Original Research Article

Natural enemies role in cost reduction: An analysis of rice cultivation in Kerala, India

ABSTRACT

Kerala, the state with the highest human development indices, is always concerned about its citizens' health. People's rising knowledge of the adverse effects of chemical inputs on agriculture has resulted in the development of eco-friendly agricultural techniques like organic farming. However, how natural enemies support pest control services in organic farming remains to be discovered at different scales and in diverse landscape contexts. The present study examined the natural enemy population in Kerala's paddy cultivation under conventional and organic systems. The reduction in the cost of cultivation in organic farming was primarily due to reduced labour charges due to the avoidance of pesticides and fertiliser application. Even though the effect of natural predators on organic farming was found to be, the farmers were unaware of the importance of natural enemies. Thus, the study highlighted the significance of organising more awareness programmes, especially the on-farm ones.

KEYWORDS: Agriculture, Kerala, Natural enemy, organic and conventional farming systems

1. INTRODUCTION

Agriculture is the backbone of the Indian economy, with more than half of the population still depending on this sector for their livelihood (Sayyed and Ahmed, 2022). Promoting sustainable agriculture needs the present-day world to overcome the challenges arising from chemical fertiliser-based farming (Tugrul, 2019). The scope of organic farming (OF) is an effective way to promote sustainable agriculture in India (Soumya, 2015).

With the highest literacy and other human development parameters, citizens of Kerala are generally conscious about health (Lieten, 2007). Together with this, the COVID-19 pandemic escalates that consciousness. The growing awareness among the people about the consequences of excessive use of chemical inputs in agriculture created a shift towards healthy practices in farming (FAO, 2017). The debates on the health effects of Endosulfan spraying in the cashew plantations of Kasaragod district in Kerala during the late 1990s initiated the idea of cultivating foods without chemical-based pesticides, which opened up a market for organically grown food items (Embrandiri, 2012). Organic farming thus gained much attention among practising farmers and the consumers of the state (Bhardwaj et al., 2019).

The improved standard of life helps people buy organic foods even though the rate is high compared to conventional products. This motivates policymakers, researchers, cultivators, and consumers to find healthy and safe alternative ways of farming. Organic farming is one such system that provides healthy food without leaving a negative mark on the environment (Ramanjaneyulu et al., 2013). It involves farming practices without synthetic inputs such as fertilisers, plant protection chemicals, or hormones (Das et al., 2020). Better education and environmental alertness promoted many farmers to seek alternative ways of conventional farming involving agrochemicals to organic farming to make agriculture more sustainable (Luo et al., 2014).

In India, chemical farming inputs, especially for rice and wheat, gained momentum during the green revolution era by introducing high yielding varieties (Parayil,1992). Although the green revolution subsided the poverty among the masses, unscientific use of fertilisers and other agrochemicals significantly affected the health of the soil, reducing the biodiversity and thereby aggravating pest and disease incidence (Nelson et al., 2019). Under the aegis of the Department of Agriculture Development and Farmers' Welfare, the Government of Kerala government initiated programmes to promote organic farming in the state. Kerala Agricultural University supported the move by publishing ad-hoc recommendations for organic farming through the Package of Practices and Recommendations (Estelitta, 2017).

All activities without chemicals are broadly classified as organic in the state. The term can be standard or scientific recommendations, alone or in combination. There are many variations in approaches and practices at farm levels across the *Padasekharams* (collectives of farms, especially in paddy) (Menon and Vogt, 2022). In agroecosystems, biodiversity positively correlates with agricultural production within a specific range (Szewczyk et al., 2015). Agricultural production decreases when biodiversity decreases (Fu et al., 2014). The warm and humid environment of the crop is highly conducive to the survival and proliferation of many insect pests (Sharma et al., 2019). Naturally controlling insect pests is crucial in organic rice production (XingHong-xing et al., 2017).

The use of high-yielding varieties warranted the application of different weedicides, fungicides, and insecticides to control weeds, diseases, and pests, respectively (Nayak and Solanki, 2021). The population of natural enemies has declined drastically following applying chemical pesticides (Gill and Garg, 2014). The promoters of organic farming argue that a wide disparity is observed among the natural enemy population between conventional farming and organic farming (Puech et al., 2014). In order to have scientific validation, the present study was conducted. The study was undertaken to compare the difference in natural enemy population in paddy cultivation under the conventional and organic systems with the following specific objectives: to assess the change in the natural enemy population under organic farming and non-organic farming (conventional) management regimes and to estimate the savings in plant protection operation in organic farming, if any.

MATERIALS AND METHODS

2.1. Study area

The study was conducted in two major paddy cultivating districts of Kerala, Alappuzha and Palakkad. These two districts account for 21% and 38% of the area and 20% and 39% of rice production in Kerala in 2020-21 (Government of KeralaGoK, 2022). Kuttanad, the rice bowl of Alappuzha, lying under mean sea level, is endowed with a network of backwaters, lakes, and rivers and is the major area under paddy cultivation. However, major and minor irrigation projects like Malampuzha, Chulliyar, Meenkara, Walayar, Pothundi and Mangalam drive rice cultivation in the district of Palakkad.

1.2. Description of paddy cultivation in Kerala with special reference to Palakkad and Alappuzha

Rice is the staple food of the state, so paddy cultivation has significance in the state's agrarian economy. Paddy cultivation in the state has been declining since the 1980s; however, a sign of revival has been witnessed in the last few years. The shortage of farm labourers, high wage rate and conversion of paddy lands for alternative purposes are the main reasons for the decline in paddy cultivation in the state. The conversion of paddy fields has led to numerous socio-economic and ecological consequences (Abraham, 2019). Seasoned farmers and the younger generation are showing enthusiasm towards rice cultivation, thoroughly fuelled by the incentivised schemes of the government, both the central and the state. Through the fallow land-free programme of the Department of Agriculture Development and Farmers' Welfare, more area is brought under paddy cultivation in the state. The revival of paddy cultivation is essential as current production meets less than 15% of the state's consumption requirement. Even if the revival rate is minimal, it will be a positive trend.

Palakkad is the land of palmyras and paddy fields, popularly known as the 'granary of Kerala' and is one of the most fertile areas in Kerala, located at the foot of the Western Ghats. Palakkad has 12 dams built specifically to irrigate paddy fields. The paddy is grown twice a year in the district, in the autumn and winter, locally termed Virippu and Mundakan, respectively. Palakkadan matta, GI tagged, one of the major types of rice with high palatability in the state, is historically grown in the district with a high nutrient content, distinct flavour and colour.

Alappuzha is popularly known as 'the Venice of the East', a major tourist destination of the state. It is the only district in the state with no forest cover and is enriched with a network of ponds, backwaters, and canals. The major rivers emptying water are the Manimala, Pamba and Achankovil, along with Vembanad Lake. Kuttanad, an area in the district, has a vast system of backwaters where rice cultivation has been practised below sea level for over two centuries. Kuttanad is a 900 km2 delta region located on the west coast of Kerala. Kuttanad Below Sea-level Farming System (KBSFS) is India's only system that cultivates rice below sea level. KBSFS's major land use structure is flat stretches of rice fields in about 50,000 ha of largely drained delta swamps. The rice fields, which are known as "Puncha Vayals", exist in three landscape elements: Karapadam (upland rice fields), Kayal (wetland rice fields) and Kari (land buried with black coal-like materials).

Presently paddy is grown in 2 seasons in *Kuttanad*, *Puncha* and the second crop in local parlance. It is purely rainfed cultivation. Since *Kuttanad* is 3 m below MSL, cultivation begins after dewatering the fields. Even though the variety 'Uma' is cultivated in more than 80% of the area, the field responses from Alappuzha revealed that another high-yielding variety, 'Pournami', is slowly gaining popularity among the farmers. The unscientific use of fertilisers and plant protection chemicals has affected the region's soil health and water bodies

(Ray et al., 2014). The practice of soil testing before fertiliser application is very much limited in the study area; moreover, farmers follow the recommendations given by fertiliser dealers/representatives of companies. The changing weather parameters bring unprecedented levels of floods in the *Kuttanad* area. Even though people are acquainted with seasonal floods, their nature and severity have increased recently, impacting the farmers' lives and livelihoods.

Typically, the agricultural season in Kerala starts in the Malayalam month of Medam (mid-April). The monsoon season gets substantial rain (1500 mm) within three months, June, July, and August, and modest rains afterwards with a short spell in the northeast monsoon. The temperature in the summer months reaches the range between 37–400C, which is altogether a new experience for age-old farmers. The change in the weather pattern has forced the farmers to adopt new farming practices. The unseasonal rains and prolonged dry periods delay the region's Mundakan (second) crop. Typically, two crops are raised in the region: Varsha Krishi and Punja Krishi. The saltwater intrusion and issues related to opening a bund (Thanneermukkom bund) in the region delayed the cropping season. Thanneermukkom bund was constructed in 1974 to ensure water security in the Kuttanad region, to enable storing of freshwater and thus helped farmers cultivate two to three crops in a year, unlike the usual single crop (Kolathayar et al., 2020). The deposition of alluvial soil in the paddy fields helps in retaining productivity. Both tidal and river floods have caused immense damage to the region.

Farming in Kari lands is only possible if freshwater is available from the Meenachilaar river. The soil pH in the region depends on the water source. The soils in the areas towards the south of Meenachilaar are highly acidic, lowering the nutrient availability and affecting the growth of paddy, together with more fungal infections like leaf blasts and sheath rot. One of the peculiar features of the Kuttanad soil is the salt deposition below the soil layer, and salt flushing usually occurs during the rains. The North-East monsoon's failure aggravates the salt's vaporisation, resulting in a poor grain setting. The reduction in rain in June (usually 250-450 mm) affects the cropping season. Based on the changes in the rainfall pattern, reorientation of the cropping season is highly warranted. The region received a bumper yield in 2018, a flood year, owing to the proper flushing of salt in the soil.

2.3. Sample selection

The study was initially proposed to include three groups of farmers: certified organic farmers, non-certified organic farmers, and conventional farmers (farming using both organic inputs, fertilisers, and plant protection chemicals). However, the data collection was limited to non-certified organic and conventional farmers due to COVID-19-induced restrictions and the non-availability of certified organic farmers in the study area. Hence, the respondents of the study include organic and conventional farmers.

Both respondent farmers were identified based on purposive sampling with the help of respective Krishi Bhavans (Panchayath level agricultural office), Rice Research Station,

Moncompu, Alappuzha and Krishi Vigyan Kendra (KVK), Palakkad. As paddy cultivation is mainly group farming under Padasekhara Samithies (committee of group farming), the possibility of organic farming at the individual level is very much limited in Alappuzha. Hence, organic farmers of Alappuzha are restricted among the upland paddy farmers. In Palakkad, organic farmers are doing paddy farming in organic methods in the upper area of their farms. The respondents were randomly selected from 10 and 8 grama panchayaths in Alappuzha and Palakkad based on the list of organic farmers in the respective Krishi Bhavans. The respondents from the Alappuzha district include 30 conventional farmers and 25 organic farmers, and 18 organic farmers and 25 conventional farmers from Palakkad, thus making a total sample size of 98.

2.4. Data collection

The present study was based on both primary and secondary data. Data was collected from each farm household using a structured interview schedule. Details on the socio-economic profile of the farmers, cost of cultivation, yield, natural enemy population, pests, awareness level, and constraints of rice cultivation were collected. Secondary data was also collected from various published and unpublished sources to support primary data. To enumerate the count of predators and pests, sweeping in the field using sweep nets has been done. Sweep net collection of insects was taken from 4 points per acre of land area. The average of the five sweeps has been taken. The collected insects were brought to the lab and segregated into pests, natural enemies, and neutrals.

2.5 Challenges in data collection

Small farmers operate non-certified organic farms. Most produce for their consumption, so the marketable surplus was practically nil. The COVID-19 pandemic posed constraints in data collection, and hence, it was limited to a few panchayats in both districts. The usual challenges in socio-economic research, like reluctance to respond, also apply to the study.

2.6. Analysis of data

The primary data collected from the sample respondents in the study area were tabulated, and descriptive statistics were presented as averages and percentages. Statistical techniques like paired t-tests were used to identify natural enemies' influence in organic and conventional farming. When two samples are considered, one sample can be paired with observations from the other, and a paired t-test can be used to compare two population means (Shier, 2004). Statistical software SPSS 22 was used for the analysis.

RESULTS AND DISCUSSION

The tabular results of the land area clearly show that the area under organic farming is less than conventional farming in both districts. As discussed earlier, the organic farms of Alappuzha were mostly restricted to upland farming in the coconut gardens. Hence, the area was relatively less compared to that of Palakkad. The organic farms of Palakkad were mostly confined to the upland of the vast paddy fields in such a way that seepage and percolation from conventional fields were practically nil. These types of fields are observed mainly in

Panchayats like Elavanjeri and Kollengode. The peculiar feature of these farms was that farmers owned a vast area of paddy fields, and a small area from that was demarcated, especially in the upper part of the field, exclusively for organic cultivation. Contrary to this, organic farmers of Alappuzha districts were small and marginal and carried out organic rice cultivation as upland cultivation.

On average, the conventional farmers own 2.9 and 1.66 ha, respectively, in Alappuzha and Palakkad districts implying medium-sized farmers in the former and small-sized farmers in the latter. Conventional farmers in Alappuzha are located along the Kuttanad rice belt (Table 1). The group farming practices were followed mostly in conventional type while farming operations were done individually in organic farms. The years of farming experience showed that the farmers of Alappuzha were well experienced, with around 25 years of farming experience, and middle-aged (45–65 years) farmers actively farm in the district. However, in Palakkad, respondent farmers have relatively less farming experience, primarily due to the involvement of more youth and retired employees in farming. The financially sound retired personnel are engaged in organic farming as a subsidiary or leisure-time activity, and their marketable surplus was practically nil.

Table 1: Details of wetland area and farming experiences

Particulars	Alappuzha		Palakkad	
	Organic	Conventional	Organic	Conventional
Wetland area (ha)	0.85	2.9	0.97	1.66
Years of farming experience (years)	28	25	12	15

Table 2: Details of yield and cost of cultivation of Alappuzha and Palakkad

Districts	Yield (t ha^{-1})		Cost of cultivation (₹ ha^{-1})	
	Organic	Conventional	Organic	Conventional
Alappuzha	3.23	5.73	54133	84102
Palakkad	3.14	5.78	56112	82876

Generally, the productivity of paddy is relatively higher in both Alappuzha and Palakkad compared to other parts of the state. The average productivity observed was almost equal in Alappuzha and Palakkad districts (3.23 and 3.14 t ha-1, respectively), while the state average was only 2.92 t ha-1 (Gok, 2021). At the state level, the highest productivity is recorded in Alappuzha, while Palakkad holds the first position in production. However, a wide disparity in yield has been observed in lowland and upland paddy. The upland farming yields significantly less, around a 60% reduction in yield, compared to lowland paddy. The main reason attributed was the difference in soil properties, poor crop management, and the varieties used were traditional. Similar observation was done by by Chintalapati et al. (2023).

The upland paddy farmers of Alappuzha broadcast the seeds after ploughing. Intercultural operations like weeding and other operations are not practised. The variety used in upland farming was known as 'Virippu', a local variety. The varietal difference viz. 'Uma' in low land and 'Virippu' in the upland were the significant factors contributing to the difference in the yield. The local variety is low-yielding compared to the high-yielding variety like Uma. The average yield in conventional farming was 5.7 t ha-1, while it was only

3.2 t ha-1 in organic farming, with a yield difference of around 66 %. (Table 2) The lower yield was due to local variety and less input-intensive farming, especially in the upland.

A similar pattern could be observed in the cost of cultivation, wherein there exists a 67% reduction of cost in organic farming compared to conventional farming. The reduction was primarily due to reduced labour charges because of the avoidance of pesticides and fertiliser application. Most farmers following organic cultivation were not commercial farmers compared to conventional farmers. The pattern was more observed in the Alappuzha district. A marketing channel that fetches higher returns can motivate organic farmers to produce more or bring the larger area under cultivation.

Mechanisation was widely adopted in lowland paddy; however, such machines cannot be operated in upland paddy areas due to trees and other plants in the field. Hence, manual land preparation needs to be done. The upland farmers use their seeds for the next cropping season, while lowland farmers depend on the Krishi Bhavans or National Seeds Corporation for high-yielding seeds. Even though there was a reduction in the cost of cultivation in organic farming, the yield reduction was very pertinent. Organic cultivation yields only around 50% of the conventional method in both districts. The yield reduction was more than 2.5 t ha-1 between the two types of farming. In value terms, it amounts to about ₹ 70000 (@ ₹ 27.4 kg-1). The reduction in returns can be compensated only through the premium pricing of organic produce. Only a few organic farmers are getting the premium price as organic production is strictly confined to household purposes for most farmers, and they were not bothered much about the reduction in yield. The conventional farmers were marketing the paddy to Supplyco (the agency for procuring paddy on behalf of the Government of Kerala) at the rate of ₹ 27.40 kg-1.

In contrast to Alappuzha, large farmers in Palakkad are organically raising crops in a small area and the rest in conventional methods, mainly as commercial cultivation. The organic production in Alappuzha and most organic farmers in Palakkad is confined to household consumption, while the rest of the organic farmers are selling.

During the survey, a different picture was observed in a few pockets of the Palakkad district, like Kollengode and Vadakkancherry panchayaths. The organic farmers in Palakkad use traditional varieties like Chettadi, Kuttadan, Kuruva, Chettani and Raksthashalli. The seasoned organic farmers (farmers doing organic farming for many years, about 30% of the study respondents) are getting premium prices, have a select group of regular customers for their products, and are supplying to reputed domestic organic retailers. The market value of rice in the local market is about ₹ 35-40 kg-1, while the organic farmers sell at a rate of ₹ 90-110 kg-1. These farms operate with assured market linkages, adding value to rice by producing various rice-based products like different types of rice flours, broken rice and rice flakes. These farmers also capitalise on the market opportunity by selling other organic farm-grown pulses like black, red, horse, and green.

There is a clear indication that a premium market exists among society's affluent class; hence, the farmers can capture that market and fetch higher returns. During the survey, it was understood that organic farmers in the region are in the process of setting up a sales outlet in the locality. However, Farmer Producer Organisations (FPOs) can be a better solution than a sale outlet which brings more organic farmers together and can benefit from higher returns. FPOs will ensure the collective bargaining power of farmers and the achievement of economies of scale.

The two districts have noticed slight variations in the cost of cultivation. The higher cost of cultivation in Palakkad is attributed to using more organic manures like farmyard and green leaf manures. The farmers in Alappuzha are using only farmyard manure. However, the lower wage rate in Palakkad restricts the variation in the cost of cultivation to a minimal level.

`Natural enemies play a crucial role in regulating the pest population in the rice ecosystem. However, chemical pesticides disturb the balance of natural enemies and pests. Natural enemies as predators consume many insect pests during their lifetime. Predators can be generalistic (feeding on many host insects) or specific (feeding only on a specific host), and most predators are generalistic. Parasitoids are host-specific and mainly belong to the Order Hymenoptera. Parasitoids require their host for their development. Parasitoids can be classified as egg, larval, pupal or adult parasitoids based on the host stage attacked by the parasitoid. Egg parasitoids, especially Trichogramma, are mass-reared and released in paddy fields.

Several species of spiders are found in the rice ecosystem. They feed on rice pests such as stem borer moths, plant hoppers, and leafhoppers. Dragonflies and damselflies predate on moths and leafhoppers. Ophionea is a carabid beetle that mainly feeds on leaf folder larvae. Coccinellids such as Micraspis, Cheilomenes sexmaculata, Harmonia, etc., are common in rice fields. They are generalistic predators of plant hoppers. Polytoxus is a reduviid predator of moths and butterflies. Crickets are predators of eggs, tiny larvae and hoppers. Telenomus is an egg parasitoid of stem borers. Xanthopimpla is an Ichneumonid parasitoid of stem borer larvae.

The list of natural enemies/predators seen in the fields of both districts is given in Table 3. *In lower numbers*, Polytoxus, ladybird beetle, Telenomus, Xanthopimpla, and Ophionea are observed. In Alappuzha, spiders are seen in most organic and conventional fields, followed by coccinellids. Table 4 gives the count of predators per five sweeps in an acre. The results show that spiders are seen maximum among different predators in both organic and conventional fields of Alappuzha, while spiders and damsel fly in both the fields of Palakkad.

Table 3: List of predators
Name of predator seen in the study area
Ophionea

Spider
Dragonfly
Damselfly
Coccinellids
Telenomus
Crickets
Xanthopimpla
Polytoxus

Table 4: Predators in Alappuzha and Palakkad

Name of predator	Alappuzha (Count 5 sweeps^{-1} a^{-1})		Palakkad (Count 5 sweeps^{-1} a^{-1})	
	Organic	Conventional	Organic	Conventional
Ophionea	4	1	0	0
Spider	31	6	12	7
Dragon fly	5	3	2	3
Damsel fly	1	2	10	11
Coccinellids	12	2	4	1
Telenomus	2	0	2	0
Crickets	1	2	5	0
Xanthopimpla	0	1	0	0
Polytoxus	0	0	0	0

Table 5 gives the results of the paired 't-test. It shows a significant difference in the population of dragonflies, damselflies and crickets in conventional fields compared to organic fields in Alappuzha. The rest of the natural enemies were not significant. However, there are fewer natural enemies in conventional than organic fields (Table 4). In Palakkad, the difference was not statistically significant (Table 6). Even though natural enemies were recorded in the organic fields of Palakkad, the numbers were low compared to Alappuzha (Table 4). As discussed earlier, the organic farming system in Alappuzha is entirely different from that of Palakkad. In Palakkad, organic farms are located on the upper reaches of conventional farms. Whereas, in Alappuzha, organic farming is practiced as upland cultivation. It might be the reason for not seeing any statistically significant difference among the natural enemies in Palakkad.

Table 5: Results of Paired Samples t test in Alappuzha

Organic Vs Conventional

	Paired Differences					t	df	*Sig. (2-tailed)
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
Paired Samples				Lower	Upper			
Dragonfly- Dragonfly	-2.16	1.88	0.38	-2.93	-1.38	-5.73	24	.000*
Damselfly - Damselfly	-1.16	2.25	0.45	-2.09	-0.23	-2.58	24	.016*
Cricket - Cricket	-2.4	2.61	0.52	-3.48	-1.32	-4.59	24	.000*
Opionea - Opionea	0.56	2.20	0.44	-0.35	1.47	1.27	24	.215
Spider - Spider	-.04	4.06	0.81	-1.71	1.63	-0.05	24	.961
Coccinellidae - Cocc.	0.12	4.91	0.98	-1.91	2.15	0.122	24	.904

*Significant at 1% level

Table 6: Results of Paired Samples t test in Palakkad

Organic Vs Conventional

	Paired Differences					t	df	*Sig.(2-tailed)
	Mean	Std. Dev.	Std. Error Mean	95% Confidence Interval of the Difference				
Paired Samples				Lower	Upper			
Spider - Spider	0.89	4.04	0.95	-1.12	2.90	0.93	17	0.36
Dragonfly - Dragonfly	-0.28	1.18	0.28	-0.86	0.31	-1.00	17	0.33
damselfly - Damselfly	0.06	2.55	0.60	-1.21	1.32	0.09	17	0.92

*Significant at 1% level

The awareness about natural enemies is highly varied among the respondents. Table 7 shows that all the organic farmers in Alappuzha and the majority in Palakkad knew the importance and significance of natural enemies. At the same time, it was 40% and 15% for conventional farming in Alappuzha and Palakkad. The results showed that natural enemies were seen only in less than 50% of the conventional farms in Palakkad, while the percentage was much higher in organic farms and both types of farms in Alappuzha. Friends and neighbours are the sources of awareness for those who have it. The study observed that conventional farmers are interested in something other than gathering information about natural enemies. Most of them need to learn more about the roles played by the natural enemies in the paddy fields and the economic gain in reducing the application of plant protection chemicals. Interestingly, none of the respondent farmers in both types of farming has released any natural enemies to the field nor attended any training sessions. The organic farmers in both districts are using neem-based products for plant protection.

Table 7: Details of awareness about the natural enemies

	Alappuzha		Palakkad	
Particulars	Organic	Conventional	Organic	Conventional
Awareness about natural enemies (%)	100	40	72	15
Natural enemies seen in the field (%)	100	90	89	45
Trainings on natural enemies	0	0	0	0

Pests are common in both types of rice fields in Alappuzha and Palakkad. The presence will be very much pronounced in poorly managed fields and unweeded conditions. Rice bugs, followed by green leafhoppers, are seen in maximum numbers in Alappuzha and Palakkad organic fields. In contrast, rice bugs follow leaf hoppers and leaf rollers, and rice bugs follow the green leaf hoppers in conventional fields of Alappuzha and green leafhoppers in Palakkad (Table 8). Rice bugs are less in number in the conventional fields of Alappuzha. This was primarily due to the increased weeds in the poorly managed upland areas. Rice bugs will be more prevalent in fields where weed growth is at maximum.

Table 8: List of pests in Alappuzha and Palakkad

Name of pests	Alappuzha (5 Counts sweeps^{-1} a^{-1})		Palakkad (5 Counts sweeps^{-1} a^{-1})	
	Organic	Conventional	Organic	Conventional
BPH	7	7	3	8
Hispa	1	2	3	1
Leaf roller	7	11	3	5
Rice bug	18	9	38	38
Leaf hopper	6	11	1	0
Stem borer	2	0	8	9
Caseworm	3	0	3	6
Grasshopper	4	9	0	2
Green Leaf Hopper	13	7	11	56
Gall midge	0	0	0	4

Even though farmers have an awareness of the natural enemies, none of them in both districts are not releasing any natural enemies to the field. The awareness is limited to the knowledge that natural enemies exist. They received awareness mainly through training conducted in the Krishi Bhavans and from fellow farmers. However, they have yet to undergo specific training on natural enemies or witness the release of natural enemies in the field. The minimal awareness level points towards the broader gap in extension activities in popularizing the knowledge and advantages of natural enemies to cultivation. A study by Perez et al. (2023) reported on similar lines.

3.1. Suggestions were given by farmers based on the survey and farmers' group discussions in Alappuzha and Palakkad

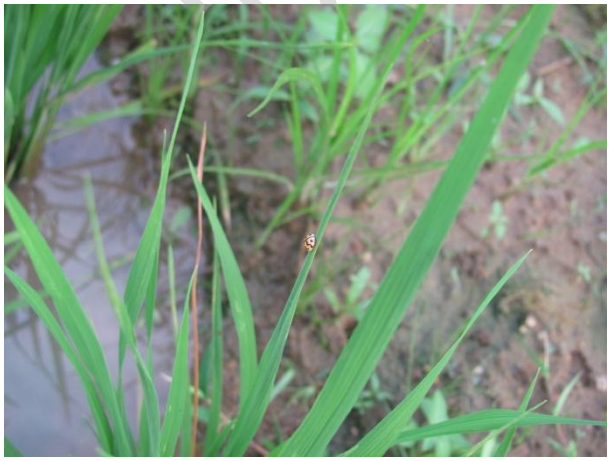
Farmers are positively seeking on-farm training and demonstrations rather than classroom sessions. A loop comprising scientists from the Krishi Vigyan Kendra and Regional Agricultural Research Station and the farmers is needed for timely intervention and monitoring of the crops. Creation of an FPO for exploring newer marketing avenues for organic rice. Organic produce has a niche market; however, the price advantages have not been realized for the farmers, who have sought a separate procurement of organic rice with a differential rate from the flat rate fixed by the government. The organic certification procedures are complex and not farmer-friendly; hence, steps are needed to simplify them. Organic farmers are facing a shortage in the availability of quality bio fertilizers and pesticides, and the timely availability of quality substances needs to be ensured. More promotions are warranted for organic cultivation through incentives and subsidies.

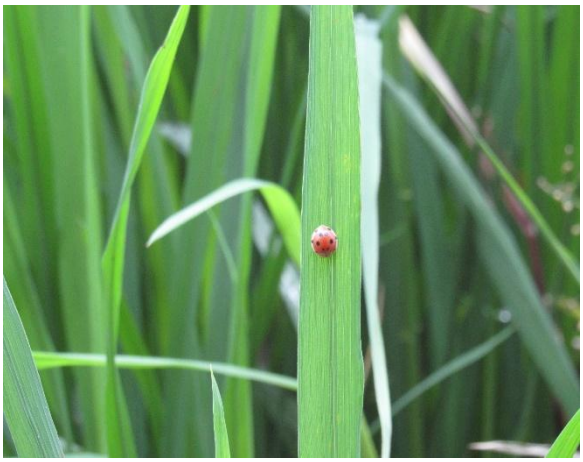
CONCLUSION

Organic Farmers in Kerala need a separate marketing channel to promote their products. The success of seasoned organic farmers in Palakkad highlighted the need for such a channel and also through the formation of FPOs. Even though the Conventional Farmers are aware of natural enemies, none in the study area have tried to release or see any demonstration in the field or attend awareness training. Imparting skills and continuous awareness programmes are vital, which eventually give positive results and can bring more area under organic cultivation in rice in Kerala.

Fig. 1. Image of predators seen in the study area

Fig. 2.**Lady bird beetles (**Damselfly)





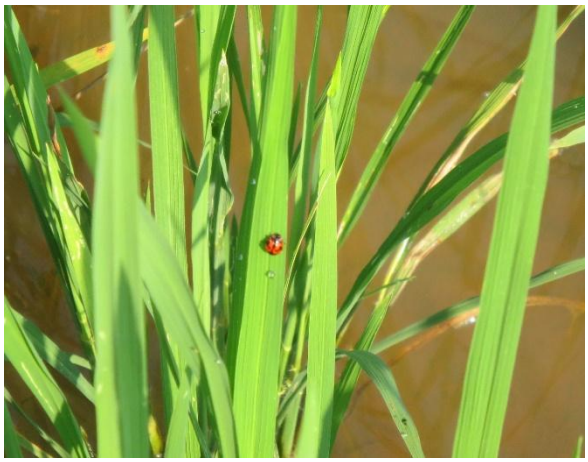
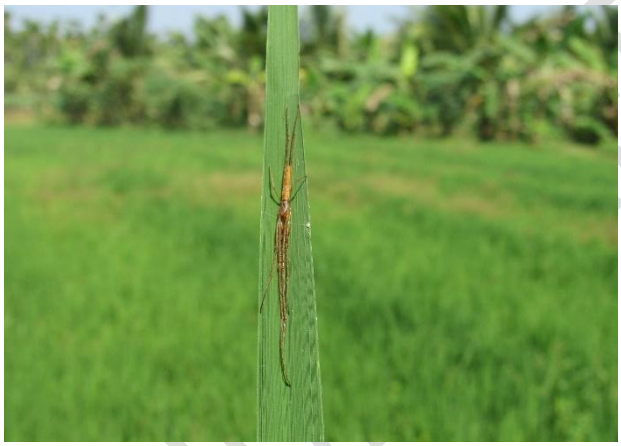
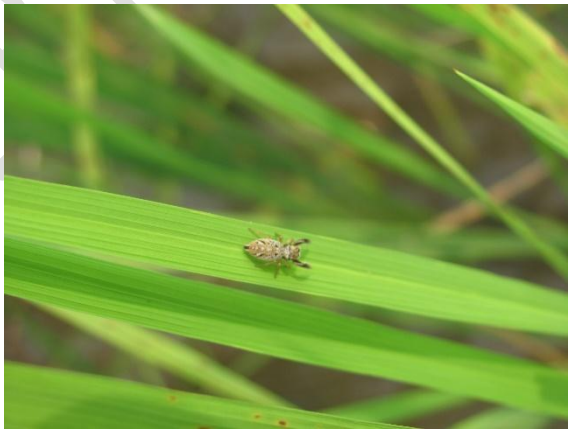


Fig. 3. Image of Spiders





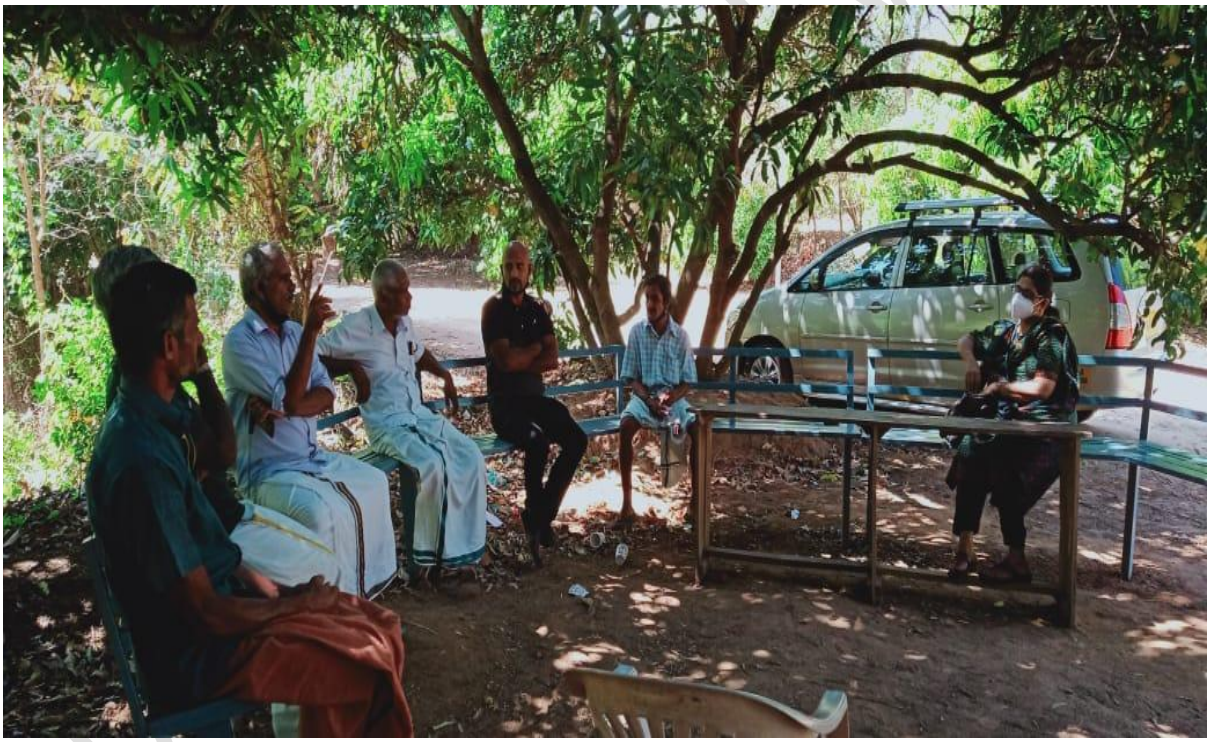


Fig 4: Interacting with farmers

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