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Sustainability of rainy-season cropping systems under dryland conditions of Vertisols

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ARSTRACT

An experiment was conducted during 1988–1993 on Vertisols to study sustainabiltiy of rainy-season (*kharif)* cropping systems under rainfed conditons. Grain yield of pearl millet [*Pennisetum glaucum* (L.) Br. remend. Stuntz] (19.64 q/ha) incressed owing to intercropping with pigeonpea [*Cajanus cajan* (L.) Millsp.] (3.58 q/ha) compared with sole pearl millet (17.68 q/ha) showing complimentary effects. Pearl millet yield increased by 17.9% under sunflower (*Helianthus annuus* L.)–pearl millet system compared with continous pearl millet and by 32.8% under sunflower–pearl millet + pigeonpea system compared with sorghum [*Sorghum bicolor* (L.) Moench]–pearl millet + pigeonpea system. Significantly highest monetary returns (Rs 9,414/ha) were obtained from pearl millet + pigeonpea (2 : 1) intercropping in current-year cropping. Similarly, sole pearl millet also gave significantly more monetary returns (Rs 6,980/ha) than rest of the sole crops. Sustainable value index was the highest (0.62) under pearl millet + pigeonpea (2 : 1) intercropping, followed by sole pearl millet (SVI 0.50), indicating sustainability of these crops during the *kharif* season on medium deep Vertisols (30–45 cm) of dryland areas.

Most of the farmers of dryland areas have a tendency of growing winter-season (*rabi*) sorghum [*Sorghum bicolor* (L.) Moench] even on medium deep Vertisol having depth from 30 to 45 cm. However, due to low moisture-holding capacity of these coils, they could not sustain *rabi* sorghum under receding soil moisture. Therefore, Patil *et al.* (1981) suggested to put these soils under rainy-season (*kharif)* cropping to increase their productivity. However, the productivity of *kharif* crops in drought-prone areas is very low. Out of the several reasons of low productivity, continuous monoculture of either pearl millet [*Pennisetum glaucum* (L.) R. Br. emend. Stuntz] or sunflower (*Helianthus annuus* L.) is important. One of the ways to increase the productivity of *kharif* crops is to adopt crop rotations. The productivity of these medium deep (30–45) Vertisols could considerably be increased with intercropping of pearl millet + pigeonpea [*Cajanus cajan* (L.) Milssp.]. This intercropping is also more stable and remunerative than sole cropping during *kharif* season (Umrani, 1981; Jadhav *et al.*, 1991). An investigation was therefore carried out during 1988–1993 to assess the potential of rotation on the productivity of *kharif* crops and to estimate sustainability.

MATERIALS AND METHODS

The investigation was conducted on Vertisol having depth 45 cm with pH 8.2, electrical conductivity 0.13 mmhos/cm, available N 172.5 kg/ha, available P_2O_5

21.95 kg/ha and available K_2O 524.0 kg/ha. The treatment consisted of pearl millet ('ICTP 8203' at 45 cm x 22.5 cm), pigeonpea ('No. 148 at 60 cm x 22.5 cm), sunflower ('Mordern' at 60 cm x 22.5 cm), castor (*Ricinus communis* L.), ('VI 9' at 60 cm x 22.5 cm), groundnut (*Arachis hypogaea* L.), ('Phule Pragati' at 30 cm x 10 cm), sorghum ('CSH 5' at 45 cm x 20 cm), intercropping of pearl millet ('ICTP 8203') + pigeonpea ('No. 148') at 30–60 cm x 15 cm and greengram (*Phaseolus radiatus* L.) ('S 8' at 30 cm x 10 cm). The experiment was conducted in strip-plot design with 4 replications. There were 8 *kharif* cropping of current year and 8 *kharif* cropping of previous year making 64 combinations. Sowing of the crops was undertaken in metecrological week (MW) 24 during 1988 and 1990, in MW 26 during 1991, in MW 28 in 1989 and MW 29 in 1992 and 1993. Pearl millet, sorghum, castor, sunflower and pearl millet + pigeonpea intercroppings were fertilized with 50 kg N/ha + 25 kg P_2O_5/ha, pigeonpea and greengram with 12.5 kg N/ha + 25.0 P_2O_5/ha and groundnut with 25 kg N/ha + 50 kg P_2O_5/ha. Fertilizers were applied at seeding by placement. The gross plot size was 4.2 cm x 3.5 m. The net plot size for pigeonpea, sunflower, castor and greengram was 3.0 m x 3.3 m and for pearl millet, groundnut, pearl millet + pigeonpea (2:1) intercropping and sorghum was 3.3 m x 3.3 m. Data on monetary returns were pooled over 6 years. The market rates prevailing in the

Table 1. Grain and fodder yields (q/ha) as influenced by different *kharif* croppings (average data of 6 years from 1988–1993)

Current-year cropping	Previous year cropping								
	Pearl millet	Pigeon-pea	Sun-flower	Castor	Ground-nut	Sorghum	Pearl millet + pigeonpea	Green-gram	Mean
Pearl millet	17.91 (36.82)	20.30 (40.59)	21.12 (40.77)	20.20 (43.89)	19.83 (38.84)	17.91 (36.36)	19.47 (39.12)	20.57 (44.35)	19.68 (40.09)
Pigeonpea	7.27 (37.58)	6.06 (25.05)	6.16 (27.68)	6.26 (27.17)	6.26 (28.99)	8.38 (34.34)	5.96 (26.06)	6.06 (25.66)	6.55 (29.07)
Sunflower	6.16	5.86	4.24	5.35	6.97	7.27	5.66	6.06	5.95
Castor	4.34	3.74	2.73	2.93	4.55	4.85	3.74	3.23	3.76
Groundnut	5.05 (14.97)	5.14 (14.69)	5.23 (15.79)	4.41 (14.78)	4.41 (14.33)	4.73 (13.41)	4.87 (14.60)	4.50 (14.05)	4.79 (14.58)
Sorghum	5.14 (41.32)	6.98 (43.89)	4.04 (40.77)	6.70 (46.00)	5.60 (41.60)	4.22 (34.99)	6.43 (42.88)	5.69 (42.98)	5.60 (41.30)
Pearl millet +	18.35 (29.57)	20.66 (34.62)	22.31 (32.23)	20.75 (34.71)	20.02 (31.13)	16.80 (29.38)	17.08 (29.48)	20.94 (32.97)	19.64 (31.76)
Pigeonpea	4.87 (23.60)	1.74 (12.21)	3.31 (13.31)	3.12 (17.17)	4.04 (20.02)	5.14 (23.05)	3.68 (16.99)	2.75 (14.51)	3.58 (17.63)
Greengram	2.63 (15.05)	1.92 (13.33)	1.82 (9.80)	1.72 (10.51)	2.12 (15.66)	2.63 (14.65)	2.02 (14.04)	1.72 (10.40)	2.07 (12.91)
Mean	7.99 (28.42)	8.05 (26.31)	7.89 (25.76)	7.94 (27.75)	8.20 (27.22)	7.99 (26.60)	7.66 (26.17)	7.95 (26.42)	

Figures in parentheses indicate the fodder yield

experimental year were considered for calculating monetary returns. Sustainable value index was calculated as per the formula suggested by Singh *et al.* (1990).

The rainfall received during *kharif* cropping period from MW 23 to 44 was 1,002, 451.2, 348.8, 394.2, 465.7 and 590.4 mm in 1988, 1989, 1990, 1991, 1992 and 1993 respectively.

RESULTS AND DISCUSSION

Performance of crops

Based on an average of 6 years, the grain yield of pearl millet did not decrease due to intercropping with pigeonpea compared with sole pearl millet, owing to complimentary effects among the component crops for natural resources (Table 1). Pearl millet + pigeonpea is considered as an ideal combination under limited soil moisture, as pigeonpea remains suppressed in the initial stages while pearl millet grows by utilizing available resources (Umrani, 1981; Jadhav *et al.*, 1991). However, the productivity of castor, groundnut, sorghum and greengram was very low under dryland conditions (Table 1).

The pooled monetary returns were significantly the highest (Rs 9,414/ha from pearl millet + pigeonpea intercropping (Table 2) indicating monetary advantage. The slow-establishing and late-maturing pigeonpea combined well with early-maturing pearl millet which helped for improved use of above- and below-ground resources by component crops and subsequently increased monetary returns. These results corroborate the findings of Umrani (1981), and Jadhav *et al.* (1991). Sole pearl millet also gave significantly more monetary returns (Rs 6,980/ha) than rest of the crops, indicating its better performance under dryland conditions.

Table 2. Monetary returns (Rs./ha) as affected by previous years cropping x current year croppings (pooled mean of 6 years from 1988 –1993)

Current-year cropping	Previous year cropping								
	Pearl millet	Pigeon-pea	Sun-flower	Castor	Ground-nut	Sorghum	Pearl millet + pigeonpea	Green-gram	Mean
Pearl millet	6,183	7,208	7,413	7,351	6,933	6,323	7,032	7,399	6,980
Pigeonpea	4,672	3,913	3,952	4,076	4,120	5,316	3,959	3,921	4,221
Sunflower	4,659	4,568	3,345	4,152	5,297	5,374	4,249	4,513	4,517
Castor	2,226	1,928	1,334	1,498	2,782	2,670	1,838	1,855	2,016
Groundnut	5,245	5,396	5,342	4,534	4,436	4,821	4,915	4,637	4,912
Sorghum	4,921	5,637	4,688	5,950	5,010	4,089	5,237	4,995	5,066
Pearl millet + pigeonpea	9,639	8,620	10,209	9,256	9,699	9,892	8,667	9,328	9,414
Greengram	1,332	1,115	963	1,028	1,229	1,214	981	904	1,096
Mean	4,860	4,795	4,656	4,731	4,936	4,962	4,610	4,694	
CD (P = 0.05) for									
Previous year cropping			NS,						
Current year cropping			1,561						
Previous x current year cropping			626						

Table 3. Sustainable-value index as influenced by different *kharif* to *kharif* croppings (mean data of 6 years)

Current year cropping	Previous year cropping								
	Pearl millet	Pigeon-pea	Sun-flower	Castor	Ground-nut	Sorghum	Pearl millet + pigeonpea	Green-gram	Mean
Pearl millet	0.40	0.58	0.53	0.51	0.49	0.46	0.50	0.53	0.50
Pigeonpea	0.18	0.19	0.15	0.19	0.19	0.19	0.14	0.19	0.18
Sunflower	0.22	0.24	0.20	0.26	0.26	0.28	0.24	0.21	0.24
Castor	0.01	–0.005	–0.02	–0.002	–0.05	–0.01	0.05	0.05	0.003
Groundnut	0.28	0.28	0.33	0.23	0.27	0.29	0.27	0.24	0.27
Sorghum	0.20	0.23	0.22	0.24	0.25	0.17	0.26	0.18	0.22
Pearl millet + pigeonpea	0.66	0.63	0.66	0.67	0.59	0.64	0.53	0.57	0.62
Greengram	0.04	0.01	0.02	0.02	0.01	0.02	0.02	0.02	0.02
Mean	0.25	0.27	0.26	0.26	0.25	0.26	0.25	0.25	

The monetary returns of castor (Rs 2,016/ha) and greengram (Rs 1,096) were significantly lower than other *kharif* crops.

The highest sustainable-value index was observed under pearl millet + pigeonpea intercropping (Table 3) indicating that this intercropping was more sustainable during *kharif* season under dryland conditions. The sustainable-value index of 0.50 was also observed under sole pearl millet, indicating its better sustainability during the *kharif* season. However, sustainable-value index was very low in castor and greengram indicating that they were not sustainable crops during *kharif* season under dryland conditions.

Effects of rotations

The grain yield of pearl millet was increased by 17.9% owing to sunflower–pearl millet system compared with continuous pearl millet and sorghum–pearl millet system (Table 1). Similarly, grain yield of intercropped pearl millet was increased by 32.8% when it was grown after sunflower compared with preceded sorghum. The additional monetary returns of Rs 1,230/ha were obtained from sunflower pearl millet system compared with continuous pearl millet (Table 2). Similarly, additional monetary returns of Rs 1,589 and 1,542/ha were obtained from sunflower pearl millet + pigeonpea system compared with pigeonpea–pearl millet + pigeonpea and sorghum–pearl millet + pigeonpea *kharif* cropping systems respectively. Sunflower, an important crop of dryland area, also gave an additional return of Rs 2.029 and 1,934/ha when grown after sorghum and groundnut, respectively, compared with continuous sunflower. These increases were substantial under poor resource base of dryland agriculture. Umrani *et al.* (1992) also reported such advantages owing to rotations.

The sustainable-value index was higher, i.e. 0.58, 0.53 and 0.51, when pearl millet was grown after pigeonpea, sunflower or greengram and castor, respectively, compared with 0.40 with continuous pearl millet (Table 3). The sustainable-value index of pearl millet + pigeonpea intercropping was also higher, i.e. 0.67, 0.66, 0.64 and 0.63, when it was preceded by castor, pearl millet

or sunflower, sorghum and pigeonpea respectively compared with 0.53 with continuous intercropping of pearl millet + pigeonpea indicating that these cropping systems were more sustainable during the *kharif* season under dryland conditions.

Effects of interaction

Significantly the highest monetary returns were obtained from intercropping of pearl millet + pigeonpea, followed by sole pearl millet and significantly the lowest from greengram in current-year cropping and when these crops were grown after different the *kharif* crops during previous year (Table 2). The sustainable-value index was also maximum with intercropping of pearl millet + pigeonpea, followed by sole pearl millet and least with castor during current year as well as when these crops were grown after different *kharif* crops. Therefore, pearl millet + pigeonpea intercropping and sole pearl millet could be considered more remunerative and sustainable cropping systems during *kharif* season on medium deep Vertisols (depth 30–45 cm) under dryland conditions.

REFERENCES

Jadhav, A. S., Patil, E. N. and More, S. M. 1991. Intercropping of pearl millet and sunflower with pigeonpea genotypes under dryland conditions. *Journal of Maharashtra Agricultural Uviversities, Pune* **16** (3) : 380–382.

Patil, N. D., Umrani, N. K., Kale, S. P., Shende, S. A., Manake, B. S. and Shingte, A. K. 1981. Improved crop production technology for drought-prone area of Maharashtra. Dry Farming Research Station, Solapur. *Technical Bulletin*, pp. 47–68.

Singh, R. P., Das, S. K., Bhaskra Rao V. M. and Narayan Reddy, M. 1990. Towards Sustainable Dryland Agricultural Practices. *Central Institute for Dryland Agriculture. Hyderabad.* pp. 5–8.

Umrani, N. K. 1981. Intercropping for higher production of pulses. *Indian Farming* **31** (9) : 13–14.

Umrani, N. K., Gaikwad, C. B. and Gare, B. N. 1992. Sustainability of cropping systems under dryland conidtion of vertisols. *Indian Journal of Agronomy* **37** (4) : 345–349.