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Evaluation of maize cowpea intercropping as fodder through front line demonstration

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Abstract
A study was carried out through front line demonstration during Kharif season of 2015-16 to promote the Intercropping of maize+cowpea as fodder in 1:1 ratio in Ganjam District under East & South Eastern Coastal Plain Zone of Odisha. The KVK scientists has conducted frontline demonstration in maize+cowpea intercropping with the active participation of farmers with the objective to demonstrate the improved technologies in crop. From the front line demonstration, it was observed that the higher values of fresh forage yield was recorded in Intercropping of maize+cowpea in 1:1 ratio(504.5q/ha) where as in sole maize and sole cowpea it was 487.6 q/ha, 230.3 q/ha respectively. The total Land Equivalent Ratio (LER) is found to be 1.24 which is 24% of yield advantageous over sole crop. The maximum cost of cultivation was recorded in sole maize(Rs 42517/ha) while the lowest was recorded in sole cowpea(Rs18695/ ha).The highest net return was observed in intercropping of maize+cowpea (Rs 26117/ha) over sole maize(Rs 15965/ha) and sole cowpea(Rs 2032/ha).The B:C ratio was highest in intercropping of maize cowpea as fodder in 1: 1 row proportion of (1.83) over sole maize(1.37) and sole cowpea (1.10).

Keywords: intercropping system, cowpea-maize, fodder, land equivalent ratio (LER), economics

Introduction
India is the largest country which is having 529.7 millions of livestock population (Anon., 2010) [2]. The total area under fodder crops is 6.6 m ha which constitutes about 4% of cultivated area and is insufficient to meet the fodder requirement of existing livestock. It is often not possible to set aside arable land for fodder production alone, as cultivable land is not enough for food grain production. Agriculture land is shrinking day by day as it is used for non - agricultural purposes. It is rather inevitable to accommodate fodder production in existing crops /cropping systems. There is ample inter – space in widely spaced crops like grain maize, sorghum, bajra, hybrid cotton, red gram etc., which can be advantageously used to raise short duration pulse crops such as fodder cowpea or multi – cut fodder crops without much reduction in the main crop yields. Maize is being widely spaced crop, cowpea can be introduced as fodder crop by altering the plant geometry of maize.

Maize (*Zea mays* L.) is one the most important C4 crop plants and is almost an ideal cereal forage crop because of its quick growing, high yielding, palatable with nutritious qualities and and can be fed to the cattle at any stage of growth, as there is no problem of hydrocyanic acid or oxalic acid poisoning to cattle. Hence, it is widely known as “ready- made fodder crop”. The green fodder of maize has also been reported to have lactogenic properties and hence, is specially suited for milch cattle. The main aim of fodder maize production is to provide nutritious fodder in accordance with feed requirement of animal. Although maize provides high yield in terms of dry matter, it produces forage with low protein content. However, protein isneeded by livestock for growth and milk production. Protein is also needed by rumen bacteria which digest much of the feed for ruminant animals (Ghanbari-Bonjar, 2000). Because of low protein content, maize hay is usually lower than that of required to meet satisfactory production levels for many categories of livestock. Therefore, it is necessary to provide livestock with protein supplements when forage quality is low.

Even though, maize provides adequate fodder, there is need to improve its quality by mixing suitable fodder legume without reduction in its forage yield. Inclusion of legumes along with cereals has been reported to improve the forage quality since legumes are rich in protein (Sharma *et al*., 2008) [4]. It is well established fact that livestock feed should contain enough protein to maintain their health, according to an estimate the minimum protein content of 5-6%

is essential in the maintenance ration and 14 % for productive purposes. The mixed sowing of legumes with cereals not only improves the quality of fodder but also enhances the soil fertility by fixing atmospheric nitrogen (Ahamad *et al*., 2007). The type of intercrop and spatial arrangement in intercropping has an important effect on the balance of competition between component crops and their productivity.

Cowpea (*Vigna unguiculata*) is an annual legume with high level of protein (about twice times more than maize) content can be mixed with maize to improve forage protein content of diets and, thus, the costs of high quality forage production can be lowered. Forage legumes such as soybean, cowpea, cluster bean etc. are rich sources of protein but their forage yield only half in comparison with cereal forages (Iqbal *et al*., 2015) [5]. Maize when grown as fodder, the crop gives huge quantities of green herbage in a short time. 59 per cent of total maize grain produced in the country is utilized in manufacture of concentrate feed for livestock (Raju, 2013) [7].

Fodder cowpea when mixed with fodder maize at 15 kg ha-1 increases the protein content and tonnage of fodder with higher palatability. Maize has the potential to supply large amounts of energy-rich forage for animal diets, and its fodder can safely be fed at all stages of growth without any danger of oxalic acid, prussic acid as in case of sorghum (Dahmardeh *et al*., 2009) [3].

The crude protein and fibre content of fodder is 7-10per cent and 25-35per cent in maize respectively and the crude protein content in cowpea fodder ranges between 16-21 percent. The Nutritive value of fresh biomass of cowpea (dry matter basis) is 12.5 per cent digestible crude protein, 62.0 per cent in total digestible nutrients, 2.7 M cal kg-1 of digestible energy and 2.2 M cal kg-1 Metabolizable Energy.

The growing of two or more crop species simultaneously with definite row proportion in the same field during a growing season is known as intercropping, has many advantages over sole cropping. It provides an efficient utilization of environmental resources, reduces risk to the cost of production, provides greater financial stability for farmers, decreases pest damages, suppresses weeds growth more than monocultures, improves soil fertility through nitrogen increasing to the system and improves forage yield and quality.

The concept of intercropping is to get increased total productivity per unit area and time besides equitable and judicious utilization of land resources and farming inputs (Marer *et al*., 2007) [6]. Intercropping legumes contribute to increased productivity of other crops when incorporated into cropping systems as intercrops. Maize-legume intercropping is currently receiving global attention because of its prime importance in world agriculture.

Intercropping is a type of mixed cropping and defined as agricultural practice of cultivating two or more crops in the same space at the same time. The important reason to grow two or more crops together may be increase of productivity per unit of land. In the intercropping system all the environmental resources utilized to maximize crop production per unit area and per unit time.

Intercropping is a sustainable soil management means in many developed and developing countries. Introduction of a grain legume in cereal-based cropping system aims at increased productivity and profitability to achieve food and nutritional security and sustainability.

Cereals are commonly intercropped with legumes, in the hope that the former will benefit from the N-fixed by the later other benefits include maximum resource utilization and income stability and higher total returns. Intercropping is widely accepted as a sustainable practice due to its yield advantage, high utilization efficiency of light and water, and pest and disease suppression. Most studies on intercropping have focused on resource utilization, including water, light and nutrients, resulting in substantial yield advantage compared with sole cropping. In the intercrop the degree of resource complementarily, the total yield and the participation of yield between the individual species is determined by both inter- and intraspecific competition, which again is influenced by the availability of environmental resources, the relative frequency of the species and the density of components. However, the intercropped species might utilize the growth resources more efficiently than sole crops, and resources may thus support a greater number of plants.

The main aim of the Krishi Vigyan Kendra is to reduce the time lag between generation of technology at the research institution and its transfer to the farmers for increasing productivity and income from the agriculture and allied sectors on sustained basis. KVKs are grass root level organizations meant for application of technology through assessment, refinement and demonstration of proven technologies under different 'micro farming' situations in a district. Front line demonstration (FLD) is an appropriate tool to demonstrate recommended technology among the farmers. The technologies developed at the agricultural universities and research stations through research activities are demonstrated in farmers' field through FLDs.

Materials and Methods

Krishi Vigyan Kendra, Ganjam-II conducted front line demonstration (FLD) on maize cowpea intercropping as fodder at the farmer's field of Kukudakhandi, Padripalli and Sunathara of Ganjam district during kharif season of 2015-16. The soil of demonstration plots is sandy loam. The district of Ganjam lies in two agro climatic zones i.e East & South Eastern coastal plain zone and North Eastern Ghat Zone of Odisha extending from $18^0$13'N to $19^0$10' North latitude to $82^0$5' to $83^0$23' East longitude. The Average Normal Rainfall of this district is 1276.2 mm and more than 75% of the precipitation is received over five months i.e. June- October. Agriculture is the primary occupation of inhabitants of this district. The maximum and minimum temperature of this district is 39^0C and 18.9^0C respectively.

The seeds of maize variety African Tall were treated with Azotobactor @ 250 g per 10 kg of seed then used for sowing. This variety of maize comes tasseling within 65 to 70 days and gave fodder yields of about 500 to 600 q ha-1. The seed of cowpea variety EC4216 were treated with Rhizobium @ 250 g per 10 kg of seed, then used for sowing. This variety of cowpea come blooming within 45 to 50 days and gave fodder yield about 300 to 350 q ha-1.

Fodder maize (African tall)

It is a tall annual, growing to height of 220-600 cm. Leaf blades are 30- 150 cm long and 5 to 15 cm wide and this variety is ready for harvesting in 60-70 days after sowing. The green and dry fodder yields ranges from 29.0 to 60.0 t ha-1 and 8.0 to 12.0 t ha-1 respectively.

Cowpea (EC-4216): It is a semi-erect, fast growing and high yielding fodder variety suitable for cultivation all over the country. It can be harvested for fodder in 60-70 days and yields 35-40 t ha-1 of green fodder with 17.5-19.0 per cent crude protein and tolerant to many pests and diseases.

Sowing was done by opening very small furrow with the help of marker at a distance of 30 cm between the line and 10 cm between the plants. The seed was sown 5 cm deep by manual labours and was covered with soil. 75 kg seed rate of maize and 40 kg of cowpea seed rate was required for one hactare.

The maize crop was fertilized with 100 kg N, 50 kg P2O5 and 50 kg K2O ha-1. At the time of sowing of maize 50 per cent nitrogen, full dose of P2O5 and of K2O were applied as basal dose. The remaining 50 per cent nitrogen was applied at (30 DAS). The cowpea crop was fertilized with 20 kg N, 40 kg P2O5 and 00 kg K2O Per hectare of fertilizer at the time of sowing of cowpea. Nitrogen was supplied through urea having 46.0 per cent nitrogen, while phosphorus and potash were supplied through single super phosphate and murate of potash having 16 per cent P2O5 and 60.0 Per cent K2O respectively one hand weeding was done 29 days after sowing (DAS) and maintained field from weed free.

To maintain the optimum plant population 15 days after sowing (DAS). Thining was carried out and unhealthy, diseased seedling were removed at days after sowing. Harvesting of the experimental crop was done when 50 per cent flowering occurs.

The data were collected through personal contact with farmers at farmer's field and after that tabulated and analyzed to find out the findings and conclusion. The statistical tool like percentage used in this study for analyzed data.

Land equivalent ratio

LER is defined as the relative land area under sole crop that is required to produce yields achieved in intercropping. It verifies the effectiveness of intercropping for using the resources of the environment compared to sole cropping.

The LER was worked out by using the following formula given by Willey (1979).

$$LER = \frac{Ya}{Sa} + \frac{Yb}{Sb}$$

Where,

Ya and Yb: Individual crop yields under intercropping

Sa and Sb: Individual crop yields under sole cropping.

Economics of the demonstration

On the basis of result obtained from the field experiment, the economics of various treatments was worked out. The gross income per hectare was calculated on the basis of green and dry fodder yield from each respective treatment.

The net profit ha-1 was calculated by deducting the cost of cultivation ha-1 from the gross income ha-1.

$$\text{B:C ratio} = \frac{\text{Gross returns (Rs. ha-1)}}{\text{Cost of cultivation (Rs. ha-1)}}$$

Results and Discussion

The major differences were observed between demonstration package and farmer's practices are regarding recommended varieties, seed treatment, method of sowing, fertilizer dose, method of fertilizer application, weed management and plant protection measures. Table 1 shows that under the demonstrated plot only recommended varieties, seed treating culture, herbicide and plant protection chemicals were given to farmer by the KVK and other practices were timely performed by the farmer itself under supervision of KVK scientist.

Table 1: Differences between farmer's practices and demonstrated practices

Sl. No.	Practices	Demonstrated practice	Farmers' practice
1	Field preparation	2 ploughing	single plough
2	Method of sowing	.Line sowing behind the plough	Broad casting
3	Variety	Intercropping Maize (var- African Tall)+ Cowpea(var-EC 4216) in 1: 1 ratio	Sole cropping
5	Seed rate & spacing	Maize 50 kg / ha Cowpea 20kg/ha &30 x 10 cm	
6	Fertilizer Application Schedule	1) Maize - 100:50:50 kg N,P2O5 and K2O ha-1	injudicious use of chemical fertilizers
		2) Cowpea – 20:40:00 kg N, P2O5 and K2O ha-1.	
		Uniform recommended dose of 40 kg P2O5 and 20 kg K2O per hectare was applied as basal application in all plots after sowing. Nitrogen was applied in two split doses, first dose was applied as basal and remaining half of N was applied after 30 days after sowing (DAS).	
8	IPM Measures	Need based plant protection measures	Indiscriminate usage of pesticides

Total fresh forage yield (q/ha)

Table 2 depicts the total fresh forage yield of the sole maize, sole cowpea and maize cowpea intercropping in 1: 1 ratio. The fresh forage yield obtained from sole maize was 487.6q/ha and from sole cowpea it was 230.3q/ha. But from the intercropping fresh forage recorded was (412.2+92.3) q/ha. The result showed that the forage yield was recorded higher in intercropping in comparision to the sole cropping. This is due to increased efficiency of land use, enhancing the capture and use of light, water and nutrients, controlling weeds, insects, diseases. From the result it was also observed that there was decreased yield of maize due to intercropping of legumes namely cowpea. Intercropping may result in decreases in yield of one or both of the individual crops in a mixture. Nevertheless, the productivity of a unit land area is improved by intercropping rather than monocultures.

Land equivalent ratio (LER)

Mixtures of maize-legume showed advantages in land use efficiency expressed as LER. The vegetative growth of component crop in a mixture is affected by intercropping. The highest yield was obtained from sole cropping while the lowest yield was obtained when intercropped maize-cowpea. Results in Table 2 showed that LER value was greater than one (1.24) which indicated yield advantage of intercropping over sole cropping. This study indicates that LER of 1.24 can be interpreted as 24% greater yield for intercropping or as a 24% greater area requirement for the monocrop system. Higher LER in intercropping treatments indicated yield advantage over monocropping due to better land utilization.

Table 2: Yield, LER and Economics of maize cowpea intercropping as fodder

Treatments	Green fodder yield (Q/ha)	Land equivalent ratio (LER)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B: C Ratio
Sole maize	487.6	0.84	42517	58512	15995	1.37
Sole cowpea	230.3	0.40	18695	20727	2032	1.10
Maize+ cowpea intercropping (1:1)	412.2+92.3	1.24	31654	57771	26117	1.83

Economics

As regards economics of the demonstration studied revealed that the sole maize recorded highest cost of cultivation of (Rs. 42517ha^{-1}) than sole cowpea (Rs18695 ha^{-1}) and intercropping maize+cowpea in 1:1 (Rs 31654 ha^{-1}). Among the intercropping Maize +Cowpea (1:1) row ratio recorded significantly highest net monetary returns (Rs.26117 ha-1) as compared to sole maize (Rs 15965 ha^{-1}) and sole cowpea (Rs 2032 ha^{-1}). Similarly B:C ratio was found to be highest in intercropping of maize +cowpea 1:1 (1.83) in compared to sole maize(1.37) and sole cowpea(1:10).

Conclusions

This study has thus clearly brought out the beneficial effects of maize-cowpea intercropping for forage yield. As a conclusion, intercropping is more productive than sole cropping. Interc ropping can be used as a tool to improve competitive ability of a canopy with good suppressive characteristics. The results indicated that LER showed that intercropping had a major advantage over sole cropping particulary when the maize and cowpea were planted within the same basin. Therefore, it may be concluded that this initial investigation show results of maize + cowpea mixture (1:1) row cropping was found suitable for higher yield and also producing better quality forage crops compared to both sole crops of maize and cowpea.

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