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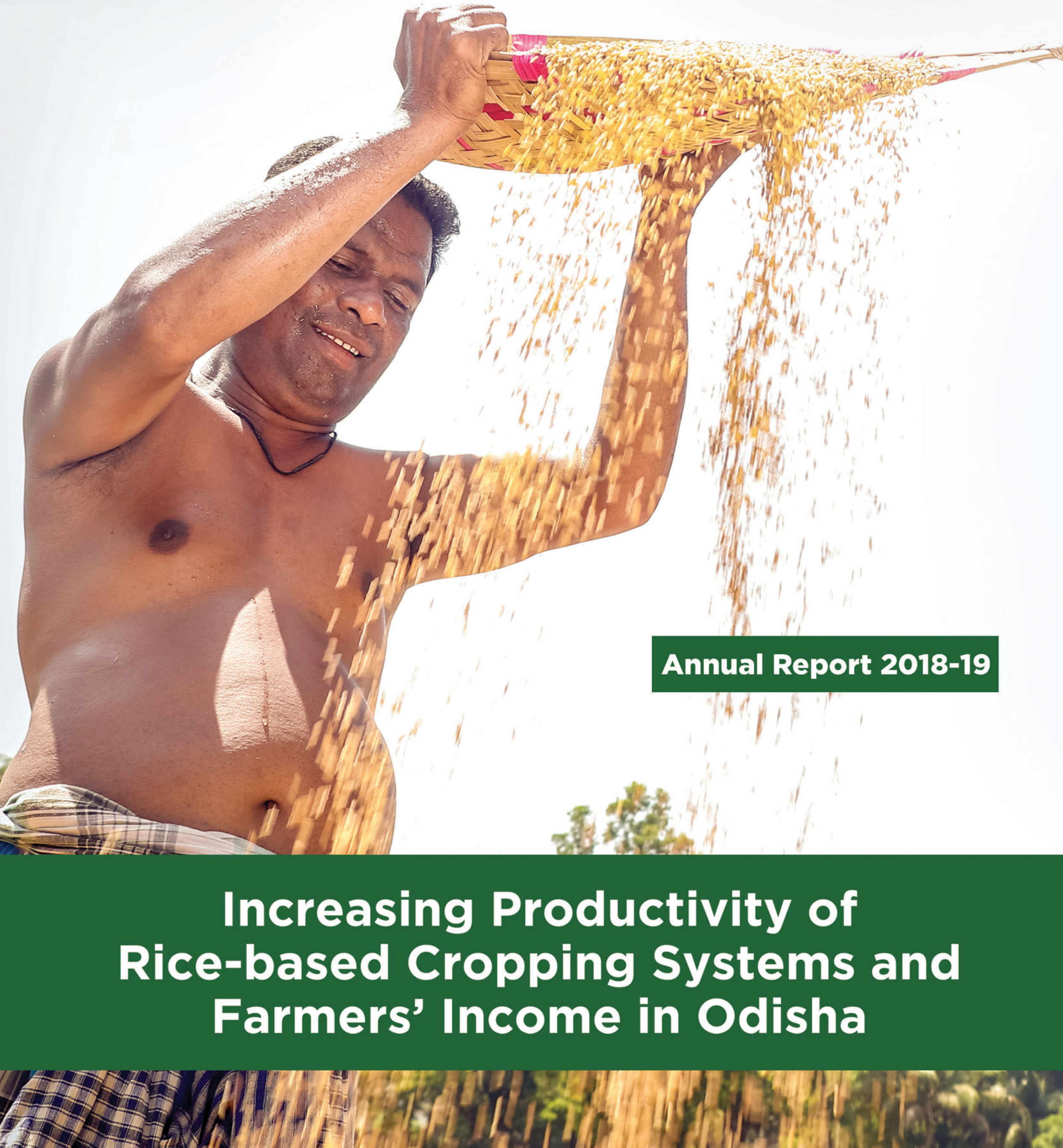

Annual Report 2018-19

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

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Annual Report

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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.

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Preface

The primary focus for development of the agricultural sector in India has changed from a productivity to income centred approach that attempts to achieve higher income through improved productivity, resource use efficiency, increased cropping intensity and diversification towards possible high value crops. Shifting farmers from agriculture to non-farm activities and improvements in terms of trade (real prices received) for farmers are other strategies beyond the agricultural sector, envisaged by the Government of India.

Rice is the major food crop with highest level of farmer engagement, many subsistence smallholder farmer's dependents on the crop for food security and livelihoods and few commercial rice growers, more rainfed than irrigated systems, poorly mechanised, labour intensive farming practices and above all, limited information flows. The strategies needed to transform the rice sector to a technology and knowledge driven enterprise need to be multi-faceted, explicitly supportive of the small and marginal farmers, youth and women and, increasingly focused on equity, household food and nutrition security and, building resilience of farming households and communities. Governments are investing in Research for Development programmes to ensure that technology is not just about sustained productivity growth but also able to address the issues of climate related perturbations and changing demographics of the rural landscape.

International Rice Research Institute, with financial support from the Department of Agriculture and Farmers' Welfare, the Government of Odisha, has been working to 'Increase Productivity of Rice and Rice-based Cropping Systems and Farmers' Income in Odisha' in project mode encompassing several themes that collectively purports to better livelihoods of farmer's dependent on rainfed rice systems. The work plan is envisaged and implemented in collaboration with several National Agricultural Research Institutes, State Agricultural University, Non-Governmental Organizations, development agencies, the state/district/block/GP officers and functionaries of the Department of Agriculture and Farmers' Welfare, Odisha Livelihood Mission and the farmers in different districts. Information generated from the interventions at different levels during the last three years have been analysed by domain experts, inferences have been drawn and the way forward to accelerate, sustain and scale the products and processes is being discussed.

This annual report for the period 2018-19 outlines the directions that this ambitious project has taken based on the field data emerging from researcher-designed, farmer-managed trials and demonstrations, research station experiments, capacity building programmes and, discussions on policy and investment that has the potential to increase the odds of a successful transformation of the rice based farming system in the state of Odisha.

Several new initiatives are also on the anvil within and outside the project to upgrade and scale out new risk reducing technologies, improve genetic gain, conserve the resources base and convert a hitherto subsistence system to a commercially oriented enterprise, involving village youth and women farmers and riding on the efficiencies of ICT and GIS based rice science. The process serves to fulfil the responsibilities of the government in so far as it helps to better navigate the complexity of transformation and reinforces its commitments to make agriculture sustainable and profitable, ensuring access to food for all farmers and consumers.

Ranjitha Puskur

Acknowledgement

The project on 'Increasing Productivity of Rice-based Cropping Systems and Farmers' Income in Odisha' was initiated in 2016 by IRRI with the support of the Department of Agriculture and Farmers' Empowerment (DAFE) of the Government of Odisha. IRRI would like to express sincere gratitude to all the government officials, ICAR institutions, OUAT, partner organizations, NGOs, seed growing agencies, dealers, and farmers for their tremendous support to achieve the desirable goal of strengthening the rice-based cropping system in Odisha. Dr. Saurabh Garg, Principal Secretary, DAFE has 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) to implement the activities as envisaged in the third year plan. Without his constant encouragement and support, the project objectives would not have been achieved by IRRI's efforts alone.

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 support & 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 the district functionaries. The active role played by the directors of OSSC and OSSOPCA in prioritizing the production and certification of stress-tolerant rice varieties and the support from Director, IMAGE in holding numerous meetings and workshops through the year is also thankfully acknowledged.

Many institutions also provided their enormous support in the implementation of this project. Orissa University of Agriculture and Technology (OUAT), Krishi Vigyan Kendras in different districts, National Rice Research Institute (ICAR-NRRI), and Central Institution for Women in Agriculture (ICAR-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 on women leadership. The proactive roles of Dr. Surendranath Pasupalak, VC, OUAT; Dr. Himanshu Pathak, Director, NRRI; and Dr. S K Srivastava, Director ICAR-CIWA, in facilitating these activities are gratefully acknowledged. The collaborative initiatives by IRRI & Odisha Livelihood Mission (OLM), was hugely supported by Mr. Pranabjyoti Nath, IAS, and subsequently Mr. Smruti Ranjan Pradhan, IAS, CEO cum Director. IRRI is thankful for their support in implementation of its activities through OLM.

The active participation of officers of the DDAs, Assistant Agriculture Officers (AAOs), and other staff in training programmes, meetings 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. Their valuable suggestions and feedback was helpful to implement the activities smoothly. Shri Suresh Pal, Joint Director of Agriculture (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 dynamic role in project implementation is really appreciated. The continuous support from Sri Saroj Kant Chand and Tarun Chotoray, officers of DAFE, was very helpful in timely & smooth reporting of project activities. The enthusiastic support and partnership of thousands of men & women farmers, field functionaries of DoA, seed and input dealers, NGO representatives and many SHGs made it possible for IRRI to reach out to the rice farming community in the state effortlessly. Their contributions and efforts are thankfully acknowledged.

Introduction

India harvested a record 284.8 million tons of food grains during 2017-18, which included 112.9 million tons of rice. The government set a target of 290.25 and 113 million tons for food grains and rice respectively for 2018-19, despite a monsoon deficiency of 9% during the wet season of 2018. The first advance estimate (Agricultural Statistics Division, Department of Economics and Statistics, September, 2018) indicate that kharif rice production would be 99.24 million tons, marginally surpassing the target of 98 million tons. Absence of major shortfall in production during the current decade, especially for rice, with annual production above 105 million tons even in drought years, indicate that the rice production system has attained some resilience to adverse climatic events of drought, flood etc. Having achieved the target of 280 million tons of food grain production and 110 million tons of rice by 2020, and rising levels of export of basmati as well as non-basmati rice during 2010-11 to 2017-18, the country is poised to reflect on its future strategy for better returns to farmers with equity considerations riding over other factors. The income approach focuses on achieving high productivity, reduced cost of cultivation and remunerative price on the produce, with a view to earning higher profits from farming.

Strong and incessant technology backstopping is needed to resiliently respond to the adverse effects of climate change and sustain the productivity gains over the years. Government of Odisha has invested in Research for Development with the aim to upgrade the technology, create awareness, fast track dissemination and, enable adoption of an integrated suite of technical and institutional innovations that can meet the requirement of farmer's dependent on rice based cropping systems. International Rice Research Institute has been working in the state of Odisha since 2016-17, with the support of DAFE, to fulfil the mandate of achieving high and sustained system productivity with climate resilience, better income, risk reduction and equitable distribution of the gains from productivity growth among small and marginal famers, especially women.

Seed systems: A cursory glance at the technological options and their use in rice farming in the state reveals that though there has been modest enhancement in productivity *per se*, there is good scope for improvement in varietal replacement rates and seed provisioning to adequately mitigate the effects of adverse weather events. During 2018, the state agency, Odisha State Seed Corporation, sold 27,220 tons of paddy seed through the Primary Agricultural Cooperative Societies (PACS) and other input dealers. This is sufficient to cover only about 15% of the rice growing area of the state. Private players would have contributed to another 2-3%. Rest of the seeds are farmer-saved seeds. Productivity growth becomes a formidable challenge when seeds of eight of the top ten varieties sold to farmers by the seed corporation are 15 or more years old. During 2018, 71% of the seeds sold belonged to this category (Swarna, Pooja, Vijetha, MTU 1010, Lalat, Pratikhya, Sarala and Khandagiri). Two varieties among the top ten (14%) were stress tolerant varieties, released during the last ten years (Swarna Sub1 and Sahbhagidhan) and the rest 15% were either old varieties gradually fading out or new entrants finding foothold in specific ecologies. Most farmers in climate vulnerable areas use improved cultivars selected many years ago or land races selected generations ago, in a different climate. The current commercial cultivars were developed in a climate different than today's, placing farmers at risk. The objective of breeding and seed systems serving small holder farmers should therefore be to ensure that they use varieties developed in the last 10 years (Atlin et al 2017). Rapid varietal turnover must be supported by active dissemination of new varieties and active withdrawal of obsolete ones. The farmers who are best protected from climate change are those who have access to a steady stream of new cultivars bred in the current climate. Seed systems are required that deliver new varieties to farmers quickly, and then just as quickly replace them, keeping pace with the changing climate.

IRRI has invested in research to ensure a steady supply of superior performing, region specific rice genotypes with stress-tolerance and also made efforts to fast track the adoption of such varieties through awareness creation that help build seed demand from the different stakeholders of the seed value chain. During kharif 2018, about 220 tons of paddy seeds of stress tolerant varieties were mobilised for crop cafeteria, cluster demonstrations, head to head trials and seed production programmes. IRRI team worked with DoA, OLM, a number of NGOs, input dealers, seed producers and involved directly or indirectly more than ten thousand farmers to enable them to harvest a good crop of rice and to make them aware of the technological options to reduce risk from recurrent problems of drought and submergence. Incidence of severe drought in the districts of Sundergarh and nearby areas during mid-September to October and occurrence of sequential floods in the coastal districts during September and October were 'trials by fire' for the stress tolerant genotypes during the season. Remarkably superior performance of STRVs in the face of intense stress has, however, boosted the confidence of farmers. They will continue to adopt and spread the seed and message to fellow farmers for greater benefits in years to come.

Managing resources: Nutrient management decisions require knowledge of the expected crop yield response to nutrient application, which is a function of crop nutrient needs, supply of nutrients from indigenous sources, and the short and long term fate of the fertilizer applied. Application of fertilizers without information on soil fertility status and nutrient requirement by crop leads to nutrient toxicity or deficiency either by overuse or inadequate use. General fertilizer recommendations, standardised based on yields of multi-location trials equated with variable doses of major fertilizers, rely on medium soil fertility rating. The doses are then increased or decreased by 25-50% as per the fertility gradient. Soil test based application of plant nutrients help to realize higher response ratio and benefit: cost ratio as the nutrients are applied in proportion to the magnitude of the deficiency of a particular nutrient. Correction of the nutrients imbalance in soil helps to harness the synergistic effects of balanced fertilization. The Soil Test Crop Response (STCR) approach is based on the three basic requirements i.e., quantity of nutrients required in kg per quintal of economic yield, the percentage contribution of nutrients by the soil and the contribution of nutrients through the fertilizers to optimize the yield.

Soil-based approaches have attempted to tailor fertilizer recommendations to the soil nutrient-supplying capacity of specific fields, as determined through soil-test analyses. Rice, unlike other main food crops, is typically grown on submerged soils. Soil submergence alters biological and chemical processes that influence the release of plant-available nutrients. Soil-test analyses often do not effectively account for these effects of soil submergence on soil nutrient supply and the needs of rice for supplemental nutrients (Buresh, 2014). The quantity of soil nutrient chemically extracted with soil-test analyses is consequently often not as effective for submerged as non-submerged soils in assessing the nutrient needs of the crop. Soil-based approaches also do not provide rice farmers with flexibility to adjust their fertilization practices based on crop performance and climatic conditions during a given season.

Site-specific nutrient management (SSNM) for rice, developed as a plant-based approach, provides the principles and guidelines that enable farmers to apply fertilizer to optimally match the needs of their rice crop in a specific field and season. The SSNM approach was developed, evaluated and refined with information gathered from about 200 irrigated rice farms in diverse rice growing environments in Asia. With the plant-based SSNM approach the fertilizer N required by a crop can be estimated from the anticipated crop response to fertilizer N, which is the difference between a yield target and yield without fertilizer N—referred to as the N-limited yield. N-limited, P-limited and K-limited yields are calculated from nutrient omission plot trials (NOPT) fertilized with other nutrients to ensure they do not limit yield. Nearly 500 data points from NOPT conducted in Odisha, Bihar and Uttar Pradesh (CSISA NOPT Rice, 2012-2015) are available for estimation of nutrient (NPK) limited yield.

Rice Crop Manager, which works on the principles of SSNM, is an application that could be accessed via a smartphone or a computer with net connectivity. It allows extension officers to give farmers a site-specific recommendation on nutrient management, depending on the specific variety they use, their yield from the previous season, and the site-specific conditions of their field. RCM derives the nutrient management recommendations from Oryza Version 3, an eco-physiological crop growth model, calibrated and validated over many years with comparisons between model simulations and real world measurements. Case studies have shown that the root mean square errors (RMSE) between simulated and measured values for total biomass and yields ranged from 11.2% to 16.6% across experiments in non-drought and drought and/or nitrogen-deficient environments making Oryza v3 a robust and reliable model for predicting the growth and yield of rice in non-stressed, water stressed and Nitrogen stressed environments.

Rice Crop Manager interface has been made multi-lingual, including Odia, to suit the local requirement and it is being disseminated widely among the resource poor, small and marginal farmers of the State. Till date around 90,000 farmers have been reached through this tool. Different extension channels have been identified and a mix of them is being deployed to reach out to more and more farmers. Directorate of Agriculture, with its robust presence and programmes in all districts of the state constitute the largest extension channel and IRRI, in collaboration with the Directorate, is investing in capacity development of the state extension functionaries who can ensure the sustainability of the usage of the tool. The extension staff at block and village levels have been trained in a Training of trainers (ToT) mode to operate the tool, interview the farmers and to transfer the crop management advisories to them in a printed one-page format. A number of RCM Kendras (kiosks) with ICT devices have also been established at block office level in many districts for this purpose. IRRI has also partnered with many leading NGOs having wide network and catering to a large group of rural communities in a symbiotic association. Experts from IRRI are helping the NGOs in expanding their knowledge base on rice farming and at the same time using the NGO's capacity to mobilise and motivate farming community in adopting better crop management practices through RCM. NGO's community resource persons are trained in the use of RCM to reach out to the rice growing farmers of their operational areas. Input dealers enjoy a large number of footfalls of farmers who visit them both for purchase of inputs and advice. So they were considered to be an important source for knowledge dissemination and a pilot has been initiated by IRRI to work with them to help disseminate RCM recommendations. IRRI has also collaborated with IFFCO Kisan Sanchar Limited (IKSL) and Precision Agriculture for Development to improve farmers' decision-making with improved techniques, fertilizer doses, weather forecasts, and health.

Managing fallows: Environmental heterogeneity is higher in Odisha compared to the Indo-Gangetic plains and the deltaic regions of the south. Hence rice varieties ranging in duration from 90-160 days are needed in different parts of the state, matching with the hydrology and soil type. Many current commercial cultivars are longer in duration and there being no moisture after their harvest, the land remains fallow in the rainfed drought prone inland districts. Early withdrawal of monsoon in some years also reduce moisture available after rice harvest. The concept of yield per unit area and time would be desirable where the yield of individual crops may be slightly reduced (e.g. by shorter season) to allow for improved annual yield of the whole system (in currently mono-cropped areas). The advantage is that early duration varieties vacate the land early and the subsequent crop gets a head start of 10-25 days. A number of early duration, drought-tolerant varieties (Sahbhagi dhan, DRR 42, DRR 44, Swarana Shreya) are being promoted in the state by IRRI, keeping in view the requirement of drought-prone areas. Bina dhan 11, a submergence tolerant, early duration (120-125 days) variety and several other stress-tolerant varieties are also finding acceptance among farmers who wish to grow a rabi crop after early rice harvest in medium and shallow lowlands. In the coastal region, excess moisture after rice harvest delays the establishment of the second crop. The farmers grow pulses or other crops with receding moisture and rely on the occurrence of one or two winter showers, failing which the crop is severely affected by drought at pod formation. Moisture conservation and protective irrigation would be needed to save the crop but many farmers settle for a reduced harvest or abandon the crop after a meagre picking of pods.

Managing fallows with a sequence crop, beyond the primary benefits of increased cropping intensity and higher farm returns, also add Carbon to the soil, and extract plant available N unused by the preceding crop, thereby reducing N2O emissions. IRRI is promoting water and nutrient efficient rice-pulse systems to manage fallows and derive benefits from both – higher farm productivity and better environment. However, to efficiently target these potential fallows, a detailed characterization of the resources is needed (e.g., salinity, submergence, inundation depth and groundwater availability, etc.) to systematically analyses the potential opportunities and constraints.

IRRI carried out high resolution mapping of rice fallows (current and permanent fallows) and its spatial-temporal change (by comparing the rice fallows in the year 2006, 2010, 2016, 2017 and 2018) along with the mapping of major associated abiotic stresses (e.g., flood, drought, and salinity) and other reasons for monocropping (e.g identification of areas having long duration rice cultivars). Residual soil moisture content after rice are often sufficient in most of the districts to raise short-duration pulses (55-75 days) and oilseed crops. However, a detailed analysis of spatiotemporal profiles of soil moisture availability and duration during the Rabi season was required to precisely target and utilize the short residual soil moisture window (varies from 10-30 days, depending upon land types). Analysis of long-term average of spatiotemporal soil moisture profile can assist in identifying the areas having low, optimum and excessive soil moisture during the sowing period in Rabi season. It also provides the information (1) to identify the areas where soil moisture is retained for shorter or longer period after initial germination, and (2) whether adequate soil moisture can be available up to the pod formation/grain filling stage of the crop. By compiling all the information as mentioned above, a detailed atlas has been prepared (covering data of all 30 districts of the states) to precisely target short duration pulses at village/block level in the potential rice fallows lands in Odisha.

Demonstration of improved cultivation practices for green gram and black gram were targeted in 22 districts in Odisha covering approximately 7200 hectares in last three years (2016-17, 2017-18 and 2018-19). Agronomic interventions with extra short duration varieties of green gram and black gram, use of hydrogel for in situ moisture conservation and better crop vigour and nano chemicals (root growth promotors to utilize sub-surface soil moisture) were also evaluated/demonstrated during rabi 2019.

During January 2019, IRRI organized a workshop of CGIAR institutions active in the state of Odisha to collate efforts on mapping rice fallows in the state and document current synergies and future prospects. The purpose was to prepare a strategic, joint work plan for the mapping and management of rice fallows in Odisha. Following the workshop, IRRI has established on-farm trials jointly with ICRISAT, ICARDA and CIP in several villages to showcase the potential of rice fallows for intensified cropping.

Satellite based monitoring of rice and crop insurance: Development of remote sensing technology has greatly improved our capability to monitor agricultural crops at large scale on a repetitive basis. Remote sensing along with ground-truthing and other geospatial technologies offer immense potentialities and advantages in estimating start of the season, rice area mapping and yield estimation when combined with crop modelling. Integrating remote-sensing data and a crop growth model is more promising than the empirical approach of translating remotely sensed vegetation indices directly into crop yield and production values. This is because the integration approach exploits the synergies between: (i) remote-sensing technology strength in capturing spatial and temporal variation related to agro-practices (e.g., crop establishment dates) and seasonal crop development (i.e., phenology) and vegetation status (e.g., leaf area index); and (ii) process-based crop growth model strength in reliably simulating yield by capturing biophysical growth drivers (microclimate, water, and nutrient) once key parameters are properly assigned (Setiyono et al 2018). In addition to supporting risk reduction efforts by supporting crop insurance, the information from remote-sensing technology can be used to identify and target hot-spot areas for interventions to reduce yield gaps and optimize resource use to ensure sustainable rice production. During the wet season of 2018, IRRI generated rice area map, estimated yield and provided flood maps affected by the cyclone 'Titli', during October, 2018. These efforts were followed by socio-economic and policy research to identify factors that affect crop insurance uptake and ways to improve acceptance of the insurance scheme by bundling risk reducing technologies and other options.

Managing pests, diseases, deficiencies/toxicities: ICT tools for problem diagnosis and development and testing of Integrated Pest Management modules to effectively manage the major biotic constraints require clear understanding of the prevailing pest/disease scenario, varietal composition, input use and the weather that affect the rice crop during the wet and dry seasons. Rice Doctor is an App based diagnostic tool developed by IRRI that helps in the diagnosis of field problems by an elimination process. User testing of this App was done during this year and IPM modules evaluated in a number of districts to identify suitable modules for management of diseases and pests.

Enabling women farmers: The change from complete dependence on farm income to farm-plus-off-farm income, necessitated by poor returns from the farm and cash needs to meet family expenses including education of children and healthcare, have set up a process of predominantly male out-migration, leaving behind women in the household to manage the household as well as farming activities. This entails a shift of focus to enable women to take farming decisions on their own, reduce drudgery and the time spent on tasks, improve and standardise product quality, link them directly to markets (farmer to consumer) to realise profits with minimum cost per unit area and help create wealth. Organizing women into groups and federations of SHGs in Odisha by the Department of Cooperation have brought about modest changes in the livelihood scenario in several villages. Formation of SHGs in villages across the country have also helped in small savings and instilled confidence among the women to take up small businesses to medium enterprises though the number of success stories are countable on fingers. What is needed next is to learn from the existing change agents, adapt and catalyse the transformation to scale using appropriate business models. In the rice sector, the immediate requirement is a de-centralised seed producer to consumer (farmer) model to accelerate the process of sourcing breeder seeds of recently released paddy varieties and converting them to foundation and certified seeds for sale in the different districts. This will not only improve the availability of recently released varieties locally but also help the Odisha State Seed Corporation to fulfil the demand for new varieties without having to procure, transport and process the seeds centrally. The seed corporation and certifying agency may assist the women led groups/federation in maintaining quality standards, setting up mobile seed processing units, certify their products and help the groups get remunerative prices by collectivisation and saving on avoidable fringe expenses. IRRI made an initiative in this direction during 2018-19 and selected a prospective region in the district of Kalahandi to establish a women-led farmer producer organization. Working with Access Livelihoods India, IRRI is trying to equip a group of 3000 women farmers to come together, use technology and skills needed to build and operate a market-oriented collective revolving around seed production, agro-processing, input and services supply to leverage the economies of scale with better efficiencies in production and ensure a greater share of returns to themselves.

Knowledge management, *Capacity building*: Sharing and exchanging the wealth of information and knowledge generated from rice research at International, national and regional level through intermediaries to the farming community has to be done in a way that makes the information relevant, localised and useful. ICT tools have opened up new avenues for knowledge dissemination and access to information has increased manifold with internet and cell phone penetration in the rural area but most farmers, especially the small holding farming communities, lack access to the digitized world. Developing content in local language, updating information periodically and training extension service providers and farmers to use ICT tools will help overcome the digital divide. IRRI has transformed the content of Rice Knowledge Bank suitably to address these needs.

Linking research to farmers has been the traditional role of extension specialists through training and communication of technical information. Changing agricultural landscape has necessitated that extension specialists, or those who work in Extension and Advisory Services (EAS), acquire new knowledge, skills and expertise to respond effectively to the emerging challenges, broaden their mandate and work collaboratively with other actors to support rural communities beyond technology and information sharing. IRRI organized a workshop on Capacity Needs Assessment in collaboration with Department of Agriculture and Farmers' Welfare and the Centre for Research on Innovation and Science Policy to identify capacity needs at individual and organization level. Outputs from the workshop has been summarised into a report and the next steps to implement the recommendations are work in progress.

The executive summary and narrative report in the following sections highlight the various activities and outcome of research conducted under the IRRI-Odisha project during 2018-19. Activities planned for 2019-20 are also listed at the end.

Executive summary

Rapid breeding cycles, selection of productive commercial cultivars and their dissemination are important in developing and intensifying cropping systems facing climatic perturbations. While ensuring improved productivity with stress-tolerant rice cultivars, the project also addressed variability in soil fertility across farms by disseminating location specific, ICT based crop management tools that maximises resource use efficiency, reduces losses from biotic stresses and helps build and maintain soil health. GIS tools were used to delineate rice fallows amenable to crop intensification and trials conducted to identify and promote techniques to improve the performance of pulses under varying moisture regimes. Opportunities to scale up and scale out these technologies and processes were explored with a lens on gender-responsiveness. Potential to increase and sustain farm income through decentralised entrepreneurship models in the rice agri-food systems including seed and agro-processing is under appraisal. Near-real time assessment of crop losses using satellite based rice crop monitoring, socio-economic studies that helps to understand risk perception by farmers and bundling insurance products for better acceptance among the farming community were other interventions made. Salient findings and outcomes of the activities undertaken during 2018-19 are summarised below:

Seed systems:

Five evidence hubs (EHs) were organised in the districts Angul, Bhadrak, Sambalpur, Koraput and Puri to assess the performance and fitness of STRVs in a particular agro-climatic region. Collective evaluation and ranking of the varieties by different stakeholders, based on the phenotypic acceptability and perceived suitability for the location combined with the data on grain yield and other known varietal characteristics including tolerance to abiotic and biotic stresses helped in choosing appropriate varieties for different regions.

Swarna sub 1, CR 1009 sub 1, Bina dhan 17 and Bina dhan 11 were the best bets for submergence ecologies while BRRI dhan 71, Bina dhan 11, Swarna Shreya, DRR 44, and Sahabhgi dhan were rated high for their suitability in the drought prone districts. Swarna Shreya, a drought-tolerant variety of 125 days' duration, released and notified in Bihar recently, proved to be have good potential in the inland districts.

Ecology specific potential STRVs were evaluated by 3463 farmers in 43 blocks of 15 districts in comparison with different local and high yielding varieties of their choice. Bina dhan 11, CR 1009 sub 1 and Swarna sub 1 had distinct yield advantage over other varieties in the coastal region. DRR 44 under moderate drought and Sahbhagi dhan under severe drought condition were the preferred choice of farmers in the drought prone areas.

Cluster demonstration of different STRVs, in collective parcels of 5-10 ha owned by different farmers, were implemented in an area of 4211 ha in 43 blocks in 15 districts during 2018. While Bina dhan 11 had maximum area coverage across ecologies, DRR 44 and Sahbhagi dhan in the inland districts and Swarna sub 1 and CR 1009 sub 1 in the coastal districts predominated these demonstrations. Versatility of Bina dhan 11 under varied environments with stable performance in kharif and rabi seasons is an indicator of its potential to replace many older high yielding varieties that are in the seed chain for more than 15 years.

Awareness and demand creation through the network of input dealers (seed) was attempted by distributing mini kits of different STRVs among 2716 farmers through 199 dealers in 15 districts. Follow up with the dealers is planned to estimate increase in seed demand.

Training of trainers for quality seed production and storage at NRRI and subsequent training for 2730 farmers (1428F, 1302 M) and distribution of IRRI-super bags for seed storage has made it possible for small and marginal farmers to informally produce and use their own seed, maintaining purity and quality. On the other hand, formal seed production through OSSC and private seed entrepreneurs have also been enhanced by linking and facilitating the procurement of breeder seed from different institutions by these agencies for STRVs that are newly released and notified by the Central Sub-Committee on Crop Standards.

Fallow management:

Integrated analysis of time series remote sensing data sets of optical and microwave imageries for the three-year period 2016-19 revealed that fallow area ranged from 1.97 to 2.20 million ha in Odisha (40 to 45% of the net cropped area), out of which about 1.34 million ha would be considered as permanent rice fallow as revealed by the analysis of frequency of common area for the three mapping years of 2015-16, 2016-17 and 2017-18.

Analysis of long-term average of spatio-temporalsoil moisture profile revealed that the rice fallow areas of Bolangir, Nawarangpur and Sundergarh do not have enough residual moisture to sustain a sequence crop after rice harvest. Rice fallow area in the districts of Anugul, Cuttack, Dhenkanal, Jajpur, Kalahandi, Keonjhar, Koraput, Malkanagiri are suitable for sowing during 1st to 15th December where as in Baleswar, Bhadrak, Ganjam, Kendrapara, Khurda, Jagatsinghpur and Puri districts, sowing can be taken up to the end of January.

Agronomic interventions to enhance crop growth using a nano-solution had the highest impact on green gram productivity with 1.5 times increase in yield over the improved practice of growing pulses using fungicides, insecticides and rhizobium during the rabi season of 2017-18. Green gram variety Virat (early, 55-60 days' maturity) responded well to the treatments and produced yields comparable to other existing varieties.

During 2018-19 rabi season, pulse demonstrations have been taken up in about 2500 ha involving nearly 8000 farmers in 21 districts. Five different crops (i.e., Sweet potato, Blackgram, Greengram, Chick Pea, and Pigeon Pea) have also been demonstrated by four different CGIAR organizations (CIP, ICARDA, ICRISAT and IRRI) in around 10 ha area in two different blocks of Puri district under Multi-Institutional Rice-Fallow targeting initiative by ICAR and Ministry of Agriculture, India during rabi 2018-19.

Version 2 of the Rice Pulse Monitoring System has been developed to collect and store geo-referenced information, along with a suite of geo-spatial tools to visualize, analyse and manipulate ground data for various needs. The app has the capability to cover rice, pulses and oilseeds for polygon generation and its conversion to various formats for data management and decision making.

Crop and nutrient management:

During kharif 2018, 81 hands-on trainings were conducted in which 1729 staff of DoA and NGOs were trained to use the Rice Crop Manager in kharif season. Recommendations generated by the different dissemination channels were 29800 for the wet season of 2018. These recommendations are generated before crop establishment during kharif and rabi season. Crop advisories were sent to around 11,000 farmers during kharif 2018 through voice calls in collaboration with Precision Agriculture Development (PAD) during critical growth stages of the crop to remind the farmers about fertilizer application schedules received earlier.

Farmer group meetings, field demonstrations, field days and crop cuts were organized throughout the season to create awareness. IRRI trained field staff of OLM in several districts and collaborated with common service centres to increase access of the tool to larger number of farmers.

Convergence with other central/state government schemes was attempted. Farmers adopting improved varieties under BGREI were provided RCM recommendations in three districts of Odisha to demonstrate the advantage of improved nutrient management along with improved varieties. The farmers (20 n) harvested, on an average, an additional 0.83 t/ha over recommended fertilizer practices.

The most preferred mode for accessing RCM is the doorstep delivery of generated recommendations through a VAW/NGO staff/IRRI staff as against getting it from an RCM Kendra/nearest input dealer/generating it from farmers' own ICT device, as assessed by a survey conducted on 2200 early adopters of the ICT tool. Only two per cent of ICT device owners reported accessing crop or weather related information from internet through their ICT devices.

Knowledge management, pest management, entrepreneurship, capacity building:

Content development for a rice knowledge bank specific to the state of Odisha with information on current commercial cultivars, their distinguishing characteristics, crop calendar for STRVs and production practices were completed, e-tutorial videos captured and discussion held with NRRI for synchronization with existing platforms (Rice Xpert). Content review by knowledge management committee, and translation/voice over in Odia are next steps planned.

Diagnostic efficiency of Rice Doctor (RD), as an ICT tool for identification of rice diseases, insect pests and nutrient deficiencies/toxicities, was tested and compared with the stock knowledge of respondents and material guided diagnosis (text, pictures). Respondents (258) were officers and field functionaries of the Department of Agriculture, Odisha Livelihood Mission, PG students of OUAT and farmers. Though diagnosis took longer time with RD initially, 98.7% of respondents were confident about its efficacy with increasing familiarity of using the digital tool. The app will be integrated with e-surveillance platform and will be upgraded with additional features as a next step.

Pest management decisions were influenced by pesticide dealers as revealed by a survey conducted in 20 districts with about 3000 farmers. Majority of respondents had not contacted agricultural extension officials in the last two years. Preventive measures like seed treatment was very low and awareness about newer chemicals and biological control measures poor. A combination of chlorpyriphos and cypermethrin was the most used pesticide indicating the need to test IPM modules and step up farmer-extension service provider interactions.

IRRI entered into a partnership with Access Livelihoods Consulting India (ALC India) Ltd. to set up Women Farmers' Producer Company (WFPC) in Kalahandi district involving 3000 women farmers of a cluster of 15-18 villages of Dharmagarh and Koksara blocks. Feasibility study was completed and a business strategy developed for setting up the WFPC, revolving around quality paddy seed production, rice production, secondary processed products and other value added services.

A Capacity Needs Assessment (CNA) workshop was organized in partnership with Centre for Research on Innovation and Science Policy (CRISP) and ICAR-Central Institute for Women in Agriculture (CIWA) in July 2018 to strengthen extension and advisory services (EAS) in the state. Recommendations arising from the workshop were shared with senior officials of DAFE.

Satellite based rice monitoring and crop insurance:

IRRI implemented satellite-based rice monitoring system to capture rice planting progression at near real-time and generated relevant and reliable rice area map products. Two rounds of ground data collection were conducted, first early in the season to support site specific parameterization of rice area classification using MAPScape-Rice software and second toward later part of the growing season to conduct independent assessment of rice area map accuracy.

Estimated rice area data were consolidated at state level after validating rice area map at individual district. During 2018 kharif season, SAR based rice area estimates indicated a total of 3,501,705 ha rice cultivated. Accuracy of rice area estimates across the state of Odisha was 93.5%. Rice area map accuracy at the individual district level ranged from 86.5 to 99.1%.

Seasonal dynamics of the kharif season was effectively captured through the use of multitemporal SAR data. Start-of-season map indicated that the peak of planting occurred during August which accounts for 47% of the total planted rice area that comes under early winter, 31% during June, considered as Autumn rice along with mixed Autumn and early winter in July with 16% of area and 6% of late winter in September.

Yield estimation system was implemented based on integration of SAR data with ORYZA crop growth model using Rice Yield Estimation System (Rice-YES). RICE-YES interprets LAI maps from MAPScape-Rice to simulate yield accordingly while capturing meteorological and agronomic information through the use of spatially disaggregated weather data, varieties, soil, and nutrient management information.

Rice monitoring platform was also used during this kharif season to access the extent of rice area affected by floods. Field visits to the flood affected area complemented the assessment effort.

Farmers' limitation to understand and comprehend complex products such as insurance impact their choices, where the expected benefits depend on evaluating compound risks, probabilities and time preferences. A framed-field experiment with rice farmers to test their willingness to pay for different insurance attributes revealed low level of insurance literacy including those who availed loans and were mandatorily insured by the banks, indicating that public spending on incentivization would not yield desirable outcome without improving their cognitive ability to understand the product.

Heterogeneous preference for insurance attributes was discernible for single risk vs multiple risk coverage; products with Satellite vs self-reporting based yield (loss) estimation; individual plot or village or block as insurance unit etc. With different levels of education/cognitive levels of farmers. Ideal insurance product features based on the insurance preferences could, therefore, be used to develop such products.

Research collaborations:

A number of new advanced breeding lines combining submergence along with stagnant flood tolerance have been generated in collaboration with OUAT. Research collaboration with OUAT, NRRI and IIRR has focused on crop management aspects purported to improve precision for yield targeting for RCM under rice based systems and developing IPM modules. IRRI has initiated integrated demonstrations of pulses (green gram, black gram, pigeon pea, and chickpea) and sweet potato in collaboration with ICRISAT, ICARDA and CIP to manage rice fallows and increase cropping intensity with adequate crop diversity.

Linkages:

Odisha Livelihood Mission was co-opted to work with seed systems, fallow management and scaling up of improved production practices through its network of Krishi Mitras and field officers in several districts. Linkage with Common Service Centres (CSC) for promotion of rice crop manager, information reinforcement through interactive voice response services managed by Precision Agricultural Development (PAD) for the use of rice crop manager and integrated demonstrations with other schemes like BGREI for promotion of crop management technologies have further enhanced the scaling efforts initiated by IRRI for overall development of the rice farming community state wide.

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

Flood, drought and salinity are recurring abiotic stresses that impact rice productivity in Odisha significantly. These stresses make farmers of the region vulnerable and food insecure. This sub-project aims to make rice farming in Odisha resilient to possible impacts of abiotic stresses. Large scale adoption of STRVs, by replacing existing high yielding but stress-prone varieties, has the potential to reduce losses and stabilize the productivity in the event of flood, submergence or salinity. In order to achieve this, the project is testing a range of innovative ways to increase awareness and create demand for the varieties. Aiming at multiple linkages across extension network and seed systems, significant efforts are directed towards strengthening the formal and informal seed markets for the STRVs. By involving seed market players, this sub-project works with different state institutions and actors who could produce, multiply and, supply the STRVs at an accelerated pace. Through various capacity building programmes, this sub-project also aims at creating awareness and adoption of quality seed production practices by farmers.

Component Goal

To improve the access and availability of quality seed of stress-tolerant varieties 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:

- Identification of best approaches for improving informal seed dissemination and adoption of stress-tolerant varieties
- Development of contextually-relevant strategy for sustainable seed production, promotion and delivery of stress-tolerant varieties to farmers through demonstrations
- Strengthening of knowledge, capacity and awareness for scaling up through participatory evaluation of stress-tolerant rice
- Promotion and awareness creation of the role of STRVs in rice-based cropping systems
- Impact evaluation of adoption of stress-tolerant rice varieties

The sub project has a three-pronged strategy to develop an effective seed system for STRVs in the State. Firstly, to promote and generate mass awareness of STRVs in the farming community, to generate demand. Secondly, building a platform where government officials particularly those who are pivotal in seed chain, can observe performance first hand STRVs and can take informed decisions in influencing state seed machinery in favour of well performing and suitable STRVs. All the preferred and chosen STRVs may not be readily available for interested farmers, as those varieties are either not in the seed chain or have not been adequately promoted earlier. Therefore, the third prong is provisioning breeder seeds of STRVs to Odisha State Seed Corporation and private growers for conversion to foundation and certified seeds.

This sub-project planned and successfully implemented a host of integrated and well-designed interventions that primarily aim at systematizing seed system for STRVs. Learning from the response of stakeholders in various activities undertaken during the previous years, awareness programmes, demonstrations, quality seed production training programmes and stakeholder consultations (coordination meeting) were organised in 43 blocks of 15 districts, in close collaboration with the Department of Agriculture at appropriate levels. Through the reporting period, key functionaries of the DoA (DDAs, DAOs, and AAOs) and the Odisha State Seed Corporation facilitated the process of technology evaluation as well as seed provisioning. The interventions were also supported by Odisha Livelihood Mission and 21 grass root level NGO partners, making it easier to connect with disadvantaged farmers in different districts who are largely unaware of the productivity potential of the STRVs under adverse environments. The activities taken up during kharif 2018 and the following rabi season are summarised in Tables 1.1 and 1.2.

Table 1.1: Summary of activities 2018-19

SN	Activity		Unit	Physical Targets			Achievement	Remarks
				Districts	Blocks	Area/ No	Total	
					Kharif 2018-19			
1	Demonstrations	Demonstrations (5-10 ha each)	Ha	14	42	4200	4224	Against the target, 43 blocks from 15 districts are covered in cluster demonstration
		H2H Trials	No	14	42	3360	3463	Against the target, 43 blocks from 15 districts are covered in H2H demonstrations.
		Demos through OSSC Dealers	No	14	42	1260	1816	Farmers participated in demonstrations facilitated by OSSC and private dealers
		Crop Cafeteria	No	5	District Level	5	5	Puri, Bhadrak, Angul, Sambalpur and Koraput
		Client Oriented Crop Cafeteria	No	2	2 in state	2	2	This is done through Reliance India Foundation at Balangir and Ma Tarini SHG, Kalahandi.
2	Trainings	QRSP Trainings for farmers (25 per training)	No	15	42	2725	2730	Organized at village level, with the engagement of DoA officials, NGOs and VAWs
		TOT on QRSP and Management Practices	No		State level	2	2	Conducted at NRRI. 124 participants were trained.
3	Workshops Meetings	District Level Seed Meetings	No	30	District level	30	30	DDAs, KVK, OSSC, AAOs, Dealers participated.
		Formation of women led seed groups	No	14	12	30	30	Formation and capacity building of SHGs is in process
		Awareness creation meetings (2/season) 100 farmers each	No	14	42	252	253	AAOs, NGOs, Farmers

4	**Research support**	Pilot Seed Cast, Work in progress with DDAs, AAOs, Dealers, PACS, OSSC outlets, OSSC					
		Testing different methods of introduction of rice varieties to farmers (research)-- in progress					
		RCT based evaluation of different seed systems for faster dissemination of STRVs—in progress					
Rabi 2018-19							
5	**Demonstration**	H2H demonstrations	No	7	9	350	Crop has been established
		Cluster demonstration	Ha	7	9	75	Crop has been established
		Crop Cafeteria	No	2		2	Crop has been established at Bhadrak and Puri

Table 1.2: District-wise demonstration details

SN	District	Cluster Demonstration			H2H trials		Dealers' demonstration		STRVs demonstrated	Partner
		Seed Quantity (Kg)	Area in ha	No of farmers	No	Area in Ha	Minikits (5Kg Each)	No of dealers		
1	Angul	9442	236	902	260	43.92	170	14	Bina dhan 11, DRR 44, Sahabhagi, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	FES, OLM, KVK
2	Bargarh	300	8	85	0	0	95	8	Bina dhan 11, DRR 44, Sahabhagi	KVK, Dealers
3	Bhadrak	10510	263	1037	186	37.2	140	15	Bina dhan 11, CR 1009 sub 1, Swarna Sub 1, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	Netaji, KVK
4	Bolangir	11250	281	433	240	45.6	145	15	Bina dhan11, DRR 44, Sahabhagi, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	RARE, Global green, KVK
5	Cuttack	9282	232	614	232	40	65	15	Bina dhan 11, CR 1009 sub 1, Swarna Sub 1,	Lutheran and Pallivikash
6	Kalahandi	11255	281	417	232	46.62	145	15	Bina dhan 11, DRR 44, Sahabhagi, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	Loksebak, OLM
7	Kandhamal	13185	330	596	271	50.7	36	4	Bina dhan 11, DRR 44, Sahabhagi, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	CHARM, SWATI, Harsha Trust, OLM, KVK
8	Keonjhar	11525	288	1061	256	50.56	95	9	Bina dhan 11, CR 1009 sub 1, Swarna sub 1	STARR, OLM, KVK, FES

9	Khordha	1501	30	69	5	1	0	0	Bina dhan 11, DRR 39, DRR 44, CR 1009 sub 1, Swarna sub 1	AID
10	Koraput	12615	315	826	257	51.4	145	15	Bina dhan 11, DRR 44, Sahabhagi, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	PRAGATI, OLM, KVK
11	Mayurbhanj	11925	298	581	278	55.14	155	13	Bina dhan 11, DRR 44, Sahabhagi, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	SPARDA, OLM, KVK
12	Nayagarh	11883	297	551	236	47.2	145	15	Bina dhan 11, CR 1009 sub 1, Swarna Sub 1, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	BOJBP, SAHAYA, OLM
13	Puri	12470	312	646	289	45.4	65	15	Bina dhan 11, CR 1009 sub 1, Swarna Sub 1,	WISDOM, AID and SWAD
14	Rayagada	12770	319	559	228	50.8	165	15	Bina dhan 11, DRR 44, Sahabhagi, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	Harsha Trust, OLM, KVK
15	Sambalpur	15415	385	479	242	48.4	155	21	Bina dhan 11, DRR 44, Sahabhagi, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	ADARSHA, SEWA, OLM, KVK
16	Sundergarh	13400	335	819	251	45	95	9	Bina dhan11, DRR 44, Sahabhagi, Swarna Shreya, Sabour Harshit. Sabour Ardhajal	DISHA, OLM, KVK
	Total	**168728**	**4211**	**9675**	**3463**	**658.94**	**1816**	**198**		

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

i) Crop Cafeteria (CC)

Crop Cafeteria plays a vital role in promoting climate-resilient rice varieties to be deployed against the adverse climatic conditions and giving high-yield and income to farmers. The hubs are established either at farmer's fields or government farms to give all the stakeholders a practical experience based on the principle "seeing is believing", so that they can analyse available facts and evidence, evaluate them and select the best suitable varieties as per the ecology. Farmers are exposed to newly developed varieties along with good crop management practices to allow normal growth and good expression of vegetative (stature, tillering), reproductive (ear bearing tillers, panicle exertion, panicle length, grains/panicle, spikelet fertility) and, grain (length, breadth etc.), characteristics that help the farmers to select the desired variety. Non-lodging, disease and pest free varieties with good yield potential are preferentially selected by most farmers. At each CC, about 18-20 varieties are grown following the same management practices in two or three replications along with the local popular varieties to compare and assess their performance. Participatory selection by various stakeholders is a key feature of the CC which provides a basis to the DDAs to advocate for the most suitable varieties for the location.

Crop Cafeteria has been an important way of showcasing STRVs performance to the key actors who have a stake in the seed chain. This unique demonstration was organized to assess performance and fitness of STRVs in a particular agro-climatic region. Sets of STRVs with drought and submergence tolerance were grown and assessed in comparison with local popular varieties. Staggered sowing ensured that all varieties flower and attain maturity at the same time making comparative assessment easy for the evaluators. This intervention primarily is purposed to enable evaluators observe the STRVs performance so as to influence the seed system for large scale multiplication of breeder, foundation and certified seeds by state agencies and private seed producers/distributors. IRRI together with the Department of Agriculture, Odisha, promoted and organized CCs at five districts e.g Angul, Bhadrak, Sambalpur, Koraput and Puri along with two client-based cafeterias in Kharif 2018. In this season, the test varieties were chosen considering the agro-climate of five districts (drought/submergence prone), and previous season's performance based suitability. In addition to previously evaluated STRVs three new varieties suitable under water limited condition Swarna Shreya, Sabour Harshit and Sabour Ardhajal were also included in the demonstration to observe their performance and suitability in the drought prone ecologies.
Bearing in mind the results of varietal evaluation in the previous year, we narrowed down to a smaller set of varieties this year possessing better locational suitability. In Kharif 2018, IRRI organised two client managed CC, one in Kalahandi and another one in the Bolangir district of Odisha. The second client-based CC was organized at Bolangir by Reliance India Foundation which actively engaged in promoting better agriculture technology for livelihood augmentation of farmers.

Inspired by last years' experience, this season also Maa Thakurani SHG organized client oriented cafeteria at their farm field in Kalahandi with minimum support provided by IRRI. The CC experience gave this SHG an opportunity to develop knowledge, capacity and confidence to be a part of decision-making in varietal selection while potentially creating demand for those varieties. Women's participation and contribution in extension activities is again reinforced with this woman led intervention.

As in the last year, important outcomes achieved through this CC were (a) collective varietal ranking by the district agriculture officers led by DDA (b) reflection on field observations from CC by all participants to further analyse the performance of different varieties *vis a vis* old varieties (c) creation of an opportunity where a range of varieties are showcased to allow selection of the most suitable ones and (d) enhancement of farmers' awareness while potentially creating demand for those varieties.

Photo 1.1 CC of Puri

Photo 1.2 CC event is being organised at CC, Sambalpur

Photo 1.3 Stakeholders evaluating varieties at CC, Puri

Photo 1.4 Yield advantage of CC

Varietal assessment by DDAs

DDA is the most crucial stakeholder in recommending a variety to the DoA and OSSC. DDAs and other key officials were invited to observe and evaluate performance of demonstrated STRVs. Each variety was given a score (10-point scale) by agriculture officers headed by DDA. This assessment was based on several phenotypic parameters like stress-tolerance (when stress is present), crop height, tillering ability, duration, grain type, yield and incidence of diseases and pests. These attributes are usually considered important for choosing a best-suited variety over others. Variety wise average score is presented in Figures 1.1 and 1.2. In Crop Cafeteria, a variety is demonstrated in a 5X5 square metre plot with three replications.

Yields shown in the graph are averaged from the harvest of three replications for each variety. Usually crop cafeteria site (DDA farm) is well equipped with drainage and irrigation facilities. So stress is not strongly felt by the crop. But CC in Sambalpur, did suffer several spells of drought as irrigation facilities were not sufficient. Evaluators score these varieties keeping in mind water scarcity during crop growth.

Photo 1.5 DDA addressing a reflection meeting, Puri

Photo 1.6 ADA assessing the STRV field, Sambalpur

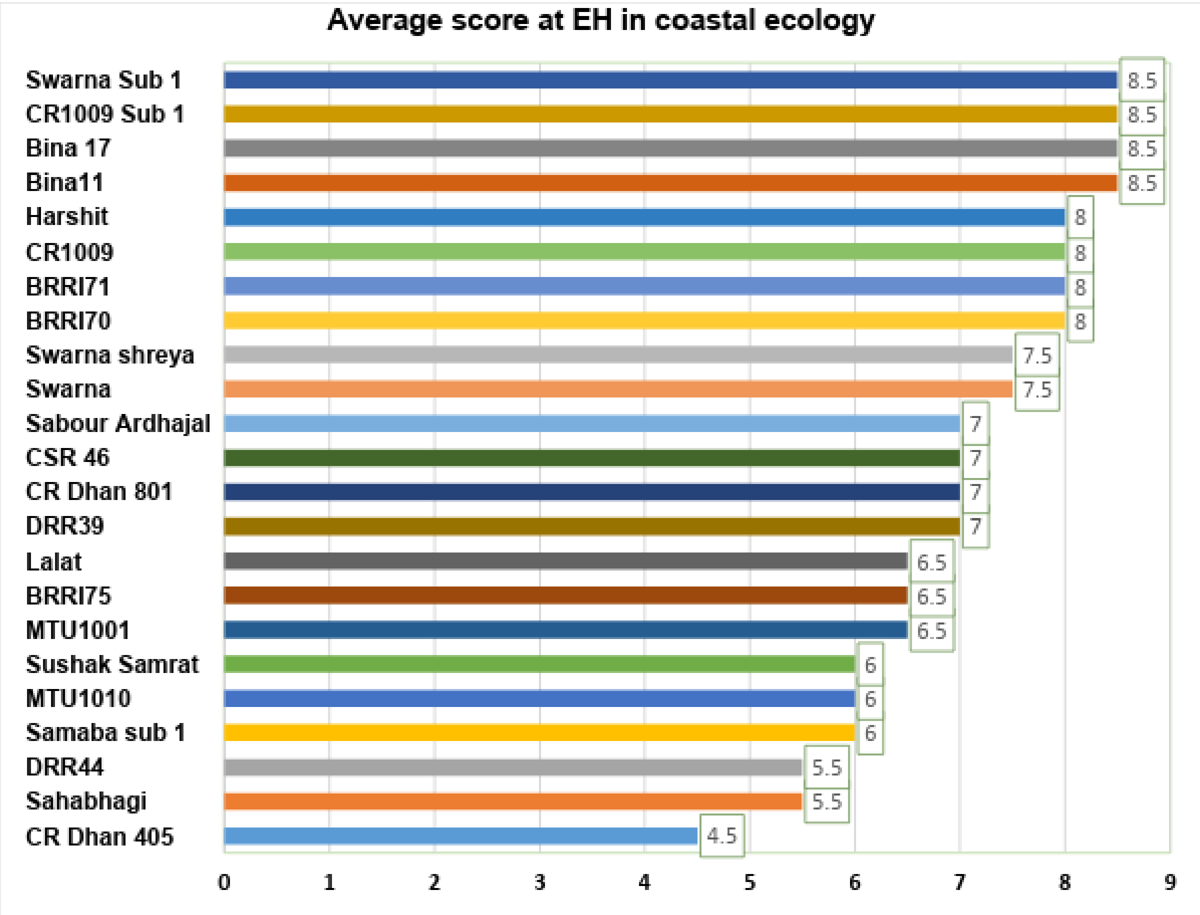


Figure 1.1: Average score of varieties at CCs (Coastal)

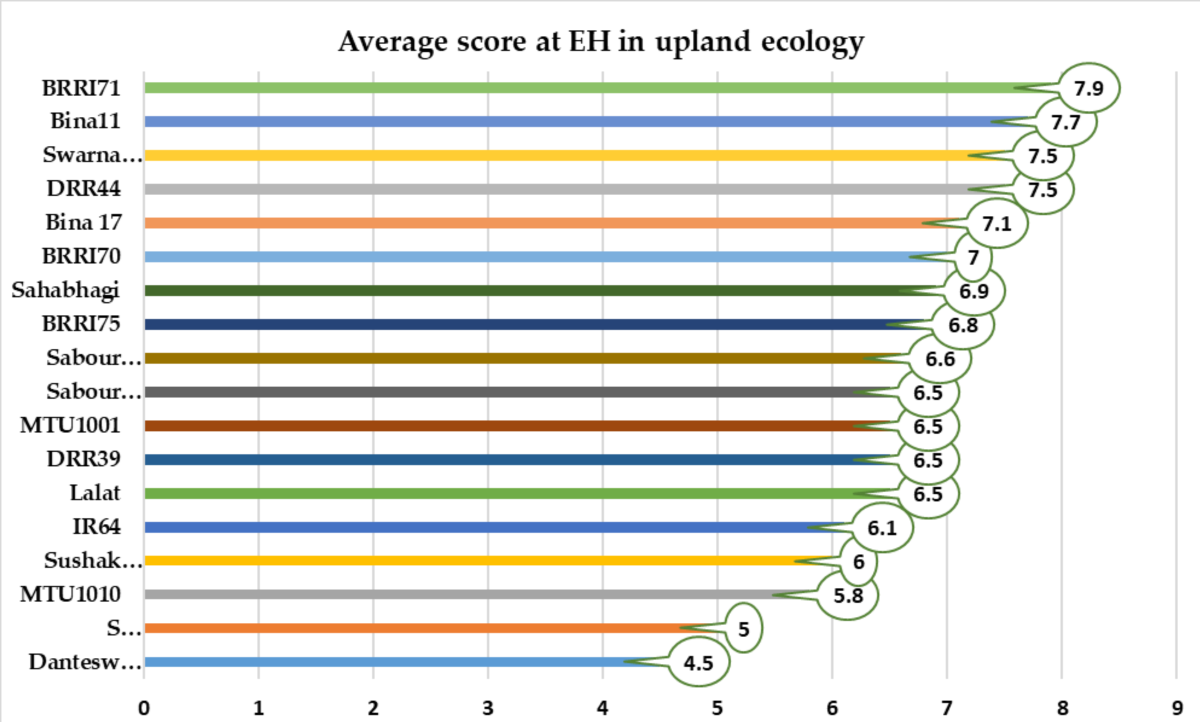


Figure 1.2: Average score of varieties at CCs (Inland)

Considering the phenotypic selection and yield record, the poorly performing STRVs were discontinued this year and the shortlisted superior performing ones re-evaluated to reconfirm their suitability for different ecologies across districts. Out of all varieties demonstrated through different CCs across two main agro ecological zones (submergence prone and drought prone), Swarna sub 1, CR 1009 sub 1, Bina dhan 17, Bina dhan 11, Sabour Harshit were given high ratings (Table 1.3). Interestingly Sabour Harshit, the newly introduced aerobic variety caught the attention of the state department following which further experimentation is planned in coastal region. Since this variety is ideal for upland ecology characterized by low moisture regime, critical evaluation is needed before it is recommended in coastal and low lying areas. In inland ecology BRR 71, Bina dhan 11, Swarna Shreya, DRR 44, Sabour Harshit and Sahabhgi dhan were rated high based on their phenotypic ranking and yield performance. During the field day and scoring it was unanimously decided that these top ranking varieties which are already in seed chain will be promoted and others not yet notified will be processed for formal notification and promotion thereafter. Swarna Shreya, another drought-tolerant variety released and notified in Bihar, also proved to be having huge potential particularly in drought prone mid land regions.

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

Most preferred varieties	Lowest score	Highest score	Mean score
Coastal districts			
Swarna sub 1	8	9	8.5
CR 1009 sub 1	8	9	8.5
Bina dhan 17	8	9	8.5

Bina dhan 11	8	9	8.5
Upland districts			
BRRI 71	7.0	9.0	7.9
Bina dhan 11	5.0	9.0	7.7
Swarna Shreya	6.5	9.0	7.5
DRR 44	6.0	9.0	7.5
Bina dhan 17	5.0	9.5	7.1
Sahabhagi dhan	5.0	7.0	6.9

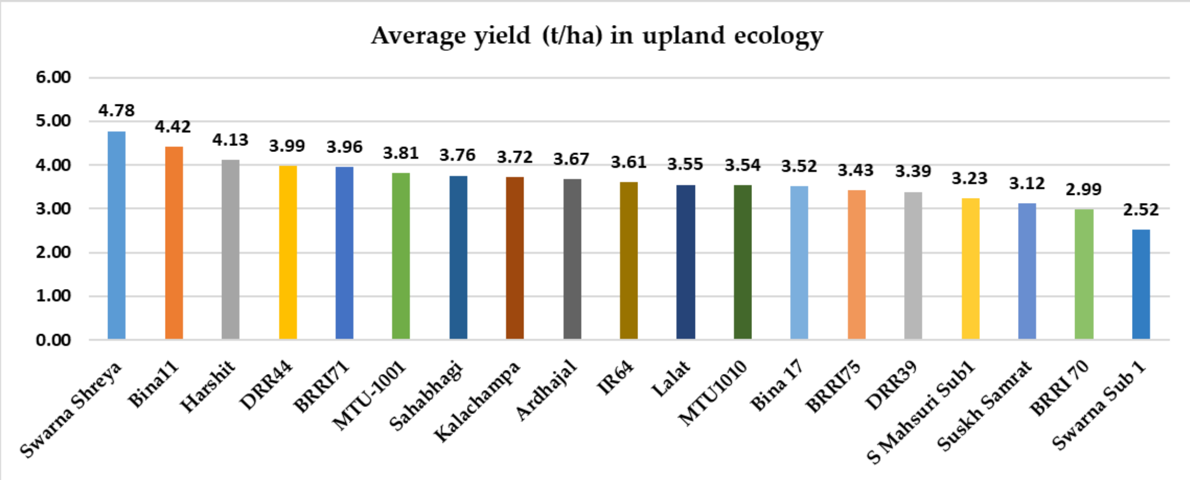


Figure 1.3 Average yield at CCs in upland districts

In inland districts, average yield of Swarna Shreya, Bina dhan 11, Sabour Harshit, DRR 44, BRRI 71, BRRI 75 are found to be high. This follows the same trend and pattern of previous years' scoring exercise thus emphasizes our earlier recommendation to make provision of these varieties in upland ecology.

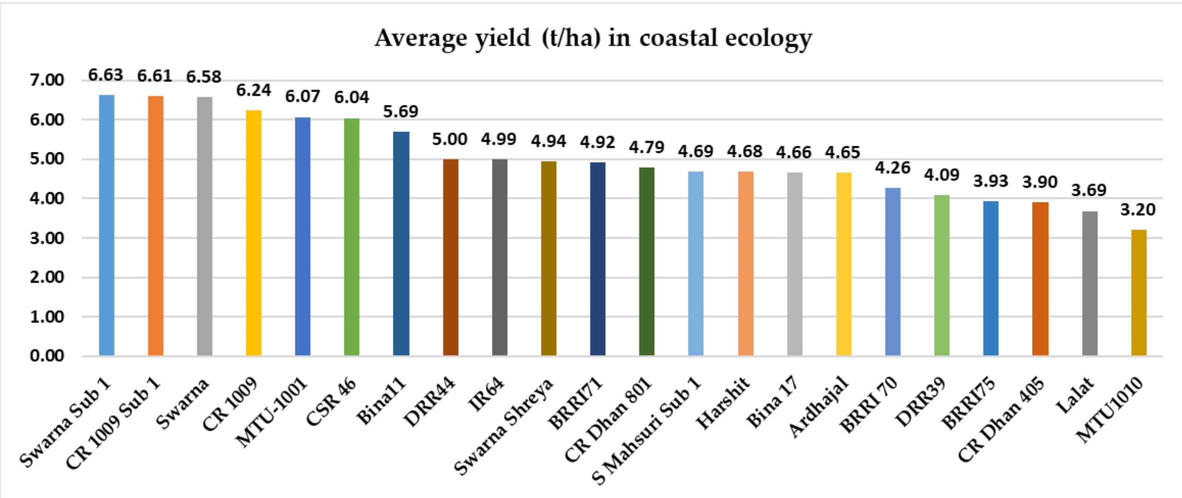


Figure 1.4: Average yield at CCs in coastal districts

In case of coastal region, of all varieties demonstrated Swarna sub 1, CR 1009 sub 1, Swarna, Swarna sub 1, Bina dhan 11, MTU 1001, CSR 46 produced better yield. In accordance with adaptability, duration and yield potentiality observed from these varieties, it is recommended that CR 1009 sub 1 (155 days) should be encouraged in lowland areas where poor drainage is a concern and submergence is a seasonal occurrence. This can successfully replace CR 1009, Varsha dhan, Gayatri, Sarala, Kalachampa which are widely grown in the coastal belt but do not possess submergence tolerance trait. In shallow low land, Swarna sub 1 was the best performing variety. Since Swarna sub 1 is witnessing increasing uptake, IRRI suggests further appropriate measures by department that enhances production and distribution of this STRV. Bina dhan 17 another addition to the set of STRVs which is a 115-day variety can withstand water stress considerably, therefore this can be promoted in moderately stress prone areas. Bina dhan 11 being a short duration variety and its feature of wider suitability should be promoted in medium lands where currently varieties like Pratikshya, Lalat, Naveen, Manswani, Jajati, Konark, Padmni ets are still farmers' choice. CSR 46- recently notified for UP exhibited very high yields and it calls for further experimentation to assess its suitability in saline prone rice growing areas. This is a salt-tolerant rice variety with 135-day duration and is quite promising in coastal areas. This suggests to step up further efforts to enhance availability and accessibility of these varieties in these districts.

ii) Head to Head Trials

Previous year's results of head to head trials and farmer's response to the intervention proved it to be an effective demonstration model to popularize target STRVs. Continuing with this, STRV vis-à-vis traditionally grown variety was grown and evaluated under same farmer management conditions, preferably in same field (half each of at least 500m^2) or two adjoining fields. This has provided participating farmers a unique opportunity to observe and compare performance of STRV in relation to his own variety. Since the management practices for both varieties remain the same, any advantage gained (yield, grain quality etc) is exclusively attributed to STRV and this was a trigger for farmers to contemplate and plan for varietal replacement through adoption of these demonstrated STRVs. Besides farmers, department functionaries (DDAs, DAOs, AAOs) and implementing NGO partners attached high importance to this demonstration and endorsed this as an effective method for varietal promotion.

In the reporting year, 3463 head to head trials were conducted against the target of 3360 spread across 43 blocks of 15 districts where ecology-specific potential STRVs were demonstrated. Participating farmers were provided support throughout the crop growth period to rightly establish these trials and crop cutting experiments were undertaken with them in presence of other fellow farmers, VAWs and officials in some places. Yield advantage of STRVs over other varieties was amply evident in addition to other favourable STRV specific attributes. When displayed at farmer's field, advantage of STRV over adjacent variety is keenly observed, minutely assessed and well accepted by farmers, thus is an effective way in boosting uptake of these STRVs. Table 1.4 succinctly presents yield gain with STRVs. In coastal ecology, Bina dhan 11, CR 1009 sub 1, Swarna sub 1 are having distinct yield advantage over other varieties. Observed yield of these varieties are strong triggers for farmers to consider their adoption.

Likewise, in upland ecology Bina dhan 11, DRR 44 and Sahabhagi dhan hold immense potential to change varietal pattern of the area. While DRR 44 was found suitable in moderate drought condition, Sahbhagi dhan expressed tolerance to severe drought with less yield penalty. Bina dhan 11, originally developed for medium and shallow low land areas, was also found to be yielding satisfactorily in medium land ecology mainly because, drought induced yield reduction is adequately compensated by its high yield. Therefore, it is strongly recommended that Bina dhan 11 and DRR 44 be promoted for medium land, moderate drought prone areas whereas Sahabhagi dhan is perfectly suitable in the area facing severe drought. Being a short duration variety, yield potential of Sahbhagi dhan (105 days) is not comparable with longer duration varieties. Therefore, promotion of this variety should be rationalized and restricted to areas where severe drought is chronic and a regular phenomenon.

Absence of deviations in the ranking of these varieties during the previous year, under normal conditions (absence of drought), reinforces the stability of their performance under drought (many inland districts had moderate to severe deficient rainfall after September 15, 2018) corroborating and concretizing our recommendations for varietal promotion.

Comparison of mean yields of upland and lowland varieties in H2H trials is a good indication of the severity and yield depressing effects of drought over floods. While minimum yields of the top ranking submergence-tolerance varieties were more than 4.5 tons/ha, the drought-tolerant varieties had minimum average yields hovering around 1.75 tons/ha, even though the maximum yields obtained by these varieties (obviously without stress) were only marginally lower than the submergence-tolerant varieties. Apparently floods of transient nature (less than 7 days) may not depress yields as drastically as it happens with drought spells of similar duration. However, it is important to note here that time of occurrence of flood and drought vary with differing consequences, as it happened in the upland areas of Sundargarh during 2018, when the crop was affected by drought at panicle initiation/flowering in the second half of September. Many currently popular, high yielding but drought susceptible varieties succumbed to drought in this area. Interestingly, Bina dhan 11 was an exception, performing better in the inland region, logging maximum yields exceeding 8 t/ha compared to average maximum yields of about 7.5 tons in the lowlands. The versatility of this variety under varied environments with stable performance is an indicator of its potential to replace many older high yielding varieties that are in the seed chain for more than 15 years.

Heterogeneity of the rice growing environment in the inland districts compared to the relatively homogeneous areas of the coastal region is evident by the high number of varieties that are grown by the farmers in uplands and medium lands and fewer options available for farmers in the lowlands (Table 1. 4). For example, Bina dhan 11 was compared to ten different varieties by farmers in the coastal region whereas it was grown in comparison with nearly 50 varieties in the inland districts. While the superior performance of Bina dhan 11 and the other drought-tolerant varieties like DRR 44 and Sahbhagi dhan reconfirms their suitability, it is increasingly evident that there is a need to step up varietal replacement with newer varieties to fill the different niches. The fact that the Odisha State Seed Corporation indents breeder seed of the highest number of varieties in the country is a realisation of the heterogeneity of the rice ecology in the state and consequent requirement to fulfil the need with matching varieties. Evaluation and identification of drought-tolerant varieties like Sabour Harshit and drought-tolerant varieties like Swana Shreya are therefore right steps in this direction. IRRI has developed and released a number of drought-tolerant, high-yielding varieties in the north eastern region (Tripura) in association with ICAR-Tripura and the seeds of these new releases are being multiplied in the rabi season for contextualization in Odisha. Depending on their suitability, these varieties (Hakuchuka 1 and 2, Khura 1 and 2, Nirog Dhan and Chikan Dhan) would also be evaluated in Crop Cafeterias during kharif 2019. Participation of farmers in this head to head trials is also table below (Table 1.6).

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

STRVs	Average Yield (t/ha)	No of observations	Min Yield	Max Yield
Coastal				
Bina dhan 11	6.12	44	4.60	7.48
CR 1009 Sub -1	6.61	37	5.26	7.92
Swarna Sub 1	6.28	66	5.12	7.74
Upland				
Bina dhan 11	4.57	377	1.90	8.40
DRR 44	4.44	172	1.58	7.74
Sahbhagi dhan	3.99	126	1.80	6.75

Table 1.5: Ecology wise yield comparison between STRVs and Adjacent variety*

STRVs	Adjacent Variety	Average yield of STRV (t/ha)	Average yield adjacent variety (t/ha)	Yield advantage (t/ha)	P value
Coastal ecology					
Bina dhan 11	All Adjacent varieties	6.12	5.35	0.77	0.0000
Bina dhan 11	Asina	5.91	5.57	0.33	
Bina dhan 11	Dehradun	6.20	5.84	0.36	
Bina dhan 11	Lalat	5.36	5.27	0.09	
Bina dhan 11	MTU 1001	5.88	5.56	0.31	0.0121
Bina dhan 11	Niranjan	5.19	4.00	1.19	
Bina dhan 11	Otara	6.89	5.08	1.81	0.0000
Bina dhan 11	Pratikshya	6.44	6.28	0.16	
Bina dhan 11	Sumagold	5.73	5.75	-0.02	
Bina dhan 11	Swarna	6.50	5.72	0.78	
Bina dhan 11	Udayagiri	6.28	5.44	0.84	
CR 1009 Sub 1	All Adjacent varieties	6.61	5.89	0.71	0.0000
CR 1009 Sub 1	CR 1009	6.51	6.22	0.29	0.0608
CR 1009 Sub 1	Pooja	6.78	5.71	1.08	0.0029
CR 1009 Sub 1	RGL 2537	5.54	5.39	0.15	
CR 1009 Sub 1	Sarala	6.27	5.94	0.33	0.013
CR 1009 Sub 1	Siva	6.40	5.40	1.00	
Swarna Sub 1	All Adjacent varieties	6.28	5.57	0.71	0.0000
Swarna Sub 1	Pooja	6.44	5.28	1.16	
Swarna Sub 1	Sarala	6.16	5.66	0.50	
Swarna Sub 1	Swarna	6.07	5.98	0.09	0.2357

Upland ecology					
Bina dhan 11	All Adjacent varieties	4.57	3.93	0.64	0.0000
Bina dhan 11	Agnisal	3.19	2.48	0.71	
Bina dhan 11	Ankur	5.11	3.87	1.24	
Bina dhan 11	Apurba	3.60	2.93	0.67	
Bina dhan 11	Batuli Gold	3.38	2.72	0.66	
Bina dhan 11	Bhojna	3.20	2.00	1.20	
Bina dhan 11	Bhuvan	5.16	4.31	0.86	
Bina dhan 11	Danai	2.72	2.40	0.32	
Bina dhan 11	Deeprekha	6.32	5.64	0.68	
Bina dhan 11	Dhani	5.16	3.98	1.19	
Bina dhan 11	Dibrekha	4.50	4.20	0.30	
Bina dhan 11	Gayatri	4.02	3.40	0.62	
Bina dhan 11	Gold	4.16	3.24	0.92	
Bina dhan 11	Gurukrupa	4.60	3.84	0.76	
Bina dhan 11	Hasanta	4.00	3.00	1.00	
Bina dhan 11	Jajati	4.56	3.56	1.00	
Bina dhan 11	Jhalka	4.74	4.42	0.32	
Bina dhan 11	Jira	2.05	1.76	0.29	
Bina dhan 11	Kaberi	3.03	2.81	0.21	
Bina dhan 11	Kamal kranti	3.38	2.74	0.64	
Bina dhan 11	Kelirasa	4.96	4.05	0.91	
Bina dhan 11	Khandagiri	3.42	2.66	0.76	
Bina dhan 11	Kranti	4.68	3.92	0.76	
Bina dhan 11	Kranti	3.64	3.36	0.28	
Bina dhan 11	Kuduchiphul	4.27	3.57	0.69	
Bina dhan 11	Lalat	4.65	3.92	0.73	0.0000
Bina dhan 11	Laxmi	5.72	4.96	0.76	
Bina dhan 11	MC13	2.28	2.30	-0.02	
Bina dhan 11	MTU 1001	4.52	4.12	0.41	0.2177
Bina dhan 11	MTU 1010	5.11	4.58	0.53	0.0049
Bina dhan 11	MTU 1056	5.40	5.08	0.32	
Bina dhan 11	MTU 1156	5.24	5.02	0.22	
Bina dhan 11	Mughai	4.20	3.00	1.20	
Bina dhan 11	Naveen	5.17	4.52	0.61	0.0043
Bina dhan 11	Pana	5.72	5.12	0.60	
Bina dhan 11	Pooja	5.00	4.58	0.42	
Bina dhan 11	Pratikshya	4.08	3.58	0.50	0.0099
Bina dhan 11	Punia	4.94	4.03	0.91	
Bina dhan 11	Rasi	4.56	4.24	0.32	
Bina dhan 11	Samrat	4.60	4.00	0.60	
Bina dhan 11	Silky	4.86	3.58	1.28	
Bina dhan 11	Sonali	4.48	4.08	0.40	
Bina dhan 11	Supersona	2.92	2.72	0.20	
Bina dhan 11	Surendra	4.63	3.93	0.70	
Bina dhan 11	Swarna	4.51	4.28	0.23	
Bina dhan 11	Tulasiganthi	4.64	4.32	0.32	
Bina dhan 11	US 312	3.64	2.90	0.74	

DRR 44	All Adjacent varieties	4.44	3.59	0.85	0.0000
DRR 44	MTU 1056	3.65	2.65	1.00	
DRR 44	MTU 1156	4.07	2.97	1.10	
DRR 44	Agnisal	3.49	2.47	1.02	
DRR 44	Apurba	4.40	2.60	1.80	
DRR 44	Bhuvan	3.94	3.02	0.92	
DRR 44	Bullet	5.11	3.63	1.48	
DRR 44	Chandan	4.88	4.42	0.46	
DRR 44	Chinmali	5.92	5.04	0.88	
DRR 44	Gayatri	3.74	3.40	0.34	
DRR 44	Jajati	4.65	3.34	1.31	
DRR 44	Jira	2.86	2.02	0.84	
DRR 44	Kania	5.16	2.68	2.48	
DRR 44	Khandagiri	4.13	3.14	0.99	
DRR 44	Konark	5.47	3.73	1.74	
DRR 44	Lalat	4.79	3.74	1.05	0.0011
DRR 44	MASURI	4.40	4.08	0.32	
DRR 44	MTU 1001	3.93	3.58	0.35	0.1391
DRR 44	MTU 1010	4.34	3.54	0.80	0.0051
DRR 44	Naveen	4.75	4.18	0.57	0.0690
DRR 44	PADMINI	4.00	3.60	0.40	
DRR 44	Pratikshya	3.88	3.09	0.79	
DRR 44	Punia	5.89	4.74	1.15	
DRR 44	Rani	4.50	1.80	2.70	
DRR 44	Samlei	4.52	3.20	1.32	
DRR 44	Silky	3.23	3.17	0.07	
DRR 44	Subarana	4.86	3.90	0.96	
DRR 44	Surendra	4.16	3.32	0.84	
DRR 44	Swarna	4.62	4.07	0.55	
Sahbhagi dhan	All Adjacent varieties	3.99	3.33	0.65	0.000
Sahbhagi dhan	Agnisal	3.30	2.92	0.38	
Sahbhagi dhan	Annapurna	5.18	4.54	0.64	
Sahbhagi dhan	Bhojna	2.14	1.70	0.44	
Sahbhagi dhan	Bhuvan	3.29	2.82	0.47	0.0158
Sahbhagi dhan	Budhia	3.89	3.16	0.72	
Sahbhagi dhan	Bullet	4.70	3.66	1.04	
Sahbhagi dhan	Dehradun	3.20	2.60	0.60	
Sahbhagi dhan	Hardil	4.40	3.60	0.80	
Sahbhagi dhan	Jhalka	4.18	3.66	0.52	
Sahbhagi dhan	Jharkhand	5.00	4.00	1.00	
Sahbhagi dhan	Jira	2.29	1.73	0.57	
Sahbhagi dhan	Khandagiri	4.23	3.75	0.48	
Sahbhagi dhan	Khijorjhopa	3.00	1.60	1.40	
Sahbhagi dhan	Lalat	4.33	3.73	0.60	0.0562
Sahbhagi dhan	MC13	3.60	2.80	0.80	
Sahbhagi dhan	MC13	2.00	1.80	0.20	
Sahbhagi dhan	MTU 1001	3.04	3.08	-0.04	
Sahbhagi dhan	MTU 1010	3.91	3.44	0.47	0.0637

Sahbhagi dhan	MTU1056	4.34	3.34	1.00	
Sahbhagi dhan	MTU1156	3.86	2.62	1.24	
Sahbhagi dhan	Nandi	2.00	0.72	1.28	
Sahbhagi dhan	Naveen	4.93	3.73	1.20	0.0225
Sahbhagi dhan	Pratikshya	4.20	4.00	0.20	
Sahbhagi dhan	Punia	3.95	2.93	1.03	
Sahbhagi dhan	Silky	4.20	5.40	-1.20	
Sahbhagi dhan	Sindhu	4.96	4.56	0.40	
Sahbhagi dhan	Apurba	4.40	3.20	1.20	
Sahbhagi dhan	Jajati	5.68	4.52	1.16	
Sahbhagi dhan	Khijorjhopa	2.76	2.10	0.66	
Sahbhagi dhan	Lalat	4.73	3.86	0.87	
Sahbhagi dhan	Pratikshya	3.80	3.20	0.60	

*The yields are average of the same varieties in different farmers' fields. Yields are obtained from cropping cutting experiment in 5X5 square metre plots.

Table 1.6: Gender segregated details of H2H trials

District/Block	Female	Male	Total	% Female Farmers	% Male Farmers
Angul	21	239	260	8.08	91.92
Bhadrak	13	173	186	6.99	93.01
Bolangir	22	218	240	9.17	90.83
Cuttack	25	207	232	10.78	89.22
Kalahandi	108	124	232	46.55	53.45
Kandhamal	50	221	271	18.45	81.55
Keonjhar	107	149	256	41.8	58.2
Khordha		5	5	0	100
Koraput	93	164	257	36.19	63.81
Mayurbhanj	122	156	278	43.88	56.12
Nayagarh	8	228	236	3.39	96.61
Puri	42	247	289	14.53	85.47
Rayagada	137	91	228	60.09	39.91
Sambalpur	55	187	242	22.73	77.27
Sundergarh	86	165	251	34.26	65.74
Grand Total	**889**	**2574**	**3463**	**25.67**	**74.33**

Photo 1.7 H2H trial at Dhamnagar block, Bhadrak

Photo 1.8 A woman farmer in her H2H field at Puri

Photo 1.9 Farmers measuring yield after crop cut, Koraput

Photo 1.10 Yield results from H2H field

ii) Cluster Demonstrations

Cluster demonstration aims at creating mass varietal awareness on STRVs. This is similar to large scale demonstrations under BGREI and other schemes. This is typically a collective demonstration by a small group of farmers who come together to select contiguous plots to make a patch of 5-10 ha to grow one STRV. This varietal promotion method culminates with crop cutting experiment and field day attended by a large number of farmers in the area. Cluster demonstration patch is owned by several small and marginal farmers, managing the field operations individually, but following common crop establishment and management guidelines. The acceptance level of the variety is high as they realise that the varietal benefits are collectively observed and assessed. They also understand that in the event of an extreme weather condition, the STRVs would benefit entire farming community.

The demonstration of different STRVs were implemented in an area of 4224 ha in 43 blocks in 15 districts during 2018. After assessing performance of STRV in last two kharif seasons in about 5000 ha each year, and farmers' response to different varieties, we zeroed in on the most suitable ones in different ecologies. Bina dhan 11, CR 1009 sub 1 and Swarna sub 1 were demonstrated in the coastal belt, while in upland region, Bina dhan 11, DRR 44 and Sahbhagi dhan were evaluated. Maximum area was covered by Bina dhan 11, followed DRR 44 and Sahbhagi dhan. The yield estimation was done during crop cutting experiments to measure the yield and create awareness among the farmers. The findings from cluster demonstration on the performance of STRVs are in line with what was revealed through head to head demonstrations and this only substantiates our varietal recommendations. The details on area and yields are given in tables 1.7 and 1.8.

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

District/ Variety	Bina dhan 11	CR 1009 Sub 1	DRR 44	Sahbhagi dhan	Swarna Sub 1	Total
Angul	80.71		70.88	84.47		**236.05**
Bargarh			7.50			**7.50**
Bhadrak	120.00	58.75			84.00	**262.75**
Bolangir	85.62		96.25	99.37		**281.25**
Cuttack	22.50	52.16			157.38	**232.04**
Kalahandi	109.50		94.37	77.50		**281.38**
Kandhamal	106.50		108.50	114.63		**329.63**
Keonjhar	97.63		97.75	92.75		**288.13**
Khordha		10.00			20.03	**30.03**
Koraput	113.00		105.00	97.38		**315.38**
Mayurbhanj	96.13		102.25	99.75		**298.13**
Nayagarh	97.50		101.65	97.93		**297.08**
Puri	100.31	64.20			147.24	**311.75**
Rayagada	59.38		137.38	122.50		**319.25**
Sambalpur	130.50		125.38	129.50		**385.38**
Sundergarh	122.00		106.25	119.75		**348.00**
Total	**1328.27**	**185.11**	**1153.15**	**1135.52**	**408.66**	**4223.70**

Table 1.8: Average STRV's yield in cluster demonstration (Ecology wise)

STRVs	No of observations	Average Yield (t/ha)	Min Yield (t/ha)	Max Yield (t/ha)
Coastal Ecology				
Bina dhan 11	41	5.76	4.12	7.41
CR 1009 Sub1	27	6.46	4.60	7.88
Swarna Sub 1	91	5.93	4.04	7.64
Upland Ecology				
Bina dhan 11	187	4.74	2.52	8.17
DRR 44	254	4.61	1.64	7.24
Sahbhagi Dhan	200	4.11	1.68	6.56

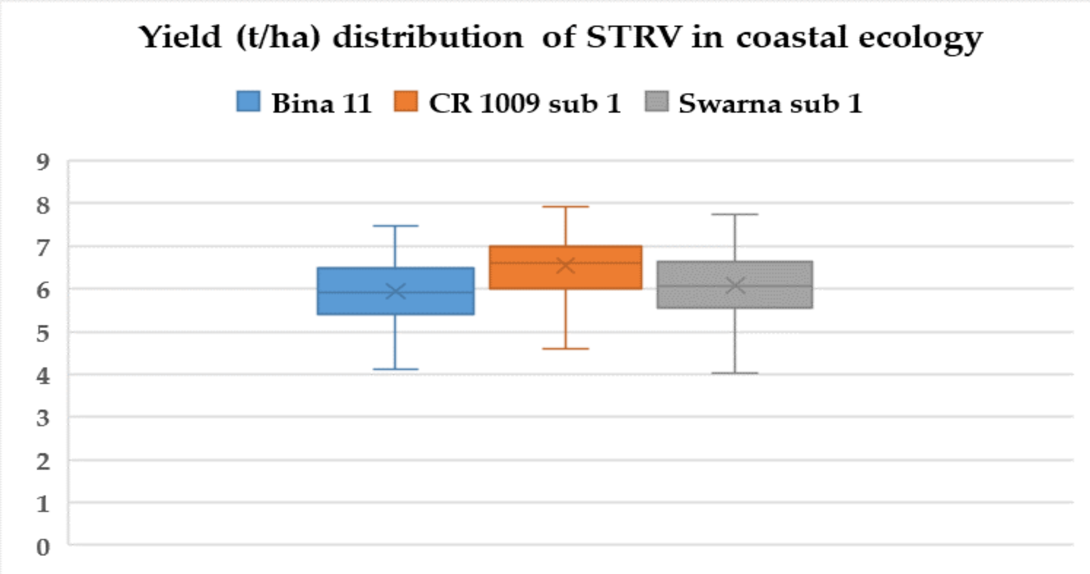


Figure 1.5: Yield distribution of STRVs as observed in H2H and cluster demonstrations (coastal ecology)

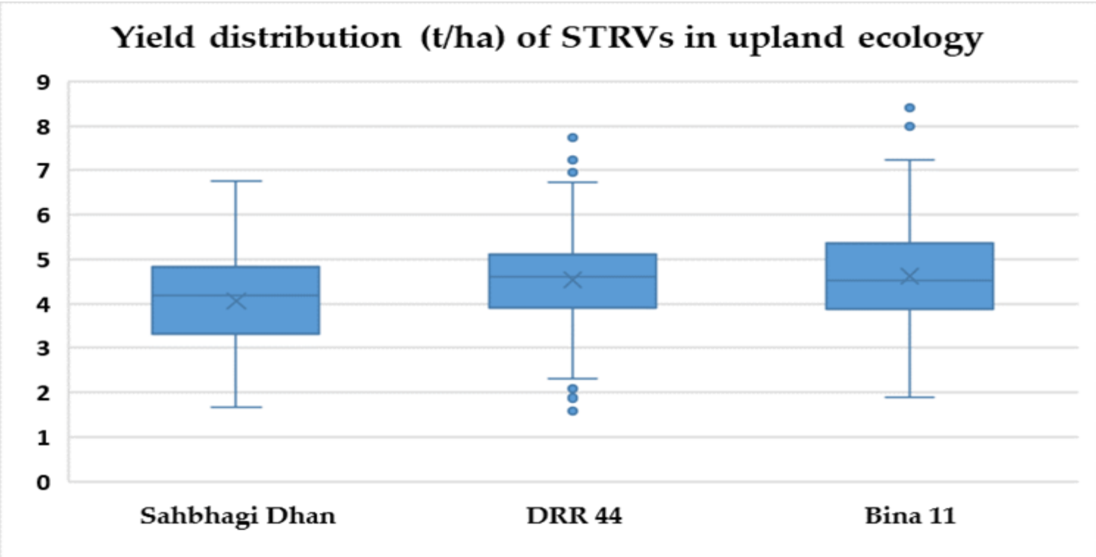


Figure 1.6: Yield distribution of STRVs as observed in H2H and cluster demonstrations (inland ecology)

Table 1.9: Sex-disaggregated details of cluster demonstration in 15 districts

District/block	Female	Male	Total	% of female farmers	% of male farmers
Angul	131	771	902	14.52	85.48
Bargarh	42	43	85	49.41	50.58
Bhadrak	134	903	1037	12.92	87.08
Bolangir	57	376	433	13.16	86.84
Cuttack	121	493	614	19.71	80.29
Kalahandi	82	335	417	19.66	80.34
Kandhamal	124	472	596	20.81	79.19
Keonjhar	378	683	1061	35.63	64.37
Khordha	0	69	69	0	100
Koraput	108	718	826	13.08	86.92
Mayurbhanj	293	288	581	50.43	49.57

Nayagarh	11	540	551	2	98
Puri	66	580	646	10.22	89.78
Rayagada	487	72	559	87.12	12.88
Sambalpur	121	358	479	25.26	74.74
Sundergarh	232	587	819	28.33	71.67
Total	**2387**	**7288**	**9675**	**24.67**	**75.33**

Photos 1.11 Cluster demonstrations at farmer's field of Bhadrak district of Odisha

iv) Dealer-led Demonstrations

Previous research indicates that input dealers are important actors in the agricultural innovation system and have a crucial role to play in promoting and supporting adoption of new technologies, including new varieties. The wide network of roughly 5000 dealers in the state has not been tapped optimally and its capacity not exploited to introduce and diffuse new varieties among farmers. Building on experience and learning from the previous years, 198 active dealers from 15 districts were provided with mini kits of 12-15 STRVs depending upon location of the dealers and surrounding rice ecology. In 2018-19, 2716 farmers participated in demonstrations led by 199 dealers (Table 1.10).

This was primarily to sensitize dealers about new stress-tolerant trait of STRVs. These dealers in turn selected some progressive and venturesome farmers to grow these varieties. Upon crop maturity, both farmers and dealers learnt about the comparative advantage of an STRV. This approach contributes strongly towards awareness and demand creation and, consequently enhanced STRV adoption and varietal replacement. Both end users (farmers) and distributors (dealers) are armed with knowledge of STRV to better deal with abiotic stresses and possible benefit from provisioning seed of new varieties. Once farmers are convinced about the benefits of using an STRV, an intrinsic demand for STRV is generated. This demand could be passed on to the production planners and suppliers at state level like OSSC. The recent spurt in the demand for Bina dhan 11, DRR 44 and Sahabhagi dhan could be reflective of this pathway.

Table 1.10: Dealers demonstration details in intervening districts

District	Quantity of seeds (q)	No of dealers	Farmers' participation
Anugul	21	14	170
Bargargh	13.5	9	95
Bhadrak	18	15	95
Bolangir	22.5	15	140
Cuttack	10.5	15	145
Kalahandi	22.5	15	65
Kandhamal	7.6	4	145
Keonjhar	13.5	9	36
Koraput	22.5	14	145
Mayurbhanj	19.5	13	155
Nayagargh	22.5	15	145
Puri	10.5	15	65
Rayagada	22.5	15	165
Sambalpur	31.5	21	155
Sundargargh	13.5	9	95
Grand Total	**271.6**	**198**	**1816**

Photo 1.12 Meeting with dealers at Puri

Photo 1.13 Dealer's demonstration at Bhadrak

v) Collaborative demonstration with Odisha Livelihood Mission (OLM)

In order to scale up project activities, IRRI collaborated with OLM to promote different technologies which included joint demonstration of STRVs. OLM's mandate of sustainable agriculture perfectly matches the project goal of enhancing farmers' income through varietal promotion. To fructify the common agenda, suitable STRVs were demonstrated in 11 districts where OLM wanted to work with rice farmers. Table 1.11 is details of joint interventions under the seed system component.

Table 1.11: Collaborative varietal promotion activities with Odisha Livelihood Mission

District	Variety	Seed quantity (kg)			Area under demonstration	Number of H2H trials
		Cluster demonstration	H2H trial	Total		
Angul	DRR 44	80	20	100	2	4
Kalahandi	DRR 44	80	20	100	2	4
Kandhamal	DRR 44	80	20	100	2	4
Keonjhar	Bina dhan 11	80	20	100	2	4
Koraput	DRR 44	80	20	100	2	4
Nayagarh	Bina dhan 11	80	20	100	2	4
Rayagarh	DRR 44	80	20	100	2	4
Bolangir	DRR 44	80	20	100	2	4
Sambalpur	DRR 44	80	20	100	2	4
Mayurbhanj	Bina dhan 11	80	20	100	2	4
Sundergarh	DRR 44	80	20	100	2	4

Photo 1.14 OLM team orientation meeting, Rayagada

Photo 1.15 Training on STRVs demonstration, by OLM, Angul

vi) Testing new varieties

Swarna Shreya, Sabour Ardhajal and Sabour Harshit are three new varieties that IRRI developed under the drought breeding network program with BAU, Sabour and several other Eastern Indian research institutions. These are medium-duration aerobic/drought tolerant varieties requiring less water and other inputs, and hence hold potential in drought prone areas of Odisha where water scarcity is a glaring issue. We tested these new varieties in districts spread across two main ecologies—inland and lowland. From crop establishment to maturity and harvest, the growth pattern was recorded including important agronomic parameters to assess the desirability of introduction of these varieties in Odisha. Table: 1.12 revealed Swarna Shreya is maturing in 119 days with 5.48 ton per ha yield. Grain bearing capacity and (165 per panicle) and tillering ability is quite promising. Sabour Harshit and Ardhajal both reported to attain maturity by 120 days with yield of 4.94 ton and 4.94 ton per hectare. Considering these performances and assessment done by seed system stakeholders, it is strongly recommended that Swarna Shreya and Sabour Harshit be brought into seed chain by indenting for breeder seed.

Table 1.12: Performance of new drought tolerant varieties in selected districts, Kharif 2018

Variety/District	Tillers (no)	Duration (days)	Plant height (cm)	Grains/Panicle (#)	Grain yield (t/ ha)
Sabour Ardhajal (all selected districts)	**12**	**125**	**103.43**	**161.57**	**3.72**
Angul	15	122	100.00	162.00	3.04
Bhadrak	15	123	104.00	144.00	4.60
Koraput	14	131	84.00	162.00	4.68
Sambalpur	4	127	95.00	132.00	2.20
Kandhamal	12	135	119.00	210.00	4.39
Sundergarh	12	126	102.00	146.00	3.20
Puri	15	110	120.00	175.00	3.92
Sabour Harshit (all selected districts)	**13**	**126**	**104.21**	**155.57**	**3.93**
Angul	11	122	97.00	128.00	3.36
Bhadrak	18	123	107.50	147.00	5.12
Koraput	12	131	88.00	176.00	5.40
Sambalpur	7	127	110.00	134.00	2.50
Kandhamal	16	138	118.00	196.00	5.00
Sundergarh	11	128	99.00	140.00	2.60
Puri	14	110	110.00	168.00	3.53
Swarna Shreya (all selected districts)	**13**	**124**	**105.60**	**165.43**	**4.53**
Angul	13	127	94.00	162.00	4.48
Bhadrak	19	123	114.20	156.00	5.88
Koraput	12	131	88.00	188.00	5.84
Sambalpur	6	127	109.00	155.00	3.70
Kandhamal	14	130	111.00	185.00	5.68
Sundergarh	15	119	113.00	150.00	2.80
Puri	13	110	110.00	162.00	3.34

vii) STRVs recommendation

In past three years, IRRI has demonstrated a range of potential STRVs in the state through different innovative extension methods with a view to assess locational suitability of STRVs and recommendation thereafter. Different extension methods with distinct purposes has one thing in common—estimation of yield potential under stress. This sub project has gathered large scale yield data of STRVs across seasons and rice ecologies for last three years. Multi-year, multi-location data ensured that the STRVs experienced stress at many places and also competed with existing high yielding varieties under normal conditions for yield. Based on these evaluations, ecology wise recommendations have been made (Table 1.13).

Table 1.13: Summarized varietal recommendation

Rice Ecology	Major stress	Major existing varieties	Recommended STRV	Remark
Rainfed				
Upland	Drought	Mandakini, Sidhanta, Parijat, Khandagiri, Udaygiri, Shatabdi, Pathara etc	Sahbhagi dhan	Being short duration variety Sahbhagi has less yield compared to other STRVs
Lowland				
Shallow (0-30 cm flooding depth)	Occasional drought	Lalat, Naveen, Manaswini, Konark, Pratikshya, Gouri, Jajati etc	Bina dhan 11, DRR 44, Swarna Shreya, Sabour Harshit	Swarna Shreya, Sabour Harshit are aerobic/drought tolerant rice, require atleast 25% less water
Medium (upto 50cm flooding depth)	Flooding	Dharitri, Pooja, Mahanadi, Swarna, Ramadhan etc	Swarna sub 1	
Deep (upto 1 m flooding depth)	Stagnant flooding	Tulsi, Durga, Sarala, Varsha dhan etc	CR 1009 sub 1	
Rabi				
Rabi	Low temperature during seedling stage	Otara, Naveen, Lalat, Khandagiri, Butter, Mahalaxmi	Bina dhan 11	
Coastal	Salinity	CR405	DRR 39, CSR 46	Suitability of CSR 46 in terms of duration to be further evaluated

viii) Capacity building and coordination

An important aim of overall endeavour of strengthening seed system for STRVs is building capacity of stakeholders and generating mass awareness about STRVs. This effort revolves around a number of interconnected activities that bring relevant stakeholders like AAOs, VAWs, NGO staff and farmers together where participants comprehended the features of STRVs as well as different methods of demonstrations. This was followed by coordination meetings with DoA officials to update them on the progress and seek their participation in field days, awareness camps, etc. Table 1.14 presents the details.

Table 1.14: District wise capacity building and awareness activities

Districts	No of Quality Seed Production training organized	Awareness Meeting					Coordination meetings
		Field day	Seed distribution	H2H orientation	Demonstration	Crop Cafeteria	
Angul	3	3	2	1	6	1	1
Bhadrak	6	3	3	3	5	1	1
Bolangir	2	3	3	3	4		
Cuttack	6	3	3	3	6		
Kalahandi	5	4	3	2	4		1
Kandhamal	6	3	3	2	3		1
Keonjhar	6	4	4	2	3		1
Khordha	1	1	1	1	1		
Koraput	6	3	3	3	3	1	1
Mayurbhanj	6	4	3	3	3		1
Nayagarh	6	3	3	2	3		1
Puri	6	3	3	1	3	1	1
Rayagada	5	4	4	1	5		1
Sambalpur	6	4	3	1	3	1	1
Sundergarh	6	2	2	3	4		1
Total	**76**	**47**	**43**	**31**	**56**	**5**	**12**

Photos 1.16 Awareness creation meetings with men & women farmers at village level

Photo 1.17 Seed distribution at Cuttack in presence of VAW & PRI members

Photo 1.18 Seed distribution to SHG Maa Laxmi, Jay Krishna by AAO, Koraput

Apart from activity based awareness and capacity building program, following IEC materials were developed and widely circulated among farmers and NGO partners for rapid dissemination of information.

Developed materials

- Quality seed production manual/booklet (Odia)
- Varietal catalogue for all STRVs in (Odia)
- Package of practices/Varietal leaflets of major 8 STRVs (Odia/English)
- Innovation-A varietal adoption strategy brochure (English)

ix) Quality Seed Production (QSP) ToT

Quality seed is at the core of enhancing productivity of rice. Therefore, it becomes imperative to train key stakeholders in the seed system who essentially will support the system in producing and maintaining quality of the variety and seeds. In consultation with DoA and OSSC, 125 people (Table: 1.13) were trained to be master trainers. ICAR-NRRI facilitated this training program at Cuttack. These master trainers then contributed to conducting QSP training at farmers' level (Table: 1.14).

Table 1.15: Details of ToT organized for participants from different organizations

Batch No	Date	Agriculture department	NGO partners	OLM	OSSC Seed Grower	IRRI Field staff	Total
1	25-26 Sept, 2018	13	19	3	19	10	64
2	28-29 Sept, 2018	9	20	7	19	7	62

Table 1.16: Block level Quality Seed Production details

District/Block	Total no of farmers trained in different blocks	Female	Male	No of super bags distributed
Angul	Angul (90)	1	89	90
Bhadrak	Basudevpur (57), Sadar (56), Bhandaripokhari (73)	10	176	27
Bolangir	Bolangir (65)	36	29	64
Cuttack	Baranga (32), Kantapada (58), Niali (78)	119	49	161
Kalahandi	Dharmagar (72), Kalampur (78), Koksara (75)	102	123	225
Kandhamal	Khajuripada (61), Phulbani (73), Tikabali (87)	108	113	75
Keonjhar	Ghatgaon (56), Patana(122), Saharapada (72)	136	114	133
Koraput	Boriguma (74), Dashmantpur (26), Jeypore (78), Kotpad (20)	141	57	198
Mayurbhanj	Sadar (92), GB Nagar (61), Udala (58)	152	59	113
Nayagarh	Bhapur (53), Khandapada (39), Nuagaon (101)	135	58	140
Puri	Sadar (46), Delanga (46)	72	20	92
Rayagada	Bissamcuttack (32), K.Singhpur (32), Muniguda (124)	102	86	188
Sambalpur	Dhankoda (80), Kuchinda (105), Maneswar (84)	165	104	264
Sonepur	Agalpur (70), Loisingha (65)	42	93	135
Sundargarh	Bisra (73), Bonai (80), Nuagaon (77)	107	132	230
Total	**2730**	**1428**	**1302**	**2135**


Photos 1.19 Conducting block level quality seed production workshops at Bhadrak and Koraput


Photos 1.20 ToT on quality seed production training is being conducted at NRRI, Cuttack

As per proposed plan for Kharif 2018, the target was to work with 30 SHGs by involving them in various interventions. The target has been achieved by reaching out to 351 women farmers, involving 30 SHGs. But more importantly, close interactions with the women farming community through various demonstrations of STRVs and training programmes on different aspects of seed selection, production, storage, quality and purity maintenance, the IRRI team was able to inculcate confidence in the women and equip them with the knowledge to handle the seed system productively.

x) Seed production of recommended STRVs

Seed production is the process of multiplication of a particular class of seed (breeder, foundation and certified) from specific class of seed up to certified seed stage. The adoption of quality seeds accompanied by other recommended inputs can alone boost productivity in rice by 15-20%. *(source: http://seednet.gov.in/material/indianseedsector.htm*).

STRVs demand channelized to OSSC through dealers, farmers and backed by the government officials are met by the multiplication of breeder seeds supplied by IRRI. The breeder seed material of the newly released varieties was sourced from the breeder and other agencies. 29.5 quintals of breeder seeds of three STRVs namely, DRR44, Bina dhan 11 and CR1009 sub 1, DRR 39, Samba sub 1 was supplied to the Orissa State Seed Corporation for further multiplication into foundation seed (Table 1.17). CSR 46, a newly developed salinity-tolerant variety by ICAR-CSSRI, Karnal has been provided to OSSC to understand its adaptability in saline ecology of Odisha.

Table 1.17: Breeder seed supply to OSSC for multiplication

Variety	Source	Quantity delivered to OSSC (q)	Multiplication (q)
Bina dhan 11	NDUAT	15	900
DRR 42	IIRR	2.7	162
DRR 44	IIRR	2.7	162
DRR 39	IIRR	2.7	162
CRR1009 sub 1	TNAU	4.5	270
Samba sub 1	Gorakhpur	1.8	108
CSR 46	CSSRI	0.1	6
Total		**29.5**	**1770**

xi) Seed production through private seed companies

There was increasing demand for STRVs by many private seed growers and dealers who were actively engaged in the previous year's demonstrations. Following realization of better yield and other positive aspects of STRVs, they placed request for breeder seeds. This was a significant development in infusing proven STRVs in to the seed chain. These private growers were linked with research institutes which produce breeder seeds of the preferred STRVs. Table 1.18 provides details of variety wise STRV quantity made available to them.

Table 1.18: Breeder seed provided to private companies/foundations and multiplication by them

Variety/seed growers	Samba sub 1	Sahabhagi dhan	CSR 36	DRR 42	DRR 44	DRR 39	CRR 1009 sub 1	Total (q)	Seed Multiplication (Foundation) (q)
Gopal Jee Seeds, Dungarpali Sonepur	0.25	0.6	0.3					1.15	69
Hindustan Seeds Bolangir	0	0.3	0					0.3	18
Vivekanand Seeds Bargarh	0.25	0.6	0.1					0.95	57
Birtia Seeds Bargarh	0	1.2	0					1.2	72
Bhulaxmi Seeds Baragh	0.25	0	0.1					0.35	21
Anima Seeds Sambalpur	0	1.2	0					1.2	72
Sri Ram Seeds Sonepur	0	0.6	0					0.6	36
Kapileswar Agrotech, Dharmagarh, Kalahandi	0.3			0.3	0.3		0.3	1.2	72
Krishna Seeds, Balasore						0.3	0.3	0.6	36
Total	**1.05**	**4.5**	**0.5**	**0.3**	**0.3**	**0.3**	**0.6**	**7.55**	**453**

xii) IRRI super bag: Low cost high impact option for seed storage

Maintenance of optimum moisture content is key to ensuring seed quality. In the absence of farmer-friendly low cost storage methods, farmers often experience seed quality loss and consequently yield reduction in successive crops. Reduced germination rate, insect infestation and considerable loss of weight are some of the yield depressing disadvantages when seeds are stored traditionally (using gunny bag). With a view to ameliorate this situation, the project introduced and distributed a low cost storage material—IRRI super bag that store seeds hermetically. This simple and easy-to-use material has helped farmers in seed quality maintenance. The project conducted a sample survey with 199 farmers who had been given IRRI super bags in 2017. Since each farmer receives one bag, they used jute bag as well to store seeds. Therefore, this study made a comparative assessment on important seed quality parameters when the seeds are stored until the next season.

The study revealed that weight loss of seed in jute bag is relatively high at 5.27% whereas IRRI super bag significantly minimizes it to only 0.68%. The germination rate dropped by 7.35% when stored in jute bag compared to only 0.68% in IRRI super bag. Insect infestation was also negligible in the super bags. Most of the respondents felt that IRRI super bag is a better option to store seeds as against the conventional jute bag and majority of them (81%) are ready to buy it if sold at local market at price lower than Rs 100. Following is the summary (Table 1.19)

Table 1.19 Comparative advantage of IRRI super bag over Jute bag

Parameter	Jute Bag	IRRI super bag
Weight loss %	5.27	0.68
Germination loss %	7.35	1.27
Seed damage by insect%	3.71	0.02
Average no of Insect found in the bag	4.31	0.04


Photos 1.21 Promoting IRRI super bag for grain storage among farmers

xiii) SeedCast application progress

SeedCast—a mobile based application; beta version of which was launched last year, is now fast-tracked to be ready at the earliest. The preliminary version has caught some technical glitches which caused unavoidable delay in its implementation with dealers. This application envisaged to forecast and rationalize demand and supply of a variety with greater efficiency.

xiii) Activities during Rabi 2019

In order to understand seasonal variability, demonstrations for selected STRVs have been planned in the 2018-19 Rabi season. Rabi interventions cover 9 blocks from 7 districts from both coastal and upland ecologies. These districts and blocks have been chosen carefully keeping in mind assured irrigation facilities throughout the crop growth period. Based on the performance of salinity-tolerant varieties evaluated earlier, DRR 39 was selected for further promotion as it is widely accepted by key actors in the chain including dealers and farmers. Bina dhan 11 which proved to be ideal across seasons and ecologies is also being demonstrated in all locations. During this season we have partnered with local NGOs Netaji, Pragati, Loksebak and Wisdom to organise these demonstrations. About 6 ton seeds have been distributed among farmers selected by partner NGOs. The partner organizations have been oriented on process and methods of demonstration and provided support through the entire process. 8 SHGs were selected and oriented on STRVs and provided with seeds (Refer annexure table 1.3) These women groups are being constantly supported and guided to engage in seed multiplication initiative and develop an STRV bank at their SHG level. Demonstration details in rabi season has been summarized in table 1.20 below.

Table 1.20: Rabi plan 2019

Rabi Plan 2019			Cluster Demo seed in (q)			No of H2H demonstrations				
District	Block	Proposed NGO Partners	Bina dhan 11	DRR 39	Seed for CD (q)	Bina 11	DRR 39	Swarna Shreya	Sabour Harshit	Sabour Ardhajal
Bhadrak	Tihidi	Netaji	2.5	0	2.5	40		2	2	2
Bhadrak	Tihidi	Netaji	2.5	0	2.5	40		2	2	2
Puri	Brahmagiri	Wisdom	2.5	2.5	5	20	15	2	2	2
Puri	Nimapada	Wisdom	2.5	2.5	5	20	15	2	2	2
Puri	Delang	Wisdom	2.5	2.5	5	20	15	2	2	2
Bargarh	Attabira	IRRI/AAO	2.5	0	2.5	40		2	2	2
Sambalpur	Maneswar	IRRI/AAO	2.5	0	2.5	40		2	2	2
Subarnapur	Dungripalli	IRRI/AAO	2.5	0	2.5	40		2	2	2
Kalahandi	Junagarh	Loksebak	2.5	0	2.5	40		2	2	2
Koraput	Jeypore	Pragati	2.5	0	2.5	40		2	2	2
Seeds for women led seed group			6	0	6			2	2	2
Total			**31**	**7.5**	**38.5**	**340**	**45**	**22**	**22**	**22**

Apart from H2H and Cluster demonstrations, we have established CCs in two districts—Puri, Bhadrak. These were jointly planned with local agricultural department officials. In both the locations, we are going to test 14 varieties selected basis the performance and rating last year. Details are given in Table 1.21.

Table 1. 21: List of varieties selected for Crop Cafeteria in Rabi season 2019

	Crop Cafeteria varieties	Duration in days	Check
1	Swarna Shreya	115	Early Check
2	BRRI 75	115	Early Check
3	BRRI 71	120	Early Check
4	BRRI 69	120	Early Check
5	Bina dhan 11	120	Early Check
6	Bina dhan 17	120	Early Check
7	Sabour Ardhjal	120	Early Check
8	Sabour Harshit	120	Early Check
9	Lalat	120	Early Check
10	DRR 39	125	Medium Check
11	MTU 1010	125	Medium Check
12	BRRI 70	125	Medium Check
13	CSR 46	130	Late Check
14	MTU1001	130	Late Check

xiv) Monitoring, supervision and evaluation of interventions

This subproject implemented a range of interventions in the reporting year and these activities were guided by a strong monitoring framework, with each intervention supervised and monitored at three critical levels.

State level: State team comprising cluster leader, state coordinator, subject specialists for this subproject shaped a yearly plan after multiple consultations with domain experts and scientists at IRRI. List of interventions were planned in accordance with deliverables outlined and shared with DoA. The state team oriented field team and NGO partner officials on standard operational guidelines, training details, data collection methods and quality check. The state team with district level staff visited demonstration sites as and when required to support implementers in implementing interventions efficiently. Project progress from different activities was recorded timely in prescribed templates. Collected data were cleaned and analysed in supporting management to enable strategic decision making. The state team at regular intervals shared with DoA synthesized project progress and briefed them on major achievements, findings and challenges. Project details and other reports were provided as when requested by DDAs.

District level: A cadre of well-trained field staff teamed up with local NGO partners. This team on a regular basis oriented, trained and supported NGO personnel on different forms of demonstrations, operational guidelines, data collection and management. This helped NGO partners establish and maintain demonstrations as per the agreed operational framework. Field team periodically undertook visits to demonstration plots in order to ensure quality and timely completion of activities. Required data and information for different interventions received from partners were reviewed and checked by this field team before sending to the state unit for further compilation and analysis. District team after collating and analysing project progress, achievement and challenges from the field, briefed district department functionaries on a regular basis.

Block/NGO level: NGOs, after pre-season orientation from the state team and regular interactions with field team, selected farmers and demonstration plots in consultation with village level leaders. During the reporting year, 20 NGOs trained participating farmers about demonstration methods, quality seed production, shared varietal information and distributed seeds. NGO staff being in the close vicinity of operational sites, monitored all activities. These NGOs included AAOs and VAWs into field plan right from the varietal and site selection to crop cutting experiment. This approach made the interventions inclusive, participatory and well-monitored. Field level data on all project activities were gathered in given template to be furnished to district team.

Photo 1.22 Field day meeting at village, Bhahmagirii, Puri   *Photo 1.23 Crop cutting at Jeypore, Koraput*

Some inspiring stories from the field to showcase project achievement have been documented. Following is a list of such case stories featured in IRRIs' online publication RiceToday.

- A new varietal delivery program designed to win farmers' hearts and minds http://ricetoday.irri.org/a-new-varietal-delivery-program-designed-to-win-farmers-hearts-and-minds/
- Seeds of Empowerment- http://ricetoday.irri.org/seeds-of-empowerment/
- Women Farmers' Crop Cafeteria Serves Practical Rice Science- http://ricetoday.irri.org/women-farmers-crop-cafeteria-serves-practical-rice-science/
- Seed Dealers Help Speed up Dissemination of Stress-Tolerant Rice Varieties- http://ricetoday.irri.org/seed-dealers-help-speed-up-dissemination-of-stress-tolerant-rice-varieties/
- Head-to-Head Demonstrations Promote Varietal Replacement among Farmers in India and South Asia- http://ricetoday.irri.org/head-to-head-demonstrations-promote-varietal-replacement-among-farmers-in-india-and-south-asia/
- Women's Groups Lead Agricultural Innovations in Odisha- http://ricetoday.irri.org/womens-groups-lead-agricultural-innovations-in-odisha/
- Evidence Hubs" Help Increase use of Improved Rice Varieties in Odisha- http://ricetoday.irri.org/evidence-hubs-help-increase-use-of-improved-rice-varieties-in-odisha/

xv) Collaborative research with OUAT on varietal development

IRRI under its collaborative research program with OUAT is in constant endeavour to develop new breeding lines that can potentially outperform existing STRVs and be better suitable to stress prone ecology. This breeding program led by Dr S.R Das for stagnant flood and submergence has led to the selection of a number of advanced breeding lines in three groups, late, medium and mid-early duration. For example, under late duration category there are four cultures ready for on farm testing against the checks Savitri sub 1 having submergence tolerance and Mahanadi which is high yielding but lacks stress-tolerance genes. Likewise, IR 88228-33-3-5-2 is performing superior to checks Swarna sub 1 and Pratikshya. Under mid early group, IR 87439-BTN-145-2-1 holds potential against Ciherang sub 1, Lalat and IRRI 119.

These advanced breeding lines are enormously encouraging and are being promoted for coordinated testing under the National programme. Simultaneously IRRI will further conduct multi-location demonstrations and seed multiplication of **IR 85086-SUB 33-3-2-1, IR 87092-26-3-1-3, IR 88760-SUB 93-3-3-3, IR 88228-33-3-5-2, IR 87439-BTN-145-2-1** to assess their performance in on-farm demonstrations and this will help us take further course of action in this joint breeding program. Following table 1.22 gives a summary of those advanced breeding lines.

Table 1. 22: Promising advanced breeding lines

SN	Entry No	Advanced breeding line/Variety	Parentage	Days of 50% flowering	Grain yield (kg/ha)
Late Group					
1	31	IR 85086-SUB 33-3-2-1	**PSBRc 68** / IR 02A 464	109	5305
2	32	IR 87092-26-3-1-3	**IR 49830-7-1-2-3** / 2* IR 07F101	108	5283
3	43	IR 88760-SUB 93-3-3-3	IRRI 154 **/ BR 11-Sub 1**	107	4982
4	34	IR 87118-39-1-1-6	IR 75417-R-R-R-R-246-4 / IR 07F101 // IR 06F148	109	4959
Checks		**Savitri Sub 1**	CR 1009*3 / IR 49830-7-1-2-3	109	5169
		Mahanadi	IR 19661-131-1-3-1 / Savitri	106	4933
Medium Group					
1	38	IR 88228-33-3-5-2	IR 80410-B-197-4 / **IR 64-Sub 1** // NCIC RC 158	100	6770
2	39	IR 88230-60-1-2-2	IR 07F294 / **Swarna-Sub 1** // NCIC RC 158	104	4759
3	42	IR 88250-20-1-1-3	Savitri / 2* **IR 64-Sub 1**	102	4749
4	35	IR 86256-6-2-2-2	IR 68703-AC-24-1 / **Swarna-Sub 1*2**	103	4738
5	33	IR 87098-55-2-1	**Swarna-Sub 1*2** / IR 75416-R-R-R-R-261-4	103	4387
Checks		**Swarna Sub1**	Swarna*4/ IR 49830	103	4144
		Pratikshya	Swarna / IR 64	100	4753
Mid Early Group					
1	37	IR 87439-BTN-145-2-1	IR 70215-4-CPA 3-1-3-1 / NCIC RC 158	94	6409
2	41	IR 88243-17-1-1-3	IRRI 141 / **IR 64-Sub 1** // NCIC RC 158	92	5237
3	40	IR 88234-STG-11-1-1-1	**IR 64-Sub 1 /** IR 06F 148 // NCIC RC 158	89	5202
4	44	IR 88762-SUB 51-3-1-3	IR 05N 444 / **BR 11-Sub 1**	95	5075
5	50	IR 89262-SUB 5-2-3-2	Manaw Thukha / IR 71701-28-1-4 // **IR 64-Sub 1**	93	4606
6	48	IR 88789-SUB 64-2-2-3	Mekongga / **Thadokkham- Sub 1**	98	4608
Checks		**Ciherang Sub 1**	Ciherang / IR 40931-33-1-3-2 / 3* IR 64	90	5282
		Lalat	OBS 677 / IR 2071 // Vikram / W 1263	88	4613
		PSBRc 68 (IRRI 119)	IR 43581-57-3 / IR 26940-20-3-33 // Khao Dawk Mali 105	94	5789

Photos 1.24 Intensive research for developing new breeder lines of STRVs is being initiated at NRRI, Cuttack

xvi) Lessons learnt and Recommendations

Bina Dhan 11-a game changer in the varietal landscape

We have been closely observing and monitoring field performance of Bina dhan 11 in all forms of demonstration in last three years. This variety has performed exceptionally with regards to yield as well as submergence-tolerance in medium land. What makes Bina dhan 11 unique and makes it stand apart is its wider adaptability and suitability across seasons and ecologies. Not surprisingly, this was overwhelmingly accepted and demanded by farmers which reflected in higher production plan of OSSC and private growers. Therefore, production and distribution plan of this variety is to be enhanced to make this available to farmers. IRRI has stepped up its efforts by supplying 15 quintal breeder seeds to OSSC in 2018-19. This variety is to be positioned and targeted so that it can replace checks like Naveen, Lalat, Pratikshya, MTU 1001, MTU 1010 and other old varieties of similar duration.

Head to Head trials as an effective demonstration method

Compared to the traditional way of demonstrating a variety alone in large pieces of land, head to head demonstrations proved to be a powerful and replicable method. Block level officials who closely monitored this demonstration till crop maturity advocate to increasingly use this for the display of a new varieties. This method draws quick response from farmers that indicates the level of acceptability of STRVs being demonstrated. Realising this benefit, the number of these demonstrations were increased by 36% in the reporting year. Based on experience and demonstrated outcomes, it is strongly recommended that DoA promote this method at farmers' level through its block level functionaries with need based technical support from IRRI.

Targeting and positioning of STRVs

IRRI restricts its varietal range to STRVs since the project aims at mitigating impact of environmental aberrations. But recommending specific varieties for promotion as replacement varieties warrants very thoughtful and meticulous analysis and planning. For example, Sahabhagi dhan, being a shorter duration variety has low yield potential but can successfully withstand severe drought. So this variety needs to be diffused typically in upland ecology frequented by drought spell. On the other hand, DRR 44 which can moderately tolerate drought is to be advocated in medium land with occasional water scarcity. Any erroneous approach may mislead farmers and therefore weaken the efforts in promoting STRVs. Given this, convergence and commonality of understanding among key functionaries like DoA, OUAT, grassroot NGOs need to be established at appropriate level through discussion, deliberation and integrated planning.

Engaging women farmers

IRRI promotes and recognizes women's participation and efforts in the agriculture sector. With this project intervention, their knowledge, capacity enhancement, skill development, exposure to various technologies, methods and self-confidence have been increased through their active engagement in various innovative extension activities and their participation in platforms promoted by IRRI. Crop cafeterias, head to head and cluster demonstrations, training, and capacity building on quality seed production and storage practices are some of the methods, which have given enormous opportunities for women participation to realize their potential, ability to analyse and make decisions in farming activities.

Women usually being custodians of seeds have huge potential and capacity to produce high-quality seeds. To build their capacity, training on quality seed production and storage practices have been imparted to self-help groups (SHGs) at various districts. To establish the local seed banks for ensuring timely availability of quality seed in desired quantity through SHGs is one of the interventions that has been accelerated. Stress-tolerant paddy seeds were given to oriented SHG groups to involve them in seed production by enhancing their knowledge and capacity to produce and further disseminate the seed within and outside their networks. Since the strategy also gives ample scope to participating farmers to work with OSSC, women farmers are also being promoted as “seed growers”.

Added to this, to scale up the process and enabling the women farmers to link with markets would further boost their confidence and decision-making ability. Their role as change agents to bring about changes in knowledge, attitude and practice towards varietal adoption in the farming community; leading to the spread and adoption of climate-smart technologies that will definitely improve livelihoods and promote women entrepreneurship.

Photos 1.25 Engaging with women farmers for build their capacity & making them self-reliant

Deeper engagement with state agriculture department

Ever since this project started rolling out, DoA has been an important collaborator. Engagement with DoA, will further be intensified mainly at two levels. At block level all processes (demonstration, QSP) will be gradually delegated and handed over to AAO offices in consultation with respective DAOs and DDAs. In close coordination with DDA office, interventions like crop cafeterias will be lined up with their annual plan. This will be done with the active participation and facilitation of OSSC and directorate of agriculture.

Partnership with other government agencies

Building on the fruitful partnership with OLM, the project will scale out interventions of varietal promotion of stress-tolerant rice in association with OLM. OLM with its vast network of resource persons offers an opportunity to sustain gains made and continue support after the project.

Capacity enhancement of OSSC

The preferred and best evaluated STRVs (Table 1.17) have already been selected by OSSC. They have been provided breeder seeds for multiplication and it is expected that OSSC would become self-sufficient in those popular STRVs. During the next two years, breeder seeds of other STRVs conclusively found to be suitable and demanded by farmers, dealers and OSSC will also be provided.

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

Substantial area of potentially productive land in Odisha remains fallow during the winter (Rabi) season after the monsoon (Kharif) rice crop due to four major factors: (1) lack of irrigation, mostly in the plateaus and tablelands (2) stagnant water causing waterlogging in the coastal low land areas (3) high soil or water salinity in the coastal zone area and, (4) late harvest of the Kharif crop or excessive soil wetting after harvest leading to late planting and low productivity of Rabi crops. Increasing the productivity and profitability of these low productive areas is a major challenge for the state.

Increasing cropping intensity in fallow lands could substantially improve the food supply and enhance 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, there are significant opportunities for bringing large areas of rice fallows to double cropped systems. Moreover, there is considerable scope to improve the productivity of rice-based system by adjusting varietal characteristics (e.g. by planting shorter-duration rice, stress tolerant rice, hybrid rice). Potential crops for rice fallows could be green gram, black gram, chickpea and mustard, etc. To efficiently target these potential fallows, detailed characterization of the resource profile is needed (e.g. salinity, submergence, inundation depth and groundwater availability) to systematically understand the potential opportunities and constraints.

Traditional single-layer characterization method may not be adequate for assessing cropping system suitability in these multi-stress, low land coastal environments, where resource profiles vary both spatially and temporally. Any single improved practice may not be suitable for all areas, which suggests that technologies should be targeted to the most appropriate places. Advance 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. The International Rice Research Institute has developed considerable expertise in delivering geospatial solutions (integration of remote sensing and GIS through logical decision tree approach) through "extrapolation domains" for stress tolerant varieties (STRVs) and improved cropping system.

Objectives

- To develop, test and validate appropriate and productive cropping systems to target rice fallows
- To identify the land use requirements of tested cropping systems, and the development of decision rules
- To develop extrapolation domain maps using geospatial modelling and decision tree approach for targeting improved technologies (STRVs and relevant cropping systems) in rice fallows
- To demonstrate different tested technologies (STRVs and cropping system) at extrapolation Domain Analysis (EDA) guided farmers' fields for accelerated dissemination
- To disseminate project outputs to national partners including government organizations and agriculture extension through various means including open access web-GIS system, mobile applications, atlases and research papers

Rice-Fallow distribution in Odisha

A standard methodological approach has been developed for processing and analysing the time series remote sensing datasets of Optical, Microwave (SAR) imageries in different years to identify the rice-fallow area in Odisha. The multi-temporal remote sensing data from Landsat OLI (Optical) and Sentinel-1 (Microwave) sensor has been used to identify the rice-fallow distribution in Odisha. The study area is covered under 14 Landsat and 12 Sentinel – 1 tiles. The Landsat OLI and Sentinel-1 SAR data were downloaded from NASA (i.e., https://search.earthdata.nasa.gov/) and ESA (i.e., https://scihub.copernicus.eu/) websites respectively. The Landsat OLI data was downloaded covering annual crop calendar (i.e., June to May) of Odisha during 2015-16, 2016-17 and 2017-18.

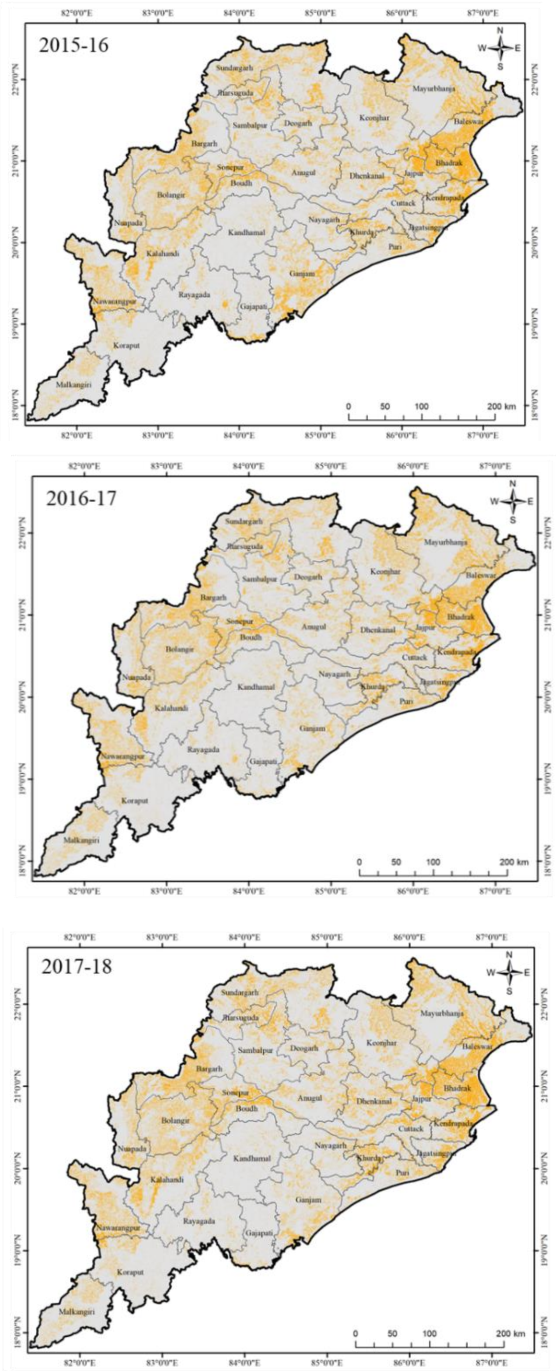


*Figure 2. SEQ Figure * ARABIC 1: Spatial distribution of Rice-Fallow area extracted during (a) 2015-16, (b) 2016-17, and (c) 2017-18 crop calendar in Odisha*

The spatial distribution of Rice-Fallow area in Odisha extracted using integrated analysis of Landsat OLI and Sentinel-1 data for 2015-16, 2016-17 and 2017-18 crop calendar is depicted in Fig. 1 and the district-wise estimated area is provided in Table 1. The total Rice-Fallow area in Odisha during 2015-16, 2016-17 and 2017-18 crop calendar are 2,206,365 ha or 45% of net crop area (NCA), 1,970,300 ha or 40% of NCA and 2122161 ha or 43% of NCA, respectively. Nine among the 30 districts, i.e., Mayurbhanj and Keonjhar district in North-Central plateau, Bargar and Bolangir district in Western-Central table land, Baleswar and Bhadrak district in North-Eastern coastal plain, Sundargarh district in North-Western plateau, Kalahandi district in Western undulating zone, and Nawarangpur district in Eastern Ghat highland, account for about 50% of total Rice-Fallow area. The Rice-Fallow area is considerably less in the districts situated in the South-Eastern coastal plain.

Table 2. 1: District-wise distribution of rice-fallow area (in ha) for 2015-16, 2016-17 and 2017-18 crop calendar

SN	District Name	2015-16	2016-17	2017-18
		Area in hectare		
1	Anugul	69415	67292	69629
2	Baleshwar	128354	98304	121256
3	Bargarh	80168	84287	89939
4	Bhadrak	138152	121705	125401
5	Balangir	132779	133711	135828
6	Baudh	47729	45696	48577
7	Cuttack	53726	41187	52690
8	Debagarh	27398	24180	25818
9	Dhenkanal	54311	51275	72485
10	Gajapati	24407	11636	10473
11	Ganjam	145329	68356	82800
12	Jagatsinghapur	35841	30941	32824
13	Jajapur	75904	70702	67199
14	Jharsuguda	32923	34032	35047
15	Kalahandi	112412	86937	111827
16	Kandhamal	19040	20596	17240
17	Kendrapara	81882	73398	81305
18	Keonjhar	111562	127777	119902
19	Khordha	55200	52162	58174
20	Koraput	46636	41125	48091
21	Malkangiri	43558	48471	47876
22	Mayurbhanj	179241	172680	187473
23	Nabaranagpur	97105	96141	100421
24	Nayagarh	28203	19033	24639
25	Nuapada	56737	56776	54089
26	Puri	38014	37642	40825
27	Rayagada	25155	22593	22235
28	Sambalpur	75993	65025	68060
29	Sonepur	49976	48885	49692
30	Sundargarh	139214	117756	120346
	Total	**2206365**	**1970300**	**2122161**

Validation

A field survey was conducted during both Kharif and Rabi season to collect the ground truth (GT) data from 28 districts out of the 30 districts in the state. For the Kharif season, the field survey was conducted during October 2017 to collect the ground samples of rice and another crop (such as pulse, cotton, Maize). For the Rabi season, the survey was conducted during March 2018 to collect the samples of both areas under crop (rice, pulse, vegetables etc.) and fallow. In addition, information about the cropping system, sowing time, seasonal length, etc. was collected by interviewing farmers across the districts.

The accuracy of Rice-Fallow was evaluated using the collected ground truth (2017-18) samples having specific Kharif crop type information (such as Rice, Pulse, Cotton, Maize, Groundnut) and corresponding rabi season crop or non-crop areas. A time-series MODIS NDVI-based cross-checking strategy was developed to identify the correct scenario during the previous year. In this process, time-series NDVI profile during 2015-16 and 2016-17 crop calendar was extracted corresponding to each GT sample and then checked for its correct labeling. These were then rechecked and labelled samples were used to generate the error matrix of 2015-16 and 2017-18 crop calendar.

The overall accuracy for Rice-Fallow maps during 2015-16, 2016-17 and 2017-18, were estimated as 0.85, 0.85 and 0.84, respectively (Table 2). The user and producer accuracy of Rice-Fallow class during all the three mapping year varied between 0.89 (2016-17) to 0.90 (2015-16 and 2017-18), and 0.88 (2017-18) to 0.90 (2016-17), respectively (Table 2).

Table 2.2: Error matrix of Rice-Fallow map during 2015-16, 2016-17 and 2017-18 crop calendar

	Crop calendar	Class name	Reference categories			UA	OA	F-score
			RF	OCF	Total			
Map categories	2015-16	RF	1365	144	1509	0.90	0.85	0.90
		OCF	161	431	592	0.73		0.74
		Total	1526	575	2101			
		PA	0.89	0.75				
	2016-17	RF	1209	145	1354	0.89	0.85	0.90
		OCF	133	418	551	0.76		0.75
		Total	1342	563	1905			
		PA	0.90	0.74				
	2017-18	RF	1237	142	1379	0.90	0.84	0.89
		OCF	169	433	602	0.72		0.74
		Total	1406	575	1981			
		PA	0.88	0.75				

RF = Rice-Fallow, OCF = Other Crop-Fallow

2.1 Rice-Fallow dynamics in Odisha

The extracted Rice-Fallow area during all the three mapping years were used to generate Rice-Fallow frequency map (Fig. 2) which provides three frequency occurrences having total 7 categories, i.e., 3 categories each under single (i.e., Rice-Fallow during 2015-16, or 2016-17, or 2017-18) and double (i.e., Rice-Fallow during 2015-16 & 2016-17, or 2015-16 & 2017-18, or 2016-17 & 2017-18) frequency and 1 category under triple (i.e., Rice-Fallow during 2015-16 & 2016-17 & 2017-18) frequency. The district-wise area computed for each of the 7 categories are provided in Table 3. The Rice-Fallow area under triple frequency (i.e., the area common occurrences during all the three mapping year) is estimated about 1.34 m ha which can be considered to be under permanent Rice-Fallow (Table 3). About 50% of total triple frequency Rice-Fallow (TTFRF) area can be observed in Mayurbhanj (9.5% of TTFRF area), Bhadrak (7.1% of TTFRF area), Bolangir (7.1% of TTFRF area), Sundargarh (6.4% of TTFRF area), Keonjhar (6.2% of TTFRF area), Baleswar (5.8% of TTFRF area), Nawarangpur (5.4% of TTFRF area) and Bargarh (5.2% of TTFRF area) district (Table 3 & Fig. 2). About 0.75 m ha area is estimated to have been left fallow during Rabi season after Kharif rice harvesting in at least two years out of three mapping years (Table 3) whereas, about 0.78 m ha area is estimated as single occurrence Rice-Fallow, out of which 47% (0.37 m ha) and 32% (0.25 m ha) area was fallow during 2015-16 and 2017-18.

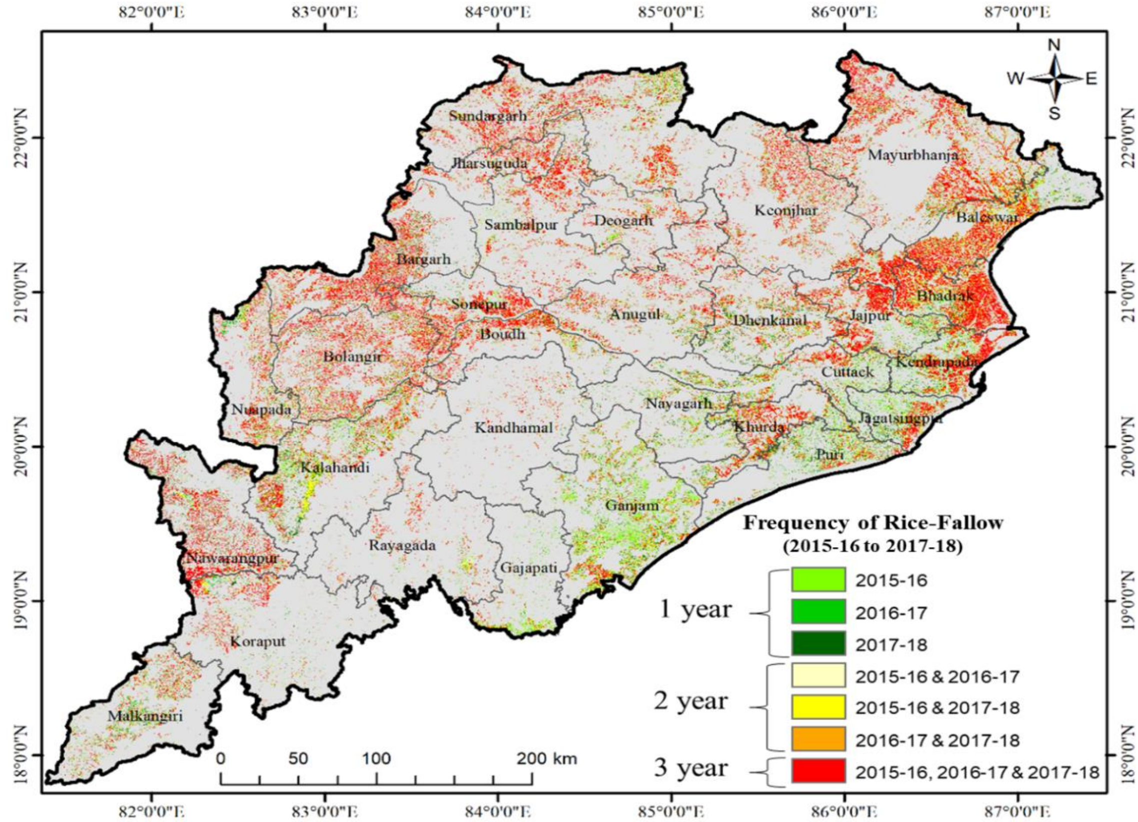


Figure 2.2: Rice-Fallow frequency map generated using extracted Rice-Fallow area during the mapping year 2015-16, 2016-17 and 2017-18. Five rectangular boxes in green, red, yellow, black and blue colour in the map area presented as locational reference of zoom figures presented in Figure 3

Table 2.3: Distribution of district-wise area for each of the seven sub-categories under three Rice-Fallow

Districts	Number of the occurrences-wise areas (in hectare)						
	Single frequency			Double frequency			Triple frequency
	2015-16	2016-17	2017-18	2015-16 & 2016-17	2015-16 & 2017-18	2016-17 & 2017-18	2015-16, 16-17 & 17-18
Anugul	9862	4025	7238	6223	5347	9061	47983
Baleswar	15175	4136	9718	9011	26381	7370	77787
Bargarh	3044	4690	8181	2438	4599	7072	70088
Bhadrak	11032	3874	5009	14657	17218	7929	95245
Bolangir	12696	8211	11763	13312	11877	17294	94894
Boudh	4807	2299	4049	4354	5484	5959	33085
Cuttack	16264	6414	13937	5894	9875	7185	21694
Deogarh	4328	1168	2074	2589	3321	3263	17160
Dhenkanal	7875	4606	17953	4499	12361	12595	29576
Gajapati	12355	2050	1586	4049	3350	884	4654
Ganjam	74653	11222	20756	17658	22568	9027	30449
Jagatsingpur	10640	5225	6585	4169	4692	5207	16340
Jajpur	11287	5744	6607	11042	6675	7017	46899
Jharsuguda	5412	906	2102	764	584	6199	26162
Kalahandi	19871	9096	24431	16127	25682	10982	50731
Kandhamal	2256	2319	1535	4166	1594	3087	11024
Kendrapada	13284	5625	9857	6771	10446	9622	51380
Keonjhar	7653	8131	7065	14113	7303	23041	82493
Khurda	10298	3947	8282	5442	7118	10431	32343
Koraput	4781	5005	5663	2635	8943	3208	30277
Malkangiri	3742	14871	5394	2845	11728	5512	25243
Mayurbhanja	16807	8171	11381	11898	23481	25556	127055
Nawarangpur	5077	5370	16701	13370	6319	5061	72340
Nayagarh	11576	3872	8567	4073	4985	3519	7569
Nuapada	7500	5813	4454	7390	6061	7787	35786
Puri	13411	9409	12479	5892	6005	9635	12706
Rayagada	4032	2093	2212	3979	3502	2880	13641
Sambalpur	13923	1600	4503	4971	5102	6457	51997
Sonepur	4953	2193	3360	4366	4006	5675	36650
Sundargarh	30817	4477	9689	12413	9791	14673	86193
Total	**369411**	**156562**	**253131**	**221110**	**276398**	**253188**	**1339444**

An example of temporal growth profiles of multiple Rice-Fallow frequency categories extracted from time-series MODIS NDVI during three mapping years is presented in figure 3. The temporal NDVI profile of multiple Rice-Fallow frequency categories from five sample areas shows the dynamism of Rice-Fallow (vis-à-vis Rice-Rabi) cropping pattern especially in Koraput (Fig. 3c), Kalahandi (Fig. 3d) and Nuapada (Fig. 3e) district. The peak crop growing pattern (NDVI > 0.5 for more than 100 days) during Kharif season and flat temporal NDVI pattern (NDVI < 0.35) during Rabi season shows the consistent Rice-Fallow pattern in all the three mapping years in Balasore district (red colour profile in Fig. 3a). The green temporal profile corresponding to single frequency Rice-Fallow in Fig. 3b shows the absence of Rabi season crop during 2015-16 crop calendar in Ganjam district, whereas, a yellow temporal profile corresponding to double frequency shows the same during 2015-16 and 2016-17 crop calendar.

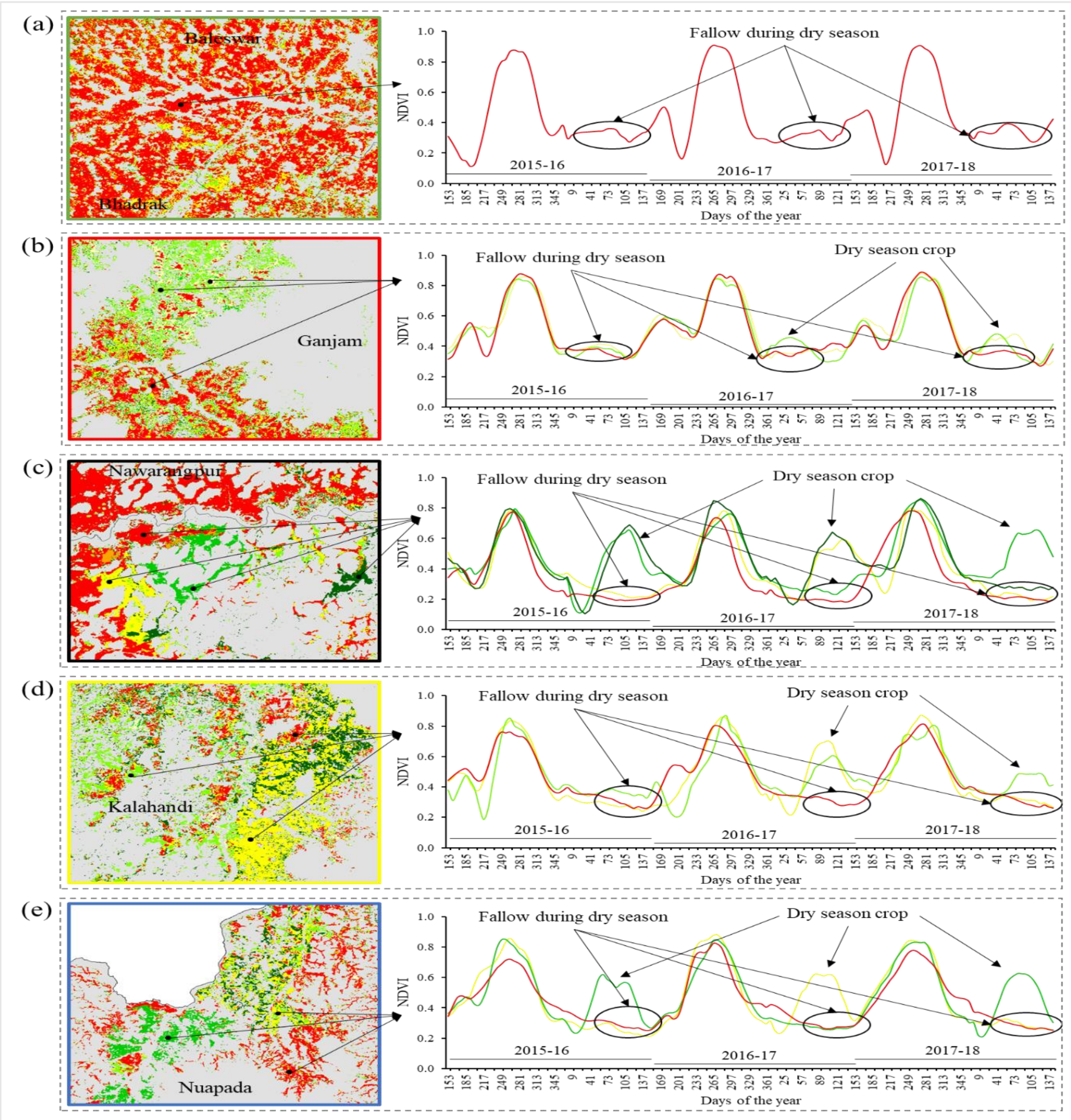


Figure 2.3: Examples temporal dynamics of Rice-Fallow presented for five sample area, i.e., (a) part of Baleswar and Bhadrak, (b) part of Ganjam, (c) part of Koraput and Nawarangpur, (d) part of Kalahandi, and (e) part of Nuapada district. The temporal profiles extracted from time-series MODIS NDVI during 2015-16 to 2017-18. The colour of each temporal NDVI profile represents the corresponding category of Rice-Fallow frequency. The colour border in each subset given to show the locational reference with a color rectangle in Figure 2

2.2 Soil moisture suitability for targeting Rabi crop in Rice-Fallow area

The residual soil moisture at the time of rice harvest is often sufficient to raise short-duration pulses (55-65 days) and oilseed crops in rainfed rice-fallow cropping systems. Analysis of long-term average of spatiotemporal soil moisture profile can assist in identifying the areas having low, optimum and excessive soil moisture during the sowing period in Rabi season. This information can support decisions about the type and duration of the cultivars as well as sowing time to target the pulse crop in the rice-fallow cropping system.

The daily SMAP (Soil Moisture Active Passive Mission) soil moisture product from May 2015 to December 2018 was obtained from the European Space Agency (ESA) and analysed. The three-year average soil moisture data is used to generate soil moisture suitability map over Odisha for targeting Rabi crop (especially short duration and water efficient pulse crop) (Fig. 4). The rice-fallow area has been classified into five categories based on the optimum soil moisture availability from November to January.

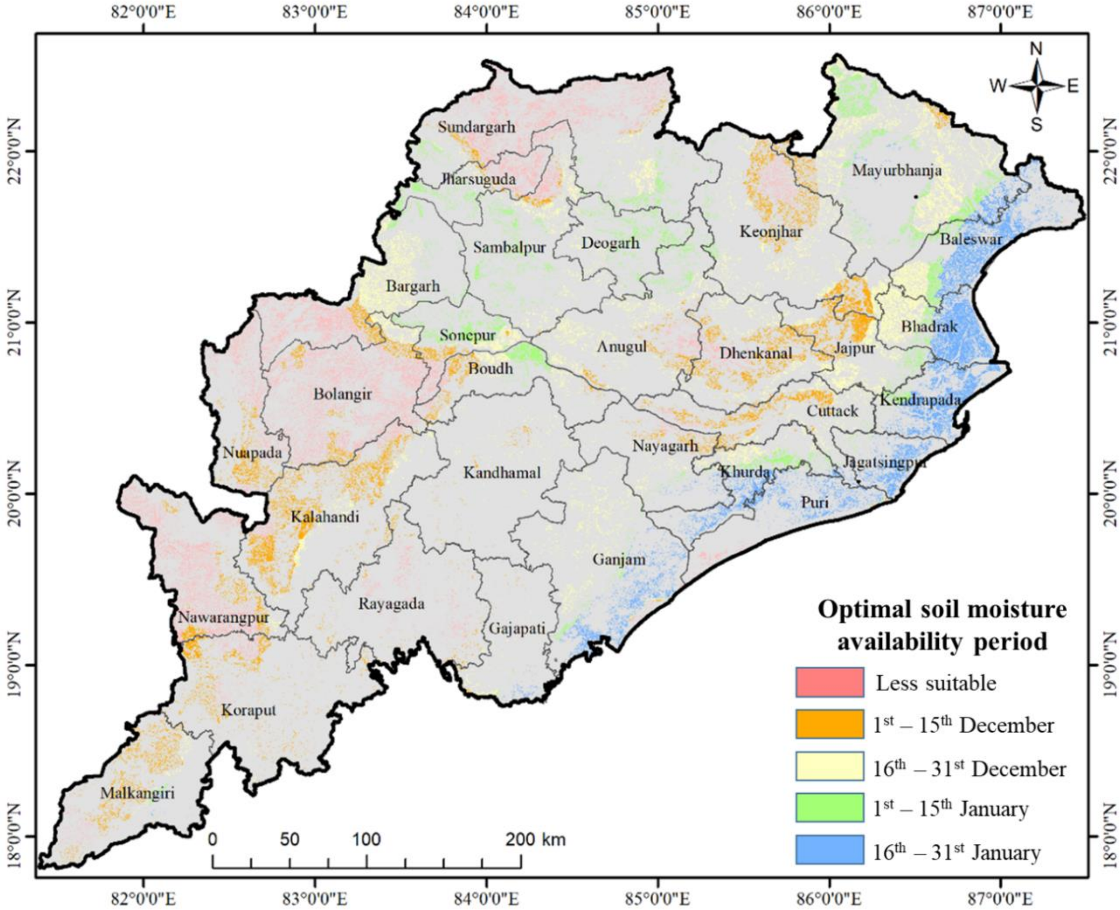


Figure 2.4: Spatial distribution of optimal soil moisture availability period for targeting Rabi crop (especially short duration and water efficient pulse crop) in Rice-Fallow area in Odisha

Majority of the Rice-Fallow area in Bolangir, Nawarangpur and Sundargarh district is less suitable for sowing Rabi season crop based on the residual soil moisture after harvesting Kharif season Rice crop. Rice-Fallow areas in part of Anugul, Cuttack, Dhenkanal, Jajpur, Kalahandi, Keonjhar, Koraput, Malkanagiri are suitable for sowing during 1st to 15th December. The Rice-Fallow areas in coastal districts such as Baleswar, Bhadrak, Ganjam, Kendrapara, Khurda, Jagatsinghpur and Puri are suitable for sowing till the end of January.

2.3 Targeting of pulses in Rice-fallow system

i) Activity during Rabi season (2017-18)

During Rabi season 2017-18, the demonstration of improved cultivation practices for green gram and black gram was carried out in 22 districts of Odisha covering 2095 hectares. Around 6020 farmers in 499 villages tested improved package of practices for pulses. Improved disease (such as Yellow mosaic virus (YMV)) resistant varieties of green gram (IPM 02-3, IPM 02-14, Virat, PDM-139 etc.) and black gram (PU 31, VBN-8, Azad etc.) were introduced. Around 353 field days' / farmers interactions were carried out at regular intervals for imparting the necessary technical knowledge for better crop management.

ii) Results from adaptive trials of pulses

Adaptive trials of Green gram and Black gram in Rabi season (2017-18) were conducted in Puri and Khorda districts (covering 70 ha) to study the effect of Nano-solution, hydrogel and *Trichoderma harzianum* in Rice – Pulse cropping system. The adaptive trials on pulses were laid out in seven management combinations, i.e.,

1. Farmers practices (Broadcast without fertilizer application),
2. Improved practices (Line sowing + Seed treatment with FIR i.e., fungicide, Insecticide and Rhizobium + 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 + seed treatment with Zn Nano-solution and Improved practices + seed treatment with Iron Nano-solution.

Selected high yielding extra short duration (55-75 days) disease resistant varieties of Black gram (IPU-31, VBN-8 and Azad) and Green gram (VIRAT, IPM-02-03, IPM-02-14 and Meha-421) were tested at different locations in these adaptive trails. Recommended fertilizer dose of 20:40:20 kg N: P: K per hectare was applied in all treatments. Under 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.

An example of the plot-wise spatial depiction of adaptive trials of different pulse varieties along with different treatment or management practices carried out in Kanhapur and Khandiagiri village of Pipli block, Puri district is presented in figure 5.

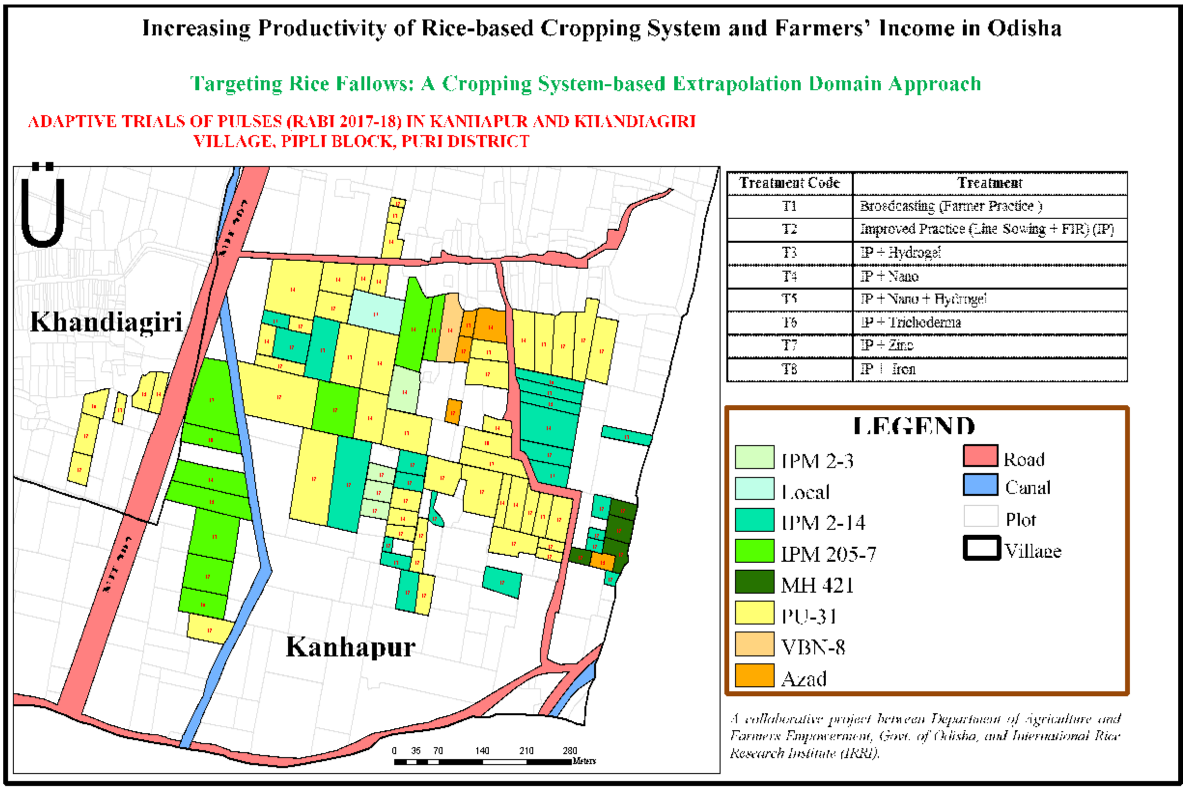


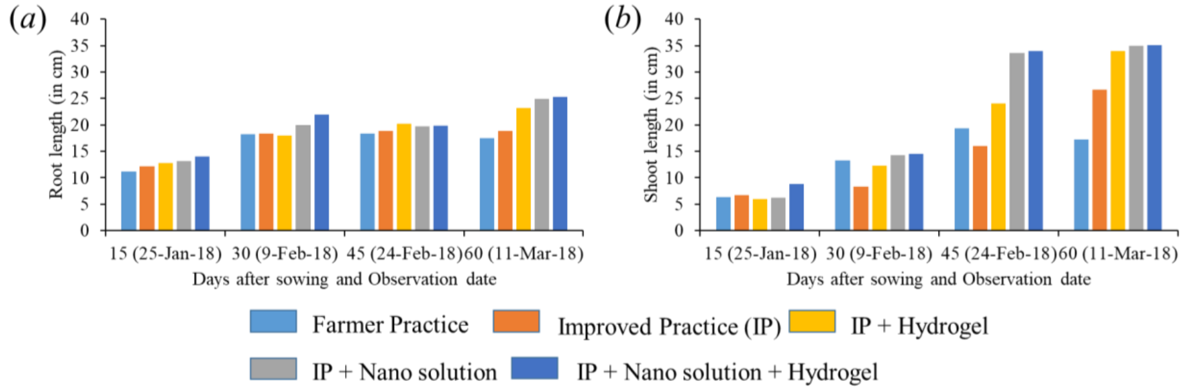
Figure 2.5: Plot-wise spatial depiction of Adaptive trials of different pulses varieties along with different treatments in Kanhapur and Khandiagiri village, Pipili block, Puri district

2.4 Effect of improved management practices on Root-Shoot length of pulses

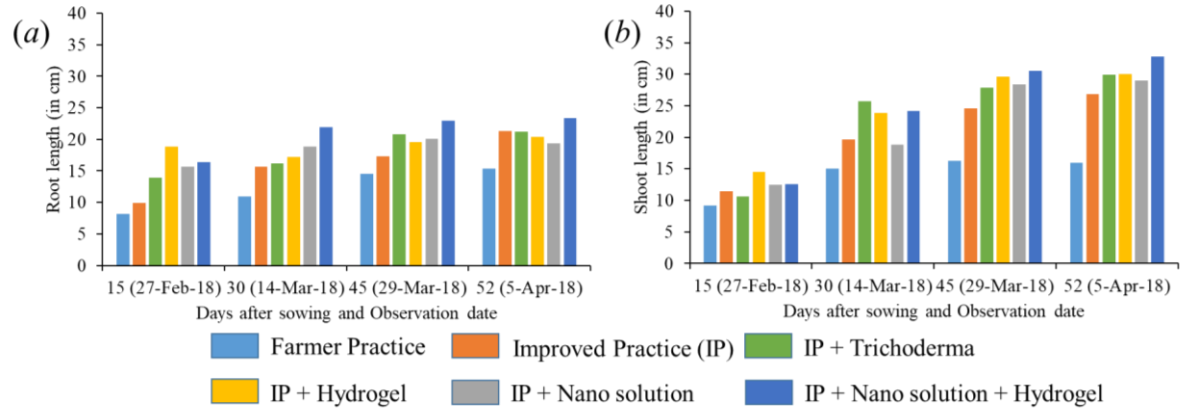
Root and shoot observations were collected in two villages (Karimul, and Kanhapur) in Pipili block, Puri district to observe the effect of different treatments on plant growth (apart from yield). For root-shoot observations, five plants were randomly selected from each treatment at 15 days' interval from the date of sowing.

Photo 2.1 Root length of Nano with Hydrogel treated plant is almost doubled in comparison to other treatments

The root and shoot length observations of IPM 2-14 (in Kanhapur village) and VIRAT (in Karimula village) varieties collected at different growing period are presented in Fig. 7 and Fig. 8. Overall, it was observed that IP along with Nano solutions + Hydrogel treatment resulted in maximum lengths of root and shoots during maturity stage followed by IP along with only Nano solution and IP along with Hydrogel treatment in IPM 2-14 variety (Fig. 7a and 7b). Similar pattern was also observed for Virat. However, root and shoot length is higher in Virat in early growth stage since its seasonal length is very short (55-60 days) in comparison to IPM 2-14 (65-70 days). The experiment results show better performance (in terms of plant growth) with treatments having Nano solution which helps to increase the root length of plant.



Figures 2.6: Schematic representation of (a) Root and (b) shoot length observation of different treatment collected from Karimula village, Pipili block, Puri district. All observations have been collected from IPM 02-14 variety (Greengram)



Figures 2.7: Schematic representation of (a) Root and (b) shoot length observation of different treatment collected from Kanhapur village, Pipili block, Puri district. All observations have been collected from VIRAT variety (Greengram)

2.5 Effect of improved management practice on pulse yield

Photo 2.2 Showing crop cutting experiment of black gram (PU-31)

In adaptive trials, crop cutting experiment (CCE) has been conducted in 98 farmers' fields in Pipli (Karimul, Khandiyagiri and Kanhapur village), Satyabadi (Gopada and Bastapada village) and Delanga (Gaouradeipur village) blocks of Puri district, and Balipatna block (Athantar, Giringa and Siripur village) of Khorda district. The CCEs were carried out in 4 m^2 (2m*2m) area in three different locations in a field, and the average yield from three plots has been computed which was used to estimate yield per hectare. Treatment wise and pulse variety wise yields obtained by CCE in Puri and Khorda districts are provided in table 2.4 and 2.5, respectively. All the tested treatments provide considerably higher yield (1.5 to 2.5 times) in comparison to conventional framer practice (Table 2.4 and 2.5). Two treatments in which Nano solution is used shows remarkable performance, i.e., about 2.5 times increase in yield in comparison with farmer practice and about 1.5 times more than improve practice (Table 2.4 and 2.5). Improve practice along with Nano solution and hydrogel provides highest yields. Among the different green gram varieties tested in Puri district, IPM 2-14 achieved the highest yield (>12 q/ha) under IP + Nano solution + Hydrogel treatment followed by VIRAT (>11 q/ha), IPM 2-3 (10.92 q/ha) and MH-421 (10.24 q/ha) (Table 2.4). Among the different black gram varieties tested, Azad provided highest yield (12.17 q/ha) followed by IPU 49-1 (11.87 q/ha) and PU-31 (11.56 q/ha) under the same treatment in Puri district (Table 2.4).

Table 2.4: Treatment wise and pulse variety wise yield obtained by crop cutting experiment in different villages in Puri district

Village name	Pulse		Farmer Practices	Improved Practices (IP)	IP + Hydrogel	IP + Nano solution	IP + Nano solution + Hydrogel	IP + Trichoderma	IP + Nano + Zn	IP + Nano + Fe
	Type	Variety	Yield (q/ha)							
Bastapada	Green gram	VIRAT	4.72	7.84	9.84	10.73	11.54	8.65	--	--
Kanhapur			4.14	6.93	9.48	10.11	11.28	8.36	9.51	9.62
		IPM 2-3	4.85	6.74	9.71	9.75	10.92	7.87	9.44	8.89
		MH-421	3.86	6.53	8.34	8.91	10.24	7.21	8.78	7.95
		IPM 2-14	4.56	7.22	9.86	10.95	12.32	8.62	10.18	9.86
Karimula			5.11	7.96	9.87	10.22	12.74	8.26	--	--
Gopada			4.56	6.85	10.04	10.57	12.11	8.28	--	--
Khandiyagiri	Black gram	PU-31	4.57	7.89	9.67	10.12	11.56	8.69	9.12	9.85
		Azad	4.67	7.98	9.91	10.26	12.17	8.24	9.86	9.58
		VBN-8	4.11	5.22	7.76	8.27	9.85	6.88	7.15	6.78
Gaouradeipur		IPU-49-1	4.79	7.16	9.68	9.92	11.87	8.32	--	--

Table 2.5: Treatment wise and pulse variety wise yield obtained by crop cutting experiment in different villages in Khurda district

Village name	Pulse		Farmer Practices	Improved Practices (IP)	IP + Hydrogel	IP + Nano solution	IP + Nano solution + Hydrogel	IP+ Trichoderma
	Type	Variety	Yield (q/ha)					
Athantar	Green gram	IPM 2-14	4.32	7.22	9.52	10.28	11.84	8.68
Giringa	Black gram	PU-31	4.95	7.83	9.54	10.52	12.44	8.28
Siripur			4.75	7.02	9.95	10.02	11.93	8.47

2.6 Ongoing activity during Rabi season (2018-19)

In the current Rabi season (2018-19), more than 2500 ha (more than 8000 direct farmer beneficiaries) has been covered under pulse demonstration program in Rice-Fallow area. The district wise details are provided in table 6. Green gram seeds have been distributed among 4674 farmers of 363 villages covering about 1541 ha in 77 blocks of 21 districts. Black gram seeds have been distributed among 3625 farmers of 314 villages covering about 980 ha area in 65 blocks of 19 districts. Spatial distribution of pulse demonstration, adaptive trials and on-station experiment locations in different districts of Odisha are provided in Fig. 10.

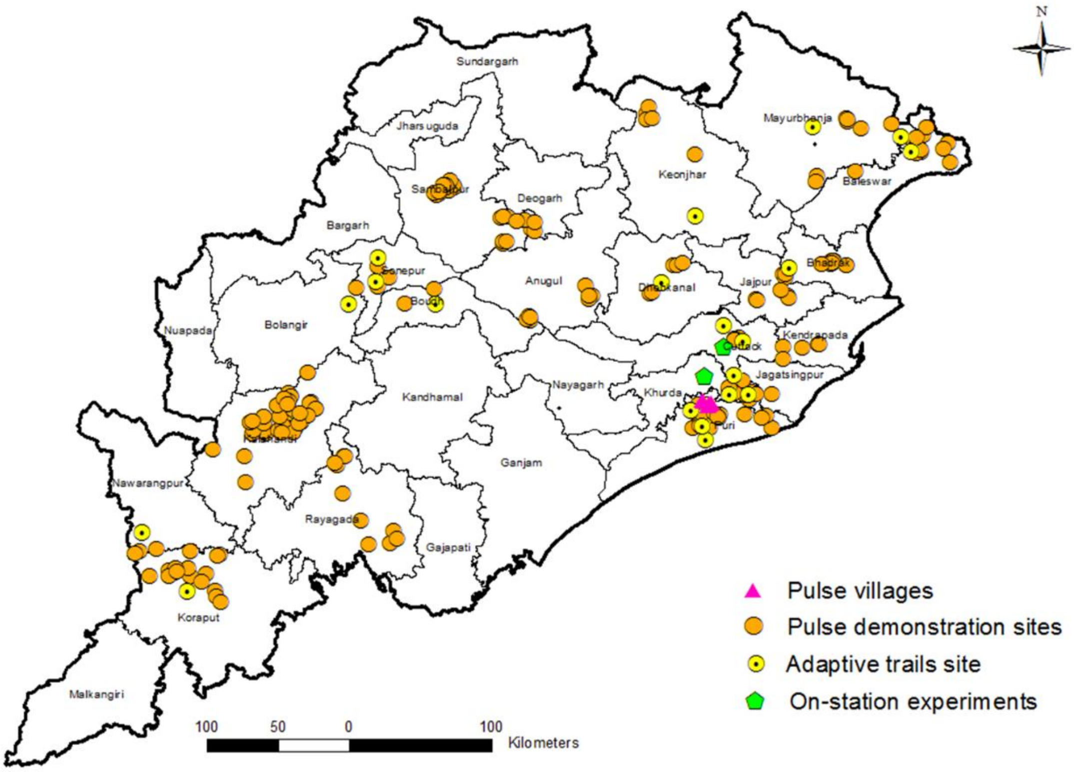


Figure 2.8: Spatial distribution of pulse demonstration, adaptive trials and on-station experiment locations in different districts of Odisha during Rabi season 2018-19

Table 2.6: IRRI-DOA pulse demonstration activity during Rabi season (2018-19) in rice-fallow cropping system in Odisha

District	Varieties	No. of blocks	No. of villages	No. of farmers	Demonstration area (in ha)
Green gram					
Angul	V1,V3	2	7	94	21.84
Balasore	V2, V3	8	15	462	121.30
Bhadrak	V2, V3	4	20	296	77.38
Bolangiri	V1	2	2	81	40.20
Boudh	V1,V2	2	3	48	33.80
Cuttack	V2, V3	3	24	308	130.53
Dhenkanla	V2, V3	2	5	151	60.00
Jagatsinghpur	V3	2	13	155	49.40
Jajpur	V2, V3	2	7	129	32.60
Kalahandi	V1, V2,V3	8	38	368	180.78
Kendrapada	V3	3	5	60	16.20
Keonjhar	V3	3	11	221	49.08
Khordha	V2, V3	1	5	30	25.00
Koraput	V1, V2,V3	5	60	459	110.36
Mayurbhanj	V2, V3	8	30	578	158.60
Nabarangpur	V1	1	6	142	30.80
Puri	V1,V2,V3	10	59	659	240.0
Rayagada	V1	3	11	45	24.10
Sambalpur	V1	3	35	282	71.40
Subarnapur	V1, V2	4	6	98	74.20
Sundhargarh	V1,V3	1	1	10	2.00
Subtotal		**77**	**363**	**4676**	**1549.57**
Black gram					
Angul	V4	3	6	158	37.72
Balasore	V4	4	11	184	43.20
Bhadrak	V4, V5	3	17	251	29.40
Bolangiri	V4	1	1	54	18.20
Boudh	V4,V5	2	4	29	12.20
Cuttack	V4,V5	3	16	105	47.81
Jagatsinghpur	V4	2	5	164	40.01
Jajpur	V4	2	6	113	11.20
Kalahandi	V4, V5	7	44	326	169.50
Kendrapada	V4	4	8	119	29.85
Keonjhar	V4,V5	3	10	188	45.01
Khordha	V4	1	5	50	33.60
Koraput	V4, V5	5	44	512	127.18
Mayurbhanj	V4, V5	6	25	442	68.80
Nabarangpur	V4	1	6	145	35.00
Puri	V4,V5	8	50	352	123.22
Rayagada	V4	3	15	116	53.80
Sambalpur	V4	3	35	257	29.40
Subarnapur	V4, V5	4	6	62	23.60
Subtotal		**65**	**314**	**3627**	**978.7**
Total (Green gram + Black gram)				**8303**	**2528.27**
Green gram variety: V1 = MEHA (IPM 99-125), V2 = Virat, V3 = IPM 02-03 Black gram variety: V4 = PU-31, V5 = IPU 2-43					

Photos 2.3 Sowing of Pulses, involvement of women in mechanised seeding, spraying of insecticides and pesticides at different growth stages in adaptive trials Rabi season 2018-19

Photos 2.4 Performance of Pulse crop at different growing stages

2. 7 Multi-institutional targeting of Rabi crop in Rice-fallow system:

Under the Multi-Institutional Rice-Fallow targeting initiative by ICAR and Ministry of Agriculture, India, five different crops (i.e., Sweet potato, Black gram, Green gram, Chick Pea, and Pigeon Pea) have been demonstrated by four different CGIAR organizations (i.e., CIP, ICARDA, ICRISAT and IRRI) in around 10 ha in two blocks of Puri district. The organization wise targeted crop and respective area are provided in table 2.7.

Table 2.7: Details of Multi-Institutional targeting (MIT) of Rabi crop in Rice-Fallow system in Puri district

Organisation Name	District	Block	Village	Crop Type	Variety	Area (in ha)
CIP	Puri	Pipili	Kanhapur	Sweet potato	Kanjangad	0.32
			Karimula			0.40
			Srikanthpur			0.40
			Burundei			0.40
		Satyabadi	Uttan sahi			0.40
ICARDA		Pipili	Kanhapur	Black gram, Green gram	PU-31, IPM 02-3	1.00
ICRISAT			Srikanthpur	Chick Pea	JG 14	0.40
			Burundei			0.40
			Kanhapur			0.48
			Karimula			0.40
		Satyabadi	Uttan sahi			0.40
				Pigeon Pea	ICPL 20338	0.40
		Pipili	Srikanthpur			0.32
			Burundei			0.30
			Kanhapur			0.32
			Karimula			0.32
IRRI			Kanhapur	Green gram	VIRAT	0.90
			Karimula			0.50
			Srikanthpur			0.40
			Burundei			0.80
		Satyabadi	Uttan sahi			0.60
Total		**2**	**5**	**5**	**6**	**9.86**

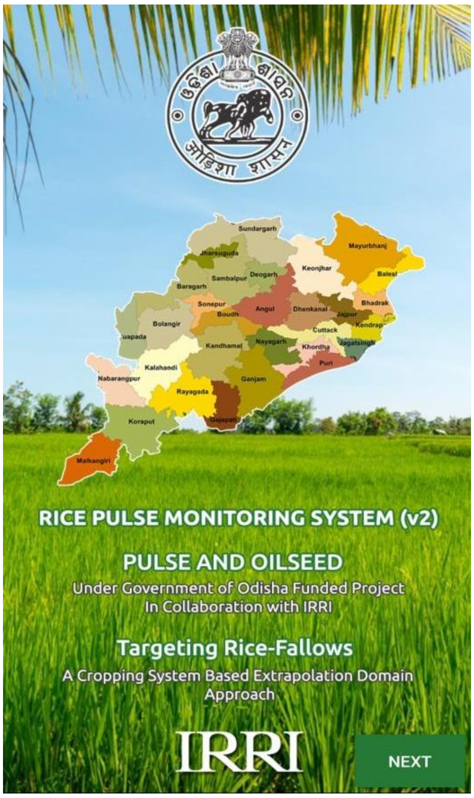

Photos 2.5 Sweet Potato trial carried out by IRRI-CIP collaboration. Sprinkler irrigation in sweet potato field and fully grown sweet potato field Uttansahi village of Satyabadi block, Puri district

Photos 2.6 Chick Pea field in Uttansahi village of Satyabadi block, Puri District. The trial is carried out through IRRI-ICRISAT collaboration

Photos 2.7 Pigeon Pea field in Uttansahi village of Satyabadi block, Puri District. The trial is carried out through IRRI-ICRISAT collaboration

2.8 Rice Pulse Monitoring System (V2)

Based on the feedback from the DOA officials, an updated version of Rice-Pulse Monitoring System (RPMS) has been developed. RPMS (V2) is a customized android (phone/tablet) based survey application system for rice, pulses and oilseeds crops which can be used to collect and store geo-referenced information, along with a suite of geo-spatial tools to visualize, analyse and manipulate ground data for various needs of Department of Agriculture in different projects. Compared to earlier version, RPMS V2 features include coverage of rice crop (along with Pulses and oilseeds in cropping system mode), user friendly polygon generation and its conversion to various formats (e.g., KML for viewing on google earth), strong backend support and controls, provides overlay and viewing facilities of Geospatial layers (e.g., crop and land information, rice, rice fallow, flood or drought areas). RPMS V2 enables a better understanding of of agricultural data for decision making for research and management purposes. RPMS's goal is to is to provide an open source platform that can support online/offline application to cater to the needs of current and future geo-spatial agricultural data collection.



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

This sub-project, revolving around the generation and dissemination of ICT-based nutrient management advisory, was initiated in the wet season of 2016-17 and has thus far delivered more than 90,000 recommendations through five seasons. Farmers get access to climate-informed RCM service through printed guidelines and SMS before the start of the season to help them procure the required inputs (fertilizers, herbicides) and use them as per the schedules associated with the phenological stages of the crop. The requirements are quantified and split as per the land parcel size and target yield for varieties chosen by the farmer in his responses to the queries the service provider had asked, before generating the recommendation. The service providers are field functionaries of the state department of agriculture, input dealers and NGO partners who have received training on using the ICT-based tool. Recommendations are generated using installed facilities (computers and printers) in different blocks linked to the IRRI based server hosting RCM.

RCM was originally developed for irrigated environments. The need to suitably adjust the recommendations for rainfed environments with in-season corrections was felt and hence efforts have been made to incorporate the changes for such conditions in the second year onwards. Dissemination channels, public and private, differently influence farmer behavior and hence the speed and effectiveness of different channels need to be assessed to select the best combinations that would ensure sustained adoption of RCM as the preferred crop /nutrient management tool. During the year under report, IRRI team evaluated the available pathways using a survey of farmers selected from different districts. Further to the generation and recommendation of RCM, IRRI also monitored the level of adoption by farmers and recorded the responses to estimate the outcomes of interventions.

There is a need to fine-tune and develop nutrient management recommendations suitable for different crop establishment methods with integration of nutrient management for cropping systems, instead of separate recommendations for component crops. IRRI collaborated with OUAT and NRRI to establish various trials, including on-farm weed management trials, during the last two years to find out best crop and nutrient management practices with a bearing on system productivity.

Various stakeholders were trained to use the RCM tool, query the farmers on site specific information, upload the information to the IRRI based server for computations and generate and print recommendations for farmers. On-farm trials (Head 2 Head) were conducted for comparative evaluation of crop performance with and without RCM. Results of the activities undertaken during the year are described in the following sections.

3.1 Dissemination of RCM recommendations to farmers

3.1.1 Capacity building of extension staff on use of RCM application

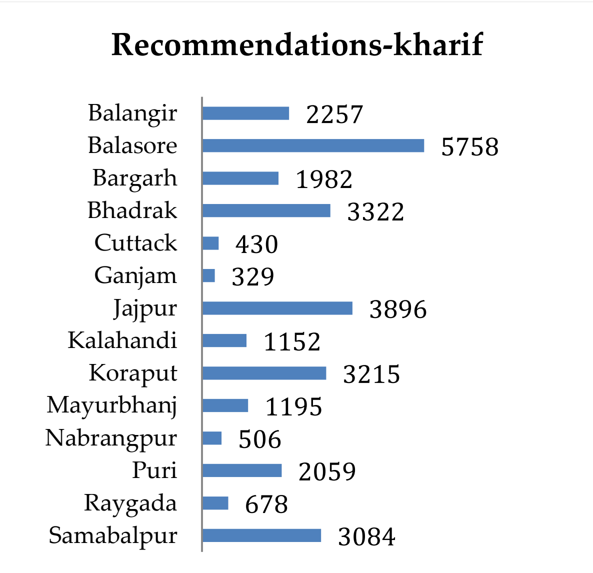
One of the objectives of the sub-project is to provide farmers with RCM recommendations before start of every cropping season and extension staff of DoA and Community Resource Persons (CRPs) of NGOs have been identified as the major channels for dissemination of these recommendations. To fulfill the objective, the concerned staff are provided hands-on training on use of RCM app and thereafter given a target to reach out to farmers, interview them using RCM app and provide them with a printed recommendation. During Kharif 2018, 81 hands-on trainings were conducted in which 1729 staff of DoA and NGOs were trained to use the RCM app in kharif season (Table 3.1). Training for Rabi season is in progress and till date two trainings for CRPs of NGO partners have been conducted.

Table 3.1 Training organized for state agencies and NGO partners during 2018-19

SN	Training	Season	Districts	No. of participants
1	Hands-on training of VAWs and AAOs	Kharif	9	1470
2	Hands-on training/awareness meeting for CRPs of NGO partners	Kharif	13	259
3	Hands-on training/awareness meeting for CRPs of NGO partners	Rabi	5	32

3.1.2 Recommendations generated & distributed

During kharif 2018, using the RCM app, 29863 farmers were interviewed and were provided with a printed RCM recommendation across 14 districts (Figure 3.1). In each district, about 10-15% farmers were monitored throughout the season through field visits and phone calls and were encouraged to follow crop management practices as recommended by RCM. These recommendations are generated every season and are provided to farmers before they go for basal dose application. For rabi season, recommendation generation and distribution is ongoing and by 15 February, 11,352 farmers have received RCM recommendations (Figure 3.2).



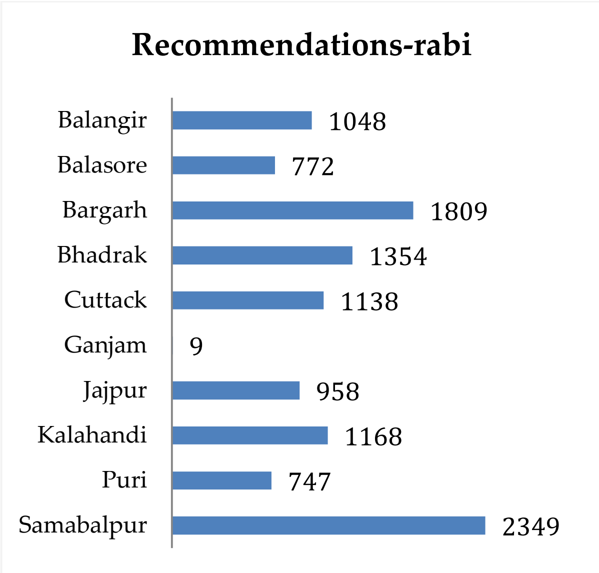


Figure 3.1 and 3.2 Number of printed RCM recommendations provided to farmers during Kharif 2018 and rabi 2018-19

3.1.3 Awareness and monitoring

Photo 3.1 Field day-cum-farmer awareness creation workshop at Puri

Adoption of a new technology or a management practice takes time and continuous follow up is required to ensure its usage at farmer's field level. Farmers will deviate from their conventional ways of farming to an improved method only when they are convinced of its benefit. To create awareness among farmers regarding benefits of RCM, large number of meetings, field demonstrations, field days, crop cuts etc. were conducted throughout the season. Farmers are reminded during critical growth stages of crop through visits/phone calls to apply nutrients as per recommendation, so that at the end they can see the effect of timely and balanced nutrient application. They are also encouraged to test the RCM practice vs their own practices on side-by-side plots, to better judge the effect of the technology.

3.1.4 Engagement with women farmers

In India, women's roles in rice farming have been traditionally limited to transplanting, weeding, and similar tasks. Although rural women play a significant role, their participation in decision-making for purchasing and applying fertilizer and other inputs in the field remains low. Efforts were made to create awareness among women farmers regarding balanced nutrient application, soil health and improved crop management practices by providing them with RCM recommendations and explaining the advisories.

Photos 3.2 RCM activities with women farmers at various locations in Odisha

3.1.5 Establishing RCM kendras

To ensure the availability of RCM recommendation to any willing farmer, 91 RCM kendras have been established in 69 blocks and 7 DDA offices of 7 districts under DoA and at 15 NGO offices during 2017-18. In 2018-19, 10 new RCM kendras were set up at 5 block offices of Koraput and Kalahandi each. In each block, one trained staff of DoA has been given the responsibility of the Kendra to provide the visiting farmers with printed recommendation page, at the beginning of the cropping season. District offices, as per DoA instructions, are providing the recurring operational cost of running these kendras. To ensure that these kendras are able to ensure sustainable dissemination of recommendations in the coming years it would be important to include it in the annual agricultural plan. Integration with BGREI scheme could be a first step towards this.

Table 3.2: Blocks with established RCM kendras

District	Blocks with RCM Kendra
Koraput	Kotpad, Boriguma, Jeypore,Kundura, Boipariguda
Kalahandi	Jaypatna, Kalampur, Junagarh, Dharamgarh, Bhawanipatna

3.1.6 Recent Engagement with different extension agencies/projects for wide coverage

IRRI is engaging with different agencies that have the mandate to improve the livelihood of farming community. These agencies through their different programmes cater to large group of farming community. They also share a strong and close association with the farming community which gives them an advantage in motivating the farmers to come forward and try a new technology.

Photo 3.3 RCM plot

3.1.6a. Dissemination of RCM through Odisha Livelihood Mission (OLM)

Under the convergence programme with OLM, IRRI has trained their field staff from Nayagarh, Angul, Sundargarh and Koraput on the use of RCM and they were engaged to disseminate RCM recommendations. RCM demonstration plots were taken under the Season Long Training programme to show the effect of RCM recommendations vs traditional farmers' practices.

3.1.6b. Dissemination of RCM recommendations through Common Service Centres

Common Service Centres (CSC) are physical facilities for delivering the Government of India e-Services to rural and remote locations where availability of computers and internet was negligible or mostly absent. They are multiple-services-single-point model for providing facilities for multiple transactions at a single geographical location. In an effort to make the improved technologies easily accessible to the farmers, IRRI has collaborated with CSCs and in the coming seasons, farmers of Odisha will be able to obtain RCM recommendations for their rice plots from their nearby CSC centres. A letter of agreement has been signed between IRRI and CSC and a state level training was organized for district staff of CSC to train them on the use of RCM application.


Photo 3.4 RCM training program for CSC staff

3.1.6c. Voice calls on crop management and fertilizer recommendations sent to registered farmers throughout the season

Crop advisories through voice calls were sent to around 11,000 farmers during kharif 2018 through voice calls in collaboration with Precision Agriculture Development (PAD). These calls were sent during the critical growth stages of crop to remind the farmers to apply nutrients as per RCM recommendations to farmers who have already registered through RCM app and have received recommendations in a printed format at the start of the season.

3.2 Convergence with government schemes for faster adoption

RCM recommendations for BGREI plot

Bringing Green Revolution to Eastern India (BGREI) was launched in 2010-11 to address the constraints limiting the productivity of "rice-based cropping systems" in eastern India. Under the scheme farmers are provided with improved varieties and micronutrients like Zinc. They are advised to apply fertilizers as per state blanket recommendation (RDF), which is 80-40-40 in Odisha. Under the convergence scheme selected BGREI farmers were provided RCM recommendations in Ganjam, Cuttack and Bargarh. These farmers have been motivated to apply balanced fertilizer doses in their plots and were guided throughout the season by DoA and IRRI. Farmers were encouraged to apply fertilizers as recommended by RCM app for their specific plots. At the end of season, crop cuts were conducted in two side by side plots to compare the effect of RCM vs. farmers' practice in the presence of farmers, DoA and IRRI staff. The crop cut data averaged for 20 plots of Swarna Sub-1 variety shows that RCM plots had a yield advantage of 0.83 t/ha with added net benefit of Rs 11882 per hectare over that of RDF plots. All other management practices were same including variety used; only fertilizer management differed.

Table 3.3 Yield gain and Net added benefit with use of RCM recommendations in BGREI plots (on-farm results n=20)

Treatment	Yield gain (t/ha)	Net added benefit (Rs/ha)
BGREI RCM vs BGREI non-RCM	0.83	11882

3.3. Socio-economic studies: Identifying and developing dissemination and scaling pathways for ICT-based RCM and estimating its impact on rice productivity and cost management

A farmer makes decisions regarding purchase and use of various inputs to enhance productivity and economic returns from his farming. Many factors influence input application behaviour of farmers and bringing an induced change to the same is not a very easy task. RCM, as a web based app, aims in cultivating sustainable and balanced fertilizer application behaviour among the farming community, along with ensuring significant additional economic gains. To ensure sustainable reach and adoption of RCM technology amongst the farming community, the best-fit dissemination channel/combination(s) had to be identified. This demands an appreciation of the farmer behavioural process surrounding fertilizer application. A socio-economic baseline survey of 2200 farmers, which included RCM- using, and non-RCM farmers was designed and implemented during the year. The study sample was drawn from 5 districts namely Sambalpur, Bargarh, Balasore, Jajpur and Puri since they had various combinations of private and public dissemination channels that were employed. Kharif and Rabi farmers were in almost equal proportions in the sample with a few farmers cultivating two crops. Some of the key findings are presented here.

Figure 3.3 depicts various channels of dissemination ranked in the order of farmers' preferences (derived using Garrett's ranking). Our study indicated that the most preferred mode for accessing RCM is the doorstep delivery of generated RCM recommendations through a VAW/NGO staff/IRRI staff as against getting it from an RCM Kendra/nearest input dealer/generating it from farmers' own ICT device. However, this also becomes a cause of concern since the survey revealed that generated recommendations have not reached the farmer. The information captured during RCM interviews was not accurate which made tracing of farmers in our random sample cumbersome. This happened mostly with channels like VAWs and fertilizer dealers due to which our initial sample underwent pretty high replacement (78-79 per cent with both channels). However, this also helped us in understanding the challenges in implementation. Lack of incentive was cited by VAWs as the major reason. Letter from higher authorities with respect to target achievement also could not persuade them. With provision of incentives not being a long-term solution, a policy level integration of RCM at the state level appears to be the most promising solution to invoke response from these public dissemination agencies.

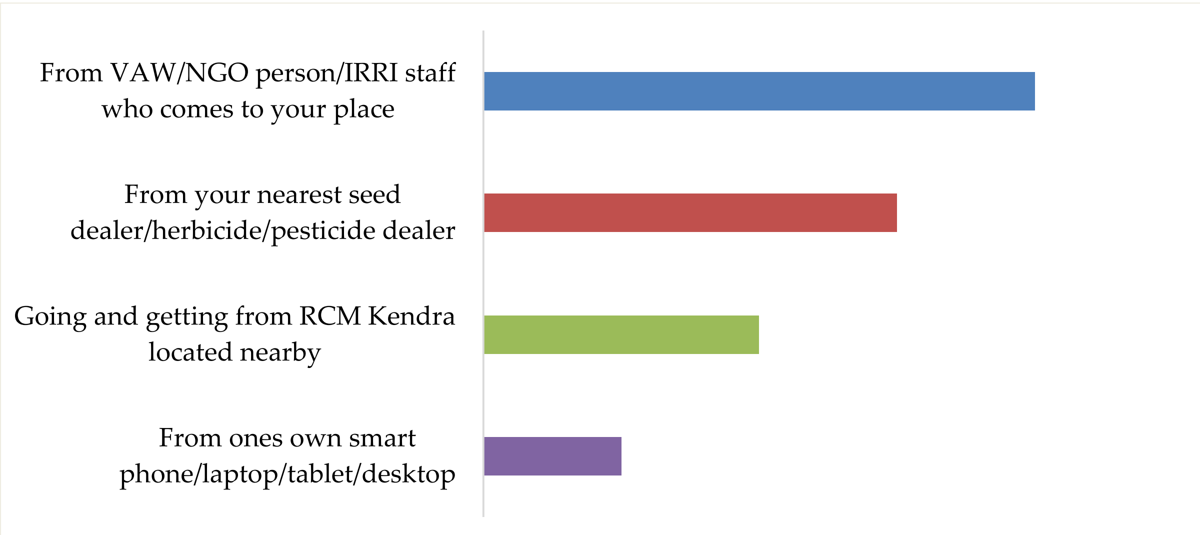


Figure 3.3: Channels of Dissemination: Farmers' Preferences

The option of operating RCM as a sustainable business model through IFFCO associated input dealers was experimented with, wherein IRRI paid a fixed amount per recommendation generated to dealers through IFFCO. Dealers were chosen as one of the channels since farmers have good rapport with them and frequently visit these shops. Although farmers' second preferred option was procuring it from a nearby input dealer, the preliminary field experiences with fertilizer dealer on the other hand were not quite encouraging. The opportunity cost of time spent to generate, distribute and monitor the recommendations has persuaded the dealer to show less interest and sincerity in taking this as a business option. IRRI is meanwhile exploring the option of Common Service Centres (CSC), a neutral agency, as another option since around 24 per cent of farmers had expressed interest in purchasing RCM recommendations from an input dealer. We believe CSCs, with a wide range of network percolating down to the gram panchayat level, can serve as an effective replacement for dealers with improved accessibility for the farmer.

It is posited that the most dependable and sustainable option for any digital agricultural technology is ensuring digital reach and literacy of farmers. The most optimistic scenario hence would be a farmer generating recommendation in his own ICT device and following the same. With 45 percent of farmers owning a smart phone and 31 percent of them stating that they know how to operate them, this is potentially possible. However, this option ranked the lowest by farmers. Only 2 percent of ICT device owners reported accessing crop or weather related information from internet through their ICT devices. The usage of smart phones by farmers, particularly when it needs internet access, is limited. Farmers were also not asked to establish the web link for RCM on their own in their smartphones and try operating the RCM application before ranking the preferences. Practical experience with respect to app usage could potentially have influenced their preferences.

Although RCM Kendras ranked third in the options available to obtain RCM recommendations, awareness about the existence of these kendras was found to be abysmally low at 2 percent. Coupled with the fact that only 2.8 percent of sample farmers knew about the availability of RCM recommendations during other season, the need for increasing awareness about the availability of RCM recommendations free of cost from already established RCM Kendras is emphasized. This would suggest intensive promotion of the technology as well as its accessibility in existing/proposed channels such as RCM Kendras, CSCs through mass media/print media with sufficient reach to the farmers. Rather than establishing stand-alone Kendras, they should be integrated with other functions of the department and/or with CSCs with its wide network. Nineteen percent of kharif RCM farmers responded that they have completely followed the recommendations, with an additional 20 percent stating a partial adoption. Figure 3.4 presents various reasons farmers cited for not following the recommendation fully or partially. The most prominent reason quoted for non-adoption or partial adoption was the increased doses of fertilizer with RCM recommendation as against farmers' practice with 41 percent of non/partial followers citing the same. In the following months further data analysis would be undertaken especially with respect to assessing adoption and fertilizer usage disaggregated at channel level. The study also aimed to assess the impact of information re-enforcement through voice calls/SMS that were sent out through agencies such as IFFCO and PAD on adoption. Certain complementary information available with these agencies with respect to the farmers covered is required before processing the information.

A change in the decision making process with respect to fertilizer application, which is a deeply engrained habitual choice, is not an easy task which would happen in one or two seasons. Nevertheless, the fact that a good proportion (53 percent of the total farmers in the sample) including non-RCM farmers, expressed an interest in obtaining recommendations in the upcoming seasons is encouraging.

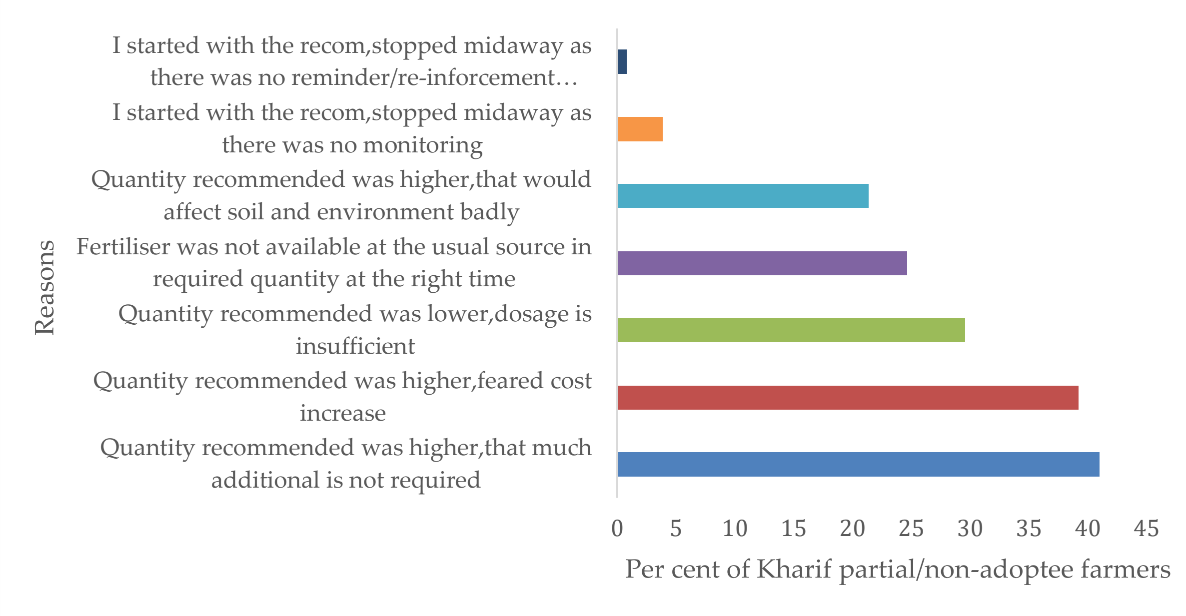


Figure 3.4: Reasons for non-adoption or partial adoption of RCM recommendations

3.4 Strategic and adaptive research to improve and refine RCM framework

Various experiments have been initiated for refining the nutrient and crop management module in rice crop manager framework. The results from these experiments will be used to improve the algorithms and develop better decision trees for both irrigated and rainfed environments (Table 3.4)

Table 3.4: Details of strategic and Adaptive trials during 2018-19

SN	Experiment	Number	District	Blocks	Location/ Integration
1	Productivity and resource use efficiency of rice-rice system under different establishment methods.	1	1	1	IRRI-OUAT experimental station
2	Optimization of Nutrient management for rice based cropping system	1	1	1	IRRI-OUAT experimental station
3	Optimising Fertilizer application rates and timing for rainfed rice	1	1	1	IRRI-OUAT experimental station
4	Evaluation of crop management component of RCM- (weed management)	15 (Kharif) + 15 (Rabi) + 1 (on station)	3	8	IRRI-NRRI Total: 31 trials
5	Development, validation and evaluation of RF component of CMRS	66 (Kharif) + 54 (Rabi)	10	20	Total: 120 trials (with Sub component 1)
6	Development and evaluation of RCM for wet DSR	11 (kharif)	2	4	Total 11
7	Adaptive trials on using GIS based yield monitoring for developing better yield targets	13 (Kharif) +22 (Rabi)	4	12	Total: 35 Trials (with Sub component 5)

8	Development of better zinc management for Rice based systems for Odisha	95 farmers (Kharif) +75 farmers (Rabi)	5	12	Total: 170 farmers
9	Development of better nutrient management module for rice pulse systems for Odisha	25 trials (Rabi)	4	14	Total: 25 Trials (with Sub component 2)

3.4.1 Under IRRI-OUAT collaborative project, three experiments were undertaken at the Research platform of OUAT, Bhubaneswar as detailed below:

3.4.1a Productivity and resource use efficiency of rice-rice system under different establishment methods and green manuring:

The experiment was laid out in split-plot design with 18 treatment combinations and three replications in rice crop during kharif season. The crop var. Swarna Sub 1 was sown on 7th July 2018. The direct seeded rice was drill seeded at 25 cm spacing, which took 111 days to reach at fifty per cent flowering, whereas transplanted plots took 8-11 days extra for reaching fifty per cent flowering. Direct seeded crop matured in 141 days whereas the transplanted crop was delayed by 9 days in Non puddled transplanting (NPTR) and by 13 days in puddled transplanting (PTR). Green manuring with Sesbania recorded 7.9 percent higher grain yield (5.78 t/ha) as compared to no green manuring. Among different establishment methods, the highest grain yield (5.86 t/ha) was obtained under NPTR-PTR establishment method followed by PTR-PTR (5.63 t/ha) and NPTR- NPTR (5.39 t/ha) establishment methods. In rabi 2018-19 rice variety Lalat is undertaken in sequence.

3.4.1b Nutrient management in rain fed direct seeded rice-green gram cropping system

The experiment was laid out in split-plot design with 24 treatment combinations with three replications for the rice crop in kharif season. Rice variety Hiranmayee was sown on 14th July 2018. The direct seeded rice was drill seeded at 25cm spacing and the broadcasted rice was established using beushening after 30 days. The drill seeded rice took 101 days to reach at fifty per cent flowering whereas, rice established with beushening took five extra days for reaching at fifty per cent flowering. The crop matured in 129 days when grown without nitrogen application whereas it matured in 131 days with 40kg N/ha and for each successive 40 kg additional doses of nitrogen the duration extended by one day. The drill seeded rice yielded around 4.43 t/ha whereas the yield in beushening method was higher (5.90t/ha). Without any nitrogen application the yield was restricted to 3.12t/ha, yield increased to 5.33 and 5.70 t/ha, respectively with successive addition of 40kg N/ha but decreased to 4.63t/ha at 120 kg/ha nitrogen. In following rabi season green gram variety IPM 2-14 is undertaken in sequence.

3.4.1c Nitrogen and potassium nutrition in Rice and its effect on Toria and Horse gram under rain fed situation

The experiment was laid out in RBD in kharif season with seven treatments over three replications for the rice crop. Rice variety Sahabhagi dhan was sown on 7th July 2018 and harvested on 31st October. The crop was drill seeded at 20cm spacing. It took around 76 days to reach fifty percent flowering and matured in about 104 days. With the omission of Nitrogen and Potassium, the grain yield recorded was 2.64 and 3.33 t/ha, respectively; but when 60kg N was applied in two splits as basal and at active tillering the grain yield increased to 3.76 t/ha; further splitting of Nitrogen up to panicle initiation increased grain yield to 4.49 t/ha. Maximum grain yield of 5.11 t/ha was obtained by splitting both K (two splits as basal and panicle initiation) and N (in to three splits as basal, active tillering & panicle initiation) doses.

Photos 3.5 IRRI-OUAT collaborative experiments

3.4.2 Under IRRI- NRRI collaborative project the following experiments were conducted
a) Wet season (kharif 2018)

On-farm trials were conducted at 15 locations in three districts of Odisha (5 each in Cuttack, Puri and Jajpur districts of Odisha) during kharif season, 2018. The treatments consisted of T_1: Farmer's practice (both fertilizer and weed management) T_2: Farmer's practice+ RCM based weed management only, T_3: RCM based fertilizer management only and T_4: RCM based fertilizer and Weed management. RCM managed weed management include: Bensulfuron methyl+pretilachlor (10 kg ha^{-1}) at 5-7 DAT.

- There was significant yield advancement (9.8 to 22.5%) in RCM based nutrients and weed management over FP
- Rice variety, Hasanta recorded highest grain yield of 7.58 t ha-1 in the plot treated with RCM based nutrients and weed management

b) Dry season (summer 2019)

On-farm trials were conducted at 15 locations in 3 districts of Odisha (5 each in Cuttack, Puri and Jajpur distict of Odisha) during 2019 summer season. The treatment consists of T_1: Farmer's practice (both fertilizer and weed management) T_2: Farmer's practice+ RCM based weed management only, T_3: RCM based fertilizer management only *and* T_4: RCM based fertilizer and Weed management.

On-station trial was also conducted. Main plot: Rice varieties are V_1: Bina dhan 11, V_2: CR Dhan 203, V_3: CR Dhan 206; Sub plot: Spacing, S_1: 20cm x15 cm & S_2: 15cm x15 cm; Sub-sub plot: weed management practices, W_1: Without weed management, W_2: Partial weed management (One weeding at 30 DAT) & W_3: Weed free (Manual weeding at 15, 30, 45 and 60 DAT)

- Planting was completed in both the activities. Imposition of treatments will be completed by February 22, 2019

Photos 3.6 NRRI-OUAT collaborative experiments (a. Crop cutting conducted at Nimapara block in Puri district; b. RCM (WM+ NM) Intervention at maturity stage in Puri district)

3.4.3 Development, validation and evaluation of rainfed component of CMRS

Photo 3.7 Head to Head trails

Sixty-six farmers' fields were used to evaluate the coupling effect of better nutrient and crop management practices through RCM with stress-tolerant rice varieties (STRVs) provided under component 1 of the project. Selected farmers in different districts of Odisha (n=66) were provided with stress-tolerant varieties as per site suitability in kharif 2018. Every farmer's field was then divided into four plots with the help of bunds. The treatments included: 1) Farmer fertilizer practice + site suitable stress tolerant variety 2) Rice Crop Manager + Farmer variety and 3) Rice Crop Manager + Site suitable stress tolerant variety. Comparisons were made against a check (Farmer fertilizer practice + Farmer variety). Over farmer fertilizer practice, RCM recommendation could produce a yield advantage of 0.70 t/ha and 0.61 t/ha respectively in the context of farmers' variety and site suitable stress tolerant variety. The yield gain was higher (1.24 t/ha) when better nutrient management practice and site suitable variety were used together (Figure 3.5).

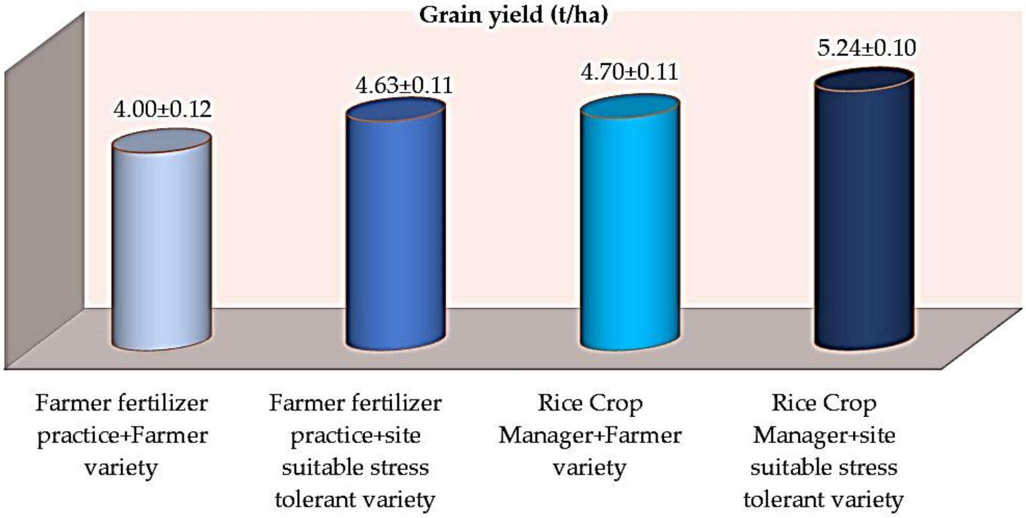


Figure 3.5: Average Grain yield (t/ha) in Head-to-Head trials: Stress prone Rainfed Conditions

3.4.4 Development and evaluation of RCM for DSR

Photo 3.8 RCM vs. FFP in DSR plots

Due to difference in crop establishment, the nutrient management for DSR crop varies from that for transplanted rice. RCM aims to match nutrient management to the crop management practice for maximum benefit. Selected farmers (n=10) in the two districts, Puri and Bhadrak, were provided Rice Crop Manager (RCM) recommendation for wet direct seeded rice (DSR). Each farmer followed Rice Crop manager recommendation in one plot and Farmer Fertilizer Practice (FFP) in a similar adjacent plot. Average fertilizer applied in these treatments is shown in Figure 3.6. The average yield under RCM recommendation was 0.65 t/ha higher than the FFP for DSR crop indicating the advantage of better nutrient management through RCM in increasing agronomic efficiency of DSR crop. (Figure 3.7).

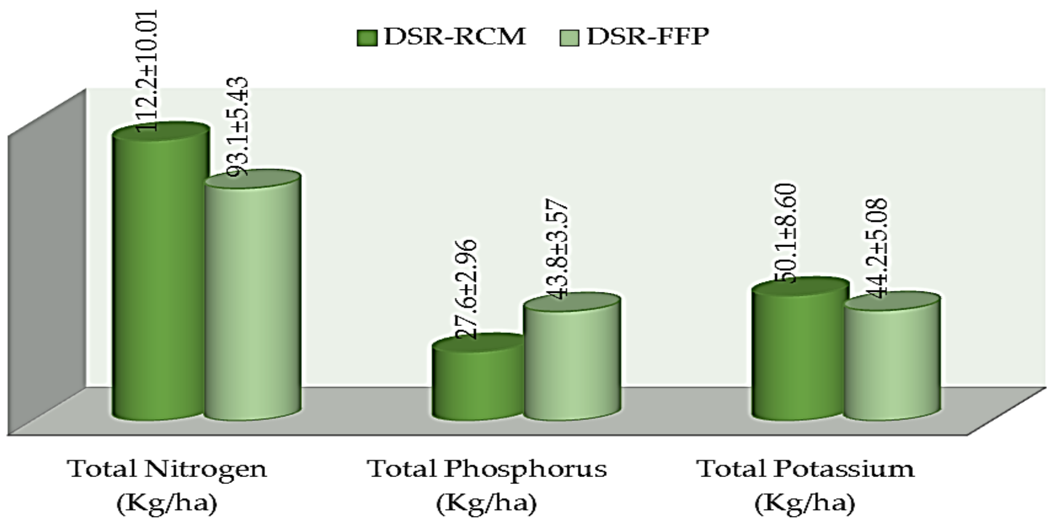


Figure 3.6: Average NPK applied (Kg/ha) in DSR-RCM plots and DSR-FFP

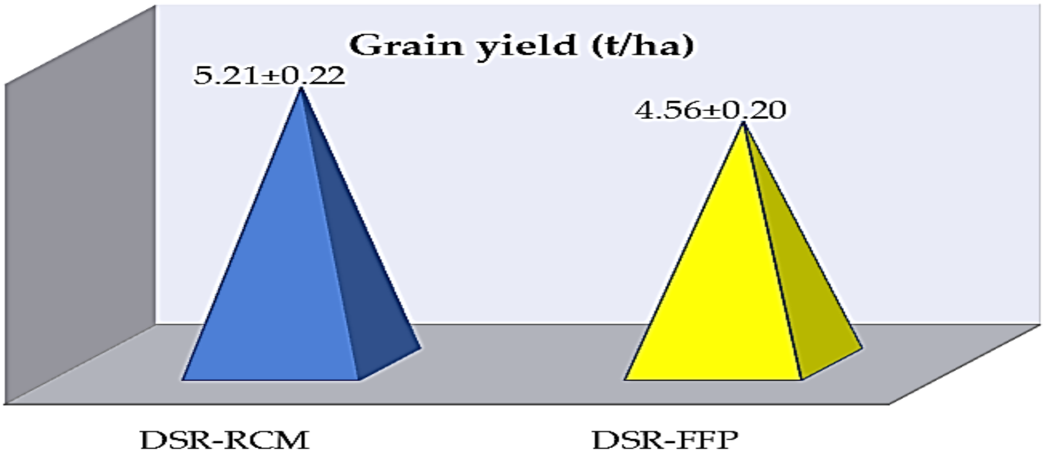


Figure 3.7: Average grain yield (t/ha) in DSR-RCM plots and DSR-FFP

3.4.5 Adaptive trials on using GIS based yield monitoring for developing better yield targets

GIS and RS can play a crucial role in site-specific nutrient management (SSNM) for increasing nutrient use efficiency with precise and real-time yield estimation. Use of GIS and RS in the SSNM can help provide mid-season correction, setting target yield based on local environment and conditions and in generating weather based advisories, leading to balanced nutrient recommendation and ultimately augmenting soil and crop productivity. To improve the crop production and farmer's income, appropriate achievable target yield should be set in the SSNM. Use of GIS can help to set in precise target yield. Overall, use of geo-informatics in SSNM can really be a boon for sustenance under changing climate and increasing variability. The present experiment aims to evaluate the use of GIS & RS for setting the yield targets in RCM. Selected farmers in the two districts of Puri and Balasore, Odisha were provided two types of Rice Crop Manager recommendations. In built RCM tool has set target yield based on farmers' yield prediction whereas GIS based RCM set target yield using GIS tool considering soil, plant and local environment conditions. The objective of this study was to understand the suitability and constraints of using GIS for yield estimation over farmer's questionnaire based yield estimation for this region. Two treatments: 1) Using GIS based RCM yield input and 2) Using farmer's based RCM yield input (Check) were evaluated in farmer's field. Average fertilizer dosages under the intervention are shown in Figure 3.8. Amongst them, average target yield, average actual yield and its' mean difference were more for farmer's based RCM yield (Figure 3.9), but the obtained kg yield per kg NPK application was more under GIS based RCM. Initial data indicate that GIS approach can be an alternative to farmers' interview to set up the target yield and can help to make RCM automated.

Photos 3.9 Target yield prediction trials

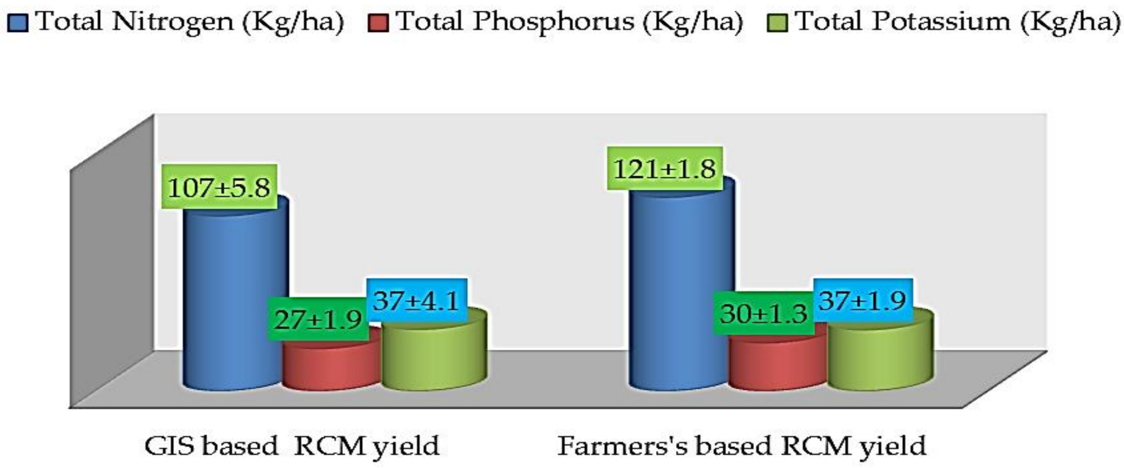


Figure 3.8: Average NPK applied (Kg/ha): GIS based RCM yield vs. Farmer based RCM yield

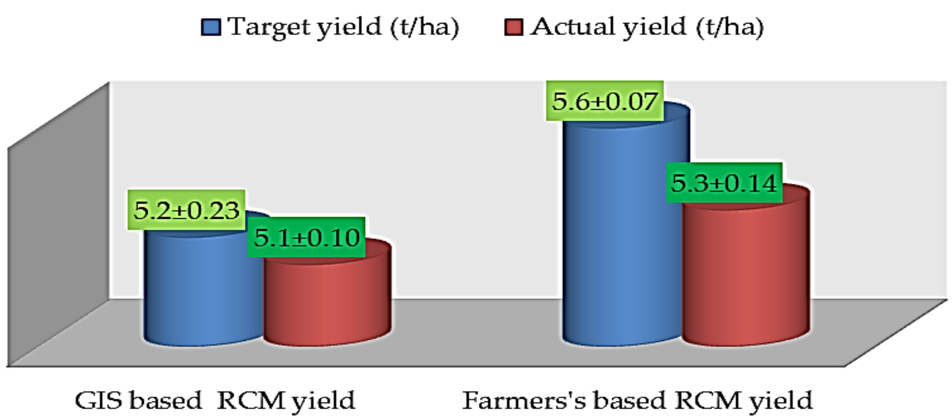
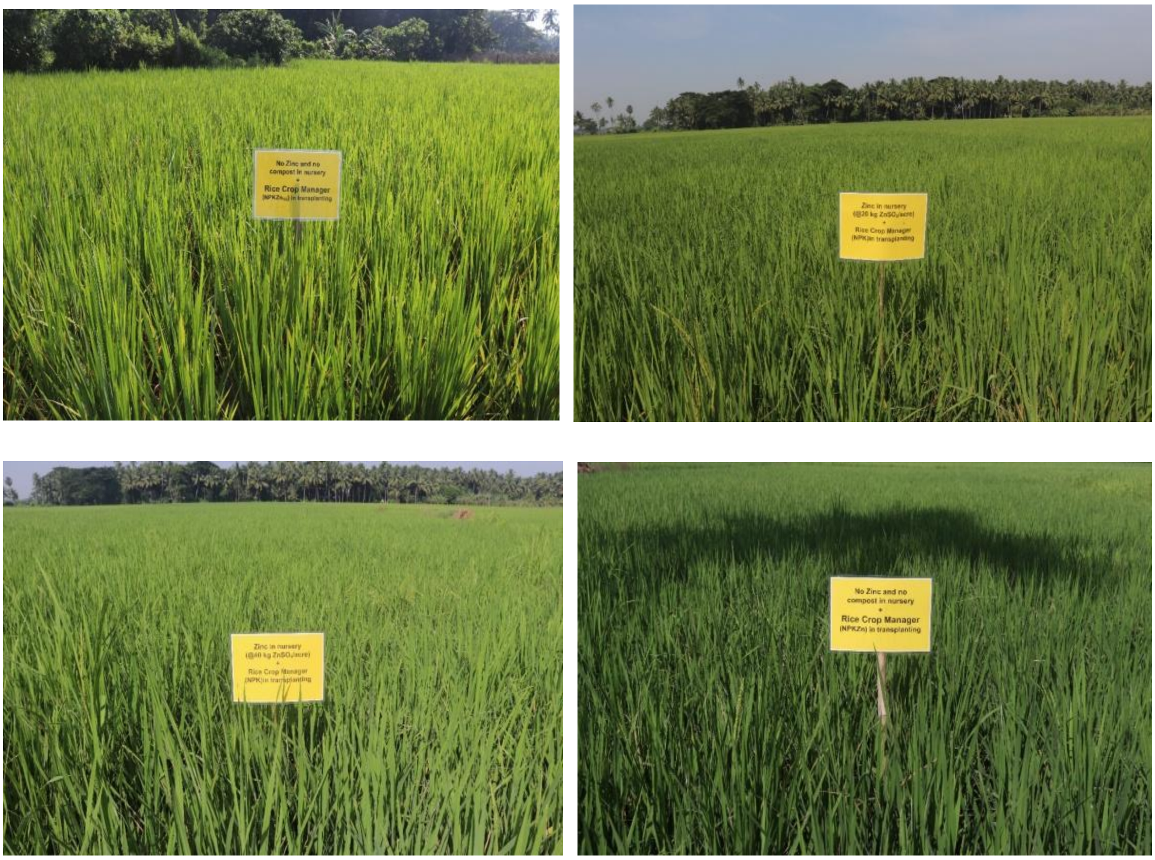


Figure 3.9: Average yield (t/ha): GIS based RCM yield vs Farmer based RCM yield

3.4.6 Zinc management options for Rice Crop Manager (RCM)

Although a costly fertilizer, Zinc, is critical for reproductive development in rice crop. Farmers prefer to apply compost as against zinc either in nursery or in transplanted rice. These trials were conducted in farmers' field to demonstrate the importance of zinc for the rice crop and to identify better zinc management options. 95 farmers from different districts were provided with RCM recommendation under following treatments 1) Half dose zinc in nursery 2) Full dose zinc in nursery 3) Half dose zinc in transplanted field 4) Full dose zinc in transplanted field. They were further compared against the RCM recommendation generated based on the practice of applying compost in nursery. Treatment/Check wise yield on an average (t/ha) are depicted in Figure 3.10.



Photos 3.10 Zinc management trials

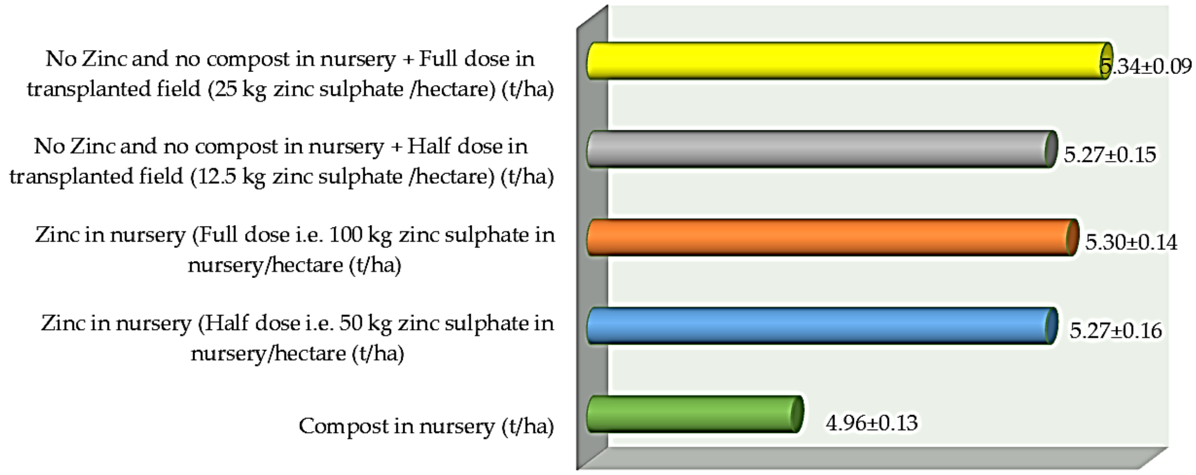
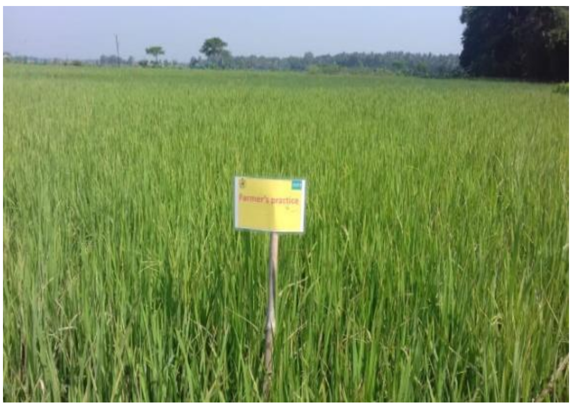


Figure 3.10: Treatment wise average yield (t/ha) obtained with RCM NPK recommendations

The highest yield obtained was in the treatment using full dose zinc in transplanted field which was on an average 0.38 t/ha more than the minimum yield recorded with compost application in the nursery. Application of zinc in nursery was also found beneficial over the compost application in the nursery.

3.4.7 Demonstration of Rice Crop Manager practice over farmer fertilizer practice

In an effort to create awareness among farmers about the benefits of using RCM recommendations over the existing farmers' fertilizer practice, demonstration plots were established in farmer fields in a head to head manner in different districts of Odisha. Crop cuts were done in selected monitored plots in the presence of government officials, farmers and other relevant stakeholders. An average grain yield of 5.25 t/ha (n= 81) was recorded from RCM monitored plots as against 4.76 t/ha (n = 74) in FFP, with a yield gain of 0.49 t/ha (10.29% higher yield) with RCM (Figure 3.11).



Photos 3.11 Demonstration RCM vs. FFP

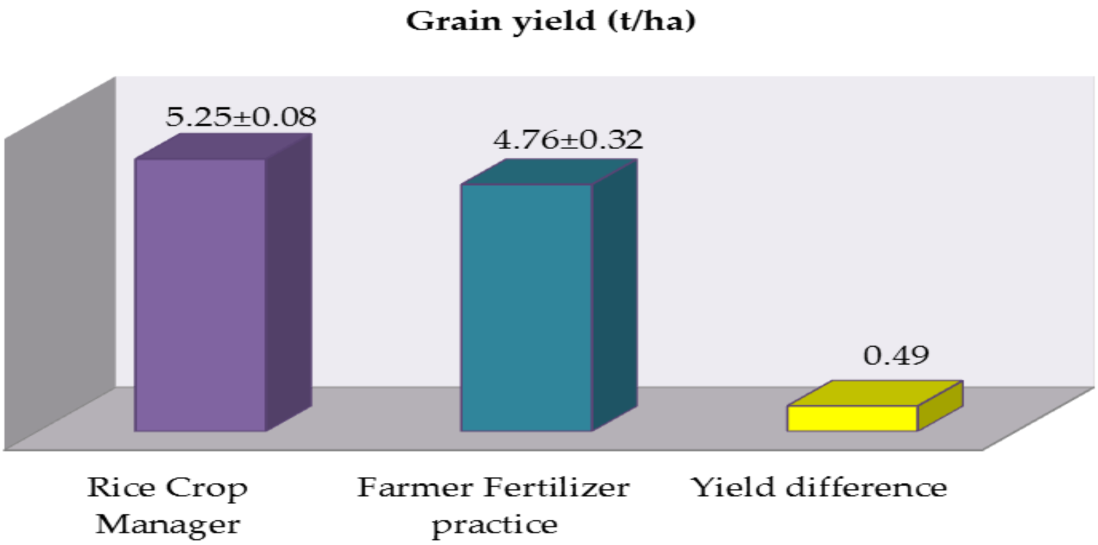


Figure 3.11: Average grain yield (t/ha) RCM vs. FFP

3.5 Summary and conclusion

During the reporting period from Kharif 2018 and Rabi 2018-19 seasons, the following outputs were achieved:

- 10 RCM Kendras set up
- 84 hands-on training sessions organized at district and block level for field staff of DoA and NGO partners where staff were oriented on the operation and use of RCM and on troubleshooting problems with the app
- Maintained the uninterrupted operation of RCM (http://webapps.irri.org/in/od/rcm/), which enabled generation and distribution of 29,863 printed RCM recommendations to the farmers. Generation of recommendation for rabi is ongoing
- Send out crop advisories throughout the crop growing season to around 11000 farmers through voice calls during Kharif 2018 in collaboration with PAD
- Organized field days in RCM plots which were attended by government officials to showcase the outcome and benefits of RCM in farmers' fields
- Baseline socio-economic survey covering 2200 farmers completed
- Strategic and adaptive research in collaboration with DAFE, NRRI, and OUAT conducted to develop capabilities within RCM for irrigated and rainfed environments

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

Food and nutrition security is not only a technological and productivity challenge but also a social and ecological challenge. For example, there is evidence that smallholder farmers are more efficient in the use of scarce resources even though farming is labour-intensive, compared to large farmers who rely more on hydro-carbon intensive, mechanized agriculture. To make growth 'inclusive', therefore, there is a need to prioritize and differentially target farmers and geographic areas with tailored strategies. Smallholder farmers will need different skill sets and knowledge to intensify cropping for profit while preserving the resource base, emphasizing value chains and linkage to local markets while larger farmers need to unlearn fertilizer and pesticide intensive methods and learn to adopt sound practices that reduce the dependency on external inputs. To promote the use of knowledge-intensive, extension and advisory services also need to adopt innovative methods of knowledge transfer and are key for creating an enabling environment for development, dissemination and adoption of new science and technologies.

The sub-project "Inclusive development through knowledge, innovative extension methods, networks, and capacity building" aims to catalyze changes in the capacities of a wide range of actors including researchers and agricultural extension making them more responsive to the differential requirements of the rice farming community. The project collaborates with national and other state level partners in this process of capacity building and scaling of new knowledge. IRRI collaborated with ICAR-CIWA, ICAR-NRRI, OUAT, organizations involved in promoting social enterprises (ALC Livelihood India) and non-profit research (CRISP, Hyderabad) to achieve the objectives outlined below:

- Development of Rice Knowledge Bank web-portal in Odia
- Modification of Rice Doctor and App to make it region specific
- Development of Ecological Engineering based Integrated Pest Management Modules
- Strengthening capacity of Extension and Advisory Service (EAS) Providers
- Leadership and entrepreneurship development of women farmers
- Research Capacity development through Scholars Program

The activities undertaken and outputs achieved in these areas are described in the following sections:

4.1: Rice Knowledge Bank:

To bridge the gap between research-generated science and evidence and their application in rice production, the International Rice Research Institute (IRRI) developed the Rice Knowledge Bank (RKB)—a digital repository of practical and tested knowledge solutions for rice farmers in developing countries. The RKB includes rice production techniques presented through a set of accessible and usable materials including guide of best management practices, decision tools, videos, fact sheets and, e-learning.

A Rice Knowledge Bank with content tailored for the context of Odisha to serve as a source of information for extension intermediaries, students, researchers and farmers is being developed. It draws on the available research and knowledge from various sources and updated with information being generated from this project, other projects and local knowledge platforms/resources. It will be available in both Odia and English languages.

A committee involving research institutions and the DAFE was formed to decide the Standard Operating Procedure for establishment of RKB and oversee the content. Reference database of IRRI-RKB and unique sources of information from the state has been compiled to provide context, depth and relevance to the content. Discussion was initiated with National Rice Research Institute to ensure synchrony across platforms. Translation of the collated information and conversion to various formats would be done in a writeshop that is planned. A number of E-tutorial videos have been completed.

4.1.1: Content and backend development

i) Varietal information

Information for varieties with passport data and distribution in use in Odisha was collated which is available at:

https://docs.google.com/spreadsheets/d/1IghNuvDIOEqh5E7AQiyVLfbtSjLrbXtzySft237wCO8/edit?usp=sharing

The content was collated from IRRI surveys, OSSC, Seed net portal and, NRRI. Files were updated and would be completed during content workshops.

ii) Distinguishing varietal characteristics

The major passport data presented here are the characteristics that can support farmers and extension agents or a seed certifying agency at the time of roguing, for the identification and the removal of off types. These include plant height, plant type, duration, days to 50% flowering, panicle exsertion, flag leaf angle, awning, grain type and potential yield.

iii) Crop calendars

A cropping calendar is a schedule of operations in the rice growing season from the fallow period and land preparation, to crop establishment, crop management, harvest and storage that allows the farmer to plan budget, credit needs, its timing and cash flow for the season/year, purchase of fertilizer and other inputs, arrangement of required labor for timely operations and contracts for land preparation, harvesting etc. Crop calendars for STRVs for Odisha were collated, and are available in the following format for all varieties grown in the state (Table 4.1**).**

Table 4.1: A typical crop calendar for a medium duration variety

Method of Establishment	Transplanting
1st ploughing	30-20 DBT
Nursery bed preparation and sowing	20DBT
2nd ploughing	16 DBT
Harrowing	2 DBT
Basal fertilizer application	1 DBT
Transplanting	DOT
Weeding and fertilization	15-20 DAT
Topdressing	45 DAT

Weeding	60 DAT
Crop protection	60 DAT (Need based)
Drain water	80 - 85 DAT
Harvesting	90 - 95 DAT
Storage	7 DAH

DBT: Days before transplanting; DOT: Date of transplanting; DAT: Days after transplanting; DAH: Days after harvest

iv) Production practices

Production practices for major varieties are being finalized and will be approved by the knowledge management committee as a part of an upcoming writeshop. A typical production practice package follows the format given below.

Variety	**Swarna Sub 1**
Seed rate	35-60 kg/ha (Depending on crop establishment methods)
Seed preparation	
Visual inspection of seed	Visually inspect the seed lot for any damaged, discolored or broken seed. Remove unhealthy seed
Breaking dormancy	Expose seeds to high temperatures (40–42°C) for 1–2 days prior to sowing
Germination testing	Remove a sample of the seed and test for germination. At least 80 seeds should have germinated to be considered "good seed" (80% germination)
Seed priming	Soak seeds for 4–8 hrs, remove empty or damaged seeds that float and re-dry prior to sowing. Seeds must be sown within 1–2 days after priming
Pre-germination	Primed seed should be soaked in water for 12-24 hrs and the water may be drained for air circulation. In colder weather, seeds may need to be soaked for 36–48 hrs. Drain and keep the seed in bag for 24 hrs in a shady area where air can circulate around the bags. If bag temperatures exceed 42°C, some seeds will be damaged
Seed treatment	Seed treatment prevents and controls seed-, soil-, and air-borne diseases. It improves germination, vigor, and productivity. Treat the seeds either with azospirillum or with a fungicide before sowing
Nursery management	Land for the nursery should be near a reliable source of irrigation. Plough sufficiently, level well, and keep the seedbed free of weeds. Use pre-germinated seeds in the nursery bed. Use raised nursery beds to avoid stagnation of water. For 1 ha rice field distribute the seeds evenly over an area of 1000 m2 and use 40 kg seed for manually transplanted rice. Use 500 kg manure or compost or 20 kg fertilizer (through DAP 18-46-0) for a 1000 m2 area. Ensure that seedlings are transplanted at an appropriate age, 30-35 days for manual transplanting
Land preparation	When possible plow immediately after the previous harvest- especially if the soil is still moist. First or primary plowing: Use a disc or mouldboard plow to kill weeds and incorporate trash, at least 30 days before planting - maximum depth needed 10-15 cm. (4-6in). Second plowing: Plow across the field with the disc or tine harrow at least twice to produce small soil clod sizes. Second plowing should be 14-20 days before planting and the last harrowing or puddling 7 days before planting. Maximum depth should be 5-8cm (2-3in). Repair bunds: Destroy rat burrows and repair any holes and cracks and re-compact the bunds. Bunds should be at least 0.4m high and 0.8m wide. Leveling the field will give better water coverage, better crop establishment and better weed control. A level field should have 1cm slope /100m length and 1 cm side slope. Final soil puddling for rice should be done at least 1-2 days before transplanting

Transplanting	Uproot the seedlings from the nursery with care to avoid damage. For uniform spacing, use ropes as guides to establish the crop in regularly-spaced lines. Use an inter-row spacing of 20 cm and inter-plant spacing of 10 cm. Transplant seedlings in an upright position at a soil depth of 1.5 to 3 cm. Transplant 2 to 3 seedlings per hill. For uniform spacing, use planting guides made of jute rope with appropriate spacing. Maintain alley ways for ease of operation						
Fertilizer application	Apply fertilizer as per the recommendation given by the Rice Crop Manager.	Growth stage	DAT	Kilograms of fertilizer for 1 ha			
				DAP	Urea	MOP (Potash)	Zn sulfate
		Early	Basal to 15	80	46	54	25
		Active tillering	33-37	-	105	-	-
		Panicle initiation	58-62	-	105	54	-
Pest and disease management	Rice crop should be checked regularly for insects and disease outbreaks. Use a mobile application like the Rice Doctor to identify your pest and diseases. Control measures should be only be applied when pest numbers reach an economic threshold level						
Weed management	Control weeds when they are few and during the early stages of crop growth. If using manual or mechanical methods such as the cono-weeder, control weeds at 15 and 30 days after transplanting. If using chemical methods, apply pre-emergence herbicide at 2-3 DAT in 3-5 cm standing water in the field. Use butachlor 50 EC at 1.25 - 1.50 kg a.i./ha (2.5 to 3.0 liter/ha) or pretilachlor 50 EC 750 g a.i./ha (1500 ml/ha product dose). If pre-emergence herbicide is not applied, then apply post-emergence herbicide at 15-25 DAT. Use bispyribac sodium 10 EC at 25 g a.i./ha /250 ml/ha product dose). Use flat fan nozzle with a multiple nozzle boom for application of herbicide. When applying herbicides, follow the indicated safety guidelines and labelled rate recommendations						
Water management	Flood after transplanting. Maintain shallow water (2-3 cm depth) upto the third stage of panicle development. Drain water one week before harvest.						
Harvest	Check crop moisture levels -The optimal stage to harvest rice seed is between 20-25% grain moisture or when 80-85% of the grains are straw colored and the grains in the lower part of the panicle are in the hard dough stage						
Threshing	Freshly cut crop should be threshed and dried within 24 hours after cutting. Field drying or prolonged stacking should be avoided whenever possible as this results in high losses from insects, birds, rodents, disease, and molds. Machine threshers are best used for grain at 20-25 % moisture while manual threshing is easier when grain has 14-18 % moisture						
Drying and measurement of moisture	Ensure the panicles and grain do not touch the ground or lay in water during drying. Dry the grain within 24 hours of harvesting. Reduce moisture contents to 12-14% as soon as possible. When sun drying, turn or stir the grains at least once every hour to achieve uniform drying. Use a moisture meter to check the levels. Ideally the grain should be dried to 12-14%						
Pest control before storage	Disinfestations require a systematic and thorough cleaning of all sources of infestation before storage. Storage containers, structures and equipment can be treated with: Malathion (50EC) at 5ml/20l of water @20ml/m^2 or Deltamethrin (2.5% WP) at 1.5g/l water @20ml/m^2. All second hand bags should be examined and where necessary treated with either a fumigant, insecticide or dipped in boiling water. Solutions of Malathion (50EC) and Fenitrothion (50EC) at 5ml/20l of water and Deltamethrin (2.5% WP) at 1.5g/l water @20ml/m^2 can be used for dipping the bags						
Storage	Grain can be stored in bags or hermetic containers. Hermetic storage - seed is stored in an airtight container so that moisture content of the stored grain will remain the same as when it was sealed. This type of storage can extend viability of seeds, control insect grain pests, and improve head rice recovery. Examples include: IRRI Superbag - available to farmers and processors at low cost and the locally available containers - like the painted pot, where						

	local containers can be easily converted into hermetic storage systems. Ensure that the stored bags or containers are kept protected from rodents and moisture

V) E-tutorial videos

Video production is complete. Few videos are being reviewed and corrected. The modules in each section include:

- Introduction: focusses on the importance of the variety, the ecological zones in which it can be grown, and the overall impact it can have on the cropping systems of that area
- Land preparation: focusses on the major activities that are included in making land pliable for cultivation. These include (1) plowing to "till" or dig-up, mix, and overturn the soil; (2) harrowing to break the soil clods into smaller mass and incorporate plant residue, and (3) leveling the field. Modern precision leveling techniques like the laser-assisted land levelling process have also been described
- Seed treatment: Seed is the foundation of any crop. It must be grown, harvested, and processed correctly for best yield and quality results. Sowing good quality seeds leads to lower seed rate, better emergence (>70%), more uniformity, less replanting, and vigorous early growth which helps to increase resistance to insects and diseases, and decrease weeds. As a result, yield can increase by 5–20%. This section focuses on the methods of seed treatment and also explains the importance of seed treatment to healthy plant growth
- Crop establishment: focusses on the various methods that could be used for planting a crop, including direct seeding and mechanical transplanting. Topics like when to plant, how to plant, what method to choose have been elaborated
- Fertilizer management: focusses on appropriate fertilizer application processes and information and communication technology tools that could be used for calculation of fertilizer recommendations like the IRRI rice crop manager
- Weed management: Weed control is important to prevent losses in yield and production costs, and to preserve good grain quality. Specifically, weeds decrease yields by direct competition for sunlight, nutrients, and water increase production costs e.g., higher labor or input costs reduce grain quality and price. This section focusses on managing weeds and also explains the latest of the available herbicides to control them
- Pest and disease management: Farmers lose a huge percentage of their rice crop to pests and diseases every year. In addition to good crop management, timely and accurate diagnosis can significantly reduce losses. This video focusses on the identification and the control of the major pest and disease problems of the state and also on how chemicals can be used to control them. The video also explains safe sprayer use
- Harvesting: Time of harvest immediately followed by post-harvest interventions like threshing and drying are important to prevent losses and also fetch the right market price for the grain. This video focusses on the harvesting and threshing options that are available to the farmers today

Some of the Hindi versions of the videos can be found at the following links. The next steps are translation and including Odia voice over.

- Swarna Sub 1, DSR
  https://drive.google.com/open?id=1SSljuTCNxj4xTm8n1ffqepvFxv1271c6
- Swarna Sub 1, Transplanted
  https://drive.google.com/open?id=15kbJnbvNZCpzFg3h5xkBDUbHQwtpSExI
- Sahbhagi Dhan, DSR
  https://drive.google.com/open?id=1DbZOX1HKAMm5MurJBQ1J74VZBmlRpzC1
- Sahbhagi Dhan, transplanted
  https://drive.google.com/drive/folders/1xlQZUkL6qbYjMYeuYLSX0PSEX7sHC9NX?usp=sharing
- Quality seed production
  https://drive.google.com/open?id=11RdqaqGP6JgzaChiPDmM1helzWtqCsZh

4.1.2 RKB orientation and dissemination

Over the year, seven trainings were given to 258 extension functionaries and staff associated with the Odisha Livelihoods Mission (Table 4.2). The orientation programs included classroom presentations, interaction and hands on training for the usage of RKB (Photos 4.1-4.2).

Table 4.2: Training for the dissemination of the rice knowledge bank in various districts

SN	Date	No. of Male	No. of Female	Total no. of Participants	Location
1	10.10.2018	29	14	43	IRRI, DoA, Cuttack, Odisha
2	09.11.2018	23	6	29	IRRI, DoA, Nayagarh, Odisha
3	14.11.2018	4	16	20	IRRI, OLM,Sundargarh
4	17.11.2018	30	17	47	IRRI, DoA, Puri, Odisha
5	20.11.2018	29	11	40	IRRI, DoA, Jagatsinghpur, Odisha
6	01.12.2018	8	17	25	IRRI, OUAT, Odisha
7	15.12.2018	18	36	54	IRRI, OLM, Nayagarh
	Total	**141**	**117**	**258**	

i) RKB vendor identification

Through a systematic process, a vendor was identified for developing the website and mobile app. The evaluation panel used assessment criteria (Table 4.3) with a maximum rating of 5 against each.

Table 4.3: Evaluation criteria for RKB vendor identification

SN	Characteristics
1	**Company Profile:** Duration for which the company has been in business, core services offered, composition, size and domain expertise of the web development team, clarity on work location, whether some part of the work will be outsourced
2	**Experience:** Portfolio, current projects handled by the company, time dedicated for a project, time taken for completion, completed projects of industry standard, project planning
3	**Technical Efficiency:** Website/Mob. App development technology & tools to be used, use of project management tool (Trello, Podio, Evernote etc), Content Management system to be used (Wordpress, Drupal, Magento etc.), Search Engine Optimized development, responsive design.
4	**Methodology and delivery system:** Communication management, preferred mode of communication, point of contact, status update and reporting frequency, response to calls and other forms of communication (virtual assistant, etc.)
5	**Maintenance:** Assistance or training after the project, demonstration whenever required, review from both sides for testing, use of analytics and measurement tool for performance.
6	**Others:** Language compatibility, proper management of work contract, maintaining confidentiality in data and project structure, flexibility of working, commercial flexibility (project pricing and free services)
7	Proficiency in Drupal/Joomla
8	Proficiency in Odia Language
9	Familiarity with Agriculture/Livelihoods
10	Experience in developing knowledge archives

Based on the presentations made by the invited organizations, the panel shortlisted three potential vendors for the next steps. Three financial quotations were received and there was an evaluation of the same and, then a vendor was selected.

ii) Collaborative efforts with NRRI and creating a synchronous platform

For Odisha, the primary actors involved in the process of the development and the dissemination of the RKB with IRRI are OUAT, ICAR-NRRI and other national schemes and projects. IRRI and NRRI took the lead in the development of the knowledge bank in collaboration with other partners, for the synchronization of existing platforms and content. three meetings were held at NRRI with an aim to ensure that the RKB for Odisha value adds to the existing platform Rice Xpert.

Photo 4.1 Orientation on Rice Knowledge Bank, OUAT

Photo 4.2 Orientation on Rice Knowledge Bank, Nayagarh

4.2: Rice Doctor

4.2.1 Evaluating the usability of Rice Doctor as a crop diagnostic tool for extension advisories and farmers in Odisha

Rice doctor is a one stop source of information on insect pests, diseases, nutrient deficiencies, toxicities and, agronomy related problems. It is a mid-season diagnostic tool that aims to help extension advisories and farmers have accurately and timely diagnose more than 80 crop problems, pest infestations and disease infections. It also offers information on these problems as well as recommendations in order to address the crop problems it was able to diagnose. Rice Doctor's primary target audience are the extension advisers and farmers. It can also be used by students, private input dealers, and others who help in bridging the information gap between research and farm practice.

Usability testing refers to the evaluation of a product by a representative of its intended users. (extension service providers) The main intention of usability tests is to identify problems by collecting quantitative and qualitative data among participants and assess their satisfaction toward the product. It helps developers identify and address problems that users encounter while using the product. Rice Doctor user testing was done in Kharif 2018-19 with Department of Agriculture and Farmers' Empowerment (DAFE) in the districts of Puri, Nayagarh, Jagatsinghpur and Cuttack; Odisha Livelihoods Mission (OLM) in the districts of Nayagarh and Sundergarh, and post graduate students of Orissa University of Agriculture and Technology (OUAT) (Photos 4.3 to 4.6 and table 4.4).

The main objective of the study was to assess the efficiency and accuracy of rice doctor mobile application for mid-season diagnosis and management of insect pests, diseases, abiotic stresses and agronomic problems.

Photo 4.3 Rice doctor user testing at Cuttack

Photo 4.4 Rice doctor user testing at Nayagarh

Table 4.4: Profile of respondents

SN	Designation	Number
1	Deputy Director of Agriculture (DDA)	3
2	District Agriculture Officer (DAO)	10
3	Assistant Agriculture Officer (AAO)	37
4	Village Agriculture Worker (VAW)	87
5	Farmers	64
6	Students	25
7	Others (PPO, NGO, DPM, BPM, APD, PC, Agronomists)	32
Total		**258**

Photo 4.5 Rice doctor user testing at Jagatsinghpur

Photo 4.6 Rice doctor user testing at Sundergarh

i) Methods followed for usability testing of Rice Doctor include:

a) **Visual identification (VI):** Using this method the respondents identified the problem based on their stock knowledge and experiences in identifying and managing insect pests, diseases and agronomic problems

b) **Material Guided Identification (MG):** In this method, participants were given sufficient reference materials to diagnose the pest and disease problems of rice (booklets, pictures etc.)

c) **Rice Doctor Identification (RD):** Participants were provided with a device (tablet) wherein they were able to access the mobile version of rice doctor to identify the problems

ii) The criteria underlying the usability testing of Rice Doctor app are, effectiveness, efficiency and user satisfaction:

a) Effectiveness is the accuracy and completeness of a product being used to attain a certain goal. In this study, diagnostic accuracy was measured by comparing what the respondents identified in the field and what a crop protection specialist determined to be present in the selected fields
b) Efficiency is the relation between effectiveness and the resources being expended on achieving its goal. For this research, the main accuracy indicator is the ability to deliver correct results in the shortest amount of time
c) User satisfaction deals with the users' comfort and positive attitude towards the diagnostic methods and technology

iii) The results of Rice Doctor usability testing are briefly described here:

The respondents under the visual identification (VI) method spent an average time of 3.0 minutes in diagnosis. Material Guided (MG) and Rice Doctor app (RD) users follow second and third with an average time of 4.5 and 10.0 minutes respectively. Although it is noteworthy that most Rice Doctor app (RD) users only needed 5.0 minutes in finishing diagnosis (Figure 4.1). In the case of Rice Doctor app (RD) method, majority of the respondents thought it was easy as they were supported by references without flipping pages of books, booklets or manuals.

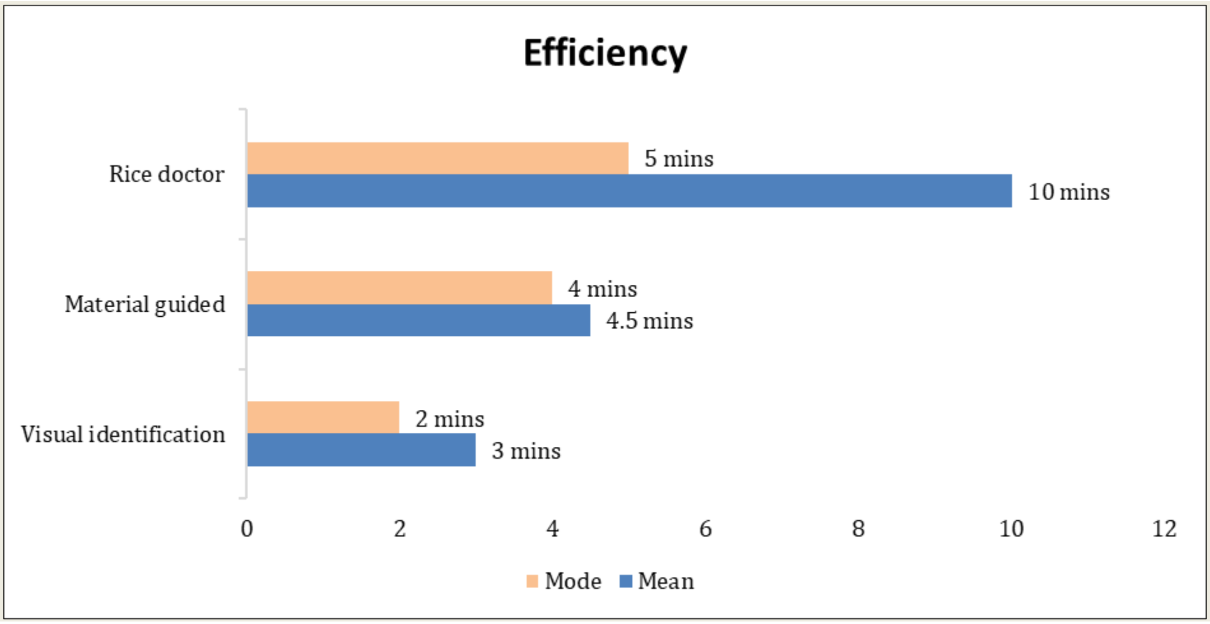


Figure 4.1: Time spent in diagnosis by different diagnostic methods

Most of the respondents have expressed confidence in the diagnosis made using Rice Doctor. According to them, their lack of confidence in the recommendation is a result of their unfamiliarity of the technology and the use of tablet. However, they believe that in order to be confident, constant practice or training of Rice Doctor would be needed.

Figure 4.2: Satisfaction from using rice doctor

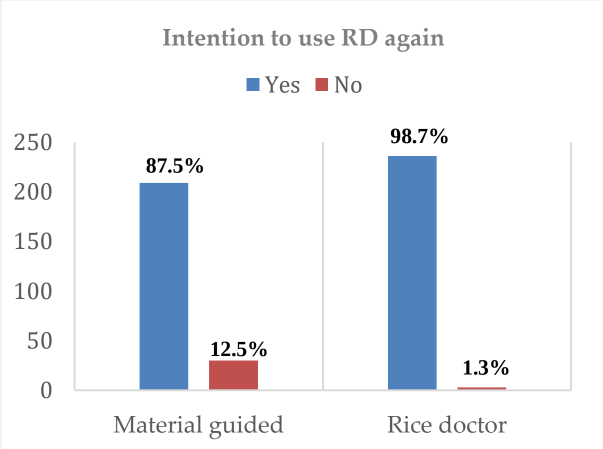


Figure 4.3: Intention to further use of diagnostic methods

Most of the respondents had positive perception towards Rice Doctor app method (Figure 4.2). Although the respondents believed that they need references or applications that would act as their verification tool for maintaining accuracy, they would still choose the Rice Doctor (RD) over Material Guided (MG) approach. The respondents found that Rice Doctor app (RD) offers all the information that they need in one handy device. They described Rice Doctor as an *"all-in-one-package"* needed for diagnosis and verification. They also believed that Rice Doctor is good for confirmation or validation and that 'confirming' is an advantage. Most of the respondents were willing to use Rice Doctor (98.7%) again to become more familiar with the technology and found that it is a single source of information for all problems (Figure 4.3). The usability research highlighted a few areas for improvement:

a) The fact sheets and recommendations may include a list of varieties that are resistant to insect pests, diseases, deficiencies and toxicities being discussed
b) The fact sheets for Integrated Pest Management (IPM) should be included in Rice Doctor
c) The fact sheets may include list of chemicals effective against insect pests and diseases
d) RD photos must be updated and must include more photos showing pests (young and adult stage) and their feeding marks; photos of diseases with varying levels of severity
e) Linking of Rice Doctor images acquisitions related to undiagnosed crop problems with Department of Agriculture so that the extension personnel and farmers can receive proper recommendations for the respective problems

4.3: Integrated Pest Management (IPM) solutions for Odisha

IPM is the application of an interrelated set of principles and methods to manage problems caused by insects, diseases, weeds and other agricultural pests affecting the yield of rice. IPM includes pest prevention techniques, pest monitoring methods, biological control, pest resistant varieties, pest attractants and repellents, bio pesticides and synthetic organic pesticides. IPM takes into consideration the ecology of environment and all relevant pest management practices which do not have any adverse effect on environment and uses minimum inputs so as to avoid economic risks to farmers.

A study was conducted to understand farmer's perceptions, beliefs and practices in rice pest management in Odisha. The study was designed to identify farmers' stock of knowledge and perceptions regarding rice diseases, pests, natural enemies, and pest management practices, as well as to specify knowledge gaps with respect to rice disease and pest control. It is also important to understand the socio-economic factors that influence the disease/pest perceptions, practices and potential constraints to IPM adoption. If follow up surveys were to be conducted, these results will allow quantitative comparison of changes in pest management practices followed by rice growers over time and the retrospective assessment of net benefits from the intervention.

A survey was conducted in 20 districts with 3000 farmers during January – April, 2018 to collect data pertaining to pest management of previous seasons (Kharif and Rabi) using a structured questionnaire. The incidence of Brown Plant Hopper (BPH) and stem borer was found to be 50% and 40% respectively during kharif 2017. Usage of new chemicals to tackle major pests was very low. Majority of the farmers used a combination of Chlorpyriphos (30%) and Cypermethrin chemicals (10%) against major insect pests. The incidence of Bacterial Leaf Blight (BLB) and blast was 45% and 20% respectively during kharif 2017 and the usage of chemicals against BLB was found to be very low (3%). Most of the farmers don't follow any seed treatment before sowing but adopt one or more cultural methods like summer ploughing for pest management (70%).

Farmers seek more information and suggestions on pests and diseases management from traders and dealers of pesticides (40%) rather than from government extension officials (22%). Nearly 60-70 % farmers did not contact any extension officials for the past two years. Out of 63% farmers using mobile phones, 36% farmers received information on pest management, out of which 78% found them useful. Some farmers used to call pesticide dealers and extension officials to get information on pest management. There is no regular and specific information on pest management (Figure 4.4).

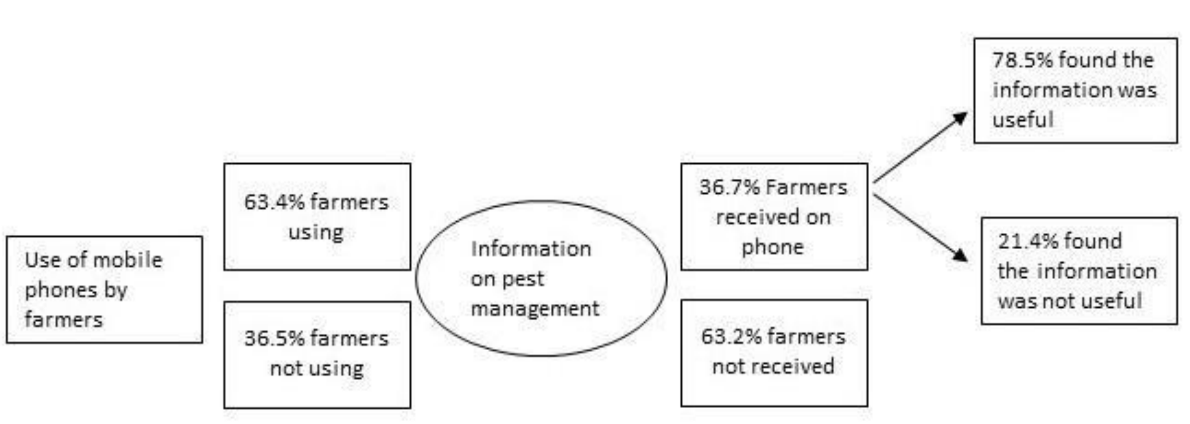


Figure 4.4: Information provision on pest management

We analysed the level of knowledge of farmers on pesticides, including identification of chemical name, trade name of pesticides; calculation of pesticide dosages based on active ingredient; information related to safety measures to be taken while using pesticides. Nearly 27% farmers had poor knowledge on pesticide information and 70% of the farmers were aware of trade name of pesticides. Satisfaction of farmers on usage of pesticides also varies from 16% rating it poor to 68% rating it average. 49% of the insect pests and 36% of diseases incidence occurred at panicle initiation stage.

The very low adoption of pest management practices like seed treatment and usage of new and effective chemicals against major insect pests by farmers could be due to low awareness, suggesting that extension efforts should be directed towards bridging this gap. This data may further be useful for planning and targeting of IPM research, extension and training efforts in the state. There is a need to build capacity of extension personnel and input dealers on different aspects of insect pests and disease management.

Farmers appear to solely depend on local pesticide retailers for technical guidance. In order to make Extension programmes more effective and share information effectively, we need to look for alternate measures. E-pest surveillance identifies the pest problems at district, block level. Subsequently, advisories are generated by DoA in collaboration with OUAT and are published in daily newspapers. Some advisories for pest intense blocks and districts are sent to Extension officials by PAD (ADAPT Programme). Rice Doctor can also be used by pest scouts and Krishi Mitras for pest surveillance.

4.3.1 Testing of ecological engineering based Integrated Pest Management (IPM) module

Any IPM intervention should integrate considerations of farming systems sustainability and include low cost ecologically friendly techniques for management of biotic stresses. The farmers' participation in IPM trials and field days indicates amenability for acceptance of good management practices and introduction of biological control techniques such as ecological engineering.

Photo 4.7 IPM trail with marigold as border crop

Photo 4.8 PM trial at Rayagada

Ecological engineering is the modification of environment to enhance biological control for sustainable pest management. It involves habitat management for enhancing natural enemy survival and action through increasing floral diversity on rice field bunds. Ecological engineering based Integrated Pest Management (IPM) module was tested along with farmers' practice (Photos 4.7 and 4.8) in collaboration with ICAR-NRRI (in Bhadrak, Kendujhar, Jajpur, Dhenkanal, Angul), ICAR-IIRR (in Koraput, Kalahandi, Rayagada, Nabrangpur, Malkangiri), OUAT (in Puri, Khordha, Cuttack, Jagatsinghpur, Kendrapada). Analysis of the data is in progress.

Field days were conducted at Kalahandi, Jajpur and Puri districts (Photos 4.9 and 4.10) to compare the effect of ecological engineering based IPM module with farmers' practice. The extension officials from respective blocks and scientists participated in field days and interacted with farmers about the insect pests and disease management practices.

Photo 4.9 IPM field day at Kalahandi

Photo 4.10 IPM field day at Jajpur

4.4: Capacity strengthening of Extension and Advisory Services

As a part of the capacity strengthening of EAS, some new methods of information and knowledge provision and, skill building of farmers are being tested in the project.

4.4.1 RiceCheck:

This focuses on identifying critical management practices of rice farming identified and adopted by individual farmers in their own plot to get highest yield. It was implemented in collaboration with Orissa University of Agriculture and Technology (OUAT). It encourages farmers to manage their rice crop by comparing their practices with other 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 practices. 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 allows users to have statistically analysable data to study the effect of management practices. Based on the modified guidelines provided to OUAT, the program was implemented in *Kharif* 2018 in 3 districts (Table 4.5).

Table 4.5: Geographic spread of RiceCheck implementation and details of Krushak Sathi

District	Block	Gram Panchayat(GP)	Village	Krushak Sathi
Puri	Kanas	Sirei	Sirei	Manoj Kumar Penthoi
		Jamalagoda	Siripur	Gangadhar Sahoo
		Gadisagoda	Gadisagoda	Bibhuti Bhusan Mangaraj
		Bijipur	Jagannathpur	Sahadev Subudhi
		Badal	Badaora	Ashok Lenka
	Brahmagiri	Ambapada	Barjanga	Narayan Pradhan
		Badabenakudi	Badabenakudi	Bhajamana Palai
		Talamala	Talakokala	Srinibas Chhotray
		Brahmagiri	Sandhyatala	Subash Chandra Dalai
		Manapada	Srikatnuapada	Gopabandhu Pradhan
Balasore	Bhograi	Mahagab	Basulipat	Bimal Chandra Patra
		Kamarda	Khairda	Jyotikant Jena
		Durpal	Durpal	Madhusudhan Padhi
		Kusuda	Kusuda	Basanta Das
		NM Padia	NM Padia	Rama Chandra Adhek
	Jaleswar	KM Sahi	Munatunia	Tapas Kumar Paradhan
		Srirampur	Malipal	Pradeep Kumar Pradhan
		Kaliko	Bhadua	Rabindra Kumar Das
		Khalina	Ikada	Mihir Kumar Pradhan
		Sugo	Sugo	Rabindranath Jena
Sambalpur	Dhankauda	Kankhinda	Kankhinda	Naresh Naik
		Talab	Talab	Pradeep Patel
		Kudgundirpur	Kudgundirpur	Ananta Bhusagar
		Govindpali	Govindpali	Niranjan Podh
		Kalamati	Kalamati	Ranjit Debta
	Maneswar	Batemura	Batemura	Durga Shankar Behera
		Tabala	Kulta Nuapali	Prafulla Pradhan
		Sahaspur	Sahaspur	Chittaranjan Naik
		Bhikampur	Bhikampur	Krushna Chandra Badhai
		Baduapali	Labdera	Sanjay Kumar Bhoi

The selected and trained Krushak Sathis in each program village work as RiceCheck facilitators to support the implementation and guide the farmers implementing checks. 30 Krushak Sathis were engaged by OUAT and were given a two-day training on RiceCheck including their roles and responsibilities. Twenty farmers in each village were identified and at least one check was adopted by each of them. All farmers implementing checks were provided with a booklet by OUAT for collection of information and monitoring of the programme (Photo 4.11).

Based on previous experience and results of implementing RiceCheck, it was decided to work in three districts instead of targeting 30 districts of the state, but keeping the number of villages at 30. It was decided to engage Krushak Sathis as facilitators as they are selected and engaged by the Department of Agriculture and Farmers' Empowerment, it would be easier for them to facilitate the program. Focus Group Discussions (FGD) were held in the presence of representatives from Department of Agriculture and Krushi Vigyan Kendra (KVK) in each village with a group of 20 selected farmers to discuss the management practices of rice crop they use and identify major Checks practiced in that particular village. 8-10 checks were identified per village and at least one check was adopted by each of the farmers who would use head to head (H2H) methodology to compare the results. The farmers adopting Checks were oriented and provided with a pre-designed booklet for recording of crop growth data adopting Checks using H2H trials. The data was then analyzed by OUAT. Farmer group meetings were conducted at least three times in season, specifically during crop establishment, panicle initiation and harvest to discuss the progress, challenges and learning. Crop cuts were planned at the end of season to estimate yields.

Photos 4.11: RiceCheck orientation and field activities

Type of Checks adopted by farmers

1	Transplanting/sowing
2	Harvesting time
3	Use of quality seeds
4	Seed treatment
5	Nursery management
6	Transplanting healthy seedling/sowing at right time
7	Use of pre and post emergence herbicide
8	Use of fertilizer at right time and dose
9	Water management
10	Need based pesticide application
11	Need based fungicide application
12	Harvesting (80-85%) grains are straw coloured
13	Threshing within 3rd day of harvesting and dry before storage
14	Residue management

Table 4.6: Results of RiceCheck

District	Block	No. of Checks adopted by farmers	Yield range in q/ha	Highest yield vs Checks adopted	
				Highest yield in %	Checks adopted
Balasore	Bhograi	4-10	51.2-63.4	4.7	10
	Jaleswar	1-9	50.7-71.2	6.8	9
Puri	Kanas	3-10	43.4-63.8	7.9	10
	Brahmagiri	2-10	39.7-71.3	6.5	9
Sambalpur	Dhankauda	5-10	40.1-72.8	6.0	9
	Maneswar	2-10	45.8-74.7	3.4	8

The results in general revealed that the farmers who adopted higher number of Checks (management practices) experienced a higher increase in yield (Table 4.6). However, in some places like Bhograi the yield increase was low despite using a high number of checks. While the number of Checks adopted by farmers might be playing a major role in in crop yield, other ecological factors also influence the yield. The RiceCheck process, however, proved to be an effective method of "farmer to farmer" communication and spreading the knowledge among the farming community for adopting better management practices of rice farming.

4.4.2 Season Long Training (SLT)

Photo 4.12: District Collector distributing certificates to SLT participants

The Season Long Training programme started in December 2017 for 40 participants consisting of 25 VAWs and 15 Krushak Sathis and completed in the month of May 2018 in Puri. A workshop was organized for sharing the results of the SLT to trigger wider implementation. The workshop was attended by all the district and block level Agriculture Officers. The SLT participants including Assistant Agriculture Officers of five blocks of the district shared their learning and benefits of hands-on training. The Collector and District Magistrate awarded certificates to the participants for successful completion of the training programme (Photo 4.12).

4.4.3 Scaling up of best practices in collaboration with Odisha Livelihoods Mission (OLM)

An agreement was signed between International Rice Research Institute (IRRI) and Odisha Livelihoods Mission (OLM) to take up demonstrations/adaptive trials on rice and rice based cropping systems through building the capacity of women farmers and, developing a cadre of Master Trainers at state level. A total of 11 districts were selected for implementation. A cluster of 5 acres was taken up for demonstration in each district for Quality Rice Seed

Production (QRSP) and 1-1.5 acres in four districts at Farmer Field School locations to impart Season Long Training (Photo 4.13).

Photo 4.13 Signing of MoU with OLM

4.4.4 Quality Rice Seed Production and H2H Trial

Stress Tolerant Rice Varieties (STRVs), Bina dhan 11 and DRR 44, were provided to farmers selected by OLM in each cluster of five acres in 11 blocks of 11 districts during kharif 18, with an objective of producing Truthfully Labeled (TL) seed for meeting their seed requirements. In addition, two farmers were selected in each location to lead H2H trials of the STRVs in 0.5 acre each. The state and district staff were oriented on the management practices of cultivation of STRVs to take up the planned demonstrations at district locations (Table 4.7)

4.4.5 Season Long Training at Farmer Field School (FFS)

The objective was to build the capacity of the community cadre of facilitators of OLM, mostly women members on advanced management practices in rice farming and rice based cropping systems through a hands-on training programme in kharif 18. Both class room and practical sessions were conducted at the critical stages of rice plant growth. Demonstration sites of STRVs were developed in each FFS as part of the season long training. 115 participants were trained at four locations of OLM operational area, out of which 95 were women and 20 were men. The major topics covered were nutrient management (using Rice Crop Manager), weed and water management, insect pests and diseases management, harvest and post-harvest including Rice Knowledge Bank (Photos 4.14 and 4.15).

Photo 4.14 SLT & Crop Cut at Sundargarh

Photo 4.15 SLT at Nayagarh

4.4.6 Pulse Demonstration (Rice Fallow Management) Programme

Adaptive trials and/demonstrations of pulses were conducted in nine OLM operational districts in clusters of five acres in each district. Seed varieties of pulses, Green Gram (IPM-02-3) and Black Gram (PU-31), and Hydrogel and Nano solution were provided to selected farmers. A day long orientation programme was organized for OLM nodal officials who would be overseeing the implementation. The practices followed in adaptive trial plots included 1) sowing seeds in line with hydrogel, 2) sowing in line with both hydrogel and Nano solutions, 3) sowing seed in line with Nano solutions,4) Farmer practice (broadcasted), and 5) Line sowing with Trichoderma. Seed treatment was done with insecticide, fungicide and rhizobium culture for all the adaptive trial plots. (Photo 4.16)

Photos 4.16: Orientation on Pulse Trial and Field Demonstration at Purosattampur GP, Puri Sadar

Table 4.7: Operational districts and blocks

District/Block	Area covered in acres			
	QSP	H2H	SLT	Demo(Pulses)
Angul (Athamalik)	5	1	1.5	5
Kandhamal (Phulbani)	5	1	-	-
Keonjhar (Harichandanpur)	5	1	-	5
Koraput (Sadar)	5	1	1.5	5
Nayagarh (Nuagaon)	5	1	1	-
Rayagada (Bisamkatak)	5	1	-	-
Bolangir (Muribahal)	5	1	-	5
Sambalpur (Jujumara)	5	1	-	5
Mayurbhanj (Karanjia)	5	1	-	5
Sundargarh (Tangarpali)	5	1	1	5
Puri (Sadar)	5	1	-	5+5
Kalahandi	-	-	-	5
Total	**55**	**11**	**5**	**50**

Through this process, the awareness of OLM staff and farmers regarding STRVs and high yielding pulses was built. The trainings and demonstrations built their capacity to use good management practices. The farmers were able to access seeds of new varieties and compare them with the varieties they have traditionally used.

4.4.7 Understanding the extension and innovation landscape in Odisha

Extension and Advisory Services (EAS) play a very important role in providing quality services to the farmers for successful adoption of best practices. Extension Officials of the Department of Agriculture and Farmers' Empowerment (DAFE) of the state government have been implementing projects and schemes through various extension service providers. With an objective of further strengthening the Extension Advisory Services (EAS), a workshop was organized on "Capacity Needs Assessment (CNA) in partnership with Centre for Research on

Innovation and Science Policy (CRISP) and ICAR-Central Institute for Women in Agriculture (CIWA) in July 2018. The participants included senior officials of DAFE, ICAR Institutes, OUAT and staff of leading NGOs. The suggestions and recommendations based on the results of the CNA workshop were shared with the senior officials of DAFE (Photo 4.17).

4.4.8 Workshop on scaling up new knowledge

The International Rice Research Institute (IRRI) over the past few years has been working towards scaling up several types of new knowledge its research has generated. A two-day workshop was organized in collaboration with the Centre for Research on Innovation and Science Policy (CRISP) with an intention to support IRRI researchers and its partners in approaching scaling up systematically.

The expectation was to broaden the understanding of scaling up IRRI staff and help them to deploy a broader set of tools while planning scaling up. The workshop used an interactive learning methodology to engage participants actively in the learning process including case analysis, card exercises and group discussions, supported with a few power point presentations.

Photo 4.17: Capacity Needs Assessment Workshop at ICAR-CIWA Bhubaneswar

4.5 Leadership and Entrepreneurship for women in Agriculture Program (LEAP)

4.5.1 Establishment of Women Farmer Producer Company (WFPC)

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 on rice value chain. Within this framework, IRRI entered into a partnership with Access Livelihoods Consulting India (ALC India) Ltd. to set up Women Farmers' Producer Company (WFPC) in Kalahandi district involving 3000 women farmers of a cluster of 15-18 villages of Dharmagarh and Koksara blocks. A feasibility study was completed by ALCI and a business strategy was developed for setting up the WFPC. The major businesses would revolve around quality paddy seed production, rice production, secondary processed products and other value added services (Photos 4.18-4.20).

1470 women farmers were oriented on the concept of Producer Company (PC), project deliverables and requirements for promotion of women farmer enterprise. 56 Women Farmers' Affinity Groups (WFAG) were formed with 869 members. A total share capital of INR 1,09,500 (One lakh nine thousand and five hundred only) was collected from the members towards membership fees. WFAG took the responsibility of keeping the collected amount at their level with all details. Tools like flexes, video and learning materials were used and FAQs were upgraded, and mobilizers were updated accordingly. 10 promoters were identified for the registration of PC. Selected women farmers were taken on an exposure trip to Mulkanoor of Telangana to understand the institution building process and business activities. This motivated 28 women farmers to lead the mobilization process in the area. Two central training events were conducted to orient identified mobilizers who were local youth (all women female) to carry forward the mobilization process at the village level. A WhatsApp group was created among mobilizers and implementers to keep each other updated on the progress, communicate challenges and learnings on a daily basis to make the process stronger and faster. Learning workshops were organized on fortnightly basis for bringing improvements in the achievement parameters.

Two teams consisting of 42 members (both male and female) were engaged for mobilizing women farmers for their individual contributions as membership towards formation of Women Framer Producer Company (WFPC). At the same time, another two teams consisting of 7-10 members (both male and female) were engaged including staff from ALCI for identifying women farmers interested in seed production as well as studying the market opportunities for taking up seed business in Kharif 2019. Central hiring and subsequent training were provided on the project concept, mobilization processes, tools applicable and preparation of business plan etc. Regular monitoring system has been put into place to review, reflect and making course corrections in the ongoing mobilization process.

To start with seed business Kharif 2019, identification of seed growers has been initiated and 70 women farmers have been interviewed. Prior to this, a meeting was organized with IRRI-Odisha staff to understand the input-output requirements and processes to be followed in rice seed production processes. Accordingly, the instrument for market study, identification of seed growers and interview of farmers were designed for the seed grower identification process.

Photos 4.18 Concept sharing on PC company

Photo 4.19 Stakeholder consultation

Photo 4.20 Consultation with Pvt. Seed dealers

4.5.2 Learning trip on women led entrepreneurship

An exposure visit to learn from women-led Farmer institutions of Mulkanoor of Telangana State was organised in January 2019 for a team consisting of representatives of IRRI, ICAR-Institutes and State Agriculture University. The team interacted with various stakeholders on different aspects of seed production and marketing, rice milling, dairy farming and milk processing. This created an understanding of the principles that underlie development and sustenance of farmer organizations and, challenges in establishing women-led business models (Photo 4.21)

Photos 4.21: Visit to Seed Growers Cooperative, Mulkanoor

4.5.3 Women entrepreneurs

IRRI-Odisha had a renewed partnership with ICAR-Central Institute for Women in Agriculture for building the capacity of three grantee organizations to develop women agri-entreprenuers. ICAR-CIWA with the support of IRRI-Odisha project entered into partnership with BSSS (Balasore Social Service Society) in Balasore district, SWAD (Society for Women Action and Development) in Puri district and PRAGATI in Koraput district (Photos 4.22-4.24) to develop women-led enterprises (Table 4.8).

Table 4.8: Details of the achievements of grantee organisations

Organisation	Operational area	Objective	Progress
BSS	Rasagobindpur and Badasahi blocks, Mayurbhanj district	To produce quality seed by improving the capacity of farmers in seed production techniques	40 women leaders and 300 women farmers trained in quality rice seed production
SWAD	Nimapara, Satyabadi & Delang blocks, Puri district	Collective initiative and skill upgradation of women farmer groups for flood and deep water resistant rice seeds production and cultivation of high yielding pulses to reduce vulnerability due to crop loss caused by flood and water logging.	-500 women sensitized about poverty reduction through agriculture and allied activities, leadership, conflict resolution, resource planning and utilization, income generation. They were trained in advanced management practices of rice production including post-harvest technology. -Established linkages and farmers interface among district administration, agriculture department, KVK and other line department officials for ensuring best support to women farmers
PRAGATI	Kotpad block, Koraput district	- To strengthen Women Producer Groups in leadership, group management, post-harvest and quality management and, collective marketing. Setting up a Producer Company for collective marketing of aromatic and organic rice	-62 members of 30 Producer Groups trained on leadership and group management. -146 women from 30 Producer Groups trained on post-harvest and quality management. -8 Producer Groups have marketed aromatic rice and during Kharif 18. They have cultivated 612 acres of aromatic rice. -365 members were mobilized and share capital contribution collected from the members -Part of support was mobilized from NABARD for strengthening the Producer Company after registration

Photo 4.22 SLT training by BSSS

Photo 4.23 Sensitization meeting by SWAD

Photos 4.24 FPO initiative by Pragati

4.6 Scholars Program

IRRI and ICAR-National Rice Research Institute in collaboration have initiated a Masters and Doctorate fellowship programme in FY 2018-19. The fellowship programme provides students to pursue Ph.D. and M. Sc. courses with theses or dissertations focused on prioritized research areas. A total of 10 Ph. D. and 15 M.Sc. scholarships for 3 years will be awarded through the program. The program is being administered through ICAR-NRRI.

Photo 4.25 Synopsis Seminar by Ph.D. students at ICAR-NRRI

Fellowships are given to students for a period of two years and nine months for Ph.D. and Masters students respectively. A total of 5 Ph.D. students took admission into the Ph.D. course in the month of November 2018, and presented their synopsis for finalization of research topics (Pic 4.25). Another advertisement was sent out in Feb 2019, for admission of students into Ph.D. (5 students) and Masters (10 students) courses under this fellowship. The research areas for fellowship are as follows:

i. Nutrient management, climate change adaption and mitigation, better-bet agronomy
ii. Seed systems, plant breeding and varietal evaluation
iii. Geospatial analysis and yield modelling, land use-land cover mapping, extrapolation domains
iv. Crop insurance, impact assessment
v. Knowledge management, innovations in extension, gender and youth research, entrepreneurship in agri-food systems

Subproject 5: Science-based crop insurance
5A: Remote sensing-based rice monitoring and yield estimation

During this reporting period, the project team advanced with activities implementing remote sensing technology, specifically earth observation using cloud penetrating synthetic aperture radar (SAR) data, to timely monitor rice planting progression and forecast rice yield. In addition to the previously used data source from Sentinel 1A, this time the team also made use of SAR data from Sentinel 1B covering portion of the north-eastern part of Odisha (Figure 5.1). Multi-temporal SAR data (January to December 2018, every 12 days) spanning across 3 tracks of Sentinel 1A & 1B were used for discrimination of land cover types to develop rice baseline map (Figure 5.2) and data within the 2018 Kharif season (June to December 2018, every 12 days) were used to generate cultivated rice area (Figure 5.4), start of season (Figure 5.5) and leaf area index (LAI, Figure 5.7) maps. Optical images from Landsat 8 and Sentinel 2 satellites were used to cross-check and verify rice area classification based on SAR data.

Adaptation of this near real-time rice monitoring system for Odisha includes intensive effort to collect ground data for model calibration in the beginning of the season (Figure 5.3) followed by independent datasets from field visits for validation during later part of the season (Figure 5.6). The team also continued to implement yield estimation system based on integration of SAR data with ORYZA crop growth model using Rice Yield Estimation System (Rice-YES) capturing meteorological, management, and varietal factors. In the case of flood induced by excessive monsoon downpour (Figure 5.9) and cyclone (Figure 5.10), the rice monitoring platform was also used to access the extent of rice area affected from such climatic adversaries.

Objectives

- 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
- Conduct local capacity building programmes

Product Generation

This report includes rice monitoring products for Kharif 2018 season which were generated for the whole state of Odisha involving three tracks of Sentinel-1A satellite providing multi-temporal C-band SAR imageries with VV and VH polarization (owned by EU and developed and operated by ESA) for the 2018 Kharif season (Table 5.1 and Figure 5.1). Whereas Track 19 and 121 were captured by Sentinel 1A satellite, track 48 was captured by Sentinel 1B.

Table 5.1. Sentinel 1A acquisition schedule, Kharif 2018

Track 19	Track 121	Track 48
12-Jun-18	07-Jun-18	14-Jun-18
24-Jun-18	19-Jun-18	26-Jun-18
06-Jul-18	01-Jul-18	08-Jul-18
18-Jul-18	13-Jul-18	20-Jul-18
30-Jul-18	25-Jul-18	01-Aug-18
11-Aug-18	06-Aug-18	13-Aug-18
23-Aug-18	18-Aug-18	25-Aug-18
04-Sep-18	30-Aug-18	06-Sep-18
16-Sep-18	11-Sep-18	18-Sep-18
8-Sep-18	23-Sep-18	30-Sep-18
10-Oct-18	05-Oct-18	12-Oct-18
22-Oct-18	17-Oct-18	24-Oct-18
03-Nov-18	29-Oct-18	05-Nov-18
15-Nov-18	10-Nov-18	17-Nov-18
27-Nov-18	22-Nov-18	29-Nov-18
09-Dec-18	04-Dec-18	11-Dec-18

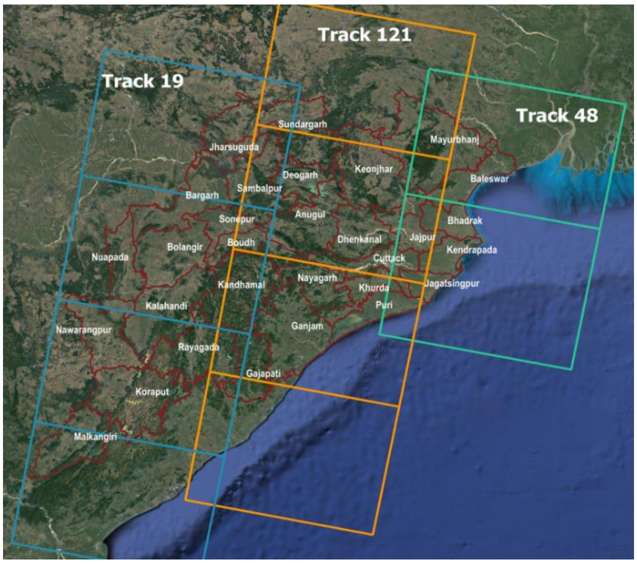


Figure 5.1 S1A tracks covering Odisha State

Rice area and start-of-season map generation

Multitemporal signatures of SAR data of rice and non-rice areas were first checked using ground data collected for calibration in order to properly set rice area classification parameters in MAPscape-Rice. The classification parameters can considerably vary from one geography to another, mostly depending on agronomic practices and the ecosystem (e.g. irrigated, rainfed, direct seeded, transplanted, etc.), water availability, and climatic conditions. The district-level rice area maps and start-of season 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. It is important to note that these reference data are not the same used for validation exercise. Rice baseline map (Figure 5.2) derived from SAR data (Sentinel 1A and 1B) and optical satellite data (Landsat-8 and Sentinel-2) served as a mask in generating the rice area (Figure 5.4) and start-of season (Figure 5.5) maps.

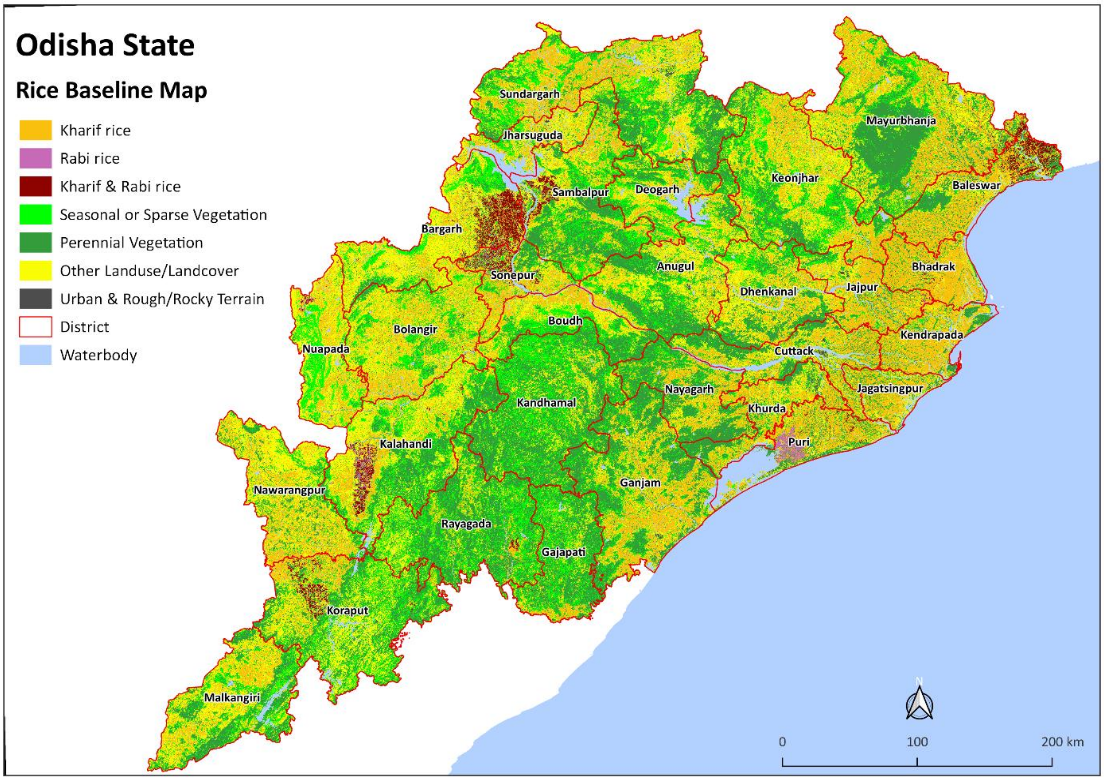


Figure 5.2: Odisha rice baseline map

Early in the growing season, a total of 1,254 rice points were collected throughout the state capturing information on planting date, planting method, geotagged pictures, etc. At the same time, 515 non-rice (particularly other annual crops) points were also collected (Figure 5.3). This ground data set was used for parameters calibration for classifying rice area using MAPscape-Rice. These early season ground data spanning 1st week of July to 3rd week of August 2018 suggested that majority of rice fields started planting/sowing in 3rd week of June and lasted until 1st week of August. These ground data also showed that 72% of rice area was rainfed while 28% was irrigated.

Rice area estimates were derived from SAR data from Sentinel-1A & 1B for all 30 districts in Odisha (Figure 5.4) suggesting that overall 35,04,705 ha of rice was cultivated during 2018 Kharif season. District level rice area estimates are shown in Table 5.2 along with comparison of rice area estimates against data from the Department of Agriculture (DoA), Odisha with overall agreement at 92.3%.

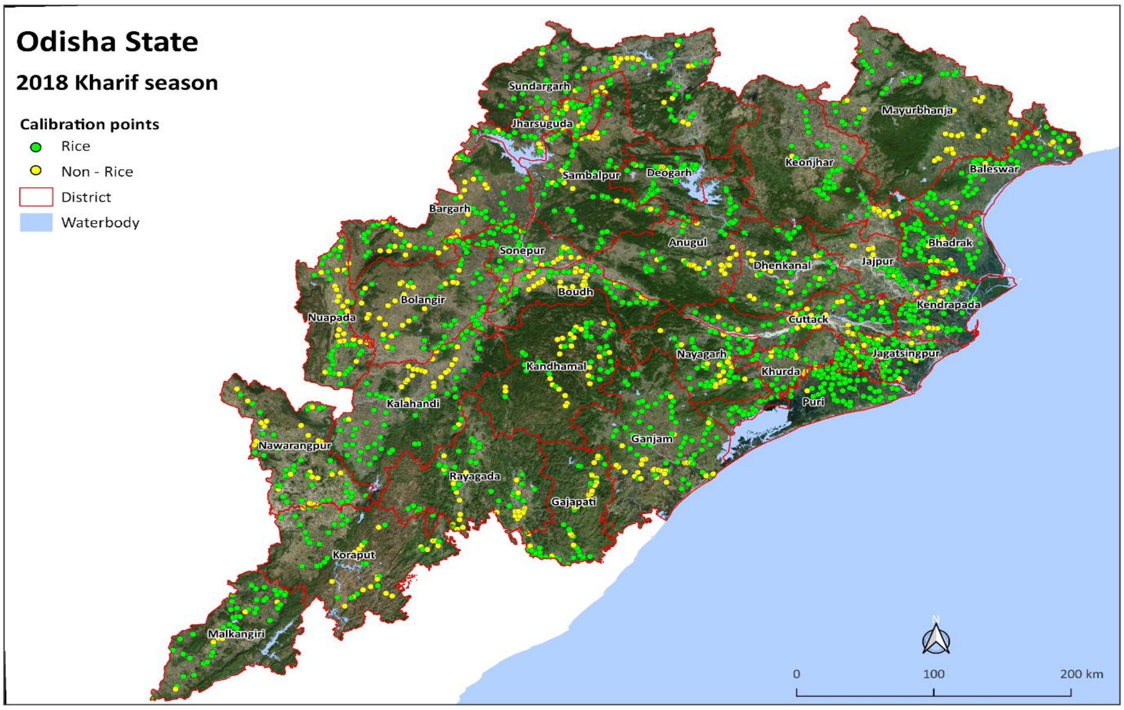


Figure 5.3: Location of the rice and non-rice ground samples used for rice area classification

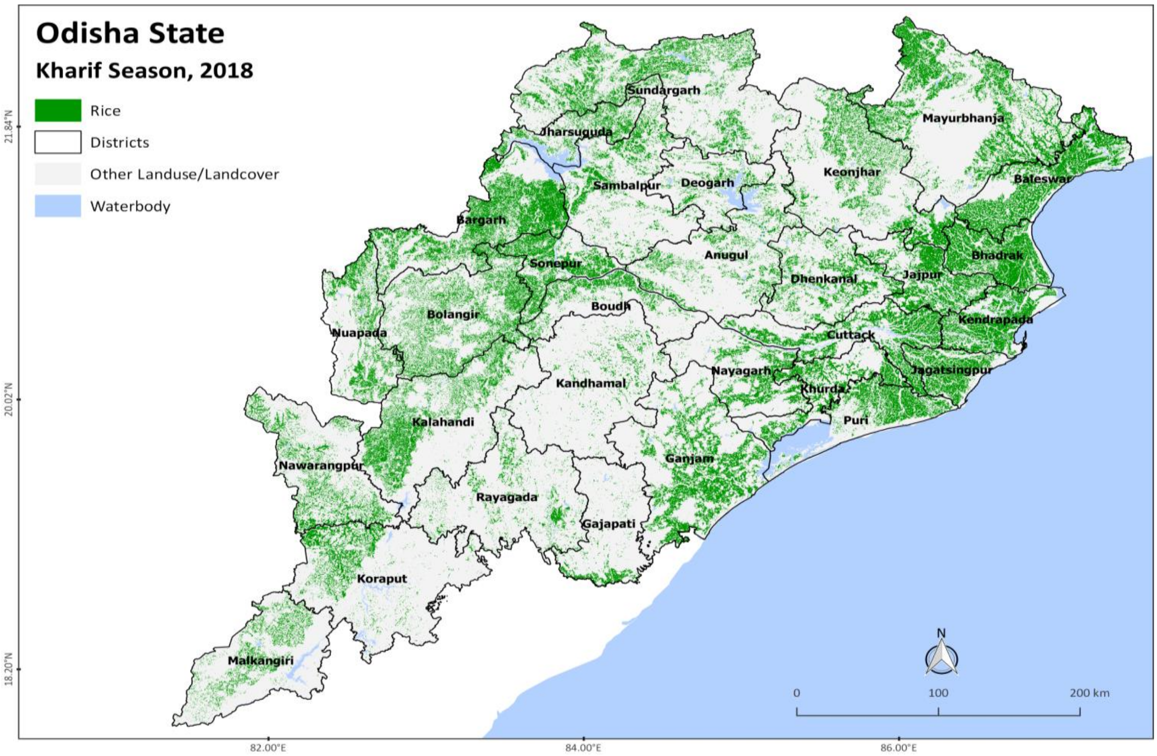


Figure 5.4: Kharif 2018 rice areas in Odisha

Table 5.2: Kharif season 2018 satellite based planted area estimates at district level as compared with rice area statistics from the Department of Agriculture (DoA)

District	SRM estimates (ha)	Reported rice area (ha)	RMSE	NRMSE	Agreement (%)
Anugul	84,984	87,666	2,683	3.1	96.9
Balasore	1,86,036	1,99,369	13,333	6.7	93.3
Bargarh	2,43,175	2,50,993	7,818	3.1	96.9
Bhadrak	1,47,921	1,52,373	4,452	2.9	97.1
Balangir	1,83,649	1,84,032	382	0.2	99.8
Boudh	56,175	57,556	1,380	2.4	97.6
Cuttack	1,37,205	1,34,850	2,355	1.7	98.3
Debgarh	34,248	34,500	253	0.7	99.3
Dehenkanal	99,284	1,00,679	1,394	1.4	98.6
Gajapti	27,861	29,519	1,658	5.6	94.4
Ganjam	2,16,435	2,08,291	8,144	3.9	96.1
Jagatsinghpur	81,322	83,414	2,092	2.5	97.5
Jajpur	1,17,739	1,06,823	10,917	10.2	89.8
Jharsguda	56,575	50,392	6,183	12.3	87.7
Kalahandi	1,64,348	1,75,488	11,139	6.3	93.7
Kandhamal	38,859	50,000	11,141	22.3	77.7
Kendrapada	1,19,495	1,21,425	1,929	1.6	98.4
Keonjhar	1,59,921	1,65,501	5,581	3.4	96.6
Khorda	88,270	1,05,218	16,948	16.1	83.9
Koraput	91,241	96,876	5,635	5.8	94.2
Malkangiri	69,990	73,105	3,116	4.3	95.7
Mayurbhanj	2,68,654	2,92,209	23,556	8.1	91.9
Nabrangpur	1,03,555	1,03,881	326	0.3	99.7
Nayagarh	78,090	1,01,200	23,110	22.8	77.2
Nuapada	90,039	92,952	2,913	3.1	96.9
Puri	92,829	1,11,430	18,602	16.7	83.3
Rayagada	60,531	58,879	1,652	2.8	97.2
Sambalpur	1,02,858	1,07,864	5,005	4.6	95.4
Sonepur	1,01,471	1,01,844	374	0.4	99.6
Sundergarh	2,01,945	2,07,571	5,626	2.7	97.3
Odisha	**35,04,705**	**36,45,900**	**9,348**	**0.08**	**92.3%**

The map of rice crop start-of-season (SoS) for Odisha (Figure 5.5) was derived based on detection of the lowest backscatter value of multitemporal SAR signature. Start of season dates were detected starting from 1st week of June with peak of planting observed in August. By delineating rice area estimates based on start of season, it was possible to generate monthly progression of cultivated rice area by district in Odisha (Table 5.4).

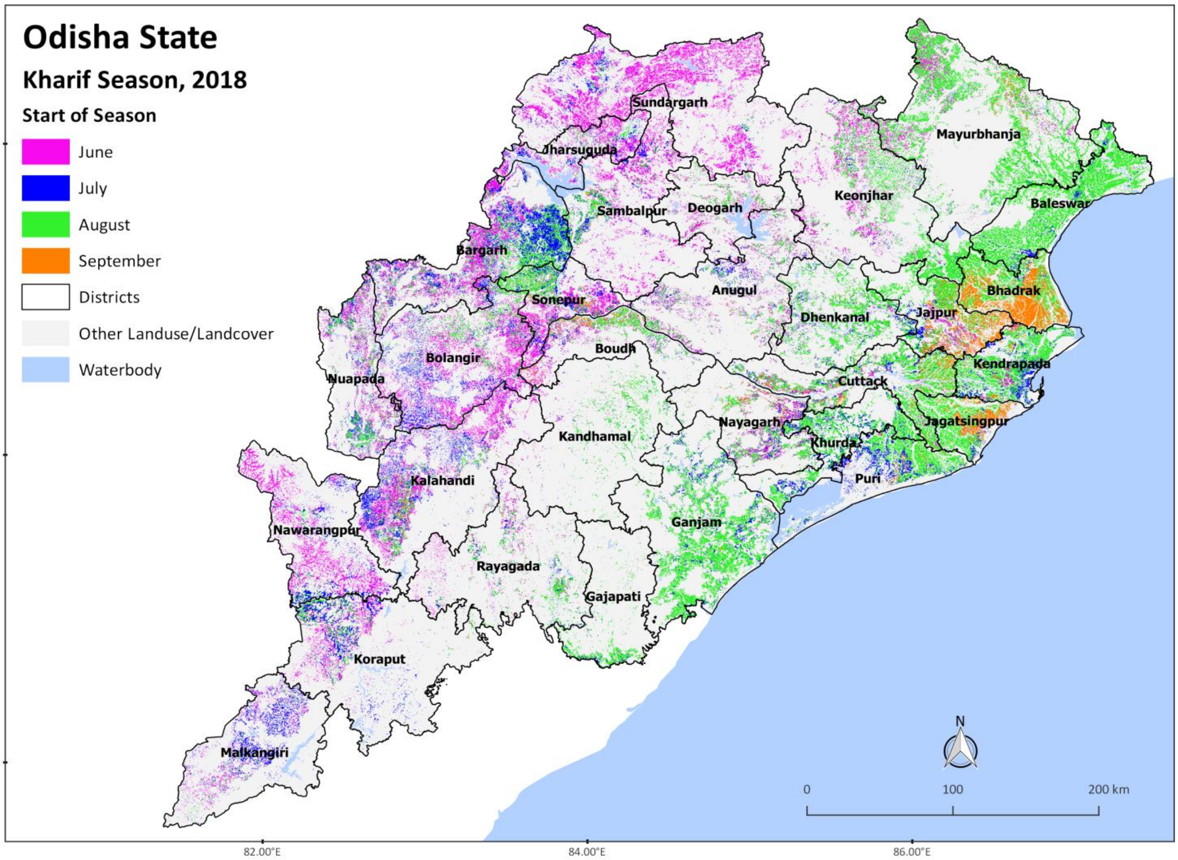


Figure 5.5: Rice crop start of season map with different colors represent to different start of season dates during Kharif 2018

Table 5.4: Rice area estimates at district level, 2018 Kharif (June-December)

District	2018 Monthly rice area estimates (ha)				2018 Kharif rice estimates (ha)
	June	July	August	September	
Angul	37,350	11,752	34,552	1,330	84,984
Baleswar	3	11,183	1,74,127	723	1,86,036
Bargarh	80,972	80,588	80,654	961	2,43,175
Bhadrak	260	2,812	65,484	79,365	1,47,921
Bolangir	1,04,482	47,603	30,605	959	1,83,649
Boudh	19,876	5,542	22,726	8,031	56,175
Cuttack	14,691	12,134	93,308	17,072	1,37,205
Deogarh	19,609	977	13,662	0	34,248
Dhenkanal	6,759	15,225	74,363	2,937	99,284
Gajapati	674	3,229	23,307	651	27,861
Ganjam	4,340	28,568	1,82,107	1,420	2,16,435
Jagatsinghpur	9	4,537	51,239	25,537	81,322
Jajpur	11,279	9,158	54,769	42,533	1,17,739
Jharsuguda	35,995	11,831	8,399	350	56,575
Kalahandi	81,726	50,363	26,568	5,691	1,64,348
Kandhamal	5,088	3,243	29,967	561	38,859
Kendrapara	5,740	24,148	83,855	5,752	1,19,495
Keonjhar	51,861	7,256	1,00,726	78	1,59,921
Khurda	1,007	20,678	66,578	7	88,270
Koraput	36,694	30,156	23,104	1,287	91,241
Malkangiri	23,854	38,597	7,372	167	69,990

Mayurbhanj	40,090	6,080	2,16,982	5,502	2,68,654
Nabarangpur	73,999	21,795	7,761	0	1,03,555
Nayagarh	25,933	10,002	36,778	5,377	78,090
Nuapada	38,038	21,567	28,266	2,168	90,039
Puri	3	30,699	56,699	5,428	92,829
Rayagada	23,242	7,312	28,732	1,245	60,531
Sambalpur	65,184	14,421	22,351	902	1,02,858
Sonepur	43,613	17,552	34,102	6,204	1,01,471
Sundargarh	1,82,265	14,728	4,952	0	2,01,945
Total	**10,34,636**	**5,63,736**	**16,84,095**	**2,22,238**	**35,04,705**

Rice area maps validation

Towards the end of the season rice and non-rice (RnR) ground truth data were collected intensively (1815 rice points and 1,328 non-rice points) across the entire state of Odisha with each district having approximately 100 ground truth points (ca. 50 rice and 50 non-rice) to be compared with the satellite derived rice area maps. Accuracy assessments using these points showed an overall accuracy of 94.4% (with kappa index of 0.89) at state level (Table 5.5). Accuracy assessment at district level is summarized in Table 5.6. Satellite derived rice area aggregated at district level are generally in good agreement with DoA statistics. Some small deviations were observed in Khandamal and Nayagarh districts. In these districts, the discrepancy was likely a result of not having sufficient resolution in satellite data (20m), limitation of SAR in detecting rice areas in hilly terrains in these districts, rice area on the ground being relatively in small patches and, fields surrounded by trees. These issues will be tackled more carefully in the next reporting period through visually interpretation in those problem areas and solutions will be sought to improve rice area estimates in these districts. Rice area estimates along with the validation points are shown in Figure 5.6. During the RnR collection, majority of the rice crops are already at maturity to harvesting stage. Ground data used in the validation procedure are independent from the ground data used in the calibration of rice area classification.

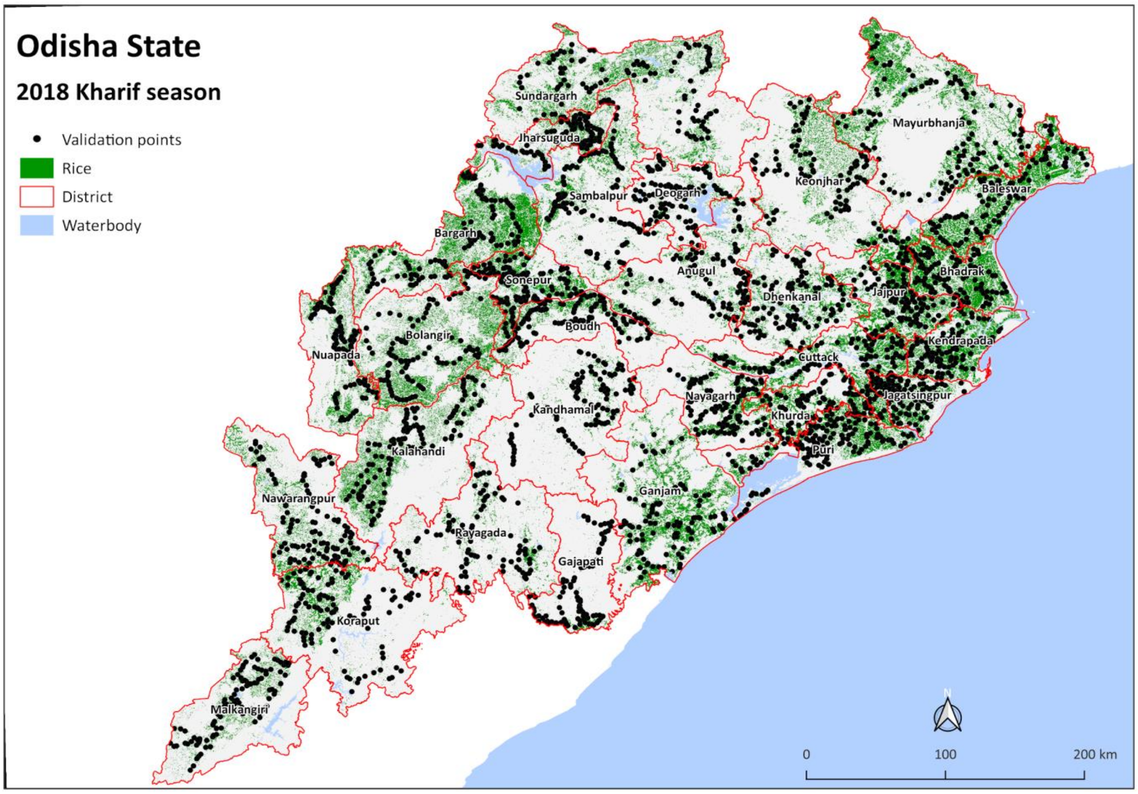


Figure 5.6: Kharif 2018 rice areas with validation points

Table 5.5: Odisha rice area map accuracy computation (state level)

Confusion matrix computations				
		Predicted class from the map		
		Rice	Non-Rice	Accuracy
Actual class from survey	Rice	1724	91	95.0%
	Non-Rice	86	1,242	93.5%
	Reliability	95.2%	93.2%	**94.4%**
Average accuracy		94.3%		
Average reliability		94.2%		
Overall accuracy		**94.4%**	**Good Accuracy**	
Kappa index		0.89		

Table 5.6: Rice area maps accuracy by districts in Odisha

District	Validation Points	Average Accuracy (%)	Average Reliability (%)	Overall Accuracy (%)	Kappa index
Angul	101	91.8	92.5	92.1	0.84
Baleswar	110	99.2	98.9	99.1	0.98
Bargarh	106	87.9	89.3	87.7	0.75
Bhadrak	103	98.1	99.4	99.0	0.98
Bolangir	96	93.7	94.1	93.8	0.88
Boudh	102	96.2	96.3	96.1	0.92
Cuttack	104	86.4	92.9	91.3	0.83
Deogarh	98	93.9	92.8	94.9	0.90
Dhenkanal	103	93.6	95.6	95.1	0.90
Gajapati	100	93.0	92.8	93.0	0.86
Ganjam	101	90.2	89.9	90.1	0.80
Jagatsinghpur	100	98.3	99.3	99.0	0.98
Jajpur	101	94.2	94.5	94.1	0.88
Jharsuguda	106	90.7	91.0	90.6	0.81
Kalahandi	109	96.3	96.3	96.3	0.93
Kandhamal	102	95.6	96.2	96.0	0.92
Kendrapara	100	97.1	97.1	98.0	0.96
Keonjhar	105	96.1	96.1	96.2	0.92
Khurda	104	99.2	98.8	99.0	0.98
Koraput	112	91.1	91.1	91.1	0.82
Malkangiri	109	97.5	97.2	97.2	0.94
Mayurbhanj	108	98.6	99.3	99.0	0.98
Nabarangapur	112	88.6	88.9	88.4	0.77
Nayagarh	102	91.4	94.7	93.9	0.88
Nuapada	99	94.9	95.1	94.9	0.90
Puri	124	92.2	92.2	91.9	0.84
Rayagada	103	90.3	90.4	90.3	0.81
Sambalpur	104	96.4	95.9	96.2	0.92
Sonepur	116	99.2	99.0	99.1	0.98
Sundargarh	103	88.3	88.3	88.3	0.77
Odisha	**3,143**	**94.3**	**94.2**	**94.4**	**0.89**

Generation of the Inputs for Crop Yield Modelling

This process exploits the multitemporal signature of SAR with VH polarization and the SoS map. Specific algorithm in MAPScape-Rice (developed jointly by IRRI and sarmap) computes the leaf area index (LAI) from the SAR intensity measured at about 1/3 of the season; the approximate season duration must be known apriori (Fig. 5.7). The final outputs consisting LAI values, SOS dates, along with weather data identifier are then used to run ORYZA for forecasting pre-harvest yield and estimating end of season yield (Fig. 5.8).

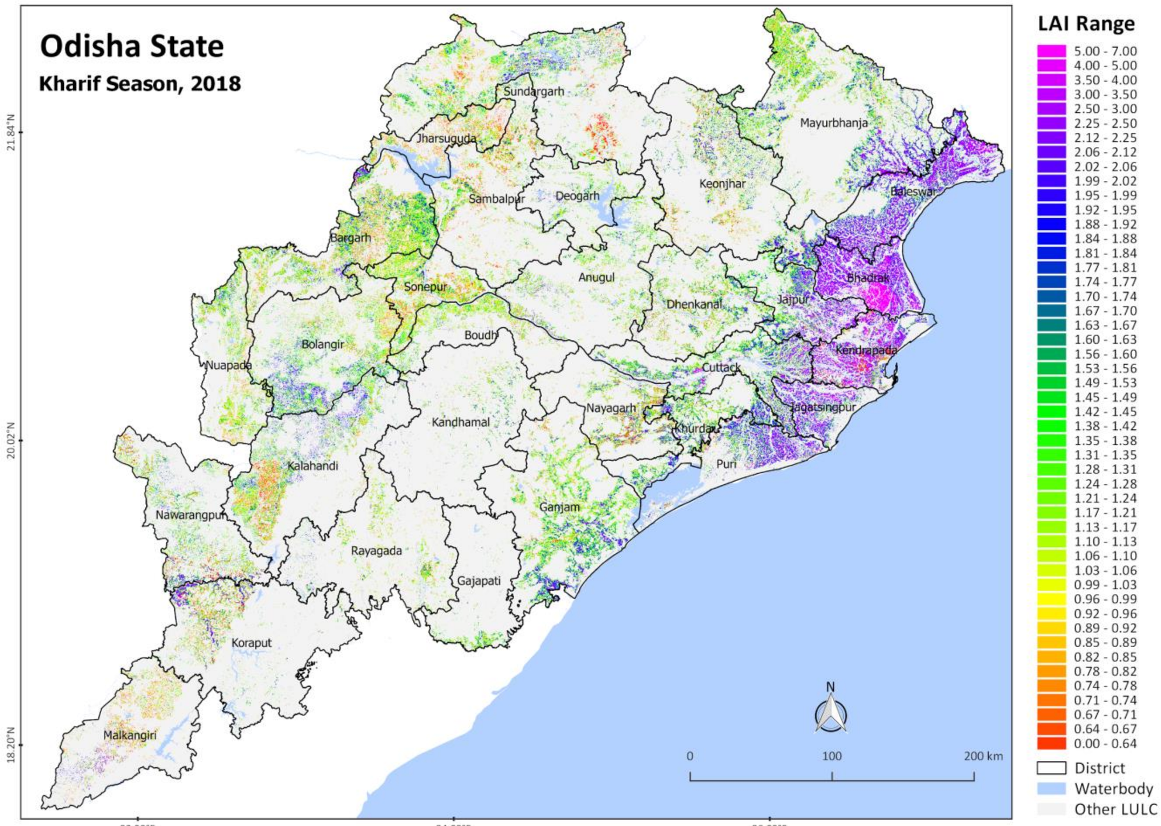


Figure 5.7: Rice LAI map with colors from red to green to magenta correspond to progressively increasing values

Kharif 2018 yield estimates

Rice yields (paddy yield at 14% moisture content) were estimated using ORYZA crop growth model and Rice-Yield Estimation System (Rice-YES). Rice-YES integrates remote sensing information into the crop model along with non-remote sensing inputs (weather, soil, agronomic management, rice varietal characteristics). The following input data were used: processed SAR images from Sentinel-1A and 1B satellites (from June 7 to December 11), weather data, varietal characteristics, soil data, and crop management information. For weather data, the total daily values of solar radiation, daily 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 provided as inputs to the model. Production estimates were calculated by multiplying end of season yield estimates with rice area estimates. Rice yield map for the 2018 Kharif season in Odisha is shown in figure 5.8.

During 2018 Kharif season, end of season yield estimates ranged from 2.02 t/ha (Sundargarh district) to 4.23 t/ha (Rayagada district) with majority of the districts having yields between 2.0 t/ha to 3.0 t/ha (Table 5.7). The model suggests state-wise average yield at 2.83 ton/ha. The total production in Odisha was estimated at about 9.9 million metric tons. The low yields obtained in some of the locations in Sundargarh, Nabarangapur, Kalahandi, Dhenkanal, Bolangir could be attributed to the dry spell that happened during September to mid-October. The government of Odisha declared drought for these western districts, which received scanty rainfall during this monsoon period.

Figure 5.8 shows the simulated yield for Odisha during the 2018 Kharif season. Given the yield maps, spatial distribution of the variation in yield can easily be identified. With this information, policymakers and other stakeholders are aware in which location needs to be prioritize for targeting interventions such as improving productivity.

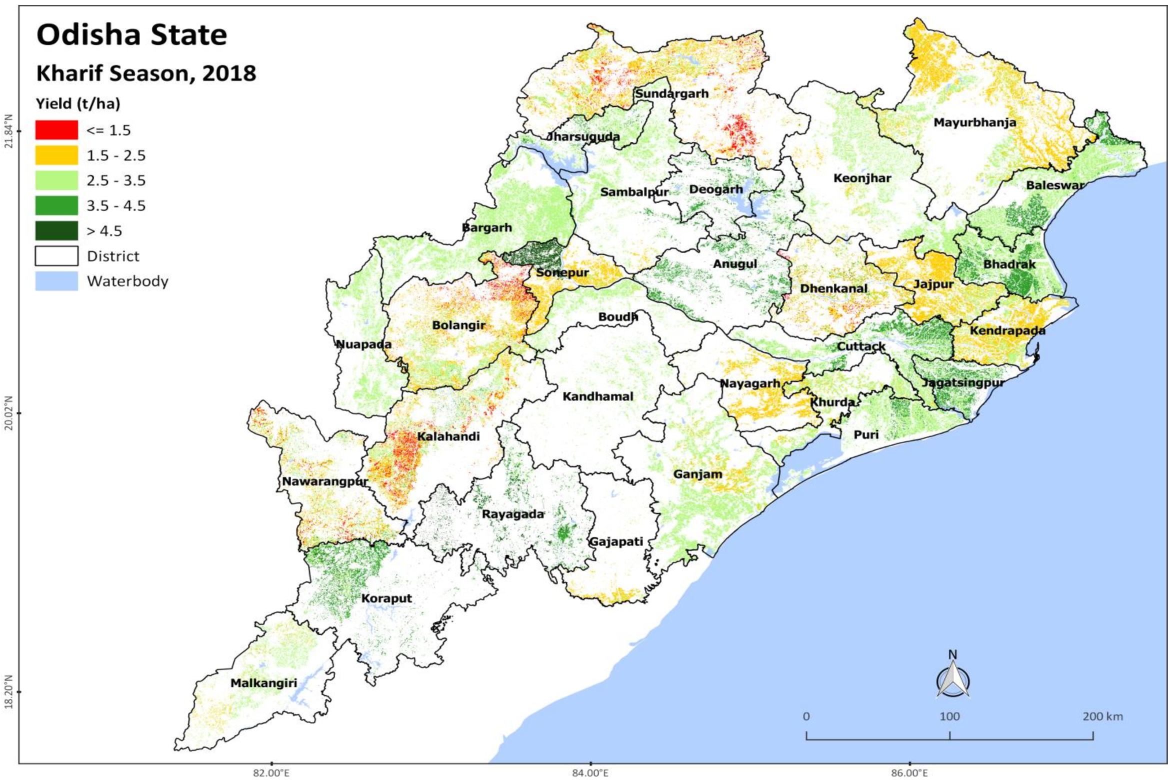


Figure 5.8: Color-coded map shows the district-level estimated yield for Kharif 2018

Table 5.7: Rice yield (paddy yield at 14% moisture content) and production estimates aggregated by district during 2018 Kharif season in Odisha, India

District	Yield (t/ha)	Total Production (t)	District	Yield (t/ha)	Total Production (t)
Angul	3.90	331,323	Kandhamal	3.06	118,974
Balangir	2.23	409,537	Kendrapara	2.48	296,868
Baleshwar	3.44	186,037	Keonjhar	2.80	448,274
Bargarh	3.01	730,830	Khurda	2.63	231,757
Baudh	2.89	162,467	Koraput	3.85	350,952
Bhadrak	3.32	491,643	Malkangiri	2.89	201,990
Cuttack	3.37	462,150	Mayurbhanj	2.29	616,211
Debagarh	3.77	129,111	Nabarangpur	2.41	249,568
Dhenkanal	2.33	231,334	Nayagarh	2.30	179,922
Gajapati	2.52	70,324	Nuapada	2.90	261,365
Ganjam	2.82	609,486	Puri	3.27	303,104
Jagatsinghpur	3.63	295,199	Rayagada	4.23	255,763
Jajapur	2.28	268,677	Sonepur	3.13	237,430
Jharsuguda	3.37	190,909	Sambalpur	2.87	295,205
Kalahandi	2.26	371,451	Sundargarh	2.02	407,929
			Odisha	**2.83**	**9,929,843**

Flood damage assessment during Kharif 2018

Below are calamities assessed during this reporting period with critical maps delivered to the government.

The impact of excessive rain during 1st week of September in rice growing area of Bhadrak district was assessed and flooded rice area was mapped (Figure 5.9). Field visits were coordinated in the aftermath of the calamity to validate the generated map (Figure 5.10). The flood map was generated using Sentinel-1A and 1B imageries (Track-48) from the date from 25 August to 06 September 2018. Estimated flood affected rice area in Bhadrak district was 16,475 ha involving 12% of total rice growing area in the district. The assessment suggests Tihidi block as the worst affected with flooded rice area at 6,850 ha involving 32% of total rice growing area in this block. Table 5.8 shows the rice area affected at the block level.

In the aftermath of cyclone Titli, impacting Gajapati and Ganjam districts during 11-13 October 2018, satellite-based flood maps were generated (Figure 5.11) and ground data collection were conducted immediately after cyclone (Figure 5.12). Sentinel-1A acquisitions were not available during the cyclone, commercial X-band SAR data with 15 m resolution from TerraSAR-X satellite dated 13 October 2018 were used to generate flood map over Gajapati and Ganjam. As of last week of September, total rice area estimates for Gajapati was

19,660 ha and in the entire district it was estimated that the flooded rice area was 593 ha. In Ganjam, out of 216,434 ha of rice area estimates 4,120 ha was affected by flood. In both districts, it was observed during field work data collection that most of the rice crops were in panicle initiation to flowering stage. Rice areas affected by the cyclone-induced flooding in these districts at block level are shown in table 5.9.

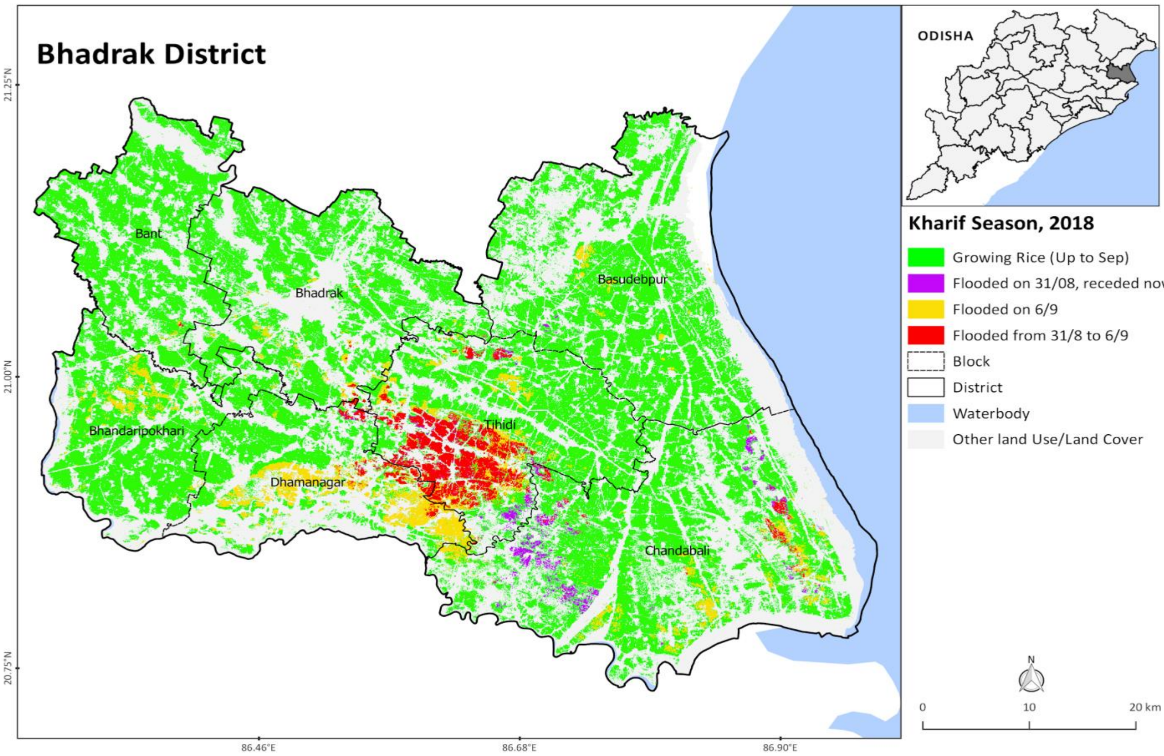


Figure 5.9: Rice area affected by excessive rain during 1st week of September 2018

Table 5.8: Bhadrak flood affected areas, September 2018

Block Name	2018 Kharif rice estimates (ha) up to September	Flooded Rice Area	
		Ha	%
Bant	15,579	76	1
Basudebpur	24,580	359	2
Bhadrak	18,525	619	3
Bhandaripokhari	14,813	898	6
Chandabali	29,138	3,478	12
Dhamanagar	12,529	4,195	34
Tihidi	21,645	6,850	32

Photo 5.1: Flooded rice field \during September 2018 in Dappa village, Kanpada GP in Tihidi block of Bhadrak District

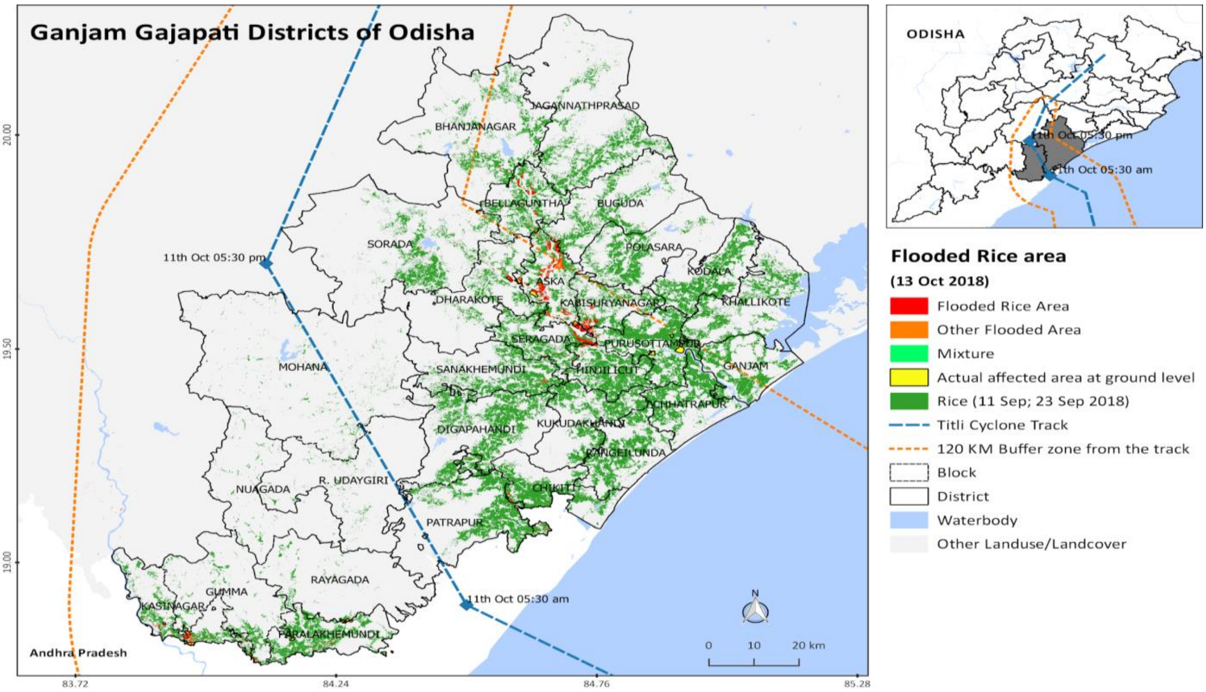


Figure 5.11: Rice area affected by cyclone Titli on 13 October 2018. Actual affected area at ground level was observed based on field visit after the cyclone

Photo 5.2 Rice field damaged by flood in the aftermath Titli cyclone in Mangalpur Gram Panchayat in Aska block, Ganjam District, 22 October 2018

Table 5.9: Gajapati and Ganjam flood affected areas, October 2018

Block Name	2018 Kharif rice estimates (ha)	Flooded Rice Area	
		Ha	%
Ganjam			
Aska	7,045	1,746	25
Bellaguntha	7,694	413	5
Bhanjanagar	8,410	49	1
Buguda	9,285	88	1
Chhatrapur	9,281	-	-
Chikiti	9,921	122	1
Dharakote	6,516	167	3
Digapahandi	16,650	24	0
Ganjam	7,336	-	-
Hinjilicut	10,711	181	2
Jagannathprasad	11,899	-	-
Kabisuryanagar	7,541	440	6
Khallikote	12,104	-	-
Kodala	10,870	-	-
Kukudakhandi	11,111	-	-
Patrapur	12,563	68	1
Polasara	8,493	9	0
Purusottampur	12,878	132	1
Rangeilunda	8,696	-	-
Sanakhemundi	10,616	86	1
Seragada	8,641	579	7
Sorada	8,171	15	0
Gajapati			
Gumma	2,728	61	2
Kashinagara	3,632	384	11
Mohana	1,571	-	-

Nuagada	546	-	-
Paralakhemundi	9,118	128	1
R. Udayagiri	704	-	-
Rayagada	1,360	19	1

Capacity Development

The following hands-on training sessions were conducted in 2018 to develop local technical capacities:

i) A five-day intermediate training on MAPscape-Rice (2nd phase) was provided to the DoA and IRRI-Odisha staff during 02-06 August 2018. The training focused on (a) recap of MAPscape-Rice basic processing steps and description of the new data and processing procedures and optical data processing (LANDSAT and Sentinel-2); (b) data processing in MAPscape-Rice and analysis/interpretation in QGIS (multi-temporal features, BSQ, etc.) and data classification in MAPscape-Rice i.e. rice-not rice masking, Multi CASD. On the last day of training, the local team and DoA staff discussed the analysis of information relevant to the rice ecosystem discrimination in order to revise the baseline map. A one-day field trip with training team was conducted in Kendrapada district to observe the season start situation

ii) Specific training on GIS application with open source software Quantum GIS has been conducted with DoA and IRRI-Odisha staff from 29 October to 02 November, 2018. This training aimed to accelerate practical skills on GIS tasks using Quantum GIS software for visualizing, analyzing, and producing relevant maps from the Satellite based monitoring outputs/products as well as ground data collection activities

iii) A 2-week long intensive training on MAPscape-Rice was conducted at sarmap in Purasca, Switzerland from 26 November to 07 November, 2018. This training was attended by one DoA AAO and one IRRI staff in order to accelerate know-how transfer from sarmap to local team for SAR-based rice area estimation

Conclusion

The project team successfully identified **Rice Area** with fairly accurately considering the complexity of the monitored area i.e. different crop practices such as direct seeded vs. transplanted, different environmental/climatic conditions i.e. rainfed and irrigated, dynamic sowing/planting for Autumn rice growing area (mostly in upland) and Winter rice growing area (mainly in medium and lowland), fragmented areas with different crops or with very different stages of rice growth, etc.) and the resolution of the input data. It is, however, important to note that rice area accuracy has improved this 2018 Kharif (94.4%) as compared to the previous year (87.6%). It shows a promising trajectory when efforts were made to capture more information (collecting more ground data for model calibration), such efforts eventually translate into a positive outcome demonstrated by the improved accuracy of rice area. These extra ground data collection efforts also generate spillover benefits of better understanding of rice growth in different environments in terms of vast geographical spread as well as different time of sowing/planting. In case of rice SoS detection, satellite imageries starting from 07 June was used to analyse start of season. Analysis of SoS data showed good agreement while detecting transplanting date as well as in direct seeding date, but a slight discrepancy occurred in the case of direct seeded rice area in rainfed districts, especially in upland area where sowing started around mid-June to early July with short duration rice varieties denoted as Autumn rice. This is probably due to a rain event which triggered widespread grass growth in winter rice areas that was very similar to direct seeded rice growth in Autumn rice area. Results of yield estimation shows that the current estimation process can detect yield distribution pattern depending on the ecosystem where it is grown. However, government yield statistics are also needed to validate the yield estimates from crop modeling. Likewise, continuous collection of management practices and accurate weather information will help to improve the current estimation processes.

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

Socially acceptable comprehensive Crop Insurance, 2018-19

With the government supported crop insurance scheme emerging as one of the key agricultural risk management strategies, there is a need for designing an insurance product that is relevant to the context of farmers in Odisha, especially small and marginal landholders to ensure its widespread acceptance, adoption and use in the long run. This could have a significant impact on farmers' income stabilization and sustainable agricultural production. Therefore, this subproject documents policy options for development of a comprehensive crop insurance scheme by testing different ways of bundling technologies (risk mitigating) with the insurance scheme and their acceptance among farmers.

The major objectives of this sub-component are to:

- Identify key indicators of an ideal crop insurance product based on farmers' preference
- Elicit farmers' insurance literacy levels and awareness about the Prime Minister Fasal Bima Yojana (PMFBY)
- Understand farmers' cognitive abilities, and risks and their current adaptation strategies
- Design educational interventions to increase farmers' awareness and acceptability of crop insurance
- Examine substitutability and complementarity effects of coupling insurance with alternative risk mitigation strategies (STRVs) and farmers' uptake

Preliminary outputs in 2018-19

Insurance is a complex product to many, as it requires an individual's understanding on the probability of risk discounted over a period of time and possible pay-out under different scenarios. Given the poor education among farmers in the developing countries, their ability to process the information on insurance products varies substantially. The economics and psychology literature have discussed the limitations and implications of an individual's ability to process information on choice behaviour. In addition, individuals may attempt to avoid conflict when choices are complex, leading to simpler heuristic choices, stick to status quo and attribute non-attendance. It is well evident that incentivising choices while eliciting the preference decreases the hypothetical bias, thus enable policymaker to gather the true preferences which aid in estimating unbiased demand for product and price appropriately. In order to elicit farmers' crop insurance preference for different product profiles we used discrete choice experiment (CE). We hypothesized that, a substantial difference exists between the hypothetical and non-hypothetical choice distribution if farmers belong to similar cognitive abilities. It is also contended that, farmers might not be able to trade of different insurance product if they have low cognitive bandwidth which might exhibit no significant difference between hypothetical and non-hypothetical choices. Therefore, we postulate that the size of the hypothetical bias in eliciting preference for crop insurance depends on the farmers' cognitive ability to understand the product.

We conducted an extensive household survey and a framed-field experiment with real rice farmers who make the decision on the purchase of crop insurance. Following between-subject design, we implemented incentivized and non-incentivized CE which is randomized at the village level. In contrast to the non-incentivized CE (NICE), in the incentivized CE (ICE), farmers have to purchase the insurance product from the endowment provided in the experiment. Our design consists of 5 attributes[1] namely insurance unit, types of risk covered, yield assessment method, claim processing time and transparency of the insurance system (attributes and attribute levels are presented in Table 1). Each farmer was faced with 4 choice cards (an example choice card can be referred in Figure 1) and in each card, they chose the most preferred option amongst three alternatives consists of two alternative crop insurance products and an opt-out option.

Table 5.1: Attributes and levels of choice experiments

Attribute name	Attribute levels
Unit of Insurance	1. Block; 2. GP; 3. Village; 4. Individual plots
Risk Coverage	1. Prevented sowing; 2. Full crop coverage (FCC) (1+2+3); 3. FCC + market price/MSP; 4. Full farm coverage (Farm + livestock + farm machinery)
Yield loss estimation process	1. Crop Cut Experiment (CCE) - selection of plot at the harvest time (no pre-selection); 2. Remote sensing; 3. Self-reporting (farmers)
Claim settlement time (Turnaround time)	1. Within 3 months from the damage time; 2. Within 6 months; 3. More than 6 months
Process improvement/transparency (yield assessment, claim settlements and their information)	1. Transparency*; 2. No transparency [*A transparent system provides clear information about yield estimation, claim settlement details, and update/ status of the application for each individual through SMS. Claim settlement is processed digitally and indemnity is transferred directly to the beneficiary account. Whereas, in a system with no transparency, these characteristics of an insurance process are absent]

[1] Attributes are arrived at by following protocol. From literature and based on focus group discussions in 2017-2018 with farmers and discussions during a workshop in Feb, 2018, involving all the stakeholders concerned with crop insurance scheme, key indicators or attributes of crop insurance product were identified. The identified (most or least) preferred attributes are validated by different stakeholders for designing choice experiment to elicit farmers' preferences for crop insurance scheme. These designs were piloted and validated in field before the actual experiment started.

Sampling methods

Photo 5.3 Enumerator's training and piloting at Pipli, Puri

A representative 15 districts were selected accounting for factors such as weather risk, gross cropped area, agro-climatic zones and, insurance clusters classified by the government of Odisha. Using, probability proportional to size (PPS) sampling, 300 villages were randomly selected from these districts. Prior to sampling of farm households, a village census was conducted in the selected 300 villages to gather basic information about the farming households and crop insurance status. Based on the village census, 10 rice-growing farmers were randomly selected to carry out a detailed household survey and to elicit their preference for crop insurance using CE. In total, our sample consists of 3000 rice-growing farmers. In the choice experiment, around half of the selected farmers (1500) were incentivized for their choices. The payoff of farmers depends on the decisions they made and risk events they face. Table 5.2 presents the details of the sampling strategy of the study.

Before eliciting farmers' preference for crop insurance products, we recorded details of their household characteristics and awareness about the PMFBY. In addition, we also measure different behavioural and psychological characteristics such as time preference, risk preference, skills on understanding probability, mathematical skills, financial literacy, insurance literacy, and logical thinking using pre-structured psychological questionnaire. We compound these factors to classify farmers with different cognitive ability classes. The survey was administered with CAPI (computer assisted personal interview) using *surveybe*.

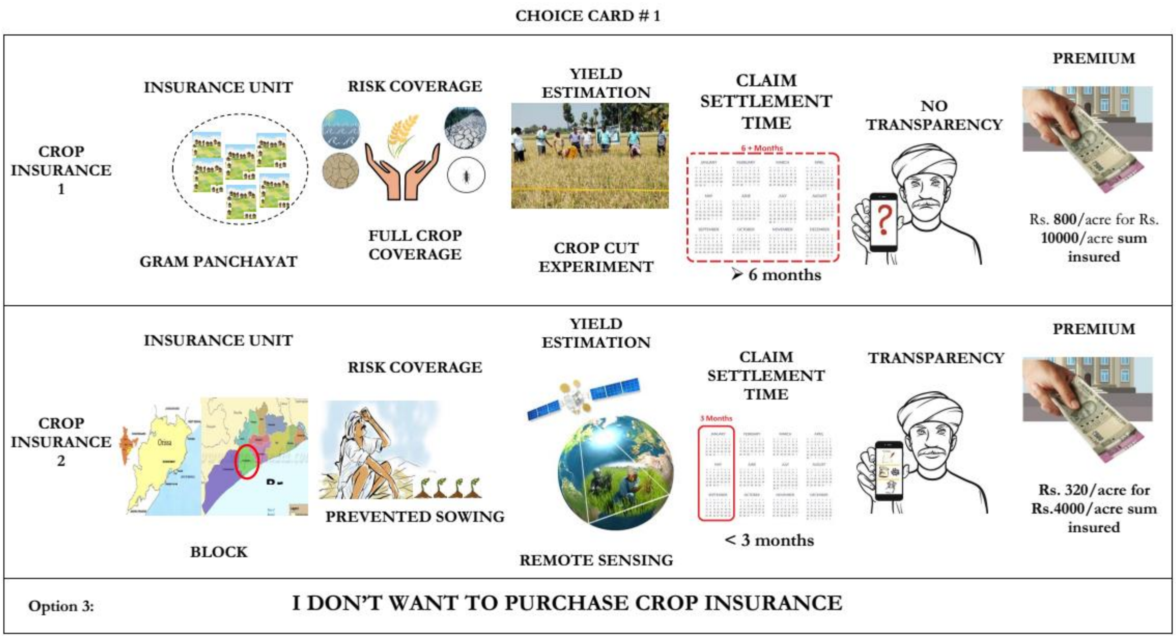


Figure 5.1: An example choice card used in the crop insurance choice experiment

Table 5.2: Sample selection details

Districts	Total No. of Villages	GCA*_RICE ('000 hectares)	Risk Type	Agro-climatic Zone	Notified Insurance Company during 2017	Insurance Cluster	No. of Villages Sampled proportionately (300)
Bargarh	1211	326	Drought	9	National Insurance Company Limited	Cluster 3	13
Mayurbhanj	3966	305	Drought	2	Tata AIG General Insurance Co. Ltd.	Cluster 1	43
Ganjam	3216	252	Flood	4,5	Tata AIG General Insurance Co. Ltd.	Cluster 1	35
Kalahandi	2255	249	Drought	8	Tata AIG General Insurance Co. Ltd.	Cluster 4	24
Balasore	2953	226	Flood	3	Agriculture Insurance Company	Cluster 2	32
Balangir	1789	204	Drought	9	Cholamandalam MS General Insurance Company	Cluster 5	19
Keonjhar	2128	175	Both	2	Agriculture Insurance Company	Cluster 2	23
Bhadrak	1318	168	Flood	3	Cholamandalam MS General Insurance Company	Cluster 5	14
Sambalpur	1317	162	Both	1, 9	Tata AIG General Insurance Co. Ltd.	Cluster 1	14
Nabarangapur	897	147	Drought	6	Cholamandalam MS General Insurance Company	Cluster 5	10
Subarnapur	963	137	Drought	9	Agriculture Insurance Company	Cluster 2	10
Puri	1709	135	Flood	4	Agriculture Insurance Company	Cluster 2	19
Kendrapara	1547	134	Flood	4	Tata AIG General Insurance Co. Ltd.	Cluster 4	17
Jajpur	1792	126	Flood	3,10	Agriculture Insurance Company	Cluster 2	19
Nuapada	668	105	Drought	8	National Insurance Company Limited	Cluster 3	8

*GCA – Gross Cropped Area

Results

Preliminary results indicate that around 70 per cent of the farmers are not aware of crop insurance. Majority of the farmers are not availing the crop insurance (around 91 per cent), out of which a small portion had availed before and discontinued (Figure 2). Around 80 per cent of the loanee farmers reported that they have not taken crop insurance, yet credit is by default linked to PMFBY, which suggest poor credit knowledge and financial awareness of farmers. Less than 20 per cent of the farmers reported that they are aware off and know few terms of insurance such as premium, sum-insured, claim settlement which suggests that the insurance literacy of the farmers is very low.

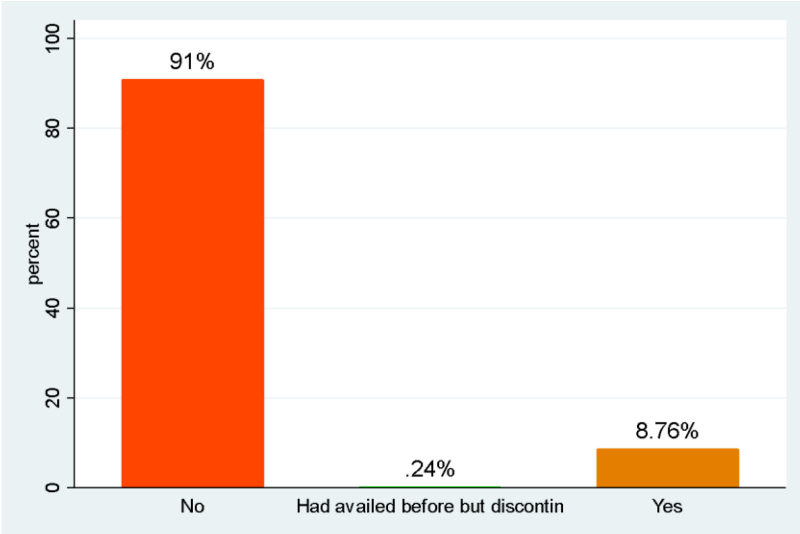


Figure 5.2: Status of insurance take

Around 94 per cent of the farmers approached either formal or informal sources for credit. Banks including cooperative banks are the most preferred sources for registering for crop insurance. Majority of the farmers (70 per cent) are found to be highly risk averse. Farmers perceive drought as the major threat to rice crop and on average they face major crop loss (min 30%) once in at least 3-4 years. STRVs and varietal diversification are found to be their most preferred strategy for risk adaptation. Off-farm engagement, input management, changing consumption pattern are other risk management strategies farmers have reported.

Farmers crop insurance preferences

The farmers' choices in the CE are analysed using Latent class model (LCM). The model classified the farmers into three classes (see Table 3). Class 1 includes farmers who are not insured and have low cognitive ability, class 2 composes of farmers with low cognitive ability but are insured, and class 3 consists of farmers having high cognitive ability. We found significant differences in the distribution of insurance choice preferences between these classes of farmers (a preliminary model is presented in table 5.3).

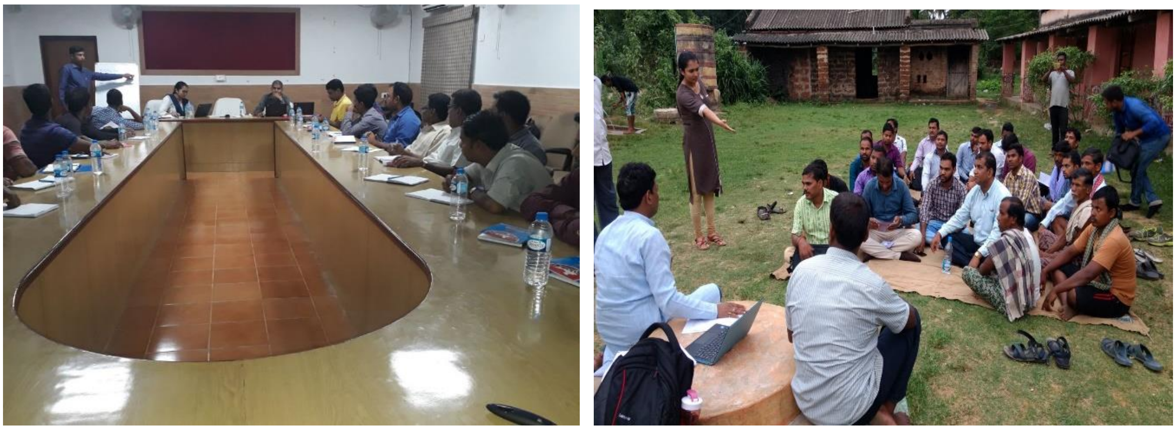
Table 5.3. Latent Class Model (LCM) on insurance attribute preferences[2]

Variable	Class 1 (avg. class prob: 32.5%)	Class 2 (avg. class prob: 4.6%)	Class 3 (avg. class prob: 62.9%)
Risk Coverage (reference: Prevented sowing)			
Full crop coverage	-29.398*** (5.889)	-0.450 (8.642)	0.747 (2.555)
FCC + Market risk	-34.479*** (7.361)	-16.103 (10.721)	2.408 (3.292)
Yield (loss) estimation (reference: Crop Cut Experiment)			
Satellite based	0.647*** (0.204)	0.0381 (0.458)	-0.355*** (0.120)
Self-reporting based	-0.616*** (0.172)	0.298 (0.432)	0.419*** (0.097)
Turn Around Time (reference: <3 months)			
3 – 6 months	0.811*** (0.200)	0.299 (0.494)	-0.494*** (0.110)
> 6 months	0.427*** (0.152)	0.086 (0.377)	-0.135* (0.080)
Process Transparency	-2.020*** (0.363)	0.303 (0.600)	-0.388** (0.155)
Insurance Unit (reference: Block)			
Individual plot	6.402*** (1.829)	6.691** (2.769)	-3.412*** (0.989)
Village	4.093*** (1.365)	4.612* (2.784)	-3.743*** (0.822)
Gram panchayat	1.803** (0.736)	1.630 (1.484)	-1.078** (0.435)
Premium	0.014*** (0.002)	-0.006** (0.002)	0.010*** (0.000)
Full Crop Coverage × Premium	0.029*** (0.006)	0.005 (0.010)	-0.007** (0.003)
FCC + Market Risk × Premium	0.030*** (0.007)	.0219* (0.011)	-0.008** (0.003)
Individual plot × Premium	-0.015*** (0.003)	-0.007* (0.004)	0.003** (0.001)
Village × Premium	0.010*** (0.002)	-0.005 (0.004)	0.003*** (0.001)
Gram panchayat × Premium	-0.006*** (0.001)	-0.002 (0.002)	0.001** (0.000)

*, ** and *** indicates 10%, 5% and 1% significance level respectively

[2] Please note that this result is from a preliminary model and hence we restrict the interpretation of results to very generalized results. The final model with more detailed interpretation and policy implication will be presented later. Nevertheless, we will not expect a significant change in the overall direction of results.

The class 1 farmers prefer targeted single purpose insurance coverage to multipurpose insurance product, that is, their choice on prevented sowing is significantly higher than FCC or FCC plus market risk coverage. Other classes of farmers do not differ in their choices of insurance coverage. With reference to yield loss estimation, farmers belonged to both class 1 and 3, do not prefer CCE, rather opting either satellite (class 1) or self-reporting (class 3) based approaches. Those who prefers self-reporting based yield loss estimation also wanted to have a low turn-around-time whereas class 1 farmers who prefers satellite based approaches are ready to wait longer. The result reported an unexpected direction of preferences for transparency which required careful evaluation and hence we interpret the result after finalizing the model. Individual plot is the most preferred insurance unit for first two classes whereas it is the block for the farmers in the class 3. Premium has a similar effect on insurance preferences for both class 1 and class 3 farmers – positive and significant which is in contrary to the classic economic principle. In the insurance scenario, higher the premium higher would be the sum insured.



Photos 5.4 Enumerators training (class room & field) program for Implementing Crop Insurance Preference Experiment

Photo 5.5 Interviewing Farmers on Crop Insurance Preference

Photo 5.6 Monitoring and Evaluation of Crop Insurance Experiment

Second, the insurance premium is already highly subsidized and hence such positive effect is plausible with an expectation of higher pay off during the extreme events. Making the village as insurance unit will increase the positive effect of premium on insurance choice. Please note that this result is from a preliminary model and hence we restrict the interpretation of the model in generalized way, by not discussing the detailed implications. The final model with more detailed interpretation and policy implications will be presented later. Nevertheless, we will not expect a significant change in the overall direction of results. In summary, we observed preference heterogeneity among farmers as well as some unexpected preferences which needed further validation on farmer's choices whether it is heuristic dependent or not. Post evaluations on incentivization effect via-a-vis cognitive understanding is expected to shed light on this.

Conclusion

The study has a direct bearing on the policy. The results provide valuable information on the attributes of crop insurance that are highly valued by farmers which can be used by policymakers and insurance companies in designing/re-designing the product as well as pricing appropriately to ensure take-up. A proper understanding of the impact of incentivization on insurance take-up can streamline the ongoing huge investment in crop insurance program. The results have following major conclusions:

1. We observed heterogeneous preferences and found that not one product suits to all types of farmers
2. Scope of different product mix exists – for example, single risk vs multiple risk coverage; products with Satellite vs self-reporting based yield (loss) estimation; individual plot or village or block as insurance unit etc. Ideal insurance product features based on the insurance preferences could be used to develop such products
3. The above products satisfy different levels of education/cognitive levels of farmers and satisfy the average preferences of around 95% of farmers

Work plan 2019-20

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

SN	Activity	Number	Districts	Blocks	Area (Ha)/No	Remark
1	Demonstrations (5-10 ha each)	560	24	80	5600	70 ha per block
2	H2H Trials	2400	24	80	2400	30 H2H per block
3	Demos through OSSC Dealers & their Customers	3600	24	80	3600	240 blocks, 3 dealers from each block. Each dealer will target 15 farmers
4	Evidence Hubs (Crop Cafeteria)	12	12			12 CCs in different districts
5	Client Oriented Crop Cafertia	2	2			CIFA KVK and NRRI are partners
6	QRSP Trainings for farmers (25 per training)	160	30		4000	2 QSPs per block
7	TOT on QRSP and Management Practices	3		1	150	To be conducted at IMAGE
8	District Level Seed Meetings	30			30	Coordination meeting for all components with DDA and other offices.
9	Formation of women led seed groups	30		42	30	NGOs, SHGs, DDAs
10	Awareness creation meetings	350		42	14000	DDAs, NGOs, Farmers, 200 participants per block
11	QLY & HYL Review	4			4	
12	Annual Review & Planning Meeting	1			1	DOA, DDAs, AAOs, OSSC, KVKs, NRRI, OUAT, NGOs, SHGs, Dealers, Seed Cos, Farmers
13	Research Program to attain various research outputs	1			1	
14	Breeding program with NARES	1			1	OUAT and NRRI are research partners
15	Pilot SeedCast	1	10	30	1	DDAs, AAOs, Dealers, PACS, OSSC outlets, OSSC (Pvt in phase Lanch)
16	Boro/ rabi demonstrations	1			1000	1000 ha palnned for Rabi 2019

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

SN	Activities	Units	Number	Districts	Blocks	Area/No.	Partner
	Demonstrations						
1	Demonstrations of pulses in Rice fallow system and suitable flood tolerant cultivars in flood prone rice-fallow system - atleast 2500 ha is covered during dry season and 200 ha in wet season fallows	ha	12500	15	60	2500 ha	DoA, NRRI, OUAT, IIPR and NGOs
	Pulse Varieties are tested and demonstrated under pulse village (in cluster form) - atleast 3 improved pulse varieties are tested	No	3	3	5	3 districts	DoA, NRRI, OUAT, IIPR and NGOs
	Research Support & Supplies						
2	Extrapolation domain maps showing potential areas for cropping intensification at village level for all districts shared with District Level DOA officers for targeting of cultivars, technologies and various other uses	No	1	30		30 districts	DoA, NRRI and OUAT
	Inundation depth with varied duration, gravity drainage maps, water salinity, ground water depth, quality and potential maps are prepared and submitted to Government	No	1	30			
	Open WebGIS portal with all the Rice-fallow, Cropping systems, Stress-prone and suitability map layers is prepared and hand over to Govt.	No	1	30			DoA, NRRI and OUAT
	Hydrogel and Nano-materials are tested at multiple sites - includes station experiements and adaptive trials	No	750	5	15	150 ha	DoA, NRRI, OUAT and NGOs
	Land Use requirement & assessment and preparation of decision rules/tree for extrapolation domains - addtional 2 major cropping systems are covered. Extrapolation domains are ready for rice-pulse and rice-rice systems	No	2	10		10 districts	DoA, NRRI and OUAT
	WebGIS						
3	Research Collaboration for development of improved pulse technologies for rice fallow areas						NRRI, OUAT, IIPR, and OSSC
	Training on WebGIS portal usage system	No	1				DoA, NRRI and OUAT

Workshop & Meetings							
4	Districts Level Meetings	20		15	20		
	Awareness Creation Meetings	10		10	10		
	QTL & HYL Review Meeting	4					
	Annual Review & Planning Meeting	1					
	Miscellaneous contingencies (supplies, services, equipment)	1					
	Management Cost (Over head)	1					

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

SN	Activities	Unit	Districts	Partners
1	Training of VAWs	110	17	DoA
2	Training of trainers (AAOs) in kharif and rabi	10	8	DoA
3	Training of NGO partners	10	30	CSC, PAD, Netaji Jubak Sangh, LWSIT, SWAD, Harsha Trust
4	Dissemination of recommendations	60,000	30	DoA, NGOs, IRRI
5	Monitoring the use of recommendations	7000	30	DoA, NGOs, IRRI
6	H2H trials and Demonstrations	500	17	DoA, NGOs, IRRI
7	Study the effects of different rice establishment methods and tillage practices in rice in both dry and wet season on crop performance, nutrient and water use efficiency and soil characteristics	1	State	OUAT
8	Optimising Fertilizer application rates and timing for rainfed rice in Odisha	1	State	OUAT
9	Development and evaluation of RCM for DSR	11	3	
10	Development of better zinc management options for Rice based systems for Odisha	170	5	
11	Evaluate and demonstrate the suitability of N fixers to curtail the use of inorganic nitrogenous fertilizers in RCM for RBS in Odisha	8	2	
12	Development of better nutrient management module for rice pulse systems for Odisha	100	3	
13	Evaluation of crop management component of RCM- (weed management)	30	2	NRRI
14	Development, validation and evaluation of rainfed component of CMRS	120	10	
15	Adaptive trials on using GIS-based yield monitoring for developing better yield targets in RCM	20	3	

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

SN	Name of the activity	Unit	District/State	Number	Partners
Rice Knowledge Bank (RKB)					
1	Content writeshop	Workshop	State	3	ICAR-NRRI
2	State level Knowledge Management Committee (KMC) meetings	Meeting	State	1	DAFE
3	Development of RKB-English version	Activity	State	1	IRRI
4	RKB user tests	Event	District	1	DAFE & OLM
5	Stakeholder workshop	Workshop	State	1	DAFE
6	RKB Odia development	Activity	State	1	IRRI
7	RKB/RD launch	Event	State	1	IRRI & DAFE
8	Printing and distribution of Odia rice production manual	Booklet	State	1000	IRRI
9	Training of extension intermediaries	Training	District	10	OUAT
Rice Doctor (RD)					
10	RD design upgradation	Activity	State	1	IRRI
11	RD Odia version upgradation	Activity	State	1	IRRI
12	Training of extension intermediaries	Training	District	10	OUAT
Integrated Pest Management (IPM)					
13	Testing of ecological engineering based IPM module	Trial	District	15	ICAR-NRRI,IIRR & OUAT
14	Testing of ecological engineering based IPM module in cluster demonstrations	Demonstration	District	2	IRRI
15	Setting up of a production unit of Trichocards with women farmers	Production unit	District	1	ALCI
16	Odisha Plant protection workshop	Workshop	State	1	ICAR-NRRI,IIRR,OUAT & DAFE
17	Policy dialogue on sustainable and effective pest management approaches	Event	State	1	DAFE

Capacity Building					
A.	Strengthening Extension Advisory Services (EAS) in Odisha				
18	Develop a policy brief on the results of capacity needs assessment (CNA) workshop and host a sharing workshop	Event	State	1	DAFE &CRISP
19	Develop training modules and organise training of trainers (ToTs) for SAMETIS/identified key resource persons in Odisha	Activity	State	1	DAFE & CRISP
20	Study the organizational structure and management of Odisha extension system (DAFE), and suggest reforms for strengthening extension provision (DAFE-Department of Agriculture and Farmers Empowerment)	Activity	State	1	DAFE & CRISP
21	Study the current induction training programmes of Asst. Agriculture Officers(AAOs) and suggest modifications by bringing revised modules/impart it (along with IMAGE/MANAGE faculty)	Activity	State	1	DAFE,IMAGE & CRISP
Leadership and Entrepreneurship Programme for Women in Agriculture (LEAP)					
22	Support to and monitoring of women-owned Producer Company (PC) in rice-based agriculture food system in Kalahandi	Producer Company	District	1	DAFE & ALCI
23	Capacity building of women farmers/groups on leadership and entrepreneurship development by working with ICAR-CIWA and its grantee organisations	Organisation	State	3	ICAR-CIWA
Scaling activities through Odisha Livelihoods Mission (OLM)					
24	Training of Trainers(ToTs) on quality rice seed production(QRSP), Rice Crop Manager(RCM), Rice Fallow Management and Rice Knowledge Bank	Training	State	2	OLM
25	Season-long demonstration at FFS for Master Trainers	Demonstration	District	1	OLM
B.	Scholars Programme				
26	Fellowship to Masters and Ph.D. students	Student	State	20	ICAR-NRRI

Subproject 5: Science-based crop insurance

5A: Remote sensing based rice monitoring system

SN	Activities	Unit	Number	Districts	Area/No.	Partner
1	Ground data collection for Start-of-Season (SoS) verification & calibration	30dt	30	30	50	Possible partner DoA
2	Ground data collection for rice-and-non-rice (RnR) area validation	30 dt	30	30	50	Possible partner DoA
3	SAR (Sentinel-1) and Optical (landsat 8) acquisition planning	state	1	30		
4	SAR (Sentinel-1) and optical (landsat 8) data processing and analysis	state	1	30	Entire state	
5	Early season product generation : rice area maps and area estimation	state	1	30	Entire state	
6	Early season product generation: SoS maps	state	1	30	Entire state	
7	Data collection for historical yield; historical & current daily weather data; agronomic management; and official yield data	30 dt	30	30	Entire state	
8	Mid-season product generation and yield forecast	state	1	30	Entire state	
9	End-of-season (EoS) product generation and yield estimates	state	1	30	Entire state	
10	RnR area map validation and accuracy assessment	state	1	30	Entire state	Possible partner DoA
11	EoS validation of yield estimates	state	1	30	Entire state	Possible partner DoA, component-1 and component-3
12	Preventive sowing mapping	state	2	30		
13	Abiotic stress map (Flood / drought) in case of natural disaster event.	state	1			Areas affected by the abiotic stress will be monitored and mapped
14	Rice Ecosytem Map Generation	State	1		Entire state	
15	Rice Ecosytem Map field Validation and stakeholder consultation	State	30		Entire state	
16	Drone data collection	2 disticts	2			
17	Tranining on SoS and RnR data collection procedures	10 trainees	4			
18	Training on MapscapeRice	3 trainees	1			
19	Training for District officers on field data collection	30 trainees	1			
20	Training on RiceYES (Yield Estimation)	3 trainees	1			

5B: Crop insurance

SN	Activity	Number	Districts	Villages	Area/ sampled farmers	Partners/ participants
1	Development of insurance awareness video	1	15	126	1260	This side up, Survey Jena and CSC
2	Development of Insurance simulation app	1	15	126	1260	Survey Jena and CSC
3	Insurance awareness training	1	15	126	1260	Survey Jena and CSC
4	Insurance stakeholders' workshop	1	-	-	-	Insurance companies, CSC, and Banks
5	Bundled product choice: Insurance with STRVs	1	15	252	1512	Survey Jena and CSC
6	Insurance uptake - survey	1	15	300	3000	Survey Jena and CSC
7	Endline survey	1	15	300	3000	Survey Jena

Photo gallery: A glimpse of Dr. Matthew Morell's visit to Odisha
Director General, IRRI
29-30, March 2019


Photo 6.1 IRRI DG meeting with Dr. S. Garg, PS, DAFE

Photo 6.2 DG meeting with staff at IRRI office, BBSR


Photo 6.3 Visited RCM managed plot, Pipli, Puri


Photo 6.4 Interacting with farmers at Satyabadi, Puri


Photo 6.5 Interacting with women groups at Sayabadi


Photo 6.6 Visiting pulse demonstration plot, Puri

Annexures

Table 1.1: Number of farmers growing various varieties in cluster demonstrations

District	Bina dhan 11	CR 1009 Sub1	DRR 44	Sahabhagi dhan	Swarna Sub1	Grand Total
Angul	323		251	328		902
Bhadrak	556	204			277	1037
Bolangir	132		156	145		433
Cuttack	56	169			389	614
Kalahandi	155		123	139		417
Kandhmal	200		177	219		596
Keonjhar	348		357	356		1061
Khordha		23			46	69
Koraput	272		283	271		826
Mayurbhanj	193		181	207		581
Nayagarh	209		161	181		551
Puri	140	118			388	646
Rayagada	63		291	205		559
Sambalpur	161		163	155		479
Sundergarh	248		283	288		819
Grand Total	**3056**	**514**	**2426**	**2494**	**1100**	**9590**

Table 1.2: H2H details (Quantity and area)

District	No of farmers	Seed Received (Kg)	Area Sown (in Acre) for STRV
Angul	260	2196.10	109.81
Bhadrak	186	1860.00	93.00
Bolangir	240	2280.00	114.00
Cuttack	232	2000.00	100.00
Kalahandi	232	2331.00	116.55
Kandhamal	271	2535.00	126.75
Keonjhar	256	2528.00	126.40
Khordha	5	50.00	2.50
Koraput	257	2570.00	128.50
Mayurbhanj	278	2757.00	137.85
Nayagarh	236	2360.00	118.00
Puri	289	2270.00	113.50
Rayagada	228	2540.00	127.00
Sambalpur	242	2420.00	121.00
Sundergarh	251	2250.00	112.50
Grand Total	**3463**	**32947.10**	**1647.36**

Table 1.3: The details of eight SHGs oriented on STRVs and provided with seeds

SN	SHG name	District	Block	Village	STRVs
1	Narishakti	Sambalpur	Maneswar	Haldi	Bina dhan 11
2	Maa Mangala	Rayagada	Muniguda	Samadola	Bina dhan 11
3	Maa Laxmithakurani	Kalahandi	Dharmgarh	Gundriguda	Bina dhan 11
4	Mother Teresa Sanchay Samity	Keonjhar	Ghatgaon	Akhupal	Bina dhan 11
5	Rajashree	Mayurbhanj	Baripada Sadar	Langalkata	Bina dhan 11
6	Jhansi Rani	Keonjhar	Patana	Naugaon	Bina dhan 11
7	Maa Biswasari	Puri	Delanga	Bidiurpur	Bina dhan 11
8	Asha Alok	Cuttack	Kantapada	Dhanamandal	Bina dhan 11

Table 1.4: Women farmer groups associated with seed system improvement in kharif 2018

SN	District	Block	Village	SHG name	CC	H2H	Cluster demo	SP training
1	Sambalpur	Maneswar	Haldipali	Narishakti				Yes
2	Bhadrak	Tihidi	Shyamsundarpur	Shiva Shambhu			Yes	Yes
3	Bhadrak	Tihidi	Shyamsundarpur	Subhalaxmi			Yes	Yes
4	Bhadrak	Tihidi	Shyamsundarpur	Omkar			Yes	Yes
5	Bhadrak	Tihidi	Shyamsundarpur	Urmi			Yes	Yes
6	Keonjhar	Ghatgaon	Akhupal	Mother Teresa Sanchay Samity		Yes	Yes	Yes
7	Keonjhar	Ghatgaon	Sanamasinabilla	Chetana Sanchay Samity		Yes		Yes
8	Mayurbhanj	Baripada Sadar	Langalkata	Maa Mangala			Yes	Yes
9	Mayurbhanj	Baripada Sadar	Langalkata	Rajashree			Yes	Yes
10	Keonjhar	Patana	Naugaon	Jhansi Rani			Yes	Yes
11	Kandhmal	Chakapad	Nepasaru	Maa Saraswati		Yes	Yes	Yes
12	Kandhmal	Khajuripada	Gumagada	Rukmini		Yes	Yes	Yes
13	Bargarh	Attabira	Chakuli	Maa Samaleswari		Yes	Yes	
14	Kalahandi	Bhawanipatna	Gananathpur	Maa Thakurani	Yes			
15	Kalahandi	Kalampur	Bagpada	Maa Mangala		Yes	Yes	Yes
16	Rayagadaa	Muniguda	Ankulapadar	Maa Jageswari		Yes	Yes	
17	Rayagadaa	Muniguda	Talachhelianala	Maa Hiranila		Yes	Yes	
18	Koraput	Kotpad	Chintra	Sriram			Yes	

19	Koraput	Jayepore	Kumarguda	Maa Laxmi			Yes	
20	Nayagargh	Nuagaon	Korada	Maa Khaparamalla		Yes	Yes	Yes
21	Nayagargh	Khandapada	Kunjabihari Prasad	Singhabahini		Yes	Yes	Yes
22	Nayagargh	Khandapada	Kunjabihari Prasad	Maa Sulia			Yes	Yes
23	Nayagargh	Bhapur	Bhagabanpuru	Maa Santoshi		Yes	Yes	Yes
24	Nayagargh	Bhapur	Bhagabanpuru	Maa Mangala		Yes	Yes	Yes
25	Nayagargh	Bhapur	Bhagabanpuru	Maa Bjarangi		Yes	Yes	Yes
26	Cuttack	Kantapada	Dhanamandal	Asha Alok		Yes	Yes	Yes
27	Cuttack	Baranga	Usuma	Arabinda		Yes	Yes	Yes
28	Puri	Puri sadar	Nuagaon	Baba Jodalinga		Yes	Yes	Yes
29	Puri	Delanga	Bidiurpur	Parbati		Yes	Yes	Yes
30	Puri	Delanga	Bidiurpur	Maa Bhairabi		Yes	Yes	Yes

Table 1.5: (a) ToT on Quality Seed Production and storage (batch1) at NRRI Cuttack

SN	Name of the Participants	Designation	Location	Mobile	Email
1	Dillip Kumar Sahu	AAO	Angul	9438394059	
2	Smitarani Behera	AAO	Banarpal	9938052626	smitaranib90@gmail.com
3	Anjan Kumar Nayak	AAO	Athamalik	9439511807	anjanayak95@gmail.com
4	Braja Kishore Behera	AAO	Bhandaripokhari	9437290409	aaobhandaripokhari@gmail.com
5	Jagabandhu Mishra	AAO	Basudevpur	9438675619	mishrajagabandhu1963@gmail.com
6	Ratnakar Pattanaik	AAO	Bhadraksadar	9861203067	aaobhadrak@gmail.com
7	Surendra Ghodanath	AAO	Niali	9937591270	aao.niali@gmail.com
8	Gourahari Biswal	AAO	Baranga	9853215339	aao.mahidharpada@gmail.com
9	Ruchismita Mohapatra	AAO	Bhapur	9938074461	aaobhapur@gmail.com
10	Lopamudra Sahoo	AAO	Odagaon	9438582272	aaosarankul@gmail.com
11	Sonali Mishra	AAO	Delanga	9437257343	sonalimishra@gmail.com
12	Jagruti Nanda	AAO	Purisadar	9178319945	jagrutinanda3693@gmail.com

13	Bibhudata Sahoo	AAO	Balipatana	9438705387	aaobanamalipur2014@gmail.com
14	Suchit Chandrasekhar Tripathy	OSSC Seed Grower, BBSR	Khordha	8763191869	suchitchtripathy@gmail.com
15	Bijaya Kumar Satapathy	OSSC Seed Grower, BBSR	Khordha	9237123056	
16	Satyanarayan Satapathy	OSSC Seed Grower, BBSR	Khordha	8018819851	
17	Santosh Jena	OSSC Seed Grower, BBSR	Khordha	7327824867	
18	Janmajaya Pradhan	OSSC Seed Grower, BBSR	Khordha	9692141259	
19	Madhusudan Pradhan	OSSC Seed Grower, BBSR	Khordha	9938196963	madhusudan65pradhan@gmail.com
20	Laxmidhar Nayak	OSSC Seed Grower, BBSR	Khordha	9337701266	nayak7894@gmail.com
21	Saroj Kumar Sahoo	OSSC Seed Grower, BBSR	Khordha	9437513178	sarojkumar641@gmail.com
22	Dillip Kumar Baral	OSSC Seed Grower, BBSR	Khordha	9238987387	baraldillip@gmail.com
23	Dipak Kumar Baral	OSSC Seed Grower, BBSR	Khordha	9124323354	dipakbaral@gmail.com
24	Ganesh Nayak	OSSC Seed Grower, Berhampur	Berhampur	9437721870	
25	Prasanta Kumar Patra	OSSC Seed Grower, Berhampur	Berhampur	9692224785	
26	Anil Kumar Das	OSSC Seed Grower, Berhampur	Berhampur	9437358522	
27	Rajendra Prasad Patra	OSSC Seed Grower, Berhampur	Berhampur	9439804076	
28	Gourahari Jena	OSSC Seed Grower, Berhampur	Berhampur	9437513969	
29	Kokoram Jena	OSSC OSSC Seed Grower, Berhampur	Berhampur	9938413978	kokoramjena@gmail.com
30	Johan Swain	OSSC OSSC Seed Grower, Berhampur	Berhampur	9861896182	
31	B Purushottam	OSSC OSSC Seed Grower, Rayagada	Rayagada	8895686085	
32	V Damodar Rao	OSSC OSSC Seed Grower,Parala khemundi	Paralakhemundi	9437956616	

33	Dillip Mohanty	Disha (NGO Partner)	Sundragarh	9338105617	dillipmohanty54@gmail.com
34	Sher Ali	Disha (NGO Partner)	Sundargarh	9437248131	sk.sundargarh@gmail.com
35	Lingaraj Acharya	Pragati (NGO Partner)	Koraput	8018919649	lingarajctc@gmail.com
36	Pabitra Mohan Nayak	Pragati (NGO Partner)	Koraput	9438164542	pabitranayak1970@gmail.com
37	Sanjay Kumar Badamali	FES (NGO Partner)	Athamalik,Angul	8018103305	sanjaya.rat360@gmail.com
38	Jibetesh Rath	FES (NGO Partner)	Angul	9938211113	jibetesh9938@gmail.com
39	Tulamani Khamari	Adarsa (NGO Partner)	Sambalpur	9668368870	
40	Dakarat Bag	Adarsa (NGO Partner)	Sambalpur	9556655760	dakaratbag1998@gmail.com
41	Ghanashyam Barik	Harsha Trust (NGO Partner)	Koraput	9437466359	barikghanashyam@gmail.com
42	Krushna Chandra Mohakuda	Swati (NGO Partner)	Phulbani,Kandhamal,Odisha	9439594428	
43	Biswaranjan Kar	Swati (NGO Partner)	Phulbani,Kandhamal,Odisha	8895174132	brkarswati@gmail.com
44	Nalinikanta Nayak	Global Green (NGO Partner)	Sonepur	9178399286	globalgreen24@yahoo.in
45	Bibekananda Panda	Global Green (NGO Partner	Sonepur	9337125092	nandabibeka36@gmail.com
46	Sripati Patra	Charm (NGO Partner)	Khajuripada,Kandhamal	8480322231	
47	Rajkumar Patra	Charm (NGO Partner)	Khajuripada, Kandhamal	8895412625	
48	Manoja Kumar Jena	Loksebak (NGO Partner)	Bhawanipatna	9853612815	manojakjena@gmail.com
49	Rajesh Kumar Sahu	Loksebak (NGO Partner)	Bhawanipatna	8114923104	
50	Dambarudhar Digal	Sewa (NGO Partner)	Jharsuguda	9437589386	dddigal.sewa@gmail.com
51	Manoratha Majhi	Sewa (NGO Partner)	Jharsuguda	8763655733	
52	Kamlesh Roy	Odisha Livelihoods Mission Bhubaneswar	Bhubaneswar	8456016450	
53	Renu Basumantaray	Odisha Livelihoods Mission Bhubaneswar	Bhubaneswar	9422596305	yp.renuolm16@gmail.om

54	Maheswata Samal	Odisha Livelihoods Mission Bhubaneswar	Bhubaneswar	9437289169	**maheswata.jhunu@gmail.com**
55	Janmejay Biswal	IRRI, Odisha	Bhawanipatna	9437596143	
56	Subrajeet Swain	IRRI, Odisha	Bhubaneswar	9090211619	
57	Sampad Kumar Nayak	IRRI, Odisha	Sambalpur	9861134958	
58	Ashis Kumar Mohapatra	IRRI, Odisha	Sambalpur	9090022880	
59	Deepti Saksena	IRRI, Odisha	Bhubaneswar	7205701266	
60	Pradeep Kumar Sethi	IRRI, Odisha	Kalahandi	9438040911	
61	Dillip Kumar Rout	IRRI, Odisha	Sambalpur	9438710325	
62	Bhanu Prasad Bhaduria	IRRI, Odisha	Sambalpur	9634182420	
63	SK M.Hossain	IRRI, Odisha	Bhubaneswar	8018379922	
64	Girija Prasad Swain	IRRI, Odisha	Bhubaneswar	9439778893	

Table 1.5: (b) ToT on Quality Seed Production and storage (batch 2) at NRRI Cuttack

SN	Name of the Participants	Designation	Location	Mobile	Email
1	Biswajit Panda	AAO	At-Maneswar,Sambalpur	7008817104	pandab80@gmail.com
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3	Susanta Panda	AAO	At-Ghatagaon,Keonjhar	7381390982	susantapanda20@gmail.com
4	Varsha Vaishali	AAO	At-Turumunga, DAO-Ghatagaon Keonjhar	9776366776	varshavaishali66@gmail.com
5	Pragyan Paramita Jena	AAO	At-Saharpada, Keonjhar	9853722865	pragyanpinky2001@gmail.com
6	Karunakanti Tete	AAO	At-Hatibari Circle,DAO-Panposh, Sundergarh	9437142147	karunakantitete@gmail.com
7	Subhashree Bandita	AAO	At-Semiliguda,DAO-Koraput	9439920547	aao.semiliguda@gmail.com

8	Sushil Kumar Sethi	AAO	AAO,Loisingha, DAO-Balangir	9937994911	susku@gmail.com
9	Chandra Mohan Chand	AAO	AAO,Agalpur,Balangir	9437105183	Chandramohanchand66@gmail.com
10	Sarat Chandra Singh	OSSC	Salepur,Atada	9853451790	singhseeds@rediffmail.com
11	Shyam Sundar Das	OSSC	At-Pasulunda Po-Kuanpal,Cuttack	7894875331	
12	Mohan Kumar Rout	OSSC	Salepur,Atada	9938298638	
13	Sachidananda Parida	OSSC	Nilria	9337280261	
14	Pradipta Kumar Sahoo	OSSC	Salepur,Sapanpur	9861950281	Pradiptakumar005@gmail.com
15	Jachindranath Sahoo	OSSC	At/Po-Salio,Jharapada, Cuttack	9438044204	
16	Dillip Kumar Parija	OSSC	Kuamanga,Raghunathpur,Jagatsinghpur	9437365950	
17	Abhaya kumar Samal	OSSC	Kujanga,Jagatsinghpur	8280694625	
18	Bhabagrahi Bhoi	OSSC	At/Po-Fakirabad,Dist-Kendrapada	8895950646	bbhoi1977@gmail.com
19	Dillip Kumar Rout	OSSC	At-Khamarbelarpa, Kendrapada	9938658459	
20	Rajendra kumar Giri	OSSC	At-Taladhananda,Po-Mikhira,Baliapal, Balasore	7894084994	rajendragiri54 @gmail.com
21	Charuchandra Jena	OSSC	At/Po-Baliapal,Balasore	7873426507	
22	Santosh Barik	OSSC		9438322482	
23	Rajkishore Giri	OSSC	At-Gopalpur,Bonth, Bhadrak	9337610328	
24	Narendra Panigrahi	OSSC	At/Po-Chandigaon,Dist-Bhadrak	8895755707	
25	Aswini Mallik	OSSC	Block-Tihidi,Dist-Bhadrak	9439052077	
26	Kartikeswar Nayak	OSSC	At-Nandurasahi,Kaptipada	8917527054	

27	Sukant Bhuyan	OSSC	Block-Ghasipur,Dist-Keonjhar	9937969416	
28	Mamata Jena	OSSC	Anandpur,Keonjhar	7751815269	
29	Rojalin Pradhan	OLM (NGO)	OLM,BBSR	8637287277	rosalin1988pradhan@gmail.com
30	Harekrishna Nayak	Netaji (NGO)	Bhadrak	9438353337	biswambar_sahoo@rediffmail.com
31	Pratap Mohanty	Netaji (NGO)	Bhadrak	9439483532	
32	Jayakrishna Pradhan	Bojb (NGO)	At/Po-Kesarpur,Dist-Nayagarh	9778789409	
33	Srikant Mohanty	Bojb (NGO)	At/Po-Kesarpur,Dist-Nayagarh	9348515598	bojbp_ngo@yahoo.co.in
34	Geetanjali Mohanty	Lutheran (NGO)	IRC Village,N-1-204,Bhubaneswar	8895034855	
35	Sarita Manjari Dash	Lutheran (NGO)	CDA-10,Cuttack	9937497578	
36	Babaji Charan Swain	Pallivikash (NGO)	At-Malanga,Po-Bodal,Via-Naugaon,Dist-Jagatsinghpur	9853054596	pallivikash99@gmail.com
37	Anadi Charan Barik	Pallivikash (NGO)	At-Malanga,Po-Bodal,Via-Naugaon,Dist-Jagatsinghpur	9853640417	
38	Manas Kumar Mahapatra	Sahaya (NGO)	Godipada,Nayagarh	9124637832	
39	Bibhuprasad Nanda	Sahaya (NGO)	Godipada,Nayagarh	9778919503	bibhuprasadngrh@gmail.com
40	Sanjay Kumar Sahu	Rare (NGO)	At/Po-Agalpur,Via-Loisingha,Dist-Balangir	9439144565	
41	Sahadev Sahu	Rare (NGO)	At/Po-Agalpur,Via-Loisingha,Dist-Balangir	9078523045	
42	Mohan Murmu	Sparda (NGO)	Baripada.At-Udala	9438084890	
43	Chaitanya Prasad Mahanta	Sparda (NGO)	Baripada.At-Udala	8895402618	
44	Gokulananda Ojha	Starr (NGO)	Akhupal,Ghatagaon,Dist-Keonjhar	7377720394	gokulanandaojha@rediffmail.com
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46	Suryakanta Swain	Wisdom (NGO)	Puri,Pipili	7991085858	
47	Sisira Kumar Mishra	Swad (NGO)	At-Mulaalasa,Via-Sakhigopal,Puri	9861102298	sisiraswad@gmail.com
48	Srikrushna Mohapatra	Swad (NGO)	At-Mulaalasa,Via-Sakhigopal,Puri	9439029082	krushnaswad@rediffmail.com
49	Pradeep Jena	Aid (NGO)	BBSR	9090223246	jenapradeep0006@gmail.com
50	Tapan Kumar Giri	OLM	BBSR	8908785384	tapan.ouat@gmail.com
51	Bijaya Ram Senapati	OLM	BBSR	7978272757	bijay94@gmail.com
52	Anil Kumar Mishra	OLM	BBSR	9658135692	mishra.anil380@gmail.com
53	Dr.Bibhu Santosh Behera	OLM	BBSR	9583159389	bibhusantosh193@gmail.com
54	Rudraashish Behera	OLM	Keonjhar	9438003177	rudraashish.pm@gmail.com
55	Biswajit Mishra	OLM	BBSR	7008726695	biswajitmishra1006@gmail.com
56	Himadri Tanaya	IRRI Odisha	BBSR	7873619086	h.tanaya@irri.org
57	Sarvesh Shukla	IRRI Odisha	BBSR	7376265234	s.shukla@irri.org
58	Rabindra Moharana	IRRI Odisha	BBSR	7507506074	r.moharana@irri.org
59	Girija Prasad Swain	IRRI Odisha	BBSR	9439778893	g.swain@irri.org
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