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# Yield gap analysis of hybrid maize variety Kalinga Raj (OMH 14-27) through front line demonstration in south eastern Ghat zone of Odisha

**Samir Ranjan Dash, Manasi Bhol, Amaraesh Khuntia and Sangram Paramguru**

**Abstract**
The present study was conducted during 2021-22 in Malkangiri and Korkunda block of Malkangiri district, comprising forty number of farmers from four adopted villages of Krishi Vigyan Kendra, Malkangiri, in South Eastern Ghat Zone of Odisha. Conducting front line demonstrations on farmer's field was to identify potential of variety Kalinga Raj in specific area as well as its impact on economic and social status of the farmers. Most of the farmers in the study area were (55.0%) belonged to medium level of adoption followed by (27.5%) low level of adoption of the recommended cultivation practices of cultivation. Also the farmers were getting very good price in local and peri-urban market and this might be the reason for high adoption of the recommended technologies. The study revealed that socio-economic attributes of the respondents such as education, extension contact, communication material use, land holding size were the pertinent variables exhibiting positive influence towards adoption behavior of the respondents. The result of the demonstration indicated that seed yield of Kalinga Raj was 45.8 q ha-1 with net return of Rs 44730/ per ha with B: C ratio 2.2. The technological and extension gap was 33.68 q ha-1 and 7.47 q ha-1 respectively with technological index 42.36 percent. It has been revealed that by conducting front line demonstration of intervention practices of proven technologies in farmer's field, yield potential of enhanced to a great extent which has increased farmers income level. Under crop diversification in upland situation in Malkangiri district, cultivation of variety Kalinga Raj should be popularized, since it fits to the existing farming situation for higher productivity with incremental net return.

**Keywords:** yield gap, front line demonstration, adoption behavior, socio-economic attributes, technological and extension gap

## Introduction

Maize (*Zea mays* L.) is a vital food crop and gives a big volume of raw materials for farm animals and many agro-related industries in the world (Bello *et al*., 2010; Randjelovic *et al*., 2011) [2, 19]. Maize is the primary cereal crop in the world followed by the important cereal crop such as rice and wheat. The agriculture is the back bone of the country and more than 65 percent population of country directly or indirectly depends on agriculture for their livelihood. In most of the tribal areas of the country, traditional agricultural practices with old crops or cropping system are being practiced in order to fulfill the needs of the family. The farmers of the south eastern ghat zone particularly in district Malkangiri are tribal, small and marginal, resources poor and usually grow low value crops like paddy, sesame sorghum finger millets and little millets and depend upon forest minor product for their livelihood. Therefore, to enhance the production and income per unit area, crop diversification is the priority thrust area un upland situation and it is very essential to grow high value crops like in upland situation, which will not only increase their profitability with net income but also meet requirement of their food and can give quality green fodder for their milch animal which will result in an increased milk production and thus, enhance the income of farmer. Maize is the primary cereal crop in the world follows the important cereal crop such as rice and wheat. It is cultivated for food, feed and also as a source of raw materials for various industrial products. Besides a major food crop, it is also a key component of poultry and livestock ration (Dhakal, *et al*. 2017) [7]. Maize demand has been increasing constantly by 5% in the last decade and is expected to grow 4–6% every year for the next 20 years (Sapkota and Pokhrel, 2010) [21]. Therefore, efforts are made to increase the yield of maize through introduction of high yielding maize variety Kalinga Raj with adoption of improved package and the practices.

Among the factors which influence the yield, plant population and fertilizer are important.
The factors which hamper the yield potential of maize crop include unavailability of improved seed varieties and low optimal plant density per hectare (Nasir, 2000) [17]. The higher yield can be obtained by adoption of with application of balanced fertilizers, pesticides use, and agricultural mechanization.
Front line demonstration is one of the important tools for transfer of technology. Conducting cluster front line demonstrations on farmer's field help to identify the constraints and potential of the groundnut in specific area as well as it helps in improving the economic and social status of the farmers. Font line demonstrations are a concept of field demonstrations evolved by in Indian Council of Agriculture and Research (ICAR) during the inception of Technology Mission on Oilseed crops during mid-eighties. The field demonstrations conducted under close supervision of scientists of the National agricultural Research System is called front line demonstration because the technologies are demonstrated for the first time by the scientist themselves before being fed into the main extension system of the state department of agriculture (Venkatasubramanian *et al.,* 2010) [26]. The main objective of front line demonstrations is to demonstrate newly released crop production technologies and its management practices in the farmers' field under different farming situations and at different agro-climatic regions. The newly and innovative technology having higher production potential under the specific cropping system can be popularized through front line demonstrations programme. The aim of the front-line demonstration is to convey the technical message to farmers that if they use recommended package and practices then the yield of this crop can be easily doubled than their present level. Keeping the above point in view, the Front Line Demonstration on using improved production technologies was conducted with the objective of showing the productive potentials of the integrated production technologies under actual farm situation. The present front line demonstration was carried out by Krishi Vigyan Kendra, Malkangiri, under the supervision of agricultural scientists and the seeds of high yielding maize variety Kaliga Raj and other critical inputs were provided to the farmers by KVK under Front Line Demonstration (FLD) programme in four villages namely Kotliguda, Dariguda of Malkangiri block Pedawada and Tandapalli of Korkunda block in cluster approach during rabi season 2021- 22.

**Yield Gap in Production**

Yield potential (Yp) also called potential yield, is the yield of a crop variety when grown with water and nutrients no limiting and biotic stress effectively controlled (Evans, 1993; Van Ittersum and Rabbinge, 1997) [30, 31]. The Genotypes showed considerable variation in grain yield in different agro ecological situation as reported by (Dhakal *et al*. 2017) [7]. Researchers acknowledge the presence of yield gaps between potential and farm level yields across ecologies, regions, and countries (FAO, 2004) and yield gaps could be attributed to factors such as: biophysical, socioeconomic, policy and/or institutional, technology transfer, and linkage to agricultural experts. These gaps could be differentiated into three categories

- **Gap I:** The gap between the theoretical yield and yields attained at experimental station- this serves as a guide in varietal breeding at research stations
- **Gap II:** The gap between the attainable yield at experimental stations and the potential yield realized at the farm level- normally attributed to factors that are non-transferable
- **Gap III:** The gap between the potential farm yield and the actual yield realized by the farmers- mainly attributed to management practices

At the farm level, the most viable option is to narrow the gap between the potential and actual farm yields or Gap III. Nonetheless, this gap is not static. As noted by (Van Tran, 2010) [32] the gap enlarges with new technology development; thus, development of new Hybrid varieties changes the yield potential. Hence, the actual yield at the farm level depends on management practices adopted by the farmers also that are associated with socioeconomic condition in addition to biophysical factors (Bindraban *et al*., 2000) [33]. The yield gap is viewed as differences between achievable yield and the actual yield under optimal management practices. Yields of crops must increase substantially over the coming decades to keep pace with global food demand driven by population and income growth. Ultimately global food production capacity will be limited by the amount of land and water resources available and suitable for crop production, and by biophysical limits on crop growth. Quantifying food production capacity on every hectare of current farmland in a consistent and transparent manner is needed to inform decisions on policy, research, development and investment that aim to affect future crop yield and land use, and to inform on-ground action by local farmers through their knowledge networks.
Front line demonstration is one of the important tools for transfer of technology. Conducting cluster front line demonstrations on farmer's field help to identify the constraints and potential of the groundnut in specific area as well as it helps in improving the economic and social status of the farmers. The field demonstrations conducted under close supervision of scientists of the National agricultural Research System is called front line demonstration because the technologies are demonstrated for the first time by the scientist themselves before being fed into the main extension system of the state department of agriculture (Venkatasubramanian *et al*., 2009) [26]. The main objective of front line demonstrations is to demonstrate newly released crop production technologies and its management practices in the farmers' field under different farming situations and at different micro farming situations. The newly and innovative technology having higher production potential under the specific cropping system can be popularized through front line demonstrations programme. The aim of the front-line demonstration is to convey the technical message to farmers that if they use recommended package and practices then the yield of this crop can be easily doubled than their present level. Keeping the above point in view, the FLDs on variety Klainga Raj, using improved production technologies was conducted with the objective of showing the productive potentials of the integrated production technologies under actual farm situation. The present front line demonstration was carried out by Krishi Vigyan Kendra, Malkngiri, under the supervision of agricultural scientists and the seeds of maize variety Kalinga Raj and other critical inputs were provided to the farmers by KVK to find out yield gaps between farmers practices (FP) and Recommended Practices

(RP) under Front Line Demonstration (FLD) programme in four different villages.

**Objectives**

The present investigation was under taken for assessing the performance along with yield attributing parameters and economic of return of Variety Klainga Raj in specific micro farming situation of Malkangiri district under South Eastern Ghat Zone of Odisha in comparison with farmers variety (P 3501) as check. The present study has been undertaken to evaluate the difference between demonstrated technologies vis-a-vis practices followed by the local farmers in cultivation under actual farm situation. The present study was also designed to assess the adoption level of farmers about different recommended package and practices of cultivation. But given the diverse agro-ecological regime of our country, not all hybrids are suitable for cultivation in all areas. So, there is a need to assess the region-specific performance trials before recommending for that region. Therefore, our objective is to conduct a performance evaluation to identify the superior maize hybrids for the particular micro farming situation under South Eastern Ghat Zone of Odisha.

**Materials and Methods**

The district Malkangiri is counted as most backward tribal dominated district of the state Odisha, with (61%). of the people remaining under poverty line and literacy rate is 30.53% only (Priyambada, 2017) [18]. The present study was undertaken to assess the field performance of Variety Kalinga Raj as compared to the farmers variety (P-3501) as local check also to assess the Extent of adoption level of the farmers about recommended technologies of cultivation in Malkangiri district during rabi season in the year 2021-2022. A total 40 number demonstrations on variety Kalinga Raj were conducted in farmers field condition, in two blocks namely Malkangiri and Korkunda in cluster approach in an area of 20.0 ha of by Krishi Vigyan Kendra, Malkangiri.

Before conducting demonstration a list of 40 farmers was prepared by conducting group meeting and specific skill training was imparted to the selected farmers regarding improved crop management aspects. Forty numbers front line demonstrations (FLDs) were conducted in three clusters or villages on (variety Kalinga Raj) cultivation. All the participating farmers were trained on packages and practices of production technologies and recommended agronomic practices and genuine seeds of (Kalinga Raj) variety were used for demonstration and this variety Kalinga Raj having 92days duration, tassel colour – light pink, resistance to common rust, MLB & TLB with yield potential 79.5 q /ha developed by Odisha University of Agriculture Technology, Bhubaneswar in the year 2019.

The total area demonstrated was 20.0 ha and plot area of individual farmer was 0.2 to 0.4 ha. The soil composition of the study area was found to be sandy loam to clay loam with and was slightly acidic in reaction (pH-5.0 to 5.68) with sandy loam in texture and EC was 0.168 ($dS\ m^{-1}$). The available nitrogen, phosphorus and potassium was between 217.00, 23.20, 146.00 ($Kg\ ha^{-1}$) respectively and available Sulphur was 22 to 32 (kg/ha) with Organic Carbon (0.46%).

The crop was sown in under irrigated condition in the second week of January with irrigation at critical stages of the crop. Fertilizer was applied at the rate of 150:60:40 NPK $kg\ ha^{-1}$. A half dose of N and a full dose of $P_2O_5$ and $K_2O$ were applied as a basal dose. The remaining half of the N was applied in two splits at knee-high and pre-tasseling/silking stages.The crop was raised with recommended agronomic practices and harvested within second to fourth week of March.

The observations were recorded for various parameters of the crop. The farmers' practices were maintained in case of local checks. The field observations were taken from demonstration plot and farmers plot as well. Parameters like Plant height, number of pods $plant^{-1}$, 100 seed weight and seed yield were recorded at maturity stage and the gross returns (Rs $ha^{-1}$) were calculated on the basis of prevailing market price of the produce. The extension gap, technology gap, technology index along with B: C ratio was calculated and the data were statistically analyzed applying the statistical techniques. To estimate the technology gap, extension gap and technology index following formulae have been used: The farmer's practices (FP) plots were maintained as local check for comparison study. The data obtained from intervention practices (IP) and famers practices (FP) were analyzed for extension gap, technological gap, technological index and benefit cost ratio study (Samui *et al*., 2000) as given below.

Technology gap = Pi (Potential yield) - Di (Demonstration yield)

Extension gap = Di (Demonstration Yield) - Fi (Farmers yield)

$$\text{Technology index} = \frac{\text{Technology gap}}{\text{Potential Yield}} \text{X100}$$

This maize variety Kalinga Raj has been developed by Odisha University of Agriculture and Technology Bhubaneswar, having 92days duration, with tassel colour – Light Pink, and it is Resistance to common rust, MLB & TLB with Yield Potential 79.5 q /ha, was taken for demonstration.

This study has been conducted in the Malkangiri district of Odisha covering two blocks namely Malkangiri and *Korkunda*. The blocks were selected purposively because these blocks were leading in terms of area and production of maize cultivation in the district. A sample size of 40 maize growers randomly selected from three villages from two blocks Malkangiri block and Korkunda block were selected as the respondents. Total sample size comprising forty maize growers were randomly selected from three villages were selected through population proportion to sample size technique covering two blocks, as the respondents. The socioeconomic variables as age, education, family type, family size, social participation, cosmopoliteness, extension contact, communication materials used, house type, holding size, occupation and annual income were selected as the independent variables for the study. The dependant variable in the study was knowledge and adoption level of the farmers. To collect data semi- structured interview schedule was developed and it was pre- tested and modified accordingly for assembling the relevant data. Percentage and frequency were used to measure Knowledge and adoption of contact farmers. The other selected independent variables like age, education, land holding, annual income, extension participation, innovativeness, risk orientation, scientific orientation and mass media participation were measured by using already developed scales by the earlier researchers. Finally the data were tabulated and analyzed by using frequency, percentage, mean, SD and Pearson's Coefficient of correlation "r" was calculated to draw the inferences.

## Results and Discussion

The selected maize growers were asked to indicate the adoption of different recommended technologies through a pre -structured interview schedule and the information collected by interviewing the selected growers and tabulated them to identify the level of adoption of different practices. The suitable statistical tools like percentage, mean, Standard deviation were used for analysis and interpretation of the data. The results obtained from the present investigation as well as relevant discussion have been summarized under following heads.

## Adoption Behavior

The distribution of the respondents according to their overall adoption beahviour of hybrid maize cultivation practices is given below in Table 1. The results of table 1 revealed that (55.00) percent respondents had medium adoption behavior, (27.5) percent had high rate of adoption followed by (17.5) percent of respondents having low adoption of different recommended practices of cultivation. As the farmers were conducting participatory FLDs under the guidance of KVK scientists and due to regular training and capacity programmes conducted in the operational areas and majority (82.5%) of farmers had medium and high level adoption. It can be concluded from these findings that majority of the respondents adopted recommended practices and this may be probably because the respondents might be convinced about the benefits of the technology on cultivation. The results of the study were in line with the findings reported by (Waghmod, *et al*., 2020) [27].

**Table 1:** Over all adoption level of recommended practices of cultivation (n=40)

| Category | Frequency (f) | Percentage (%) | |
|---|---|---|---|
| Low (Mean – SD) | 11 | 27.5 | *Mean - 5.36 SD -2.27* |
| Medium (Mean ± SD) | 22 | 55.0 | |
| High (Mean + SD) | 7 | 17.5 | |

Also the farmers are getting very good price of maize in local market and this might be the reason for high adoption of the recommended technologies. The findings were corroborated with the findings of (Birthal and Sant, 2004) [5] and (Jirli 1996) [10]. It was revealed that majority of the respondents (82.5%) were found to possess medium to high level of adoption behavior.

## Package of Practice wise adoption

Practice wise adoption of improved method of cultivation practices is presented in table 2. A total thirteen recommended practices were taken for the present study and adoption level was measured for each specific practice.

**Table 2:** Adoption of Recommended package and Practice of production technology (n=40)

| Sl. No. | Cultivation Practices | Full adoption | | Partial adoption | | Non adoption | |
|---|---|---|---|---|---|---|---|
| | | Frequency (f) | Percentage (%) | Frequency (f) | Percentage (%) | Frequency (f) | Percentage (%) |
| 1 | Suitable Variety | 12 | 30.0 | 17 | 42.5 | 11 | 27.5 |
| 2 | Seed rate | 21 | 52.5 | 11 | 27.5 | 8 | 20.0 |
| 3 | Seed treatment | 12 | 30.0 | 17 | 42.5 | 11 | 27.5 |
| 4 | Time of sowing | 27 | 67.5 | 9 | 22.5 | 4 | 10.0 |
| 5 | Land preparation | 13 | 32.5 | 22 | 55 | 5 | 12.5 |
| 6 | Method of sowing and spacing | 14 | 35.0 | 21 | 52.5 | 5 | 12.5 |
| 7 | Optimum plant population | 14 | 35.0 | 21 | 52.5 | 5 | 12.5 |
| 8 | Fertilizer application | 11 | 27.5 | 18 | 45.0 | 11 | 27.5 |
| 9 | Irrigation management | 31 | 77.5 | 6 | 15.0 | 3 | 7.5 |
| 10 | Intercultural operation | 13 | 32.5 | 22 | 55.0 | 5 | 12.5 |
| 11 | Plant protection measure | 10 | 25.0 | 21 | 52.5 | 9 | 22.5 |
| 12 | Weed Management | 9 | 22.5 | 17 | 42.5 | 14 | 35.0 |

It was revealed from the table 2 that the majority of the respondents (72.5%) were adopting these hybrid varieties due to good yield and the quality of grain and size of the cobs. A medium to high level of adoption was recorded in use of optimum Seed rate (82.5.5%). Maintain Optimum plant population in field (87.5%), followed by seed treatment (72.5%). The adoption level was very low in practices like Weed Management (35.0%) followed by judicious use of fertilizer applications (27.5%) and plant protection measures (22.5%).

Majority of the respondents were adopting optimum seed rate and maintaining optimum plant population as optimum plant population which are the key attributing factor related to cob yield in hybrid maize. The major differences were observed between recommended package of practices and farmer's practices were regarding method of integrated weed management, plant protection and Nutrient management measures. The result was in conformity with the finding of (Chaudhary *et al*. 2018) [6], (Tiwari *et al*. 2003) [25], (Singh and Chaudhury, 1995) and (Katar *et al*., 2011)**.** By conducting front line demonstration of intervention practices of proven technologies in farmer's field, yield potential ofhybrid maize has enhanced to a great extent which increased in the income level of farmers and improved livelihood of farming community. These results are similar with the findings of (Ratna *et al*., 2010) [20] and (Jasinski and Haley, 2014) [9].

**Table 3:** Agronomical parameters of observed in farmers field and demonstration field

| Treatment | Plant Height (cm) | Cob Length (cm) | Seeds/ Row | Weight of 100 grains (g) | Yield (q/ha) | Gross Return (Rs/ha) | Net Return (Rs/ha) | BC Ratio |
|---|---|---|---|---|---|---|---|---|
| Farmers practice (FP) | 214.6 | 25.8 | 40 | 32.4 | 38.3 | 70,855/- | 30,340/- | 1.5 |
| Recommended practice (RP) | 265.4 | 24.5 | 42 | 35.2 | 45.8 | 84,730/- | 44,730/- | 2.2 |

The data on crop growth parameters as reported in table 3 that plant height significantly differed between hybrids. The difference in plant height among genotypes was attributed to genetic as well as environmental factors. The Plant height at maturity stage in Kalinga Raj was recorded as 265.4 cm under demonstration. The increased in plant height provides more areas for photosynthetic activities and assimilates needed for grain filling (Koirala *et al*., 2020) [13]. The cob length and number of seed per cob was recorded in Kalinga Raj as compared to farmers practice under demonstration. Number of grains per row of cob plays a key role in the final yield production of maize crop. More the number of grains per row of cob more will be the grain yield. A significant difference was noted on grain yield, cob length and 100 grain weight in Kalinga raj and similar findings were reported by (Bhadru *et al*. 2011) [3] The result indicated that seed yield of Kalinga Raj was 45.8 q ha-1 and in FP practices (variety-P 3501) recorded yield of 32.4 q ha-1. Number of grains per row of cob plays a key role in the final yield production of maize crop and cob length is also an important parameter which contributes to the production potential of maize crop. Similar findings were also reported by (Ijaz *et al*., 2015) [15]. The percent increased in yield with RP over FP was (19.42%). By conducting cluster front line demonstration of intervention practices of proven technologies in farmer's field, yield potential of enhanced to a great extent which increased in the income level of farmers and improved livelihood of farming community. Under demonstration the incremental income was Rs 14390 /- per ha with B: C ratio 2.2.

**Table 4:** Yield performance of under farmers practice and demonstration

| Treatment | Mean Yield (q ha$^{-1}$) | Standard Deviation | Standard Error | CV% | % increase over FP | 'Z' Value | p-value equals |
|---|---|---|---|---|---|---|---|
| Farmer's practice (FP) | 38.35 | 1.86 | 0.29 | 3.47 | 19.42 | 3.981* | (p(x≤Z) = 0.0006) |
| Recommended practice (RP) | 45.82 | 3.74 | 0.59 | 14.00 | | | |

(The test statistic Z equals -3.981, Indicates significance value at p=0.05 critical value two tail z score =1.96

The grain yield was recorded as 45.82 (q ha$^{-1)}$ in Klanga raj and 38.35 (q ha$^{-1)}$ under Farmers' practice. The calculated 'Z' value (3.981) was found to be significant indicating significant difference in yield between farmer's practice and recommended practice. It was concluded that yield variation was more in case of recommended practice as compared to Farmers practices practice (FP) as CV % was 14.004 in RP. There was significant difference between average yield of under Farmers practice (FP) and Recommended practice (RP).

**Table 5:** Technology gap, extension gap and technology index of var. Kalinga Raj under frontline demonstration

| Treatment | Average yield (q ha$^{-1}$) | Technology gap (q ha$^{-1}$) | Extension gap (q ha$^{-1}$) | Technology Index (%) |
|---|---|---|---|---|
| Farmers practice (FP) | 38.35 | 33.68 | 7.47 | 42.36 |
| Recommended practice (RP) | 45.82 | | | |

The technological and extension gap was 33.68 q ha-1 and 7.47 q ha-1 respectively with technological index was 42.36 percent. It has been revealed that by conducting front line demonstration of intervention practices of proven technologies in farmer's field, yield potential of enhanced to a great extent which increased in the income level of farmers and improved livelihood of farming community. The technology index showed the feasibility of the improved technology at the farmer's field and such fluctuation in technology index during the study period may be attributed to the dissimilarity in soil fertility status, weather condition, non-availability of irrigation water at critical stages and insect-pest like FAW incidence in early vegetative stage.

**Correlation analysis of the selected dependent and independent variables of maize growers**

Attempt was also made in the study to assess the influence of socio-economic variables with increasing the knowledge and adoption level of hybrid maize growers. The correlation coefficients indicating the nature and degree of association between adoption with the selected independents variables has been calculated and analysis made with Pearson's Coefficient of correlation has been reflected in table 6.

**Table 6:** Influence of socio-economic variables on adoption level (n=40)

| Variables | Value of Correlation coefficient (r) |
|---|---|
| Age (X1) | 0.124 |
| Education (X2) | 0.471** |
| Family type (X3) | -0.054 |
| Family size (X4) | 0.118 |
| Social participation(X5) | 0.356* |
| Cosmopoliteness (X6) | 0.468* |
| Extension contact (X7) | 0.551** |
| Communication material use (X8) | 0.412** |
| Type of house (X9) | 0.142 |
| Land holding (X10) | 0.517** |
| Occupation (X11) | 0.194 |
| Annual Income(X12) | 0.321* |

* Significant at 0.05 level, ** Significant at 0.01 level

The data in the table 5 revealed that some of the selected socio-economic variables covered under study had significantly and positively influenced the knowledge and adoption level of the respondents. The correlation coefficient "r" value indicated that education, social participation, cosmopoliteness, extension contact, communication materials used, holding size and annual income of the respondents were the important variables accelerating the knowledge and adoption level of the respondents toward adopting the recommended package and practices of cultivation. Land holding, extension contact and communication material use were found to have positive and significant correlation at ten percent level of significance. The socio- economic variables like education, extension contact, communication material use, holding size were the pertinent variables exhibiting influence towards adoption behaviour of the respondents. Similar findings were also reported by (Veeresh Kumar, *et al*. 2020) and (Jadeja, 2008) [14, 8].

## Conclusion

The study revealed that (53.3%) of the percent of the respondents had "medium" level of adoption, while (16.7%) of the respondents had "low" level of adoption and (30.0%) of the respondents had "high" level of adoption. From the findings, it was concluded that majority of the respondents (83.3%) were found to possess medium to high level of adoption behavior regarding different recommended package and practices about hybrid maize cultivation. It means that the respondents were more energetic, progressive and adopting the hybrid maize as cash crop keeping the market demand in mind and practicing the technologies for better production and higher net return. Majority of the farmers had adopted good promising F1 hybrid varieties and also adopted proper spacing for maintaining optimum plant population for better yield in hybrid maize cultivation. The socio economic variables like land holding, extension contact and communication material used and education status were found to be positively significantly correlated with adoption of recommended technologies of cultivation. This means that big farmers having more land holdings and educated farmers with high extension contact had grater adoption level as they had access to market and possessed more risk bearing ability. It was implied that big farmers were willing to adopt crop diversifications in upland situation with assured irrigation facility and ready to switch over from traditional crop to high value cash crop like cultivation, though the production cost was high, but it was more remunerative with high net return to the farmers. From the above findings it can be concluded that use of scientific methods and technological practices of variety Kalinga Raj cultivation can reduce the technological gap to a considerable extent thus leading to higher productivity of maize in the district.. In conclusion, variety Kalinga Raj has become a cash crop for the farmers of the Malkangiri district and efforts are being made at different levels to maximize the area, production and productivity of maize in this region. Moreover, extension agencies like KVK, ATMA, NGO's of the district need to provide more technical support to the farmers through demonstration, capacity building programme, exposure visit to other fields and field days which can enhance the horizontal spread of the technology in the district, with its positive impact on livelihood of the farmers.

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## Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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