RICE REGENERATIVE AGRICULTURE PILOT IN NIZAMABAD

Annual Report
2024-25

DIAGEO
INDIA

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SINCE 2004

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Acronyms

ANNUAL REPORT

Rice Regenerative Agriculture Pilot in Nizamabad, Telangana (2024-25)

1. Executive Summary

Rice is a staple crop for a majority of India's population and occupies 25% of the country's gross cropped area. However, rice is also a water-intensive crop and methane emissions from rice paddies alone contribute to about a fifth of all agricultural GHG emissions in India. (*India BUR 4*, n.d.) In semi-arid states such as Telangana, it is crucial to tackle ecological issues, especially high-water usage, greenhouse gas emissions, the use of synthetic chemicals, and biodiversity decline.

The **Rice Regenerative Agriculture Pilot** in Nizamabad, Telangana, is a collaborative initiative between the Centre for Sustainable Agriculture (CSA) and DIAGEO, India. Its primary goal is to transform conventional rice cultivation into an ecologically and economically sustainable practice. The project engaged **439 farmers across 2,012 acres in 15 villages,** promoting regenerative techniques like System of Rice Intensification (SRI), Alternate Wetting and Drying (AWD), and Direct Seeded Rice (DSR) to reduce environmental impact and improve farmer income. The project emphasized a participatory approach, involving extensive training and awareness sessions, and the establishment of Custom Hiring Centres (CHC) for appropriate machinery to support farmers in adopting new methods.

The adoption of AWD on 2,009 acres led to an average of 30% water savings without compromising yield, based on Kharif-to-Kharif measurements. This, combined with improved residue and fertilizer management, resulted in a reduction in CO2 equivalent emissions per acre during the Kharif season. Nitrogen Use Efficiency (NUE) also improved, with 82% of farmers achieving optimal nitrogen uptake during the Kharif season, compared to a baseline of 42 farmers. The project also fostered soil health and biodiversity through practices like bund planting and green manure crops, and notably facilitated a community-led initiative to prevent stubble burning across over 800 acres.

Several challenges to the adoption of AWD were also observed during the project. The free electricity provided to farmers, as per state policy, encourages borewell use and continuous flooding, providing little incentive for farmers to change their irrigation practices. Adoption of SRI also proved challenging as transplantation was labour-intensive and was affected by low temperatures in Kharif 2024. The availability of inputs also influenced farmers' practices, such as green manuring, where they could not access suitable seed. Recommendations include promoting AWD at a landscape level, providing better market linkages for alternative crops, and continuous awareness campaigns to encourage wider adoption of regenerative practices.

2. Introduction

2.1 Background

Telangana's agricultural landscape has undergone a significant transformation over the past few decades. Before 1997, farming systems in the region were diverse and integrated, combining crop cultivation with livestock rearing. These systems supported food security and ecological balance. However, policy changes and economic incentives gradually encouraged farmers to shift toward input-intensive monocultures, particularly focusing on paddy, cotton, and maize(Hunter et al., 2022).

Since the formation of Telangana in 2014, agricultural production, especially rice, has seen a dramatic increase. Paddy production rose from 68 lakh tonnes in 2014 to over 218 lakh tonnes in 2020–21, driven by enhanced irrigation coverage and procurement incentives (*Socio Economic Outlook 2022*, n.d.). This shift marked a departure from traditional crops like millets and pulses, significantly altering the region's cropping patterns.

2.2. Irrigation Expansion and Cropping Pattern Shift

The expansion of net irrigated area, especially the tripling of tube well irrigation, directly supports the cultivation of water-intensive crops, including paddy, cotton, and maize. Expanded access to irrigation has been driven by massive public investment in irrigation infrastructure and farmer welfare schemes. The Kaleshwaram Lift Irrigation Project (KLIP) has expanded irrigated areas across north and central Telangana (*CAG Report 2024*, n.d.), while Mission Kakatiya, which focused on restoring tanks, added over 20 lakh acres to the irrigated area by 2021. This expansion has led to a shift in cropping patterns from traditional millets and pulses to paddy and cotton (Saritha et al., 2023).

2.3 Groundwater Stress and Sustainability Challenges

While surface irrigation expanded, groundwater remains the primary source of irrigation in many regions, especially during the Rabi season. According to the Central Groundwater Board(CGWB,2022, n.d.), several blocks in districts like Nizamabad, Medak, and Karimnagar are already classified as overexploited. The Composite Water Management Index (*Composite Water Management Index 2019*, n.d.) report found that the number of borewells increased by 20% from 2014 to 2020, particularly in paddy-growing zones, resulting in rapid water declines. As such, sustainable management practices that address these problems are essential for maintaining the region's long-term agricultural productivity.

2.4 Objectives of the Project

In response to these challenges, the CSA, with support from DIAGEO India, launched a pilot project during the 2024–25 crop season. The initiative aimed to evaluate the impact of Rice Regenerative Agriculture on ecological and economic outcomes. The key objectives of the project were:

- To reduce Green House Gas (GHG) emissions (methane, nitrous oxide, carbon dioxide) through adoption of regenerative practices such as AWD, DSR, and SRI
- To prevent stubble burning and promote rice straw composting to reduce particulate emissions and improve soil health
- To reduce agrochemical dependency and to improve soil health
- To enhance farmer capacity on rice regenerative agriculture and community engagement
- To monitor, measure, and document the impact of rice regenerative agriculture

3. Village Profile and Community Engagement

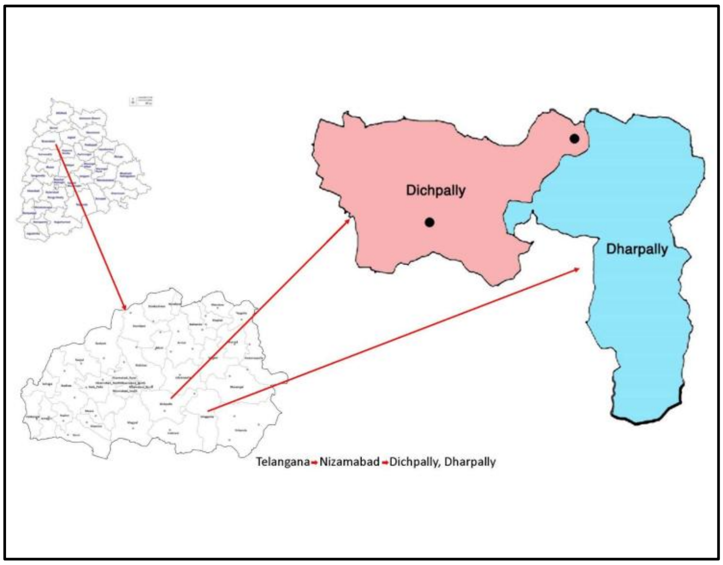

Figure 1 Project Implementation Blocks (Mandals)

In the **Kharif 2024 season**, the project engaged **230 farmers across 12 villages** in Dichpally and Dharpally mandals (blocks), covering a total of **1,054 acres** under regenerative rice cultivation. This effort expanded during **Rabi 2024, reaching 2,021 acres** and involving **211 additional farmers** across a total of **15 villages.** These 15 villages collectively cultivate approximately 20,000 acres of rice annually, and the project's reach of 2,012 acres represents roughly 10% of the total cultivated area. The average landholding size among participating farmers in Nizamabad is approximately 2.27 acres (0.92 ha), indicating a predominance of small and marginal farmers. A portion of this area was brought under AWD, demonstrating strong community interest and adoption of regenerative practices.

Table 1: Project overall reach

Season	No. of Farmers	No. of Villages	No. of Mandals	Area Covered (in Acres)
Kharif 2024	230	12	2	1,054
Rabi 2024 (existing + new farmers)	439	15	2	2012
Total in 2024	**439**	**15**	**2**	**2012**

4. Methodology

4.1 Criteria for Selecting Pilot Locations

The selection of project sites was based on a combination of technical feasibility and community acceptance. Priority was given to mandals that have active Farmer Producer Organizations (FPOs), access to borewell irrigation, and cultivate paddy in both Kharif and Rabi seasons. Proximity to the DIAGEO distillery unit (located in Dharmabad) was also considered to facilitate coordination and monitoring during the project period.

Following a stakeholder consultation workshop held in May 2024 with participation from the Agriculture Department, National Bank for Agriculture and Rural Development (NABARD), and other institutions, Dichpally and Dharpally mandals were proposed as ideal locations.

4.2 Baseline Data Collection

Baseline data for the project was collected in June 2024. The project initially enrolled 228 farmers in the Kharif 2024 season, and an additional 211 farmers in the following Rabi season. From the group of farmers enrolled in the kharif season, surveys were conducted with 42 farmers to assess existing practices, challenges, and knowledge gaps. Of these, 30 farmers were randomly selected and 12 additional farmers were included based on their expression of interest to be included in the program. Data was collected on basic demographic information, farm plot, cultivation practices, yield, and profitability of the farm. During the crop season, we collected all necessary data on the same parameters at the pre-season, mid-season, and post-season stages.

4.3 Green House Gas emissions and Nitrogen Use Efficiency

Impact on GHG emissions was assessed using the Cool Farm Tool (CFT), an online calculator developed by the Cool Farm Alliance (CFA). The CFT is based on empirical models and Intergovernmental Panel on Climate Change (IPCC) Tier 1 and Tier 2 methodologies, and enables the estimation of emissions from on-farm activities, including crop production, fertilizer use, soil management, and energy consumption. It is widely used for assessing the carbon footprint of farms and supply chains, offering a practical and standardized approach for smallholder and commercial farming contexts alike.

In addition to assessing GHG emissions, NUE was also calculated using the CFT to measure how effectively crops utilized the applied nutrients, especially nitrogen. NUE is calculated as the ratio of nitrogen output (the amount of nitrogen contained in the harvested crop yield) to nitrogen input (the total nitrogen supplied through synthetic and organic fertilizers). This ratio indicates how much of the applied nitrogen is actually absorbed by the crop, versus how much is lost to the environment through leaching, volatilization, or runoff.

4.4 Water use and Soil Analysis

Water consumption was estimated by first measuring the irrigation discharge rate, which was measured by calculating the amount of time it took for the water pump to fill a 20-litre can. We then recorded the total number of irrigations applied per field throughout the season as well as the amount of time per irrigation.

For soil analysis, a stratified sampling strategy was implemented across eight villages, selected for their variations in soil type, structure, and colour. Four samples were collected from different locations within each village to ensure comprehensive coverage and to provide an understanding of village-level soil health. These samples were subsequently analysed using the BHU Vision soil testing device, which assessed 16 key parameters, including pH, Electrical Conductivity, Organic Carbon, primary and secondary nutrients like Nitrogen, Prosperous, Potassium, Sulphur and micronutrients & physical properties, to generate a detailed soil health profile. This comprehensive assessment was critical for understanding the specific types and conditions of soils in the project area, allowing for the development of targeted nutrient management strategies, the creation of tailored advisories for farmers (for instance, addressing widespread sulphur deficiencies), and the evaluation of the suitability of proposed agricultural technologies based on local soil conditions.

4.5 Monitoring and Evaluation Framework - Theory of Change

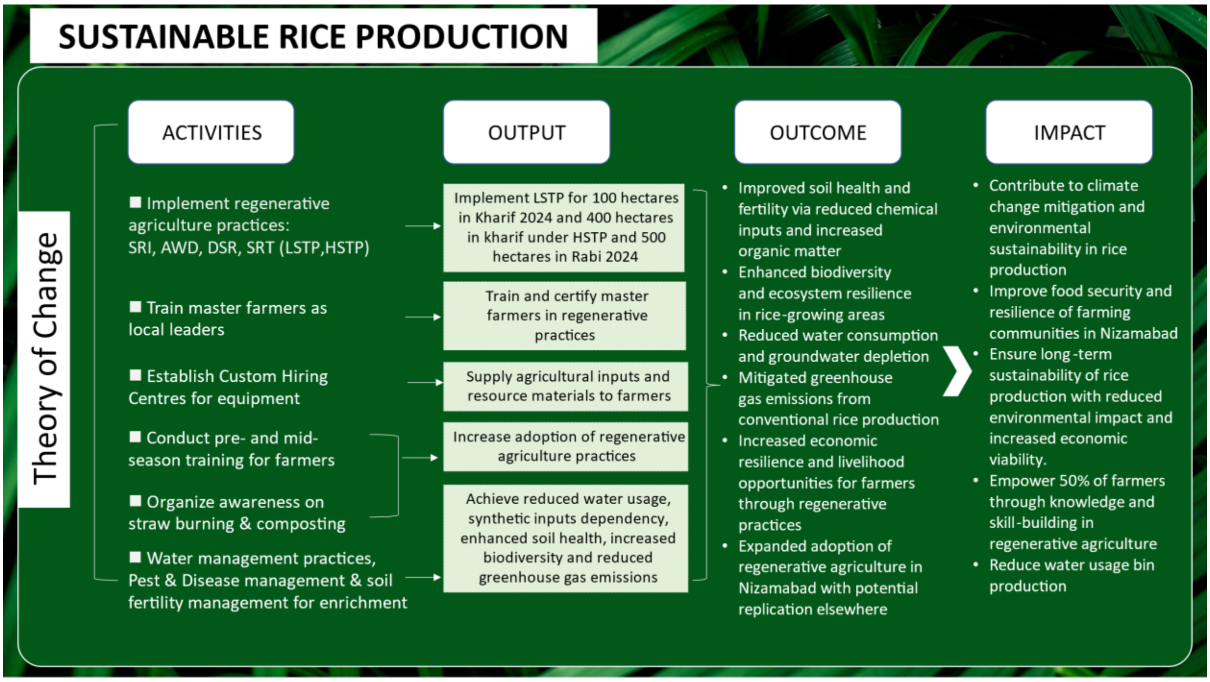

Figure 2: Theory of Change

5. Implementation

5.1 Stakeholders Involved

In May 2024, a start-up workshop was organized with active participation from the Department of Agriculture, Groundwater, and NABARD, Krishi Vigyan Kendra (KVK), local FPOs, and Civil Society Organizations (CSOs). This collaborative initiative successfully united key stakeholders to encourage farmers to adopt regenerative rice cultivation practices. Bringing together multiple stakeholders through such a launch workshop also helped build convergence with other existing programs. With support from NABARD, participating farmers were able to receive support for tree plantations, including guava and mango saplings, vegetable seeds, vermicompost, and neem cakes. These inputs were distributed through Dichpally Farmer Producer Company Ltd and Govindpally Farmer Producer Company Ltd., FPOs that partnered with this project. KVK-Rudrur provided free soil testing and pheromone traps, laying a foundation of trust and demonstrating tangible benefits to farmers for partnering with the project.

5.2 Capacity Building and Training

5.2.1 Awareness and Training Programs

The project adopted a participatory approach that enabled active farmer engagement, hands-on learning, and data-driven decision-making. To strengthen awareness and build local capacities, 64 awareness sessions and 38 training programmes were conducted across the intervention areas. While the initial outreach covered 21 villages to introduce the initiative and gauge community interest, the project was implemented in 12 villages in Kharif (2024) and expanded to 3 more villages in Rabi, making a total of 15 villages. Villages were chosen based on the enthusiasm and willingness of the communities to participate.

Both awareness and training programs covered key regenerative practices such as line transplantation, pest and disease management, bio-input production, effective water usage in rice cultivation, and soil and nutrient management. Over 28 live demonstrations were conducted in fields, covering everything from quality seed selection to the identification of pests, diseases, and nutrient deficiencies, as well as AWD fields, allowing farmers to observe and practice new techniques in real time. These demonstrations played a crucial role in building farmer confidence and encouraging the adoption of regenerative methods.

5.2.2. Tools, Inputs, and Infrastructure Support

To gain a better understanding of the agri-system and farmer needs, soil samples were tested in each village to assess nutrient availability. Farmers were also provided with field diaries and perforated pipes to help them monitor input usage and water levels, to promote a culture of record-keeping and self-assessment.

Additionally, the project established CHCs's at the FPO level to improve access to essential farming equipment such as drum seeders, power weeders, bio inputs, seeds, and training materials. These shared resources reduced the financial burden on individual farmers and supported early adopters in implementing labour-saving and efficient practices, thereby accelerating the shift to regenerative agriculture.

5.2.3. Advisory Services

A season-long advisory service was provided to farmers covering weather, crop, stubble burning, nutrient management, and usage of fertilizers and pesticides. These recommendations were delivered by the extension team through direct field visits, phone calls, and WhatsApp channels. Farmers were also made aware of digital applications for disease and pest identification and recommendations, such as Centre for Agriculture and Bioscience International (CABI) and Pesto scope, an app-based advisory service developed by CSA.

The project also facilitated support for farmers facing agricultural issues or seeking information on schemes through the Kisan Mitra helpline, a farmer helpline run by CSA to provide advisories and to connect farmers to relevant material on government programs.

5.3. Key Intervention Technologies

5.3.1. Alternate Wetting and Drying

AWD is a water-saving technique in rice cultivation where fields are not kept continuously flooded. Instead, water is allowed to drain periodically, and irrigation is given only when the water level drops below a set threshold. This practice conserves water, lowers methane emissions, improves plant health, and helps prevent certain diseases and pests such as Bacterial Leaf Blight (BLB) and Brown Plant Hopper (BPH).

A total of 435 farmers managing 2009 acres adopted AWD, along with reduced use of synthetic fertilisers and pesticides. Perforated pipes were provided to these farmers to monitor water levels in their fields, enabling them to alternate between wet and dry conditions rather than relying on continuous flooding for irrigation. Training provided to farmers suggested waiting till the water level dropped 15 cm before irrigation.

In addition to AWD, all farmers embraced certain 'non-negotiable' practices, including line transplantation, ensuring adequate spacing between rows and plants, and creating an extra gap every 10 feet (or 10-12 rows) for improved air circulation. They also transplanted seedlings that were 22-25 days old and adopted 'tip cutting' (the practice of cutting the top of paddy seedlings before transplanting them into the main field) during transplantation to minimise stem borer infestation.

5.3.2. System of Rice Intensification and Direct Seeded Rice

AWD is primarily a water management technique employed in traditional rice cultivation to reduce water usage and enhance plant health, whereas SRI and DSR are alternative cultivation methods that involve modifications in planting techniques, spacing, and input use.

Among the three practices AWD, SRI, and DSR, AWD had the highest adoption rate among farmers. This is because it involved minimal changes to traditional practices, and farmers perceived lower implementation risks along with immediate benefits such as water savings and reduced pest incidence. Farmers also found AWD easier to adopt, especially with the use of perforated pipes to monitor water levels.

During the Kharif season of 2024, the SRI was implemented on 15 acres, while DSR was piloted on 8 acres. Unfortunately, continuous rainfall during the sowing period affected the DSR plots, resulting in only about 40% plant establishment. SRI, on the other hand, involves transplanting young seedlings at wider spacing, using minimal water, and maintaining aerobic soil conditions. This method showed promising results, delivering good yields while significantly reducing input requirements such as seed quantity.

5.3.3. Biodiversity Enhancement

In an effort to address the ecological and cultural challenges posed by mono-cropping in paddy cultivation, the project introduced a bund cropping model that integrates biodiversity enhancement with cultural preservation and economic enhancement. The initiative engaged 50 farmers and covered approximately 80 acres of land and was implemented in collaboration with KVK - Rudrur in Doosegaon Thanda village, Dichpally mandal.

The intervention involved cultivating *Celosia cristata*, locally known as Setha Jada puvvu, along the bunds of paddy fields. This flower species is well-suited to the high-moisture conditions of paddy fields and does not compete with the main crop, making it ideal for bund cropping. Its introduction brought back floral diversity to the fields, attracting pollinators and beneficial insects, and contributing to ecological balance. The flower also acts as a trap crop, helping to reduce pest pressure on the main crop and thereby lowering the need for chemical pesticides. In addition to its ecological importance, the intervention was designed to generate supplementary income for farmers. Given the cultural significance of Setha Jada in the Bathukamma festival (a floral celebration observed by women during Dusserah in Telangana), the flower holds seasonal market value. The intervention aimed to tap into this demand, offering farmers an opportunity to earn additional income during the Kharif season.

Along with Setha Jada, the project encouraged farmers to grow other crops on bunds for different purposes. **Glyricidia**, a fast-growing tree, was planted by some farmers to improve soil health. It adds nitrogen to the soil and breaks down quickly, acting as green manure. Others cultivated **red gram** to enhance soil fertility and yield an additional harvest. **Vegetables** were also planted by a few farmers to add variety to their diets and for their market value. **Fruit trees** like **drumstick, mango, and guava** were introduced with support from a local NGO (Swati Women Rural Development Society - SWRDS).

6. Results and Impact

6.1. GHG Emission per Acre per Season

Measured at baseline, CO_2 equivalent (CO_2eq) emissions ranged from 1.53 to 5.43 thousand kg per acre, with an average of 2.5 thousand kg per acre. During the Kharif season, emissions declined to an average of 2.0 thousand kg per acre (range: 1.28 to 4.43), reflecting a reduction of approximately 500 kg CO_2eq per acre, or around 20%, compared to the baseline. This indicates a positive impact of improved practices such as better irrigation, residue, and fertilizer management. However, emissions increased again during the Rabi season, averaging about 2.52 thousand kg per acre and exceeding both baseline and Kharif values in many cases. This rise is likely due to greater irrigation demands and input use during the dry season. While a general reduction trend was seen from baseline to Kharif, several cases showed significant spikes in Rabi emissions. A few instances exhibited consistent emission reduction across all three seasons.

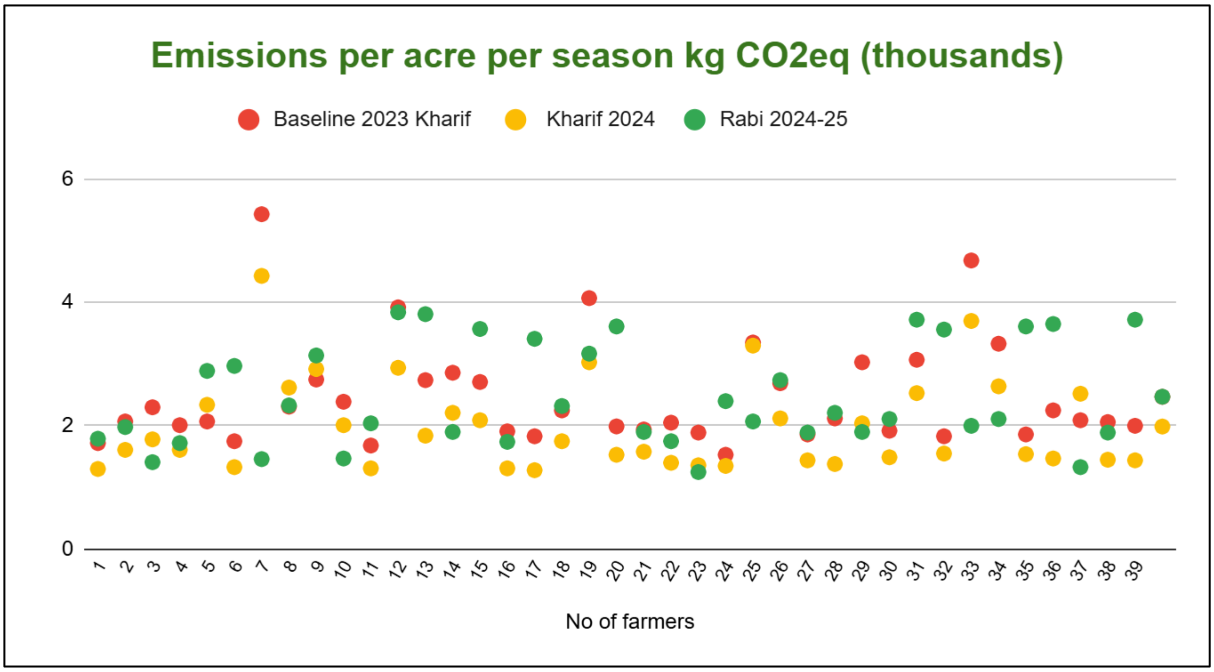

Figure 3: GHG Emissions per Acre per Season in Kg Co2eq (Thousands)

6.2. GHG Emissions per kg Yield

The average reported yield 2832 kg/are at baseline, 2819 kg/acre in Kharif, and 2763 kg/acre in Rabi, showing only marginal variation between the three measurements. In the baseline scenario, greenhouse gas emissions associated with rice production ranged from 0.55 to 1.87 kg CO_2 equivalent (CO_2eq) per kg of rice, with an average of approximately 0.88 kg CO_2eq/kg.

During the Kharif season, emissions were notably lower, ranging from 0.45 to 1.32 kg CO_2eq/kg, with a mean value of around 0.71 kg CO_2eq/kg. This represents a substantial reduction of approximately 0.17 kg CO_2eq per kilogram of rice, corresponding to a decrease of about 19% compared to the baseline average. This reduction highlights improved efficiency in emissions per unit of output, likely due to better water management, reduced fertilizer inputs, and improved residue practices. However, Rabi season emissions rebounded, averaging about 0.92 kg CO_2e/kg and reaching as high as 1.9 kg in some cases. This increase suggests a decline in emission efficiency during the Rabi season, potentially due to higher irrigation requirements due to the lack of rainfall and increased input use, or less effective climate-smart practices.

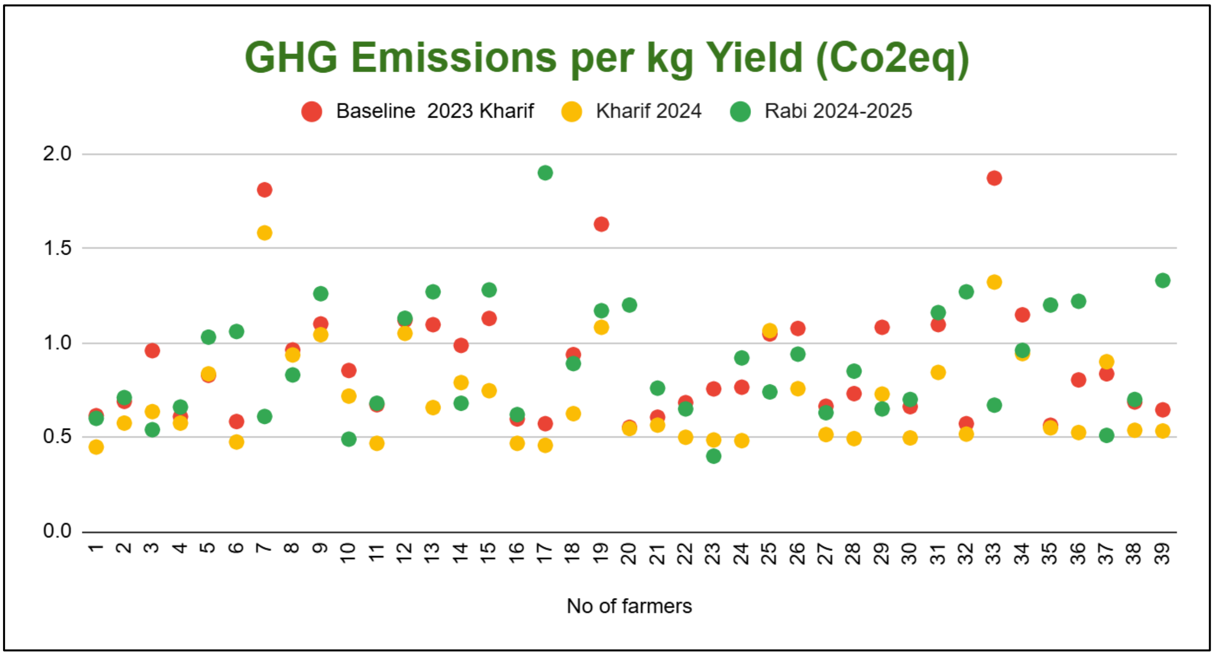

Figure 4: GHG Emissions per Kg yield (Co2eq)

6.3. Chemical Inputs and Enhanced Nitrogen Use Efficiency

During the baseline, 23% of farmers had NUE below 50%, while 64% were in the optimal 50–100% range, and 13% exceeded 100%, indicating possible over-application or inconsistencies in nitrogen uptake reporting. In the Kharif season, NUE improved significantly - only 10% of farmers were below 50%, and 82% were in the optimal range, with no instances of excessive (>100%) NUE, reflecting more balanced and efficient nitrogen management. However, in the Rabi season, NUE performance declined sharply 56% of farmers had NUE below 50%, and only 36% fell within the optimal range, with none exceeding 100%. This drop is likely due to multiple factors, most notably the common perception among farmers that applying more nitrogen leads to higher yields in Rabi, especially under irrigated conditions.

Table 2: Season-Wise Analysis of Nitrogen Use Efficiency in Crop Production

Percentage	Baseline (Kharif 23)	Kharif 24	Rabi 24-25
<50 NUE %	23%	10%	56%
50-100 NUE %	64%	82%	36%
>100 NUE %	13%	0%	0%

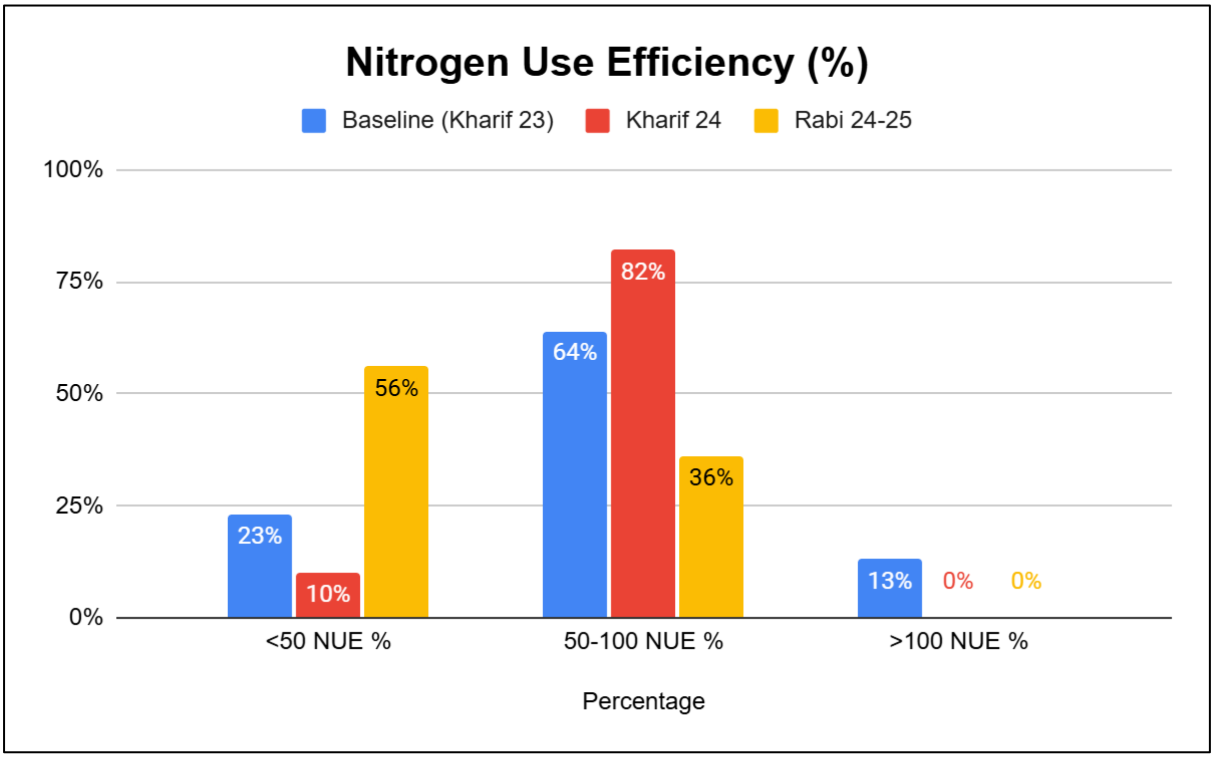

Figure 5: Season-Wise Analysis of Nitrogen Use Efficiency in Crop Production

6.4. Crop Residue Management Through Collective Action

A powerful example of social capital in action was the community-led initiative to prevent stubble burning across more than 800 acres during the post-Rabi production period in the project villages.

The practice of burning rice stubble is prevalent because affordable alternatives for managing residue are not available. This issue cannot be resolved individually, as the fire spreads from one plot to another, making it impossible for any single person to prevent it from spreading. However, by raising awareness and making collective decisions, farmers united to eliminate this harmful practice affecting the soil and environment. This accomplishment was made possible through community-level decision-making and cooperative action. The project team took up efforts to organize community level meetings to increase awareness of the adverse effects of stubble burning on the soil and the environment.

The project succeeded in some areas depending on water availability, resource access, and community acceptance. In Bardipur village, for instance, farmers utilized pond water to incorporate rice straw into the soil and applied microbial decomposers to accelerate decomposition. This approach not only prevented CO_2 emissions but also protected soil health. In total, stubble burning was prevented in Bardipur village (250 acres), Kesaram village (200 acres), Dichpally village (80 acres), and Damannapet (100 acres).

6.5. Water Use and Irrigation Efficiency

The analysis of farmers' irrigation practices across the Baseline, Kharif, and Rabi seasons reveals a notable change in water management following the adoption of AWD. Initially, most farmers irrigated daily or every 2 to 4 days, with each session lasting about 9.5 hours, reflecting unregulated and excessive water use. During the Kharif season, daily irrigation was entirely phased out, and most farmers irrigated every 2 to 3 days or as needed by the crop, lowering the average irrigation duration to 8.9 hours. This marks a positive behavioural shift towards structured water-saving practices. However, in the Rabi season, while the frequency remained similar to Kharif, the average irrigation time increased to 10.2 hours, with some sessions lasting up to 24 hours. This is likely due to total dependence of ground water (not on rainfall), lower groundwater levels in the Rabi season, requiring longer irrigation times.

These findings underscore the success of AWD in reducing frequency, but also highlight the need to optimise irrigation volume to achieve full water-use efficiency. It is essential to note that this is a basic analysis; a more detailed and season-specific assessment, considering soil type, rainfall, crop stage, and water table variations, is necessary to derive stronger insights and support precision irrigation planning for future interventions.

Choice of new technology adoption in the kharif season was evenly split between two techniques. All farmers adopted the AWD practice, but only half adopted line transplanting, ensuring a specific distance between paddy plants. All farmers installed AWD pipes for monitoring water levels. The larger-diameter perforated pipes allowed for easy observation of water levels in the field. Once the water level within the pipe drops to 15 cm below ground level, the fields are flooded again to a depth of about 5 cm as per the crop stage.

6.6. Economic Benefits to the Farmers Through Input Saving and Income

A comparison of farming outcomes across the Baseline (Kharif 2023), Kharif 2024, and Rabi 2024 seasons reveals a notable improvement in farmer profitability, despite crop yields remaining largely consistent.

A major change observed was the decrease in cost of cultivation following the project intervention. Farmers' expenses dropped from an average of ₹25,585 per acre at baseline to

₹20,650 during Kharif and ₹22,582 in Rabi. This decline likely stems from improved agronomic techniques and better input management facilitated by the project. These practices probably involved more timely operations and enhanced access to technical advice, making farming more economical.

Gross income remained relatively stable across all three seasons: ₹62,896 at baseline, ₹62,029 in Kharif, and ₹64,111 in Rabi season, likely because yield remained stable. Despite this, net profits increased from ₹37,310 in the baseline to ₹41,378 in Kharif and ₹41,259 in Rabi. This represents an 11% increase in net profit in Kharif and also in Rabi as compared to the baseline.

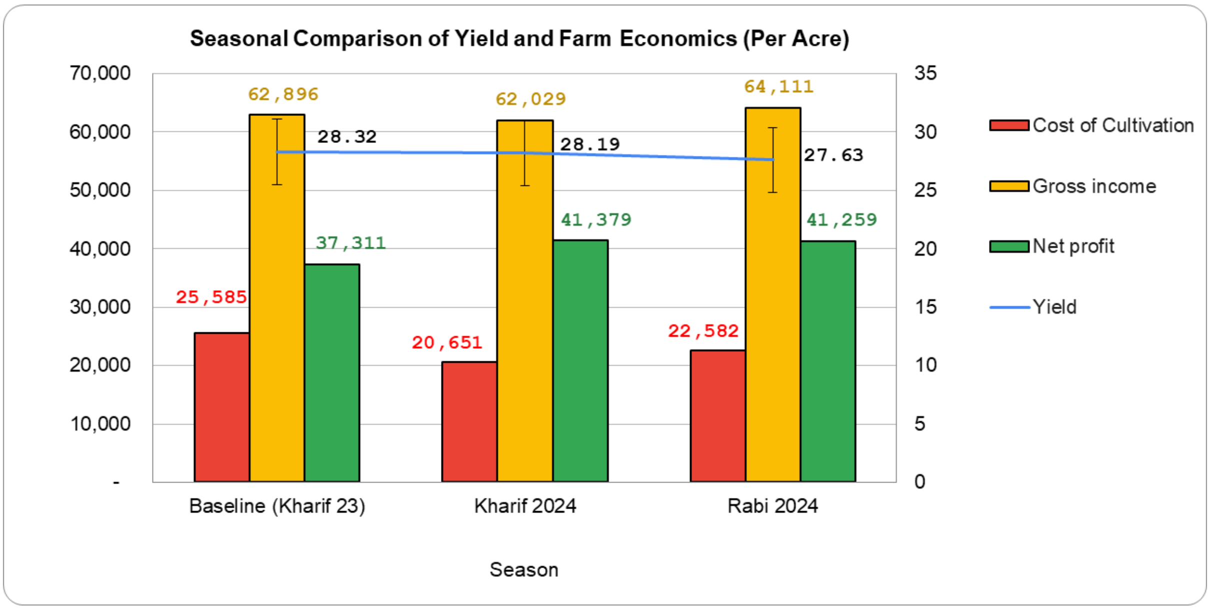

Figure 6: Season wise Yield and Income of the farmers

6.7. Income and Diversification Through Bund Cropping

The bund cropping initiative, especially the cultivation of *Celosia cristata* (Setha Jada puvvu), was a low-risk option for farmers. By using underutilized bunds of paddy fields, they could grow flowers without compromising their main rice cultivation. This strategy enabled farmers to sustain their primary farming activities while exploring new income sources. During the Bathukamma festival, demand for Setha Jada flowers increased significantly, allowing farmers to sell bunches for INR 15 to 30. Many reported earning between INR 6,000 and 10,000 during the season, providing valuable supplementary income during the Kharif season.

The introduction of additional crops such as red gram, vegetables, Glyricidia, and fruit trees like drumstick, mango, and guava further diversified farm outputs. This diversification not only improved soil health and biodiversity but also reduced the risks linked to mono-cropping and market dependence. Since these interventions required minimal investment and maintenance, they provided a safe and scalable model for enhancing farmer resilience and income security.

6.8. Impact On Yield and Productivity

To assess the impact of irrigation practices on rice productivity, a crop cutting experiment was conducted during the 2024 Rabi season. The study aimed to compare the effectiveness of the **Conventional method of irrigation and** with the **AWD** technique.

Six farmers were identified, three practicing conventional irrigation and three implementing AWD. These farmers cultivated adjacent fields. Both the conventional and AWD fields were sown with the same rice variety and followed the same agronomic practices, including land preparation, sowing, fertilization, and pest management.

Each of the six participating farmers managed a 5 × 5-meter plot, with three plots under continuous flooding (conventional) and three under intermittent irrigation (AWD). Data collection involved measuring the number of grains per panicle, grain weight, and straw weight for each plot. These values were used to calculate the total yield and to compare the productivity of the two irrigation methods.

The results of the crop cutting experiment indicated that the **AWD method slightly outperformed the conventional method** in terms of both grain and straw yields. The **average grain yield** under AWD was **20.99 kg per 25 m² plot**, compared to **20.34 kg** under conventional irrigation. Similarly, the **average straw yield** was marginally higher in AWD plots (**22.48 kg**) than in conventional plots (**22.28 kg**). Although the **average number of grains per panicle** was slightly higher in the conventional method (218) than in AWD (210), the greater grain weight in AWD suggests improved grain filling or panicle density under alternate irrigation.

In terms of total yield (grain + straw), AWD again showed a slight advantage, averaging **3397 kg/acre** compared to **3291 kg/acre** under the conventional method. These findings support the potential of AWD as a **sustainable and efficient irrigation strategy** that can maintain or even enhance rice productivity while conserving water. However, few more detailed analyses are required further.

6.9. Social Inclusion Outcomes

A crucial aspect of this project's success was developing social capital with farmers and local departments. We concentrated on fostering relationships among farmers in our target villages through collaborations with local NGOs, FPOs, the local KVK (Rudrur), and government entities.

Frequent field visits and active engagement with farmers, along with the provision of essential services such as access to seeds, bio-inputs, and advisory support, facilitated the establishment of trust in a short period. This robust social capital foundation enabled the project to effectively achieve its goals and make a sustainable impact in the targeted villages.

The project demonstrated a strong commitment to social inclusion by engaging a diverse group of farmers across different landholding sizes. Out of the 439 farmers involved, 23% were small farmers with holdings of 2.5 acres or less, and 54% were marginal farmers owning between 2.5 to 5 acres. This means that over 77% of the participants were from small and marginal farming backgrounds groups that typically face greater challenges in accessing agricultural resources, technologies, and advisory services.

6.10 Pest Incidence and Farmer Perceptions

In addition to lower water consumption and improved profitability, farmers also reported a lower incidence of BPH and BLB, both major pests and diseases in paddy in Nizamabad. Additionally, a slight increase in grains per pinnacle was observed in some areas based on the crop cutting experiments. This will need further investigation to better understand the impact of AWD on crop productivity.

7. Farmer Testimonials

- Before joining the project, I used to burn paddy stubble, unaware of its environmental and soil impact. After CSA's awareness sessions, I stopped burning and noticed improved soil health and better yields. I also used fewer fertilizers and saw more beneficial insects. Encouraged by these results, I spoke with other farmers, and many agreed to stop stubble burning. Together, we now manage stubble naturally, protecting our environment and improving farming outcomes. - *Shri Satish Reddy, A farmer from Bardipur village.*

- I planted Sitha Jada flowers along my field bunds. They attracted beneficial insects and added biodiversity. During Bathukamma festival, the flowers were in high demand, giving me a side income. Bund plantation has now become a regular part of my farming. - *Shri Srinivas, A farmer from Dichpally thanda*

- I adopted the AWD method using pipes provided by CSA. By monitoring water levels, I saw healthier plants, more tillers, and better yields. AWD also helped prevent BPH infestation and reduced BLB. It's an effective method for better crop health and water efficiency. - *Shri. Sai Gopal - A farmer from Govindpally village.*

- As a Community Resource Person (CRP), I've supported farmers in adopting regenerative practices like AWD, DSR, and bund plantations. These methods have improved yields, reduced costs, and promoted regenerative farming. CSA's ongoing training and advisory support have built trust and confidence among farmers. - *Mr. Wesley, Community Resource Person.*

8. Challenges In Programme Implementation

The transition to regenerative rice cultivation is met with several significant obstacles that must be addressed for successful implementation. The challenges range from on farm practices, resource mismanagement and market pressures to knowledge gaps and systemic inefficiencies.

- A key issue is the **free electricity provided by state policy**, which results in widespread water mismanagement and groundwater depletion. This allows farmers to adopt continuous flood irrigation, leading to water wastage, soil degradation, and poses a long-term threat to agricultural viability.
- A significant barrier to progress is the **limited awareness and resistance to adopting regenerative agricultural practices** among many farmers, who are often unfamiliar with sustainable methods like crop rotation, organic inputs, AWD, and composting.
- The shift to new systems is further complicated by the technical **challenges of alternative cultivation methods** like DSR and SRI, which require precise water, weed, and nutrient management that is difficult to achieve with current infrastructure and knowledge gaps.
- Despite its potential to improve productivity and sustainability, scaling the SRI in the project area faced several challenges. The cold wave during the Rabi 2024 season **adversely affected early seedling growth**, leading to poor crop establishment. Labour groups were **hesitant** to adopt early-stage transplanting practices, as SRI involves using younger seedlings (around 14 days old) that are more delicate and require extra care. The method also demands wider spacing and precise planting of only one or two seedlings per hill, unlike traditional bulk transplanting methods. This made the process slower and more labour-intensive, which was less appealing to labourers accustomed to faster techniques. Furthermore, since labourers in the region typically charge on a per-acre basis rather than by hours worked, they preferred conventional methods that allowed quicker completion, making SRI less economically attractive from their perspective.
- Finally, sustainable practices are hindered by **logistical issues related to input supply**, as the inconsistent and untimely availability of green manure seeds, such as Sesbania and Sunn hemp, from government sources makes it difficult for farmers to plan and execute soil enrichment strategies effectively.

9. Mitigation Strategies

To address the challenges encountered during the implementation of regenerative rice practices, particularly AWD, SRI, and crop residue management, the following mitigation strategies are proposed:

9.1 Strengthen AWD Adoption Through Landscape-Level Planning

AWD adoption can be significantly enhanced by implementing a landscape-level approach, where contiguous farms coordinate their irrigation schedules in other regions. This collective strategy allows for synchronized water management, maximizing water savings and reducing methane emissions. FPOs can play a key role in facilitating this coordination, ensuring that water release and irrigation practices are aligned across farms.

9.2 Enhance Farmer Capacity and Confidence

Building farmer confidence in AWD requires continuous capacity-building efforts. Season-long training programs should cover water budgeting, pest management, and soil health. Field demonstrations and farmer-to-farmer exchange visits can showcase successful AWD practices, helping farmers understand the benefits and encouraging wider adoption through peer learning.

9.3 Address Groundwater Challenges During Rabi Season

Groundwater stress during the Rabi season poses a major challenge to rice cultivation. To mitigate this, promoting short-duration rice varieties and crop diversification during Rabi can reduce water dependency and improve resilience against water scarcity.

9.4 Integrate AWD with Other Regenerative Practices

AWD should be implemented alongside complementary regenerative practices to maximize its impact. Bund cropping, green manure application, and composting can enhance soil fertility and reduce input costs. Providing farmers with bund planting kits and microbial decomposers will support in-situ residue management and reduce the need for stubble burning, while improving overall farm health.

9.5 Prevent Stubble Burning Through Community Action

Stubble burning remains a major environmental concern. To address this, community-level awareness campaigns should be organized to educate farmers on its harmful effects. Collective action strategies, such as village-level agreements to eliminate burning and shared use of pond water and microbial decomposers for residue incorporation, can be highly effective.

10. Policy Recommendations

10.1. Promote A Landscape-Level Approach to AWD Implementation

To enable large-scale adoption of AWD in Telangana, especially in canal-irrigated regions, a landscape-level approach should be adopted. This involves coordinated water management across contiguous farms, supported by FPOs or water user associations. By aligning water release schedules and enabling collective decision-making, this approach can overcome individual-level constraints and ensure effective implementation of AWD. Pilot projects in command areas should be initiated with state facilitation, showcasing demonstrable water savings, yield retention, and reduced emissions to build farmer confidence.

10.2 Reform Power Subsidies and Strengthen Water Governance

The availability of free electricity for agriculture has encouraged water-intensive practices, such as continuous flooding in paddy fields, which contributes to groundwater depletion and soil degradation. To support the shift toward AWD, power subsidy reforms should be linked with water-saving outcomes by the government. Strengthening groundwater governance through participatory water budgeting and localized monitoring will ensure accountability and promote responsible water use.

10.3. Support Transition Through Capacity Building and Infrastructure

Despite its demonstrated benefits, AWD adoption remains low due to technical complexity and limited farmer awareness. The government should invest in intensive capacity-building efforts, including field demonstrations, hands-on training, and integration of AWD into KVK advisory programs. Providing farmers with simple, low-cost tools such as field water tubes can support accurate water management.

10.4. Diversify Cropping Systems and Strengthen Regenerative Practices

AWD should not be promoted in isolation but as part of a broader transition toward sustainable and diversified cropping systems. Current over-reliance on paddy, even in unsuitable agroecological zones, reduces resilience and increases vulnerability to pests and soil degradation. Policies should incentivize the inclusion of pulses, vegetables, and agroforestry species on field bunds and during off-seasons. This will improve soil fertility, reduce input dependency, and provide alternate income streams. Moreover, improving the timely availability of regenerative inputs such as green manure seeds will enhance the effectiveness of soil health restoration strategies alongside AWD.

10.5 Foster Behaviour Change Through Collective Action and Social Mobilization

Adoption of AWD requires not only technical know-how but also behavioural change. Regular awareness campaigns, participatory workshops, and experience-sharing platforms should be institutionalized to shift farmer mindsets and overcome resistance to change. Collective action initiatives, such as community-led prevention of stubble burning and promotion of composting, can reinforce environmental stewardship and strengthen the social fabric needed for sustained adoption of regenerative practices, including AWD. Village-level champions and progressive farmers should be recognized and supported to serve as peer educators and demonstration leaders.

11. Annexures

11.1. An article on the cultivation of Celosia cristata in Rice Bunds:
https://drive.google.com/file/d/1yjjYU3er1K1gqW_1jsPDOxoWD9dhq9L2/view?usp=sharing

11.2. A case study on “How farmers stopped stubble burning”:
https://drive.google.com/file/d/1l1NMa0a7GshcHSQJj1lDT96RHE_fACYh/view?usp=sharing

11.3. A documentary on “The Harm Caused by Crop Residue Burning: Ways to Protect Soil and the Environment." in local language:
https://youtu.be/HJRs9CxXqb4?si=jtCcYLLVic3l2DZF

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13. Photographs

Figure 8: Start-up workshop organized with multi-stake holders

Figure 9: Interaction with the farmers in fields

Figure 7: Night trainings on AWD at villages

Figure 12: Perforated pipe installation in the AWD fields

Figure 15: Seed sowings through Wet DSR

Figure 11: Floriculture crops in rice bunds

Figure 10: Building social capital with the farmers

Figure 14: Using waste decomposers for incorporating straws in to the soils

Figure 13: Prevention of stubble burning in rice fields through direct incorporation

Figure 22 : Awareness meetings with the farmers on AWD

Figure 20: Awareness meetings with the farmers on Regenerative Agriculture

Figure 21: Preparation of concoctions for pest control

Figure 19: AWD with Line transplantation

Figure 16: Crop cutting experiments

Figure 18: Azolla preparation in large scale

Figure 17: Saplings transplantation through SRI technique