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Hortipastoral system for rainfed vertisols of Tamil Nadu

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Abstract: Experiments were conducted during *rabi* seasons of 1995-96 and 1996-97 to identify a suitable fruit tree based fodder production system for rainfed vertisol, Green fodder production was higher under mango plantation (15.25 t ha^{-1}). Among the various fodder crops, fodder sorghum produced higher mean green fodder yield of 22.35 t ha^{-1}. Increased fruit yield of 2897 kg ha^{-1} was obtained in ber plantation. Fruit yield reduced by intercropping the fodder crops in between the fruit trees. Among the various fodder crops, cowpea combination has registered higher fruit yield of 2356 kg ha^{-1}. Ber and sapota plantations were found suitable for raising fodder crops recording increased mean gross income of Rs. 21,032 and Rs. 18,670 ha^{-1} respectively. *(Key words: Horti-pastoral system, Fruit trees, Fodder crops, Intercropping).*

Development and identification of suitable farming system will help to increase and stabilize the production through better use of natural resources. Resource management plans are incomplete with out consideration of trees in the dry farming tracts. We can optimize their production and maximize the returns without detriment to the environment. Unless a system is attractive to a resource-poor farmer, it may be adopted. Farmers prefer fruit trees compared to fodder and fuel wood trees. Further the economic returns are found to be in favour of agri-horticulture and horti-pastoral system compared to arable farming in low and marginal rainfall areas.

At present, the dry and green fodder requirement is estimated at 949 and 1136 million tonnes respectively, for supporting the livestock population. To meet the growing demand of fruit and fodder, horti-pastoral system, a combination of fruit trees and pasture was therefore identified as one of the potential alternative land use options is shallow to medium deep soils (Singh and Osman, 1995). The integrated approach of growing fruit trees along with fodder crops simultaneously on the same piece of land offers an extra yield of grass during rainy season. Tree based system of cropping proved to be successful in areas receiving less than 1000 mm rainfall with nine months of dry season (Panjab Singh, 1987). In semi-arid tropics (SAT), growing of horticultural crops like mango, sapota, ber and custard apple is common. Since the trees are widely spaced, growing of short duration fodder crops as intercrops is possible. Studies conducted at IGFRI, Jhansi revealed that growing grain and fodder annu in the inter spaces of custard apple recei increased grain and forage yields (Gill Gangwar 1987). Hence, the present study taken up to identify a suitable horti-pastoral sy for rainfed vertisols of Southern district Tamil Nadu.

Materials and Methods

Field experiments were conducted at Regio Research Station Farm, Aruppukottai during t *rabi* seasons of 1995-96 and 1996-97 to identi a suitable fruit tree based forage production syste for the rainfed vertisol. The soil of the experimen site is clay loam, having low available N, and high K with 8.2 pH. The soil moisture conte at field capacity and at permanent wilting poi was 31.5 and 12.4% respectively. The experime was conducted in a split-plot design, with thr replications. The treatment combinations consist of three fruit tree plantations *viz.* Mango *(Mangife indica)*, Sapota *(Achrus zapota)* and Ber *(Ziziph mauritiana)* as main plot treatments and fiv annual crops *viz.* Fodder sorghum (K7), fodde maize (African Tall), fodder cumbu (TNSC 1 fodder cowpea (Co 5) and deenanath grass a sub-plot treatments.

The range of the fruit tree was eleve years old, which were planted during Octobe 1984 at a spacing of 8 x 8m. The fodder intercrop were sown on 02-10-1995 and 12-10-1996 durin 1995-96 and 1996-97 respectively. A spacin of 25 x 10cm was adopted for fodder sorghum fodder maize, fodder cumbu and fodder cowpe

Annexure 1. Rainfall Distribution during 1995-96 and 1996-97

Month	1995-96		1996-97	
	Rainfall (mm)	Rainy days (No.)	Rainfall (mm)	Rainy days (No.)
October	214.0	10	341.0	9
November	184.0	7	97.2	6
December	31.5	2	102.	8
Total	429.5	19	540.2	23

Table 1. Soil moisture content (%) at 15, 30and 45 DAS

Treatments	1995-96			1996-97		
	15th day	30th day	45th day	15th day	30th day	45th day
Horticultural components						
M_1 - Mango	17.60	20.06	17.26	18.14	18.51	16.85
M_2 - Sapota	17.58	19.56	19.22	18.94	19.15	18.91
M_3 - Ber	20.94	21.06	19.72	18.94	19.15	18.91
CD (P=0.05)	-	-	-	-	-	-
Intercrops						
I_1 - Fodder sorghum	19.10	20.70	19.07	18.14	18.43	17.56
I_2 - Fodder maize	19.90	20.47	18.57	18.57	18.36	17.56
I_3 - Fodder cumbu	17.60	20.07	19.00	18.34	19.31	16.34
I_4 - Fodder cowpea	18.90	20.43	18.67	19.04	18.91	17.85
I_5 - Deenanath grass	19.10	20.33	18.33	18.91	18.82	16.44
CD (P=0.05)	-	-	-	-	-	

while it was 20x10 cm for deenanath grass. A total rain fall of 495.5 mm in 19 rainy days and 540.2 mm in 23 rainy days was received during the cropping season. (October to December) of 1995-96 and 1996-97 respectively. Soil moisture content was estimated at 45 cm depth at fornight interval starting from 15 days after sowing.

Results and Discussion

Effect of rainfall and soil moisture content

The rainfall distribution was normal and uniform throughout the cropping season during 1995-96 and hence moisture stress was not noticed. (Annexure 1). During 1996-97, the rainfall was more as compared to 1995-96 season, but the distribution was not normal during flowering stage of annual fodder crops. During both the years, the growth of fodder crops was satisfactory. Higher soil moisture content of 20.94, 21.06 and 19.72% were observed on 15, 30 and 45 DAS during 1995-96 and 18.94, 19.15 and 18.91% were recorded during 1996-97 under ber plantation (Table1). Due to the presence of higher soil moisture content (19.07 and 17.56 % during 1995-96 and 1996-97 respectively) upto 45 DAS (Table 1), during both the years, fodder sorghum has recorded increased green fodder yield compared to other fodder crops.

Tree species did not compete with shallow rooted crops growing under its canopy (Sharma and Venkateswarlu, 1990). There was little difference in soil moisture content between the various fruit tree based fodder production systems on 45 DAS during 1995-96. But, during 1996-97, because uneven distribution of rainfall and competition between component crops, greater

Table 2. Green fodder yield (t ha^{-1}) and fruit yield (kg ha^{-1})

Treatments	1995-96		1996-97		Mean	
	Yield		Yield		Yield	
	Green fodder	Fruit	Green fodder	Fruit	Green fodder	Fruit
Horticultural components						
M_1 - Mango	13.2	649	17.3	970	15.25	810
M_2 - Sapota	13.7	1619	15.4	2638	14.55	2126
M_3 - Ber	14.2	2489	14.3	3305	14.25	2897
CD (P=0.05)	0.39	508	2.04	283	6.23	1098.7
Intercrops						
I_1 - Fodder sorghum	22.1	1337	22.6	19.17	22.35	1627
I_2 - Fodder maize	17.5	1509	19.3	2006	18.40	1757
I_3 - Fodder cumbu	13.2	1640	12.8	2146	13.00	1893
I_4 - Fodder cowpea	8.7	1861	9.9	2850	9.30	2356
I_5 - Deenanath grass	7.0	1574	13.8	2603	10.40	2088
CD (P=0.05)	0.57		3.03	391	2.72	323.5

Table 3. Yield and economics of hortipastoral systems

Treatments	Yield		Gross income		Total Gross income (Rs ha^{-1})	BCR
	Green fodder (t ha^{-1})	Fruit (kg ha^{-1})	Green fodder (t ha^{-1})	Fruit (kg ha^{-1})		
Horticultural components						
M_1 - Mango	15.25	810	3904	5568	9572	1.11
M_2 - Sapota	14.55	2126	3790	11352	18670	1.96
M_3 - Ber	14.25	2897	3649	17383	21032	1.75
CD (P=0.05)	6.23	1098.7	1574.8	7493.1	6847	0.73
Intercrops						
I_1 - Fodder sorghum	22.35	1627	5592	10573	16165	1.60
I_2 - Fodder maize	18.40	1757	4596	11352	15947	1.57
I_3 - Fodder cumbu	13.00	1893	3246	12308	15554	1.51
I_4 - Fodder cowpea	9.30	2356	2875	15355	18230	1.76
I_5 - Deenanath grass	10.40	2088	2596	13631	16227	1.60
CD (P=0.05)	2.72	323.5	685.6	2086.6	N.S	0.24

difference in soil moisture content was noticed among the systems on 45 DAS.

Performance of fruit trees

Fruit yields showed significant variation during both the years (Table 2). During 1996-97, the fruit yield of all fruit trees was higher as compared to the yield of 1995-96 season, because of higher rainfall. Maximum fruit yield of 2489 and 3305 kg ha^{-1} was registered in ber plantation during 1995-96 and 1996-97 respectively which was followed by sapota plantation. The lowest yield was obtained in mango plantation. Increased fruit yield in ber plantation might be due to coincidence of fruit development stage with the higher soil moisture availability period i.e, rainy season. The trend of fruit yield obtained in fruit trees was same during both the years whereas variations in fruit yield were noticed during different years. Higher fruit yield of 1861 and 2850 kg ha^{-1} was recorded in fruit trees grown in association with fodder cowpea during 1995-96 and 1996-97 respectively. Fruit trees grown in association with sorghum produced the lowest yields of 1337 and 1917 kg ha^{-1} during 1995-96 and 199-97 respectively which was 28.2 and 32.7 per cent lower than the fruit yield obtained in association with fodder cowpea. The results are in conformity with those obtained by Sharma (1996) who reported fruit production increased with legume style compared to control and decreased in association with grass. This clearly indicated the competitive effect of sorghum on fruit trees as compared to other fodder crops.

Performance of fodder crops

The green fodder yield was higher during 1996-97 as compared to 1995-96 because of high rainfall. The pooled data on mean green fodder yield revealed that annual fodder crops can be raised successfully as intercrops in the interview spaces of all fruit trees as there was no significant variation in the mean green fodder harvested. However, higher mean green fodder yield of 15.25 t ha^{-1} was recorded under mango tree canopy (Table 2). Lesser competition with minimum aerial crown spread of mango tree on the fodder intercrops might be the reason for better growth and yield of fodder crops. Sapota and ber canopy followed it with a green fodder yield of 14.55 and 14.25 t ha^{-1} respectively.

The yield trend of fodder crops was identical during both the years but variations in forage yield were observed between years because of rainfall deviation. Among the fodder crops, fodder sorghum recorded significantly more green fodder yield of 22.1 and 22.6 t ha^{-1} during 1995-96 and 1996-97 respectively which was 26.3 and 17.5 per cent higher than the fodder maize. This indicated clearly that fodder sorghum was the most suitable annual fodder crop, which can be raised as intercrop in the inter spaces of mango, sapota and ber trees under rainfed vertisol situation. Similar higher production from fodder sorghum raised in between the sesbania or neem or acacia tree plantations under rainfed vertisol condition was reported by Solaiappan *et al.* (1998)

Gross Income and Benefit Cost Ratio

The trend of gross income obtained from fodder crops and fruit trees was similar to that of fodder yield and fruit yield. The pooled data on gross income (Table 3) revealed that ber + fruit tree combination recorded higher mean gross income of Rs. 21032 ha^{-1} which was at par with the mean gross income of sapota + fodder crop combination (Rs. 18670 ha^{-1}). Ber + fodder crop and sapota + fodder crop combination recorded higher benefit cost ratio of 1.75 and 1.96 respectively compared to mango + fodder crop combination (1.11). Higher fruit yields of ber and sapota have contributed in getting increased mean cross income along with higher benefit cost ratio in ber + fodder crop and sapota + fodder crop combination.

Intercropping of different fodder crops had no significant effect on overall gross income (Table 3). Higher mean gross income of Rs. 18230 ha^{-1} with a maximum benefit cost ratio of 1.76 was received from fodder cowpea + fruit tree combination. This was followed by deenanath grass and fodder sorghum based fruit tree system with a mean gross income of Rs. 16,227 and Rs. 16165 ha^{-1} respectively and a benefit cost ratio of 1.60. This finding is in agreement with that of Solanki an Newaj (1999) who reported that ber + mungbean gave highest monetary returns than ber + sorghum or clusterbean or pearl millet.

The results revealed that annual fodder crops can be grown successful and profitably

under the tree canopy of ber, sapota and mango. Considering higher fruit yields and income, ber and sapota trees are found suitable for rainfed vertisols. Among the annual fodder crops, fodder cereals have produced more biomass, but they suppressed the fruit yields of base crop whereas fodder cowpea has a complementary effect on fruit yield. However, higher green fodder yield from fodder sorghum could compensate the yield loss from fruit trees. Further, the fodder sorghum is being utilized as dry fodder in the rainfed tracts. Hence it can be concluded that fodder cowpea, deenanath grass and fodder sorghum can be grown as intercrops with ber or sapota trees.

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