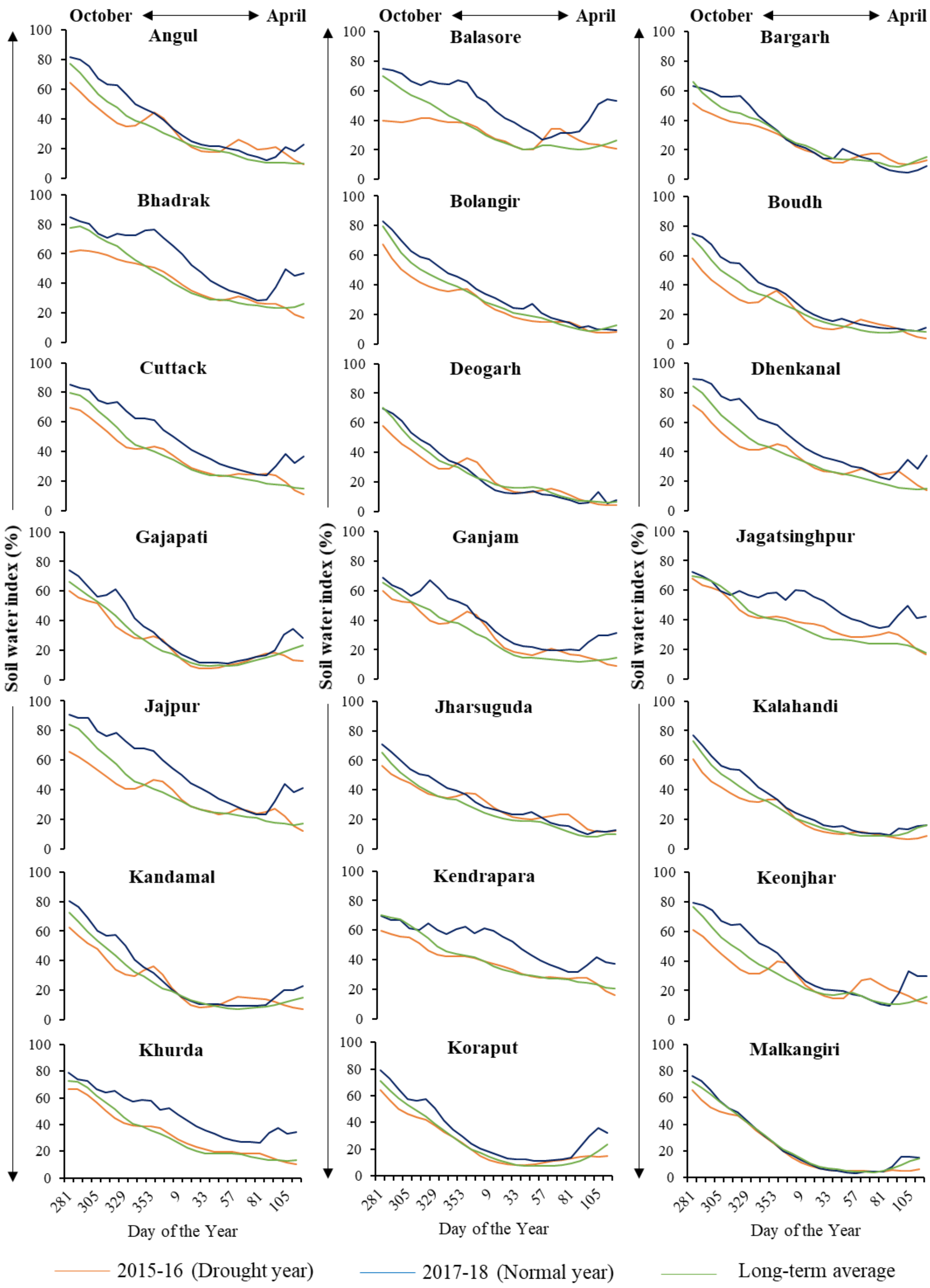


Figure 2.5: Month-wise spatial depiction of soil moisture in Odisha during the Rabi season of 2015-16 (drought stress year) and 2017-18 (normal year) in comparison with the long-term average


October
April
Soil water index (%)
Angul
Balasore
Bargarh
Bhadrak
Bolangir
Boudh
Cuttack
Deogarh
Dhenkanal
Gajapati
Ganjam
Jagatsinghpur
Jajpur
Jharsuguda
Kalahandi
Kandamal
Kendrapara
Keonjhar
Khurda
Koraput
Malkangiri
Day of the Year
2015-16 (Drought year)
2017-18 (Normal year)
Long-term average

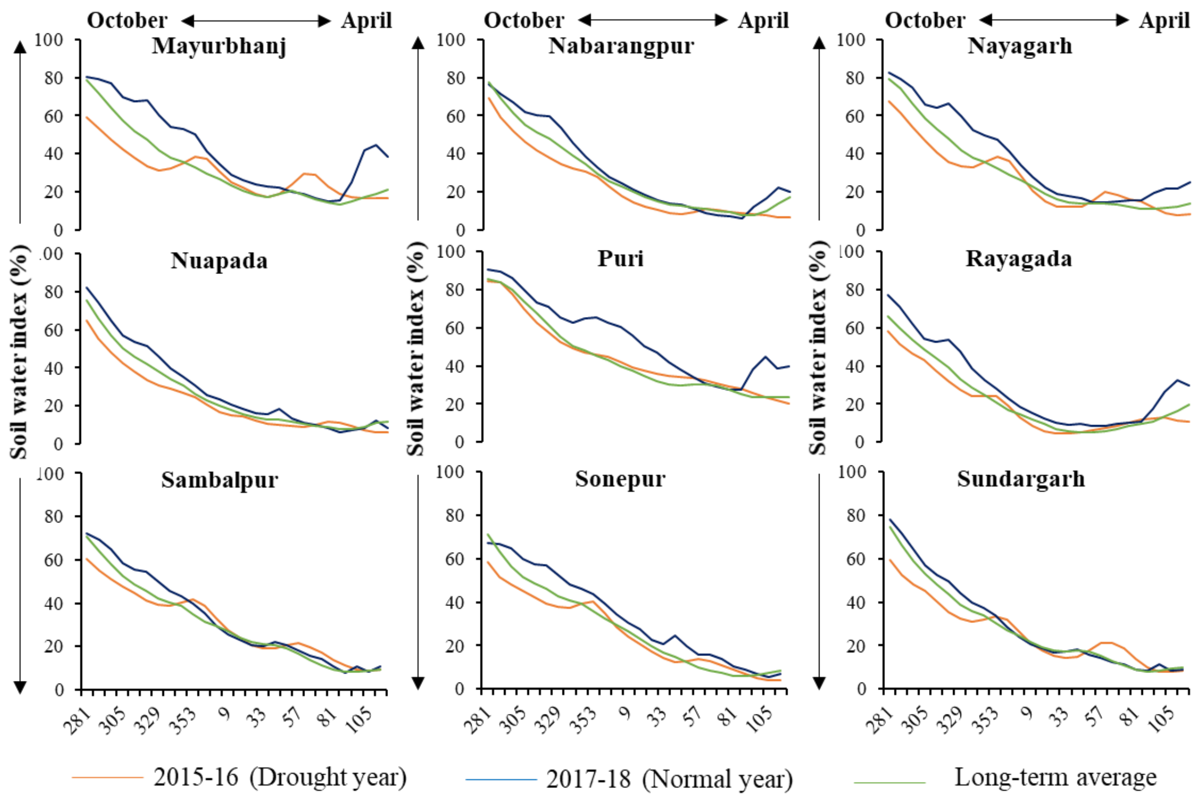


Figure 2.6: District-wise comparative depiction of temporal progression of top soil moisture during the Rabi season of 2015-16 (drought year) and 2017-18 (normal year) in comparison with the long-term average

Characterization of drought-stress areas: Agricultural drought can be referred to as "a stressed and declined crop growth condition" over a period of time due to a shortage of precipitation coupled with increased surface temperature, leading to a deficit in soil moisture. The increasing frequency of drought events coupled with the uncertainty of intra-seasonal droughts imparted by climate change poses a grave threat to agriculture and thereby overall food security. This is especially true in Odisha where more than 80% of the people are dependent (directly or indirectly) on agriculture for their livelihood. Despite the many rivers and vast forest cover in the state, the inevitable impact of climate change is highly affecting the regularity and even distribution of monsoon rainfall especially in the western part of Odisha. As a result, drought stress in the state is gradually becoming one of the major constraints of productivity and agricultural growth. Improper irrigation facility and inadequate groundwater development are also limiting the possibility to prevent damage occurring from droughts. As a result, many farmers leave the land fallow in moisture-deficient areas.

In recent decades, remote sensing domain has progressed well to map different biophysical variables related to drought such as vegetation condition index, surface temperature condition index, topsoil moisture, and precipitation condition through continuous satellite observation over a regional to global scale. Satellite data products from MODIS, TRMM, ASCAT, and others have been extensively used in drought studies as these data are available at a regional scale having high temporal resolution, consistent data compositing, and web-data access facility. In line with this, the project is developing an integrated drought stress index based on historical satellite measured climatic and biophysical variables in order to understand the drought dynamics in the state.

The agricultural area under drought stress during Kharif 2015, Rabi 2015-16, Kharif 2017, and Rabi 2017-18 is presented in Figures 2.7a, 2.7b, 2.7c, and 2.7d, respectively. In comparison with 2015-16, Kharif 2017 and Rabi 2017-18 can be considered normal years. Odisha had a considerable rainfall deficit during Kharif 2015 and, according to the state government, around 270 blocks were under drought stress. Around six percent of the total agriculture area across 70 blocks were declared under drought stress during Kharif 2017.

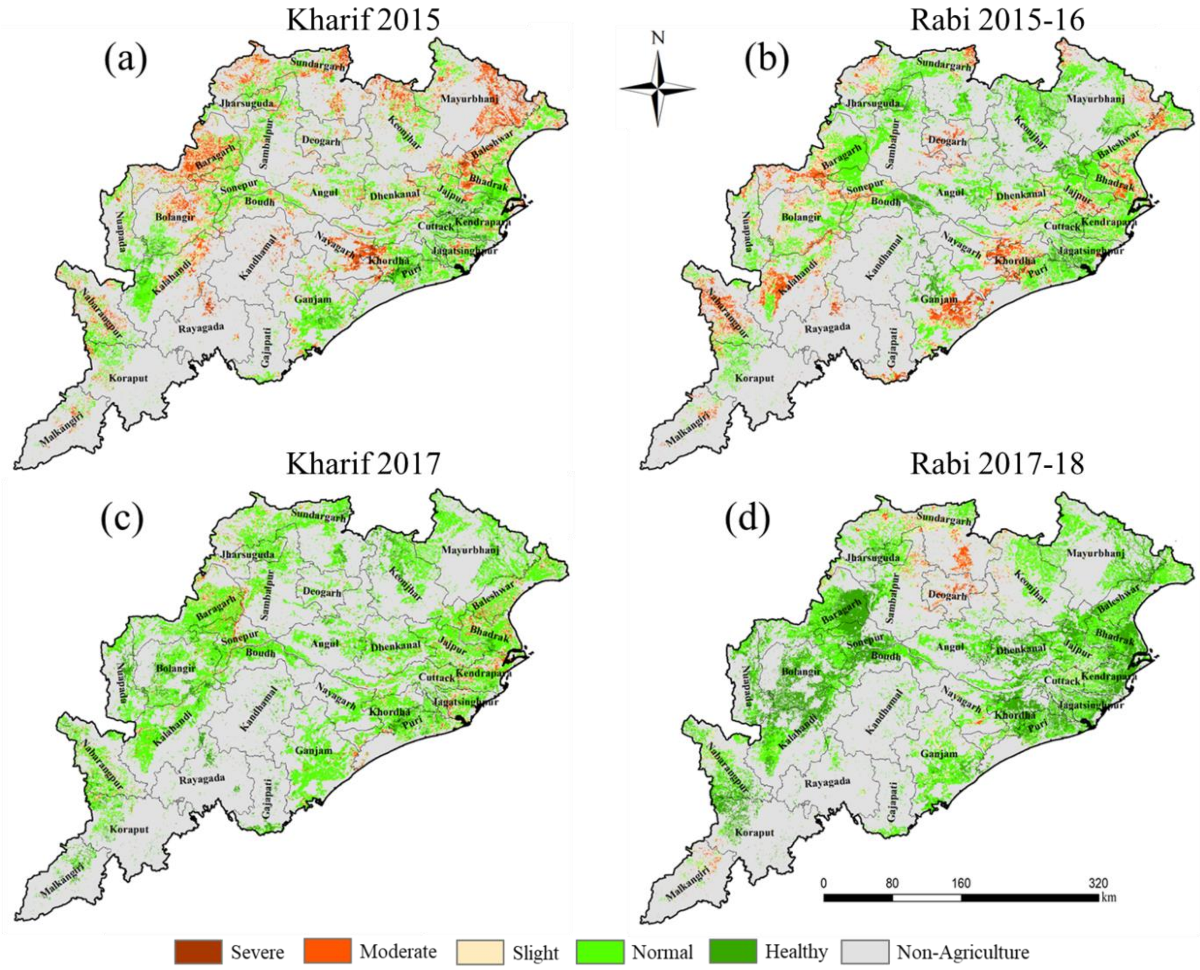


Figure 2.7: Spatial distribution of agriculture area under varying drought stress during (a) Kharif 2015, (b) Rabi 2015-16, (c) Kharif 2017, and (d) Rabi 2017-18 in Odisha

Flood inundation mapping in coastal districts of Odisha: North-eastern parts of Odisha suffer heavily from recurring floods during the months of monsoon causing submergence conditions and damage to Kharif rice crops. A detailed characterization of the flood-inundated areas is required to target submergence-tolerant cultivars (sub-1) of different durations for these areas. Remote sensing technology using microwave or SAR data is efficient to provide accurate and cost-effective mapping of flood-inundated areas.

Mapping for flood inundation was carried out in 13 flood-prone districts using the Sentinel-1 SAR (20 m) imageries in the most flood-affected months in two recent years. Data were analysed using sample threshold values and rule-based classification to identify the flood extent in 2016 and 2017.

Apart from high-resolution flood maps (generated from SAR data), the medium-resolution flood-prone area map was generated using MODIS (250 m) data by combining the flood events in the last 10-12 years.

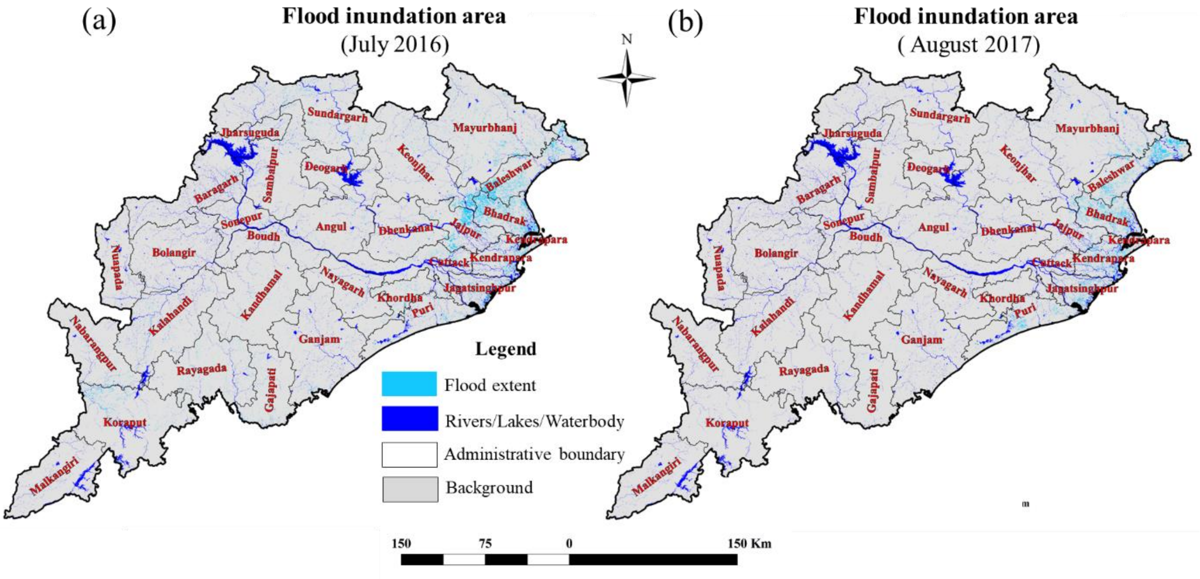


Figure 2.8: Flood inundation map of Odisha in (a) July 2016 and (b) August 2017.

Table 2.3: Distribution of flood inundation area during 2016 and 2017 in selected coastal districts of Odisha

District	Geographical area (in ha)	Flood inundation during 2016		Flood inundation during 2017	
		Total flood inundation area (in ha)	Flood-affected rice area (in ha)	Total flood inundation area (in ha)	Flood-affected rice area (in ha)
Baleshwar	380600	42068	40178	39667	37331
Bhadrak	250500	40861	38491	27487	25288
Cuttack	393200	6534	4744	1367	889
Gajpati	432500	2904	1374	1152	486
Ganjam	820600	4140	2006	2534	298
Jagatsinghpur	166800	8941	4672	11974	9511
Jajpur	289900	22595	20174	3135	2265
Kendarpara	264400	13082	9604	19795	15999
Keonjhar	830300	18423	4847	2856	2173
Khurda	281300	5327	4506	628	177
Mayurbhanj	1041800	15707	9625	12155	7470
Nayagarh	389000	1064	888	401	211
Puri	347900	7620	2008	10820	2718
Total	**15570700**	**189267**	**143117**	**133971**	**104815**

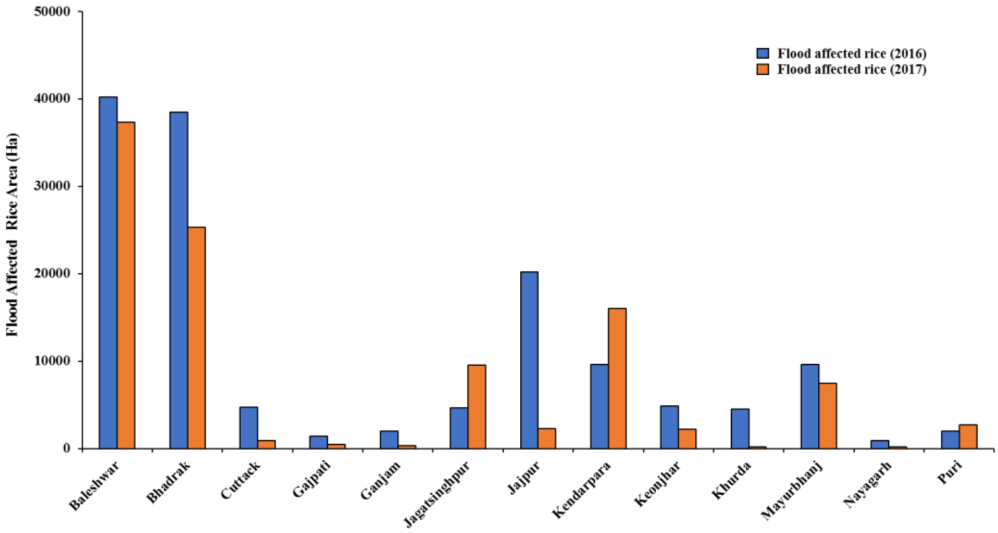


Figure 2.9: Distribution of flood-affected rice area in 2016 and 2017 in selected coastal districts of Odisha

Rice-Pulse Monitoring System Version 2

The Rice-Pulse Monitoring System (RPMS) is an android (phone/tablet)-based application system for pulses and oilseed crops. It is a customized application built on an open-source platform called "Geographical open data kit". RPMS enables its users to collect and store geo-referenced information and comes with a suite of tools to visualize, analyse and manipulate ground data for various needs of the DoA in different projects. Through geo-spatial viewing and integration with various geo-thematic layers, RPMS enables better understanding of the agricultural data for decision-making, research, and management purposes. As a multi-dimensional application, RPMS's goal is to provide an online/offline mobile application to cater to the needs of existing and future agricultural data collection in geo-spatial mode.

RPMS Ver.1 was released in May 2017 in the presence of the Principal Secretary and Director of Agriculture during a training of trainer's session organized for DoA officials. RPMS includes offline mapping, visualization of collected data on the phone/tablet, the ability to collect point, polygon and GPS tracing data, and the ability to link this spatial information with all the collected information. Based on the suggestions of the DoA authorities, essential details of almost 1.7 million registered farmers of Odisha were added in the system. RPMS Ver.1 handles data collection and geo-spatial viewing but lacks some abilities on the query part, remote sensing data integration, and report generation components. In RPMS Ver.2, options for viewing and overlaying of remote sensing data collected in the project (rice-fallows, flood-prone and drought-prone areas, etc.) have been added, along with improvement in the execution part of the system. RPMS Ver.2 (Beta) is ready for initial testing and will be released by September 2018 along with a training manual.

Effect of improved crop management on grain yield of the rain-fed rice-pulse system

Experiment I: Effect of Nano-materials of Iron (Fe) and Zinc (Zn) on the growth and yield of rice: Rice is one of the primary staple foods in South and South East Asian countries but it is not a good source of micronutrients such as Zn and Fe needed by humans and animals. Nano technology is a growing field with broad application in the field of science. The use of nano-materials in the growth of plants and modulating its physiological response is a recent practice. Nano-materials interact with plants causing many morphological and physiological changes, depending on their properties. The impacts of nano-materials on plants depend on the properties of both the nano-materials (i.e. type, composition, concentration, size, etc.) and the plant (i.e. type and species, etc.) Nano-materials could be potentially taken up by plant roots and transported to shoots through vascular systems depending upon the composition, shape, and size of nano-materials, and plant anatomy. The objective of this research was to study the effect of nano-materials of Fe and Zn on the growth and yield of rice.

A field experiment was carried out at the research farm of the ICAR-NRRI in Cuttack, India during the Kharif season of 2017. The experiment was laid out in a split-plot design with three replications. Main plots consisted of two rice varieties, i.e. Sahbhagi dhan and CR dhan 205. The subplots consisted of five nutrient treatments, i.e., control, nanomaterial of zinc oxide, nanomaterial of iron oxide, zinc sulphate (0.5% spray), and iron sulphate (2.0% spray). Plant density was maintained at 44 plants m^{-2} with a spacing of 15 x 15 cm. The soil type at the experimental field was clayey in texture. Rice was fertilized with a uniform dose of 80 kg N + 40 kg P_2O_5 + 40 kg K_2O ha^{-1}. The N, P, and K were applied through urea (46% N), single superphosphate (16% P), and potash (60 % K), respectively.The nano solution was prepared by heating 1 liter of water up to 100ºC and letting it cool at normal temperature. The nano materials were applied by mixing 125 ml of nanomaterial with water. Upon cooling it was again mixed with 19 liters of lukewarm water. Seeds were soaked in the solution for about 3 hours.

The yield and yield-attributing characters such as number of panicles, number of grains per panicle, panicle length, test weight, grain yield, and straw yield were significantly higher in Sahbhagi dhan compared to CR dhan 205. A number of panicles per m^2, number of grains per panicle, panicle length, grain yield, and straw yield of rice differed significantly, whereas sterility percent, test weight, and harvest index did not differ significantly among the nutrient treatments. Highest grain yield and yield-attributing parameters such as number of panicles and number of grains per panicle were recorded in the treatment where nano solution for the promotion of root growth was applied but comparable with nano Fe and nano Zn treatments. Among the micronutrient-applied treatments, the highest number of panicles was registered in the nano iron oxide being at par with nano zinc oxide but significantly higher (13.5%) than the control treatment (Table 2.4). Sahbhagi dhan produced 11.15% higher grain yield over CR dhan 205. Significantly, the highest grain yield was noticed in the nano root growth promoter which was at par with nano zinc oxide as well as nano iron oxide. Nano zinc oxide and nano iron oxide treatments produced 8% and 3.5% more grain than zinc sulphate spray and iron sulphate spray, respectively. In terms of growth attributes, Sahbhagi dhan was found to have a higher crop growth rate (CGR) as well as relative growth rate (RGR) than its counterpart CR dhan 205 over the period of 60 days after seeding (DAS) which was not significant. The highest CGR and RGR were observed in nano iron oxide which was at par with nano zinc oxide but significantly higher at 45 DAS and 60 DAS, although its superiority over the control at 30 DAS could not be proven. From this experiment, it may be concluded that the application of nano materials of Fe and Zn, and root growth promoting material, can improve the vegetative growth of STRVs and higher grain yield can be achieved with the application of nano materials of growth promoters, zinc oxide, and iron oxide.

Table 2.4: Performance of rice varieties under different nano-materials

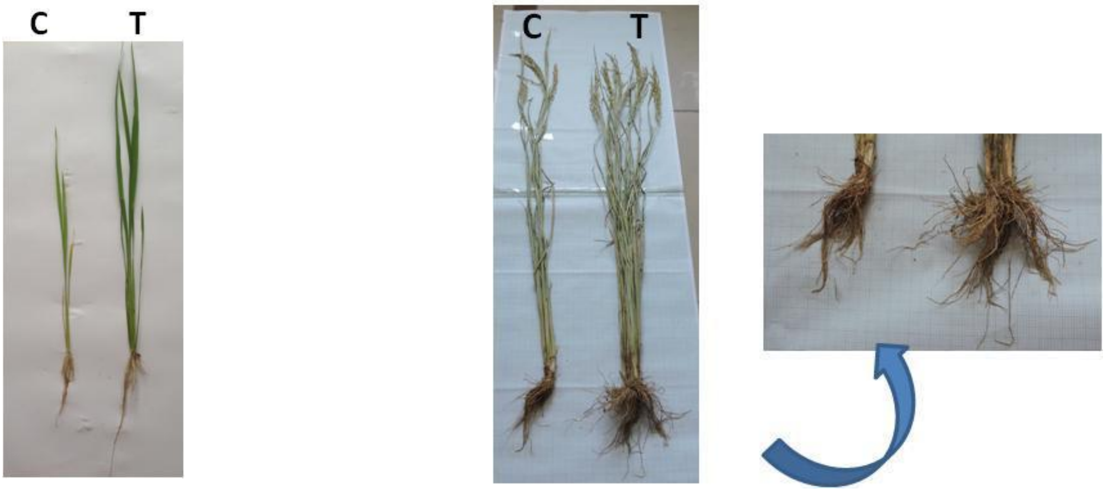
Treatments	No. of Panicle (m^2)	No. of grains $Panicle^{-1}$	Panicle length (cm)	Sterility (%)	Test Weight (gm)	Grain yield (ton/ha^{-1})	Straw yield (ton/ha^{-1})	Harvest Index
Varieties								
Sahbhagi dhan	286	141	22.99	12.11	23.96	5.78	7.85	0.42
CR Dhan 205	265	130	22.39	11.21	22.51	5.20	6.95	0.42
CD (P = 0.05)	20	8	0.16	NS	0.94	0.56	0.89	NS
Nano materials								
Control	246	127	19.93	13.05	22.29	5.15	6.11	0.43
Nano Zinc oxide	279	139	23.36	10.86	23.54	**5.67**	7.64	0.43
Nano Iron oxide	276	139	23.21	11.09	23.39	**5.63**	7.54	0.43
Nano Root growth promoter	307	141	23.76	12.11	23.48	**5.81**	8.61	0.40
$ZnSo_4$ spray	272	132	22.60	11.22	23.37	5.25	6.97	0.43
$FeSo_4$ spray	275	137	23.26	11.63	23.03	5.44	7.50	0.42
CD (P = 0.05)	17	9	1.15	NS	NS	0.44	0.61	NS

Experiment 2: Effect of nano-material, hydrogel, and bioagents on the performance of green gram: A field experiment was conducted at ICAR-NRRI, Cuttack in the dry season of 2017-18 to study the effect of nano solution, hydrogel, and *Trichoderma harzianum* on green gram in a rice-green gram cropping system. The experiment was laid out in a split plot design with two treatments in the main plots (irrigated and rainfed), two treatments in the subplot (green gram and black gram), and seven management treatments: (1) Farmers' practices (broadcasted without fertilizer application); (2) Improved practices (line sowing + seed treatment with Fungicide, Insecticide and Rhizobium [FIR] + recommended dose of fertilizers [RDF]); (3) Improved practices + hydrogel (2.5 kg/ha); (4) Improved practices + seed treatment with nano solution; (5) Improved practices + hydrogel + seed treatment with nano solution; (6) Improved practices + seed treatment with *Trichoderma*; (7) Improved practices + hydrogel + *Trichoderma* (seed treatment), and (8) Improved practices + nano solution + hydrogel + *Trichoderma* (seed treatment) in sub plots replicated twice. The Green gram variety IPM 02-03 and Black gram variety PU -2-43 were used in the experiment. A recommended fertilizer dose of 20: 40: 20 kg N: P_2O_5: K_2O/ha was applied in improved practice treatments. Under the improved practice, the seeds were treated with Carbendazim and Imidacloprid before seed treatment with the microbial treatments. The nano solution was applied by making the solution in warm water and soaking the seeds in warm water for 3 hours. Crop harvest and data and analysis are in process. The application of hydrogel, seed treatment with *Trichoderma* or nano solution alone with improved practice (line sowing + RDF + FIR treatment) had recorded significantly higher grain yield compared to farmers' practice during the previous year. The highest grain yield of 10.29 q/ha was achieved in the Green gram variety IPM 02-03 with improved production technology (line sowing + seed treatment with FIR + nano solution + RDF + hydrogel @ 2.5 kg/ha) which is significantly higher than the rest of the treatments and 29.4% higher compared to the Line sowing + Seed treatment with FIR + RDF treatment.

Experiment 3. **Modulation of the root architecture for climate-resilient and bio-fortified rice and pulses through different modes of applications of nano-zinc particles:** Zinc (Zn) deficiency is one of the most widespread micronutrient disorders in rice. It leads to Khaira disease of rice grown in calcareous soils which can be found in many parts of Odisha. Zn deficiency causes multiple symptoms that usually appear 2 to 3 weeks after transplanting. Among these symptoms are: leaves developing brown blotches and streaks that may fuse to cover older leaves entirely and plants remaining stunted and, in severe cases, may die, while those that recover will show a substantial delay in maturity and reduction in yield. To counter this problem, treating the seeds and seedlings through foliar spray with Zn nano-particles is being studied to find out the best practice to limit the disease and increase yield.

A field experiment was designed on the basis of random block design with a total of 84 blocks developed. All sets of experiments were done in three replicates with two genotypes. Seven sets of experiments were applied using three treatments (Seed priming (T1), Seedling (T2,) and Foliar (T3) alone, and in combination such as Seed priming + Seedling treatment (T4), Seed priming + Foliar spray (T5), Seedling treatment + Foliar spray (T6), Seed priming + Seedling treatment + Foliar spray (T7). Several indices were investigated during the experiment including rice root length, shoot length, chlorophyll a & b content, fresh weight, and dry weight.

The application of Zn nano-particles (ZnNPs) caused an increase in root and shoot length in rice (Fig. 2.10). Biomass (fresh weight and dry weight) of the rice plants was also significantly altered with different treatments of ZnNPs in comparison with the control. The varied response of ZnNPs was observed on grain yield and was differential with respect to genotype and mode of application. The PD-16 genotype showed the highest response of ZnNPs on grain yield (18%)with seed priming followed by seedling treatment mode while NDR-359 showed 16% in the case of seeds treated in priming mode. Interestingly, it was observed that the Zn-efficient genotype (PD-16) responds better with a combination of treatments while NDR-359 (zinc-inefficient) responded better with the individual treatment of ZnNPs such as seed priming and seedling treatment. However, non-significant or slight increase in grain yield was observed with foliar treatment of ZnNPs. The epigenetic alteration of root phenotype by ZnNPs will be interesting to note to elucidate the molecular basis of modulation of root architecture (Fig 2.11.) and to boost the effect of Zn accumulation in rice seeds through nano-technology intervention. Quality analysis for grain Zn content from harvested seed samples of both PD-16 and NDR-359 varieties is under process.



(A) **(B)**

Figure 2.10: Effect of ZnNPs on the rice plant: Modulation of root architecture in (A) 15 days, (B) 60 days of rice plants (PD-16 genotype). C: Control ; T: Treated with ZnNPs

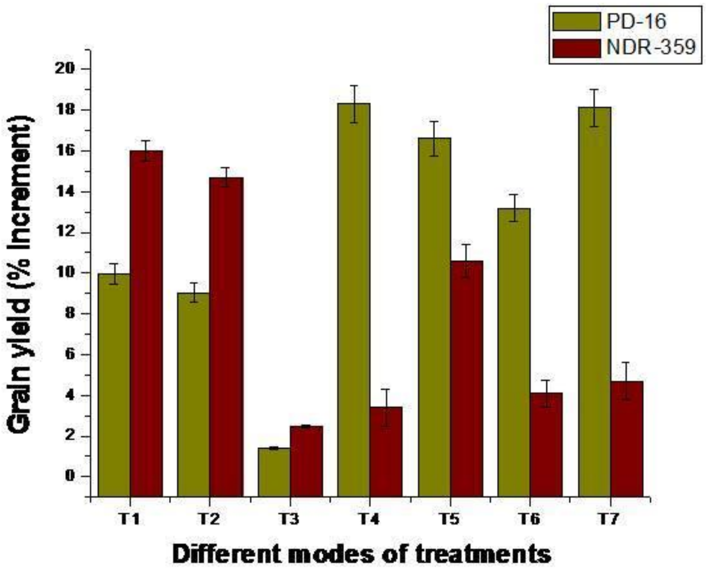


Figure 2.11: Percentage increment in grain yield of two different genotypes PD-16 and NDR-359 of rice after treatments with different modes of application of ZnNPs.

Mode of treatments: Seed priming (T1),Seedling treatment (T2), Foliar spray (T3), Seed priming+Seedling treatment (T4), Seed priming+Foliar spray (T5), Seedling treatment+Foliar spray (T6), seed priming+ Seedling treatment+Foliar spray (T7).

Demonstrations of pulses in the rice-fallow system and assessment of land use requirements: The demonstration of improved cultivation practices for Green gram and Black gram was undertaken in 22 districts in Odisha covering 2095 hectares (as listed in Table 2.5 & Fig. 2.12) and around 6020 farmers in 499 villages. Improved short-duration and disease-resistant varieties were introduced, e.g. IPM 02-3, IPM 02-14, Virat, and PDM-139 of green gram and PU 31, VBN-8, and Azad of black gram. Around 353 field days / farmers' interactions were carried out on regular intervals to impart necessary technological knowledge for better crop management (Table 5).

Table 2.5: IRRI-DOA pulse demonstration activity during Rabi season (2017-18) in rice-fallow cropping system in Odisha

District	Varieties	No. of blocks	No. of villages	No. of farmers	Demonstration area (in ha)	Field days / farmer interactions
			Green gram			
Angul	V_1& V_2	2	6	132	21.40	4
Balasore	V_1, V_2& V_4	4	11	272	87.40	11
Bargarh	V_1& V_2	2	6	35	17.50	3
Bhadrak	V_1& V_2	4	9	313	62.90	7
Bolangiri	V_1	1	2	37	10.40	2
Boudh	V_1	1	1	104	51.00	2
Cuttack	V_1& V_4	2	3	14	14.40	8
Dhenkanla	V_1& V_2	1	6	81	15.00	4
Jagatsinghpur	V_1, V_2& V_4	4	19	210	141.30	17
Jajpur	V_1& V_2	4	12	204	87.60	9
Kalahandi	V_1, V_2, V_3, V_4& V_6	5	35	215	135.50	9
Kendrapada	V_1, V_2& V_4	2	9	138	61.00	5
Keonjhar	V_1	1	2	30	8.00	2
Khordha	V_1, V_2, V_4& V_5	2	7	28	11.80	11
Koraput	V_1, V_2& V_4	8	50	927	325.00	18
Mayurbhanj	V_1, V_2, & V_5	8	40	302	91.60	11
Nabarangpur	V_1, V_2, V_4& V_6	4	20	564	64.40	14
Puri	V_1, V_2, V_4& V_5	3	10	112	30.80	20
Rayagada	V_1& V_2	2	12	121	76.00	9
Sambalpur	V_1& V_2	4	42	40	22.50	4
Subarnapur	V_1, V_2, V_4& V_6	3	8	205	85.60	6
Sundargarh	V_1& V_2	2	5	38	20.00	3
	Subtotal	**69**	**315**	**4122**	**1441.10**	**179**
			Black gram			
Angul	V_7	2	2	39	5.80	4
Balasore	V_7	3	4	105	20.00	13
Bargarh	V_7	2	2	10	6.25	4
Bhadrak	V_7	4	9	60	19.20	7
Bolangiri	V_7	1	2	10	10.40	2
Boudh	V_7	1	1	12	6.00	2
Cuttack	V_7	2	5	105	47.92	10
Dhenkanla	V_7	1	3	11	1.54	4
Gajapati	V_7	1	1		10.00	
Jagatsinghpur	V_7	4	24	215	98.60	16
Jajpur	V_7	2	7	72	24.80	9
Kalahandi	V_7& V_8	5	21	85	51.30	8
Kendrapada	V_7	2	12	169	64.00	7
Keonjhar	V_7	1	1	8	4.00	2
Khordha	V_7& V_9	1	3	42	20.80	8
Koraput	V_7& V_8	4	12	187	22.80	16
Mayurbhanj	V_7	8	30	136	35.30	15
Nabarangpur	V_7	4	14	321	59.40	10
Puri	V_7, V_8 & V_9	3	8	163	40.80	17
Rayagada	V_7	2	9	68	50.80	8

District	Varieties	No. of blocks	No. of villages	No. of farmers	Demonstration area (in ha)	Field days / farmer interactions
Green gram						
Sambalpur	V_7	2	3	8	4.10	3
Subarnapur	V_7	3	7	57	44.60	6
Sundargarh	V_7	2	4	15	5.00	3
Subtotal		**60**	**184**	**1898**	**653.41**	**174**
Total (Green gram + Black gram)		**129**	**499**	**6020**	**2094.51**	**353**
Green gram variety: V_1 = IPM 02-3 ,V_2 = IPM 02-14 ,V_3 = IPM 99-125 ,V_4 = PDM-139 ,V_5 = Virat ,V_6 = MH-421						
Black gram variety: V_7 = PU 31 ,V_8 = VBN-8 ,V_9 = Azad						

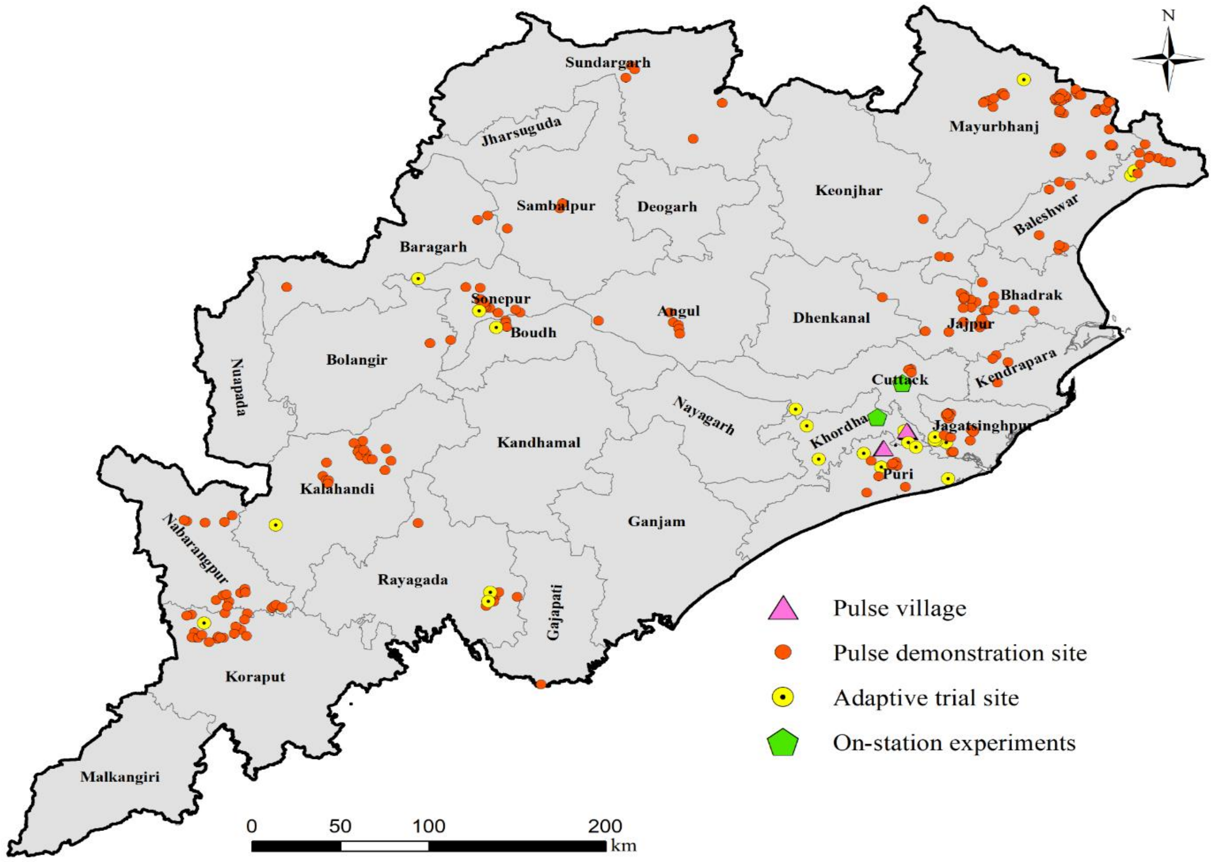


Figure 2.12: Distribution of pulse villages, demonstration sites, adaptive trial sites, and experiment stations in different rice-fallow dominated districts of Odisha

Summary and Conclusion

Nearly 1.6 million ha of rice fallows were detected during the year 2016-17, based on the analyses of spatio-temporal profiles of the satellite data for this period. High-resolution SAR data revealed that 1.43 and 1.04 lakh hectare of rice area were affected by flash floods in 2016 and 2017 respectively.Spatio-temporal profiles of soil moisture availability during the rabi season were also analysed to precisely estimate the short residual moisture window which gives opportunity to cultivate short-duration pulses in the rice fallow areas. Feasibility of growing green gram and black gram in rice fallows were demonstrated in about 2095 ha in 22 districts. Nano-materials of iron and zinc and a root growth promoting material not only improved the vegetative growth of drought tolerant varieties of rice but also improved the grain yield of green gram when combined with standard fertilizers compared to farmers' practice.

Subproject 3: Raising the productivity and profitability of rice-based cropping systems in Odisha through the Rice Crop Manager (RCM)

The RCM for Odisha (http://webapps.irri.org/in/od/rcm/) was adapted, developed, evaluated, and verified for use with personal computers and smart phones through collaboration between IRRI, Odisha University of Agriculture and Technology (OUAT) and, the National Rice Research Institute (NRRI) from 2012 to 2015 with support from the 'Cereal Systems Initiative for South Asia' project funded by the Bill & Melinda Gates Foundation. It is being further enhanced in collaboration with the Department of Agriculture and Farmers' empowerment (DAFE), OUAT, and NRRI to develop its capabilities as a tool for both irrigated and rainfed environments as well as its dissemination with personal computers and mobile phones in addressing the emerging needs of rice farming in Odisha. Research activities and socio-economic studies are undertaken to further strengthen the application and to monitor and evaluate its impact. In addition to research for further enhancing RCM, the project undertakes wide-scale dissemination to provide farmers with field-specific rice farming advice through printed recommendations and text messages.

Objectives: The specific objectives of this five-year project are

- To increase the profitability of rice farming though uninterrupted access to a climate-informed RCM service providing rice farming advice as printed guidelines and SMS to farmers;
- To train various stakeholders in using this ICT-based tool;
- To develop capabilities within the RCM for irrigated and rain-fed environments with in-season corrections;
- To identify the best fit dissemination model for the ICT-based RCM tool across different stakeholder groups; and
- To estimate the impact of the RCM tool on the productivity of rice-based system

Methodology

RCM project server is kept operational by a team based at the IRRI Headquarters that ensures that it remains available when farmers are interviewed and RCM recommendations are generated. The team based in Odisha works with DAFE and other partners to develop dissemination pathways to reach a large number of farmers and to support research for enhancing the capabilities of the RCM to cater to rainfed environments. This project, in partnership with DAFE and agro-service providers, is working to develop and sustain a cost-effective mobile messaging service based on SMS.

1.1 Dissemination of RCM recommendations to farmers

1.1.1 Setting up RCM Kendras

Photo 3.1: RCM Kendra and District DoA office are Equipped with laptop, printer, internet facility and reference materials for disseminating RCM recommendations

To date, 91 RCM kendras have been established at the offices of agriculture at district and block levels as well as NGOs in selected districts. These kendras are equipped with laptop units, printers, and data cards for internet facility (Photo 3.1). Trained staff of DAFE provide recommendation to the farmers visiting these kendras.

1.1.2 Training of trainers - AAOs, VAWs, and NGO partners during Kharif and Rabi seasons

IRRI organised 65 hands-on training sessions during Kharif 2017 (Table 3.1) and 29 during Rabi 2017-18 (Table 3.2) covering 1808 participants from 11 districts including field staff of the DoA and NGO partners. These training sessions were organised at district level for AAOs and at block level for VAWs and CRPs. The purpose of the training was to capacitate the participants on the use and operation of RCM and facilitate a more rapid dissemination and a wider reach of the RCM recommendations. The participants had to commit to provide at least 50 RCM recommendations per season per VAW, identify team members for RCM dissemination, and come up with an action plan. Photos 3.2 and 3.3 show various training sessions organized with NGO partners and DAFE.

Photo 3.2: Hands-on training on RCM with NGO

Photo 3.3: Hands-on training on RCM with DAFE

Table 3.1 RCM training sessions conducted during Kharif 2017

SN	Training	Date	No. of participants
1	Balasore (DDA office)	09-05-2017	23
2	Bhadrak (DDA office)	17-05-2017	22
3	Puri (DDA office)	19-05-2017	21
4	Puri Sadar, Puri	26-05-2017	11
5	Brahmagiri, Puri	26-05-2017	11
6	Krushnaprasad, Puri	26-05-2017	12
7	Nimapara, Puri	27-05-2017	11
8	Gop, Puri	27-05-2017	10
9	Astarang, Puri	27-05-2017	11
10	Kakatpur, Puri	27-05-2017	19
11	Satyabadi, Puri	27-05-2017	21
12	Pipili, Puri	28-05-2017	18
13	Delang, Puri	28-05-2017	16
14	Kanas, Puri	28-05-2017	23
15	Bargarh, Bheden	28-05-2017	11
16	Cuttack (DDA office)	02-06-2017	30
17	Barang, Cuttack	03-06-2017	11
18	Cuttack Sadar, Cuttack	03-06-2017	19
19	Cuttack, Block Nichnta Koili	07-06-2017	20
20	Salipur, Cuttack	07-06-2017	10
21	Mahanga, Cuttack	07-06-2017	13
22	Niali, Cuttack	09-06-2017	15
23	Kantapada, Cuttack	09-06-2017	11
24	Bahanga, Balasore,	26-05-2017	21
25	Soro, Balasore	26-05-2017	12

SN	Training	Date	No. of participants
26	Simulia, Balasore	01-06-2017	21
27	Khaira, Balasore	01-06-2017	11
28	Nilagiri, Balasore	03-06-2017	20
29	Oupada, Balasore	02-06-2017	11
30	Balasore Block (Balasore Sadar, Remuna)	05-06-2017	32
31	Balasore Block (Basta)	06-06-2017	21
32	Balasore Block (Jaleswar)	07-06-2017	12
33	Balasore Block (Bhograi, Baliapal)	08-06-2017	27
34	(Bhadrak sadar and Tihidi)	09-05-2017	22
35	Bhadrak Block (Dhamnagar)	19-05-2017	14
36	Sambalpur DDA Office	06-06-2017	16
37	Jujumara , sambalpur	02-06-2017	25
38	Maneswar, Sambalpur	02-06-2017	10
39	Sambalpur, Rengali	09-06-2017	13
40	Sambalpur, Jamankira	17-06-2017	14
41	Sambalpur, Kuchinda	17-06-2017	11
42	Sambalpur, Rairkhol	19-06-2017	10
43	Sambalpur, Naktidul	19-06-2017	15
44	Bargarh DDA Office	05-06-2017	15
45	Bargarh, Bargarh	01-06-2017	11
46	Bargarh, Attabira	03-06-2017	19
47	Sohella Bargarh	07-06-2017	29
48	Bijepur, Bargarh	07-06-2017	11
49	Gaisilet, Bargarh	06-06-2017	12
50	Bargarh, Bhatli	08-06-2017	13
51	Bargarh, Ambabhana	08-06-2017	9
52	Bargarh, Barpali	20-06-2017	19
53	Bargarh, Bheden	20-06-2017	16
54	Paikmal, Bargarh	21-06-2017	25
55	Padmapur, Bargarh	21-06-2017	17
56	Jharbandh, Bargarh	22-06-2107	12
57	Ganjam, DDA office	22-06-2017	9
58	Chikiti, Ganjam	01-07-2017	29
59	Patrapur, Ganjam	02-07-2017	9
60	SWAD, Puri	07-04-2017	9
61	LWSIT, Bhubaneswar	03-05-2017	19
62	DHAN foundation, Balasore	27-04-2017	23

SN	Training	Date	No. of participants
63	BSSS, Balasore	28-04-2017	29
64	NJS, Jajpur	19-04-2017	32
65	Harsha Trust, Koraput	19-04-2017	10
Total			**1084**

Table 3.2 Block-level RCM hands-on training sessions conducted during Rabi 2017-18

SN	Training	Date	No. of participants
1	Banki And Damapada, Cuttack	12-12-2017	26
2	Brahamgiri, Puri	13-12-2017	19
3	Pipili,Puri	17-01-2018	22
4	Nimapara, Puri	10-01-2018	14
5	Gop, Puri	02-02-2018	20
6	Satyabadi, Puri	22-11-2017	10
7	Bhubaneswar, Puri	05-12-2017	13
8	Jajpur, Puri	21-11-2017	14
9	IFFCO kisan office, Bhubaneswar	12-01-2018	4
10	Maneswar, Sambalpur	14-12-2017	35
11	Attabira and chakuli, Bargarh	15-12-2017	47
12	Dhankauda, Sambalpur	05-01-2018	27
13	Bhatli, Bargarh	05-01-2018	29
14	Bargarh	06-01-2018	35
15	Jujumara, Sambalpur	09-01-2018	16
16	Barapali, Bargarh	12-01-2018	43
17	Bheden, Bargarh	12-01-2018	45
18	Sadar, Balasore	27-12-2017	50
19	Tihidi, Bhadrak	28-12-2017	30
20	Bhograi, Balasore	06-01-2018	25
21	Basta, Balasore	09-01-2018	15
22	Jeleswar,Balasore	11-01-2018	36
23	Bonta, Bhadrak	12-01-2018	22
24	Remuna,Balasore	20-01-2018	30
25	BSSS NGO's staff at Balasore	19-12-2017	32
26	DHAN NGO's staff at Balasore	18-12-2017	25
27	SWAD NGO's staff at Puri	22-11-2017	10
28	NJS NGO's staff at Jajpur	21-11-2017	16
29	LWSIT NGO's staff at Puri	04-12-2017	14
Total			**724**

1.1.3 Provision of recommendations

Photo 3.4: *Farmers received printed RCM recommendation for Rice*

IRRI, working in collaboration with DAFE and private partners, disseminated RCM recommendations to farmers (Photo 3.4). During the reporting period, IRRI maintained the continuous operation of RCM. The information collected and transmitted by RCM to farmers were captured in a database. 49035 recommendations provided to farmers during Kharif 2017 and 15918 during Rabi 2018 across the 11 districts (Figs 3.1 and 3.2).

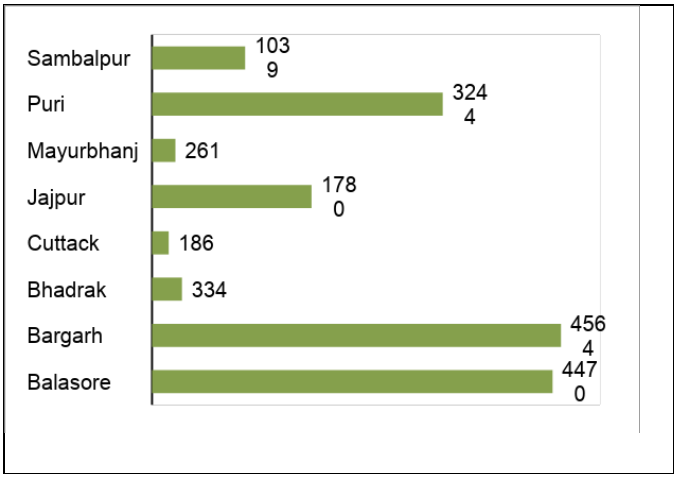


Figure 3.1: Number of printed RCM recommendations provided to farmers during Kharif 2017

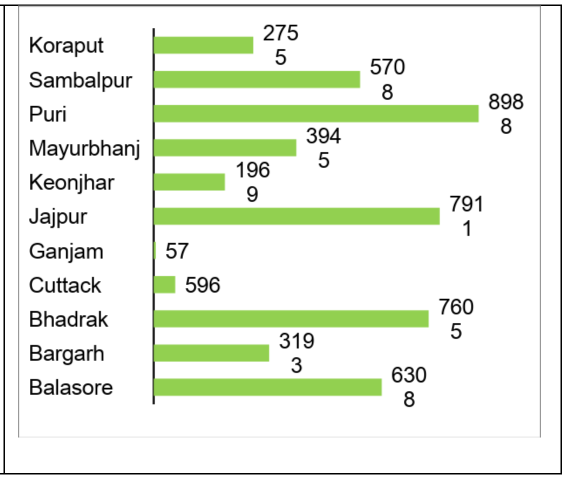


Figure 3.2: Number of printed RCM recommendations provided to farmers during Rabi 2018

Awareness generation through different communication channels

1. **Awareness generation among farmers through meetings:** Several meetings were conducted throughout the season to generate awareness among farmers on nutrient and crop management. They were motivated to use the RCM recommendations provided to them so that they themselves can judge the effect of these recommendations. (Photo 3.5)

(a) Puri

(b) Jajpur

Photo 3.5: Farmers' meetings to create awareness for RCM

2. **SMS and voice calls on crop management and fertilizer recommendations sent to registered farmers throughout the season**: Crop advisories were sent to around 6000 farmers during Kharif 2017 through SMS and voice calls in collaboration with IFFCO-K and Precision Agriculture Development (PAD) (Photo 3.6).

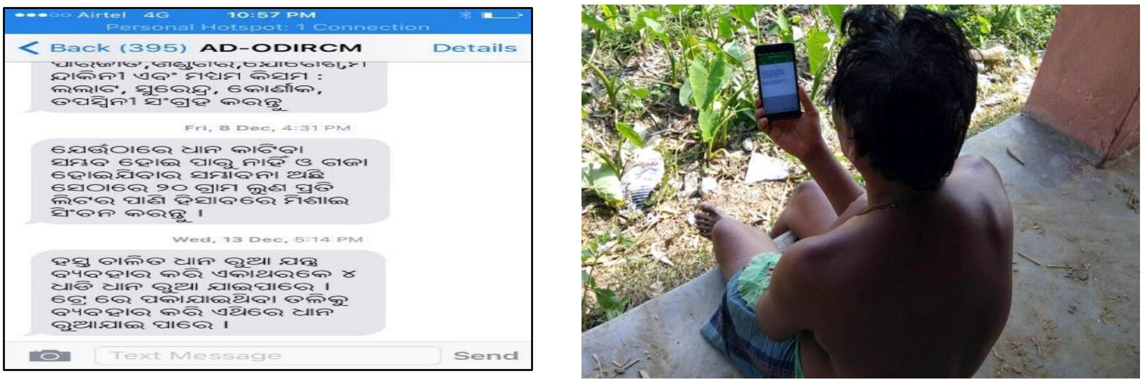


Photo 3.6: SMS and voice call on RCM to registered farmers

3. **Fields days were conducted in the presence of DAFE officials and farmers:** Field days were conducted at selected districts to compare the effect of RCM recommendations versus famers' practice. During these field days, farmers could reflect on and discuss the effect of following RCM recommendations through crop cut results. The cost-benefit ratio for fertilizer application through RCM recommendations was also discussed to them (Photo 3.7).

(a) Cuttack *(b) Puri*

Photo 3 7: Field day on RCM in presence of DAFE officials and farmers

4. **Agriculture fairs:** IRRI set up exhibition stalls at important events organized by NRRI (International Symposium, 6-8 February 2018), DAFE (State-level farmers' fair–Krishi Odisha, 9-12 April 2017 and 6-9 March 2018), ICAR-Central Institute for Women in Agriculture (CIWA) (5 March 2018), and NGO partners (BSSS, 27 December 2017). RCM kiosks were set up and recommendations were provided to farmers visiting the stalls (Photo 3.8).

Photo 3.8: Creating awareness through agriculture fairs

5. **Dissemination of RCM through dealers:** A pilot has been started during Rabi 2017-18 with IFFCO dealers to explore the potential of including agri-input dealers as channels for RCM dissemination. Hands-on training was provided to selected dealers at IFFCO State office, Bhubaneswar. The dealers provide RCM recommendations to farmers who come to their shop to buy agri-inputs. To date, around 3500 farmers have received recommendations from agri-input dealers as well as crop advisories through SMSs and voice calls (Photo 3.9).

(a) RCM training at IFFCO KISAN

(B) Dealer shop

Photo 3.9: Dissemination of RCM through dealers

1.1.4 Monitoring the use of recommendations and evaluation of RCM (Comparison of RCM vs. Farmers' method)

Recommendations were given to farmers through DAFE and private partners who also monitored 10% of the total fields to assess whether these disseminated recommendations are used. IRRI provided procedural support to DAFE and private partners for the monitoring of farmers' fields and also monitored some of the fields to monitor whether farmers could follow the recommendations as per RCM guideline. 370 fields were monitored during Kharif 2017 covering 69.12 hectares and 280 fields during Rabi 2018 (under progress). Among the RCM monitored fields, 66 crop cuts were undertaken in the presence of farmers or government officials. To showcase the RCM effects, crop cuts were also carried out in the nearby farmer's field with the same variety for which farmers had followed their own practice.

Key findings from the monitored plots

- Farmers applied excessive amounts of phosphorus and potassium as compared to the recommendations from the RCM;
- Across all locations, 26.05% yield gain was recorded with RCM (4.79 t/ha) than the farmers' field practice (3.80 t/ha) (Figure 3.3)

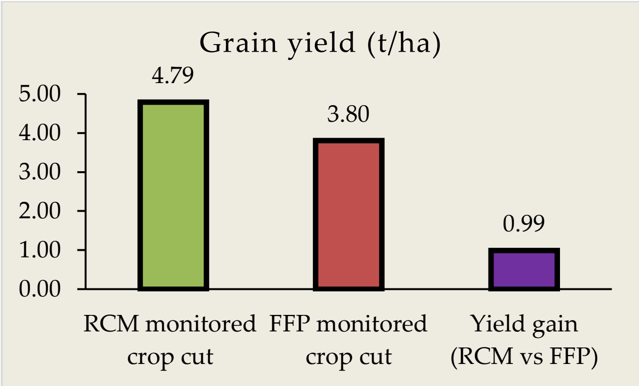


Figure 3.3: Represents data on RCM monitored crop cut

Field days were also organised at some of these crop cuts in which government officials from respective blocks participated. They apprised farmers of the benefits of balanced crop nutrition (Photo 3.10 and 3.11).

Photo 3.10: Field day at Balasore

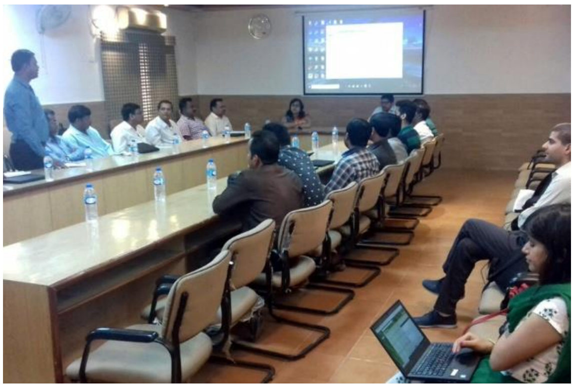
Photo 3.11: Field day at Sambalpur

1.2 Identifying and developing dissemination and scaling pathways for ICT-based RCM and estimating its impact on rice productivity and cost management

The study aims to appreciate, evaluate, and develop the best dissemination pathways for RCM along with studying the nutrient adoption behaviour of farmers. Its consequent impact on rice production planned (n=2200) in the previous year was taken up during the reported period. A training for the enumerators along with a pilot survey for the same were organised in September 2017.

The survey has started during the last week of March after a short refresher training and pilot survey. The protocol and questionnaire for baseline data collection were finalised in March 2018. Hitherto, around 650 interviews have been completed. Monitoring visits are being made at regular intervals to the various blocks in five sample districts chosen under the survey.

A fertilizer nutrient profiling survey, aimed to capture the general fertiliser use pattern at a macro level, is also ongoing at village level in association with field days and crop cut experiments (Photo 3.12).



(a) Training at Bhubaneswar

(b) Pilot testing at Puri)

Photo 3.12: Enumerators' training for the socio-economic survey

2. Strategic and adaptive research and development for better nutrient and crop management

The following experiments have been initiated for developing and evaluating better nutrient and crop management. The results from these experiments will be used to develop decision trees for better rainfed environments.

Table 3.4: Activities under strategic and adaptive research and development

No	Activity	Targets			Achievements	Kharif 2017 and Rabi 2018
		Number	Districts	Blocks		
1	Productivity and resource use efficiency of rice-rice system under different establishment methods.	1	1	1	1	IRRI-OUAT experimental station
	Optimization of nutrient management for rice-based cropping system	1	1	1	1	
	Optimising fertilizer application rates and timing for rainfed rice	1	1	1	1	
	Evaluation of crop management component of RCM (weed management)	16	3	8	16 (Kharif) + 15 (Rabi) + 1 (on station)	IRRI-NRRI Total: 32 trials
	Development, validation and evaluation of RF component of CMRS	70	10	20	61 (Kharif) + 56 (Rabi)	Total: 117 trials (along with Sub component 1)
	Adaptive trials on using GIS based yield monitoring for developing better yield targets	30	2		19 (Kharif) + 10 (Rabi)	Total: 29 Trials (alongwith Sub component 5)
	Development of better zinc management for rice-based systems for Odisha				60 farmers (Rabi)	Total: 60 farmers (under progress)
2	Development of better nutrient management module for rice pulse systems for Odisha				18 trials (Rabi)	Total: 18 Trials (along with Sub component 2) (under progress)

Findings recorded during Kharif 2017 and Rabi 2018 from the trials

2.1 IRRI-OUAT collaborative project: Three experiments were conducted on-station and the crop was harvested while data collection, compilation, and analysis were done. For Rabi 2018, the crop has been established in the trials (Photo 3.13).

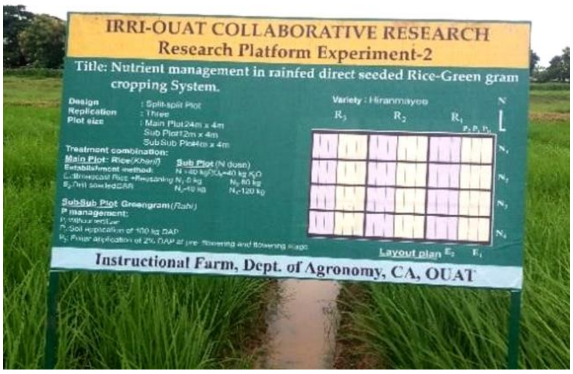


Photo 3.13: IRRI-OUAT collaborative experiments

2.2 IRRI-NRRI collaborative project: Sixteen on-farm trials were conducted in three districts during Kharif 2017 to evaluate the crop management component of RCM (Weed Management). The crop cut was done as well as data collection, compilation, and analysis. For Rabi 2018, the crop has been established in the trials (Photo 3.14).

Photo 3.14: IRRI-NRRI collaborative experiments

2.3 Adaptive trial experiment: Development, validation, and evaluation of RF component of CMRS

The study was implemented in farmers' fields in different blocks across the 11 districts of Odisha to test the effectiveness of RCM guidelines provided to farmers in rain-fed environments with the use of more suitable STRVs, remote sensing, crop modelling, and weather data for in-season adjustment of real-time nutrient management and better decision-making process (Photo 3.15).

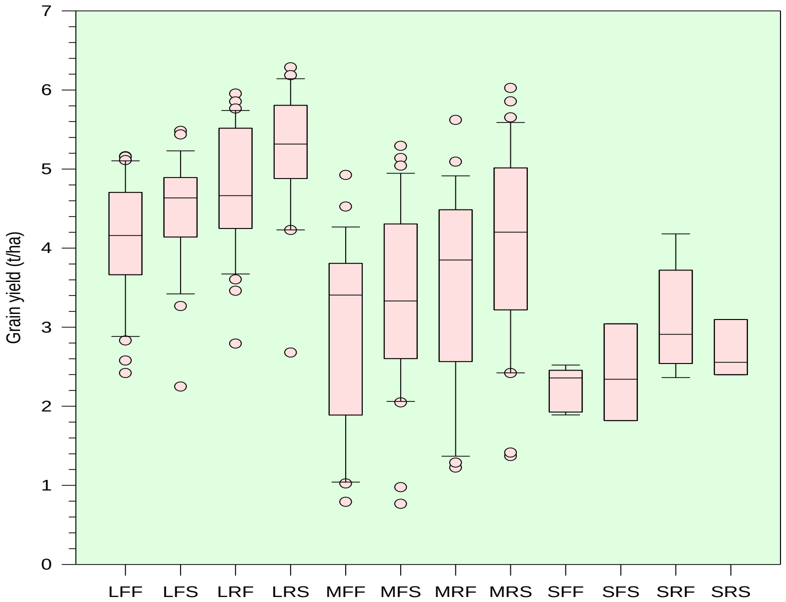
Photo 3.15: Head-to-head trials between farmers' field practice and RCM using farmers' variety and site-suited STRVs across 11 districts

Results

- IRRI practice over farmers' practice was 1.18t/ha which was approximately 36.0%. The yield gain of RCM over farmers' practice was 0.73 ton/ha with farmers' variety and 0.77 ton/ha with site-suitable STRV (Table 3.5);
- IRRI practice over farmers' practice was recorded across the 11 districts (Fig. 3.4). Over the farmers' practice, the IRRI practice had shown higher grain yield in all crop durations (Fig. 3.5). RCM recommendation had shown higher grain yield in all rice varieties (both local and STRV) over the farmers' practice (Fig. 3.6);
- There was fertilizer use savings (phosphorus and potassium nutrients) were noted, which ultimately enhanced soil health by balancing fertilizer applications (Fig. 3.7);
- Zinc application in rice fields was promoted to control micronutrient deficiency in rice

Table 3.5: Grain yield (ton/ha) using the Rice Crop Manager over farmers' fertilizer practice using farmers' variety and stress-tolerant variety

<table>
<tr><th rowspan="2">Treatments</th><th>Grain yield</th><th>Grain Yield difference of RCM over FFP</th><th>Grain Yield difference of IRRI practice over Farmer practice</th></tr>
<tr><th colspan="3">(ton/ha)</th></tr>
<tr><td>FFP + Farmer variety</td><td>3.30</td><td rowspan="2">0.73</td><td rowspan="4">1.18</td></tr>
<tr><td>RCM + Farmer variety</td><td>4.02</td></tr>
<tr><td>FFP + Stress tolerant variety</td><td>3.71</td><td rowspan="2">0.77</td></tr>
<tr><td>RCM + Stress tolerant variety</td><td>4.48</td></tr>
</table>



Where,
LFF=Long duration+FFP+Farmer variety,
LFS=Long duration+FFP+STRVs,
LRF=Long duration+RCM+Farmer variety,
LRS=Long duration+RCM+STRvs,
MFF=Medium duration+FFP+Farmer variety,
MFS=Medium duration+FFP+STRVs,
MRF=Medium duration+RCM+Farmer variety,
MRS=Medium duration+RCM+STRvs,
SFF=Short duration+FFP+Farmer variety,
SFS=Short duration+FFP+STRVs,
SRF=Short duration+RCM+Farmer variety,
SRS=Short duration+RCM+STRvs

Figure 3.4: FFP vs RCM using farmers' variety and site-suited stress-tolerant variety across 11 districts in Odisha

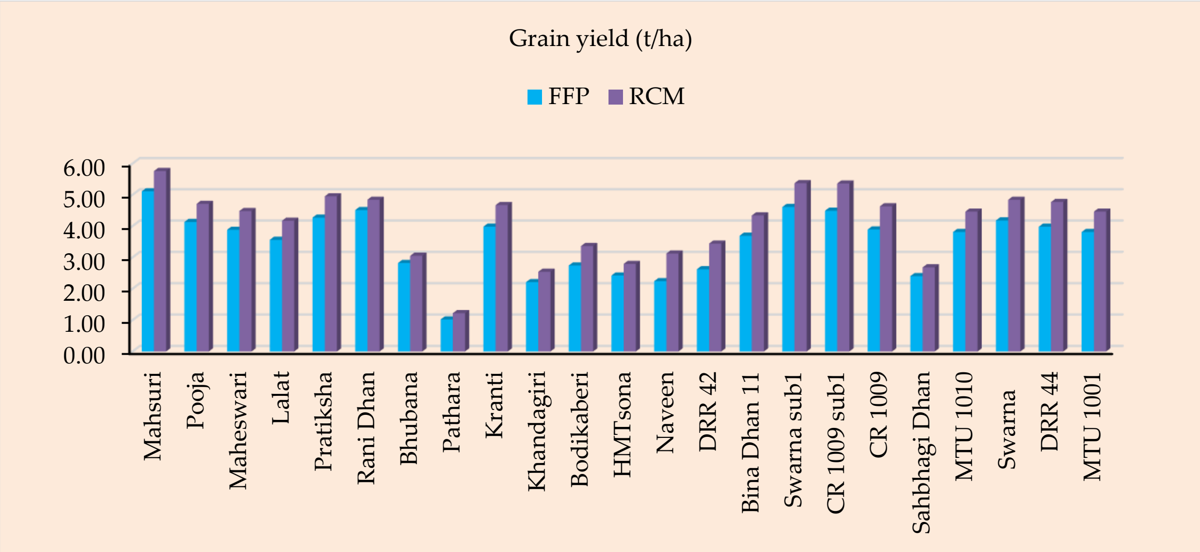


Figure 3.5: FFP vs RCM using farmers' variety and site-suited stress-tolerant variety across 11 districts in Odisha in relation to crop duration

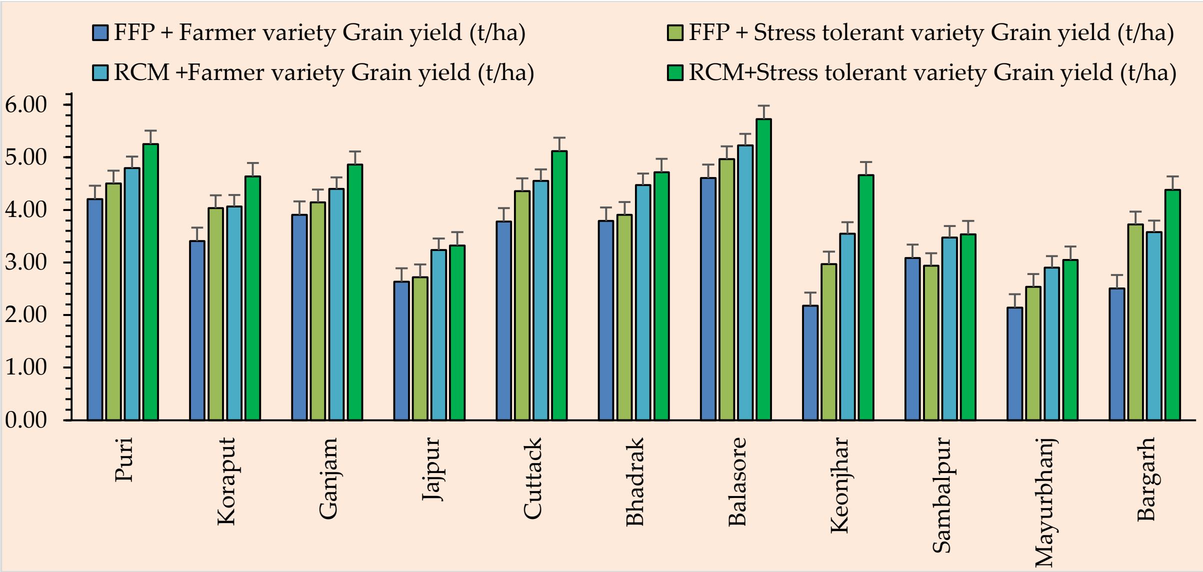


Figure 3.6: FFP vs RCM using farmers' variety and site-suited stress-tolerant variety across 11 districts in Odisha in relation to crop variety

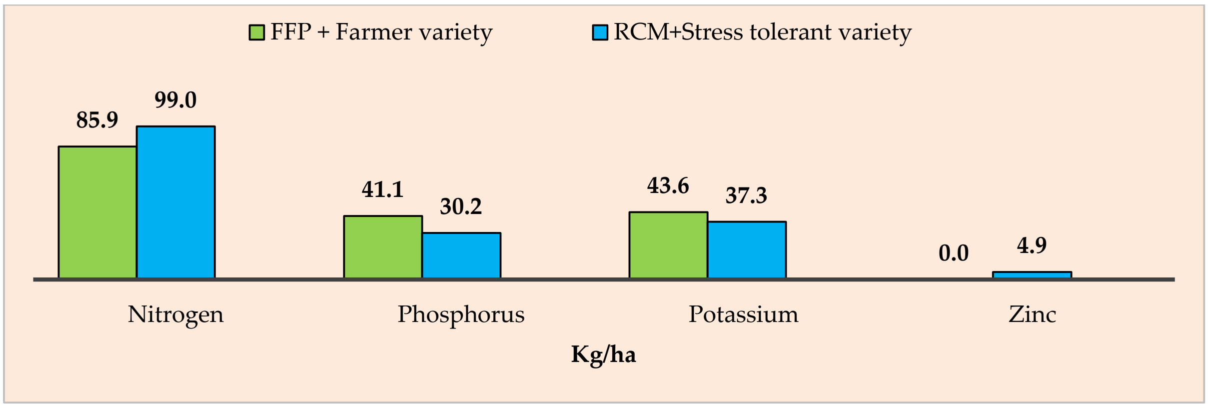


Figure 3.7: Nutrients applied in farmer practice and RCM with site-suited stress-tolerant variety

2.4 Adaptive trials on using GIS-based yield monitoring for developing better yield target

Currently, the target yield in the RCM app is set based on the questions with farmer and adjusted based on the obtained yield from the previous year. The GIS tool uses conditions and environment prevailing in the area to estimate the yield.

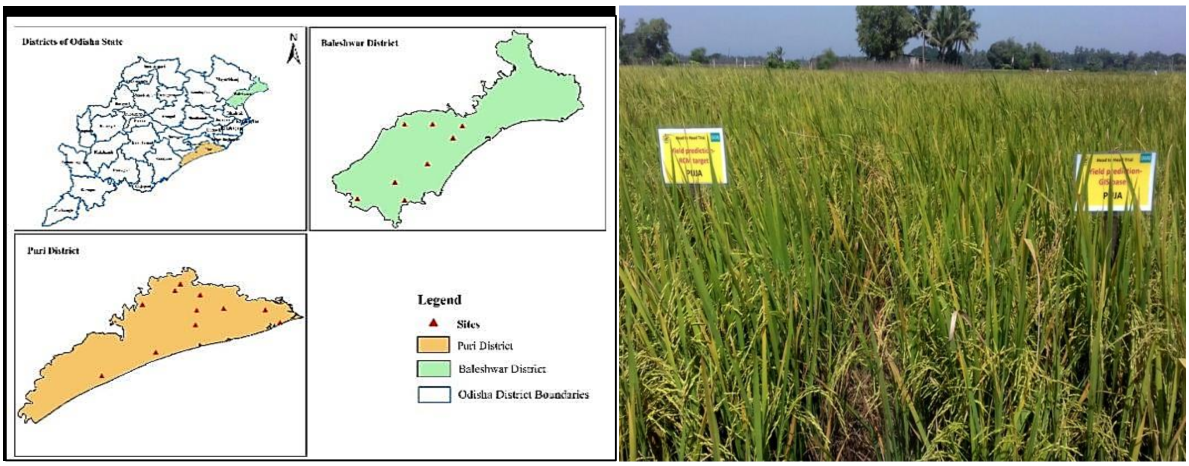


Photo 3.16: Experimental site and head to head RCM based target yield vs GIS based target yield

Table 3.6: Target yield and actual crop cut yield using GIS-based and RCM-based approaches

	Target yield		Actual crop cut yield (ton/ha)		Yield difference between Actual crop cut yield and Target yield	
	GIS Based	RCM based	GIS based	RCM based	GIS based	RCM Based
Minimum	3.00	4.50	4.00	3.82		
Maximum	5.50	5.70	7.28	7.20		
Mean	4.33	5.05	4.98	4.79	0.65	-0.26
Standard error	0.19	0.06	0.19	0.21		
RSQ	0.07	0.42				
RMSE(t/ha)	1.17	0.78				
NRMSE (%)	25.69	13.27				
Agreement	74.3	86.7				

- The average target yield set using the GIS-based approach was 4.33 ton/ha across 19 locations and the actual crop cut yield obtained was 4.98 ton/ha, whereas the average target yield set using the RCM-based approach was 5.05 ton/ha and the actual crop cut yield obtained was 4.79 ton/ha (Table 3.6);
- The study demonstrated that setting the target yield using a GIS tool was found to be approximately 74.3% in agreement with actual crop cut yield while setting the target yield using the RCM-based approach was 86.7% in agreement with the actual crop cut yield (Table 3.6);
- Further study at a broader level can positively help enhance the use of the GIS tool for estimating target yield for site-specific nutrient management in the app

Summary and Conclusion: During the reporting period from Kharif 2017 and Rabi 2018 seasons, IRRI was able to

- Set up 91 RCM Kendras;
- Organise 94 hands-on training sessions at block level for field staffs. A total of 1798 participants from 11 districts were oriented on the operation and use of RCM and on troubleshooting problems with the app;
- Maintain the operation of RCM (http://webapps.irri.org/in/od/rcm/), which enabled 64,953 printed RCM recommendations to be generated for farmers in the 11 districts;
- Maintain a database of information collected from farmer interviews which was also provided to farmers through RCM;
- Send out crop advisories to around 6000 farmers through SMS and voice calls during Kharif 2017 in collaboration with IFFCO-K and PAD;
- Monitor 'sample farmers' on the benefits of RCM adoption through follow ups and crop cuts. A total of 370 farmers were monitored during Kharif 2017 and 280 during Rabi 2018 (under progress) by technical staff of IRRI. Among all the monitored, 66 crop cuts were done in the presence of farmers or government officials;
- Organize field days in RCM plots which were attended by government officials to showcase the outcome and benefits of RCM in farmers' fields;

- Start the conduct of a socio-economic survey; stakeholders have been identified; and
- Carry out strategic and adaptive research in collaboration with DAFE, NRRI, and OUAT to develop capabilities within RCM for irrigated and rain-fed environments

Synergies with other sub-projects

- "Development, validation, and evaluation of RF component of CMRS" is being undertaken in association with subproject 1. Head-to-head trials under RCM were established jointly and the suitable stress-tolerant variety was made available to farmers;
- "Adaptive trials on using GIS-based yield monitoring for developing better yield target" is being done in association with subproject 5a (GIS component). The team provides the GIS-based yield data for establishing the trials;
- "Development of better nutrient management module for rice pulse systems for Odisha" has started during this Rabi season in association with subproject 2. Pulse seeds are being provided for establishing trials; and
- Hands-on training on RCM was conducted for the participants of the Season-Long Training (SLT) programme under subproject 4. Participants were made aware about the comparable benefits of using RCM for crop management through demonstration plots

Subproject 4: Inclusive development through knowledge, innovative extension methods, networks, and capacity building in Odisha

1. Rice Knowledge Bank

To bridge the gap between research and practice in rice production, IRRI developed the Rice Knowledge Bank (RKB)—a digital extension service that provides practical knowledge solutions designed for small-scale farmers in developing countries. The RKB is primarily based on IRRI's research, which is translated into a guide of best management practices, decision tools, and other information materials (e.g., videos, fact sheets, e-learning, etc.). The RKB showcases rice production techniques, agricultural technologies, and best farming practices based on IRRI's pool of knowledge from research findings, learning and media resources, and in-country projects. It serves to facilitate easy access to information and highlight the step-by-step production stages from pre-planting to post-production management, decision tools, and agronomy, including disease and pest management guides to help people make informed farming decisions. The RKB aims to address the challenges of ensuring fast and effective transfer of technologies from the research laboratory to farmers' fields.

One major factor impeding the use of the RKB by countries and states has been its unavailability in local languages with localized content in a ready-to-use and downloadable format. Another major problem that extension intermediaries face is the unavailability of a credible, ready-to-use, and offline content source that they could use for their recommendations and that they could also distribute. The RKB initiative for Odisha aims to plug this gap by providing ready-to-use district-level content available in different formats (factsheets, training manuals, and videos) in Oriya. Content will be developed in collaboration with OUAT and NRRI, the state agriculture department, KVKs, and experts available in the region, and will follow the standard operating procedures available at IRRI for the development of a knowledge bank.

Deliverables: This subcomponent of the project will

- Produce a rice knowledge bank for the state of Odisha in Oriya with ready-to-use content in line with the IRRI RKB in collaboration with the OUAT/NRRI;
- Make the RKB available on the web and as a mobile application with offline capabilities;
- Make science-based knowledge and information available across the state. The work through the knowledge bank will also aim to:
    - Ensure that district-specific, standardized rice-based technological knowledge is available in accessible formats and as a one-stop source of information for the extension intermediaries and farmers
    - Extend the capacity of extension intermediaries to use the knowledge bank

Standard Operating Procedure

These are step-by-step instructions that act as guidelines for development processes to produce a product that is consistent and predictable across ecosystems. The defined process for the development of the Odisha RKB has been written up into a standard operating booklet available at
https://drive.google.com/file/d/1m7pJb6h6cJx21CJX9QSpbzjAfp3Okfgs/view?usp=sharing

Status of content development: Videos details are given below:

SN	Stress Type	Crop Establishment Type	Segments in this video	Estimated Length	Current Status
1	Submergence-tolerant rice video	Transplanted	Crop Planning / Variety Selection	7-10 min	Shooting complete, final editing in progress
			Land Preparation	7-10 min	Shooting complete, final editing in progress
			Seed Treatment	7-10 min	Shooting complete, final editing in progress
			Nursery Establishment	7-10 min	Shooting complete, final editing in progress
			Transplanting	7-10 min	Shooting complete, final editing in progress
			POE Herbicide / Top dressing (tillering & P.I.) / Submergence	7-10 min	Shooting complete, final editing in progress
			Weed / Pest Management	7-10 min	Shooting pending
			Harvest	7-10 min	Shooting pending
2	Submergence-tolerant rice video	Direct Seeded Rice	Crop Planning / Variety Selection	7-10 min	Shooting complete, final editing in progress
			Land Selection	7-10 min	Shooting complete, final editing in progress
			Seed Treatment	7-10 min	Shooting complete, final editing in progress
			DSR	7-10 min	Shooting complete, final editing in progress
			PE herbicide / POE herbicide	7-10 min	Shooting complete, final editing in progress
			Top dressing (tillering & P.I.) / Submergence	7-10 min	Shooting complete, final editing in progress
			Weed / Pest Management	7-10 min	Shooting pending
			Harvest	7-10 min	Shooting pending
3	Drought-tolerant rice video	Transplanted	Seed Treatment	7-10 min	Shooting complete, final editing in progress
			Nursery Establishment	7-10 min	Shooting complete, final editing in progress

Continue ...

			Transplanting	7-10 min	Shooting complete, final editing in progress
			POE Herbicide	7-10 min	Shooting complete, final editing in progress
			Top dressing (tillering & P.I.)	7-10 min	Shooting complete, final editing in progress
			Harvest	7-10 min	Shooting pending
4	Drought tolerant rice video	Direct Seeded Rice	Seed Treatment	7-10 min	Shooting complete, final editing in progress
			DSR	7-10 min	Shooting complete, final editing in progress
			PE herbicide	7-10 min	Shooting complete, final editing in progress
			POE herbicide	7-10 min	Shooting complete, final editing in progress
			Top dressing (tillering & P.I.)	7-10 min	Shooting complete, final editing in progress
			Harvest	7-10 min	Shooting pending
5	Breeder seed production using panicle to row method			12 min	Completed https://drive.google.com/file/d/1GMBLDlRuykZaXyzZ7cWLDM7AdG4NS5Kp/view?usp=sharing
6	Farmer testimonials			1 min	100 completed

2. Rice Doctor for the state of Odisha

The Rice Doctor is a mid season diagnostic tool that can provide agriculture extension workers (public and private) and farmers accurate and timely diagnosis of more than 80 crop nutrition problems, pest infestations, and disease infections. It allows the identification of such problems and provides recommendations to address these. It can also be used by students, private input dealers, and others who help in bridging the information gap between research and farmers.

Assessment of the efficiency and accuracy of the Rice Doctor mobile application for Odisha

- The Rice Doctor was modified specifically for Odisha conditions;
- The content requirement of Rice Doctor was finalized;
- The English version of Rice Doctor Odisha has been developed on Lucid platform and pre-testing will be done during Kharif 2018 with 250 respondents including extension workers and students; and

- The translation of Rice Doctor from English to Odia language and its beta version as a mobile application will be available during Kharif 2018

Figure 4. 1: IPM Survey

2.1 Integrated Pest Management (IPM) solutions for Odisha

The basic premise of IPM is that no single pest control method can be successful over a long period of time. A mixture of biological, physical, and chemical methods must be integrated into a strategy designed to provide durable and sustainable systems of pest management. IPM combines resistant cultivars, agronomic practices known to reduce losses from pest infestations, and conservation practices that preserve and increase natural enemies. Pesticides are applied only when necessary and economically efficient and only pesticides that have a low risk to human health and to the environment are used. Decisions on whether to apply pesticides are based on criteria that identify when and where chemical control is truly justified. For long-term pest management success, strategies to control multiple pests must be integrated into the crop production systems.

Researching, developing, and implementing effective and sustainable IPM strategies require the cooperation of specialists from several disciplines and the active participation of extension services, NGOs, and farmers. With appropriate institutional support, farmers can be equipped with IPM concepts. Combined with their indigenous knowledge, they will be able to develop their own best mix of pest control techniques.

Figure 4.2: IPM awareness workshop, Koraput

Rice Integrated Pest / Disease Management (IPDM) Practices in Odisha, India: A Baseline Survey

Crop protection problems for the state were prioritized and lacunae identified for IPDM modules. Kharif and Rabi 2017 implementation plan for IPDM was finalized and 20 districts of Odisha were selected for the survey. IPDM questionnaire was developed in English and translated into Odia language. After training of enumerators and pre-testing of IPDM questionnaire in January 2018, data was collected through a structured questionnaire (Computer-assisted personal Interview CAPI-ODK based). 3000 farmer-respondents participated in the survey and shared their experience about pests and diseases during Kharif and Rabi of previous seasons and the analysis of results is underway.

Rice Integrated Pest / Disease Management (IPDM) studies and module testing

The IPDM modules were tested at five locations in Koraput region during Kharif 2017 (IIRR) and the results are being analysed. During Rabi 2017, the IPM modules were tested in four districts (OUAT) (Puri, Khurdha, Dhenkanal, Jagatsinghpur) and trials are now underway.

Awareness Workshop on Integrated pest and nutrient management

An awareness workshop was conducted on "Integrated Pest and Nutrient Management" at M S Swaminathan Research Foundation (MSSRF), Koraput on 9 January 2018. 29 officials from DoA including DDA, ADR, AAO, SMS, and VAWs from different districts of Koraput, Nawrangpur, Kalahandi, Raygada, and Malkangiri participated in the workshop. Nearly 40 farmers attended the workshop and shared their experiences about pests and diseases.

3. Innovations in extension – RiceCheck

RiceCheck encourages farmers to manage their rice crop by comparing their practices with the recommended practices for producing the highest yield. It involves crop monitoring, measuring crop performance, and analysing results. Observing, measuring, recording, comparing, and adopting best practices are the learning steps involved in identifying the strengths and weaknesses of their management. As a result, the farmers get to observe the effect of one improved management practice on the crop and also observe the effect of various management practices in a cluster. It also allows users to have statistically analysable data to study the effect of management practices. During the first part of the year, the methodology for RiceCheck was critically reviewed. Based on the internal deliberations and experiences from previous years and geographies, the methodology was modified and a new set of guidelines was issued to OUAT for the implementation of the program.

Modifications to the RiceCheck program

- In each village, one facilitator is to be identified, earlier named as RiceCheck Volunteer, who should preferably be the *Krushak Sathi* so that the state DoA is directly involved and acquainted for future scaling up;
- A group of 20 farmers are to be selected for each village for focus group discussion (FGD), involving women farmers as and where possible;
- Focus group discussions (FGDs) may be carried out to identify the best management practices in an area. KVK and DoA should also be involved in the FGDs;
- Once management practices are decided (max of 8-10 per group), each farmer will choose one management practice and test it on his/her land as head-to-head trial, following the standard methodology. The rest of the management practices are as per farmer;
- Best practices are to be decided in the focus group consulting the farmers' implementable/adaptable practice and only one practice is to be tested in the head-to-head trial with another farmer;
- Data from the head-to-head trials are recorded systematically following a designed format;
- Farmers are taught to record the data themselves;
- Regular capacity building programmes for the facilitators may be conducted to ensure the effective implementation of the project;
- The group should meet three times in a season to discuss progress. Proposed ideal times for the meetings are during establishment, panicle initiation, and harvest; and
- Crop cuts are conducted by the end of season to estimate yields

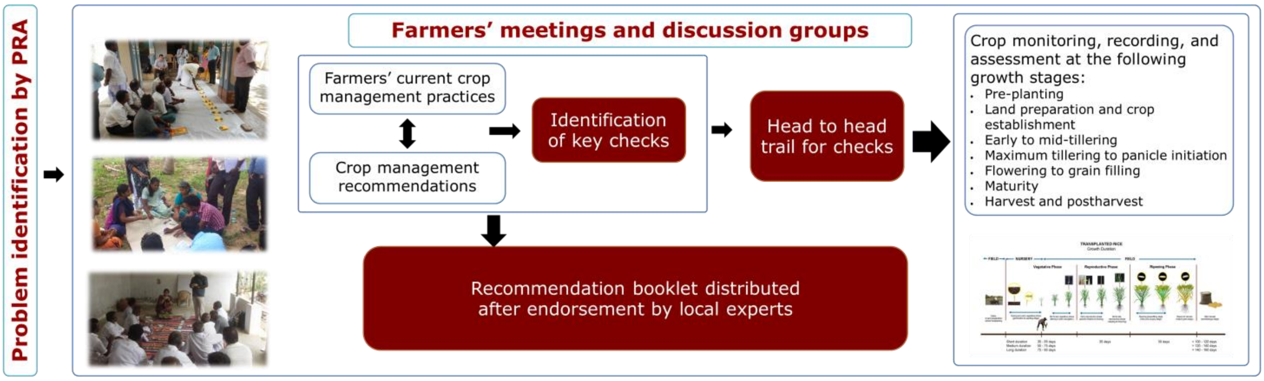


Figure 4.3: Modified RiceCheck methodology

Figure 4.4 Meeting with Krushak Sathis in Jaleshwar

RiceCheck during Rabi 2017 is being implemented in the districts of Puri, Balasore, and Sambalpur in 30 villages and with 30 Krushak Sathis.

Season-long training (SLT) program

The SLT format has been developed to improve the hands-on technical and practical skills of the extension intermediaries. The format includes the training being delivered across critical crop stages in a crop calendar, with the participants growing their own crop and practicing their skills. 25 VAWs and 15 Krushak Sathis from 5 blocks of the Puri district are being trained on advanced management practices for Rabi rice. The SLT for Kharif 2017 was implemented in the Badasahi and Rasgobindpur blocks of Mayurbhanj district in collaboration with the Baleshwar Social Services Society. 20 villages from each block were selected on the basis of the interest shown by the target groups for the implementation of the project. 340 women farmers have participated in the training.

Training Module Details	Training interval Days	Badshahi	Rasgobindpur
Day 1 Morphology of Rice crop Growth Stages Nursery and management Main field preparation Seed production techniques RCM survey		18-Jul	19-Jul
Day 2 Planning and crop calendars Transplanting and management Training on use of RCM in the training site Nutrient management (basal application) Water management	DOT	25-Jul	26-Jul

Training Module Details	Training interval Days	Badshahi	Rasgobindpur
Day 3 Nutrient management Weed management Sprayers and spraying techniques	45 DAT	10-Sep	11-Sep
Day 4 Pest and disease management Training on use of Rice doctor in the training site	50 – 55 DAT	30-Sep	1-Oct
Day 5 Harvest and management	At harvest stage	10-Nov	11-Nov
Day 6 Drying, Storage, packaging and labeling	3 DAH	13-Nov	14-Nov

Figure 4.5 Training module details:

Seed treatment module

Seed production introductory module

Seed production introductory module

Nursery bed preparation module

Mechanical transplanting module

Spraying techniques module

Nutrient management and RCM module

The group at harvest

Date	DSR	MTP
20 Dec 2017	-2DAS	-2DAS
22 Dec 2017	DOS	DOS
26 Dec 2017	4 DAS	4 DAS
9 Jan 2018	18 DAS	D0T
4 Feb 2018	39 DAS	25 DAT
7 March 2018	69 DAS	55 DAT
28 March 2018	90 DAS	75 DAT
8-10 May 2018	120 DAS	102 DAT
17 May 2018	7 DAH	7 DAH
20 May 2018	Closing	Closing

The SLT for Rabi 2017 is being implemented in the village of Sisupur, Bramhagiri block, Puri District, in the following calendar. Figure 4.6 SLT details:


Classroom sessions of the SLT


Mechanical transplanting module


Land preparation module


Nursery cutting module

Understanding the extension and innovation landscape in Odisha

With the aim of enhancing innovation and impact in the rice sector of Odisha and identifying sustainable extension methods and critical change agents, an analysis of the extension methodologies being used in the state is being conducted, in collaboration with the Centre for Research on Innovation and Science Policy (CRISP). The results of the study should be available by mid-2018.

4. Leadership and entrepreneurship program for women in agriculture

The main aim of the Leadership and Entrepreneurship program for Women in Agriculture (LEAP) is to enable organizations to conceive, develop, implement, and lead entrepreneurial projects and businesses with women farmers along the rice value chain through the formation of producer companies or other social enterprises.

The LEAP training programs

Figure 4.7 Special leadership course for Assistant Agriculture officers

LEAP also targets the personal and professional development of women scientists, extension workers, social workers, and entrepreneurs working within development organizations through training and action. Collaborators of LEAP are trained to hone their leadership and entrepreneurial skills through a series of workshops delivered by IRRI in the Philippines, CIWA and the Entrepreneur Development Institute of India, both in Bhubaneshwar, India. They are then given a chance to practice their skills through collaborative research projects that are implemented as part of the program.

LEAP trainings vie for the long-term sustainability and the scaling potential of the projects that can best insure vast impact. The women professional leaders identify the women leaders in their own communities and strive in turn to empower them to take initiatives that will benefit them. 41 women leaders from 22 organizations have participated in LEAP in two batches.

SN	Title of Training	Total no. Participants	Type of Training Event
1	Women's leadership for impact – workshop 1	16	8 day training
2	Women's leadership for impact – Workshop – 2	16	5 day training
3	Leadership and entrepreneurship program for women in agriculture	21	5 day training
4	Leadership course for Assistant Agriculture Officer	19	4 days

On the request of the Director of Agriculture, a special leadership course for AAOs was been arranged in ICAR-CIWA on February 21-24-2018.

Understanding the entrepreneurial landscape in Odisha

The strategy paper for LEAP for Odisha state envisages the preparation of a detailed intervention plan with activities, timelines, and budget so as to reach out to a minimum of 50,000 women producers in the rice and rice-related value chain system of the state by the next three years. The objectives of this strategy paper will be:

- To design an intensive strategy through collective enterprises where significant impact can be created through paddy-based and allied livelihood activities;
- To reach out to the remaining wide number of women producers indirectly through responsible agripreneurs; and
- To explore the role of different institutions (financial, NGO partners, women enterprises) in implementing the LEAP programme in Odisha

The strategy paper is being prepared in collaboration with Access Livelihood Consultancies India. The results of the study should be available by June 2018.

5. The IRRI Scholars program

IRRI and NRRI host a large number of graduate and postgraduate students undertaking research in collaboration with its NARES partners. As leading global rice research organizations, IRRI and NRRI provide an excellent opportunity for graduate students engaging in their Ph.D. and M. Sc. dissertation to be advised and guided by leading scientists from IRRI/NRRI in their field and work in a world-class scientific environment. A total of 10 Ph. D. scholarships for the duration of the project and 15 M.Sc. scholarships for three years will be awarded through the program. The program will be administered by the NRRI.

Subproject 5: Science-based crop insurance
5A: Remote Sensing Based Rice Monitoring and Yield estimation

Remote sensing as a tool for rice crop monitoring has evolved phenomenally in the last few years with the use of SAR imagery that overcomes the constraints of optical imagery as they have active sensors on board that do not require light to record the image and can 'see' through clouds. SAR-based mapping (Sentinel-1A) of the diverse rice environment in Odisha was attempted with multi-temporal data and the products integrated with the Rice Yield Estimation System (Rice-YES) model for yield estimation. IRRI initiated the work on rice monitoring in selected districts of Odisha in the Kharif and Rabi seasons in 2016 and expanded to cover all the 30 districts to determine (a) start of the rice season, (b) area, and (c) yield estimation for Kharif and Rabi seasons of 2017-18.

Objectives: This subcomponent aims to

- Develop a rice monitoring system for Odisha;
- Provide accurate and timely estimates on rice area, yield, and production along with planting time;
- Estimate damages in case of flood and drought for all the rice-growing areas;
- Provide data and information derived from remote sensing to implement PMFBY in Odisha; and
- Conduct local capacity building programmes

Product Generation

Products during the Kharif 2017 season were generated for the whole state of Odisha. Three tracks of satellite images from Sentinel-1A VV and VH multi-temporal imageries were processed (owned by EU and developed and operated by ESA) for the 2017 Kharif season (Fig. 5.1 and Table 5.1).

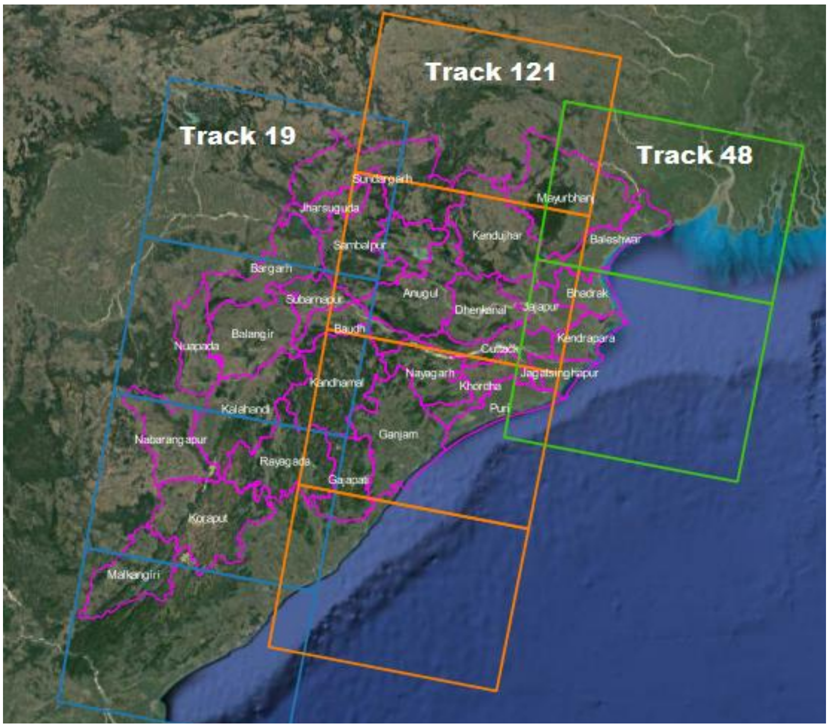


Figure 5.1 S1A tracks covering Odisha State

Table 5.1. Sentinel 1A acquisition schedule, Kharif 2017

Track_19	Track_121	Track_48
05-Jun	12-Jun	07-Jun
17-Jun	24-Jun	19-Jun
29-Jun	06-Jul	01-Jul
11-Jul	18-Jul	13-Jul
23-Jul	30-Jul	25-Jul
04-Aug	11-Aug	06-Aug
16-Aug	23-Aug	18-Aug
28-Aug	04-Sep	30-Aug
09-Sep	16-Sep	11-Sep
21-Sep	28-Sep	23-Sep
03-Oct	10-Oct	05-Oct
15-Oct	22-Oct	17-Oct
27-Oct	03-Nov	29-Oct
08-Nov	15-Nov	10-Nov
20-Nov	27-Nov	22-Nov

The following activities were carried out to generate various products

1. Satellite data downloading, screening, and preparation: Even if the crop season typically did not start earlier than June, whole year data (i.e. from January to December 2017) have been downloaded and processed in order to exploit the "out-of-season" acquisitions for the Rice Ecosystem Map. The following activities were performed during this period

    - Data selection (based on spatial, temporal, and acquisition mode/format criteria), transfer, and storage;
    - Identification of corrupted or missing images. This activity required continuous liaison with the data provider (i.e. ESA) to reprocess/upload the affected data and, most importantly, to avoid (as far as possible) acquisition cancellations. It is important to note that the accuracy of the final rice products depends dramatically on the systematic acquisition of the data (especially SAR), which in turn indicates that cancellations are inversely related to product accuracy

2. Sentinel-1A data processing: Ground Range intensity data (VV and VH polarization) have been exploited to

    - Generate multi-temporal features suitable for the discrimination of different land cover types in the Rice Ecosystem Map;
    - Analyse VV and VH SAR signatures for i) Rice Area, ii) Start of Season (SoS), and iii) Leaf Area Index (LAI) maps

    Single Look Complex data have been used to generate coherence images (VV polarization), which are an additional source of information for the Rice Ecosystem Map.

3. The NDVI is generated for each date/acquisition; NDVIs are exploited both in the Rice Ecosystem Map (usually in the form of multi-temporal features) and to cross-check/validate the SAR signature of rice for a more reliable identification of the SoS date.

4. Sentinel-2 data processing: A preliminary screening is necessary to get rid of images too much affected by clouds and haze. Due to the lack of thermal band, which is needed to perform an unsupervised (i.e. automatic) process aimed at cloud/shadow masking, these data must be visually analysed and eventually masked with a "manual" approach. The NDVI is first generated for each date and then the multi-temporal feature corresponding to the maximum value detected in a well-defined period is exploited in the Rice Ecosystem Map. When the data have to be used, as Landsat-8, to crosscheck/validate the SAR signature of rice, only cloud-free images can be exploited or a manual cloud masking must be performed first.

Field Data Collection

Field data were collected by the local team, coordinated by IRRI, from June to November. Before and during the fieldwork campaign there was continuous communication (via Skype, e-mail and FTP data transfer) with the Sarmap team, intended to support the local staff with ad-hoc, prepared satellite composites as well as indications about the most interesting location for ground sampling and the ideal collection grid, among others. Three separate sets of samples have been produced.

1. **Rice Calibration set:** It includes only rice points associated with crop-related information such as planting date, method, geotagged pictures, etc. A total of 1595 points were collected throughout the state (Fig. 5.2). This material was progressively delivered to sarmap aimed at calibrating the SAR signature and accordingly tuning the MAPscape-Rice classification parameters;
2. **Rice and Non-Rice Validation set:** It includes rice and non-rice points used by IRRI to validate the rice area map. This material has not been provided to Sarmap
3. **Non-Rice Calibration set:** Since the calibration procedures require rice and non-rice samples to be effective, a limited number of non-rice samples were provided to Sarmap between November and December, prior to the generation of the latest delivered rice products. These points cover only some districts (Fig. 5.3)

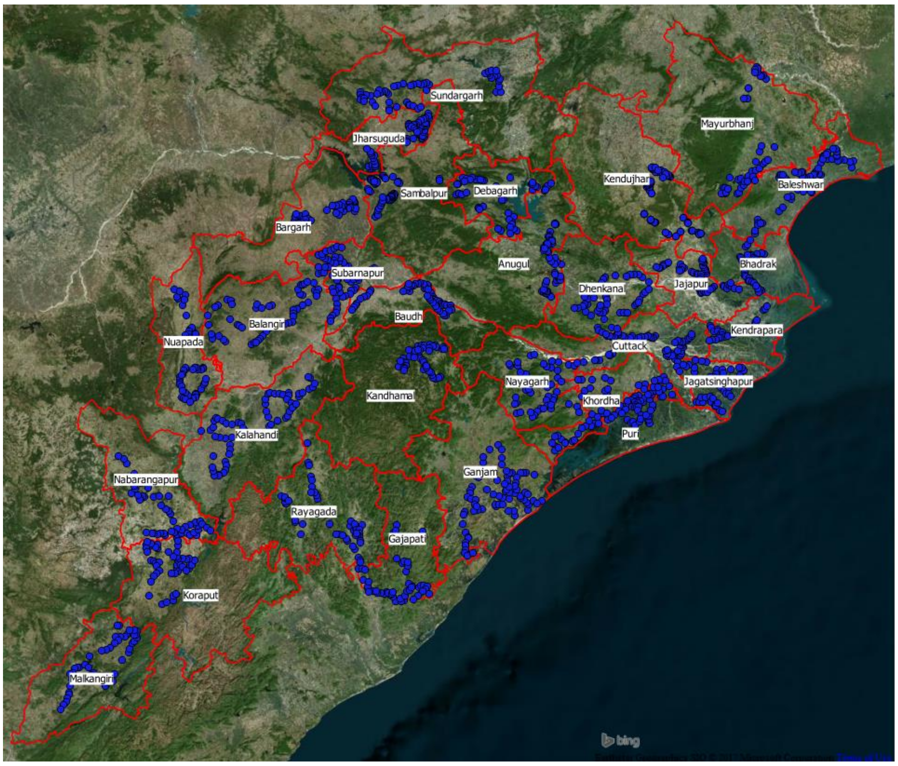


Figure 5.2: Blue dots show the location of the rice ground samples collected for calibration purposes

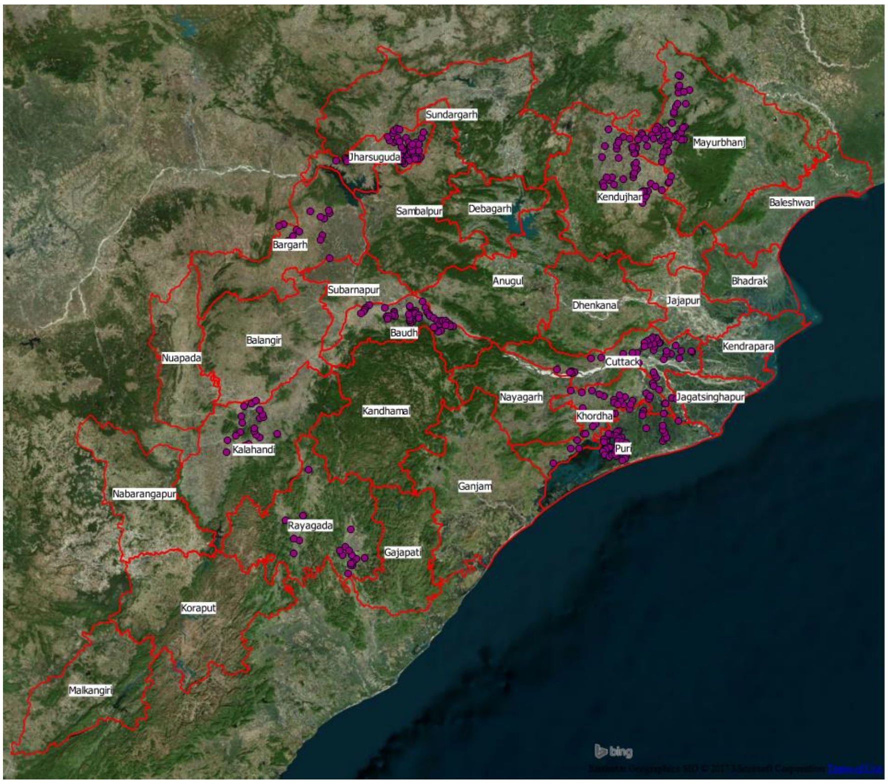


Figure 5.3: Violet dots show the location of the non-rice ground samples provided for calibration purposes

Monitoring and Mapping Rice Area and Start of Season Date

These two maps are based on the SAR signatures (VV and VH) and, when sufficiently cloud-free acquisitions are available, NDVI data. The previously generated Rice Ecosystem Map is an input to the process.

The SAR signature of rice and non-rice areas was first checked on ground calibration samples in order to properly set the processing parameters in the MAPscape-Rice classifier. The classification parameters can considerably vary from one region to another, mostly depending on crop practices (e.g. irrigated, rainfed, direct seeded, transplanted, etc), water availability, and climatic conditions. The district-level SoS and rice area maps were generated by tuning the parameters at district level; afterwards the district maps were combined to get a single product covering the entire state. For some districts, whether the rice products are inconsistent with respect to reference ground information, multiple iterations of the classification process (i.e. modifying the parameter settings) are performed until a good agreement with the reference data is reached.

The total cultivated rice area during this season is given in Figures 4a and 4b while the district-wise estimated rice areas are presented in Table 5.3. Rice area classifications were verified and calibrated using 1,700 ground data points (89% rice and 11% other land cover types) which were collected at the beginning of the season. At the end of the season, the rice area map was validated with 3,266 ground data points (50% rice and 50% non-rice) and thereby attaining an overall accuracy of 87.75%. The cumulative accuracy assessment of the rice area at district level is shown in Table 2. Start of season map was also generated from Sentinel-1A images using rule-based classification (Figs. 5a & 5b).

Table 5.2: Odisha State Accuracy Assessment

Confusion matrix computations				
		Predicted class from the map		
		Rice	Non-Rice	Accuracy
Actual class from survey	Rice	1425	208	87.3%
	Non-Rice	192	1441	88.2%
	Reliability	88.1%	87.4%	87.8%

Average accuracy	87.8%	
Average reliability	87.8%	
Overall accuracy	**87.8%**	**Good Accuracy**
Kappa index	0.76	

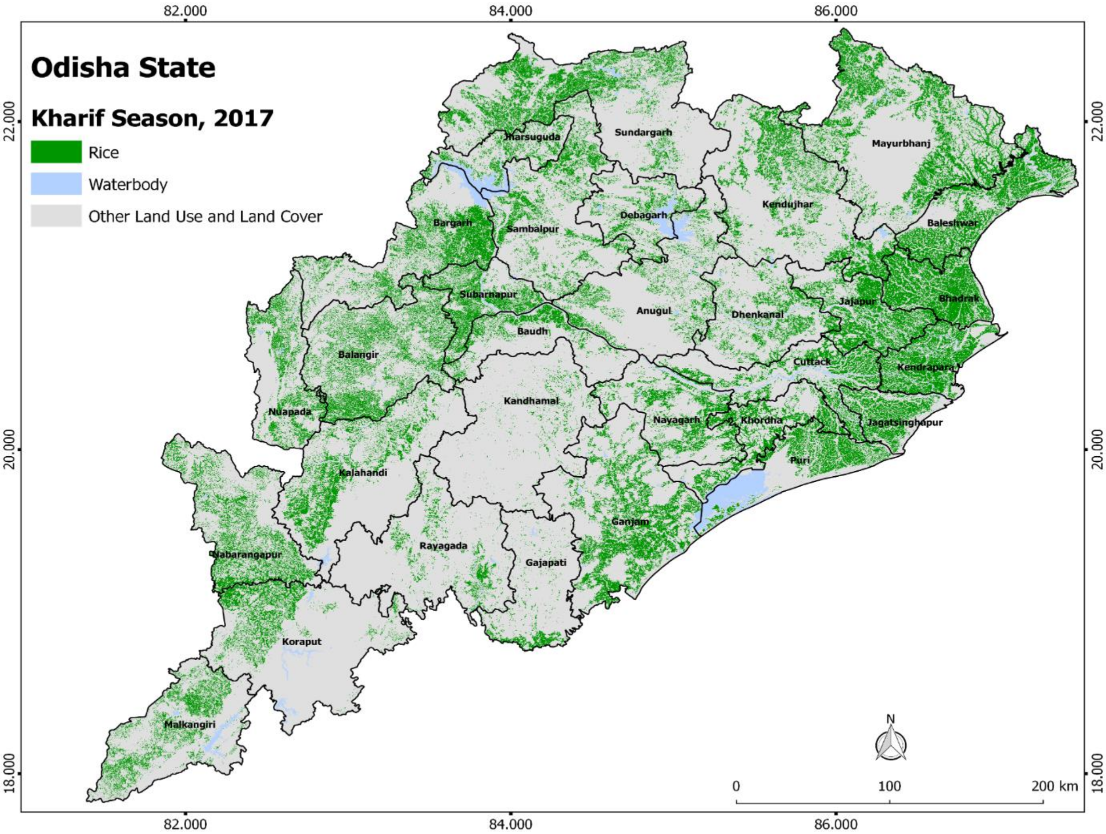


Figure 5.4a: Green color shows Kharif 2017 rice areas in Odisha

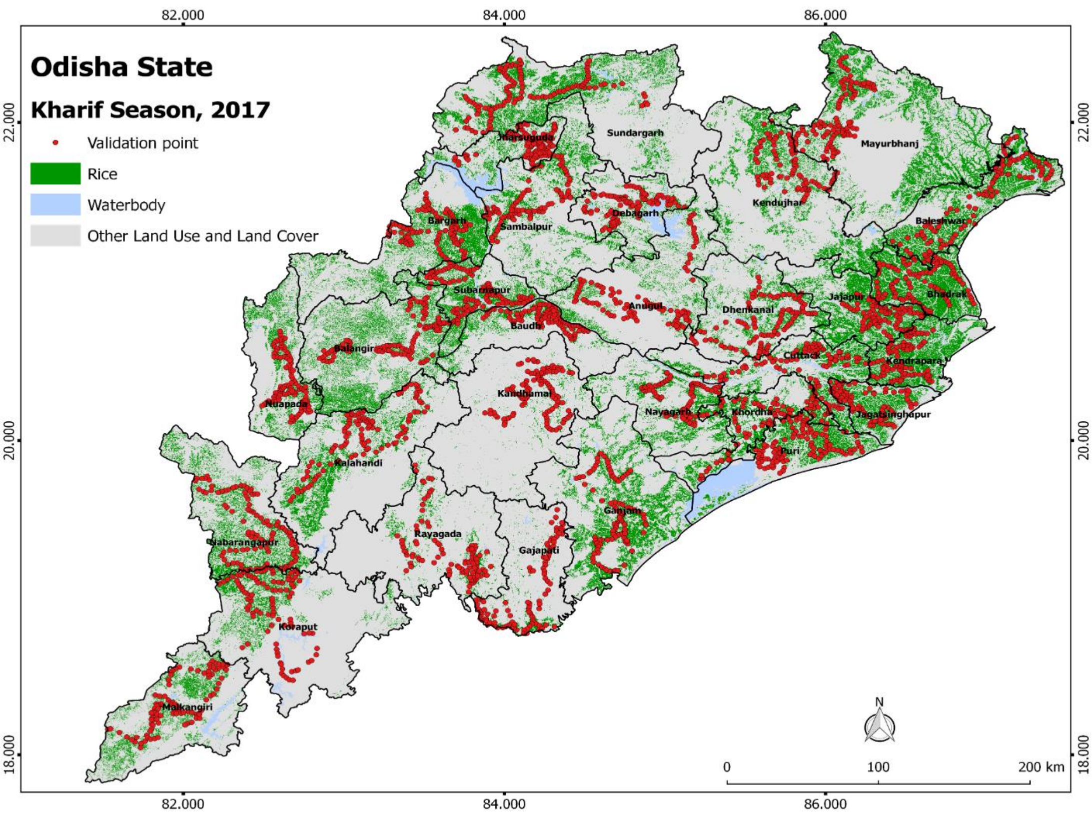


Figure 5.4b: Green color shows Kharif 2017 rice areas with validation points in black

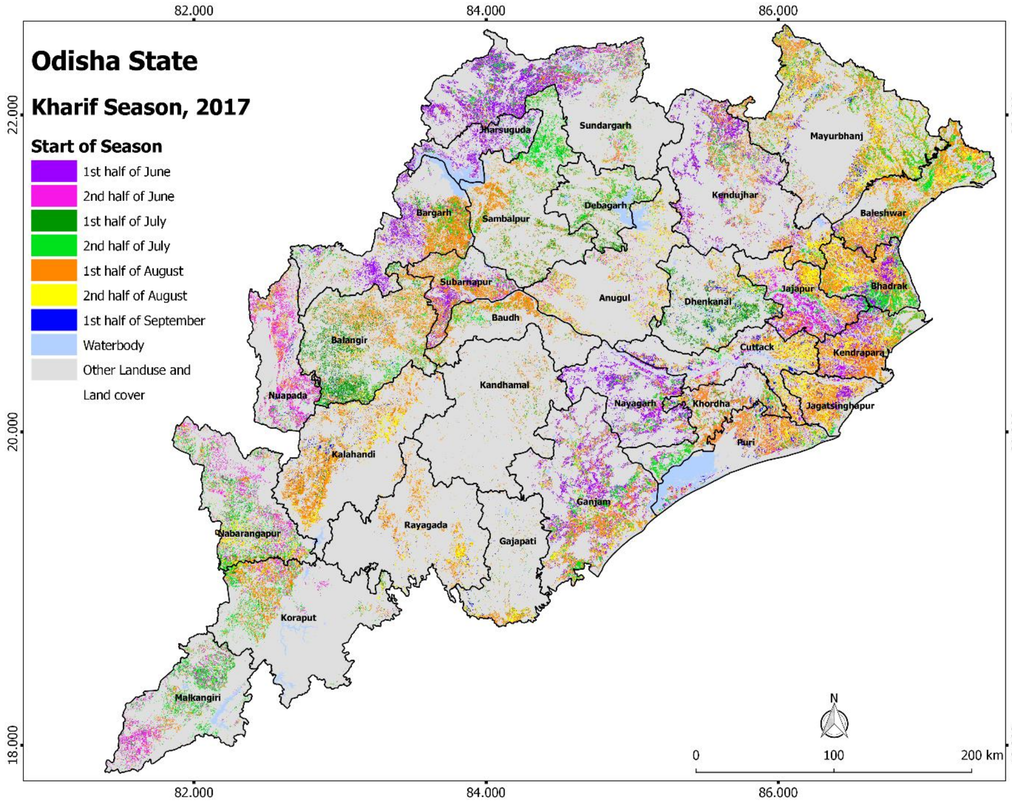


Figure 5.5a: Different colors correspond to different Start of Season dates during Kharif 2017

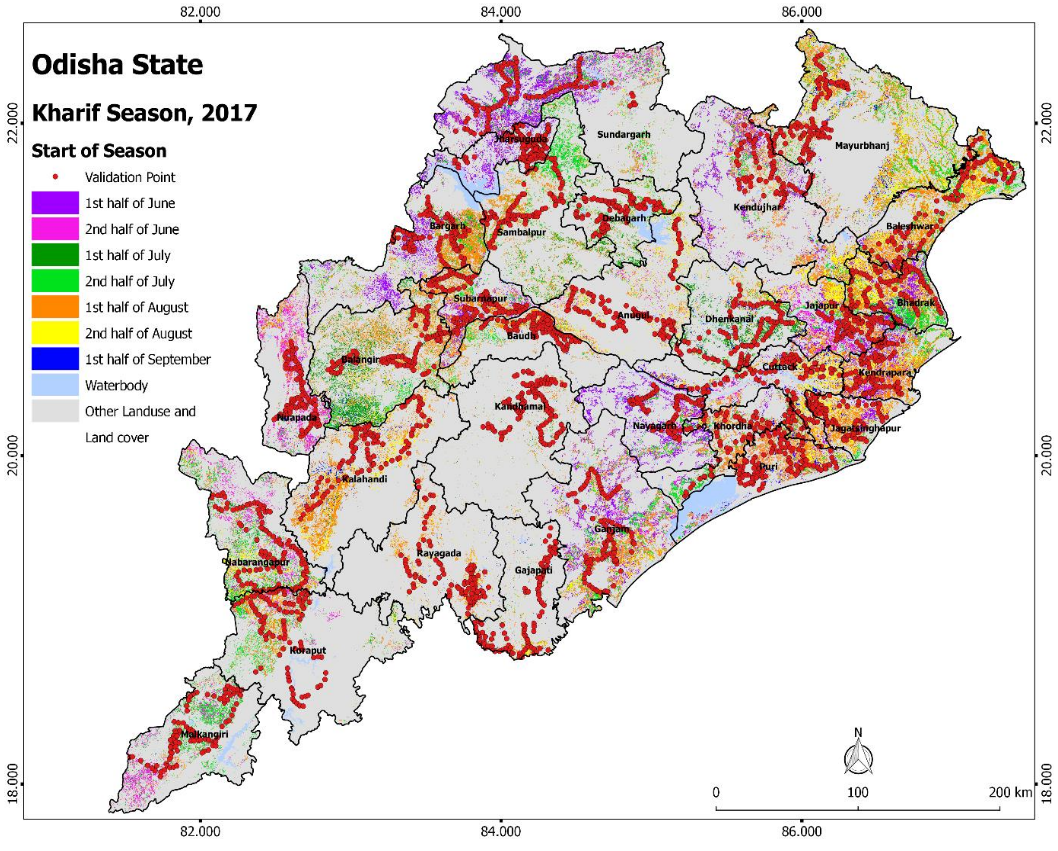


Figure 5.5b: Different colors correspond to different Start of Season dates and black dots show the validation points for Kharif 2017

Table 5.3: Rice area estimate results at district level generated by IRRI in collaboration with Sarmap, 2017 Kharif (June-November)

District	2017 Kharif start-of-season estimated area (ha)							2017 Kharif estimated rice area (ha)
	1st half of June	2nd half of June	1st half of July	2nd half of July	1st half of August	2nd half of August	1st half of September	
Anugul	8	14,123	1,922	7,115	20,039	33,661	-	76,866
Balangir	13	27	71,877	18,033	87,434	12,726	5,981	196,091
Baleshwar	10,411	587	264	35,992	101,502	29,689	1	178,445
Bargarh	52,615	560	3,363	26,230	74,301	2,365	0	159,434
Baudh	0	-	-	11,510	35,232	2,871	1,460	51,073
Bhadrak	29,657	492	302	36,180	60,804	33,502	118	161,055
Cuttack	11,233	3,807	423	6,693	40,966	32,068	10,807	105,996
Debagarh	-	1	16,895	14,374	13,639	4,054	-	48,963
Dhenkanal	1	7	40,466	5,545	18,704	12,056	10,191	86,970
Gajapati	2	0	601	2,899	13,834	9,111	3,459	29,906
Ganjam	77,052	4,053	129	40,054	80,770	25,639	1	227,698
Jagatsinghapur	12,609	877	227	2,727	37,644	21,004	1,256	76,344
Jajapur	28,320	26,008	1,141	12,300	35,783	29,121	2,149	134,821
Jharsuguda	33,641	3	1,812	8,139	2,914	44	35	46,588
Kalahandi	-	4	1,167	2,537	95,265	28,663	10,199	137,835
Kandhamal	2	-	1,739	3,818	16,076	1,811	996	24,442
Kendrapada	31,695	2,324	121	11,028	66,952	19,792	255	132,167
Kendujhar	60,400	922	2,483	21,026	69,762	17,792	2,819	175,204
Khordha	6,602	1,597	255	23,446	50,406	4,993	4,503	91,802
Koraput	-	13,563	4,391	32,095	43,211	4,718	0	97,977
Malkangiri	-	36,864	9,999	42,113	13,607	1,676	-	104,258
Mayurbhanj	5,715	632	1,777	54,099	126,735	63,550	16,873	269,382
Nabarangpur	-	47,367	9,341	47,621	23,693	18,108	-	146,131
Nayagarh	62,814	4,323	442	16,079	12,930	1,985	139	98,714
Nuapada	-	56,006	618	5,504	21,453	2,309	3,615	89,506
Puri	6,155	3,038	1,017	8,098	56,506	10,845	8,713	94,371
Rayagada	-	0	0	0	31,504	13,987	3,256	48,748
Sambalpur	20	4	23,058	45,410	55,739	5,845	-	130,076
Subarnapur	23,730	3,772	92	12,509	50,846	2,595	0	93,544
Sundargarh	101,835	23,079	40	46,887	32,481	6,609	0	210,931
Odisha	**554,531**	**244,040**	**195,962**	**600,061**	**1,390,731**	**453,188**	**86,825**	**3,525,338**

Generation of the Inputs for Crop Yield Modelling

This process exploits the temporal series of SAR VH acquisitions and the SoS map. The program computes the LAI from the SAR intensity measured at about 1/3 of the season; the approximate season duration must be known a priori (Fig. 5.6). The LAI map, with some associated files, was used to run the crop simulation model for forecasting mid-season yield and estimating end of season yield (Fig.5. 7).

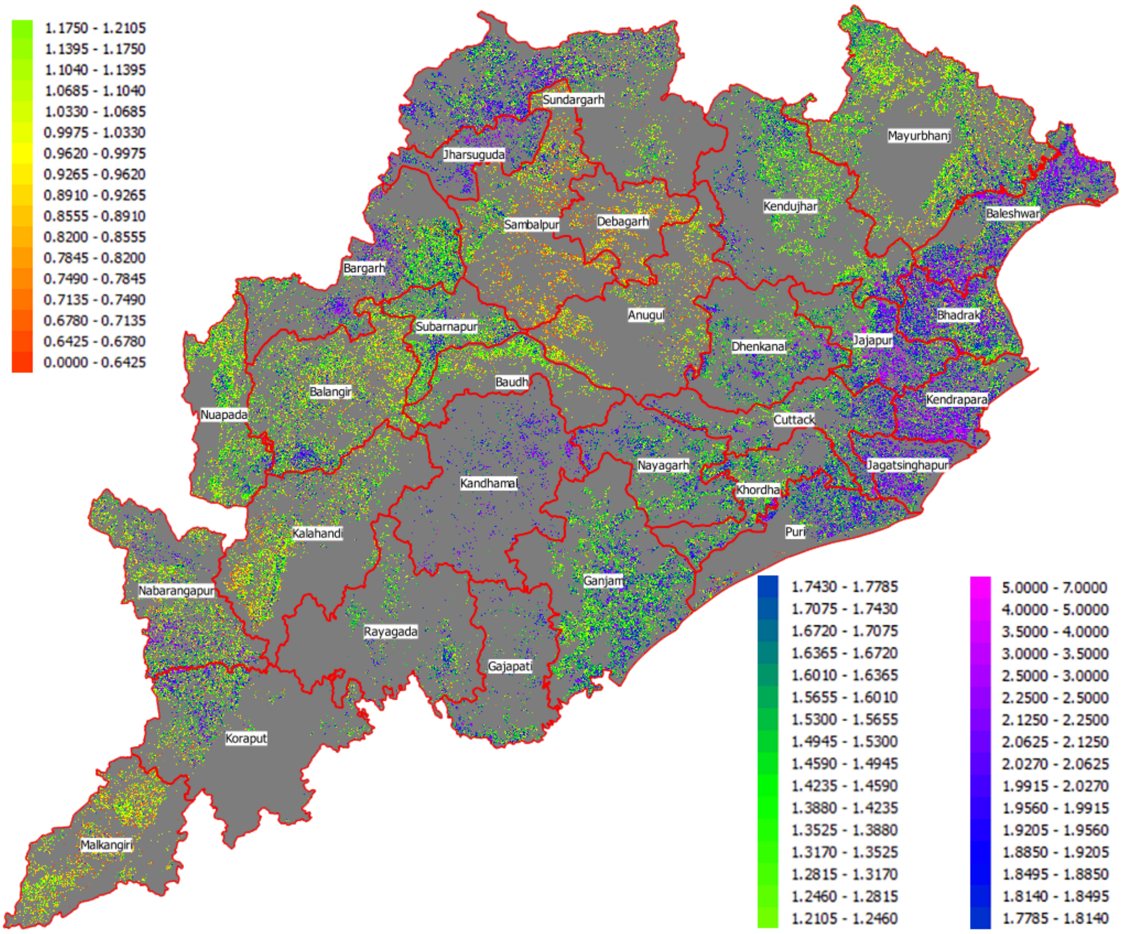


Figure 5.6: Colors from red to green to magenta correspond to progressively increasing LAI values

2017 Kharif season yield estimates

Rice yields (paddy yield at 14% moisture content) were estimated using the ORYZA crop growth model and Rice-YES to integrate the remote sensing data into the crop model. The following input data were used: processed SAR images from Sentinel-1A satellite, weather data, varietal characteristics, soil data, and crop management information. For weather data, the total daily values of solar radiation, minimum and maximum temperature, average daily wind speed, average daily vapour pressure, and total daily precipitation were used. Crop management information such as establishment method, irrigation practices, and amount of applied inorganic N fertilizer were incorporated into the model. The map of rice yield for the 2017 Kharif season in Odisha is shown in Figure 5.7.

At district-level aggregation, the estimated yield in Odisha ranged from 2.25 ton/ha in Kalahandi district to 4.18 ton/ha in Subarnapur district while the state-wise average for the whole state during the 2017 Kharif season was 3.01 ton/ha (Table 5.4).

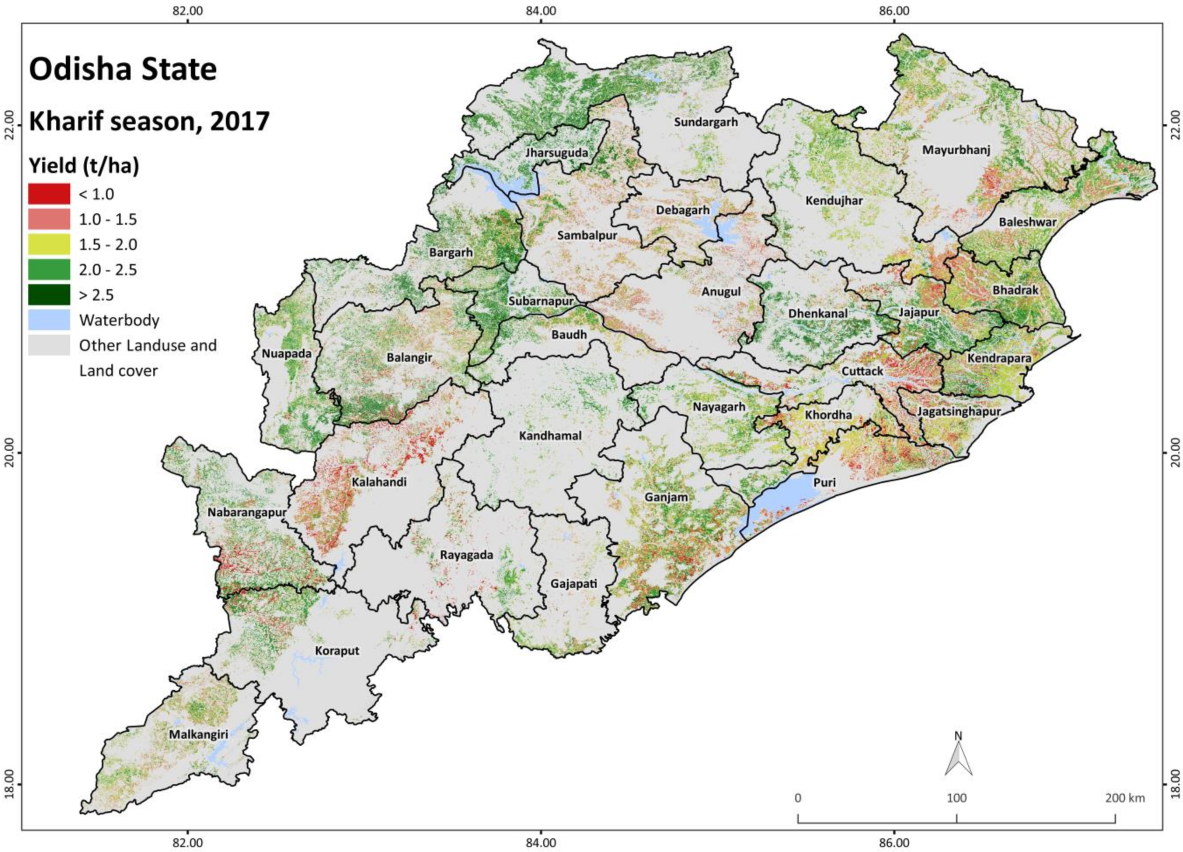


Figure 5.7: Color-coded map shows the district-level estimated yield for Kharif 2017

Table 5.4: Rice yield (paddy yield at 14% moisture content) estimates aggregated by district during 2017 Kharif season in Odisha, India

District	Yield estimates 2017 Kharif (ton/ha)	District	Yield estimates 2017 Kharif (ton/ha)	District	Yield estimates 2017 Kharif (ton/ha)
Anugul	2.90	Ganjam	2.57	Malkangiri	2.78
Balangir	3.68	Jagatsinghpur	4.05	Mayurbhanj	2.44
Baleshwar	2.49	Jajpur	2.68	Nabarangpur	3.68
Bargarh	2.73	Jharsuguda	2.97	Nayagarh	2.25
Baudh	2.53	Kalahandi	3.98	Nuapada	2.53
Bhadrak	2.51	Kandhamal	2.74	Puri	2.68
Cuttack	2.63	Kendrapada	2.67	Rayagada	3.98
Debagarh	3.08	Kendujhar	2.51	Sambalpur	3.28
Dhenkanal	4.12	Khordha	2.63	Subarnapur	4.18
Gajapati	2.56	Koraput	3.71	Sundargarh	2.72
				Odisha	**3.01**

Rice Ecosystem map

The Rice Ecosystem Map is derived from SAR (i.e. Sentinel-1A VV and VH intensities and VV coherences data) and optical (NDVI from Landsat-8 and Sentinel-2) multi-temporal features. Different land cover types are discriminated because of the typical behaviours shown in SAR and/or optical response observed over specific time frames (Fig. 5.8). The activity was carried out to generate the Rice Ecosystem Map in subsequent steps:

- Identification of one or more sample areas representative of each land-cover type. These areas can come from ground truth information or visual analysis of high-and very high-resolution imagery (e.g. Google Earth or similar sources);
- Selection of multi-temporal features, paired with selected observation periods, suitable for discriminating different land cover types;
- Definition of rules, priorities, values, etc. in a decision tree-based approach. This is implemented on the basis of the SAR/Optical signal response in the selected sample areas;
- Generation of the map; and
- Updating of the map as soon as inconsistencies appear with newly available satellite or ground information

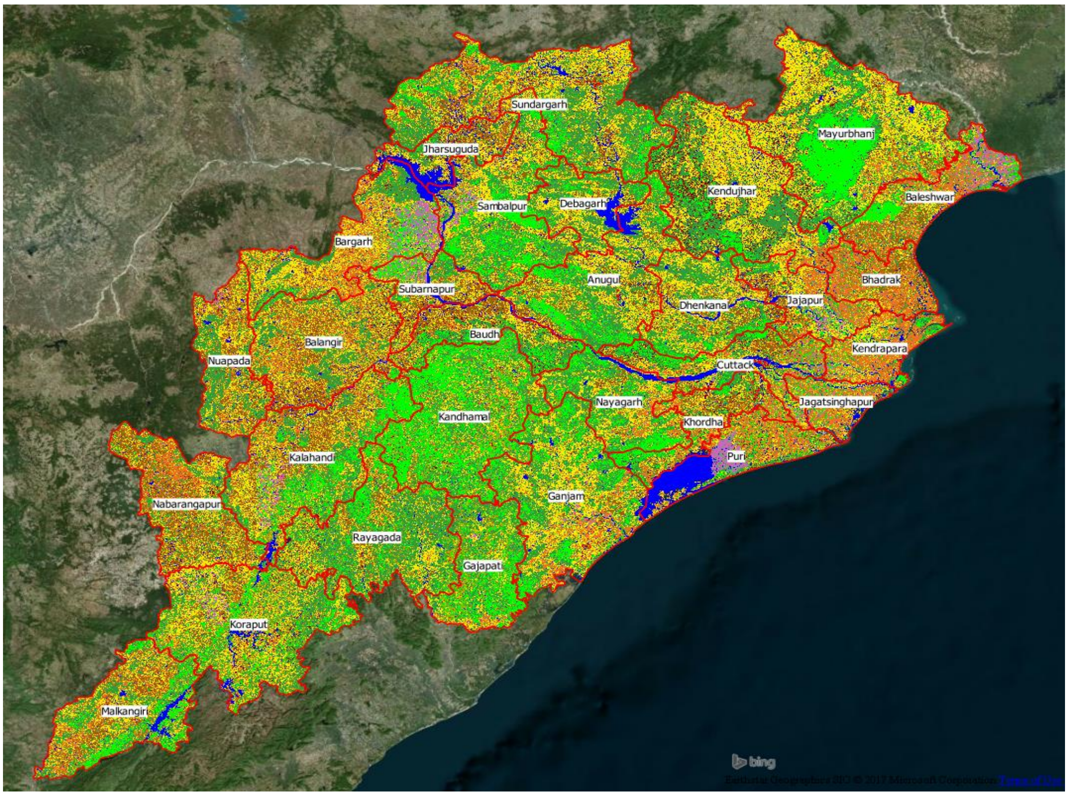


Figure 5.8: Rice Ecosystem Map. The overlaid red polygons show the districts of Odisha state

Products and Validation

Figure 5.8 shows the Rice Ecosystem map. It is exploited as Rice-Non Rice mask during the rice cultivated area detection process. It discriminates the following classes:

- Non-rice land cover – in these areas, the analysis of multi-temporal satellite data (SAR and Optical), performed throughout a whole year, did not show any evidence of rice signature. These regions are typically stable or temporary water bodies, stable or seasonal vegetation, stable target (e.g. urban settlements), and bare soil
- Rice or possible rice areas – six different classes are used to identify: i) areas where the rice signature is particularly evident in one and/or the other crop season (i.e. Kharif or Rabi or both); and ii) areas where, even if a sharp rice signature does not appear, the temporal evolution could indicate a crop growth behaviour (i.e. presence of rice cannot be excluded)

The first version of this product was generated already in 2016 and since then, the product was continuously updated on the basis of newly available satellite data and/or ground collected material.

Figures 5.5a and 5.5b show the latest delivered rice SoS map. The different colors correspond to the date when the beginning of the plant growth has been detected up to the time of the SAR signature. The dates are grouped by 15 days' intervals. During the field visit performed in October as part of a training program, it has been pointed out that direct seeding is usually done in June. When there is enough standing water in these direct-seeded plots, the farmers do 'beushaning', which is a practice intended to remove the rhizomatous weeds and to aerate the soil. Since rice population is considerably reduced during this process, the farmers fill the gaps by transplanting seedlings uprooted from the same field (the process is locally called khelua). The field looks like a transplanted plot after the khelua operation. The corresponding SAR signatures would detect these plots as transplanted in August when beushaning and khelua are completed. Normally this is about 45 days after direct seeding using long-duration varieties. With an aerial mix of the two conditions, the SAR signature identifies the SoS date corresponding to the transplanting event.

Figure 5.6 shows the latest delivered LAI map. The different colors correspond to the LAI derived from the SAR backscatter intensity at around 1/3 of the season length. The large index variability would deserve further investigation.

A comparative analysis using official statistics has also been performed; the figures provided by the Odisha Agricultural Department for the Kharif rice area at state level are:

- Year 2013 > 3879674 Hectares
- Year 2014 > 3865006 Hectares
- Year 2015 > 3708108 Hectares
- Year 2016 > 3691949 Hectares

The rice area detected with MAPScape-Rice in the latest Kharif season (year 2017) is 3,525,338 Hectares. Table 5.3 provides the area figures at district level.

Capacity Development

The following hands-on training sessions were conducted in 2017 to develop local technical capacity:

1. "Ground Data Collection Guidelines: Rice and Non-Rice Area Validation" on 23-27 October 2017 for the Odisha RSM Component 5 researchers (2) and research technicians (3). Training focused on (a) data collection protocol using Garmin Oregon 650; (b) data transfer from GPS to computer; (c) data encoding in MS Excel; (d) linking GPS points with the data forms; and (e) viewing geotagged photos linked to the GPS points.

2. A five-day training on 'MAPscape-Rice' to NARES partners of the IRRI-Odisha project consisting of staff from DoA and the Odisha Space Applications Centre (ORSAC) on 23-27 October. Training focused on (a) Sentinel-1A data set preliminary description and analysis; (b) satellite data download; (c) processing of downloaded satellite data; (d) data analysis/interpretation in Quantum GIS software; (e) products and ground data analysis and understanding; and (f) field validation.

2. The IRRI Team conducted training on Rice-YES to NARES partners of the IRRI-Odisha project consisting of staff from DoA and ORSAC from 29 January to 02 February, 2018 and one staff of the IRRI-Odisha office. The training focused on yield simulation (mid-season forecasting and end of season estimation) using Rice-YES interface, input file generation (weather data, crop management, variety and soil data), yield remapping using MAPscape-Rice, and yield aggregation based on the desired administrative level.

3. Hands-on training on Unmanned Aerial Vehicle operation to Component 5 officers (2) and senior specialist (1) and guidance for the revised protocol for SoS ground data collection (revised from the previous protocol with regards to the inclusion of non-rice data points) to all component 5 staff was also provided on 28 January to 02 February 2018.

Conclusion

The results obtained in terms of **Rice Area** detection can definitely be considered fairly accurate considering the complexity of the monitored area (different crop practices, different environmental/climatic conditions, fragmented areas with different crops or with very different stages of rice growth, etc.) and the resolution of the input data.

An in-depth assessment has not been performed yet in terms of detected SoS date; however, what appears after a preliminary analysis is that the detected SoS date corresponds quite well with the transplanting date. Some discrepancy occurs in the case of direct seeding in rain-fed areas, especially when the same area is 'beushaned' and gap-filling is done (khelua), giving the field a freshly transplanted look (captured as such by the SAR signature). Moreover, it has been noted that a "false start of season" appears in the SAR signature around mid-May; this is probably due to a rain event which triggered widespread grass growth (the trend is indeed visible all over the state territory) eventually appearing very similar to the rice growth signature. Thanks to the information exchange with local expert partners, such “false signature” was ignored during analysis for this project.

This example demonstrates once again that it is not possible to generate reliable products only from remote sensing data. The integration/support/know-how coming from local experts is a mandatory component. This is why we believe that the know-how transfer activity (e.g. training, material exchange, continuous relationship among sarmap, IRRI and the field team during the monitoring season, etc.) is an essential aspect to reach, in the long term, the goal of building a remote sensing-based rice information system in Odisha. The core team will be able to process remote sensing data and analyse/interpret them in combination with agronomic local know-how and ground truth data. We are convinced that such approach will provide more accurate and updated rice products than anything else available before.

The Kharif 2017 Yield Assessment has been performed prior to the Rice-YES training in Odisha and after training it was re-run and revised to incorporate feedback provided during the training program.

Specifically concerning the remote sensing data exploited for the generation of all rice products (Area, SoS, and LAI), it must be outlined that the use of optical images has been extremely limited (or null), especially due to the persistent cloud coverage affecting most of the territory throughout the season. Sentinel-1A SAR data actually provided at least 90% of the input information.

Also, it must be pointed out that some Sentinel-1A acquisitions have been cancelled and, especially due to the repeated failures occurring from June to July (the most important period to capture the SoS moment), the product accuracy was slightly reduced.

5B: Delivering a science-based crop insurance system for increasing farmer resilience

Introduction

Agricultural production is an outcome of biological activity which is highly sensitive to weather changes. Production risks due to extreme weather events have become a recurrent feature of the agriculture sector, causing crop loss and income instability among farmers. Crop insurance Pradhan Mantri Fasal Bima Yojana (PMFBY) could play an important role in stabilizing farmers' income by providing financial support to farmers in the event of crop loss due to risks, encouraging them to adopt progressive farming practices and improved technology in agriculture, and improving farm livelihoods. However, the scheme is facing some challenges such as delayed payment, high basis risk, huge transaction costs, and lack of transparency. Besides, designing and implementing an appropriate insurance scheme is a very complex and challenging task. Therefore, this subproject is working towards a comprehensive crop insurance scheme by testing the acceptance of different ways of bundling technologies with the insurance scheme.

Deliverables

- Profile the risk-taking capacity of farmers who are exposed to different types of risks;
- Understand farmers' perceptions, awareness, and intake of the crop insurance scheme;
- Identify and validate key indicators of a comprehensive insurance scheme from multiple stakeholders involved in crop insurance

Risk profiling of farmers

As risk attitude of farmers plays a crucial role in designing and targeting mechanisms to mitigate risks, understanding the type of risk attitudes farmers have in general, their distribution, and the factors influencing those risk attitudes could yield important policy pointers towards an effective mechanism of risk mitigation.

To study the risk attitudes of farmers, risk preference elicitation experiments were conducted with rice-growing farmers in 15 districts of Odisha that represent varied risk levels and types. In each of the selected districts, the number of villages was proportionately selected from the village census data of 2011, totalling 129 villages (total households of 15000) (Table 5.5). In each district, villages were selected in such a way that 70% were stress-prone and the remaining 30% were not prone to stress. The experiment was conducted with 1166 farmers in 129 villages in the year 2017.

Table 5.5: Sample selection details

District_ID	No. of Blocks	No. of Villages	No. of Households
Anugul	6	8	77
Balangir	6	7	65
Bargarh	9	9	82
Bhadrak	7	9	78
Jagatsinghapur	5	9	83
Jajapur	6	11	103

District_ID	No. of Blocks	No. of Villages	No. of Households
Jharsuguda	1	1	4
Kalahandi	8	10	81
Kendrapara	4	10	91
Kendujhar	9	11	113
Koraput	6	7	54
Mayurbhanj	14	17	176
Nayagarh	4	6	48
Puri	5	10	83
Sonapur	3	4	28
Total	**93**	**129**	**1,166**

Only 19% of the experimental farmers who exhibited medium to high risk-taking behaviour (Option_4 and Option_5) and majority showed risk averse attitude. Fifty-one% of farmers were completely risk averse and did not opt to play the risk game. Figure 5.9 presents the risk preference across farmer landholding classes. Among risk averse farmers, the proportion of landless and small farmers is significant and, among risk taking farmers, the proportion of medium farmers is also significant. The main model results of risk elicitation games also validate that majority of the farmers are risk averse. Farmers' decision to participate in the risk preference elicitation experiment is found to be influenced by their socio-economic characteristics such as age, household size, caste particularly those belonging to Scheduled Castes, and primary occupation. Some of these indicators will be helpful in carrying out experiments, results of which are set as a background for other activities of the project.

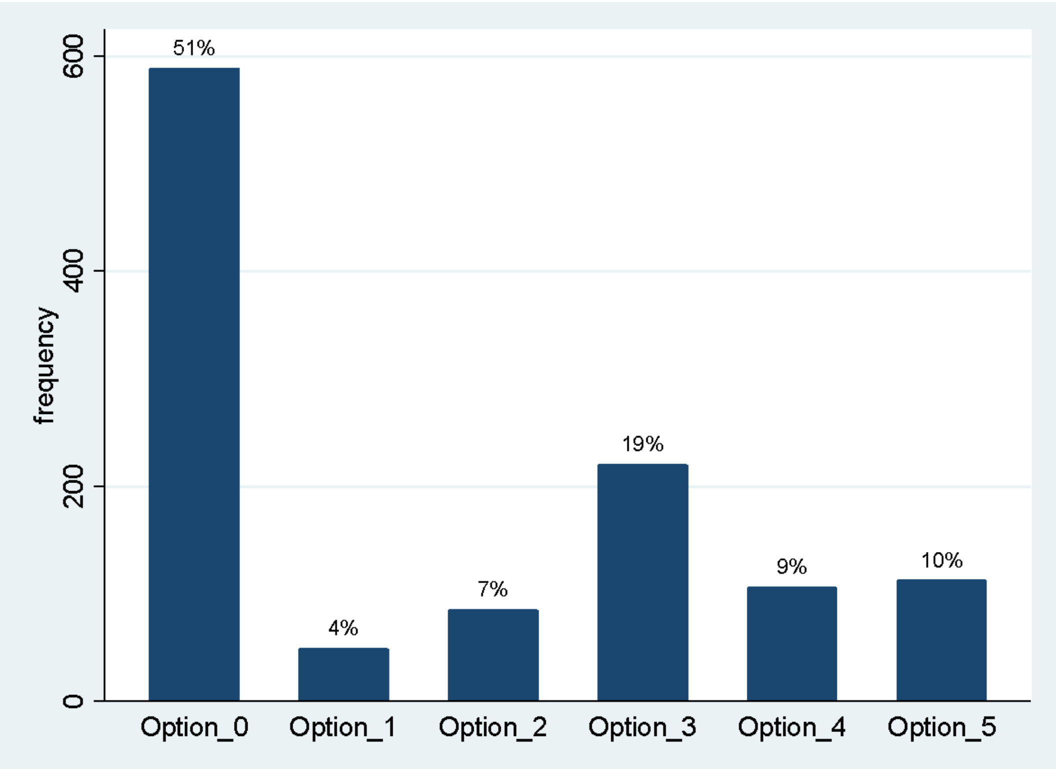


Figure 5.9: Summary of frequencies of risk preferences

Note: Option_0=complete risk averse; Option_1=High risk averse; Option_2=Medium risk averse; Option_3 = Low risk averse; Option_4=medium risk taking; Option_5= High risk taking

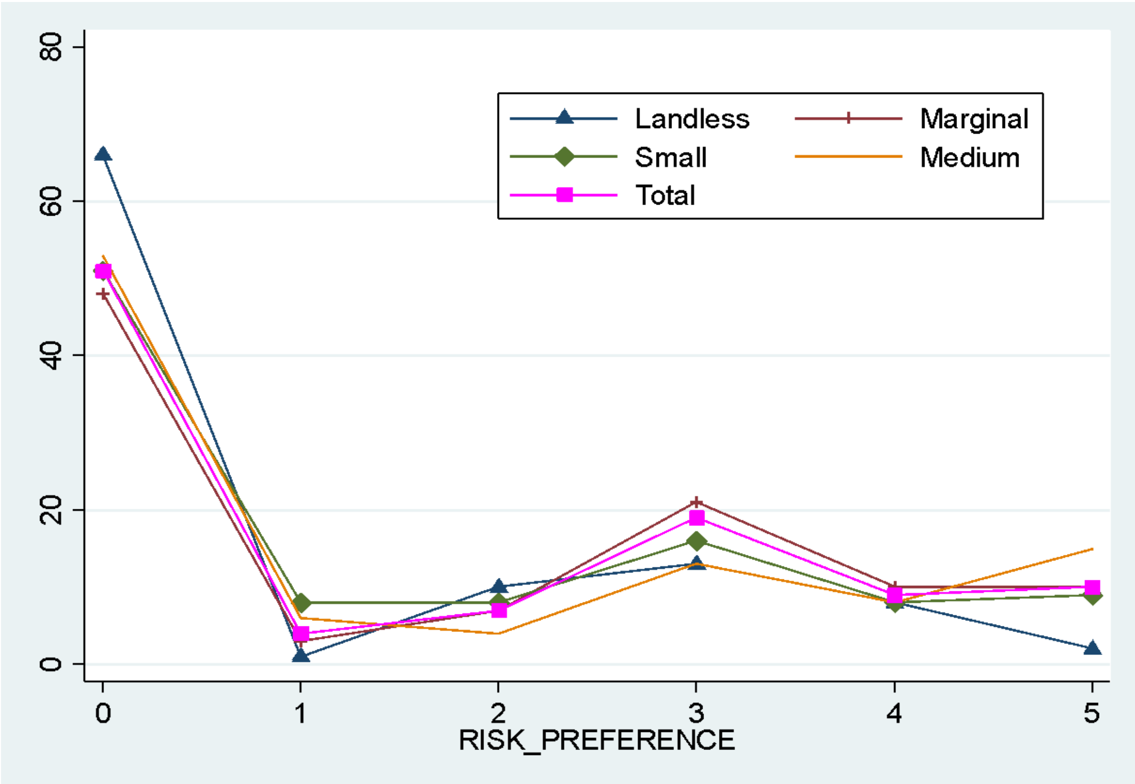


Figure 5.10: Risk preferences across landholding classes

Focus Group Discussions (FGDs) on Crop insurance awareness and perceptions

Extensive FGDs were conducted in selected districts of Odisha which represent a range of agro-climates, associated risk levels, and crop insurance clusters. The purpose of this study was to examine the contemporary field scenario about PMFBY - perceptions and understanding of farmers regarding the condition, awareness, participation, implementation and improvements of the scheme. The inferences from these studies will serve as inputs in drawing preliminary policy implications and identifying which key indicators of the scheme will be used while designing a range of ideal insurance products that are socially acceptable using choice experiments and insurance games. We believe that such insurance products facilitate the development of proper insurance market in Odisha.

An understanding of the risks and risk mitigation strategies of farmers in rice farming and their awareness and perceptions on risk coping mechanisms require more qualitative data. FGDs could be an efficient method to collect such qualitative data with open discussions that focus on key points. FGDs were conducted involving rice-growing farmers having a range of characteristics (i.e. small, medium, large, insured, non-insured, loanee, non-loanee, men and women farmers, representatives of available caste categories in selected villages (Fig. 5.10) from 12 districts. Detailed discussion with farmers (group discussion) about various aspects and issues associated with risk and crop insurance were made, followed by individual survey to collect basic information.

The villages were selected randomly from 12 districts in such a way that they represent a range of agro-climatic risks (mainly flood, drought, and pest & disease outbreak) and their frequency in the last 10 years (high and low intensity levels), agro-climatic conditions, and clusters that are identified for implementing the crop insurance scheme. The PMFBY guidelines were followed in choosing the risk clusters. The selected districts were Puri, Kendrapara, Balasore, Bhadrak, Dhenkanal, Jagathsinghpur, Keonjhar, Barghar, Bolangir, Kalahandi, Nawrangpur, and Jajpur (Table 5.2). The minimum number of participants in each FGD was set to around 12-15 but the size exceeded in some of the FGDs as it was very difficult to limit the number in the village setting. However, some of the participants left after the discussion and were not able to provide the post-FGD survey information. Consequently, there is a mismatch between the actual number of farmers who participated in the discussions and the number of farmers who responded to the post-FGD individual survey (Table 5.2). On the average, 18 farmers participated in the FGDs and 13 farmers responded to the individual survey interviews. In addition to the farmers, representatives of the Primary Agricultural Cooperative Society (PACS) banks, local-level government staff (VAWs and Krushak Saathis) and women self-help groups were invited to be part of the discussion. Post-discussion interviews were conducted with individual participants in all the 12 sampled villages.

The discussions were planned systematically through a set of guide questions to assist the participating farmers in identifying and describing the village profile, cropping pattern, their risks, vulnerability, risk-coping mechanisms, credit access, crop insurance, awareness and perceptions, etc. Two research team members, in addition to the facilitator and technical experts, were present to take notes. This allowed the facilitator to manage the session, making sure that all farmers had opportunities to take part in the discussions and that the topics were well covered. The facilitating team followed the prescribed guidelines while conducting the FGD and explained the objectives followed by other ground rules in a systematic order. The same set of guidelines and reference questions were used in all the FGDs to ensure consistency across different groups in different sample districts. The discussion mainly comprised of farmers' experience and types of risks and their adaptation, access to credit, awareness and perceptions about the crop insurance scheme (PMFBY), their interest towards insuring their crop, issues and suggestions.

Table 5.6: Location details of the Focus Group Discussions

SN	Village	GP	Block	District	Agro-Climatic Zone	Cluster	GCA_Rice ('000 ha)	Flood / Drought Prone	No. of participants	No. of surveyed farmers	Date
1	Basantapur	Singhberhampur	Delanga	Puri	4	5	135	Flood	17	11	21.06.17
2	Damarpur	Damarpur	Pattamundai	Kendrapara	4	2	134	Flood	20	13	17.07.17
3	Renupada	Mukulshi	Basta	Balasore	3	2	226	Flood	22	18	06.07.17
4	Kothar	Kothar	Dhamanagar	Bhadrak	3	4	168	Flood	23	15	07.07.17
5	Hatuari	Badasuanlo	Kamakhyanagar	Dhenkanal	10	6	93	Drought	18	17	12.07.17
6	Narendrapur	Biswali	Kujanga	Jagathsinghpur	4	6	81	Flood	22	11	17.07.17
7	Tangariapal	Tangariapal	Harichandanpur	Keonjhar	2	3	175	Both	16	10	19.07.17
8	Nuagudesira	Gudesira	Bargarh Sadar	Barghar	9	1	326	Drought	16	13	01.08.17
9	Guhuriapadar	Binekella	Titilaghar	Bolangir	9	5	204	Drought	21	11	02.08.17
10	Kanakpur	Medinipur	Bhawanipatna	Kalahandi	8	4	249	Drought	15	13	03.08.17
11	Bejuguda	Lamtaguda	Nawarangpur	Nawrangpur	6	2	147	Drought	16	11	04.08.17
12	Mangalpur	Mangalpur	Dharmasala	Jajpur	3,10	3	126	Flood	18	13	10.08.17

Note: Actual number of participants in some of the discussion was more than that indicated above, some of whom left after the discussion and couldn't provide the post-FGD survey information.

Table 5.6: Location details of the Focus Group Discussions

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6	Narendrapur	Biswali	Kujanga	Jagathsinghpur	4	6	81	Flood	22	11	17.07.17
7	Tangariapal	Tangariapal	Harichandanpur	Keonjhar	2	3	175	Both	16	10	19.07.17
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12	Mangalpur	Mangalpur	Dharmasala	Jajpur	3,10	3	126	Flood	18	13	10.08.17

Note: Actual number of participants in some of the discussion was more than that indicated above, some of whom left after the discussion and couldn't provide the post-FGD survey information.

The post-discussion individual survey was conducted using a semi-structured short questionnaire using the CAPI (Computer-Assisted Personal Interview) tool, Kobo toolbox, to collect farmer's basic information with respect to socio-economic and demographic aspects, cropping patterns, access to irrigation and credit facilities, and other individual perceptions with respect to crop insurance, risks, risk-mitigating strategies, issues, and suggestions. They were introduced to the objectives of the project, mainly through the FGD. The discussions were voice recorded with the consent of the participants. In addition, enumerators took notes during discussion and conducted the post-discussion individual survey. Data was analysed using constant comparison analysis and descriptive statistics by examining the voice recordings, field notes, and post-discussion survey data for correctness and completeness, transcribing, translating, and coding, and performing qualitative and quantitative descriptive analysis. Results and discussions indicate that there are several technical and social issues that need to be addressed in the PMFBY.

Key Findings and Conclusion

- The major problems reported were risks due to natural calamities (such as flood, drought, cyclone, and pest and disease outbreak) (Fig.5.11);
- Majority of the farmers in the state were unaware or ill-informed about the scheme;
- Basis risk was one of the most commonly reported problems in the current scheme;
- Distrust about the scheme due to past experiences was reported as another reason for low coverage;
- Farmers reported that the village should be made a unit of insurance rather than a GP;
- Need for incorporation of additional risks, especially market-related risks;
- Lack of insurance access to certain categories of farmers, mainly sharecroppers as they constituted a major section of the farmers;
- Inappropriate method of yield loss estimation and delayed payment, sometime up to 12-18 months; and
- The crop insurance was found to be a felt need of farmers as majority of them (68%) were interested to know (more) about the scheme and indicated their inability to mitigate risks without intervention from the government

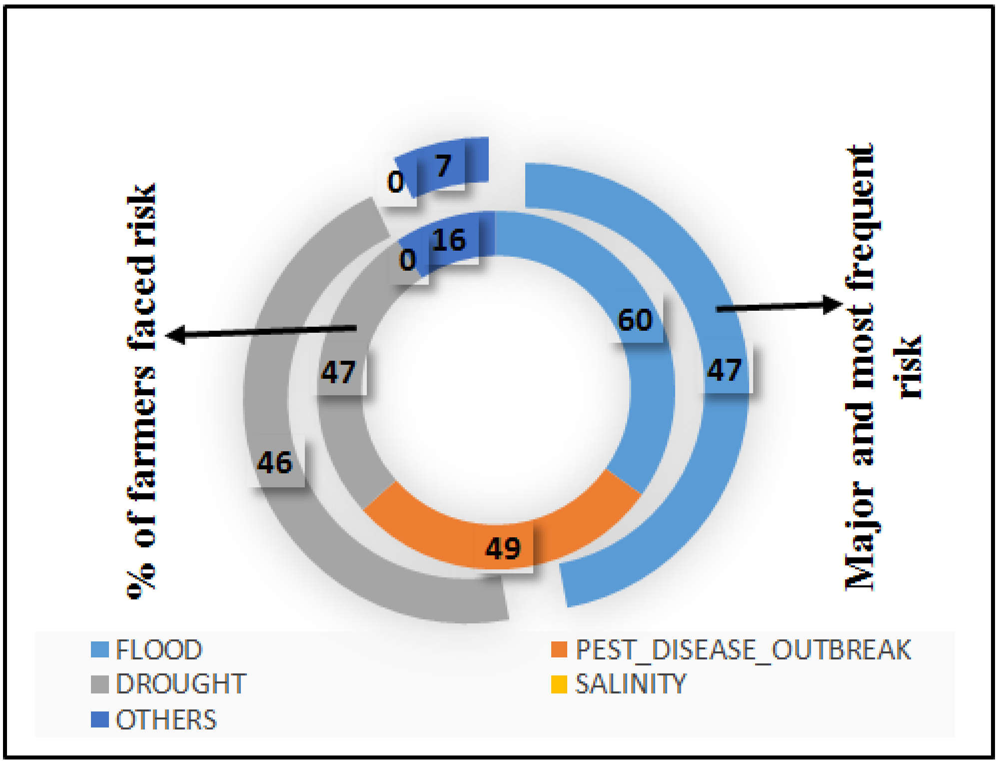

Figure 5.11: Risks in the last years reported by farmers

These findings indicate that there is high demand for the scheme and a considerable potential for enhancing its efficiency and effectiveness as well as its coverage by rebuilding trust among the farmers. Extensive awareness creation is important as it facilitates insurance coverage. Bima Mela at a village / GP could be an effective strategy to create awareness among farmers and to facilitate insurance intake. Besides, representatives (agents) from companies at the local level will act as link between farmers and insurance companies and will help build trust among the farmers and increase awareness and coverage.

Stakeholder Meeting

Comprehensive crop insurance, it is very crucial to look into the viewpoints of all concerned stakeholders associated with the scheme that help in identifying and validating key indicators. Conducting FGDs with farmers across the state was the first step to understand their perceptions and awareness about the PMFBY. Then, in order to get the viewpoints and experiences of the other stakeholders, a day-long regional stakeholder workshop was organized on "*Exploring and Validating Key Attributes/Indicators Towards a Comprehensive Crop Insurance Scheme*" in Bhubaneswar, Odisha, India on 2 February 2018. Around 25 participants representing different stakeholder groups, mainly representatives of the Government of Odisha (DAFE), implementing agencies (insurance companies), financial institutions (PACS as well as lead banks), other crop insurance facilitators like Common Service Centres (CSCs), researchers, and field level experts.

Given the state-of-the-art facilities of the agriculture sector and the production risks in the state of Odisha, a discussion was made on the need for a comprehensive insurance scheme and for the development of a conducive market that creates a win-win situation for both insurer (economically viable) and insured (affordable). A discussion on the benefits of integrating the available technologies with the scheme was also made. The participants were then asked to share their perspectives about the scheme.

The Perspectives of the Government of Odisha

The discussion with the representatives of the government started with presentations on how the crop insurance scheme(s) in Odisha evolved to become the PMFBY, its main features, detailed process of implementation, and the state's achievements. Emphasis was made on the active involvement of the State Government in taking up innovative steps to increase awareness among farmers as well as its coverage and to effectively implement the scheme, ensuring that benefits reach the targeted farmers. Besides, the government has also taken new initiatives to link the land records to the crop insurance portal to avoid duplications and target the plot-based claim settlement; to monitor CCEs through a mobile app and to receive real-time updates by incentivizing the officials at the grassroots level; to establish automatic weather stations at the second lowest administrative unit level (blocks); to establish drought monitoring cells at the lowest administrative unit level (GPs) and to use technologies and involve research communities in finding solutions to implementation constraints. Some major challenges were also indicated such as the following:

- Bringing more crops under the insurance;
- Increasing the coverage;
- Digitisation of land records to avoid redundancies and to smoothen the insurance application and settlement process;
- The issues of boundaries of insurance units as the state has recently increased new GPs from 595 to 681, which are yet to be included in the database;
- Application portal often slows down due to server problems, which often tends to limit the number of applications at the rush ends;
- Majority of the insured farmers are loanee farmers and efforts are needed to tap the non-loanee formers;
- The challenge to manage the end time rush for registration (usually 31 July for Kharif);
- Bringing sharecroppers under the coverage;
- Unifying the data base from different sources;
- Loss assessment in the case of mid-season adversity, localised calamities, and postharvest losses;
- Bringing down the delay in the claim settlement process that is currently taking more than 10 months;
- Preventing moral hazards in the yield estimation process; and
- More manpower needed at CSC to promote and increase the coverage of the non-loanee farmers under PMFBY

The Perspectives of Implementing Agencies

Representatives from all the major crop insurance implementing agencies participated in the workshop. These include the Agriculture Insurance Company of India Limited, National Insurance Company Limited, Cholamandalam MS General Insurance Company (GIC), HDFC

Ergo GIC, Reliance GIC Limited, IFFCO Tokio GIC Limited, State Bank of India GIC, and Tata AIG GIC Limited. These companies mainly emphasised the challenges that they are currently facing as far as implementation is concerned. Among these challenges are:

- Delay in receiving the data pertaining to sown area and yield estimation;
- Data processing and collation is time consuming and resource demanding data processing and collation as it is often in multiple formats with redundancies and errors;
- Technical issues with the PMFBY portal with respect to data uploading and downloading;
- Issue with the bidding method of selection of the implementing agencies and the need for an efficient alternative method;
- Unlike in other insurances, companies do not have information on the insured (individual farms and crop details) in the case of crop insurance which make it difficult to assess the sum insured;
- Lack of standard method for premium estimation;
- Double accounting due to ambiguities in land records and subsequent detail in claim settlement;
- Lack of company's infrastructure at the grassroots level;
- Problem in mid-season yield loss estimation;
- Adverse selection when there is a sign of low and delayed rainfall; and
- CCEs are being conducted at GPs but threshold yield data is available to block level which may not be appropriate for yield loss estimation

The Perspectives of Bankers

The bankers highlighted some major issues they usually come across with while facilitating the insurance application of farmers. These are:

- State is spread widely (for instance, it extends from June up to September during Kharif season) for which banks extend loans until the end of the period. However, the cut-off date for insurance application is until 31 July. Incorporating those who availed loans after the cut-off date is not possible as this would result in adverse selection and other associated problems;
- Banks are encouraging oral lease for lending crop loans to those who do not have land entitlements (mainly sharecroppers) and those will be automatically insured. However, not many are coming forward to avail of such loans; and
- PMFBY portal problem while facilitating the application

The perspectives of other stakeholders

During the 2017 Kharif season, CSCs were allotted to cover PMFBY. Since then, they are acting as third party insurance facilitators and playing a significant role in increasing insurance coverage, especially to non-loanee farmers. In addition to some of the above challenges identified by the bankers, they indicated the severe problem of accessing the portal while uploading data and during registration, especially at the last moments of the registration timeline.

The concept of choice behaviour in the context of crop insurance was introduced as well as how it could change across stakeholders and the possible driving factors. Based on previous studies and literature, a range of attributes pertaining to crop insurance was presented. The participants were then divided into two groups to discuss and identify the five most important attributes. For the first group, the five most important attributes were Insurance Unit, Risk Coverage, Transparency, Premium, Trigger point/Threshold Yield, and MSP coverage. These were identified mainly from the perspective of an ideal crop insurance scheme. The second group identified the five most important attributes mainly from the perspectives of the current scheme. They flagged village as an insurance unit, precise yield estimation method, digitalization of land records, policy reform to include sharecroppers in insurance, and timely and transparent claim settlement.

Photo 5.1 Crop insurance stakeholder workshop, IMAGE, Bhubaneswar

A way forward

The key parameters identified from all three above studies will be employed in main experiments of the study during the rest of the project:

- To conduct farmers' preferences and cognitive behavioural experiments; and
- To evaluate farmers' acceptance of different ways of integrating technologies using cognitive and field framed insurance experiments

Work plan 2018-19

The IRRI team will re-evaluate the identified varieties in H2H trials during Kharif 2018 and facilitate the seed production of the identified varieties linking demonstrations with certified seed production. RCM as a tool will be integrated with soil health card and soil mapping data to provide a holistic nutrient management plan for sustained higher productivity. Based on information from the characterisation of the rice-fallow areas, recommendations will be generated to increase the cropping intensity in fallows. A suite of knowledge management tools including the RKB, SeedCast, and Rice Doctor is in the process of contextualization and would be launched in 2018-19. With better correlation with ground data and secondary data, near real-time predictions of cropped area and yield estimates will be provided to assist the Government of Odisha in appropriately complementing crop cut information for yield loss estimates in the event of floods, among others. Details of the activities planned for Kharif 2018 and the subsequent Rabi season are as follows:

Component 1: Seed System Improvement

SN	Activity	No	Districts	Blocks	Area/ Number	Partners
1	Demonstrations (5 ha each)	420	14	42	4200	DoA, NGOs, OSSC dealers
2	H2H trials	3360	14	42	3360	AAOs, NGOs, Farmers, Dealers
3	Demos through OSSC dealers & their customers	1260	14	42	1260	OSSC dealers, Krishak Sathis, OSSC
4	Evidence Hubs (Crop Cafeteria)	5	5	Dt level	50 Dec. Each	DDAs, OSSC, KVK, Dealers & Farmers
5	Client-oriented Crop Cafeteria	2	2	2 in state	100 Dec. (Each)	NRRI, OSSC, Pvt Seeds
6	Quality seed production training sessions for farmers (25 per training)	109	30	109	2725	DDAs, IRRI, KVKs, OUAT, NGOs
7	TOT for QSP and management practices	2		1	100	NRRI, OUAT, KVKs, IRRI
8	Formation of women-led seed groups	30	30	30	30	NGOs, SHGs, DDAs
9	District-level Seed Meetings	30		Dt level	30	DDAs, KVK, OSSC, AAOs, Dealers
10	Awareness creation meetings (2/season) 100 farmers each	252		42	6300	DDAs, NGOs, Farmers
11	Testing different methods of introduction of rice seeds to farmers (a follow up research)					
12	RCT-based evaluation of the role of different seed systems for faster dissemination of STRVs					
13	Pilot SeedCast					DDAs, AAOs, Dealers, PACS, OSSC outlets, OSSC
14	Rabi demonstrations	500				DoA, NGOs, OSSC dealers

Component 2: Rice Fallow Management

SN	Activity	No	Districts	Blocks	Area/ Number	Partners
1	Demonstrations of pulses in the rice-fallow system and suitable flood-tolerant cultivars in flood-prone rice-fallow systems - at least 2500 has covered during the dry season and 200 haa in the wet season fallows	12500	15	60	2500	DoA, NRRI, OUAT, IIPR and NGOs
2	Pulse Varieties are tested and demonstrated under pulse village (in cluster form) - at least 3 improved pulse varieties are tested	3	3	3	3 districts	DoA, NRRI, OUAT, IIPR and NGOs
3	Atlas is prepared for flood and drought district-level rice productivity, village/block-level rice-fallow and cropping intensity maps at village level and shared with district-level DoA officers for the targeting of technologies and various other uses.	1	30		30 districts	DoA, NRRI, and OUAT
4	Inundation depth maps, irrigated area, land use, and soil maps are prepared.	3	30			
5	Village-level salinity maps are validated and ready for use.	1	10		10 districts	DoA, NRRI, and OUAT
6	Rice Pulse Monitoring System version 2 is ready to use and version 3 is prepared	1	30		30 districts	DoA, NRRI, and OUAT
7	Hydrogel and nano materials are tested at multiple sites including station experiments and adaptive trials	750	5	15	150 ha	DoA, NRRI, OUAT, and NGOs
8	Land use requirement & assessment and preparation of decision rules/tree for extrapolation domains - additional 2 major cropping systems are covered. Extrapolation domains are ready for rice-pulse and rice-rice systems	2	10		10 districts	DoA, NRRI, and OUAT
9	Research collaboration for the development of improved pulse technologies for rice-fallow areas					IIPR, OSRSC, NRRI, OUAT

Component 3: Rice Crop Manager

A. Dissemination of RCM recommendations to farmers and the development of dissemination and scaling pathways

SN	Activity	No	Districts	Blocks	Area/ Number	Partners
1	Setting up of RCM Kendras	25	5	25	DDA offices	OLM and CSC will use its available set up for generating recommendations
2	Training of trainers (AAOs) in Kharif and Rabi	6	3		At 7 districts	DoA and NGOs
3	Training of VAWs	150	10			
4	Training of NGO partners	18	15			
5	Dissemination of recommendations	60000	15		10 districts	DoA, NGOs, CSC, OLM
6	Monitoring of the use of recommendations	6000	15		10 districts	DoA, NGOs
7	Demonstrations / H2H (RCM vs. Farmers' method)	500	15		10 districts	IRRI staff, NGOs
8	Identification and development of dissemination and scaling pathways for ICT- based RCM	2500	5	35	2500 households	DoA, NGOs, SKYMET, IFFCO

B. Development of better Nutrient and Crop Management for Rice-based systems in stress-prone environments of Odisha

SN	Activity	No	Districts	Blocks	Area/ Number	Partners
1	Study the effects of different rice establishment methods and tillage practices in both dry and wet seasons on crop performance, nutrient and water use efficiency, and soil characteristics	1	1	1	1	OUAT
2	Optimization of Nutrient management for rice-based cropping system					
a.	Crop and nutrient management under DSR	1	1	1	1	OUAT
b.	Development of better Zn management options for Rice-based systems for Odisha	120	4			
c.	Evaluate and demonstrate the suitability of N fixers to curtail the use of inorganic nitrogenous fertilizers in RCM for rice-based systems in Odisha	2	2			
d.	Development of better nutrient management module for rice-pulse systems for Odisha	40	3			
3	Optimising fertilizer application rates and timing for rainfed rice in Odisha	1	1	1	1	OUAT

SN	Activity	No	Districts	Blocks	Area/ Number	Partners
4	Evaluation of crop management component of RCM (weed management)	1	1	1	1	NRRI
5	Development, validation and evaluation of RF component of CMRS	120	10			NRRI, OUAT, Comp. 1
6	Adaptive trials on using GIS-based yield monitoring for developing better yield targets in RCM	50	3		10 districts	Comp. 1 & 5, SKYMET

Component 4: Knowledge Management, Capacity Building

SN	Action	Mode	Collaborators	Timeline
1	Development and deployment of the RKB-Odisha			
	No. of knowledge management platforms established			Rabi 2017/18
	Development and strengthening of the district knowledge management platforms	Trainings (1+4)	OUAT/NRRI	Rabi 2017/18
	Stakeholder workshops	Workshops	OUAT/NRRI	Rabi 2018
	Content write shops	Write shops	OUAT/NRRI	May-18
	E-tutorial video production	Videos	Outsourced	Kharif 18
	Fact sheet development	Info-brochure	OUAT/NRRI	Ongoing
	Training manual development	Manual	IRRI	Rabi 2019
	Website development	Website	Outsourced	English Kharif 2018
	Field testing of the RKB	Study	OUAT/NRRI	Rabi 2018
	RKB usage training	Training	OUAT/NRRI	Rabi 2018 onwards
2	Development and deployment of the Rice Doctor Odisha			
	Pre-testing of the Rice Doctor mobile application		IRRI	Kharif 2018
	Translation of Rice Doctor to Odia language		outsourced	Kharif 2018
	Beta version of Rice Doctor in Odia language available to extension workers and farmers		IRRI	End of Kharif 2018
	Training of extension workers on the usage of the Rice Doctor		IRRI and Department of Agriculture	Rabi 2018 and Kharif 2019
3	Development and deployment of an IPM module for Odisha			
	Fine tuning of the existing IPM module as per survey results		IRRI, OUAT, NRRI, IIRR	Kharif 2018
	Testing of improved IPM module a per survey results		IRRI, OUAT, NRRI, IIRR	Kharif and Rabi 2018

SN	Action	Mode	Collaborators	Timeline
4	Implementation of the rice check program			
	Analysis of Rabi 2017/18 data		IRRI	March - May 2018
5	Implementation of the SLT program			
	Documentation and analysis of the Rabi 2017/18 SLT			May-18
6	Scholars program			
	10 Ph. D scholars joining as a part of the program		NRRI	June 2018 onwards
	5 M. Sc scholars joining as a part of the program		NRRI	June 2018 onwards
7	Partnerships strengthened			
	Collaboration and implementation of the program with OLM		OLM	Kharif 2018 onwards
8	Policy papers			
	Enhancing innovation and impact in Odisha rice sector		CRISP	End 2018
	"Leadership and Entrepreneurship Program for Women in Agriculture" for Odisha		ALCI	Kharif 2018

Component 5: Science-based Crop Insurance
5a. Remote Sensing-based Rice Monitoring System

SN	Activity	No	Districts	Area/Number	Partners
1	Ground data collection for Start-of-Season (SoS) verification & calibration	30	30	50	Possible partner DoA
2	Ground data collection for rice-and-non-rice (RnR) area validation	30	30	50	Possible partner DoA
3	SAR (Sentinel-1) and Optical (landsat 8) acquisition planning	1	30		
4	SAR (Sentinel-1) and optical (landsat 8) data processing and analysis	1	30	Entire state	
5	Early season product generation : rice area maps and area estimation	1	30	Entire state	
6	Early season product generation: SoS maps	1	30	Entire state	
7	Data collection for historical yield; historical & current daily weather data; agronomic management; and official yield data	30	30	Entire state	
8	Mid-season product generation and yield forecast	1	30	Entire state	

SN	Activity	No	Districts	Area/Number	Partners
9	End-of-season (EoS) product generation and yield estimates	1	30	Entire state	
10	RnR area map validation and accuracy assessment	1	30	Entire state	Possible partner DoA
11	EoS validation of yield estimates	1	30	Entire state	Possible partner DoA, component-1 and component-3
12	Preventive sowing mapping	2	30		
13	Abiotic stress map (Flood / drought) in case of natural disaster event	1			Areas affected by the abiotic stress will be monitored and mapped
14	Rice Ecosystem Map Generation	1		Entire state	
15	Rice Ecosystem Map field Validation and stakeholder consultation	30		Entire state	
16	Drone data collection	2			
17	Training on SoS and RnR data collection procedures	4			
18	Training on Mapscape-Rice	1			
19	Training for district officers on field data collection	1			
20	Training on Rice-YES (Yield Estimation)	1			

5b. Crop Insurance

SN	Activity	Number	Districts	Area/Number	Partners
1	Farmers' Risk Profiling	1500	15		Madhyam/GKS foundation (NGO)
2	Focus Group Discussions	12		2 in each of the 6 notified district clusters*	DoA, Madhyam/GKS foundation (NGO) *clusters as per PMFBY
3	Choice experiments and risk preference games	2000-3000	15		DoA, Madhyam/GKS Foundatn (NGO)
4	Stakeholder Workshop	1			
5	Product profiling and insurance games for their viability	2000-3000	15		DoA, Madhyam/GKS foundation (NGO)

*****End of report*****

International Rice Research Institute
First Floor, CG-Block, NASC Complex, DPS Marg
Pusa Campus, New Delhi - 110 012, India
Tel: +91-011-6676 3000
Fax: +91-011-2584 1801
Web: www.irri.org