AGROBIODIVERSITY IN SOLE AND MIXED FIELD BEAN (*LABLAB NIGER* MEDICK) AGROECOSYSTEMS IN SOUTH KARNATAKA

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SYNOPSIS

Field studies were conducted in 2009-10 to document agrobiodiversity in sole (SFB) and mixed field bean (MFB) cropping systems in and around Bengaluru (12^0 58' N, 770 35' E). In SFB only field bean was cultivated. In MFB, traditional cultivars of finger millet (*Eleusine coracana*), fodder sorghum (*Sorghum bicolor*), castor (*Ricinus communis*), niger (*Guizotica coracana*) and field bean (*Lablab niger* Medick) were cultivated. MFB supported on an average of 37 bird species with 148 individuals/km^2 while SFB supported 17 species with 30 individuals /km^2. MFB supported 13 plant species with 85250 individuals/km^2 compared to 10 species with 26000 individuals/ km^2 in SFB. MFB supported 16 butterfly species with 799 individuals/km^2 compared to SFB with 10 species and 557 individuals /km^2. Similarly it supported 30 beetle species with 76500 individuals/km^2 compared to sole crop which supported 30 species with 60250 individuals/ km^2. Application of Ekalux 25 EC @2ml/litre of water in SFB systems adversely affected pollinators, parasitoids, predators, decomposers and other beneficials.

The greater species richness at MFB was due to the greater physical habitat variability. Crop yield loss and bird species richness were negatively correlated ($r = -0.8740$), ($P < 0.5$).At study sites, crop yield loss and index of species richness were inversely related. Yield loss and insect species richness were also negatively and significantly correlated ($r = -0.9130$), ($P<0.05$). Supplementing either sole or mixed crop with bird perches (stubs), shrubs and tress along fields borders and restricted use of pesticides facilitated agrobiodiversity and mitigated problems of pests and diseases. MFB (C:B ratio 1:4.1) proved economically, environmentally and ecologically sound than SFB (1:2.3) to the growers and facilitated sustainable crop yield.

INTRODUCTION

The mixed cropping system of field bean (*Lablab niger* L.) was characterized by low input, low output returns and these crops were cultivated to meet the livelihood needs of edible oil, fodder, pulse and grains for consumption. Under sustainable agriculture, sophisticated plant protection methods are not employed. Field bean suppose to have originated in India (Rao, 1977). These crops were cultivated with family labor. In contrast, the evolution of hybrids heralded comparatively a high input and output in the farming system. Farmers began cultivating field bean under irrigated condition and they began using pesticides for the management of the pests and

diseases. So a study was initiated to compare the subsistence field bean multiple cropping system with the modern, sole cropping system of field beans. The systems were compared for environmental concern of agrobiodiversity and impact of pesticides on beneficial arthropod fauna. Economics and crop productivity issues were also addressed.

METHODS

The present investigation was carried out during rabi and kharif, 2009-10 at Rajanakunte, Bengalooru representing Eastern Dry Ago-climatic zone 77^0 34'14.4' N and Lat $13^0$5'31.6''E receives an average annual rainfall of 930 mm with two peaks in its distribution. One being in May-June and other in September-October.

Study plots: Four plots of both sole and mixed cropping systems of field bean were selected for the study. The farmers, Mr.Sriramaiah and Mr. Jayaram grew sole cropping systems and Mr.Munigowdappa and Mr.Patellappa cultivated mixed cropping system of field bean in 0.4 ha each were selected for this study. Earlier the selected plots were grew with Eucalyptus plantations. Later the farmers converted the plantations into agricultural lands. Since from 10 years the farmers started growing fieldbean in different cropping pattern in alternative years in their agricultural fields.

Documentation of Biodiversity: In order to determine the impact on the floral and faunal elements, plants and animals were sampled following the procedures detailed below.

Four quadrates of size 1mx1m were laid randomly in each type of plot in different phenotypic stages to sample the vegetation comprising cultivated plants, weeds and wild plants. So, totally from four plots vegetation was sampled in 48 quadrates of both the cropping systems. The plant stand weed species were identified and the numbers recorded.

Insects: As insects are highly diversified and occur in huge numbers and the group is represented by 29 orders, only 3 orders of insects namely butterflies, bees and beetles were sampled and these three represented the insects as a whole. The sampling of butterflies and bees were carried out between 9.00AM and 11.00AM and 3.00PM and 5.00PM once in 15 days using visual counts and handnet. Similarly beetles were sampled by visual counts and shake and tap methods. The plants were gently tapped by hand 4 to 5 times and beetles falling on a white cloth were collected, counted and identified.

The above three types of insects were sampled in both field bean systems. Birds were observed through a pair of 8X30 binoculars in and around the crop field. All the species and individuals of birds sighted for an hour were recorded. The hour count method was adopted both in morning and evening. The birds were recorded at monthly intervals from August-2009 to January-2010.

Following indices were calculated as given below

INDEX	EQUATION	REMARKS	REFERENCE
Density	Number of species A / Area sampled(m2)	Compactness with species exist in an area	Elzinga *et al., (2001)*
Relative density	Density of species A X100/ Total density of all species		Elzinga *et al., (2001)*
Dominance	Basal area of species A/ Area sampled(m2)	The occupancy of species over an area	Elzinga *et al., (2001)*
Relative dominance	Dominance of species A*100/ total dominance of all species	The occupancy of species over an area	Elzinga *et al., (2001)*
Frequency	Number of Quadrants with species A/Total number of quadrants sampled	The repeated occurrence of the species	Elzinga *et al*., (2001)
Abundance	Number of individuals of a species x 100/ Number of sampling units		Elzinga *et al., (2001)*
Shannon Weiner's Diversity index	$H= -\sum_{i=1}^{s} PilnPi$	The value ranges Between 1.5 and 3.5 and rarely surpasses 4.5	Ludwig and Reynolds(1988) Legendre and legendre(1988)
Numerical species richness	*(S-1)/(logN)*		Margaled (1958)

Biomass estimation: All the plants found in the quadrates were uprooted from the ground and brought to the lab. The plants were washed with tap water to separate soil particles from the roots and leave it for sometime. The total height and fresh weight of plants were recorded and each plant component was oven-dried at 70^{o}C then final weights were recorded using weighing balance machine. All the masses to one acre area are calculated. All herbaceous vegetation (weed) was sampled in different phenotypic stages of plant growth in both the systems.

Proforma: A questionnaire was prepared to interact with farmers about cost incurred by the farmers to raise the crop and other details like cultivation practices, pesticide applications and yields of crops will be recorded following a Proforma developed for the purpose. The cost benefit ratios of both the systems were calculated.

RESULTS

Farmers in Karnataka have developed a rainfed mixed cropping field bean (*Lablab niger Medick*) system over a long period of time. The system is a traditional mixed farming system that has sustained agriculture with diversification and at the same time conserved biodiversity and met livelihood requirements of the resource poor farmers.

The plant community parameter in sole and mixed field bean agroecosystem at poding stage is indicated in Table 1. A comparison of plant species richness in both the field bean agroecosystem revealed that biodiversity was greater in mixed than sole cropping system. Weed plants constituted an important component in the cultivated agroecosystem and played an important role in regulating biodiversity elements in the mixed field bean agroecosystems. Thripathi et al. (1987) reported that sorghum mixed with cowpea recorded significantly higher green and dry matter yield than in sole crops.

Only 3 orders of insects namely butterflies, bees and beetles were sampled and these were chosen to represents the insects as a whole. The species composition and abundance of 10 species of Butterflies from August 2009 to January 2010 in both the field bean agoecosystems are recorded in Table 2. The number of butterfly in mixed cropping system far exceeded (652) those in sole fieldbean (512) agroecosystem. The beetles under chrysomelidae (102) has more individuals compared to two other groups. The bee visits increased during November and December and decreased in January. This is because during this period the field bean and other plants in the cultivated plots attained senescence. Data on number and birds species in sole and mixed field bean agroecosystems is depicted in Fig 1. The comparison of Birds revealed 11 species in both systems. However, the number of birds in mixed cropping exceeded (325) those in sole crop ecosystems. The month wise totals suggested that January had maximum number of birds due to influx of resident and migratory species coupled with blooming and fruiting of shrubs and trees. In SFB Ekalux 25EC @ 2m/l of water was applied at pod forming stage to protect the crop from pod borers damage, application of Ekalux resulted in moratlity of beneficials like Predators viz., Coccinellid beetles, Syrphids, Wasps, *Crysoperla cornea* and pollinators viz., *Apis cerana indica*, *Apis floria*, Carpenter beetles and some Butterfly spp. Insecticidal application resulted in the mortality of many other biodiversity elements, detail study is required to document. Colignon *et al.* (2001) conducted a field study at Gembloux Agricultural University, Belgium to asses the effects of insecticides application on insect density and diversity in legume crops. The workers noticed that nearly 90,000 insects belonging to 59 major families and 64 minor families were identified and the biodiversity in terms of family numbers was significantly higher in unsprayed plots compared to spray once and biodiversity and biomass increased gradually during the season.

Economic analysis of sole and mixed field bean cultivated ecosystem and calculation of C: B ratio revealed that mixed cropping field bean agroecosystem was more profitable than sole field bean agroecosystem. In view of

the sole crop, it was subjected to more serious herbivorous insect attack compared to the mixed crop, where cross resistance and of plant volatiles did not support higher of herbivorous insects. The cost incurred in mixed cropping was thrice compared to that in sole cropping of field beans. Pandita *et al.* (1998) obtained higher benefit cost ratio (1.87) under maize-frenchbean association in 2:1 row ratio over sole maize (1.72). Thippeswamy (1999) reported that the net profit (Rs.13,822/ha) and B:C ratio (1.75) were higher in intercropping of sorghum and cowpea in 2:1 row ratio than in sole sorghum. Ghosh (2009) from central Himalayan region reported that sustainable traditional agriculture increased farmers income through agricultural crop diversification while conserving biodiversity.

Mixed cropping promoted higher biomass, utilized soil nutrients from different soil depths and also promoted biological levels at different tropic levels. Production of higher plant biomass is an indication that promotion of higher productivity at primary level. The crop biomass was higher than the weed plant biomass. Sole cropping produced more productivity of weed plant biomass than the mixed cropping system because of availability of more interspaces in the sole cropping system.

CONCLUSION

Mixed cropping system was preferred more because it was more economical and it did not require plant protection measures and reaped more crop yields. More over mixed cropping system is ecologically and environmental sound and resistant to extreme sets of natural events such as outbreak of pests and diseases. Mixed cropping systems hold higher biological diversity than sole cropping. The soil nutrients are better utilized as compared to sole cropping system. Mixed cropping promotes better turnover rates of organic matter, thus sustaining soil fertility across different layers.

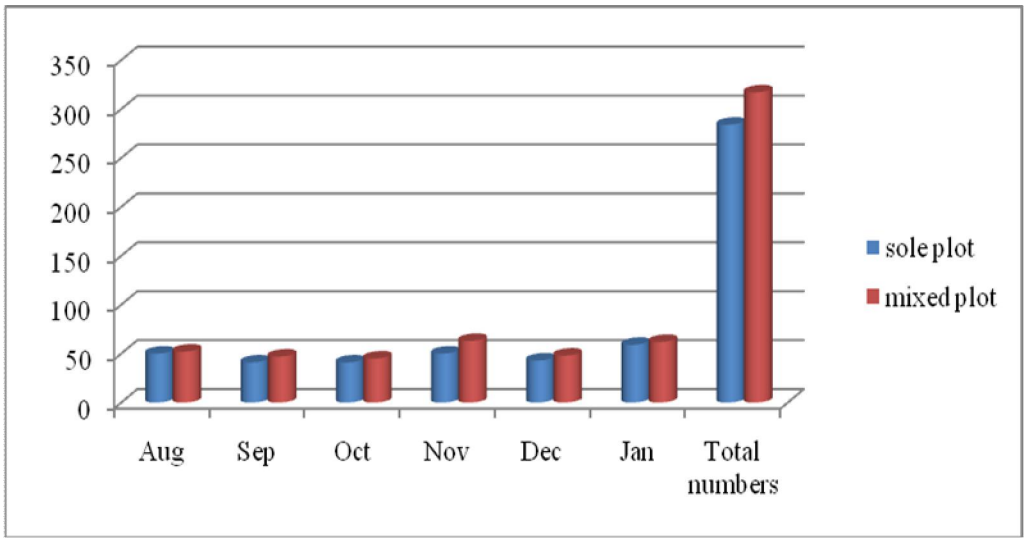

Fig 1. Comparison of Bird community in sole and mixed field bean agroecosystems

Table 1. Plant community parameters in sole and mixed field bean agroecosystem at poding phase

Plants	Species	Total No. of individuals /4m^2		Plant density /4m^2		Species frequency /4m^2	
		sole	mixed	sole	mixed	sole	mixed
Cultivated	Field bean	47	24	11.75	6.00	0.08	0.05
	Finger millet	---	0	-----	0.00	------	0.00
	Sorghum	---	34	-----	8.50	-----	0.08
	Castor	---	4	-----	1.00	------	0.00
Weeds	*Phyllanthus amara*	42	20	10.50	5.00	0.07	0.04
	Tridax procumbens	46	30	11.50	7.50	0.08	0.07
	Richardia scabra	62	54	15.50	13.50	0.11	0.12
	Mitracarpus hispida	57	51	14.25	12.75	0.10	0.12
	Cynadon dactylon	71	78	17.75	19.50	0.13	0.18
	Cyprus rotundus	86	84	21.50	21.00	0.16	0.19
	Chromoleana odarata	73	24	18.25	6.00	0.13	0.05
	Bocrhavia diffusa	25	10	6.25	2.50	0.04	0.02
	Synedrella vialis	25	12	6.25	3.00	0.04	0.02

Shannon diversity index = 0.9722; Quadrate = (1m x 1m) x 4, From November 2009 to January 2010

Table 2. Butterfly community parameters during different plant phenotypic stages (August 2009 to January 2010) of sole and mixed field bean agroecosystem

Species	**Aug**		**Sep**		**Oct**		**Nov**		**Dec**		**Jan**		**Total numbers**	
	sole	mixed	sole	mixed	sole	mixed	sole	mixed	sole	mixed	sole	mixed	sole	mixed
Mottled emigrant	11	13	18	19	24	20	20	38	44	40	7	10	124	140
Common grass yellow	14	6	12	7	14	9	11	9	25	22	2	6	78	59
Common emigrant	0	4	4	9	4	5	9	16	13	20	2	5	32	59
Common castor	5	5	7	13	8	12	8	22	16	23	1	10	45	85
Lesser grass blue	7	10	18	12	6	8	13	12	19	22	5	6	68	70
Common Indian crow	0	7	9	9	7	11	7	12	14	10	2	5	39	54
Danaid egg fly	2	5	6	7	5	8	4	21	9	20	4	4	30	65
Blue tiger	0	0	6	10	6	10	16	12	22	12	1	6	51	50
Striped tiger	0	2	3	7	5	9	10	8	15	9	2	5	35	40
Crimson rose	0	0	2	2	2	3	2	10	4	15	0	0	10	30
Total	**39**	**52**	**85**	**95**	**81**	**95**	**100**	**160**	**181**	**193**	**26**	**57**	**512**	**652**

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