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Horti-silvi-agricultural system for rainfed vertisols of Tamil Nadu

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Abstract: Field experiments were conducted at Regional Research Station. Aruppukottai during 1994-1999 to identify suitable horti-silvi-agricultural system for rainfed vertisol. The results revealed that the suppressive effect of tree seedlings on crop yield was less in combination with sapota and sesbania. Sapota, sesbania and greengram or blackgram based hort-silvi agricultural system was found suitable and highly remunerative for rainfed vertisol. *(Key words: Fruit trees, Fodder tree crops, Intercropping).*

An integrated approach of land management to utilize the natural resources more efficiently in rainfed areas is essential to meet the requirements of farmer and his livestock without deteriorating the land productivity. Agroforestry systems with judicious mixing of crops, trees and grasses meet all basic requirements of mankind and his livestock (Singh and Singh, 1987). 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). Gill et al. (1982) reported yield increase in field crops grown in the interspaces of tree rows. Detailed and systematic generation of research information about the relative performance of different tree species, their effect on the associated crops is necessary to make the agro-forestry system more meaningful and feasible proposition. Hence, this trial was conducted to develop a horti-silvi-agricultural model for rainfed vertisol of southern districts of Tamil Nadu.

Materials and Methods

Field trial was laid out at Regional Research Station, Aruppukottai during 1994-1999 to identify a suitable horti-silvi-agricultural system for rainfed vertisol. The experimental site is clay loam, having low available N and P and high available K with pH 8.2. The soil moisture content at field capacity and at permanent wilting points were 31.5 and 12.4 per cent respectively. The main plot treatments comprised combinations of three fruit trees *viz.* sapota, tamarind and pithecolobium and three forage trees *viz.* neem, subbul and sesbania. Four annual crops *viz.* sorghum (Co26), maize (K_1), blackgram (Co 5) and greengram (KM_2) were the sub-plot treatments. The experiment was conducted in a split-plot design, with three replications. The fruit tree seedlings were planted during September, 1994 at 10 m espacement with an intra–row spacing of 8 m. The fodder tree seedlings were planted in between the fruit tree seedlings with an intra-row spacing of 8m, 4m, 2m for neem, subabul and sesbania. The annual crops were sown in between the row space of tree species during the first week of September of 1996-97, 1997-98 and 1998-99. The rainfall distribution during the crop season of September to December was 590 mm, 621 mm, 939 mm, 1063 mm and 1224 mm respectively during 1994-95, 1995-96, 1996-97, 1997-98 and 1998-99. Due to low rainfall distribution during 1994-95 and 1995-96 season, the yields of annual crops were very poor. Sole crop of sorghum, maize, blackgram and greengram were raised separately to compare the yield of crops in association with trees. As the fruit tree crops have not reached the bearing stage, the income could not be arrived for the entire system and the economics was worked out for the annual crops including the cost of tree fodder.

Results and Discussion

Yield of crops

There was a conspicuous reduction in the grain yield of sorghum, maize, blackgram and greengram in association with tree crops as against the yield of sole crop, during 1996-97, 1997-98 and 1998-99 (Table 1). The mean yield reduction in sorghum, maize, blackgram and greengram under the tree canopy were low and were in the order of 8.8, 7.8, 9.4 and 8.7 per

Table 1. Yield of annual crops (kg ha^{-1})

Tree based System	Sorghum			Maize			Blackgram			Greengram		
	1996-97	1997-98	1998-99	1996-97	1997-98	1998-99	1996-97	1997-98	1998-99	1996-97	1997-98	1998-99
Sapota + Neem	1580	1369	1377	1659	1628	1140	554	475	252	598	500	238
Sapota + Subabul	1663	1445	1754	1754	1500	1331	590	482	307	638	521	286
Sapota + Sesbania	1658	1506	1785	1745	1568	1396	592	594	322	641	552	297
Tamarind + Neem	1565	1284	1102	1648	1383	1000	549	455	225	596	477	213
Tamarind + Subabul	1625	1361	1320	1711	1398	1171	579	463	272	628	502	253
Tamarind + Sesbania	1635	1414	1390	1719	1468	1223	580	488	284	628	533	267
Pithecolobium + Neem	1578	1333	1172	1660	1390	1051	556	460	237	602	472	228
Pithecolobium + Subabul	1655	1407	1369	1744	1468	1205	590	469	285	639	508	275
Pithecolobium + Sesbania	1645	1474	1428	1728	1528	1298	588	497	298	637	540	289
Mean yield												
Sapota	1634	1440	1639	1719	1497	1289	579	487	294	626	524	273
Tamarind	1608	1358	1271	1693	1416	1132	569	469	260	617	472	244
Pithecolobium	1626	1405	1411	1711	1462	1202	578	475	276	626	507	260
Neem	1574	1329	1217	1656	1400	1064	553	463	238	599	483	226
Subabul	1648	1404	1481	1736	1455	1236	586	471	288	628	510	271
Sesbania	1646	1465	1534	1731	1521	1306	587	496	299	635	542	284
Sole crop	1780	1575	1735	1830	1670	1450	635	540	360	682	575	345

Table 2. Gross and net income (Rs/ha)

Treatment Combinations	Gross income				Net income			
	1996-97	1997-98	1998-99	Mean	1996-97	1997-98	1998-99	Mean
Fruit trees								
Sapota	7826	6799	5242	6622	5051	4025	2467	3847
Tamarind	7690	6505	4490	6228	4915	3730	1716	3453
Pithecolobium	7771	6630	4805	6403	4996	3855	2030	3628
CD (P=0.05)	147	189	225	285	147	189	225	285
Fodder trees								
Neem	7298	6100	4071	5823	4523	3325	1296	3048
Subabul	7712	6417	4796	6308	4936	3642	2022	3533
Sesbania	8277	7417	5672	7122	5502	4642	2897	4347
CD (P=0.05)	147	189	225	285	147	189	225	285
Annuals								
Sorghum	6725	5919	5957	6200	3875	3069	3107	3350
Maize	7066	6157	5123	6115	4116	3207	2173	3165
Blackgram	8296	7007	4265	6522	5646	4357	1615	3872
Greengram	8963	7497	4041	6833	6313	4847	1391	4183
CD (P=0.05)	258	209	275	344	258	209	275	344

Table 3. Fodder yield from fodder trees and height of tree seedlings

Treatment Combinations	Fodder yield (kg ha^{-1})			Height of tree seedlings (Cm)	
	1996-97	1997-98	1998-99	Fruit trees	Fodder trees
Fruit trees					
Sapota	606	831	861	221	489
Tamarind	553	847	838	354	448
Pithecolobium	557	837	820	381	462
CD (P=0.05)	36	N.S.	40	14	19
Fodder trees					
Neam	188	301	334	296	426
Subabul	266	615	616	319	468
Sesbania	1248	1598	1568	342	504
CD (P=0.05)	36	31	40	14	19
Annuals					
Sorghum	557	824	818	301	460
Maize	561	819	814	303	447
Blackgram	575	850	860	334	475
Greengram	575	861	866	338	482
CD (P=0.05)	N.S	N.S	N.S.	18	23

cent during 1996-97 as compared to 11.0, 12.7, 11.7 and 12.9 per cent during 1997-98 and 17.0, 16.7, 23.1 and 24.9 per cent during 1998-99 season respectively. This was mainly due to competition for available moisture and nutrients, and shade effect of established tree seedlings. King *et al.* (1981) and Dhillon *et al.* (1982) also reported considerable reduction in grain yield in agri-silvicultural system. Among the tree components, sapota based intercropping system recorded higher mean grain yields as compared to tamarind and pithecolobium based system. Similarly, sesbania based system produced higher mean grain yields than from neem and subabul based intercropping system. This was mainly due to high competitive nature of tamarind, pithecolobium, neem and subabul as compared to sapota and sesbania. Variation in yield reduction due to different tree species was also reported by Ramshe *et al.* (1994) and Sekar *et al.* (1998).

Economics

The three years mean data revealed that among the horti based cropping system, sapota based intercropping system produced higher mean gross income of Rs. 6622/ha/year and net income of Rs. 3847/ha/year (Table 2). Among the fodder tree based system, sesbania based intercropping system gave higher gross income of Rs. 7122/ha/year and net income of Rs. 4347/ha/year. Among the annual crops, greengram registered higher gross income of Rs,. 6833/ha/year with a net income of Rs. 4183/ha/year. However, the yield and income variation among the annual crops was only due to rainfall distribution during different years. Ramshe *et al.* (1994) has also reported that the association of tree species with field crops was highly remunerative than the sole field cropping system crop.

Growth of fodder trees

Among the fodder trees, *Sesbania grandiflora* has exhibited a quick growth which attained a maximum height of 515 cm as compared to subabul (468cm) and neem (443 cm). Hence, vertical growth is an important and beneficial character of the fodder trees, to include in the tree based cropping system to reduce the shading effect on the annual crops. Further, sesbania produced higher green fodder from the first year, which is highly palatable and nutritious than subabul and neem. Sesbania produced a mean fodder yield of 1248, 1598 and 1568 kg ha^{-1} whereas subabul produced, a mean fodder yield of 266, 615 and 616 kg ha^{-1} and neem recorded a mean fodder yield of 188, 301 and 334

kg ha^{-1} during 1996-97, 1997-98 and 1998-99 respectively (Table 3). The growth and yields of fodder trees were not much altered either by the fruit trees or by the annual crops.

Growth parameters of fruit trees

Among the three horticultural components, pithecolobium exhibited vigorous growth as compared to tamarind and sapota seeldings (Table 3). Pithecolobium recorded higher mean plant height of 404 cm. Sapota seedlings recorded the lowest height of 221 cm at the end of project period (4 ½ years). Sesbania combination was found to improve the growth of fruit seedlings with a mean plant height of 342 cm whereas, neem combination was found to suppress the growth of fruit tree seedlings with a mean plant height of 296 cm. The fruit tree seedlings exhibited higher mean plant height of 338 and 334 cm in combination with greengram and blackgram respectively. The lowest plant height of 303 and 301 cm was recorded in combination with maize and sorghum respectively. Hence, *Sesbania grandiflora* will be a suitable fodder tree for inclusion with the fruit trees, which has a less suppressive effect on growth of fruit tree seedlings. Similarly, pulses intercropping will have a beneficial effect on fruit tree seedlings than millets in rainfed situation. Such compatibility of herbaceous crops with woody perennials has also been reported by Mann and Saxena (1980) and Mishra and Prasad (1980). Hence, it can be concluded that sapota + sesbania + field crops (pulses/millets) is a suitable horti-silvi-agricultural system for rainfed vertisol of southern districts of Tamil Nadu.

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