Table 2. Cormel equivalent yield and economics of taro, okra, veg.cowpea and cluster bean involved intercropping systems

Treatment	Cost of cultivation (₹ ha^{-1})	Gross return (₹ ha^{-1})	Net return (₹ ha^{-1})	B: C ratio
Taro	106800	236300	129500	2.21
Taro+okra	122400	245800	123500	2.01
Taro+veg. cowpea	124000	315100	191100	2.54
Taro+cluster bean	120400	260500	140100	2.16

Sale price of corm 10 ₹ kg^{-1}; cormel 15 ₹ kg^{-1}; okra/ veg. cowpea/ cluster bean 15 ₹ kg^{-1}

Conclusion

Taro+veg. cowpea/cluster bean intercropping system might be highly suitable for smallholder farming system to achieve food and nutritional security and improve livelihood.

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Taro intercropping with vegetables for higher income, food and nutritional security

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TARO INTERCROPPING WITH VEGETABLES FOR HIGHER INCOME, FOOD AND NUTRITIONAL SECURITY

Introduction

Taro (*Colocasia esculenta*) is a starchy vegetable crop. Corms and cormels of taro are consumed after boiling and seasoning. It contains more protein, minerals, phosphorus and iron compared to other tuber crops. It is rich in dietary fibre, potassium, calcium and magnesium, and low in fat. Corms and cormels are used for chips production and starch making. Taro starches are used in talc, along with kaoline. Young leaves and petioles are also consumed as green vegetable. Anti-inflammatory activity and its pharmacological applications of leaf of taro were reported. This crop has great medicinal value and is included in many Ayurvedic preparations. Culled tubers are used as animal feed especially for pigs.

Distribution

Taro is an important vegetable crop grown throughout India. It is grown in West Bengal, Kerala, Uttar Pradesh, Madhya Pradesh, Odisha, Bihar, Karnataka, Bihar, Andhra Pradesh, Tamil Nadu, Punjab, Rajasthan, Assam and North eastern states. North eastern region is considered to be one of the centres of origin. In India, it is commercially grown in localized pockets in different states such as Jhansi, Farookhabad, districts in Uttar Pradesh; Khandwa and Indore districts in Madhya Pradesh; Nayagarh and Cuttack districts in Odisha; East Godavari, West Godavari, Krishna and Guntur districts in Andhra Pradesh; 24-Paraganas and Nadia districts in West Bengal, and Pathanamthitta and Alapuzha districts in Kerala. In Chhattisgarh state, Bastar, Kanwardha and Jaspur districts taro is commercially cultivated. In Rajasthan, taro is the choicest tuber crop in Hadoti region (eastern Rajasthan in Jhalawar, Kota, Bundi and Baran districts).

Intercropping

Taro being a long duration crop, it takes 5-6 months to realize returns. Smallholder farmers face income stress under sole cropping of taro. Growing short duration vegetable crops as intercrop in taro will help to get returns quickly and also augment farm income. Available literature revealed that intercropping with multiple species is the best option for risk minimizing, higher productivity and staggered income. Intercropping ensures efficient utilization of natural resources like light, nutrients, water and space but also conserve it by reducing soil erosion and lodging, suppresses weed growth thereby helps in yield increment and maintain greater stability in crop yield.

In the era of shrinking resource base of land, water and energy, selection of component crops needs to be suitably planned to harvest the synergism among them towards efficient utilization of resource base and to increase overall productivity. Inclusion of vegetable crops in taro will improve the economic condition of small and marginal farmers owing to higher yield, price and staggered income. There is a growing demand for agricultural diversification and reorientation of strategies with emphasis on efficient use of available resources for improving productivity on a sustainable basis. Also, the traditional monoculture approach is unable to meet the growing and changing food demand and improve the livelihood of smallholders on a sustainable basis. Within crop diversification, intercropping – the practice of growing two or more species simultaneously in the same field for the whole or a part of their growing periods – has been demonstrated to be particularly beneficial in terms of production, yield stability, associated biodiversity and pest and disease control per unit of land. Inclusion of vegetables in the major cropping systems will not only improve the availability of vegetables and help in food self-sufficiency but will also provide means to earn foreign exchange by exporting fresh vegetables and vegetable seeds. Moreover, these vegetable crops are suitable for production on small pieces of land and their inclusion in traditional cropping systems can improve the nutritional potential of the system.

Vegetables intercropping in taro

The taro (Muktakeshi) crop was planted at normal spacing of 60 x 30 cm. In intra-row spacing of taro in between two taro plants, one plant of intercrop [okra (Arka Anamika) / veg. cowpea (Kashi Kanchan) / cluster bean (Deepti)] was sown (1:1 additive series). The fertilizer dose of N-P_2O_5-K_2O for taro 80-60-80 kg ha^{-1}, taro+okra 160-120-160 kg ha^{-1}, taro+veg. cowpea 105-110-105 kg ha^{-1} and taro+cluster bean 105-110-105 kg ha^{-1}should be applied. In all the cropping, half dose of N and full doses of P and K were applied at the time of sowing/ planting, while remaining N was applied one month after sowing/ planting. All the crops were planted/ sown on same day. Fruits/pods of okra, veg. cowpea and cluster bean were harvested as soon as matured. In veg. cowpea and cluster bean, final harvest of pods followed by shoot removal was done at 90 days after sowing. In okra, final fruit harvest followed by shoot cutting was done 105 days after sowing. Taro was harvested 165 days after planting.

The intercropping of okra, veg. cowpea and cluster bean resulted in higher system yield than sole taro (Table 1; Fig. 1-5). Though taro yield under intercropping was decreased, the vegetable crop yield compensated. The cormel equivalent yield (CEY) of taro+veg. cowpea was the highest (Fig. 4) and it was followed by taro+cluster bean and taro+okra intercropping than sole taro cultivation (Table 1). Synergetic effect of intercropping was much higher in taro+veg. cowpea treatment. The Table 1 also indicated that there was more competition for space, light, water and nutrients between taro and okra.

Table 1. Effect of intercrops on cormel equivalent yield (CEY)

Treatment	Corm yield ($t\,ha^{-1}$)	Cormel yield ($t\,ha^{-1}$)	Intercrop yield ($t\,ha^{-1}$)	CEY ($t\,ha^{-1}$)
Taro	4.78	11.99	-	15.18
Taro+okra	2.28	4.04	10.67	16.23
Taro+veg. cowpea	4.69	7.80	9.07	20.00
Taro+cluster bean	4.07	6.23	7.79	16.90

Corm Rs 10000 t^{-1}; cormel Rs 15000 t^{-1}; okra/ veg.cowpea/ cluster bean Rs 15000 t^{-1}

Taro+veg. cowpea intercropping system resulted in higher gross and net returns as well as B:C ratio and it was followed by taro+cluster bean (Table 2). This indicated that instead of sole taro, intercropping is the best option with veg. cow pea and cluster bean for higher income. Further, it also provides food and nutritional security along with regular flow of income. Inclusion of legumes as intercrop also improves soil health.