Introduction

Odisha is predominantly an agricultural state with a cultivated area of 90.54 lakhs ha and average production of 25.44 million tons. Koraput district comes under Eastern Ghats high land type agro-ecological zone. The district enjoys tropical climate characterized by hot summer (20.5°C to 38°C), cold winters (12 °C to 29 °C) and rainy seasons (19 °C to 28 °C). The winter season generally commences from late November and continues up to the end of February. The summer season commences from March and continues till middle of June. It is observed that about 80% of the total annual rainfall takes place due to south-west monsoon between the middle of June and mid-October. The north east monsoon gives erratic and insufficient rainfall. The average annual rainfall varies between 1320-1520mm (Figure 2 & 3). Although the district is having high rainfall, the number of rainy days is restricted to 70-80 days/ annum. The district is drought prone because of the erratic and uneven pattern of rainfall. The entire Koraput district has a unique physiographic set up. Except the north western and west-west central part, the rest of the district is occupied by dense forest with highly rugged mountains, interspersed with intermundane valleys. The total geographical area is 8,807 Sq. Km. The population of Koraput district as per 2011 census 1,379,647 of which male and female were 678,809 and 700,838 respectively with the schedule caste population is 196540 (14.2.%) and schedule tribe population 697583 (50.6%). The literacy percentage of the district is 49.29 as against 72.9 of the state. Population density is 157/km². The proportion of district population to the Odisha state population is 3.29%, Sex Ratio (Per 1000) 1032: 999. The total cropped area is about 3.56 lakh ha out of which 1.53 lakh ha (43.0% of TCA) is irrigated and 2.03 lakh ha (57.0% of TCA) is under rain fed area. The main sources of irrigation are canals, rivers, farm ponds, dug wells to net sown area of the district. Among the different crops, cereals accounts for 54.5% of the irrigated area followed by other crops (34.6%), coarse cereals (4.7%), horticulture & plantation (2.9%), pulses (2.5%) and oil seed crops (0.7%). The primary
source of income is from Agriculture whereas secondary source from agriculture labourer and daily wages. *Kharif* is the major cropping season where farmers cultivate cereals, millets and pulses. In *Rabi* season few pulses crops, oil seed crops and vegetables are being cultivated and majority of the farmers migrated in search of wage labourer both within the district and outside the district. The majority of farmers hold less than one hectare of land in the district and generally practice subsistence farming. Rice is the major crop cultivated in the district in *Kharif* and also in *Rabi* where irrigation facilities available. Traditional farm practices are followed in upland resulting in low level of production. In the non-agriculture season NTFP like *kendu leaf*, tamarind, *Mohua* and *Sal* seeds are the source of income. Koraput was recognized as a Globally Important Agricultural Heritage Systems (GIAHS) by FAO in 2012 for the efforts of the community in biodiversity conservation, food security, preserving the traditional wisdom and cultural diversity of the region for the benefit of the present and future generations (Figures 4-6).

![Figure 1: Hari Sukia in his finger millet field of KMR-204.](image1.png)

![Figure 2.](image2.png)
"I used to cultivate paddy, ragi, little and foxtail millet, niger in my small patch of land following traditional broadcasting method. I used to apply farm yard manure during intercultural operations and do manual weeding for once. I never follow any other package of practices. The usual yield I get from finger millet is 3 to 4 quintal per acre. When I learnt about transplanting of finger millet, I was bit scared. Finally, I accepted their suggestions and tried in 0.5 acre. I was surprised to see the result. I got more than 10 quintal from this half acre. I and my husband both are very happy to know that we topped in the state in finger millet production. I will collect good quality seeds and follow this practice in coming years and also teach the same technique to other farmers."

- Hari Sukia, millet farmer
Figure 6: Use of Cycle Weeder in Finger millet field.

Koraput is a tribal dominated district in Odisha consisting of more than 70% small and marginal farmers and 83% of population live in Below Poverty Line (Anonymous, 2013). The most dominant tribes in this proposed operational area are Bhumia, Gadaba, Paroja and Kandha. Subsistence farming still remains their main source of livelihood, supplemented by forest collection and earning wages [1]. The tribal income is mainly based on agriculture and forest products. The per capita income of the district is Rs 25161/annum (source: Odisha Economic Survey 2014-15). Though the district is rich in biological resources, experienced & hard working farming communities, existence of Women Self Help Groups and the standard of living is quite low due to poor farm productivity, lack of village level small scale industries, low level of technological know-how and lack of market knowledge. Foreseeing the sustainable yield in finger millet, M. S. Swaminathan Research Foundation launched a project on “Enhancing Production and Productivity of Millets and Pulses in Odisha through an Alternative Seed System Model for Production and Supply of Improved Seed Varieties” with support from Department of Agriculture & Food Production, Govt. of Odisha and Govt. of India under the scheme Rastriya Krishi Vikash Yojana (RKVY) in April 2018. The project was executed in 13 villages of Umuri, Mastiput, Padampur and Lankaput Gram Panchayat in Koraput district involving around 750 farmers. The project introduced new technology like System of Millet Intensification (SMI) and line transplanting. Participatory Varietal Selection was conducted with six traditional varieties and five improved varieties of finger millet. The farmers observed that among all the varieties cultivated, KMR-204 performed better in terms of no. of productive tillers, size of panicle, fingers per panicle, grain filling percentage and grain yield (Figures 7 & 8).

Figure 7: IPM training on Finger millet.
Materials and Methods

Hari and Gori used to cultivate finger millet in one acre of land following traditional practices. They used to follow broadcasting method. Weeding also was a very tedious task for them. They used to harvest 2.5 to 3.0 quintals from it. During last Kharif MSSRF implemented the seed production programme in the village. They were trained on various improved agronomic practices and System of Millet Intensification (SMI) method of cultivation such as - land preparation, FYM application, seed treatment, raised bed nursery preparation, transplanting in SMI method, organic manure and bio pesticides preparation and application, use of cycle weeder for weeding etc. Shri and Smt. Sukia were provided with 500 grams of breeder seed of KMR-204 variety to cultivate in half acre land. Initially they were little bit scared [2]. So, they decided to try in half acre and the rest half acre they cultivated their own variety Bati Mandia following traditional method. They followed all the recommended agronomic practices stated above and also followed organic way of cultivation. They also prepared NPM like Amrut jal, jeebamrut, handi kahata etc. and applied in their millet field in every 15 days interval after weeding using cycle weeder which helped in plant growth and controlling pests and diseases (Figures 9 & 10).
Study Design

A case study

Study Location

Machhara village of Koraput block, Koraput District, Odisha, India

Duration of study

June 2018 to December 2019

Results and Discussions

Despite the un-conducive weather condition during last kharif season, the crop performed very well. There were productive tillers in a range of 8 to 25 per hill. An average finger per panicle was around 9 which is higher than that of other farmers cultivating same variety (Table 1). Hari and his wife were very happy and surprised to see the crop performance of the new improved variety in comparison to her own traditional variety. They yielded 3.4 quintals/ acre from their own variety of bati mandia following traditional practices and 20.55 quintals/ acre from the improved variety i.e. KMR-204 following SMI method and improved cultivation practices (Table 2 & 3). They never dreamt of getting such a bumper yield from the improved variety. Now she is convinced that she will use the seeds of this variety in coming years and also say others to follow the same practice. She sold the foundation seeds of 400 kg @ Rs 40/- per kg and shared around 250 kg to her relatives for seed purpose and remaining grains she kept for own consumption (Figure 11). The cultivation cost was around Rs 6200/- INR for half acre. The net benefit she got after meeting all the cost of cultivation was Rs. 27,400/- INR from the same land of half acre (Table 4-6).
Table 1: Comparative statement of biometrical traits of KMR-204.

| Sl. No | Traits                                | Hari Sukia | Average of 10 Farmers |
|-------|---------------------------------------|------------|-----------------------|
| 1     | 45-day Plant height                   | 44.91      | 51.87                 |
| 2     | Plant height during harvest           | 97.32      | 87.42                 |
| 3     | 45-day No of tillers                  | 3.7        | 3.06                  |
| 4     | No. of tillers during harvest         | 10.9       | 7.15                  |
| 5     | Productive tillers                   | 10.4       | 6.72                  |
| 6     | Non-productive tillers               | 0.5        | 0.55                  |
| 7     | No. of finger (per panicle)           | 9          | 7.53                  |
| 8     | Finger Length                         | 8.26       | 8.00                  |
| 9     | Green weight in 25 sqm (Kg)           | 17.94      | 10.39                 |
| 10    | Dry weight in 25 sqm (Kg)             | 12.84      | 7.31                  |
| 11    | Yield in quintal per Ha               | 51.38      | 28.55                 |

I. KMR-204 topped the list by recording the highest yield of 2055 kg/acre and an average yield of 1630 kg/acre in Machhra. This was followed by ML-365 (1464 kg/acre) and Arjun (1182 kg/acre). The yield of other varieties were low compared to the above varieties namely Chilika recorded 1050 Kg/acre followed by Jam Mandia (985 Kg/acre) and Kalua with 630 Kg/acre.

II. KMR-204 surpassed the state average yield and the previous yield of other varieties. This shows how a combination of pure quality seeds in time and improved technology could bring out a huge impact thus creating a sustainable yield and served as an inspirational variety to the poor tribal community.

Table 2: Component-wise cost of cultivation and return from finger millet.

| Sl. No | Input                        | Demos      | Farmers’ practice |
|--------|------------------------------|------------|-------------------|
| 1      | Seeds                        | 87.5       | 150               |
| 2      | Fertilizers                  | 7050       | 3100              |
| 3      | Plant Protection             | 500        | 0                 |
| 4      | Irrigations                  | 0          | 0                 |
| 5      | Ploughing                    | 6000       | 6000              |
| 6      | Human labour                 | 6650       | 8200              |
| 7      | Total Cost                   | 20287.5    | 17450             |
| 8      | Grain yield (q ha-1)         | 3057       | 1568              |
| 9      | Fodder yield (q ha-1)        | 1568       | 1344              |
| 10     | Gross return                 | 64282      | 34048             |
| 11     | Net return                   | 43995      | 16598             |

Benefit:Cost (B:C) ratio 2.16 0.95

Table 3: Operation-wise cost on human labour for finger millet cultivation.

| S. No. | Component                  | Demos     | Farmer’s practice |
|--------|----------------------------|-----------|-------------------|
|        | Rs. / ha (%)               | Rs. / ha (%)|
| 1      | Land preparation           | 7200 35.49| 6000 34.38        |
| 2      | Sowing / Dibbling          | 3000 14.79| 600 3.44          |
| 3      | Fertilizer / Manure application | 1800 8.87 | 1500 8.6         |
| 4      | Weeding                    | 1700 8.38 | 3700 21.2         |
| 5      | Insecticide application    | 500 2.46  | 0 0               |
| 6      | Irrigation                 | 0 0       | 0 0               |
| 7      | Harvesting, bundling       | 1800 8.87 | 1800 10.32        |
| 8      | Threshing                  | 2287 11.27| 2250 12.89        |
Table 4: Results of all the demonstrations.

| S. No | Variety       | Grain yield (q ha\(^{-1}\)) | Fodder yield (q ha\(^{-1}\)) | Cost of cultivation (Rs. ha\(^{-1}\)) | Gross return (Rs. ha\(^{-1}\)) | Net return (Rs. ha\(^{-1}\)) | B:C Ratio |
|-------|---------------|-----------------------------|-------------------------------|-------------------------------------|-------------------------------|-------------------------------|-----------|
| 1     | GPU-66        | 26.39                       | 13.51                         | 20800                               | 55482                         | 34682                         | 1.66      |
| 2     | GPU-28        | 27.58                       | 14.77                         | 19562                               | 58114                         | 38552                         | 1.97      |
| 3     | Chilika       | 30.19                       | 16.95                         | 20980                               | 67160                         | 46180                         | 2.2       |
| 4     | KMR-204       | 33.82                       | 25.28                         | 20287                               | 72696                         | 52409                         | 2.58      |
| 5     | Bati Mandia   | 20.36                       | 14.66                         | 18796                               | 43652                         | 24856                         | 1.32      |
| 6     | Jam Mandia    | 21.89                       | 15.51                         | 19451                               | 63192                         | 42662                         | 2.02      |
| 7     | Arjun         | 30.12                       | 14.76                         | 20530                               | 63192                         | 42662                         | 2.02      |
|       | Farmer’s Practice (Local check) | 15.68                       | 13.44                         | 17450                               | 34048                         | 16598                         | 0.95      |

Table 5: Nutritional status of millets in comparison to Rice and Wheat.

| Crop/Nutrient | Protein (g) | Fiber (g) | Minerals (g) | Iron (mg) | Calcium (mg) |
|---------------|-------------|-----------|--------------|-----------|--------------|
| Pearl millet  | 10.6        | 1.3       | 2.3          | 16.9      | 38           |
| Finger millet | 7.3         | 3.6       | 2.7          | 3.9       | 344          |
| Foxtail millet| 12.3        | 8         | 3.3          | 2.8       | 31           |
| Proso millet  | 12.5        | 2.2       | 1.9          | 0.8       | 14           |
| Kodo millet   | 8.3         | 9         | 2.6          | 0.5       | 27           |
| Little millet | 7.7         | 7.6       | 1.5          | 9.3       | 17           |
| Barnyard millet| 11.2       | 10.1      | 4.4          | 15.2      | 11           |
| Rice          | 6.8         | 0.2       | 0.6          | 0.7       | 10           |
| Wheat         | 11.8        | 1.2       | 1.5          | 5.3       | 41           |

Source: Nutritive Value of Indian Foods, NIN, Hyderabad, 2007

Table 6: Some information on Traditional Varieties of finger millet.

| Variety         | Duration (Days) | Yield potential/ha (quintal) |
|-----------------|-----------------|-----------------------------|
| Telugu Mandia   | 135-140         | 46.90                       |
| Chili Mandia    | 135-140         | 45.20                       |
| Jam Mandia      | 140-145         | 35.30                       |
| Lala Mandia     | 120-125         | 32.30                       |
| Kalia Mandia    | 130-135         | 31.60                       |
| Bati Mandia     | 130-135         | 29.60                       |
| Kurkuti Mandia  | 130-135         | 28.40                       |
| Lado Mandia     | 130-135         | 26.60                       |
| Murda Mandia    | 130-135         | 25.90                       |
| Toya Mandia     | 130-135         | 25.40                       |

Conclusion

The study clearly reveals that millet is not a poor man’s crop. If it is cultivated with proper care in up or medium land following improved agronomic practices, it can compete with any other crop and produce good yield with very low input cost of cultivation. Inclusion and promotion of modern technological intervention like SMI is an advantage to the finger millet. So, it is proved that millet cultivation can be a viable alternative and sustainable option for the rural poor. Moreover, it is eco-friendly and improves food security and enhances economic growth. She is now a role model...
who can serve to the community by extending her knowledge and experience to promote millet in the region with a new hope.

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**References**

1. Meherda PK (2013) Agricultural Statistics of Odisha.
2. B Dayakar Rao, Vishala AD, Arlene Christina GD, Tonapi VA (2006) Millet Recipes - A Healthy Choice. ICAR-Indian Institute of Millet Research pp. 122.