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Research Paper

Agronomic and economic evaluation of alternative cropping systems for *bidi* tobacco (*Nicotiana tabacum*) in middle Gujarat conditions

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ABSTRACT

An on-farm study was carried out in rainy (*kharif*), winter *(rabi*) and summer seasons for 3 years from 2015–16 to 2017–18 at the Anand, Gujarat, to evaluate alternative cropping systems for *bidi* tobacco (*Nicotiana tabaccum* L.). The experiment was laid in randomized block design with 4 replications. Treatments comprised 6 cropping systems, viz. sole cropping of *bidi* tobacco, groundnut (*Arachis hypogaea* L.)–potato (*Solanum tuberosum* L.), maize (*Zea mays* L.)–potato, pigeonpea [*Cajanus cajan* (L.) Millsp.] + pearl millet [*Cenchrus americanus* (L.) Morrone; syn. *Pennisetum glaucum* (L.) R. Br.]–clusterbean [*Cymopsis tetragonaloba* (L.) Taub.], *sesamum* (*Sesamum indicum* L.)–potato and *bidi* tobacco–pearl millet. *Bidi* tobacco–pearl millet cropping system recorded the highest tobacco leaf-equivalent yield (TLEY) of 3.7 t/ha compared to rest of treatments, whereas the lowest TLEY was noticed with sesamum–potato (2.4 t/ha), followed by groundnut–potato cropping system. Land-use efficiency (LUE) was the highest in pigeonpea + pearl millet–clusterbean (93.0%) and the lowest in *bidi* tobacco sole cropping system (42.7%). Production efficiency was found the highest in *bidi* tobacco sole cropping system (18.77 kg/ha/day) and the lowest in pigeonpea + pear lmillet–clusterbean (8.61 kg/ha/day). The maximum employment generation (110 man-days/ha/year) was registered with *bidi* tobacco–pearl millet closely followed by pigeonpea + pearl millet–clusterbean (106 man-days/ha/year) cropping system. The highest benefit : cost ratio (BCR) of 3.0 was obtained with sole *bidi* tobacco cropping system. Among the cropping systems, *bidi* tobacco–pearl millet provided the highest net returns of ₹ 81.24 × 10^3/ha and system profitability of ₹ 223/ha/day, followed by sole cropping of *bidi* tobacco (₹76.90 × 10^3/ha and ₹ 210/ha/day respectively). Thus, *bidi* tobacco–pearl millet cropping system followed by sole *bidi* tobacco was more productive and remunerative than the other cropping systems in middle Gujarat.

Key words : Alternative crops to tobacco, Benefit: cost ratio, Cropping system, Net returns, Tobacco leaf-equivalent yield, Yield attributes

India is the second largest producer of tobacco, grown in about 0.24% of the total cropped area with annual output of 800 million kg. Tobacco, a commodity which earns excise revenue of more than ₹34,0000 and foreign exchange more than ₹60,220 million besides providing employment directly or indirectly to 45.7 million of people. In Gujarat, *bidi* tobacco is cultivated in around 0.165 million ha. Total tobacco production including *chewing*, hookah and *rustica* comes to about 324 million kg with a productivity of 1959 kg/ha (Patel*,* 2018).

Government of India is a signatory to Frame Work Convention on Tobacco Control (FCTC), the global public health treaty under the auspices of the WHO aimed at reducing tobacco supply. In the light of the growing concerns about the health hazards of tobacco, it is necessary for the alternative crops and cropping systems, which are equally remunerative. Towards fulfilling the mandatory requirement, Government is asking to wean away the farmers from tobacco cultivation and take up alternative crops. Globally several investigations are carried to find alternative crops for tobacco. In a quest to find out the suitable alternative crops that are sustainable and commercially viable, the present study was undertaken.

MATERIALS AND METHODS

The investigation was undertaken for 3 years during 2015–16, 2016-17 and 2017–18 at the Bidi Tobacco Research Station, Anand Agricultural University, Anand (22° 34’ 12" N, 72° 55’ 48" E, 45.1 m above mean sea-level). The experimental site falls in middle Gujarat agro-climatic zone III characterized by maximum temperature ranges

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from 26.0 to 40.6°C and minimum temperature ranges from 10.3 to 28.4°C. Total annual rainfall of 508.4, 586.7 and 726.8 mm was recorded, respectively, for years 2015–16, 2016–17 and 2017–18, as against the normal rainfall of the region is about 862 mm. The soil was loamy sand and slightly alkaline (*p*H 7.48), with 0.51% organic carbon, 68.78 kg/ha available phosphorus and 263.3 kg/ha available potassium. The experiment was carried out in randomized block design with 4 replications. The treatments included 6 cropping systems, viz. T_1 - sole cropping of *bidi* tobacco; T_2 - groundnut–potato; T_3 - maize–potato; T_4 - pigeonpea + pearl millet–cluster bean; T_5, sesamum–potato; and T_6 - *bidi* tobacco–pearl millet. The gross plot size of each treatment in the experiment was 5.4 m × 7.5 m. Nitrogen was applied in splits; 25% as basal at time of sowing through ammonium sulphate and remaining 75% as top-dressing through urea, whereas phosphorus and potassium were applied through diammonium phosphate and sulphate of potash respectively. Crop seeds were treated with thirum @ 3 g/kg seeds and potato seeds were treated with mancozeb @ 1 kg/ha to prevent diseases. Pre-emergence application of pendimethalin @ 1.5 kg/ha at 3 days after sowing (DAS) was sprayed as per the recommended spray volume of 500 L/ha. In rainy season, *kharif* crops, viz. groundnut, maize, pigeon pea, pearl millet and sesame, were sown manually in field during the first week of July, depending on onset of the monsoon, and crops were harvested at their physiological maturity stages during the second week of October, while 30 days old *bidi* tobacco seedlings were transplanted in the first week of September and harvested in the first fortnight of February. *Bidi* tobacco crop was topped at 24 leaves at bud stage and suckers were removed manually every week after topping. After harvesting of the *kharif* crops, potato was sown in particular treatment plots as a *rabi* crop during the third week of October without disturbing the layout. In summer season, clusterbean and pearl millet crops were sown after completion of pigeonpea + pearl millet intercropping and *bidi* tobacco, respectively, in the last week of February, and these summer crops were harvested in the last week of May. All crops were raised with assured irrigation using flood method.

The data on cured leaf yield of tobacco and yield of kharif, rabi as well as summer crops were recorded. Economic analysis was done based on the prevailing market prices of the produce i.e. tobacco cured leaf @ ₹4,052/q, groundnnut @ ₹3,400/q, potato @ ₹600/q, maize @ ₹1,200/q, pigeonpea @ ₹2,833/q, *kharif* pearlmillet @ ₹1,250/q, summer pearlmillet @ 1,190/q, sesame @ ₹4,000/q and clusterbean @ ₹2,417/q. The calculations of system productivity and system profitability were done as per Devasenapathy *et al.* (2008). The system productivity of various cropping systems was calculated in terms of tobacco leaf-equivalent yield (TLEY) as:

$$\text{TLEY} = \frac{\Sigma \text{Yi X Pi}}{\text{P (p)}}$$

where: TLEY - Tobacco leaf-equivalent yield; *Yi*, yield of different crop (kg/ha); *Pi*, prevailing market price of respective crops (₹/kg); P (*p*), prevailing market price of tobacco crop (₹/kg)

Similarly, system profitability (₹/ha/day) was calculated as:

$$\text{System profitability} = \frac{\text{Net returns/ha/year}}{365}$$

RESULTS AND DISCUSSION

Performance of crops and cropping systems

The season-wise and mean yield as well as system productivity of various cropping systems in terms of tobacco leaf-equivalent yield (TLEY) is presented in Table 1. In *bidi* tobacco sole cropping system (2.85 t/ha), tobacco cured leaf yield was higher than *bidi* tobacco–pearl millet (2.56 t/ha) cropping system. This might be owing to ad-

Table 1. Economic yield, straw/ stover yield and system productivity, tobacco leaf-equivalent yield (TLEY) of different cropping systems (data pooled over 3 years)

Cropping systems	Economic yield (t/ha)			Straw/Stover yield (t/ha)			System productivity
	Kharif	*Rabi*	Summer	*Kharif*	*Rabi*	Summer	(TLEY t/ha)
Bidi tobacco sole	2.85	0	0	0.88	0.00	0.00	2.87
Groundnut–potato	1.18	11.11	0	1.59	1.06	0.00	2.47
Maize–potato	4.17	9.92	0	6.20	1.08	0.00	3.22
Pigeonpea + pearl millet–clusterbean	1.75	1.67	0.78	7.06	6.30	2.17	2.90
Sesame–potato	0.94	11.03	0	2.29	1.33	0.00	2.41
Tobacco–pearl millet	2.56	0	3.20	1.01	0.00	6.12	3.70
SEm±	–	–	–	–	–	–	0.06
CD (P=0.05)	–	–	–	–	–	–	0.19

verse effect of succeeding pearl millet crop. These results are accordance with Singh *et al.* (2004), Singh (2006) and Kasturi Krishna *et al.* (2007). The highest TLEY of 3.7 t/ha was observed in *bidi* tobacco–pearl millet cropping system compared to rest of treatments. This could mainly be attributed to the high production potential and fair price fetched by *bidi* tobacco in the market. Among various summer pearl millet based cropping systems, *bidi* tobacco–pearl millet performed better with higher TLEY and net returns (Gediya *et al.,* 2017). Maize–potato system was the second best cropping system gained maximum TLEY of 3.22 t/ha after *bidi* tobacco–pearlmillet cropping system. Kasturi Krishna *et al.* (2007) and Kasturi Krishna *et al.* (2010) also reported that, higher mean TLEY and net returns were noticed in maize-based tobacco cropping system. The lowest TLEY was recorded with sesamum– potato (2.4 t/ha), followed by groundnut– potato cropping system. Similar findings were observed by Mohapatra and Pradhan (2017) and Pragathi Kumari (2019) that inclusion of sesame crop in tobacco as well as rice-based cropping system was found not economical, as it gained the lowest TLEY and RGEY respectively.

Resource-use efficiency

Pigeonpea + pearl millet–clusterbean cropping system exhibited the highest land-use efficiency (LUE) of 93.0% (Table 2). It can be attributed mainly to pigeonpea in respective sequence because it occupied the field for about 150 days. The lowest LUE (42.7%) was found in sole cropping of *bidi* tobacco, while, however, this system registered the highest production efficiency (18.77 kg/ha/day). The lowest production efficiency was observed with pigeonpea + pearl millet–clusterbean (8.61 kg/ha/day). *Bidi* tobacco–pearl millet cropping system generated the maximum employments (110 man-days/ha/year), followed by pigeonpea + pearl millet–clusterbean (106 man-days/ha/year). Sammauria *et al.* (2020) also reported higher resources use efficiencies in pearl millet-based systems with inclusion of legumes, vegetables and cash crops. A study conducted in Jayavaram and R.C. Puram villages in Prakasam district of erstwhile state of Andhra Pradesh indicated that, tobacco was more labour-intensive crop than bengalgram and paddy (Rao *et al.* 2012), whereas *bidi* tobacco sole cropping system registered the lowest employment generation (65 man-days/ha/year) due to monocropping.

Economics

Among the various systems, *bidi* tobacco–pearl millet cropping system realized the highest net returns of ₹81.24 × 10^3/ha and system profitability of ₹223/ha/day followed by sole cropping *bidi* tobacco (₹76.90 × 10^3/ha and ₹210/ha/day respectively) (Table 3). Kumar *et al.* (2010) from their study in Shimoga district of Karnataka also reported that, flue-cured virginia sole (FCV) tobacco to be the most remunerative crop, as it fetched higher price in the market. Similar results were also obtained by Ranganadhan (2014) and Krishna Teza *et al.* (2016). Benefit: cost ratio (BCR) was the highest (3.0) for sole cropping system of *bidi* tobacco. Our findings are in close agreement with the results of Kasturi Krishna *et al*. (2010) and Mohapatra *et al.* (2017). The preliminary studies indicated that, farmers find it difficult to shift from tobacco to alternative crops because the cultivation of tobacco is considered profitable in monetary terms (Hiremath, 2000; Mahadewaswamy *et al.,* 2006; CTRI, Rajahmundry, 2007).

Based on findings of this experiment it can be concluded that, *bidi* tobacco–pearl millet, followed by sole *bidi* tobacco cropping system was found more productive and remunerative.

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Table 2. Resource use efficiency and man-days/ha generated under different cropping systems (data pooled over 3 years)

Cropping systems	Land use-efficiency (%)	Production efficiency (kg/ha/day)	System duration (days)	Labour requirement (man-days/ha)
Bidi tobacco sole	42.7	18.77	156	65
Groundnut–potato	66.5	10.18	243	86
Maize–potato	66.5	13.23	243	95
Pigeonpea + pearl millet–clusterbean	93.0	8.61	340	106
Sesame–potato	66.5	9.94	243	81
Tobacco–pearl millet	72.8	13.99	266	110
SEm±	1.5	0.3	5.4	2.2

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