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Research Paper

Geo-tagged characterization of organic growers in Kerala

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ABSTRACT

A Global Positioning System (GPS)-based field survey of organic clusters was conducted during 2015–19 among 112 farmers in 2 districts of Kerala under the All India Network Programme on Organic Farming (AINPOF), by the ICAR-Central Tuber Crops Research Institute, Thiruvananthapuram, Kerala. The survey was based on the questionnaire provided by the AINPOF lead centre, ICAR-Indian Institute of Farming Systems Research, Modipuram, Meerut, Uttar Pradesh, to elucidate the management practices, yield, profit and soil-health benefits of organic farming. Majority of the farmers were small and marginal (80%), with a land holding size < 2 ha and the farms were uncertified. Major crops grown organically were rice (*Oryza sativa* L.), fruits, vegetables, root and tubers, spices, plantation crops, ornamentals and medicinal plants. Being health conscious and aware of the quality of the organic produce, an 85% of the farmers used the produce for sustenance to provide safe food to their family, rather than for marketing and profit. About 31.19% of the farmers owned cow, 19.26% goat, and 33.02% poultry (hen and duck) as an integral part of organic farming. Pisciculture was practiced on a small scale (3.6%). Waste management was mainly by composting and biogas preparation, which led to effective recycling of farm wastes and overall enhancement in crop growth and yield. Indigenous preparations like *Panchagavya*, *Jeevamrut*, *Ghanajeevamrut* were used for growth promotion and flowering by 48.85% of the respondents. The major constraints faced were high cost and non-availability of quality organic inputs, low farm gate price for the organic produce and yield limitations during initial years.

Key word **:** Geo-referenced survey, Natural farming, Organic cluster, Innovative preparations, Safe food, Yield gap

Over the past 4 decades, modern agricultural practices along with the irrational use of chemical inputs have resulted in not only loss of natural habitat balance and soil health but also caused many hazards like soil erosion, decreased groundwater level, soil salinization, pollution due to fertilizers and pesticides, genetic erosion, ill-effects on environment, reduced food quality and increased cost of cultivation, rendering the farmer poorer year by year (Henneron *et al*., 2014; Patidar and Patidar, 2015).

Growing awareness of health and environmental issues associated with the intensive use of chemical inputs has led to interest in alternate forms of agriculture. Organic farming is gaining popularity all over the world, as it can diversify agricultural production systems towards attaining improved productivity and farm income, safe food, as well as environmental safety. It is a holistic production-management system which promotes and enhances agro-ecosystem health including biodiversity, biological cycles and soil-biological activity (IFOAM, 2008). Organic agriculture enhances the on-farm waste-management process and effectively contributes to the recycling of waste and assures healthy and quality-food production. It relies on components such as green-manure, compost, crop rotation and biological pest control (Epule, 2019).

Zero Budget Natural Farming (ZBNF), implies that farmers need not purchase fertilizers and pesticides in order to ensure the healthy growth of the crops. The method proposes and uses locally obtainable natural biodegradable materials saturated with scientific knowledge of ecology and modern technology with traditional farming practices based on naturally occurring biological processes. This concept was advocated by Shri Subhash Palekar, for which he was honoured with Padma Shri in 2016 (Badwal *et al*., 2019).

Remote-sensing techniques are widely used in agriculture as the monitoring of agricultural activities faces special

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problems not common to other economic sectors (FAO, 2011). Remote-sensing data are used for estimating biophysical parameters and indices besides cropping-system analysis, and land-use and land-cover estimations during different seasons (Rao *et al*., 1996; Panigrahy *et al*., 2006). The data coupled with soil survey information can be integrated in the geographical information system (GIS) to assess crop suitability for various soil and biophysical conditions (AbdelRahman *et al*., 2016).

Presently, an inventory or documentation of organic growers is not available. The aim of this study was therefore to evaluate farmers perception of organic farming and issues associated with it by using well-structured questionnaire and Global Positioning System (GPS). Thus, the survey was conducted to (i) study the common organic farming practices adopted by the farmers, (ii) identify the relative share of farmers involved in organic farming either individually or in clusters, to elucidate information on major crops grown under organic management, organic inputs, nutrient sources, pesticides and other plant-protection measures used by the farmers and (iv) find out the major constrains in organic farming in the state.

MATERIALS AND METHODS

The field survey was carried out during 2015–19 by the ICAR-Central Tuber Crops Research Institute (CTCRI), Thiruvananthapuram, Kerala, under the aegis of All India Network Project on Organic Farming (AINPOF), led by the ICAR-Indian Institute of Farming Systems Research, Modipuram, Uttar Pradesh. It was executed as a Geographical Information System (GIS)-based survey in which a Global Positioning System (GPS) and a questionnaire related to farming situations were used as the major tools for the study.

As the major aim of the geo-referenced survey was to examine the common organic farming practices adopted by the farmers and to identify the relative share of farmers involved in organic farming either individually or in clusters, information regarding such clusters and leading organic farmers in each block panchayat was collected with the help of the Agriculture officials in the Kerala State Department of Agriculture and Farmer's Welfare. Organic clusters from each block were selected randomly and a field survey was conducted based on the questionnaire provided by the lead centre. The survey was done among randomly selected 112 organic farmers from Kazhakoottam, Neyyattinkara, Parassala, Vamanapuram, Nemom, Varkala, Neyyattinkara, Pothencode and Kilimanoor blocks in Thiruvananthapuram and Ponnani, Kuttippuram and Mankada blocks in Malappuram districts of Kerala. These blocks were specifically opted, as these were important tuber crops-growing area and tuber crops like cassava (*Manihot esculenta* Crantz), elephant foot yam [*Amorphophallus paeoniifolius* (Dennst.) Nicolson], taro [*Colocasia esculenta* (L.) Schott], tannia (*Xanthosoma sagittifolium*) and yams (*Dioscorea* sp.) formed components of different cropping systems, besides tuber crops were preferably and largely grown by organic methods. Personal visit to all the farm was done in order to collect the GPS details (Latitude, Longitude and Altitude) of each farm by using the GPS instrument (Garmin Montana 680)/ Google map mobile application. Using the data, each farm has been pointed out in the map using GIS software (GIS version 10.1) to identify the organic growers in the state (Fig. 1).

Another tool used for the survey was the questionnaire provided by the lead centre. It was used to collect information about the farming situations and evaluate farmer's perception of organic farming and issues associated with it. Details of the data collected using the questionnaire was:

- Farm location
- Total land holdings and area under organic farming
- Soil type
- Details of crops and cropping systems
- Farm animals and inputs
- Crop residue availability and recycling
- Weed management
- Insect-pest management
- Production and profitability
- Details of other organic inputs for used crop-management and their preparations
- Water-management practices
- Cost of cultivation
- Processing and value-addition
- Soil-health card details
- Details about certification

Yield-gap analysis of major tuber crops, cassava, elephant foot yam and taro was also done, to find out the deviation in yield under organic farming in actual farmers situation over on-station yield. It was computed as follows:

$$\text{Yield gap (\%)} = \frac{\text{(Yield under organic in farmers field–Yield under organic at on-station)}}{\text{Yield under organic at on-station}} \times 100$$

RESULTS AND DISCUSSION

Geo-referenced characterization of organic farmers

One hundred and twelve organic farmers from Kazhakoottam, Neyyattinkara, Parassala, Vamanapuram, Nemom, Varkala, Pothencode and Kilimanoor blocks in Thiruvananthapuram district, and Ponnani, Kuttippuram and Mankada blocks in Malappuram districts of Kerala were selected randomly. As the mandate crops of the study centre, the ICAR-CTCRI, are tropical tuber crops, the survey was mainly concentrated on organic tuber crop-growers. There were no organic clusters in Parassala and Nemom blocks, while Varkala and Kilimanoor blocks had

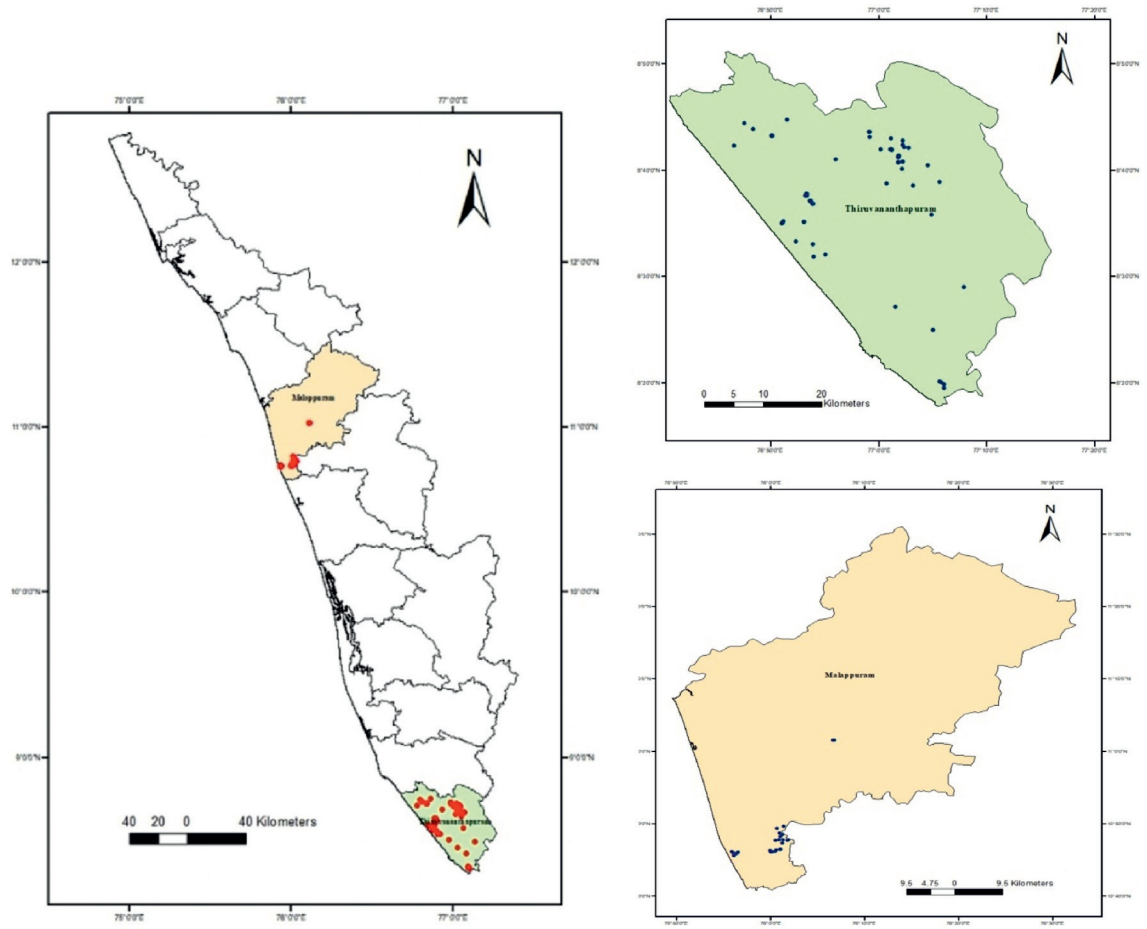

Fig. 1. Location map of geo-referenced characterization of organic clusters

clusters with 5 members or even less than that. Compared to Thiruvananthapuram, organic clusters in Malappuram district had more members, 17 members in an organic cluster named "*Nalla Bhakshana Prasthanam*" (Safe Food Project) at Kuttippuram and 12 members in cassava organic cluster at Mankada blocks. Abdel Rahman *et al.* (2016) used GIS-based survey to assess land-use suitability for agricultural planning in Chamarajanagar district, Karnataka, India. They also reported that, GIS has been used to match the suitability of main crops based on the requirements of the crops and the quality and characteristics of land. Remote sensing can also be used to compute integrated land-suitability potential considering the contribution of various parameters of land suitability. Watersheds can also be identified and categorized using the system (Bandyopadhyay *et al.*, 2009).

Size and nature of farm, soil type

An 80% of the farmers belonged to small and marginal group with land-holding size <2 ha (Fig. 2.). Farmers with land-holding size < 1 ha were predominant (59%), followed by 1–2 ha (21%), 2–4 ha (16%). Farmers with land-holding size > 4 ha were very low (4%). Average land-holding size was 1.02 ha. Minimum land-holding size was 0.02 ha and maximum land holding size was 6.2 ha. In a densely-populated state like Kerala, per-capita land availability is very less (0.22 ha) (GoK, 2016). Use of land for construction and industrial purposes also reduces the arable-land availability. Patidar and Patidar (2015) reported that there was positive perception of organic farming with

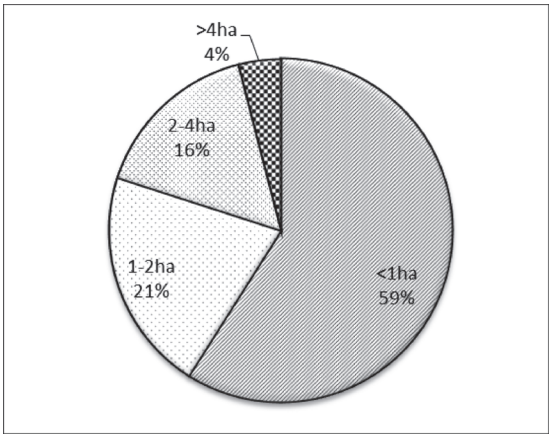

Fig. 2. Number of farmers based on land-holding size

significant relationships among age, educational background, farm size, benefits of organic farming and social factors. Sarkar and Itohara (2008) found that experience was one of the important factors deciding organic farming. Farmers with more experience preferred organic farming over the conventional ones. The small land-holding size is an important factor, which might act as a constraint in the adoption of organic farming. Also some farmers carried out organic farming on relatively smaller proportion of their land holding (Singh and George, 2012). The surveyed farms were mostly uncertified (99%), but certified in 1% case.

Most of the farming situation surveyed was rainfed (78%) due to high rainfall in the state (mean annual rainfall 3,107 m as per IMD, 2017), remaining 22% was irrigated. Being health conscious and aware of the quality of the organic produce, most of the farmers (86%) practiced organic farming mainly for sustenance to provide safe food to their family rather than marketing and making profit. Latest reports from the WHO points out that more than 50% of eatables have chemicals, which are carcinogenic in nature (Prasad, 2016). Majority of the farmers (93.33%) used the organic produce for their house-hold consumption, and the surplus was sold to the market by the farmers. The soil type was laterite (99%) as laterite is the predominant soil type in Kerala (Chandran *et al*., 2005), but in a few places, it was forest soil.

Crops grown organically

The major crops cultivated organically in the surveyed area were rice (*Oryza sativa* L.), vegetables, viz. okra [*Abelmoschus esculentus* (L.) Moench], brinjal (*Solanum melongena* L.), bitter gourd (*Momordica charantia* L.) snake gourd (*Trichosanthes cucumerina* L.), bottle gourd [*Lagenaria siceraria* (Molina) Standl.], ridge gourd [Luffa *acutangula* (L.) Roxb.] ash gourd [*Benincasa hispida* (Thunb.) cogn.], pumpkin (*Cucurbita moschata*), cucumber (*Cucumis staivus* L.), tomato (*Solanum lycopersicum* L.) chilles (*Capscicum* sp.), amaranth (*Amaranthus* sp.), vegetable cowpea [*Vigna unguiculata* (L.) Walp.], cabbage *Brassica oleracea* var. capitata L.), cauliflower (*Brassica oleracea* var. *botrytis* L.); fruit crops, viz. banana (*Musa* × *paradisciaca* L.), papaya (*Carica papaya* L.), pineapple [*Ananas comosus* (L.) Merr.], mango (*Mangifera indica* L.), jack fruit (*Artocarpus heterophyllus* Lam.), guava (*Psidium guajava* L.), root and tuber crops viz. cassava, (*Manihot esculenta* Commtz) yams, (*Droscorea alata* L.) (*Amorphophallus paeonidius* (Dennst.) Nicolson) foot yam, elephant (*Colocasia esculenta* (L.) Schott.) Taro, Chinese potato [*Coleus rotundifolius* (Pir. A. Chev. & Perrot)] spices viz. ginger (*Zingiber officinale* Roscoe), turmeric (*Curcuma longa* L.); plantation crops, viz. coconut (*Cocos nucifera* L.), pepper (*Piper nigrum* sp.), arecanut (*Areca catechu* L.), rubber, and ornamental crops such as *Heliconia*, *Anthurium*, orchids. More than 70% of the cropped area (83.05 ha out of the total cultivated area of 114 ha) were under cropping-system mode. These crops were grown in different cropping systems like intercropping, sequential cropping, double cropping and multi-tier cropping systems. Most of the plantation crops were under multi-tier cropping systems.

The percentage area occupied by the different crops in the surveyed area is illustrated in Fig. 3. Kerala is known as a consumer state. Commercial agriculture production is very less in the state compared to the other states. Root and tuber crops occupied to a larger extent in the organically cultivated surveyed regions (61.15 ha), followed by fruits, vegetables, plantation crops and rice. Among the tuber crops, cassava was the major tuber crop grown organically in the surveyed sites (Fig. 3).

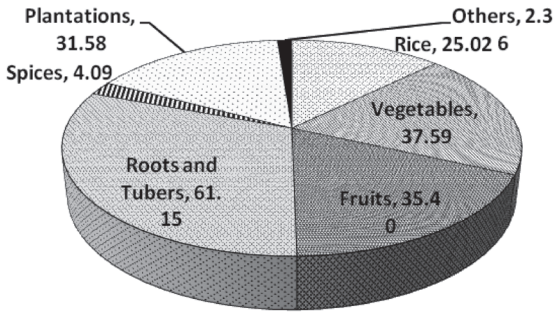

Fig. 3. Area occupied by crops (ha)

Farm animals

Out of 112 surveyed farmers, 31.19% of the surveyed farmers owned cow, 19.26% goat, 33.02% poultry and few had fish (3.60%) and duck (2.67%) as an integral part of organic farming (Fig. 4). Integrating animals into a farm help creating a closed or semi-closed system where energy and nutrients are recycled. Animals can convert non-edible biomass (e.g. grass, straw, kitchen waste) into food, while increasing soil fertility with their manure (FAO, 2015).

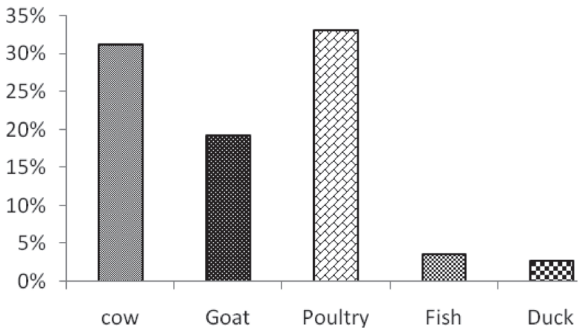

Fig. 4. Relative share of animals

Fifty per cent of the surveyed farmers adopted IFS system, in which the crop residue was fed to the farm animals and the animal waste was used as manure into the field. It reduced the dependence on external inputs leading to ZBNF approach. Two of the surveyed farmers were practicing hydroponics with waste-water produced in fish cultivation. Two of them were using the fish-pond water to irrigate the field.

Organic waste recycling

Animal wastes were converted into excellent manures using biogas (in 17% cases) and vermicompost units (26.78% farms) (with an average capacity to produce nearly 200 kg compost/annum). Yadav and Garg (2011) reported that composting of farm wastes like cowdung, poultry droppings etc. using earthworms had high-fertilizer value. According to Heckman (2006), composting had 2 benefits in organic farming system, it was an effective solid waste-management process; on the other hand rich organic manure produced by composting process had higher nutrient availability as well as acted as a conditioner favouring plant growth.

Anaerobic digestion inside biogas plant produces biogas, the energy source as well as biogas-spent slurry, the manure. Biogas slurry is a quality-organic fertilizer for sustainable agriculture. Biogas slurry offers huge nutrient potential for vegetative and reproductive growth of field crops with long term sustainability (Kumar *et al.,* 2015). Application of digested biogas slurry in the field on long-term basis helps reducing fertilizer demand and provide an eco-friendly way of maintaining productivity and soil health.

Organic nutrient sources

In the present survey, the major nutrient sources for organic farming constituted cow dung slurry/FYM (100% farmers), poultry manure (by 69.64% cases), vermicompost (50%), neem cake (*Azadirachta indica* A. Juss.) (34.82%), groundnut (*Arachis hypogaea* L.) cake (33.33%), green-manuring (30.35%), biogas slurry (14.28%), bio-formulations like egg amino acid (30.30%), fish amino acid (30.30%), *Panchagavya* (29.46%), *Ghanajeevamrut* (25%), *Jeevamrut* (12.50%), *Beejamrit* (8.92%), *Ezhilakuttu* (9.8%), *Anchilavaratti* (4.46%), *Jaivavalachaya* (4.46%) and *Amritapani* (1.78%). *Jaivavalachaya***,** prepared by mixing 5 kg cowdung, 5 litres urine, 1 kg neem-cake, 1 kg groundnut and 1 kg banana and fermentation for 10 days, was used for early flowering and fruiting. *Anchilavaratti*, a herbal preparation out of 5 herbs, neem leaf, nochi or Chinese chastetree (*Vitex negundo* L.), casuarinas (*Casurina* sp.), kiriyath [*Swertia Chirata* Roxb. Ex Fleming) H. Karst.] and thulsi or holy basil (*Ocimum tenuiflorum* L.) + cow urine was used for organic nutrient management.

Apart from these, ash (28.57%) and bone meal (22.32%) were also used. All the farmers surveyed used farmyard manure (FYM) as the primary nutrient source because of its ready availability. In 13.40% of small farms, FYM was only used as the nutrient source. Farmyard manure/cowdung slurry is the most common fertilizer used by the farmers in organic farming. Owing to high nutrient content (1.5% N, 1.6% P and 0.8% K), poultry manure was also used more frequently. Vermicompost has high-water-holding capacity (116–150%) and hence addition of vermicompost in soils particularly to those which have low water retention and low-water-holding capacity enhanced soil-moisture conservation (Thomas *et al*., 2012).

Among the surveyed farmers, 48.85% of the farmers produced bio-formulations like *Panchagavya*, *Jeevamrut, Ghanajeevamrut, Anchilavaratti* at the farm level itself. As these formulations are mainly prepared out of cowdung and cow urine through fermentation process, it is a low-cost method and nutrient content is concentrated in such formulations. Application of such formulations in field has shown to have a positive effect on the quality of the soil, improving its fertility and water-retention capacity (Tripathi *et al.,* 2018). Krishnamoorthy *et al*. (2019) also reported that liquid organic nutrient bio-formulations like *Jeevamrutham* and fish amino acid enhanced the beneficial microbial flora and fauna, higher yields, carbohydrate and protein content in fruits of okra.

Insect-pest and disease management

The bio-control agents were extensively used for the control of diseases in organic management. In this regard, *Trichoderma* was used by 58.92% farmers and *Pseudomonas* by 66.96% cases. Of the respondents, 49.11% used neem-cake-neem oil-garlic emulsion, 35.71% neem oil, 40% fish amino acid, 25% egg amino acid, 46.42% *Kanthari* emulsion, 40.17% neem soap, 53.57% *Beauveria*, and 40% pheromone trap. Apart from this cultural methods, intercropping, trap crops on field bunds and some indigenous practices were also resorted to. Biological plant-protection helps control pests and diseases, and protect us from the hilarious side effects of toxic chemicals, such as magnification, pollution, carcinogenic elements and food poisoning (Bishnoi and Bhati, 2017).

Yield-gap analysis

The mean organic yield in farmer's field was slightly lower in the case of cassava and comparatively lower by 30% in elephant foot yam, but higher by more than 10% in taro (Table 1). This may be due to the use of local varieties by the farmers and lack of scientific knowledge regard-

Table 1. Yield-gap analysis

Name of the crop	Yield as per on-station experiment (kg/ha)	Mean yield at farmers field (kg/ha)	Yield gap (%)
Cassava	25,650	24,690	–3.7%
Taro	9,180	10,100	No yield gap (higher by + 10.02%)
Elephant foot yam	30,862	21,603	–30%

ing biological method of control of collar-rot infection using *Trichoderma* in elephant foot yam. In the on-station experiment, there was 20% higher yield under organic practice in elephant foot yam (Suja *et al*., 2012) owing to control of collar-rot infection by using *Trichoderma*-incubated cowdung, neem-cake mixture in organic plots. Most of the surveyed farmers used their own planting material for cultivation, which sometimes reduced the productivity. In the case of taro, taro leaf-blight disease did not attain severe magnitude, difficult-to-be controlled organically, as it occurred in the on-station experiments and hence 10% higher yield could be obtained. Suja *et al.* (2017) reported 5% yield reduction in taro under organic management due to taro leaf-blight incidence, which could not be controlled effectively by organic measures.

However, the organic farmers were constrained by the high cost of organic inputs, non-availability of quality-organic resources, labour shortage, high labour cost, small and fragmented land holdings, low-farm gate price for the organic produce, price fluctuations during initial years and damage due to pig and other animals.

The results of survey indicated that in Kerala there is a greater thrust to avoid or rationalize the use of chemical inputs by adopting organic farming or good agricultural practices that has multiple benefits of sustainable production, reduction in production costs, improved yield and farm income. Lack of higher price for the quality-organic produce was the greatest pitfall for the organic farmers in Kerala. If the Government provided subsidies and regulated marketing, organic farming will become a profitable enterprize in Kerala.

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