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Sustainable Dryland Technologies for Improving Productivity and Livelihood Security in Alfisols of Karnataka

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ABSTRACT: Operational Research Project on dryland agriculture with its main focus on participatory technology demonstration functioned at Alanatha cluster of villages from 2010 to 2014. Based on the PRA and benchmark survey, technical interventions have been taken up under different themes. Opening of moisture conservation furrow between paired rows of pigeonpea in finger millet + pigeonpea (8:2) and groundnut + pigeonpea (8:2) intercropping systems recorded higher finger millet grain equivalent yield (3156 kg/ha) and groundnut equivalent (1007 kg/ha) yield with higher net returns(₹ 37390 and 18842/ha, respectively) and higher values of sustainable yield index (0.56 and 0.30, respectively). Introduction of pigeonpea + field bean (1:1) intercropping system resulted in higher pigeonpea equivalent yield (1173 kg/ha), sustainable yield index value (0.43) and net returns (₹ 32415/ha) compared to sole crop of pigeonpea (1093 kg/ha), field bean (461 kg/ha). Improved medium duration finger millet variety GPU-66 produced higher grain yield (2722 kg/ha) and net returns (₹ 25542/ha) followed by variety ML-365. Improved pigeonpea variety TTB 7 produced higher seed yield (879 kg/ha). Application of organic and inorganic fertilizers along with micronutrients gave maximum net returns (₹ 36504 /ha), sustainable yield index value (0.72) and higher yield (2899 kg/ha) compared to farmers' practice. Pre-emergent application of alachlor @ 2.5 lt/ha along with one hand weeding recorded lower weed menace and higher groundnut pod yield (499 kg/ha).

Key words: Dryland technologies, fingermillet, pigeonpea yield, sustainable yield index

Out of the total geographical area of 328.73 m ha in India, only 143 m ha is under cultivation. Of the 141 M ha of net sown area in the country, 80 m ha is rainfed. Rainfed agriculture contributes 40% of food grain production (Ramachandrappa *et al*., 2014). The average productivity in rainfed areas is only 0.7 to 0.8 t/ha (Singh and Venkateswarlu, 1999). These areas are marked by erratic and unpredictable rainfall with inadequate soil moisture, light/medium textured soils having rolling topography and highly erodible creating an atmosphere of high risk, insecurity and lower yields. These areas are dominated by small and marginal farmers. Despite the realization that it is much difficult to increase the production from drylands, it cannot be neglected, as a large number of farmers with more than two-thirds of the cultivated area of the country is involved. Unless the vast areas of drylands are developed, increase in production cannot be achieved. Thus, the improvement of rainfed farming is the key to meet the growing food demands of our country.

Karnataka is a typical semi-arid tropical region with 116.7 l ha is under cultivation comprising nearly 75% of the cultivable area under rainfed. About 57% of food grain production in Karnataka comes from rainfed areas while, 97% of total pulses and 80% oilseeds are produced in dry land areas. Traditional farming systems are low productive and can't ensure livelihood/food security and sustainability. Hence, an efficient research strategy should focus on sustainable technologies for improving productivity and livelihood security. Keeping this in view, Operation Research Project (ORP) on dryland agriculture with its main focus on participatory technology demonstration functioned from 2010 to 2014 at Alanatha cluster of villages in Kodhalli hobli of Ramangara district of Karnataka state has been attempted for this study.

Materials and Methods

The ORP for Dryland Agriculture initiated its participatory technology development and upscaling in Alanatha cluster of villages which is located at 12^0 23'N latitude, 77^0 31'E longitude and 968 m above mean sea level. The outcomes of participatory rural appraisal (PRA) revealed that the farmers in the domain area of Alanatha cluster village are small and are practicing traditional cropping. These areas are traditionally fingermillet mono cropped. Their major source of income was agriculture and livestock and the major production constraints are lack of awareness about improved varieties and production practices, imbalanced fertilizer use, low to medium soil fertility, undulating topography. The villages are largely composed of sandy loam soils with slightly acidic to neutral in soil reaction, low to medium in fertility status. Fields were selected based on the willingness of farmers to engage in participatory research to evaluate the science based strategy. Before conducting the demonstration, list of farmers was prepared from group meeting and specific skill training was given to the selected farmers. Selected farmers participated in each and every research intervention from soil sampling to harvest. Timely sowing, maintenance of required spacing and plant population, timely weeding and plant protection measures were attended as per the instructions of ORP scientists and a control treatment of farmers' practice was included for comparison. The villages received rainfall of 797.2, 882, 494, 848.4 and 653.4 mm during 2010, 2011, 2012, 2013 and 2014, in 41, 37, 23, 58 and 32 rainy days, respectively as against normal rainfall of 756 mm in 48 rainy days. Weather in total was normal during 2010 and 2013, delay in onset during 2011 and deficit rain (-35%) during 2014. Based on the PRA and benchmark survey, technical interventions have been taken up under different themes. Theme-wise improved practice demonstrated over the prevailing farmers' practice for the present study is given in Table 1. The economics of various treatments were calculated individually for all the years considering the prevailing price of inputs and produce. The per ha net returns accrued was worked out by subtracting cost of cultivation (per ha) from the gross return (per ha). The data were subjected to paired "t" test analysis for determining the significance of difference between the treatments and to draw valid conclusions. The level of significance used was p=0.05. Data were converted in to quantitative form and finally per cent increase in yield, technology gap and extension gap and benefit-cost ratio were calculated by using the formula given by Samui *et al.* (2000):

Technology gap = potential crop yield- crop yield under demonstration

Extension gap = crop yield- under demonstration – crop yield under farmers' practice

The maximum yield of crop obtrained at the research station with favorable weather and crop management practices were accounted as potential yield. While, the maximum yield noticed in the farmers' field during the demonstration is counted for demonstration yield.

The SYI of different intercropping systems was calculated following the equation suggested by Sharma *et al.,* 2004.

$$\text{Sustainability yield index (SYI)} = \frac{(A-SD)}{Y_{max}}$$

Where, A = Average yield over the years for a particular treatment

SD = Standard deviation for the treatment

Y_{max} = Maximum yield obtained of the treatment over the years.

$$\text{Per cent increase in yield} = \frac{\text{Grain yield under improved practice} - \text{Grain yield under farmers' practice}}{\text{Grain yield under farmers' practice}} \times 100$$

Results and Discussion

In-situ moisture conservation through conservation furrow in finger millet + pigeonpea intercropping system

Opening of moisture conservation furrow between paired rows of pigeonpea in finger millet + pigeonpea (8:2) intercropping system recorded higher finger millet grain yield (2456 kg/ha) and pigeonpea yield (275 kg/ha), with an average finger millet grain equivalent yield of 3156 kg/ha, higher returns of ₹ 37390/ha and B: C ratio of 3.13 as compared to farmers' practice (Table 2). The average additional equivalent yield under improved technology was 1675 kg/ha which is 113% higher over farmers practice. The additional net return recorded was ₹ 26,748 / ha. Finger millet + pigeonpea (8:2) intercropping system recorded higher value of sustainable yield index (0.56) over farmer's practice (0.28). The technology gap was 8.44 q/ha. Technology gap implies researchable issues for realization of potential yield while extension gap implies what can be achieved by the transfer of existing technology. Paired t test revealed significant (37.23) difference among the treatments at p=0.05 level of significance. Khan *et al.* (2009); Raikwar and Srivastva (2013); Channappa and Ashoka (1972) reported similar results. The increased yield and net returns accrued were associated with increased soil profile moisture as a result of conservation furrow. Besides, intercropping of compatible crops benefit mutually in improving system productivity and returns. Pigeonpea being a leguminous crop helps for biological nitrogen fixation fulfilling the nitrogen needs of finger millet partly.

Groundnut + pigeonpea (8:2) intercropping system for higher productivity

Among different groundnut based production systems, intercropping of groundnut + pigeonpea (8:2) with a moisture conservation furrow between paired rows of pigeonpea recorded higher groundnut pod yield (561 kg/ha) and pigeonpea seed yield (425 kg/ha) and economic returns(₹ 18842/ha), B:C ratio(1.96) compared to farmers' practice (Table 3). The average additional equivalent yield under improved technologies over farmers' practice was 567 kg/ha, which is 129% higher over farmers' practice. Higher value of sustainable yield index was recorded for 8:2 groundnut + pigeonpea (0.30) followed by 8:1 groundnut + castor (0.21) over farmers' practice (0.19). The additional net returns realized was ₹13,984/ha in a groundnut cropping system with technology gap of 6 q/ha and extension gap of 5.6 q/ha. Significant (7.58) difference was noticed among the treatments at 5% level of significance. The advantage of having conservation furrow between two rows of pigeonpea in groundnut + pigeonpea (8:2) intercropping has been reported by Ramachandrappa *et al*. (2011).These results were in conformity with the findings of Badanur *et al*. (1995), Arjun Prasad and Ratan Singh (1998), Raikwar and Srivastva (2013) and Vijay Kumar *et al*. (2014).

Pigeonpea + fieldbean (1:1) intercropping system

Introduction of pigeonpea + field bean (1:1) intercropping system resulted in higher pigeonpea average grain equivalent yield (1173 kg/ha), returns (₹ 32415 /ha) and B: C ratio (3.11)

Table 1 : Different technical interventions under different themes

Theme	Existing practice	Improved practice demonstrated
In-situ moisture conservation through conservation furrow in fingermillet + pigeonpea (8:2) intercropping system	No conservation furrow 10-14 rows of finger millet akkadi (one row of mixture of 5-9 crops like fodder sorghum, castor, mustard, sesame, cowpea, pigeonpea, field bean)	Drill sowing of finger millet and pigeonpea in (8:2) row proportion, maintaining of 30 cm spacing between finger millet and 60 cm between pigeonpea using improved seed drill.Opening of conservation furrow at 35 days after sowing between two rows of pigeonpea
Groundnut + pigeonpea (8:2) intercropping system	Groundnut + akkadi without any definite row proportions	Simultaneous sowing of groundnut + pigeonpea (8:2) row proportion and conservation furrow between two rows of pigeonpea
Pigeonpea + field bean (1:1) intercropping system	Pigeonpea as sole crop, Field bean as sole crop	Simultaneous sowing of pigeonpea and short duration field bean variety (HA-4) in 1:1 maintaining three feet distance between rows of pigeonpea without losing main crop
High yielding finger millet varieties	Local varieties	Improved fingermillet varieties for different sowing window. Viz., MR-1, MR-6 and L-5 for July, GPU-28, GPU-66 for August, GPU-48 for August end, September 1Stweek
Improved pigeonpea varieties	Local pigeonpea varieties	Improved varieties of pigeonpea (BRG-1,BRG-2, TTB-7)
Introduction of Samruddhi green chilli	Local variety of chilli	Samruddhi chilli variety
Integrated nutrient management	Imbalanced nutrition	INM practice with soil test based micronutrient application
Site-specific nutrient management (SSNM) in groundnut + pigeonpea intercropping	Application of sub-optimal levels of nutrients based on blanket recommendation	SSNM
Weed management in groundnut + pigeonpea intercropping system	2 - 3 hand weeding	Alachlor @2.5 liter/ha + 1 hand weeding

Table 2 : Yield (kg/ha) and economics (₹/ ha) of finger millet + pigeonpea (8:2) cropping system (Mean of 2010-2014)

Treatment	Number of farmers	Finger millet yield (kg/ha)		Inter crop yield (kg/ha)	Grain equivalent yield (kg/ ha)	Net returns (₹/ha)	B:C ratio	SYI	Yield increment		Addi-tional netre turns	Tech nology gap (q/ ha)	Exten sion gap (q/ha)
		Grain	Straw						(kg/ ha)	(%)			
FM + PP	202	2456	5876	275	3156*	37390	3.13	0.56	1675	113	26748	8.44	16.7
FP		1287	2651	25	1481	10642	1.71	0.28					

Paired “t” test value(grain yield) = 37.23

FM= Finger millet, PP= Pigeonpea, FP: Farmers’ practice (FM + *akkadi*), SYI: sustainability yield index, *‘ t’ value significant at 5% level of significance

Table 3 : Yield (kg/ha) and economics (₹/ ha) of groundnut + pigeonpea (8:2) cropping system (mean of 2010-2014)

Treatment	Number of farmers	Groundnut yield (kg/ha)		PP yield (kg/ha)	GN equi. yield (kg/ ha)	Net returns (₹/ ha)	B:C ratio	SYI	Yield increment		Ad ditional net returns	Tech nology gap (q/ha)	Ex tension gap (q/ha)
		Pod	Haulm						(kg/ ha)	(%)			
GN + PP (8:2)		561	1910	425	1007*	18842	1.96	0.30	567	129	13984	6	5.6
GN + Cas (8:1)	65	596	2033	189	820	10872	1.63	0.21	187	42.5	7970		
FP		444	1462	60	440	4858	1.36	0.19					
Paired "t" test (pod yield) = 7.58													

GN= Groundnut; PP= Pigeonpea;cas: castor FP: Farmers' practice (GN + *akkadi),* SYI: Sustainability yield index, *' t' value significant at 5% level of significance

compared to sole crop of pigeonpea (1093 kg/ha, ₹ 29689 / ha and 2.88, respectively) and field bean (461 kg/ha, ₹ 6778 / ha and 1.61, respectively). The average additional equivalent yield and present increment under improved technologies over farmers' practice was 712 kg/ha and 154 for sole crop of field bean and 80 kg/ha and 17.32 for sole crop of pigeonpea, respectively (Table 4). The value of sustainability yield index recorded for pigeonpea + field bean (0.43) was higher compared to farmers practice of pigeonpea as sole crop (0.37) and field bean sole (0.11). Paired t test revealed significant differences for the treatments of having sole crop of field bean (17.18) and pigeonpea (2.92). Ramachandrappa *et al.* (2014) also reported similar results.

High yielding finger millet varieties for rainfed situation

The superiority of finger millet yield during 2010, 2011 and 2013 are associated with normal rainfall (797.2, 882 and , 848.4 mm, respectively) distributed uniformly with higher number of rainy days (41, 37 and 58 days, respectively) during the cropping season (July to December) against normal rainfall of 756 mm with 48 rainy days. Deficit / scanty rains (494 mm and 653.4 mm, respectively) and ill-distribution (23 and 32 days) during the cropping season resulted in lower finger millet yield. Overall, among the long duration varieties, L-5 recorded higher grain yield (2719 kg/ha) and among the medium duration varieties GPU-66 produced higher grain yield (2722 kg/ha). Overall improved medium duration variety GPU-66 produced higher grain yield (2722 kg/ha), net returns (₹ 25542 /ha) and B: C ratio (2.71) followed by variety ML-365 (2616 kg/ha, ₹30,140/ ha and 2.77, respectively) compared to local variety (1360 kg/ha, ₹ 8644 /ha and 1.50, respectively). The average yield increase of L-5 over farmers' local variety registered 1359 kg/ha) (about 100% increase) with additional net returns (₹ 15,031/ha) which was lower compared to MR-1 (₹ 22939/ ha) with yield increase (₹ 1306 kg/ha and 96%). Significant positive correlation was observed for rainfall and yield for GPU-48 (0.87). Significant differences were noticed among the varieties compared to local except for MR-6. The yield and net returns accrued of medium duration varieties (ML-365 and GPU-66) were higher than long duration due to delayed monsoon and sowing in the domain area (Table 5). Ramachandrappa *et al.* (2010) also reported the similar results.

Table 4 : Yield (kg/ha) and economics (₹/ ha) in pulse based production system (mean of 2010-2014)

Treatment	Number of farmers	Yield (kg/ha)		PP equi. yield (kg/ha)	B:C ratio	Net returns (₹/ ha)	SYI	Yield increment for field bean		Yield increment for pigeonpea		Additional net returns (₹/ ha)	
		Grain	Stalk					(kg/ha)	(%)	(kg/ ha)	(%)	Field bean	Pigeon pea
PP + FB (1:1)	15	971	295	1173*	3.11	32415	0.43	712	154	80	17.32	25637	2726
PP sole		1093	-	1093	2.88	29689	0.37						
FB sole crop		-	460	461	1.61	6778	0.11						
Paired "t" test value(pod yield) = 17.18 (FB), 2.92(PP)													

PP: Pigeonpea, FB:Field bean, SYI: Sustainability yield index,*' t' value significant at 5% level of significance

Table 5 : Yield and economics of different finger millet varieties (mean of 2010-2014)

Variety	Number of farmers	2010	2011	2012	2013	2014	GY (kg/ha)	Correlation of yield with rainfall	Net returns (₹/ ha)	Yield increment (kg/ha)	Yield increment (%)	Additional net returns	B:C ratio
		Long duration varieties											
MR-1	12	3800	2280	2371	2578	2300	2666* (2.96)	0.57	31583	1306	96	22939	2.87
MR-6			2165	2165	2312		2214 (3.48)	0.65	25591	854	62.79	16947	2.55
L-5		4056	2050	2050			2719* (5.02)	0.71	23675	1359	99.9	15031	2.67
Medium duration varieties													
GPU-28		2889	2125	2250	2425	2260	2390* (10.14)	0.57	26294	1030	75.7	17650	2.52
ML-365		3244	2600	2500	2314	2423	2616* (7.99)	0.42	30140	1256	92.3	21496	2.77
GPU-66		3311	2405	2305	2278	3311	2722* (12.81)	0.30	25542	1362	100	16898	2.71
Short duration variety													
GPU-48		2193	2193	2014	2184	2193	2155* (5.55)	0.87*	31022	795	58.45	22378	2.46
Local		1650	1170	1170	1214	1597	1360	0.36	8644				1.50

Figures in parentheses indicate paired t test value, *'t and r' values significant at 5% level of significance

Performance of pigeonpea varieties

Improved variety TTB-7 produced higher yield (913 kg/ha), net returns (20470 /ha) and B: C ratio (2.61) followed by BRG-1 (879 kg/ha, 19,800 /ha and 2.48, respectively) compared to BRG-2 (857 kg/ha, ₹ 18900 /ha and 2.39, respectively) (Table 6). Significant and positive correlation with yield was observed for variety TTB-7 (0.91). Crop performance was normal in spite of dry spells during 2010 and 2013; delayed onset during 2011 resulted in low yield. Whereas, in 2014 dry spells during major crop stage coupled with failure of early rains hampered the crop growth. Ramachandrappa *et al.* (2010) reported the similar results. Variety BRG-1 was largely preferred by the farmers because of its yield advantage besides intermediate value addition due to selling of green pods as vegetable.

Introduction of Samruddhi green chilli

Samruddhi chilli variety with attractive lustrous green colour and medium pungent and ideal for green chilli and suited to dryland conditions, recorded higher mean yield (5274 kg/ha) and B:C ratio (3.96) as compared to Chikaballapura local (2976 kg/ha and 2.27, respectively). Deficit/scanty rains (361.6 mm) and its ill-distribution during 2012 (17 rainy days) during the cropping season resulted in lower chilli yield. The average quality and percent increase of yield of improved variety over local variety was 2298 kg/ha and 77.21% over farmers' practice with additional net returns of ₹ 35452 /ha which were differed significantly (Table 7). Similar results of superior performance in samruddhi chilli over chikkaballapur local were reported by Ramachandrappa *et al.* (2010).

Integrated nutrient management

Application of organic and inorganic fertilizers along with micronutrients gave maximum net returns of ₹ 36504/ha with B:C ratio of 2.90 with a finger millet grain yield of 2373 kg/ha and pigeonpea yield of 198 kg/ha compared to farmers' practice of finger millet + *akkadi* gave net returns of ₹ 9460/ha and B: C ratio of 1.60. The average additional equivalent yield of 50% N through FYM + 50% N and 100% PK through inorganic source + zinc sulphate (12.5 kg/ha) + borax was higher by 1604 kg/ha grain yield and per cent increase by 124 with additional net returns of ₹ 27044/ha over farmers' practice while the value of sustainability yield index (0.72) was also higher compared to other practices. Significant differences were noticed among the treatments (Table 8).

Site-specific nutrient management

Application of sub-optimal levels of nutrients based on blanket recommendation results in detoriaration of soil fertility, low productivity and poor quality produce. Supply of nutrients considering the crop need, soil fertility level and other agro-ecological situation (SSNM) + zinc sulphate (12.5 kg/ha) + borax (10 kg/ha) + biofertilizer recorded a higher grain equivalent yield of 1087 kg/ha and B:C ratio (2.36) with sustainability yield index value (0.50) compared to other practices. The average additional equivalent yield of SSNM + zinc sulphate (12.5 kg/ha) + borax (10 kg/ha) + biofertilizer was higher with 616 kg/ha and 131% increase over farmers' practice with additional net returns of ₹ 20,880 under site-specific nutrient management. Significant (6.19) difference was noticed among the treatments at p=0.05 level of significance (Table 9). Similar reports were also reported by Ramachandrappa *et al.* (2014).

Weed management in groundnut + pigeonpea intercropping system

Pre-emergent application of alachlor @ 2.5 lt/ha along with one hand weeding recorded lower weed menace and higher groundnut pod yield (499 kg/ha), B:C ratio (1.96) with higher value of sustainability yield index (0.95) compared to farmers' practice (210 kg/ha, 0.97, 0.21, respectively) in groundnut + pigeonpea (8:2) intercropping system. The average additional equivalent yield with alachlor + 1 hand weeding was higher with 288 and 138 % increase over farmers' practice with additional net returns of ₹ 18687 / ha under weed management practices, significant (4.81) difference was noticed among the treatments (Table 10). Ramachandrappa *et al.* (2014) reported similar results.

Table 6 : Average yield and economics of pigeonpea varieties (mean of 4 years)

Variety	Number of farmers	Yield (kg/ha)				Correlation with rainfall	Mean grain yield (kg/ha)	B:C ratio	Mean net returns
		2010	2011	2013	2014				
BRG-1		1060	770	870	815	0.73	879	2.48	19800
BRG-2	8	990	745	864	830	0.66	857	2.39	18900
TTB-7		1150	855	910	738	0.91*	913	2.61	20470

.*r ' value significant at 5% level of significance

Table 7 : Average yield and economics of green chilli (mean of 2010-2014)

Variety	Number of farmers	Green chilli (kg/ha)						Corre-lation value	B:C ratio	Net returns (₹/ ha)	Yield increment		Additional net returns (₹/ ha)
		2010	2011	2012	2013	2014	Average				(kg/ ha)	(%)	
Samruddhi	33	7500	5488	4440	4343	4598	5274*	0.56	3.96	59642	2298	77.21	35452
Local		4400	3364	2360	2325	2430	2976	0.58	2.27	24190			
Paired "t" test value(fruit yield) = 30.31													

*' t' value significant at 5% level of significance

Table 8 : Yield (kg/ha) and economics (₹/ ha) of finger millet + pigeonpea cropping system under integrated nutrient management (mean of 4 years 2011-2014)

Treatments	Number of farmers	Finger millet yield (kg/ha)		Pigeonpea grain yield (kg/ha)	Grain equivalent yield (kg/ha)	Net returns (₹/ha)	B:C ratio	SYI	Yield increment (kg/ha)	Yield increment (%)	Additional net returns (₹/ha)
		Grain	Straw								
T_1	4	2111	4217	163	2545	30356	2.61	0.66	1250	97	20890
T_2		2373	4669	198	2899*	36504	2.90	0.72	1604	124	27044
T_3		1140	2672	11	1295	9460	1.60	0.35			
Paired "t" test value (grain yield) = 8.05											

T_1= RDF (50:40:25 N, P_2O_5 and K2O, (Finger millet + pigeon pea) : 8:2; T_2= 50% N through FYM +50% N and 100% PK through inorganic source + zinc sulphate (12.5) + borax (10) + biofertilizer

T_3: Farmers' practice (Finger millet + akkadi): SYI: S ustainability yield index.

Table 9 : Yield (kg/ha) and economics (₹/ha) of groundnut + pigeonpea cropping system under site specific nutrient management (mean from 2010 to 2014)

Treatment	Number of farmers	Groundnut yield (kg/ha)		Pigeonpea (kg/ha)	Net returns (₹/ha)	B:C ratio	GNEY (kg/ha)	SYI	Yield increment (kg/ha)	Yield increment (%)	Additional net returns (₹/ha)
		Pod	Haulm								
T_1		562	2125	430.2	19952	2.03	888	0.39	417	89	16039
T_2	4	689	2599*	523.4	24793	2.36	1087	0.50	616	131	20880
T_3		423	1540	75	3913	1.32	471	0.26			
Paired "t" test value = 6.19											

T_1: RDF (25:50:25 NPK kg/ha) Groundnut + pigeonpea (8:2) (Naryani+ BRG-1), T_2: SSNM + zinc sulphate (12.5 kg/ha) + borax (10 kg/ha) + biofertilizer, T_3: Farmers' practice (Groundnut + *akkadi* crop)
SYI: Sustainability yield index, GNEY: Groundnut equivalent yield,*'t' value significant at 5% level of significance

Table 10 : Yield and economics of groundnut + pigeonpea intercropping system under weed management practices (mean of 3 years from 2011-2013)

Treatment	Number of farmers	Groundnut yield (kg/ha)		Pigeonpea yield (kg/ha)	Net returns (₹/ha)	SYI	Yield increment (kg/ha)	Yield increment (%)	Additional net returns (₹/ha)
		Pod	Stalk						
IP	4	499	1771	328*	19620	0.95	288	138	18687
FP		210	731	220	933	0.21			
Paired "t" test value = 4.81									

IP: Improved practice (Alachlor + 1 hand weeding), FP: Farmers' practice, SYI: Sustainability yield index,*' t' value significant at 5% level of significance

Annexure – I Cost of cultivation and produce price of different components

Cost of cultivation (₹/ha)	2010	2011	2012	2013	2014
FM + PP	14500	15000	15560	20579	25591
FM + akkadi	10420	10500	14700	15300	26666
GN + PP	17000	17500	16560	17300	34763
GN + castor	16500	16600	14800	15300	34763
GN + akkadi	14000	14500	16050	16050	35763
FB + PP	12500	12600	12800	12900	30997
Finger millet varieties	13000	13300	16250	18988	23816
Chilli	15550	15550	16500	24491	29366
Pigeonpea varieties	12000	31420	30352	40738	37251

Materials (₹/kg)	2010	2011	2012	2013	2014
Finger millet	10	11	20	20	25
Pigeonpea	35	35	40	43	43
Groundnut	28	28	50	50	60
Field bean	30	30	30	25	50
Chilli (green)	10	10	15	10	10
Castor	22	35	35	40	40
Finger millet straw	0.75	0.75	0.75	0.75	0.75
Groundnut haulm	0.5	0.5	0.5	0.5	0.5
Fuel wood (pigeonpea)	0.5	0.5	0.5	0.5	0.5

Conclusions

Sustainable dryland practices *viz.,* moisture conservation furrow in finger millet + pigeonpea (8:2) and groundnut + pigeonpea (8:2) intercropping, intercropping of pigeonpea + field bean (1:1), adoption of improved varieties of finger millet, pigeonpea and chilli varieties according to the sowing window, INM in fingermillet and SSNM in groundnut + pigeonpea as a nutrient management strategy and pre-emergent application of alachlor @ 2.5 litre/ha with one hand weeding in groundnut + pigeonpea (8:2) proved superior in improving productivity and sustainability of dryland farmers.

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