Intensifying rice-based cropping systems through mechanically sown pulses with layered agronomy can improve income and support household nutritional security: Evidence from Odisha

Rice-fallow system is very prominent in Odisha due to many biophysical and socioeconomic constraints. In the rainfed rice-based ecology of Odisha, monsoon rains have been consistently weak and unevenly distributed. This induces delayed and unsynchronized establishment of rice in the main *'Kharif'* season, causing lower yield and unfavorable conditions for the next crops. This along with other biophysical and socioeconomic constraints has led to many fields in '*Rabi*' (dry) being left fallow by farmers after the *kharif* rice harvest.

Pulses are the major crops after rice cultivated in a limited area in *rabi* season without much care so far as inputs use and better management practices followed are concerned, resulting in poor grain productivity. CSISA in Odisha prioritizes intensifying and diversifying rice-based cropping system for higher system productivity and many other outcomes through precision/ mechanized Direct Seeded Rice (DSR) in Kharif and then mechanized sowing of potential *rabi* crops (pulses and oilseeds), both layered with high performing hybrids/varieties and tailored agronomy (best management practices).

As a piece of evidence, this article briefly narrates the story of a farmer who with technical support from the CSISA team cultivated green gram in *rabi* 2021-22 and reaped very inspiring results. CSISA reasons that these ground results will further motivate other farmers, service providers and stakeholders to adopt and/or popularize the technology (mechanized sowing) and high performing varieties in Odisha and eastern India.

Improved practice leads to system-level productivity and profitability

Farmer Lingaraja Ratha in his field with green gram (MH421) cultivated with improved practices

Mr. Lingaraja Ratha, aged 71 years, is a smallholder from Srikanthpur village in the Puri district. In his nearly 45 years in agriculture, Mr. Ratha has experience in adopting many technologies, new varieties, and best management practices (BMPs), particularly in the last few decades. He has practiced both traditional and modern technologies but is very critical and selective in adopting a particular technology or variety. CSISA project team has introduced mechanical transplanting of rice (MTR) in many districts of Odisha. Ratha has also tried MTR in his fields. And whatever mechanization Ratha has adopted in his field is through the custom hiring service provision. Ratha, because of this believes, "custom hiring service model is so effective that farm mechanization in the entire district is not too far!"

Mr. Ratha had once, along with some other farmers, tried mechanized sowing of pulses in 2016. But they could not adopt it after that due to the region's lack of quality seed drills and crop varieties. After thoroughly discussing with the project team that visited his farms in 2021, he cultivated green gram in his field. When the project team approached him later to conduct a demonstration on the mechanical sowing of green gram in his field, Mr. Ratha enthusiastically agreed.

Soon after the harvest of *Kharif* rice in 2021, several decisions were taken by the project team well ahead with Ratha's active contribution to land preparation, selection of green gram varieties, sowing dates, etc. After the rice harvest, the soil moisture was retained for 3-4 weeks, and the window was optimally used for clearing the fields, land preparation, and sowing. Arrangement of seed, tractor, seed-cum-fertilizer drill/multi-crop planter (fitted with inclined seed metering system) and execution of needful field operations were managed by the farmer with the technical support (machine calibration, seed treatment, seed rate, fertilizer dose, etc.) and logistical support (seed and seed drill arrangements) rendered by the project team.

The Cereal Systems Initiative for South Asia (CSISA) is a regional initiative to sustainably increase the productivity of cereal-based cropping systems, thus improving food security and farmers' livelihoods in Bangladesh, India and Nepal. CSISA works with public and private partners to support the widespread adoption of resource-conserving and climate-resilient farming technologies and practices. The initiative is led by the International Maize and Wheat Improvement Center (CIMMYT), implemented jointly with the International Food Policy Research Institute (IFPRI), the International Rice Research Institute (IRRI), and the International Water Management Institute (IWMI) and is funded by the US Agency for International Development (USAID) and the Bill & Melinda Gates Foundation.

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Only changes adopted in the improved practice over the traditional/farmer's practice:

- Varieties like MH421, HUM16, Virat, and Shikha were adopted instead of the earlier used local variety called *Bolagada*.
- An eleven-tine multi-crop seed-cum-fertilizer drill was used for line sowing (row-to-row distance 25-30 cm spacing, depth 5 cm) of green gram with a seed rate of 20 kg/ha against the earlier practice of 30 kg/ha. The standard sowing method earlier (in the control field) was broadcasting.
- The use of Di-Ammonium Phosphate (DAP) was increased from the farmer's practice of 25 kg/ha to 75 kg/ha in the improved method. DAP was drilled along with the sowing basal application. In the farmer's practice, Muriate of Phosphate (MoP) was not used. But in the improved practice, 17.5 kg/ha of MoP was applied for the first time.
- Most importantly, in none of the practices was irrigation applied. In conditions where irrigation is a significant problem, mechanized sowing in residual soil moisture condition can help farmers significantly.
- In the farmer's practice no weed management was adopted. But in the improved practice, weeds were managed chemically (Quizalofop-ethyl (Turga super 5% EC) 1 l/ha as POE at 20-25 DAS).

It is estimated that the total cost of cultivation (cost per unit area) of green gram cultivated through farmer's practice in a controlled field (extensively) and improved practice in demo field (intensively) in rabi 2021-22 was USD 288/ha and USD 391/ha respectively. A 36% rise in the cost of cultivation is seen because of better agronomy and rising prices of inputs and services. However, when the cost of production (cost per quintal of produce) is estimated, the figure is USD 196/ton in improved practice, much lower than that from farmer's practice (USD 461/ton) – a decrease of 57% in the cost of production. Mechanized sowing layered with improved seed and tailored agronomy resulted in a very high grain yield. There is a yield advantage of 1.36 tons/ha through improved practice over the farmer's traditional practice (improved practice 1.99 tons/ha and farmer's practice 0.63 tons/ha). The yield estimation was made through mass crop-cutting experiment (CCE) events with the participation of officials and farmers. Farmers from neighbouring villages and within were apprised by the team of the practices in the demonstration field to increase yield and profit sustainably over farmers' practice.

Mechanically sown pulses with layered agronomy

Farmers motivated by increased income generated by the improved practice of packages

Ratha and all farmers and other stakeholders present at the site during the CCE activity were surprised to see such a high and unexpected yield from the demonstration fields. Because of premium quality, the grain fetched higher demand and hence higher prices over the local variety. The farmer also mentioned that many farmers wanted to use the new improved varieties for seed purposes, for which they never hesitated to purchase at higher prices. The calculated gross income from the green gram cultivation from one hectare of land and through improved practice came to USD 1889, a 300% rise over farmer's practice. Similarly, the farmer with improved practice derived a massive profit of USD 1499/ha, against USD 184/ha from the farmer's practice.

"This was beyond imagination. I've never seen such a substantial difference in any crop." L.Ratha

This intensive cultivation of green gram also added a reasonable sum to the household income. The additional gain is being used to buy agricultural inputs and services he could not afford earlier. Ratha also said the family had kept more grain for their consumption this time. This has added nutritional value to the family's diet as green gram is rich in protein and fibres. The annual income of the household has also increased because of this green gram cultivation, according to Ratha. It was estimated that Ratha could gain an additional yearly income of USD 2551 due to green gram cultivation in an improved method. The improved practice of green gram cultivation was found economically viable with a higher benefit-cost ratio (BCR). The BCR in farmers' practice (1.64) was much lower than the improved practice (4.84). This increase in farmers' income through the practice of green gram cultivation, needs to be popularized. Farmers of the village and nearby areas have expressed interest in adopting it at scale.

The land, farmer, agro-climatic condition, etc., were the same. Still, the mechanically sown improved variety of green gram with a few simple management practices changed the outputs without additional irrigation. In the mind of all farmers and stakeholders who witnessed the advantages of this package of practice recommended by the project team, it made a strong impression.

Expanding the adoption of improved green gram cultivation practices under the DSR-Odisha CSISA project

The green gram cultivation, as demonstrated in *rabi* 2021-22 through the DSR Odisha project, has been such a success that it generated so much interest from farmers like Ratha to continue next season and for others to follow. The farmers have realized the substantial monetary gain and better food and nutritional choices for the household through this improved practice. However, on a large scale, challenges remain against adoption. There is some gap in the availability of appropriate multi-crop planters and improved varieties. These gaps, if bridged with technical support from expert agencies or other stakeholders, can lead to mass adoption of the technology generating immense benefits for the household and fallow land development.

Toward this, an inclusive approach of solid coordination between the government (through policy intervention), research and development institutes (for technology and technical support), private companies (for machine/input/output market engagement), along with the farmers' participation could support the implementation of this "model" – and other models like the business model for custom hiring services, seed production models, improved varieties in formal seed systems, diversified system/ crop sequencing, etc. – to popularize the mechanized line sowing technology at scale.