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ECONOMIC COMPARISON OF INTERCROPPING OF GINGER AND TURMERIC UNDER SAPOTA-JATROPHA BASED AGRO-FORESTRY SYSTEMS IN SOUTH GUJARAT

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Abstract: The field experiments were conducted under support irrigated conditions at NAU, Navsari (Gujarat) during 2013 and 2014. The nine year old plantation of Sapota (*Manilkara acharas* (Mill.) Fosberg) with seven year old plantation of Jatropha (*Jatropha curcas* L.) was used for the present intercropping study. Two crops with two varieties *viz*. **Ginger (***Zingiber officinale* L var. Navsari local and *Zingiber officinale* L. var. Udaipur local**)** and **Turmeric (***Curcuma longa* L. var. Sugandham and *Curcuma longa* L. var. Guj. Navsari Turmeric- 1) was selected for the study.
Significantly higher B: C ratio was noted in intercropping of ginger with Sapota + Jatropha or Jatropha based agro-forestry systems as compared to sole cropping or intercropping under Sapota, whereas in intercropping of turmeric with Sapota or Sapota + Jatropha agro-forestry systems as compared to Intercropping under Jatropha or sole cropping. Overall economic analysis states that the total cost of production found higher in case of ginger but net income as well as BCR observed higher in case of turmeric.
Keywords: Agroforestry, Intercropping, Ginger, Turmeric, Sapota, Jatropha, Net Income, Benefit Cost Ratio

Introduction

Agroforestry denotes a sustainable land and crop management system that strives to increase yields on a continuing basis, by combining the production of woody forestry crops (including fruit and other tree crops) with arable or field crops and/or animals simultaneously or sequentially on the same unit of land, and applying management practices that are compatible with the cultural practices of the local population. There is immense potential in agroforestry systems to enhance productivity and sustainability of agricultural lands or the land resources, which have never been put into service due to so many factors, can be better used by adopting different agroforestry practices like inclusion of ginger and turmeric cultivation in it for high remuneration and useful combination (age and spacing of tree species) if properly managed (with recommended agronomic and/or silvicultural practices for particular region) could

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increase the production potential sufficiently. Hence, such systems need to be made popular among farmers for sustainable livelihood.

Ginger and Turmeric are most suitable Spice crops for intercropping in agro-forestry systems in Prehumid –Subhumid and Semihumid-Semiarid regions from lowlands (500 mt.) to medium elevation (500-1000 mt.) (Nair, 1993).India is the largest producer of Ginger and turmeric in the world. Ginger (*Zingiber officinale* L.) is an important commercial crop grown for its aromatic rhizomes, which are used both as a spice and a medicine. Ginger (*Zingiber officinale* L.) is an indigenous plant and important spice worldwide. In India, It is grown in an area of 1,25,347 ha with a production of 9, 24, 417 tonnes of ginger. Karnataka, Orissa and West Bengal account for more area under ginger though it is grown in almost all states of India. India is the largest producer (70 % of world production) and exporter to more than 50 countries. India, China, Taiwan, Sierra and Nigeria are the major exporter of dry ginger. The area in Gujarat is 4,389 ha with the production of 70, 646 tonnes.

Turmeric (*Curcuma longa* L.) is a herbaceous plant, native to Tropical South East Asia. In India, it is grown in an area of 2, 51,824 ha producing annually 13, 98, 862 tonnes. India is leading in its production (75 % of world output) but export is approximately 10-15 % (best quality only) of our production. In India, Andhra Pradesh is the leading state (area wise) followed by Tamil Nadu, Orissa, Maharashtra, Kerala, and Bihar. In Gujarat it covers an area of 2, 971 ha with a production of 50, 493 tonnes.

Sapota [*Manilkara achras* (Mill.) Fosberg] belongs to family Sapotaceae. It is also known as Sapodilla or *Chiku* or *Chikoo* in India and it was introduced from Tropical America. It is a native of Mexico. It is mainly cultivated for its fruits, while in South-East Mexico, Guatemala and other countries chickle is commercially produced. The Sapota fruit is a good source of digestible sugar (12-18%), protein, fat, fibre and minerals *Viz*., Calcium, Phosphorus and Iron. The fruit skin can also be eaten and is richer than the pulp in nutritive value. (Gopalan *et al*.,1977). India is considered to be the largest producer of Sapota in the world. In India, commercial scale cultivation of the fruit is taken up in the states of Gujarat, Maharashtra, Karnataka, Tamil Nadu, Andhra Pradesh and Kerala. The total area and production of Sapota in India is 158.9 thousand hectares and 1346.8 thousand million tonnes, respectively. In Gujarat the total area under Sapota is 27.4 thousand hectares and production is 272.6 thousand million tones. Gujarat contributes 20.2 % in total production of Sapota in India (Anonymous, 2010).

The botanical name of *Jatropa curcas* L. is derived from the Greek word "Jatros" meaning "doctor" and "trophe" meaning "nutrition" because of medicinal properties. Jatropha is a genus of flowering plants in the spurge family, Euphorbiaceae. It is a perennial shrub to small tree of up to 6m height, adapted to all kinds of soil and does not demand any special nutritive regime (Patil and Singh, 1991). It can be used to revegetate 33 million hectare of Indian wastelands out of 146 m ha. There is about 125.86 lakh hectare of wasteland alone in Gujarat state which can be planted under Jatropha (Saxena and Pafali, 1999).

Material and Methods

The field experiments were conducted under support irrigation conditions during *kharif* season 2013 and 2014 at Navsari Agricultural University, Navsari , Gujarat to study the growth and yield and economics of Sapota , Jatropha ,Ginger (*Zingiber officinale* L.) and Turmeric (*Curcuma longa* L.) under different agro-forestry systems in south Gujarat. Geographically, Navsari is situated at 20° 95'N latitude, 75° 90'E longitude and at an altitude of 10 metres above the mean sea level. The college farm is located 3 km away in west from Navsari city and 12 km away in the East from the historical place Dandi on Arabian Sea shore. Summer season commences during the middle of February and ends during middle of June. The temperature reached a maximum of 34.9^0C in the month of May. April and May are the hottest months of summer season. The climate of this area is humid and the mean relative humidity remains above 68.27 per cent throughout the year. The nine year old plantation of Sapota (*Manilkara acharas* (Mill) Fosberg.) at 10.0 x 10.0 m spacing grown with seven year old plantation of Jatropha (*Jatropha curcus* L.) at 2.5 x 2.5m spacing were used for intercropping study. Two crops with two varieties *viz*., Ginger (*Zingiber officinale* L var. Navsari Local and Udaipur Local) and Turmeric (*Curcuma longa* L. var. Sugandham and Gujarat Navsari Turmeric- 1) were selected for the present study. The experiment was laid out in Randomized Block Design (RBD) with three replications and eight treatments for Ginger and Turmeric attributes. The net income per hectare was calculated by deducting the total cost of cultivation from gross return per hectare. The benefit cost ratio was calculated as per following formula:

$$\text{Benefit cost ratio} = \frac{\text{Gross returns}}{\text{Cost of cultivation}}$$

Result and discussion

The data on total cost of production, net income and benefit cost ratio (B: C) as influenced by sole crop and intercrop under different Sapota-Jatropha based agro-forestry systems are

presented in Table – 1 for Ginger and Table -2 for Turmeric (Mean data for the year 2014 & 2015). It is evident from results that the intercropping of ginger recorded higher benefit cost ratio as compared to sole crop. However, maximum benefit cost ratio was recorded in the treatment G_2 (1: 2.76) where ginger var. Udaipur local was intercropped under Sapota + Jatropha agroforestry system, followed by G_1 (1: 2.52) and minimum when ginger var. Navsari Local was grown as sole crop (1:1.40). Compared to all respective treatments as per varieties of the ginger studied in the first and second year as well as in the pool data, treatments with ginger var. Udaipur Local recorded higher benefit cost ratio among all treatments. It may be due to the compatibility of these crops under investigation with regard to their growth habit, nutrient requirement as well as light and moisture conditions which ultimately might reflect in terms of better productivity and higher economic returns. Similar results were also observed by Maheshwari *et al.* (1985) in *Rauvolfia serpentina* with soybean and garlic and onion. It can be concluded that since ginger is a shade loving and long duration crop and gives sound yield with slightly higher cost of cultivation i.e. higher price and seed rate and higher organic manure but the yield compensate it and received maximum income under Sapota + Jatropha or with sole Jatropha agro-forestry system in south Gujarat. These results are in conformity with the findings of Prajapati *et al.* (2007) in ginger, Vanlalhluna and Sahoo (2010) in ginger, turmeric, maize, Saroj *et al.* (2003) in groundnut, wheat, cluster bean and mustard.

Growing of turmeric under Sapota-Jatropha based agro-forestry systems resulted in significant increase in the economic return as compared to growing turmeric as a sole crop. Compared to all respective treatments among different agro-forestry systems as per varieties of the turmeric studied in the first and second year, treatments with turmeric var. Sugandham recorded higher benefit cost ratio except for sole cropping. It can be concluded that yield might be in consonance with the soil and climatic conditions of South Gujarat as evident that maximum income occured in intercropping with sole Sapota or Sapota + Jatropha agro-forestry system in our study. Significantly higher economic returns were observed under Sapota-Jatropha based agro-forestry systems as compared to sole crop. However, the trend of net income (mean data) and BCR for turmeric was observed in order T_3 (1: 4.85) > T_4 (1: 4.61) > T_1 (1: 3.98) > T_2 (1: 3.86) > T_8 (1:3.69) > T_7 (1:3.54) > T_5 (1:2.44) > T_6 (1:2.07). The treatments with turmeric var. Sugandham recorded higher benefit cost ratio except for sole cropping, i.e. in case of sole cropping the turmeric Var. GNT-1showed the higher benefit cost ratio for both the years and in mean data.

On the other hand, if we see the performance of different agro-forestry systems as per benefit cost ratio, It was maximum where turmeric was grown with Sapota only then with Sapota + Jatropha and then sole crop and the minimum was there under Jatropha. The reason may be attributed to the compatibility of these crops under investigation with regard to their growth habit, nutrient requirements as well as light and moisture conditions which ultimately reflected in terms of better productivity and higher economic yields and returns. Similar results were also observed by Jain(2014) in turmeric with guava, Maheshwari *et al.* (1997), Kothari *et al.* (1987) in sugarcane and mint, Vanlalngurzauva *et al.*(2010)in Rice, cowpea, groundnut and blackgram. It can be concluded that since turmeric is a shade loving and long duration crop and gives high yield with slightly lower cost of cultivation i.e. lower price of seed and lesser organic manure thus the yield is in consonance with the soil and climatic conditions of South Gujarat as evident that maximum income occurred with sole Sapota or Sapota + Jatropha agro-forestry system in our study. On the basis of present investigation, it may be concluded that, growing of ginger crop in south Gujarat led higher cost of production but lesser economic return as a sole crop or under Sapota-Jatropha based agro-forestry systems as compared to growing turmeric, which has lower cost of production and results in higher net income and benefit cost ratio.

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Table – 1: Economics of Ginger cultivation under Sapota-Jatropha based agro-forestry systems in South Gujarat

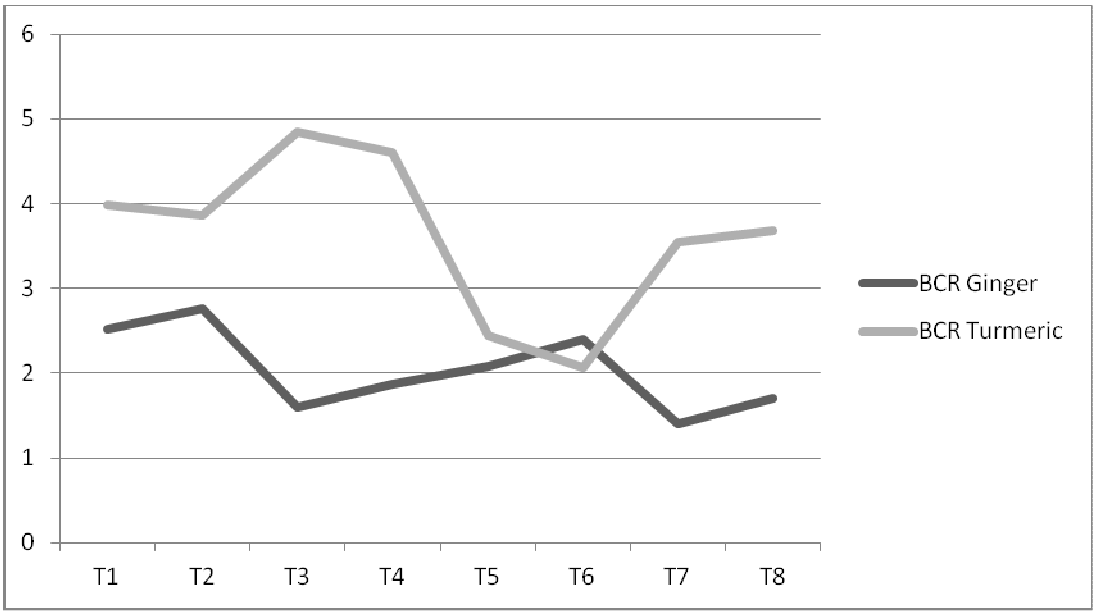
Treatments(Ginger II year)	Total cost of production (₹/ha)	**Net income (₹/ha)**	**BCR**
G_1 (Sapota + Jatropha **+** Ginger var. Navsari local)	159343.88	240598.65	2.52
G_2 (Sapota + Jatropha **+** Ginger var.Udaipur local)	159343.88	279293.65	2.76
G_3 (Sapota + Ginger var. Navsari local)	159343.88	95755.65	1.60
G_4 (Sapota + Ginger var.Udaipur local)	159343.88	136631.65	1.87
G_5 (Jatropha **+** Ginger var. Navsari local)	159343.88	171396.15	2.08
G_6 (Jatropha **+** Ginger var.Udaipur local)	159343.88	222063.65	2.40
G_7 (Ginger var. Navsari local sole)	152323.88	59698.63	1.40
G_8 (Ginger var.Udaipur local sole)	152323.88	105031.13	1.70

Table 2: Economics of Turmeric cultivation under Sapota-Jatropha based agro-forestry systems in South Gujarat

Treatments(Turmeric II YEAR)	Total cost of production (₹/ha)	Net income (₹/ha)	BCR
T_1 (Sapota + Jatropha + Turmeric var. Sugandham)	122303.93	362955.60	3.98
T_2 (Sapota + Jatropha + Turmeric var. GNT-1)	122303.93	347745.60	3.86
T_3 (Sapota + Turmeric var. Sugandham)	122303.93	470608.60	4.85
T_4 (Sapota + Turmeric var. GNT-1)	122303.93	441378.10	4.61
T_5 (Jatropha + Turmeric var. Sugandham)	122303.93	177251.10	2.44
T_6 (Jatropha + Turmeric var. GNT-1)	122303.93	131703.60	2.07
T_7 (Turmeric var. Sugandham sole)	115553.93	292896.10	3.54
T_8 (Turmeric var. GNT-1sole)	115553.93	309981.10	3.69

Comparison of Economics of Ginger (G) and Turmeric (T) Cultivation under Sapota-Jatropha based agro-forestry systems in South Gujarat

(a) Graph showing benefit cost ratio



(b) Graph showing total cost of production and net income