Environment & Ecology 27 (4) : 1561—1566, 2009
 ISSN 0970-0420

Augmenting Production and Profitability of Finger Millet and Field Bean Intercropping System

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Abstract

To enhance the productivity of field bean and finger millet in intercropping system, different duration finger millet varieties viz., L 5, GPU 28 and GPU 26 (long, medium and short duration, respectively) along with field bean an indeterminate spreading type (IST : Mani Avare) in 8 : 1 row proportion and determinate erect type (DET : Hebbal Avare 3) in 8 : 2 row proportion besides, management practice with or without clipping of young vegetative branches (tendrils) of IST field bean and application of 2% DAP spray to DET field bean were evaluated for their yield performance during *kharif* and *rabi* seasons of 2000—2003 under rainfed conditions. DET of field bean when intercropped with long duration finger millet variety L 5 gave higher finger millet grain equivalent yield (FMGEY) of 4,752 and 4,932 kg/ha, respectively with or without application of 2% DAP spray which also gave 18 and 22% higher finger millet grain equivalent yield, respectively as compared to *Akadi* practice (4,030 kg FMGEY/ha). However, short duration finger millet GPU 26 with IST of field bean gave higher FMGEY of 4,435 and 4,595 kg/ha with or without clipping, respectively as compared to farmer's practice. Data on NMR (Rs 13,872 and 12,204/ha, respectively) and B : C ratios (1.21 and 1.05, respectively) also indicated that intercropping DET of field bean with long duration finger millet variety L 5 was remunerative over farmer's practice (Rs 9,841 NMR/ha and B : C ratio of 0.92). Application of 2% DAP spray to DET of field bean did not have much impact on yield. However, clipping of young vegetative branches of IST field bean under intercropping system resulted in slight reduction in yield (4212 kg FMGEY/ha) as compared to without clipping (4,459 kg FMGEY/ha). Among the sole crops of finger millet varieties, L 5 was a superior yielder and gave higher FMGEY (4,864 kg/ha) as compared to GPU 26 (4,659 kg/ha) and GPU 28 (4,272 kg/ha). Farmer's practice of *Akadi* (8 : 1) gave lower FMGEY (4,030 kg/ha) and NMR (Rs 9,841/ha).

Key words : Intercropping, Finger millet, Field bean, FMGEY, NMR.

From time immemorial mixed/intercropping has been an important practice under dryland conditions in many parts of India. It was considered as holistic farming designed to meet diverse domestic requirements. It is now generally perceived that the main advantage of intercropping is for stability and risk aversion. In finger millet growing areas of Karnataka under rainfed conditions farmers usually go for *Akadi* cropping where several crops (Navadhanya) viz., sorghum, pigeonpea, field bean, cowpea, niger, mustard, castor, foxtail millet, litter millet and bajra are commonly found mixed and sown after every 3—4 meters interval. The combination of crops is need based and normally there will be severe competition among the component crops usually resulting in reduced yields. Whereas intercropping of pigeonpea, field bean, soybean and cowpea in finger millet are well suited to dryland conditions.

Lablab (*Lablab purpurens* L.) locally known as field bean has limited cultivation in India. On uplands either as sole crop or with millets as a mixed/intercrop, field bean is grown both for green vegetable and for dal making. It is photosensitive and has low harvest index. Plant stalks of field bean are a valuable animal fodder. With advent of photo insensitive varieties, it is also grown as pure crop under irrigated conditions. Long duration photo sensitive varieties are commonly grown as an intercrop at wider row spacing. Green pods for vegetable purpose fetches higher returns. Further, millets returns are low but with intercropping with pulses, nutritional security and enhancement in returns are possible. To meet the growing demand of pulses and to arrest further decline in production and to make the system more vi-

Table 1. Details of weather conditions prevailed during the study period.

Details	Cropping season 2000-2001 Actual	2000-2001 Normal (1972—1999)	2001-2002 Actual	2001-2002 Normal (1972—2000)	2002-2003 Actual	2002-2003 Normal (1972—2001)	2003-2004 Actual	2003-2004 Normal (1972—2002)
Amount of Rainfall (mm) Received During the Cropping Season								
Jun	104.8	87.3	18.8	87.9	150.5	85.5	30.2	84.8
Jul	97.3	99.8	136.0	99.7	44.0	100.9	90.4	99.0
Aug	312.4	127.0	78.1	133.6	31.8	131.7	107.6	128.4
Sep	239.8	213.0	347.6	214.0	43.8	218.6	65.8	212.8
Oct	168.4	167.5	121.8	167.5	167.8	165.9	231.9	166.0
Nov	5.8	70.9	32.6	68.6	52.2	67.4	4.8	66.9
Dec	16.2	14.6	13.8	14.7	2.8	14.7	0.0	14.3
Mean Annual Rainfall (mm)								
	1232.3	918.7	1000.5	929.9	632.7	932.3	650.9	922.3
Number of Rainy Days								
	66	55	57	55	37	55	45	55
Prevalence of Dry Spells During Cropping Season								
	Oct 24 to Nov 29 Dec 5 to 29		Nov 20 to Dec 22		Aug 2 to 16 Nov 15 onwards		Sep 11 to 28 Oct 10 to till harvest	

able, it is essential to enhance the productivity of the system as a whole. Hedge et al. (1980) observed competition between finger millet and field bean for light when they were intercropped in alternate rows as the field bean covered the finger millet plants and by adopting better management practices it was possible to maintain higher yield levels of both the component crops. Top priority was accorded to crop improvement activities ever since 1970, this has led to release of large number of high yielding varieties in finger millet and other crops. This has necessitated the selection of a right combination of varieties of both base and component crop for targeting higher yield and returns.

Methods

The present investigation was undertaken at Gandhi Krishi Vigyan Kendra, University of Agricultural Sciences, Bangalore, Karnataka for three consecutive years during the *kharif* and *rabi* seasons of 2000—2003. The treatments consisted of different duration finger millet varieties viz., L 5 (125—135 days duration), GPU 28 (110—115 days duration) and GPU 26 100—105 days duration) with indeterminate spreading type (Mani Avare) and determinate erect type (Hebbal Avare 3) of field bean in 8 : 1 and 8 : 2 row proportions, respectively where management practice with or without clipping of tendrils in IST and application of 2% DAP spray to DET field bean and their combinations, and respective sole crops of finger millet and field bean varieties were tried in a randomized block design with three replications under rainfed conditions.

Rainfall during the cropping seasons 2000, 2001 and 2003 were favorable for successful raising of crops whereas during 2002 scanty rainfall with uneven distribution were experienced (Table 1). The soils of the experimental site belong to Vijayapur series and are classified as Oxic Haplustalf. The soils are reddish brown lateritic derived from granite genesis under subtropical semiarid climate. The soils are sandy loam to sandy clay loam in texture. The soils are acidic (pH : 5.24) in reaction and low in organic carbon content (0.46%). Soils are normal with respect to salt content (0.08 dS/m). The available nitrogen (245 kg/ha) and potassium (130 kg/ha) content of soil was low whereas available phosphorus (151 kg/ha) was high .

Table 2. Crop management practices performed during different years.

Details\Cropping season	2000-2001	2001-2002	2002-2003	2003-2004
Date of sowing	01-08-2000	31-07-2001	26-07-2002	31-07-2003
Date of harvesting				
GPU 26	10-11-2000	12-11-2001		20-11-2003
GPU 28	24-11-2000	26-11-2001		26-11-2003
L 5	28-12-2000	03-12-2001	Crop failed	03-12-2003
Green pods for vegetables and dry pods for seeds were harvested as and when they matured	12-10-2000 to 27-11-2000	10-10-2001 to 10-12-2001		12-10-2003 to 30-11-2003

This is a typical soil suitable for growing finger millet in Karnataka.

Finger millet and field bean varieties were intercropped in 8 : 1 and 8 : 2 row proportion based on the treatments under replacement series. Finger millet spaced at 30 cm between rows and 7.5 cm between plants. Planting paired rows of DET field bean 60 cm apart after every eight rows of finger millet and opening a furrow between was taken up with an intension to conserve moisture and the crops were raised as per recommended management practices. Fertilizer doses of 50 : 40 : 25 NPK kg/ha to finger millet and 25 : 50 : 25 NPK kg/ha to field bean were applied to sole crops following the recommendation. However, for intercropping, the fertilizer dose of the base crop (finger millet) was given. Details of sowing and harvesting of crops are given in Table 2.

Apart from yield observations, finger millet grain equivalent yield, net monetary returns and benefit cost ratios were worked out. The finger millet grain equivalent yield (FMGEY) of intercropping system was calculated by taking into account the grain / pod / seed plus straw / stalk yields of both the component crops and the prevailing market price of both the fin-

Table 3. Yield (kg/ha) of finger millet and field bean crops as influenced by intercropping system (8 : 1 and 8 : 2) under rainfed conditions. FM : Finger millet, FB : Field bean, D : Dry, G : Green, S : Short duration, M : Medium duration, L : Long duration, IST : Indeterminate Spreading Type, DET : Determinate Erect Type, Clipping : Removing young shoots at later stage of crop.

	FM grain yield (kg/ha)				FM straw yield (kg/ha)			
Treatments	2000	2001	2003	Mean	2000	2001	2003	Mean
T_1	4987	3467	2573	3676	5517	6593	5683	5931
T_2	4325	3301	2079	3235	4749	5590	5408	5249
T_3	5080	3905	1783	3589	5262	5500	5747	5503
T_4	–	–	–	–	–	–	–	–
T_5	–	–	–	–	–	–	–	–
T_6	3201	2975	1891	2689	3655	5928	4502	4695
T_7	2245	3372	1760	2459	4798	5859	3115	4591
T_8	3804	3302	1776	2961	5156	5531	4109	4932
T_9	4154	3455	1516	3042	4144	5636	3931	4570
T_{10}	3524	2668	1768	2653	4766	5064	4185	4672
T_{11}	3339	2919	1563	2607	2910	4653	4575	4046
T_{12}	2978	2821	1466	2422	2998	5496	4176	4223
T_{13}	3650	2912	1437	2666	4305	5016	4287	4536
T_{14}	3321	3727	1545	2864	4717	4284	4989	4663
T_{15}	2917	3629	1653	2733	3783	4869	4477	4376
T_{16}	2621	3664	1750	2678	3749	4681	6575	5002
T_{17}	3215	3755	1603	2858	4532	5071	5010	4871
T_{18}	2837	2989	1856	2561	3175	5343	4456	4325

Table 3. Continued.

Treatments	FB green pod / dry seed yield (kg/ha) 2000 G	2000 D	2001 G	2001 D	2003 G	2003 D	Mean G	Mean D	FB stalk yield (kg/ha) 2000	2001	2003	Mean
T_1	–	–	–	–	–	–	–	–	–	–	–	–
T_2	–	–	–	–	–	–	–	–	–	–	–	–
T_3	–	–	–	–	–	–	–	–	–	–	–	–
T_4	161	312	1040	–	–	614	600	463	3898	5242	3588	4243
T_5	849	92	2480	–	1078	75	1469	84	1257	1293	1369	1306
T_6	70	127	391	–	–	277	231	202	1804	606	949	1220
T_7	58	118	141	–	–	230	100	174	673	529	535	579
T_8	544	109	561	–	343	48	483	79	770	439	200	470
T_9	331	108	417	–	140	62	296	85	337	341	245	308
T_{10}	78	138	151	–	–	310	115	224	1203	697	608	836
T_{11}	23	115	198	–	–	260	111	188	986	731	316	678
T_{12}	302	90	358	–	276	62	312	76	265	279	355	300
T_{13}	625	99	593	–	249	59	489	79	746	404	153	434
T_{14}	87	131	263	–	–	309	175	220	1275	683	584	847
T_{15}	159	120	248	–	–	302	204	211	685	529	1241	818
T_{16}	417	100	368	–	278	20	354	60	794	376	244	471
T_{17}	355	102	166	–	360	12	294	57	313	223	289	275
T_{18}	–	–	–	–	–	–	–	–	–	–	–	–

Treatment Details :

T_1 : FM (L) sole, L 5
T_2 : FM (M) sole, GPU 28
T_3 : FM (S) sole, GPU 26
T_4 : FB (IST) sole, Mani avare
T_5 : FB (DET) sole, Hebbal avare
T_6 : FM (L)+ FB (IST) 8:1, without clipping
T_7 : FM (L)+FB (IST) 8:1, with clipping
T_8 : FM (L)+FB (DET) 8:2, without DAP
T_9 : FM (L)+FB (DET) 8:2, with DAP
T_{10} : FM (M)+ FB (IST) 8:1, without clipping
T_{11} : FM (M)+FB (IST) 8:1, with clipping
T_{12} : FM (M)+FB (DET) 8:2, without DAP
T_{13} : FM (M)+FB (DET) 8:2, with DAP
T_{14} : FM (S)+FB (IST) 8:1, without clipping
T_{15} : FM (S)+FB (IST) 8:1, with clipping
T_{16} : FM (S)+ FB (DET) 8:2, without DAP
T_{17} : FM (S)+FB (DET) 8:2, with DAP
T_{18} : Farmer's practice (*Akadi*)

ger millet and field bean as follows :

$$\text{FMGEY (kg/ha)} = \text{Yield of finger millet in intercropping system (kg/ha)} + \left[\text{Yield of intercrop (kg/ha)} \times \frac{\text{Market price of intercrop (Rs/kg)}}{\text{Market price of finger millet (Rs/kg)}}\right]$$

Results and Discussion

The grain and straw yields of finger millet varieties and pod / seed and stalk yields of IST and DET of field beans as influenced by intercropping, clipping of young vegetative branches of IST and application of 2% DAP spray to DET field beans are presented in Table 3 and the finger millet grain equivalent yield, net monetary returns and B : C ratios are presented in Table 4. The variations observed in the yield during different years both in finger millet varieties and IST and DET field beans might be attributed to variation in the amount of rainfall which ranged from 632.7 to 1232.3 mm during 2000 to 2003 cropping seasons and its distribution during the different stages of crop growth.

During 2000 cropping season, both the finger millet and field bean crops experienced terminal drought especially long and medium duration varieties were affected more. On the contrary, short duration finger millet variety GPU 26 gave highest grain yield (5,080 kg/ha) as compared to medium (4,325 kg/ha) and long (4,987 kg/ha) duration finger millet varieties as they were subjected to moisture stress during flowering and grain filling stages. Similarly, short duration DET of field bean gave higher yield (849 kg green pod + 92 kg dry seeds/ha) over long duration IST of field bean (161 kg green pod + 312 kg dry seeds/

Table 4. Finger millet grain equivalent yield (FMGEY), net monetary returns (NMR) and B : C ratio as influenced by intercropping of finger millet + field bean varieties (8:1 and 8:2) under rainfed conditions.

Treat-ments	FMGEY (kg/ha)				NMR (Rs/ha)				B : C ratio			
	2000	2001	2003	Mean	2000	2001	2003	Mean	2000	2001	2003	Mean
T_1	6311	4658	3623	4864	22147	11473	13346	15655	2.36	1.21	1.31	1.63
T_2	5465	4274	3077	4272	17937	9745	9804	12495	1.91	1.03	0.96	1.3
T_3	6343	4791	2844	4659	22331	12072	8288	14230	2.38	0.26	0.81	1.15
T_4	1368	2728	1793	1963	-2676	3160	1858	781	-0.3	0.35	0.19	0.08
T_5	1181	5583	760	2508	-3110	16009	-4863	2679	-0.34	1.76	-0.49	0.31
T_6	4611	5454	3492	4519	11832	13196	10498	11842	1.05	1.16	0.86	1.02
T_7	3933	5304	2939	4059	8243	12323	6689	9085	0.72	1.06	0.54	0.77
T_8	5737	6149	2911	4932	18459	16324	6833	13872	1.64	1.44	0.56	1.21
T_9	5802	5901	2554	4752	17524	14947	4140	12204	1.52	1.29	0.33	1.05
T_{10}	5203	4391	3197	4264	14791	8413	8580	10595	1.32	0.74	0.7	0.92
T_{11}	4557	4732	3139	4143	11344	9750	7935	9676	1	0.84	0.64	0.83
T_{12}	4273	5118	2560	3984	10143	11687	3967	8599	0.9	1.03	0.32	0.75
T_{13}	5630	5585	2776	4664	16665	13528	5584	11926	1.45	1.17	0.45	1.02
T_{14}	4983	5483	3320	4595	13689	13326	9377	12131	1.22	1.17	0.77	1.05
T_{15}	4461	5534	3311	4435	10882	13356	9117	11118	0.95	1.17	0.73	0.95
T_{16}	4264	5748	3439	4484	10096	14522	10153	11590	0.91	1.28	0.83	1.01
T_{17}	4926	6008	2969	4634	13324	15432	6839	11865	1.16	1.33	0.55	1.01
T_{18}	4080	5257	2753	4030	9929	13075	6519	9841	0.95	1.23	0.57	0.92
SE ±	336	299	179									
CD at 5%	933	828	517									

ha).

There was drastic reduction in yield of finger millet during 2001 cropping season was attributable to erratic distribution and deficit rainfall of 71.1% during August (78.1 mm) from the normal (133.6 mm) which coincided with the vegetative phase of both finger millet and field bean crops and affected the crop stand and growth. Besides, the crops experienced another moisture stress during October (121.8 mm) which was 37.5% on the negative side of the normal (167.5 mm) which coincided with the reproductive stage of the crop. However, field bean yields especially short duration DET was higher during 2001 as compared to yields obtained during 2000 as the crops were subjected to terminal drought during 2000 cropping season. Whereas, both the crops completely failed to establish during 2002 cropping season due to a prolonged dry spell which prevailed immediately after sowing of the crops which severely affected the germination and crop stand of both the crops. Besides, the rainfall received during the months of July, August and September was also on the negative side of the normal to an extent of 129.3, 314.2 and 399.1%, respectively.

Whereas during 2003 cropping season, the total rainfall received was 650.9 mm which was deviation on the negative side of normal to an extent of 41.7%, besides there was a long dry spell of 18 days coupled with below normal rainfall in September month to an extent of 223.4% and they severely affected the vegetative growth stage of both finger millet and field bean crops. Besides, there was terminal drought from 10 October onwards which coincided with reproductive stages of both the crops thereby yields of both finger millet and field bean were severely affected. Hence, net returns and B : C ratios of intercropping system were affected more as compared to sole crop of finger millet varieties.

Mean over years data revealed that the sole crop of finger millet varieties gave higher grain yield (3235 to 3676 kg/ha) than sowing of finger millet varieties with IST and DET of field beans in 8 : 1 and 8 : 2 row proportions, respectively (2,422 to 3,042 kg/ha). Similar yield reduction in finger millet when intercropped with pigeonpea in 5 : 1 and 10 : 1 row proportions was also evident as reported by Jayanna (1984). Long duration finger millet variety L 5 recorded higher grain (3,676 kg/ha) and straw (5,931 kg/ha) yields as compared to medium and short duration varieties among the sole crop of finger millet varieties. Intercropping of DET of field bean with or without application of 2% DAP spray to DET of field bean in 8 : 2 row pro-

portion recorded higher finger millet grain yield (2,771 kg/ha) than intercropping of IST of field bean either with or without clipping in 8 : 1 row proportions (2,668 kg/ha). Higher reduction in finger millet yield in intercropping IST of field bean might be due to more competition for light and suppressing effect of IST of field bean on finger millet yield may be attributed to high foliage cover on finger millet. Similar results were also reported by Shankaralingappa and Hedge (1992).

With regard to pod/seed yield of sole IST and DET of field beans, sole crop of DET recorded higher yield (1,469 kg green pod + 84 kg dry seeds/ha) as compared to IST (600 kg green pod + 463 kg dry seeds/ha) which incidentally also gave higher finger millet grain equivalent yield (2,508 kg/ha), NMR (Rs 2,679/ha) and B : C ratio (0.31) as compared to IST of field bean (1,963 kg FMGEY/ha, Rs 781 NMR/ha and B : C ratio of 0.08). Irrespective of finger millet varieties, DET of field bean recorded higher yield (371 kg green pod + 73 kg dry seeds/ha) as compared to IST (156 kg green pod + 203 kg dry seeds/ha) among the intercropping systems. Similar results were also reported by Ramamoorthy et al. (2003).

Intercropping of DET of field bean with finger millet varieties in 2 : 8 row proportion with or without application of 2% DAP spray to DET of field bean incidentally gave higher finger millet grain equivalent yield (4,575 kg/ha), NMR (Rs 11,676/ha) and B : C ratio (1.01) as compared to IST field bean in 1 : 8 row proportion with or without clipping of young vegetative branches of IST (4,336 kg FMGEY/ha, Rs 10,741 NMR/ha and B : C ratio of 0.92). The higher yield of DET field bean in intercropping systems may be attributed to paired row of planting compared to single row of IST field bean which has resulted in the enhanced FMGEY as well as returns of the system.

Under intercropping systems, application of 2% DAP spray to DET of field bean had slightly increased the finger millet grain yield to the tune of 6.25% but reduced the field bean yield to the tune of 4.84%. Thus, application of 2% DAP spray to DET of field bean did not have much impact on yield. However, clipping of young vegetative branches of IST of field bean has reduced the both finger millet and field bean yields to the tune of 5.19 and 18.24% respectively as compared to without clipping.

Conclusion

It can be inferred that intercropping of long duration finger millet variety L 5 either with determinate erect type of field bean (Hebbal Avare) in 8 : 2 row proportion for areas of well distributed rainfall or with indeterminate spreading type of field bean for areas with uneven distribution of rainfall are better choices in enhancing productivity and economic returns. Besides, application of 2% DAP spray to DET of field bean did not have much impact on the yield. However, clipping of young vegetative branches of IST of field bean had negative effect on yield and economics of the system.

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