Koraput is one of the poverty stricken pockets of South Odisha, India with 83.81% population living below the poverty line as compared to the state figure of 47%. As per the 2011 Census, Koraput District has population of 1,379,647 of which male and female are 678,809 and 700,838 respectively and 50.66 % are Scheduled tribe population. Located in Eastern Ghats regions between 17° 40' - 20° 7' North latitude and 81° 24' - 84° 2' East longitude, the district lies at an altitude varying from 1500 MSL to 3000 MSL. The climate is warm with mean minimum temperature of 5.8 degree Celsius in Dec-Jan and mean maximum temperature of 35 degree Celsius during May. Monsoon starts from June 2nd week and continues till September end.
The average annual rainfall is 1567 mm (based on statistics of last 5 years). Out of this 74.64% is received from June to September, 12.90% is received from Oct- Feb and the rest 12.46% is received from March-May. The district has a total Geographical area of 8, 37,930 ha out of which cultivable land is 3, 01,000 ha (35.92 %) with irrigated area (Kharif) of 78,000 ha (9.30% of total geographical area), irrigated area (Rabi) 46,000 ha (5.48% of total geographical area) of land. Net sown area is around 215,248 ha with cropping intensity of 113.35%.

Small holders Agriculture practice in Koraput:

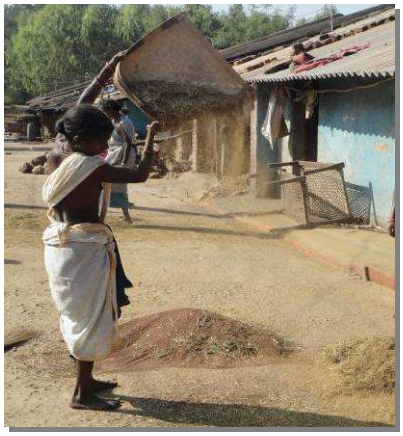
Koraput District has total 3, 53,367 households, out of which 42 % are small and marginal farmers, 58 % of households are landless who are dependent on Government revenue lands, forest lands, and do share cropping for their livelihoods. The major crops grown by the farmers are paddy followed by finger millets, pulses, maize and other small millets for food security. Out of total cultivable land (3, 01,000 ha), area under paddy cultivation is 1, 13,000 ha (37.54%) and ragi is cultivated in 74,300 ha, thus paddy and ragi are the major crops grown and also the staple food of the local people.

The major part of cropped areas are unirrigated ,rain fed uplands which constitute around 62.65% of total cropped area, where during Kharif season the people grow mixed crops i.e. up land Paddy/Ragi, Ragi with Oil seed, pulses and small millets so that the small and marginal farmers can harvest different crops, the components of 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, lack of irrigation facilities along with resource degradation have affected crop cycles and productivity. Over the years fragmentation of land holdings and diversion of agriculture land to commercial plantations have further marginalised the small holders. Most of the farming families face 5 to 6 months of food insecure periods and hence migrate out to earn their living during lean agriculture season.

RAGI- A major food crop, Existing practices

Ragi is a staple food grain for the rural population of Koraput District and has been cultivated for thousands of years. It is one of the most nutritious of all the major cereal crops, is a rich source of Calcium, Iron, Protein, Fiber and have high levels of methionine, an amino acid 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 and consume as gruel, a part of their daily diet, prepare a kind of local bread mixed with jaggery and also used for preparation of different dishes.



The tribal farmers continue to cultivate ragi, both as a sole crop and also mixed with other millets, pulses, oil seeds though the practices are very traditional, following 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 and also finger millet fodder is considered superior to other straw, especially rice. However, due to the traditional practices in millet farming, the yield is as low as 4 qnt./ha in broad casting method which is mostly done in the uplands and even in traditional transplanting method in the medium lands, yield of ragi is 9 qnt/ha.

Ragi is proving to be quite resilient to varied agro-climatic conditions and tolerant to climatic stress. Earlier, the District experienced 150 to 187 days of monsoon rain with average of 1655 mm annual rainfall. But over a period of last five years, the average number of rainy days has been reduced to 83.9 days and the annual rainfall is about 1567 mm which has also impact on agriculture, crop cycle, crop diversity and productivity. Besides, the district is also experiencing recurrent disasters like drought and flash floods and the recent cyclones since last two years. In such climatic adversities, system of rice intensification and ragi intensification has proved to be tolerant and beneficial for small and marginal farmers by increasing productivity, reduced cost of cultivation and tolerant to climatic stress.

Nutritional values of Finger Millet:

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

Experiences in System of Rice Intensification:

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

The experience of more yields with less investment was the driving force for Pragati to scale up the practice to all the 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 farmer's field, felicitation 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 had created ripples at policy level and the Government of Odisha has assigned Pragati the task of demonstrating SRI village in Koraput District covering 50 farmers in 50 acres of land. NABARD has also come forward to support Pragati for Seed Village Programme using SRI principles. Farmers clubs have been organised to create fraternity among the SRI practitioners, 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; Senior Advisor, SRI International Network and Resources Centre (SRI-Rice), Cornell International Institute for Food, Agriculture and Development (CIIFAD) had visited the field areas in Koraput and addressed a District level Symposium where 500 SRI practitioners have participated in 2008.It has also been an opportunity for the farmers to interact with Dr. Erika Styger, Director of Programs, SRI International Network and Resources Centre (SRI-Rice) from Cornell University, who has visited our field areas ,heard the experiences of farmers and also gave suggestions which has been quite inspiring for the farmers.

The technology has spread to 11,304 small and marginal farmers, now SRI practitioners, gradually increasing the average area of cultivation putting 7162 acres of land into SRI. SRI has increased productivity contributing to additional 3-6 month of food for the small and marginal farmers having less than one ha of land. We are also involved in action research with 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 make finger millet 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, finger millet, a traditional subsistence staple grown in dry land 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 surplus, since ragi as a food crop has started moving to the urban plate due to its nutritional value.

The success in System of Rice Intensification has motivated Pragati to demonstrate the principles in Finger Millet with 5 farmers in small patches of land (0.1/0.2 decimal each), in Kharif 2010 in Raising village of Nandapur Block. The demonstrations were quite successful as yield recorded from the small patches was almost double in comparison to the traditional method. The next year i.e. in Kharif 2011, 11 farmers were motivated to do Ragi Intensification in 0.5 acres each and one of the farmers, Bijaya Muduli decided to do ragi intensification in two acres land. He could harvest 21 qnt of Ragi, almost double the amount in comparison to the yield he got in traditional method (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.

Experience of Bijaya Muduli, Finger millet farmer of Raising Village

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

I continued in 2012 in one acre of land and in Kharif 2013, I did in 4 acres of land. I used 2 kg seeds, transplanted 15 days old seedlings, with two types of spacing i.e. 25 cmx25 cm and 30 cmx30 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 when they used to see my Ragi field. I got 26.52 qnt/per ha, where as in traditional method I used to get 9 qnt /ha. In the context of irregular monsoon cycles and rainfall pattern, I have observed that Ragi intensification is more preferable than the traditional method of seed broadcasting or transplanting. "Besides, my own consumption, 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 based on our field level observations and results of demonstrations with farmers. The package of practices are also easily adaptable by the farmers as well as farmers have also contributed their observations and experiences in developing the POP.

- **Variety and seed rate:** Indigenous variety. The seed rate 0.5 kg per acre, compared to 4.0 kg/acre in conventional transplanting method.
- **Seed treatment:** Brine water treatment done for separation of chaffy grains. After brine water treatment, the selected seeds are again washed with normal water. Seed treatment done by using medicinal pot manure/Bijamrita.

- **Nursery raising:** Raised nursery bed prepared by mixing soil and compost in 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 seed bed is watered once in a day by rose-cane. After 10-12 days seedlings become ready for transplantation. Farmers have also transplanted 15-18 days seedlings and observed increase in yield.
- **Land preparation:** The land should be ploughed thoroughly three to four times; compost and de-oiled cake are applied during land preparation.

- **Transplanting:** Transplanting is done with seedlings of two-leaf stage with mass of soil attached to the root; Single seedling is transplanted with a spacing of 25 cm x 25 cm. If soil is less fertile 20cm x20 cm spacing is also made. Rope marker is used for spacing.
- **Weeding:** First weeding is done within 20 days after transplanting with a roller weeder. Second weeding is done manually by hoeing as the soil is hard (due to the upland). Tillering is more die to timely weeding and also 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 ground nut fields.

- **Pest and Nutrient management:** Farmers in the areas do not use any chemical fertilisers and pesticides. Besides use of cow dung compost and farm yard 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 rain fed uplands in Kharif season, there has been no need of water management.

Increased Adoption of System of Ragi Intensification:

The knowledge of System of Ragi Intensification has started spreading to more farmers, more villages and blocks beyond Nandapur since Kharif 2012.75 farmers of 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 problem, we have introduced Roller weeders with support from SDTT- SRI Project and Trocaire, Community Development Project.

In Kharif 2013, 143 farmers of 21 villages of 5 blocks have adopted ragi intensification in 119 acres of land. Out of this, Ragi Intensification is adopted largely by farmers in Nandapur block areas i.e. 121 farmers covering 104 acres in 13 villages. Starting with demonstrations in small patches, farmers have gradually expanded their area and even some farmers who were doing maize, have started doing ragi intensification.

As a strategy of extension, Pragati had organised the 5th District level Symposium on SRI in Raising Gram Panchayat in 2013 with an objective to highlight system of ragi intensification. The District Collector, Koraput attended the programme and felicitated the progressive farmers. The Researchers, NGOs involved in SRI promotion, line Department officials, Panchayati raj representatives and media representatives participated in the event to encourage the farmers. 400 SRI Practioner 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 was an average of 28 tillers per plant hill, the highest being 39 and the yield calculated was 26.52 quintal per ha. The same land and the soil in traditional method, produces yield of 9 to 11 qnt per ha in the same geo-climatic situation. The event had a very good impact on the farmers as the practice has 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	4/5 kg	0.5 kg.
Seed Selection and seed treatment	Not done	With cow urine, Bijamrita
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 with mass of soil attached to the root, 12-15 days old seedlings
Plant spacing	Irregular	25 cm x 25 cm. in square pattern, If soil is less fertile 20cmx20 cm spacing is also made.
Weeding	Manual weeding, no specific time, in case of broad casting in upland no weeding is done	1st weeding after 20 days of transplanting with a roller weeder. 2nd weeding manually by hoeing
Water management	No need of water management since done in rain fed 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 Ha	4 qnt/ha - broadcasting in uplands. 9qnt/ha -traditional transplanting	22.5 qnt/ha on an average Maximum recorded 47.50 qnt per ha

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 is 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 reducing drudgery of women farmers. In 2014 Kharif, we have been able to scale up Ragi Intensification to reach out to 1215 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 need 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.

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 qnt/per ha, and the maximum yield being 40.80 qnt/ha. The crop cutting results done in one of the farmers field in Nandapur Block shows an average of 39 tillers per plant hill, the highest is 47, lowest 29 and the yield recorded was 40.80 qnt/ per ha. One of the key observations has been that the crops could survive the hazards of the cyclone Hudhud 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 practice adopted by the farmers is that all these lands are rain fed, mostly uplands and medium lands without any irrigation facilities. There has been huge reduction in seed rate. In traditional method of broadcasting the farmers used 8 kg of seed per acre and in traditional transplanting they used 4-5 kg seed per acre, where as in intensification method they are using only 0.5 kg of seeds. Due to preparation of raised bed for nursery, the seedlings are protected from heavy rains and transplanting is easier with seed roots intact.

The farmers have transplanted 12-15 days old seedlings and used rope marker to transplant in lines. The spacing maintained in 25cmx25 cm, in less fertile lands 20cmx20 cm. spacing is maintained. The farmers have observed that due to transplanting of young seedlings, 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 fertile lands and there is more number of tillers with increased yield. Farmers in these lands have harvested 45- 47 qnt/per ha. The average number of tillers has been 8-12 which the farmers had never seen in any Ragi plant and also there have been profuse tillering recorded i.e. 66 and 71 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/ per ha, the highest being 47.5 quintals /per ha.

Farmers have started nutrient management in Ragi, which was not done earlier except use of cow dung compost and farm yard manure in very smaller scale. Now the farmers are using pot manure, vermi compost and Jibamruta for nutrient management and also pest control measures like spraying of neem oil solution, medicinal pot manure etc. Use of Roller weeder has reduced drudgery in weeding and even the farmers have started using the same in their vegetable crops. Farmers have also made their own innovation for weeding i.e. ploughing by tying the mouth of bullocks.

Harvesting is easier for them as they only cut the grains and leave the straw for composting in the field which can increase soil fertility. Besides, the straw is also used as fodder. Farmers have also observed that the crops have been resistant to climate adversities like irregular monsoons, and also the recent experience with cyclone that hit Odisha 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 method of Ragi cultivation

Comparative Cost-benefit analysis for cultivation of Ragi- Traditional vs. SRI method (per acre)						
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 Jibamruta)	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**
Farm yard manure	Cub	500	3	1500	3	1500
Vermi compost	kg	10		0	60	600
Pot manure(Handi Khata)	Lt.	10		0	20	200
Inorganic	kg	36	10	400		0
DAP	Kg	40	15	600		0
Nutrient management				**2500**		**2300**
Irrigation	**No need since grown in Kharif**					
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
Plant Protection				**600**		**400**
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**		**11.69**

This Cost benefit analysis is 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 practice traditional as well as intensification method of ragi cultivation.

Jibamruta:
Ingredients: Cow dung: 5 Kg., Lime: 50gm, Water: 20 litres, Cow urine: 5 litre, 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 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 ltr. , Neem leaves- 1 kg, Karanja leaves(*Pongamea pinnata* - 1 kg., Arakha (*Calotropis zygantia*) leaves- 1 kg. , Jaggery: 50 gm., 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 of 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, and did not cooperate. However, I managed to do on my own. I used a Roller weeder, which made my work easy for weeding. There was an average of 32 tillers per plant hill, 42 being the highest. By using only farm yard 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 bumper crop by following SRI principles in Ragi. It is simply unbelievable for me as well as 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 were affected as the plants swayed down due to heavy winds, but my ragi fields could survive fury of the cyclone. The robust plants could resist the storm and my family can have enough of ragi for consumption this year."

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