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## Variations in soil texture of different horticulture-based agroforestry systems in South Gujarat

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### Abstract

The present investigation was carried out in four main districts of South Gujarat region *i.e.*, Valsad, Navsari, Dangs and Surat of Gujarat state with sample of 72 respondents to study the variations in soil texture of different horticulture-based agroforestry systems in South Gujarat region. The soils of Valsad, Dangs and Surat districts were found to be clayey loam and loam in texture; while, the soil texture of Navsari district was found to be clay in nature.

**Keywords:** Soil texture, agroforestry systems, horticulture, South Gujarat

### Introduction

According to a study by the World Agroforestry Centre, ICRAF, 43 per cent of the planet's agricultural lands (more than a billion hectares) has more than 10 per cent tree cover. A lesser, but, still significant area of agricultural land, 160 million hectares, has more than 50 per cent tree cover. The potential of trees to bring improvements in nutrition, income, housing, health, energy needs, and environmental sustainability in the agricultural landscape has guided ICRAF's mission, with the presence of trees being the principal component of an "evergreen agriculture". Within the array of benefits brought by trees, an important element is the positive effect of trees on soil properties and consequently benefits for crops. This paper explores the current knowledge towards relation between trees and soil, based on agroforestry research. In this scenario, agroforestry systems have been indicated as one of the more promising alternatives to achieve a more sustainable agriculture, in greater equilibrium with the environment (Pinho *et al.*, 2012) [5].

The presence of trees in farming systems, although an ancient practice began to gain institutional attention during the 1970s and 1980s, with the beginning of studies on "agroforestry systems". One of the principal definitions employed in this context is "Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, *etc.*) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence (Lundgren and Raintree, 1982) [3]. In agroforestry systems, there are both ecological and economical interactions between the different components". In South Gujarat, many farmers have already adopted different systems of Agroforestry; further, these systems are grown under different soil profile. In this study, the profile of soil texture of different areas of Navsari, Valsad, Dangs and Surat was discussed.

### Material and Methods

The present study was conducted in four main districts of South Gujarat during 2019-2020. The climate of South Gujarat is typically tropically characterized by fairly hot summer, moderately cold winter and warm humid monsoon. Generally, the monsoon in this region commences in the second week of June and ends in September. Most of the precipitation is received from the South-West monsoon, concentrating in July and August with an average annual rainfall of about 1431 mm.

In the present study, total of 72 farmer's fields, which representing horticulture-based agroforestry system was selected from 36 villages belonged to 12 talukas of four districts of South Gujarat. Soil samples were collected from these farm fields. Representative soil samples were collected randomly from 0-15 cm and 15-30 cm depth from each prevalent horticulture-based agroforestry system.

All the soil samples were labelled properly *viz.*, name of the farmer, village, location, depth and date of sampling and brought to the laboratory for further laboratory studies. After that, they were air-dried and ground to pass through a 2 mm sieve with wooden mortar and pestle and preserved processed samples for physical analysis with international pipette method (Piper, 1942) [4].

### Results and Discussion

The data pertaining to variations in soil texture under different horticulture-based agroforestry systems are presented in Table – 1. By considering soil profile of 0 - 15 cm depth in Valsad district, the maximum clay content (57.52%) was found in Mango + Turmeric based Horti - Tuber crops system, which was followed by Mango + Papaya based Mixed fruit crops system (54.30%). Whereas, minimum clay content was reported in Mango + Sorghum based Horti - Pastoral system (26.13%). Similar trend was also recorded in the soils of 15 - 30 cm depth in different agroforestry system. In the case of silt content at 0 – 15 cm soil depth, maximum silt content was recorded in the soils collected from Mango + Sponge gourd + Cowpea + Cucumber based Horti - Vegetable vine crops system (43.48%) which was followed by Mango + Ivy Gourd Hort- Vegetable vine crops system (39.11%). While, minimum silt content was noted in Mango + Turmeric based Horti - Tuber crops system (21.41%). In this case also, silt content in the soils of 15 – 30 cm depth showed similar trend as that of silt content from soils of 0 - 15 cm depth. Furthermore, sand content in the soil at 0 – 15 cm depth was found to be maximum in Mango + Sorghum based Horti – Pastoral system (44.65%) which was statistically at par with Mango + Colocasia based Horti – Tuber crops system (44.34%). While, minimum was registered in Mango + Papaya based Horti – Mixed fruit crops system (17.08%). Whereas at the depth of 15 – 30 cm soil, sand content showed similar trend to those of soils collected from 0 – 15 cm depth at different agroforestry systems. After analysing all surveyed soils, soil samples collected from Valsad district were found to be clayey loam and loam in texture.

The data presented in Table – 1 of district Navsari revealed that maximum clay content in 0 - 15 cm soil depth (57.85%) was found in Mango + Brinjal + Onion + Cabbage based Horti – Olericulture system which was on same bar with Mango + Kamini (Orange Jasmine) based Horti – Floriculture system (57.31%). Whereas, minimum clay content in 0-15 cm soil depth was reported in Mango + Colocasia based Horti – Tuber crops system (47.63%). In case of 15–30 cm depth of soil similar trend was observed. However, silt content at 0–15 cm depth was noted maximum in Mango + Sorghum based Horti – Pastoral system (28.02%) which was followed by Mango + Pumpkin based Horti – Vegetable vine crops system (27.47%) and minimum was noted in Mango + Bottle gourd based Horti – Vegetable vine crop system (19.41%). At 15-30 cm depth of soil silt content showed a similar trend during the soil analysis. Furthermore, sand content at 0–15 cm depth of soil was found maximum in Mango + Turmeric based Horti – Tuber crop system (29.87%) which was followed by Mango + Bottle gourd based Horti - Vegetable vine crops system (28.47%) and the minimum was recorded in Mango + Sorghum based Horti – Pastoral system (15.90%). At the depth of 15–30 cm, sand content showed a similar trend as 0-

15 cm. All the surveyed soils of different farmers of Navsari district were found clay in texture.

In Dangs district maximum clay content in 0-15 cm soil depth was found in Custard apple + Finger millet (Nagli) based Horti – Agroculture system (37.31%) which was followed by Custard apple + Maize based Horti – Agriculture system (36.48%). Whereas, minimum clay content in 0-15 cm soil depth was reported in Mango + Amorphophalus based Horti – Tuber crop system (24.10%). In the case of 15 – 30 cm depth of soil similar trend was observed. However, silt content at 0-15 cm depth was recorded maximum in Mango + Paddy based Horti – Agriculture system (41.05%) which was followed by Mango + Sugarcane based Horti – Cash crop system (37.08%) and the minimum was noted in Mango + Custard apple + Groundnut based Horti – Agroculture system (26.85%). As 15–30 cm depth of soil silt showed a similar trend during the soil analysis. Furthermore, sand content at 0-15 cm depth was found maximum in Mango + Paddy based Horti – Agriculture system (46.76%) which was statistically at par with Custard apple + Paddy based Horti – Agriculture system (44.25%) while minimum was recorded in Mango + Paddy based Horti – Agriculture system (25.14%). At the depth of 15-30 cm, sand content showed a similar trend as 0-15 cm. All the surveyed soils of different farmers of Dangs district were found clay loam in texture.

Soil texture of different surveyed farmers of Surat district which are presented in Table – 1 revealed that maximum clay content in 0 - 15 cm soil depth was found in Mango + Onion based Horti – Olericulture system (58.44%) which was followed by Mango + Pointed gourd + Ivy gourd based Horti – Vegetable vine crops system (56.88%). Whereas, minimum clay content in 0-15 cm soil depth was reported in Mango + Pumpkin based Horti – Vegetable vine crop system (38.51%). In case of 15 – 30 cm depth of soil similar trend was observed. However, silt content at 0 – 15 cm depth was recorded maximum in Mango + Sorghum + Maize based Horti- Pastoral + Agriculture system (27.54%) which was followed by Mango + Napier grass based Horti – Pastoral system (27.41%) and the minimum was noted in Mango + Turmeric based Horti – Tuber crops system (17.29%). At 15-30 cm depth of soil silt content showed a similar trend during the soil analysis. Furthermore, sand content at 0-15 cm depth was found maximum in Mango + Pumpkin based Horti – Vegetable vine crops system (42.33%) which was followed by Mango + Chickpea based Horti – Agroculture system (39.80%) and the minimum was recorded in Mango + Napier grass based Horti – Pastoral system (17.48%). At the depth of 15-30 cm, sand content showed a similar trend as 0-15 cm. The surveyed soils of Surat district were found clay in texture. Overall, clay loam and clay are the dominant textural classes of the soils in surveyed area as it is evidence from the proportion of soil separates presented in Table - 1. Such variation in soil texture could be attributed to parent materials, topographic conditions, pedogenic processes operating in the region owing to differences in soil farming factors, cropping systems and management practices being followed by the farmers. Among the studied locations, Prasad *et al.* (2019) in Bundelkhand district (UP), Chhina *et al.* (2019) [1] in Shiwaliks region of northwest India, Goswami *et al.* (2019) in Kwalkhad watershed Himachal Pradesh, India, were also reported similar variation in physical properties of soil.

**Table 1:** Variations in soil texture of different horticulture-based agroforestry systems in South Gujarat

District	Taluka	Texture							Class
		Horticulture-based agroforestry systems	Depth of Soil						
			Clay (%)		Silt (%)		Sand (%)		
0 - 15	15 - 30	0 - 15	15 - 30	0 - 15	15 - 30				
Valsad	Dharampur	Mango + Sweet potato	28.44	28.46	35.67	34.47	35.89	37.07	Loam
		Mango + Sorghum	32.29	31.68	37.32	38.52	30.38	29.80	Clay loam
		Mango +Ivy gourd	29.11	30.16	39.11	39.87	31.78	29.97	Clay loam
		Mango + Okra	31.22	31.25	32.45	31.12	36.33	37.63	Clay loam
		Mango + Sponge gourd+ Cucumber	33.64	33.67	29.43	28.74	34.93	37.59	Clay loam
		Mango + Banana + Brinjal	29.91	28.56	26.88	25.23	43.19	46.21	Clay loam
	Kaparada	Mango + Colocasia	27.22	28.26	28.44	29.91	44.34	41.83	Loam
		Mango + Sorghum	26.13	27.15	29.22	30.32	44.65	42.53	Loam
		Mango + Chili	29.25	30.05	29.31	28.57	41.44	41.38	Clay loam
		Mango + Rice	28.11	26.78	32.40	31.51	39.49	41.71	Loam
		Mango + Banana + Sapota	29.23	29.34	30.52	31.51	40.25	39.15	Clay loam
		Mango + Sponge Gourd + Cowpea + Cucumber	26.40	26.65	43.48	41.43	30.12	31.92	Loam
	Valsad	Mango + Amorphophallus	52.33	51.43	24.54	26.23	23.13	22.34	Clay
		Mango + Papaya	54.30	54.08	28.62	25.54	17.08	20.38	Clay
		Mango + Sorghum	51.63	52.34	25.33	26.78	23.04	20.88	Clay
		Mango + Turmeric	57.52	56.78	21.41	20.48	21.07	22.74	Clay
		Mango + Okra	52.94	53.32	26.54	27.50	20.52	19.18	Clay
		Mango + Papaya + Brinjal	54.12	54.78	24.11	23.51	21.77	21.71	Clay
		Average	37.43	37.49	30.27	30.07	32.19	32.45	
	Navsari	Chikhli	Mango + Colocasia	54.09	53.65	26.08	28.15	19.83	18.20
Mango + Sorghum			56.08	56.78	28.02	26.23	15.90	16.99	Clay
Mango + Brinjal + Onion + Cabbage			52.45	51.78	24.25	20.52	23.30	27.70	Clay
Mango + Brinjal + Onion + Cabbage			57.85	57.63	23.88	25.52	18.27	16.85	Clay
Mango + Pigeon pea			54.88	55.12	24.41	24.44	20.71	20.44	Clay
Mango + Pumpkin			51.82	50.63	27.14	28.57	21.04	20.80	Clay
Gandevi		Mango + Amorphophallus + Dioscorea + Turmeric	52.38	53.08	24.32	22.97	23.30	23.95	Clay
		Mango + Cucumber	54.32	54.78	26.33	27.57	19.35	17.65	Clay
		Mango + Rose	51.92	52.32	25.20	23.58	22.88	24.10	Clay
		Mango + Kamini (Orange Jasmine)	57.31	56.98	26.33	26.02	16.36	17.00	Clay
		Mango + Sorghum	54.23	55.14	22.35	24.98	23.42	19.88	Clay
		Mango +Okra	52.64	52.16	24.38	20.73	22.98	27.11	Clay
		Mango + Bottle gourd	52.12	53.45	19.41	20.89	28.47	25.66	Clay
Khergam		Mango + Turmeric	48.51	47.68	21.62	22.52	29.87	29.80	Clay
		Mango + Ivy gourd + Chili	51.12	51.78	24.66	21.93	24.22	26.29	Clay
		Mango + Colocasia + Turmeric	52.38	53.47	26.73	27.81	20.89	18.72	Clay
		Mango + Pumpkin	49.55	48.57	27.47	26.04	22.98	25.39	Clay
		Mango + Colocasia	47.63	46.75	24.09	25.32	28.28	27.93	Clay
		Average	52.85	52.88	24.82	24.66	22.34	22.47	
Dangs		Ahwa	Mango + Custard apple + Groundnut	32.08	31.78	26.85	27.81	41.07	40.41
	Mango +Paddy		33.14	32.48	31.10	28.03	35.76	39.49	Clay loam
	Mango +Paddy		31.12	30.15	32.61	31.30	36.27	38.55	Clay loam
	Mango +Paddy		33.81	32.78	41.05	38.73	25.14	28.49	Clay loam
	Mango +Sorghum		30.17	29.58	33.18	32.91	36.65	37.51	Clay loam
	Mango + Sapota + Paddy		29.88	30.46	29.17	27.53	40.95	42.01	Clay loam
	Subir	Custard apple + Paddy	26.33	27.32	29.42	30.23	44.25	42.45	Loam
		Mango + Paddy	24.59	23.12	28.65	27.91	46.76	48.97	Loam
		Mango + Sugarcane	28.42	29.46	37.08	35.58	34.50	34.95	Loam
		Cashew nut + Paddy	31.12	30.16	32.22	33.21	36.66	36.63	Clay loam
		Mango + Finger millet (Nagli)	28.11	27.89	34.12	34.00	37.77	38.11	Loam
		Mango + Amorphophallus	24.10	22.63	36.52	35.20	39.38	42.17	Loam
		Average	31.61	31.05	32.29	31.79	36.10	37.16	
	Waghai	Custard apple + Ground nut	36.29	37.12	32.69	30.68	31.02	32.20	Clay loam
		Custard apple + Maize	36.48	36.92	31.21	32.51	32.31	30.57	Clay loam
		Custard apple + Finger millet (Nagli)	37.31	37.18	34.34	33.21	28.35	29.61	Clay loam
		Mango + Paddy	34.51	33.14	30.06	32.51	35.43	34.35	Clay loam
		Mango + Rose	36.22	32.58	28.68	27.67	35.10	39.75	Clay loam
		Mango + Spider lily	35.27	34.18	32.25	33.25	32.48	32.57	Clay loam
	Surat	Bardoli	Average	31.61	31.05	32.29	31.79	36.10	37.16
Mango + Water melon			54.34	55.47	21.28	19.56	24.38	24.97	Clay
Mango + Turmeric			56.38	55.78	17.29	15.31	26.33	28.94	Clay
Mango + Spider lily			52.41	53.14	24.39	22.23	23.20	24.63	Clay
Mango + Onion			58.44	57.48	19.12	21.03	22.44	21.49	Clay
Mango + Napier grass			54.11	55.24	27.41	26.23	17.48	18.53	Clay
Mango + Pointed gourd+ Ivy gourd	56.88	55.68	26.52	24.53	16.60	19.79	Clay		

Mahua	Mango + Sorghum + Maize	51.68	52.35	27.54	27.91	20.78	19.74	Clay	
	Mango + Drumstick + Cowpea	54.55	55.16	24.02	25.54	21.43	19.30	Clay	
	Mango + Drumstick + Tomato	48.24	47.89	24.78	23.62	26.98	28.49	Clay	
	Mango + Brinjal + Guava	47.66	45.78	21.73	20.21	30.61	34.01	Clay	
	Mango + Sugarcane + Drumstick.	49.21	48.65	23.14	21.52	27.65	29.83	Clay	
	Bottle gourd + Turmeric	51.44	52.18	27.36	24.53	21.20	23.29	Clay	
	Mandvi	Mango + Chickpea	42.32	41.78	17.88	18.21	39.80	40.01	Clay
		Mango + Pumpkin	47.13	46.98	22.37	22.00	30.50	31.02	Clay
		Mango + Onion + Garlic	46.61	47.12	26.56	27.22	26.83	25.66	Clay
		Mango + Okra	44.60	42.89	23.05	23.51	32.35	33.60	Clay
		Mango + Pigeon pea (Tugar)	41.22	39.78	21.48	19.23	37.30	40.99	Clay
		Mango + Pumpkin	38.51	36.47	19.16	21.21	42.33	42.32	Clay loam
Average		49.76	49.43	23.06	22.42	27.12	28.15		
Total Mean		42.91	42.71	27.61	27.23	29.48	30.05		
S. Em. $\pm$		0.22	0.06	0.07	0.89	0.26	0.10		
C.D. at 5 %		0.60	0.16	0.20	2.48	0.74	0.27		
C.V. %		0.87	0.23	0.45	5.74	1.56	0.56		

### Conclusion

The study shows that there was a diversity among the 72 farmer's fields in terms of different combination of tree-crop systems of Agroforestry. The soils of these fields are varied significantly in terms of clay, silt and sand content. Out of 72 agroforestry fields studied, at the soil depth of 0-15 cm, the overall clay content ranged from 24.10% to 58.44%; silt content ranged from 17.29% to 43.48% and sand content ranged from 15.90% to 46.76% with overall mean content of clay, sand and silt was 42.91%, 27.61% and 29.48%, respectively. Whereas in soil sample collected at the depth of 15-30 cm, the overall clay content ranged from 22.63% to 57.63%, silt content ranged from 15.28% to 41.43% and sand content ranged from 16.85% to 48.97% with overall mean content of clay, sand and silt was 42.71%, 27.23% and 30.05%, respectively. The overall study shows that the soils of Valsad, Dangs and Surat districts were found to be clayey loam and loam in texture; while, the soils collected from different farmer's field of Navsari district were found to be clay in texture.

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