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Short Communication

On farm verification of maize-vegetable based intercropping systems under subsistence farming of Jharkhand

AC Mishra

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Almost 80 percent of total agricultural area of Jharkhand state is rainfed, consequently, *Kharif* crop is the most common. The Rabi and summer crops cover a limited area with assured irrigation. Productivity and profitability of *Rabi* and summer crops is higher than the *Kharif* crop due to a number of reasons including high infestation of weeds and insect-pests during *Kharif*. Increasing profitability of *Kharif* maize is major issue particularly under subsistence farming. Vegetable intercropping is an important agronomical technique that improves diversification of food supply (Francis, 1985) and ensures high economic returns (Rana *et al*., 2001). Compatibility of cowpea (*Vigna anguiculata*) and cucurbits viz., pumpkins (*Curcubita maxima*), and cucumber (*Cucumis sativa*) with maize has been realized by Mariga (1990). Some vegetable crops like sponge gourd (*Luffa cylindrica*), ridge gourd (*Luffa acutangula*), Phoot (*Cucumis melo* var. *momordica*) and okra (*Abelmoschus esculentus*) are also intercropped with *Kharif* maize in some pockets of UP, Bihar and Jharkhand. In context of subsistence farming, socio-economic concerns of crop compatibility are crop duration, profitable yield and economic use of intercrops whereas scientific concerns of intercropping are interception of incident radiation (Liebman, 1988), competition of rhizosphere for nutrients, suppression of weed germination and growth (Akobundu, 1993, Mashingaidze *et al*., 2000, Mashingaidze, 2004.) and efficiency of land utilization (Mashingaidze, 2004). Socio-economic concerns of intercropping are more important for resource poor small and marginal farmers. Therefore, assessment and refinement of intercropping of compatible crops are relevant particularly in Jharkhand where almost 80 percent farming community has marginal and small holding size.

The experiments were conducted during *Kharif* (July to October), 2008 and 2009 in participatory mode of ten farmers of Garhwa district falling in rainfed plateaus of Jharkhand (latitude between $23^0$34'11" and $24^0$32'05", longitude between $83^0$10'13" and $83^0$56'38" and altitude 350 m above msl). Soils of experimental plots were moderately acidic (pH 5.5-6.0) and organic matter content varied from 0.5 to 0.6%. Three vegetable crops viz., cowpea (pole type), ridge gourd (cv. *Satputia*) and cucumber (local) were intercropped in 1:1 ratio with maize grown at recommended spacing of 60x25 cm. Intercropping systems were compared as against the farmers' practice i.e. sole maize crop grown at 40x20 cm spacing. The fertilizer dose applied to the main crop (maize) was NPK@ 100:60:45 kg/ha. The four treatments were tested by growing each in plots of 500 m^2 of ten farmers' field in Randomized Block Design. Data were recorded on grain yield of maize (q/ha), pod yield of cowpea (q/ha), fruit yield of ridge gourd and cucumber (q/ha). With the help of these basic data, maize equivalent yield (q/ha) and land equivalent ratios (LER) were calculated to assess the productivity of intercropping systems. Land Equivalent Ratio for maize (LERm) was calculated from component crop yields as per Mead and Willey (1980) using following formula;

$$LERm = \frac{Yim}{Ysm}$$

Where, yim is yield of maize in intercropping and ysm is the yield of sole maize.

A large population of marginal and small farmers in Jharkhand grow maize as sole crop with a common perception that accommodating more number of plants in unit area will result in higher yield just contradictory to the scientific recommendations. With this view, they grow this crop in closer spacing. Convincing them for

Birsa Agricultural University, Krishi Vigyan Kendra, Garhwa-822 114, Jharkhand
*Presently at Uttarakhand University of Horticulture & Forestry, Ranichauri Campus, Tehri-Garhwal-249 199, Uttarakhand; E-mail: acm24680@rediffmail.com

wider spacing of 60x25 cm as recommended and intercropping vegetables was proved one of the ways to improve yield and profitability of this crop. In these experiments, closer planting in maize as sole crop practiced by farmers resulted in lower grain yield compared to that grown with some of the intercrops (Table 1). In first year (2008), sole crop of maize was found to be better in performance than in intercropping systems except that with cowpea. Reduced maize grain yield in intercropping with cucurbits might be due to the vigorous vines of ridge gourd and cucumber crawled over the maize and shaded some of the most photosynthetically active leaves such as the cob leaves and imposing higher competition for nutrients as cucurbits have well-developed root system (Mashingaidze, 2004). In case of pole type cowpea, vines of cowpea take support from maize plant without damaging the leaves and pods are also light in weight. Being leguminous, cowpea further improves nitrogen content in rhizosphere of maize resulting in comparatively higher grain yield. Cowpea starts fruiting after 45-50 days of sowing and picking of pods continues to next 30-35 days. The picking ends before or during reproductive stage of maize whereas cucurbits continue to yield at reproductive phase of maize which imposes competition for grain filling resources (Agboola and Fayemi, 1971; Semu and Jana 1975; Enyi, 1973). In second year (2009) maize exhibited higher yield in all the intercropping systems (23.88 q/ha with cowpea, 22.02q/ha with ridge gourd and 20.60 q/ha with cucumber) as compared to sole crop (15.82 q/ha) although the yield of cucumber and ridge gourd was appreciably low (11.80 q/ha and 52.20 q/ha, respectively) (Table 2). However, Katsaruware and Manyanhaire (2009) reported 12-22% depressed maize yield when intercropped with a legume. The yield of main crop and inter-crops depend on the spatial arrangement and foliage architecture of the component crops. Like cucumber, bush type cowpea cultivars are also likely to prone to yield reduction due to reduced Photosynthetic Active Radiation (PAR) reaching the lower parts of the intercrop canopy (Subedi, 1996). The architectures of climbing cowpea varieties well suited in inter cropping with maize which is evident from remarkable performance of this crop in both the years (56.68 q/ha in first year and 83.80 q/ha in second year). They have greater vertical separation of the leaves that probably improve the radiation interception of the climber in intercropping (Trenbath and Angus, 1975).

Land Equivalent Ratio (LER) is indicator of crop performance in unit area under intercropping and sole crop. This may be defined as the relative land area under sole crop that is required to produce yields achieved in intercropping (Willey, 1979). It evident that intercropped maize performed better than sole crop in second year. However, LER of maize was pronounced with cowpea intercropping in first year (1.22). Higher LER of maize and cowpea intercropping (1.16 and 1.35) has also been reported by Hugar (2006) and Hugar and Palled (2008). Highest maize equivalent yield was observed for maize and cowpea intercropping in the both years (39.57 q/ha and 44.83 q/ha). The B:C ratio which is related to maize equivalent yield was also highest in maize and cowpea intercropping. The *Satputia* cultivar of Ridge gourd is characterized by its cluster bearing habit and 10-12 cm long slender fruits weighing 15-20 g. This is widely grown and preferred variety by the farmers of Bihar and Jharkhand. Generally, seed of *Satputia* is not produced by any authentic agency rather farmers themselves save own seed for next season with appreciable purity. Although, the vines of *Satputia* overarch the maize plant resulting in reduced yield of maize but maize plants are proved to be good trellis for this crop. In view of maize equivalent yield and B:C ratio, this crop is second most compatible intercrop with maize (Tables 1 and 2).

This discussion indicates that maize, an important crop of uplands and important component of food basket of

Table1: Performance of different Maize-Vegetable intercropping systems during Kharif 2008

Technology assessed	Yield/ ha(q)		Maize equivalent yield (q)	Land Equivalent Ratio of Maize (LERm)	B:C Ratio
	Maize	Intercrop			
Maize sole	19.60	-	19.60	-	2.20
Maize + Cow pea	25.40	56.68	39.57	1.22	3.50
Maize+Ridge gourd cv. *Satputia*	16.47	64.32	32.55	0.84	3.10
Maize+Cucumber	18.25	15.90	28.19	0.93	2.80
CV (%)			11.40		
SE (m)			1.62		
CD (at 0.05)			3.32		

Note: Average sale rate of Cowpea and Ridge gourd Rs. 200/q, Cucumber Rs. 500/ q and maize Rs. 800/q.

Table 2: Performance of different Maize-Vegetable intercropping systems during Kharif 2009

Technology assessed	Yield/ ha (q)		Maize equivalent yield (q)	Land Equivalent Ratio of Maize (LERm)	B:C Ratio
	Maize	Intercrop			
Maize sole	15.82	-	15.82	-	1.95
Maize + Cow pea	23.88	83.80	44.83	1.51	3.80
Maize+Ridge gourd cv. Satputia	22.02	52.20	41.60	1.39	3.60
Maize+Cucumber	20.60	11.80	29.05	1.30	2.50
CV (%)			9.74		
SE (m)			1.01		
CD (at 0.05)			2.07		

Note: Average sale rate of Cowpea Rs. 200/q, Ridge gourd Rs 300/q, Cucumber Rs. 500/ q and maize Rs. 800/q.

subsistence to big farmers of Jharkhand usually suffers inherent setback of low profitability due to weather aberrations. Intercropping of certain vegetables crops compatible with maize in terms of crop duration, nutrient uptake and ultimate use of produce could be one of the important ways to improve profitability of maize based farming. Intercropping of maize and cowpea was found to be the most remunerative and compatible system. Besides their compatibility in the field, these two crops complement each other in human diets as a ready source of carbohydrates (Galinat, 1992) and proteins with 22-30% protein. Another beneficial effect of this intercropping system may relate to nutritional security of almost 80 per cent subsistence farming community of Jharkhand. Therefore, Maize-cowpea intercropping increases the efficiency of land utilization (higher LER) and has potential to improve the profitability of smallholder farmers and it is recommended in low input smallholder farming.

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