



Koraput is one of the poverty-stricken pockets of southern Odisha state in India with 83% population living below the poverty line as compared to the statewide figure of 47%. As per the 2011 Census, Koraput District has a population of 1,379,647, of which males and females are 678,809 and 700,838, respectively. Just over half are scheduled tribe population. Located in the Eastern Ghats region between 17° 40' and 20° 7' north latitude and 81° 24' and 84° 2' east longitude, the District lies at altitudes varying from 1500 MSL to 3000 MSL. The climate is warm with mean minimum temperature of 5.8 degrees Celsius in December-January and mean maximum temperature of 35 degrees Celsius during May. The monsoon starts usually from 2nd week of June and continues until the end of September.

The average annual rainfall is 1,567 mm (based on measurements of the last 5 years). Out of this, 75% is received from June to September, 13% is received from October to February, and the rest is received from March to May. The District has a total geographical area of 837,930 ha, of which cultivable land is 301,000 ha (36%), with irrigated area in kharif season of 78,000 ha (9.3% of total area) and irrigated area in rabi season is 46,000 ha (5.5% of total area). Net sown area is around 215,248 ha, with cropping intensity of 113%.

Smallholders' Agriculture Practices in Koraput

Koraput District has a total of 353,367 households according to the Census, out of which 42% are small and marginal farmers. The 58% of households who are landless are dependent on



Government revenue lands or forest lands and do share cropping for their livelihood. The major crops grown by the farmers are paddy followed by finger millets, pulses, maize, and other small millets for food security. Out of the total cultivable land area (301,000 ha), the area under paddy cultivation is 113,000 ha (37.5%). Ragi is cultivated on 74,300 ha, another 24.7%. Paddy and ragi are the major crops grown and are the main staple food of local people.

A majority of the cropped areas are unirrigated, rainfed uplands which constitute around 63% of total cropped area. During kharif season, the small and marginal farmers here cultivate mixed crops, i.e., upland paddy, ragi, and ragi with oilseeds, pulses and small millets, to have multiple crops to harvest for their food basket.



Historically, the tribal communities of Koraput have been known for their self-sufficiency through crop diversity, conservation agriculture, and eco-friendly practices. However, irregular and erratic monsoon cycles and lack of irrigation facilities along with resource degradation have affected their crop cycles and productivity. Over the years, fragmentation of land holdings and diversion of agricultural land into commercial plantations have further marginalised smallholders. Most of the farming families face food-insecure periods of 5 to 6 months, and hence migrate out to earn their living during lean agriculture season.

Ragi: A Major Food Crop, Existing Practices

Ragi, a staple food grain for the rural population of Koraput District, has been cultivated here for thousands of years. It is one of the most nutritious of all the major cereal crops, a rich source of calcium, iron, protein, and fiber, having high levels



of methionine, an amino acid that is lacking in the diets of poor people who depend on starchy foods. The cereal has low fat content and contains mainly unsaturated fat. Its carbohydrates are reported to have the unique property of slower digestibility and can be regarded as food for long sustenance. The people grind ragi to make flour they consume as gruel as part of their daily

diet, or it is prepared as a kind of local bread mixed with jiggery, also used for preparation of different dishes.

Tribal farmers continue to cultivate ragi, both as a sole crop and also mixed with other millets, pulses, oil seeds through practices that are very traditional. They use a seed-broadcasting method with little attention to nutrient and weed management. Both men and women



actively participate in finger millet production. Women are mostly involved in weeding, harvesting, threshing, and post-harvest grain cleaning and processing. Nearly 80% of farmers have marginal land holdings, less than 1 ha; and mostly they use their farm-saved seeds for growing finger millet, indicating the importance of seed recycling at the farm or village level. Finger millet fodder is considered superior to other straw, especially rice, for livestock feed. Due to the use of traditional practices in millet farming, the yield is as low as 4 quintals/ha (400 kg/ha) in broadcasting method, which is mostly done in the uplands. Even with traditional transplanting methods in the medium lands, yield of ragi is only 9 quintals/ha (900/ha).

Composition of finger millet:

- Moisture - 13.4 %
- Protein – 7.6 %
- Carbohydrate- 74.36%
- Fibre - 1.52%
- Minerals – 2.35%
- Fat - 1.35%
- Energy - 341.6 cal/100g

Ragi is quite resilient to varied agro-climatic conditions, however, and tolerant to climatic stresses. Earlier, the District usually experienced 150 to 187 days of monsoon rain, with average annual rainfall of 1655 mm. But over the last five years, the average number of rainy days has been reduced to 84 days, and the



annual rainfall is about 1567 mm, which has also impact on agriculture, the crop cycle, crop diversity and productivity. Additionally, the District is also experiencing recurrent disasters like drought and flash floods, and there were cyclones in the last two years. With such climatic adversity, the systems of rice intensification and ragi intensification have proved to be resilient and beneficial for small and marginal farmers, by increasing productivity, reducing costs of cultivation, and tolerating climatic stress.

Experiences in System of Rice Intensification



System of Rice Intensification was pioneered by Pragati in Koraput District starting with demonstrations with 11 small farmers in kharif season 2006. The success of one farmer, Dibakar Jani, who harvested a yield almost 4 times more in comparison to traditional methods, had a striking impact that motivated Pragati as an organisation to scale up the technology, and also small farm holders started adopting the SRI principles to address their food insecurity.

The experience of more yields with less investment was the driving force for Pragati to scale up the practice to all 14 blocks of Koraput District from 2008 onwards through a network of local NGOs, supported by **Sir Dorabji Tata Trust, Mumbai**. The technology is popularized through video disseminations, wall paintings, posters, skill trainings, demonstrations in farmers' fields, and felicitations and awards for successful/innovative farmers. In the on-going journey for scale-up of SRI, farmers have enriched the technology through their observations and innovations.



The successful demonstrations have created ripples at the policy level, and the Government of Odisha has assigned Pragati the task of demonstrating 'an SRI village' in Koraput District that will cover 50 farmers cultivating SRI on 50 acres of land. NABARD has also come forward to support Pragati for its Seed Village Programme using

SRI principles. Farmers clubs have been organised to create fraternity among the SRI practitioners, with platforms created for cross learning among the farmers through block, district-level workshops, annual district-level symposiums, systematically engaging in dialogue with PRIs, line departments and agencies like NABARD.

The experiments and successful demonstrations by the small and marginal farmers in the remote tribal areas of Koraput District have drawn the attention of researchers, agriculture scientists and international promoters of SRI. Prof. Norman Uphoff, Professor Emeritus of Government and International Agriculture and Senior Advisor, SRI International Network and Resources Centre (SRI-Rice), at Cornell University had visited field areas in Koraput in 2008 and addressed a district-level symposium where 500 SRI practitioners have participated. There has also been an opportunity for the farmers to interact with Dr. Erika Styger, Director of Programs for SRI-Rice at Cornell, who has visited our field areas in 2011 and heard the experiences of farmers, and also gave suggestions which have been quite inspiring for the farmers.



The technology has spread to 11,304 small and marginal farmers, now SRI practitioners, who have gradually increase their average area of cultivation, putting 7,162 acres of land into SRI. SRI has increased productivity, contributing to additional 3-6 months of food for the small and marginal farmers who have less than 1 ha of land. We are also involved in action research with the support of Livo-link Foundation that has helped in documenting and establishing the package of practices best suited to the geo-climatic condition of our areas.

The Step Ahead: Demonstrating Finger Millet (Ragi) Intensification



High calcium and carbohydrate content of finger millet make it a highly nutritious traditional cereal for infants, children, and for the sick. Its small seed size deters pests, and its grains can be stored for over 10 years without significant deterioration. Yet, the cultivation of finger millet, a traditional subsistence staple grown in dryland areas, is declining due to changing farming systems and low productivity. Improved practices in cultivation of finger millet can enhance production and fetch additional income

for the small farm holders by sale of a surplus, since ragi as a food crop has started moving onto the urban plates due to its nutritional value.

The success of the System of Rice Intensification motivated Pragati in kharif 2010 to demonstrate its principles for finger millet with 5 farmers in Raising village of Nandapur Block on small patches of land (0.1/0.2 decimal each). The demonstrations were quite successful as the yields from the small



patches were almost double those of traditional methods. The next year, i.e. in Kharif 2011, 11 farmers were motivated to do Ragi Intensification in 0.5 acre each, and one of the farmers, Bijaya Muduli, decided to go for Ragi Intensification on 2 acres land. He could harvest 21 quintals of ragi, double the amount that he got with traditional methods (10-11 quintals). Other farmers also got almost double increase in yield. The success of these demonstrations had a great impact on the

farmers of the locality, who could see the crops in the field.

The Experience of Bijaya Muduli, a Finger Millet Farmer of Raising Village

“In Kharif 2011, I started doing System of Ragi intensification in a small patch with technical support from Pragati field staff. The input provided by Pragati was technical support and a roller weeder. Although I was already doing SRI paddy, I had doubts whether ragi can be done the same way. I became confident after my first trial, however.



“I continued in 2012 in 1 acre of land, and in Kharif 2013, I did 4 acres of land this way. I used 2 kg seeds, transplanted 15 day-old seedlings, with two types of spacing, i.e., 25x25 cm and 30x30 cm. I wanted to observe the differences in tillering and yield.

“There was an average of 24 tillers per plant hill, the highest was 66 and the lowest was 17. There were more tillers in the field with 30 cm x 30 cm distance. My farmer friends envied me when they used to see my ragi field. I got 26.52 quintals/per ha, whereas with traditional methods I used to get 9 quintals/ha. In the context of irregular monsoon cycles and rainfall patterns, I have observed that Ragi Intensification is more preferable than the traditional method of seed broadcasting or transplanting. Besides, meeting my own consumption needs, I had got surplus to sell,” says Bijaya.

Package of Practices Followed in System of Ragi Intensification

We have developed a package of practices for System of Ragi Intensification, the other SRI, based on our field-level observations and on results of demonstrations with farmers. The package of practices is easily adaptable by the farmers as farmers have contributed their own observations and experiences in developing the POP.

- **Variety and seed rate:** Use indigenous variety. The seed rate 0.5 kg per acre, compared to 4.0 kg/acre in conventional transplanting method. The broadcasting seed rate is much more.
- **Seed treatment:** Brine water treatment is done for separation of chaffy grains from the good seeds. After brine water treatment,



the selected seeds are again washed with normal water. Seed treatment done by using medicinal pot manure or *Bijamrita*. The procedure for making *Bijamrita* is given below.



- **Nursery raising:** Raised nursery bed is prepared by mixing soil and compost in a 2:1 ratio. After sowing, 15 kg of vermi-compost/powdered FYM is spread over the bed in a thin layer and covered with straw. Then the seedbed is watered once in a day by rose-cane. After 10-12 days, seedlings become ready for transplantation. Farmers have also transplanted seedlings 15-18 days old and have observed an

increase in yield.

- **Land preparation:** The land should be ploughed thoroughly three to four times. Compost and de-oiled cake are applied during the land preparation.
- **Transplanting:** Transplanting is done with seedlings still at the two-leaf stage with mass of soil kept attached to the root. Single seedlings are transplanted with a spacing of 25 cm x 25 cm. If soil is less fertile, 20cm x20 cm spacing is also made. A rope marker is used for spacing.



- **Weeding:** First weeding is done within 20 days after transplanting with a roller weeder (see left). A second weeding is done manually with a hoe as the soil is hard (due to the upland). Tillering is greater in response to timely weeding and because there is better aeration in the hard soil due to use of roller weeder. Farmers are also using the roller weeder for weeding their vegetable and groundnut fields.

- **Pest and nutrient management:** Farmers in the areas do not use any chemical fertilisers and pesticides. Besides use of cow dung compost and farmyard manure, we have promoted organic nutrient management practices like pot manure, Jiba mruta, vermi compost, vermi wash and pest control measures like use of medicinal pot manure, neem oil solution, fish amino acid etc. We have observed that ragi intensification is not at all vulnerable to pest and diseases due to the use of organic practices. Further, farmers have started nutrient management in ragi which was not done earlier except use of small doses of farm yard manure.
- **Water management:** Since farmers in our areas are doing ragi in rainfed uplands in the kharif season, there has been no need or opportunity of water management.

Increased Adoption of System of Ragi Intensification



Knowledge of the System of Ragi Intensification has started spreading to more farmers and more villages and to blocks beyond Nandapur since kharif 2012. 75 farmers of the Raising, Bheja and Golluru Gram Panchayats in Nandapur Block had adopted Ragi Intensification in kharif

2012. As the number of farmers increased and weed management was observed to be a key constraint, we have introduced roller weeders with the support from SDTT's SRI Project and from Trocaire's Community Development Project.

In kharif 2013, 143 farmers of 21 villages of 5 blocks have adopted Ragi Intensification on 119 acres of land. Ragi Intensification is adopted most quickly by farmers in Nandapur block areas, i.e., 121 farmers covering 104 acres in 13 villages. Starting with demonstrations in small patches, these farmers have gradually expanded their area and even some farmers who were doing maize have started practicing Ragi Intensification.



As a strategy of extension, Pragati organised a 5th District-Level Symposium on SRI in 2013, held in Raising Gram Panchayat with an objective to highlight this System of Ragi Intensification. The District

Collector, Koraput, attended the programme and felicitated the progressive farmers. Researchers, NGOs involved in SRI promotion, line department officials, Panchayati Raj representatives, and media representatives all



participated in the event to encourage the farmers. 400 SRI practitioner-farmers from different blocks of Koraput District participated in the programme to share their successes, innovations and also challenges.

Crop-cutting was done in the ragi field of one farmer, and the results were presented for dissemination among the farmers and participants. There were an average of 28 tillers per plant hill, the highest being 39, and

the yield calculated was 26.52 quintals (2.652 tons) per ha. The same land and soil with traditional

method have produced yields of 9 to 11 qnt per ha in the same geo-climatic situation. The event had a very good impact on farmers, and these SRI practices have now spread to farmers in all the 14 blocks of Koraput District.

Comparison between SRI and traditional methods of finger millet cultivation (per acre)		
Description	Traditional method	SRI method
Seed reate	4-5 kg	0.5 kg.
Seed selection and seed treatment	Not done	Treatment with cow urine, and/or <i>Bijamrita</i> , discussed below
Nursery seedbed	No bed, done in a part of the land	Raised bed by mixing soil and compost in 2:1 ratio
Transplanting	Broadcasting/transplanting 35/40 days old seedlings	Seedlings of two-leaf stage (12-15 days old) with mass of soil attached to the root
Plant spacing	Irregular	25x25 cm. in square pattern, If soil is less fertile 20x20 cm spacing is also made.
Weeding	Manual weeding, no specific time; in case of broadcasting in upland, no weeding is done	1 st weeding after 20 days of transplanting with a roller weeder; 2 nd weeding done manually by hoeing
Water management	No need of water management since cultivation is done under rainfed conditions	No need of water management since done in rain fed conditions
Tillers per plant hill	1 to 2	8-12 on an average
Fingers per tiller	3-4	7-9
Stems	Thin	Thick
Roots	Quite shallow	Deeper, > 1 ft. into the ground
Yield per hectare	4 quintals/ha - broadcasting in uplands. 9 quintals/ha -traditional transplanting	22.5 quintals/ha, on an average Maximum recorded 47.50 quintals per hectare

Experiences of Kharif 2014

As the learnings and experiences of farmers are disseminated, System of Ragi Intensification is becoming more adaptable by the farmers. Though the farmers found it a bit labour-intensive in the beginning, it was worth of investment as the yield has substantially increased. Further, the utilisation of roller weeders has



helped for better weed management,



and at the same time it has reduced drudgery for women farmers. In 2014 Kharif, we have been able to scale up Ragi Intensification to reach out to 1,215 farmers covering an area of 824 acres. We have been able to establish convergence with Agriculture Department for

mobilisation of 300 roller-weeders at subsidised prices, which has catered to the needs of 600 farmers. Farmers have used local seeds, and we have promoted 7 varieties of indigenous seeds which range from 90 days to 120 days for maturity.

The average number of tillers per plant hill has been 8-12, the minimum recorded is 8 and the maximum is 47. The average production recorded is 22.5 quintals (2.25 tons) per hectare, and the maximum yield was 40.80 quintals (4.08 tons) per hectare. The crop cutting results done in one of the farmers field in Nandapur Block showed an average of 39 tillers per plant hill; the highest was 47, the lowest was 29, and the yield recorded was 40.80 qnt/ per ha. One of the key observations has been that the SFMI ragi crop could survive the hazards of the cyclone Hudhud in 2014 which occurred in Odisha in October 2014, whereas the traditional ragi crop was swayed by the wind and damaged.

Learnings & Observations

The beauty of the practices adopted by the farmers is that all these lands are rainfed, mostly uplands and medium lands without any irrigation facilities. There has been a huge reduction in seed rate. With traditional methods of broadcasting the farmers used 8 kg of seed per acre, and in traditional transplanting they used 4-5 kg seed per acre, whereas with intensification methods they are using only 0.5 kg of seeds. Due to the preparation of raised beds for nursery, the seedlings are protected from heavy rains, and transplanting is easier with seedling roots intact.



The farmers have transplanted 12-15-day old seedlings and have used rope markers to transplant in lines. The spacing of 25x25 cm is maintained; with 20x20 cm spacing on less fertile lands. The farmers have observed that due to transplanting of

young seedlings, mechanical weeding and spacing, there is healthy growth of the plants and more tillering, leading to increase in yield. In some fields farmers have maintained a spacing of 30x30 cm, in the more fertile lands, and there is a greater number of tillers, with increased yield. Farmers in these lands have harvested 45-47 quintal (4.5-4.7 tons) per ha. The average number of tillers has been 8-12 which farmers had never seen in any ragi plant before, and also there has been profuse tillering recorded in some fields, i.e.,



66 and 71 tillers in one plant hill, which has been an unprecedented experience for the farmers. The crop-cutting results from various fields and locations taken over a period of 3 years has established that the average yield recorded so far is 22.5 quintals (2.25 tons) per ha, the highest being 47.5 quintals (4.75 tons) per ha.



Farmers have started nutrient management in ragi, which was not done earlier except for use of cow dung compost and farmyard manure on a much smaller scale. Now the farmers are using pot manure, vermin-compost and *Jibam ruta* for nutrient management, and also pest control measures like spraying with neem oil solution, medicinal pot manure, etc. Use of the roller weeder has reduced drudgery in weeding, and the farmers have even started using the same with their



vegetable crops. Farmers have also made their own innovation for weeding, i.e., ploughing (doing inter-cultivation between rows) by tying the mouths of bullocks.

Harvesting is easier for farmers, they say, as they only need to cut the grains and can leave the straw for composting in the field so it can increase soil fertility. Besides, the straw is also used as fodder. Farmers have also observed that the crops have been more resistant to climate adversities like irregular

monsoons, and also their crop encountered less setback from the recent experience in Koraput with the cyclone that hit Odisha state in October 2014. The principles of SRI have now been extended to other crops like pulses (pigeon pea) and vegetables.

Comparative Cost-Benefit Analysis – Traditional vs. SRI Methods of Ragi Cultivation

Calculations are based on per acre use or costing						
Components	Unit	Price per unit (INR)	Traditional methods		SRI methods	
			No. of units	Cost (INR)	No. of units	Cost (INR)
Seed(if purchased)	Kg	30	5	150	0.5	15
Seed selection and seed treatment (using <i>Bijamruta</i>)*	Lump sum	30	0	0	1	30
Nursery preparation	PD	150	0	0	0.5	75
Seed and nursery preparation				150		120
Ploughing for field preparation	Rent per unit	100	4	400	4	400
Labour	PD	150	2	300	2	300
Marking & transplantation	PD	100	2	200	3	300
Field preparation				900		1000
Farmyard manure	Cub	500	3	1500	3	1500
Vermi-compost	kg	10		0	60	600
Pot manure (<i>Handi Khata</i>)*	Lt.	10		0	20	200
Inorganic fertilizer	kg	36	10	400		0
DAP	Kg	40	15	600		0
Nutrient management				2500		2300
Irrigation	No need since grown in kharif season					
Weeding	Per day	150	15	2,250	8	1,200
Cost of roller weeder		1000	1			1,000
Weed management				2250		2200
Chemical and pesticides	Lump sum	200	1	200	0	0
Labour	Per day	150	2	300	2	300
Rent of sprayer	Lump sum	100	1	100	1	100
* See recipes below				600		400

Plant protection						
Harvesting	Per day	100	12	1,200	8	800
Threshing and packaging	Per day	150	14	2,100	20	3,000
Harvesting costs				3,300		3,800
Total operational costs	Total			9,700		9,820
Management costs (10% of total)	Lump sum			940		702
Total cost of production				10,640		10,522
Value of production	INR	20/kg	400	8,000	900	18,000
Net profit	INR			-2640		7478
Production cost per kg of ragi				26.6		11.7

This cost-benefit analysis is reasonably self-explanatory as regards traditional vs. SRI method of ragi cultivation. It is based on the practices adopted by the farmers in the field areas where the farmers are practicing traditional as well as intensification methods of ragi cultivation.

Bijamrita

Ingredients: Cow dung – 5 kg; Lime - 50gm; Water - 20 litres, Cow's urine - 5 litre, A handful of soil

Process: 5 kg of cow dung is bound tightly in a piece of cotton cloth and kept in 20 litres of water for 12 hours. 50 gm. of lime is added to one liter of such water and kept overnight. Next morning, the liquid in the bundle of cow dung is squeezed into a bucket, so as to collect a concentration of cow dung. A handful of soil is added to this liquid solution and stirred. Then 5 litres of cow urine and lime water is added, stirring all together. This solution is called Bijamrita, which can be used for seed treatment.

Handi Khata:

Ingredients; Cow dung - 1 Kg., Cow urine - 5 litres, Neem leaves - 1 kg; Karanja leaves (*Pongamea pinnata* 1 kg.; Arakha (*Calotropis zygantia*) leaves - 1 kg; Jaggery - 50 g; A handful of termite soil.

Process: Grind all the leaves and mix all the ingredients in an earthen pot/drum, then cover it and keep it in a dark place for 7 days. Extract the liquid from the pot after 7 days and dilute it with water. Use 40-50 litres of water per litre of the liquid for mature plants, and 60 times freshwater water for younger plants. On every 7th day thereafter, keep adding cow urine to the leftover solid material, to be able to use it over the period of next 4 months.

Farmers Voices from the Field:

Name of Farmer: **Dambu Gunjia**, Village – Gadiagumma, Block: Nandapur, Koraput

"I was astonished to discover that Ragi Intensification has more than doubled the yield of my land. I got support from field staff of Pragati to follow the package of practices for Ragi Intensification in my 1 acre of land.

"My wife was opposed to the idea at first, and did not cooperate. However, I managed to do it on my own. I used a roller weeder, which made my work easier for weeding. There was an average of 32 tillers per plant hill, 42 being the highest. By using

only farmyard manure and pot manure, I have harvested 19 quintals of ragi, whereas I harvested only 9 quintals in traditional method of transplanting. I have got enough yield for my household consumption this year," says Dambu.



Name of Farmer: **Dayanidhi Khora**, Village – Maliput, Block: Nandapur, Koraput



“I have got a bumper crop by following SRI principles in Ragi. It was simply unbelievable for me as well as to fellow farmers that a single plant can produce 47 tillers. I have harvested 16 quintals of ragi from one acre of land, where I used to get only 6 quintals in traditional transplanting.

“During the cyclone in October 2014, most of the paddy and ragi fields in my area were affected as the plants were blown down due to heavy winds. But my SRI ragi fields could survive the fury of the cyclone. The robust

plants could resist the storm, and therefore my family can have enough ragi for consumption this year.”

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