Journal of Agricultural Extension and Rural Development Vol. 4(6), pp. 120-128, 5 April, 2012
Available online at http:// academicjournals.org/JAERD
DOI: 10.5897/JAERD11.096
ISSN- 2141 -2154 ©2012 Academic Journals

Full Length Research Paper

Provisioning ecosystem services income extend comparison between organic and conventional agricultural fields in Puducherry-India

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Accepted 12 December, 2011

Agriculture supplies provisioning services- food, fodder, fuel, timber, medicine and ornamental in ecosystem service parlance. Management of ecosystem services is vital to maintain and improve the productivity of agricultural systems in order to meet the food demands of the growing human population. However, conventional management practices can severely reduce the ecological and financial contribution of agriculture, which in the longer term can offset the ability of farming to produce large amounts of commodities for more economic return. In the current work, a novel bottom-up experimental approach is used to quantify the economic value of provisioning ecosystem services between conventional and organic agriculture fields in Kuruvinatham and Soriankuppam villages of Bahour commune, Puducherry during September 2008 to October 2010; we investigated 30 farms - 15 Organic and 15 Conventional agricultural fields with varying species composition and degree of commercialization. Data were gathered through interviews among selected farmers and we identified 51 species utilized a food, fodder, fuel, timber and medicine. Species retention is governed by species relative importance. Conventional fields were found to be less diverse with reduced density resulting in low annual gross income. Thus it has less ecological and socioeconomic advantages, as compared to organic fields. Practice of traditional organic agriculture systems plays significant roles in both ecological and economic terms by livelihood improvement, biodiversity conservation, soil fertility enhancement and poverty reduction. Therefore it is important to conserve and promote organic agriculture to achieve sustainable production and economic terms.

Key words: Organic agriculture, conventional agriculture, provisioning services, sustainability, Income generation.

INTRODUCTION

Agro-ecosystems are managed chiefly to meet food, fiber and fuel for people needs. Among the earth's land area estimated Agricultural crop and pasture land area range from 24 to 38% of the (Millennium Ecosystem Assessment, 2005; Wood et al., 2001). Tilman et al. (2001) predict that by 2050 cropland will increase by 23% and pasture land by 16%, by extrapolating global trends from 1960. Thus accounts a massive and growing agriculture share in earth's surface. Agriculture is a recent development in geological and even human history. Continuous farming has become the norm over vast areas. Among the earth's major ecosystems, agriculture is the one most directly managed by humans to meet human goals. Food, fiber, and fuel production is the overwhelmingly dominant goal of agriculture. Yet as a managed ecosystem, agriculture plays unique roles in both supplying and demanding other ecosystem services (Padmavathy and Poyyamoli, 2011a).

Ecosystem services are defined as “the conditions and

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processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life" (Daily, 1997). Agriculture supplies all three major categories of ecosystem services like provisioning, regulating and cultural services - while it also demands supporting services that enable it to be productive. Provisioning ecosystem services include services that directly produce goods that are consumed by humans. The conceptual framework of the MA (2005) lists resources like food, fiber, fuel or bio-fuel, ornamental and natural medicines, as provisioning services.

Vulnerability of provisioning ecosystem services grows as demands on ecosystems grow due to population growth, economic expansion and other factors. In wealthy countries, ecosystem services are vulnerable because of the vulnerability of small patches to disturbance and climate change. In poorer countries, services are vulnerable due to these same factors, exacerbated by over-exploitation, degradation of ecosystems by conventional agriculture and expanding poverty (Porter et al., 2009). In adapting organic agriculture, ecosystem management is often directed at reducing vulnerability; in many regions of India, decentralization and a focus on adaptive change allow ecosystem services to adjust smoothly to changes in climate and other environmental drivers (Padmavathy and Poyyamoli, 2011a, b).

Intensive conventional agriculture might increased crop yields earlier but there yields are not constant, it decreased year by year, in order to maintain the yields farmers happened to increase the chemical inputs from year to year, thus caused numerous and severe environmental problems (Pimentel et al., 1995; Mader et al., 2002; Araújo et al., 2009, Padmavathy and Poyyamoli, 2011a,b). Organic agriculture is alternative to conventional agriculture, they do not use synthetic fertilizers and pesticides and attempt to close nutrient cycles on their farms, protect environmental quality, beneficial biological interactions, to processes constant yield in sustainable long term manor (Vandermer, 1995, Poyyamoli and Padmavathy, 2011). Organic farming practices are sustainable agricultural practices, which are ecologically and socio-economically feasible; thus improves the life standard of farmers.

The objective of this study was to elucidate the economic returns from provisioning services either in form of direct or indirect benefits obtained from crop-based agricultural fields, in this case organic and conventional agricultural fields of Kuruvinatham and Soriankuppam village in Bahour commune, Puducherry. The selected farms had various levels of crop, tree, herb, and shrub diversity in terms of species compositions. Private profitability of farmers that is, organic and conventional farmers were taken into account. Private profitability is from the landowners' perspective, as gross income derived from the direct and indirect products from the fields and a comparison between biodiversity and its income generation was calculated for both types of agricultural fields. After this, we investigated the relationships between profitability and plant diversity, assessed the outlooks for improving socio-economic livelihood status of the farmers (Padmavathy and Poyyamoli, 2011b; Poyyamoli and Padmavathy, 2011).

MATERIALS AND METHODS

Study site

Puducherry located on the Coramandal coast 11°52' N, 79° 45' E and 11° 59' N and between 79° 52' E covers an area of 480 sq km. The study area experiences mean annual temperature of 30.0 °C and mean annual rainfall about 1311-1172 mm. The mean number of annual rainy days is 55, the mean monthly temperature ranges from 21.3° to 30.2 °C. The climate is tropical dissymmetric with the bulk of the rainfall during northeast monsoon October to December (Indian Meteorological Department - Chennai). Kuruvinatham and Soriankuppam villages under Bahour commune (Figure 1) are about 24 km towards South on the way to Cuddalore from the Puducherry main town. The selected villages/farms are located on the river bank/basin of Ponnaiyar River. They were selected since they portrayed similar soil characteristics and texture, more suitable and convenient for groundnut and vegetable cultivation - the dominant crops of that area.

Sampling and data collection

The present study was conducted from September 2008 to October2010 in Kuruvinatham and Soriankuppam, two adjacent villages in Bahour commune. The Department of Economics and statistics 2008 to 2010, Puducherry, estimated the areas of the two villages as 13.6 km^2 and 19.4 km^2, giving population densities of 206 and 153 individuals per km^2, with a total population 2812 and 2975 respectively. They live in small-scattered settlements. Majority of the inhabitants (70%) are small scale farmers, who overwhelmingly rely on agriculture and the most cultivatable crops are groundnut and vegetables. Animal husbandry was the next preferred livelihood after agriculture. The study area is inhabited predominantly by Hindus (85%), there are also a few Christians (10%) and Muslims (5%). The mother-tongue is Tamil which is the regional as well as the state official language.

The survey contained of both structured and semi-structured questionnaires. Depending on the perceived variability, 60 households' informants were randomly chosen, followed by semi-structured interviews, all interviewees were met on a one-to-one basis and asked the same standard questions in the local Tamil language, using open and close-ended questionnaires. Following this and depending on the answers, a series of specific questions were asked on the subjects of interest, including expansions or clarifications upon as needed. In addition, in-depth interviews were administered to household heads using pre-tested structured questionnaires. By brainstorming in focus group discussions with 5 to 8 people using open-ended discussion guidelines that were chaired and recorded verbatim by the researcher, information was captured about the purpose of growing indigenous fruit bearing species, utilities, constraints, interests and perceptions of people. Additionally, household socio-economic attributes and site diversity characteristics were recorded. Finally we ended up with a total of 30 informants (15 organic and 15 conventional farmers). The density and diversity of various species were estimated by census survey on accompanied field excursions with agricultural

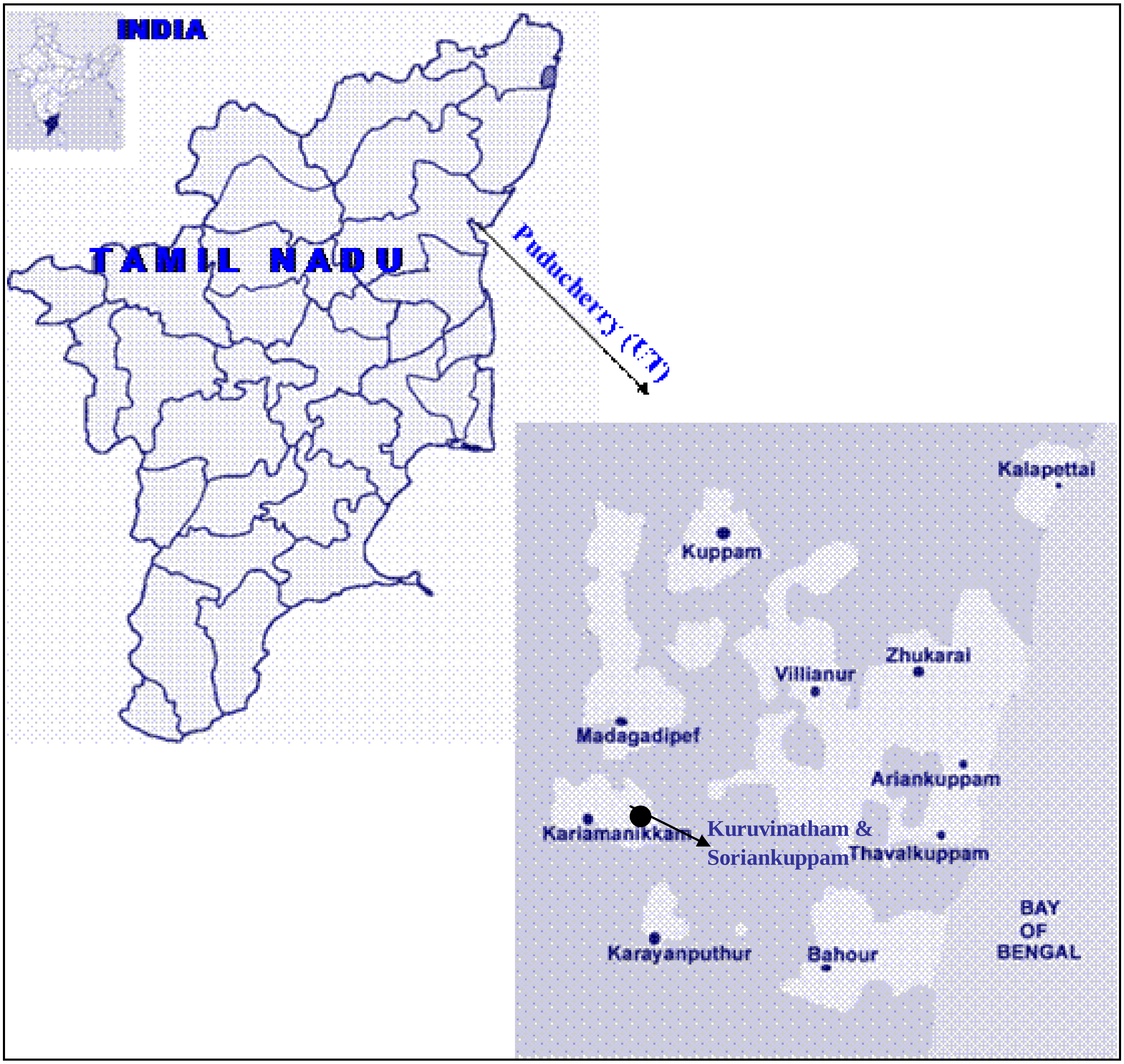

Figure 1. Location of the study area.

development experts and farmers.

A list of species in each agriculture fields, its purpose of usage and its annual production rate was recorded along with its specific agricultural niches/ land use type. Each species has a different yield cycle, so it is difficult to determine a standard/fixed system cycle (Rasul and Thapa, 2006; Okubo et al., 2010). Particularly of fruit or food tree species and older individuals are commonly replaced with new ones of the same or different species each year. Therefore, we estimated incomes as potential annual gross income assuming that timber species generate a steady income each year and treating a typical yield of other species (for example, fruit trees) as a constant. We averaged the data on yield, farm-gate price and harvesting period for each species for all the plots and then determined a typical yield per individual, a typical harvesting period, and a typical sale price per unit for each product. Typical values like fodder and fuel were selected mainly as mode values, but adjusted by judgment based on interviews with local farmers (Okubo et al., 2010).

Medicinal information were gathered among the local native traditional healers, Ayurvedic practitioner's people having the indigenous knowledge of the medicinal plants were conducted through frequent field visits in villages with the help of village head and local traders. The information was collected by group discussions and interviews with them in their local language (Tamil)

(Anbarashan and Padmavathy, 2010). Each of the plant material was assigned a field note books and documented as to Binomials with family, local name, part used and therapeutic uses, plant parts that were identified as medicine were collected, compressed, the voucher specimens were collected and identified by referring to standard flora (Hooker, 1884; Matthew, 1983). All the voucher specimens were maintained in the herbarium at Pondicherry University, Puducherry (India).

Data analysis

Species Diversity Shannon Diversity Index was used as diversity indicator in agricultural landscapes. This index takes a value of zero when there is only one species in a community and a maximum value when all species are present in equal abundance. Shannon Diversity Index (H) was calculated as (Magurran, 1988);

$$H' = -\sum P_i * \ln P_i$$

where H' = Shannon Diversity Index; Pi = proportion of individuals found in the species; ln = is the natural logarithm of this proportion.
Simpson's Index (D) Simpson's Diversity Index is a measure of diversity which takes into accounts both richness and evenness.
Simpson (1949) gave the probability of any two individuals drawn at random from an infinitely large community belonging to different species as:

$$D = ni\ (ni-1)/n\ (n-1)$$

n is the total number of species and *ni* is the number of individuals of a species. As D increases, diversity decreases. Simpson's index is heavily weighted towards the most abundant species in the sample while being less sensitive to species richness.

The differences between the organic and Inorganic farms were compared by Shannon's species diversity and Simpson's Diversity Index, statistically analyzed using ANOVA and confirmed by t-test.

Estimation of benefits and costs

Cost-benefit ratio (Poyyamoli and Padmavathy, 2011) measures the returns or benefits per unit cost of investment. Benefit-cost ratio is the ratio between total cost of production and total receipts realized by the farmer.

Benefits/costs = Number of monetary units of benefit for each unit of costs. Pearson's correlation between the diversity/density and potential annual gross income for organic and inorganic farms were calculated in order to show the cost–benefit relationship of respective farms (Okubo et al., 2010).

RESULTS AND DISCUSSION

Organic and conventional fields differed significantly in their hedgerows width, height and length (means of 0.21±0.02 and 0.17±0.01, n=15, P<0.05; 0.15±0.02 and 0.10±0.01, n=15, P<0.05, respectively). Organic fields had a total of 55 species and conventional fields with 17 species (Table 1). Number of tree species in organic fields was 4±2 and conventional fields were 2±1 respectively. Proportion of grass/fodder area and number of species was much higher on organic than conventional fields (respective percentage means of 35.7±1.5 and 15.2±1.5, n=26, P<0.01; 1±2.5 and .5±1.5). Hedgerow structure differed in its height (P<0.05), base width (P<0.05) and top width (P<0.01), organic fields were greater than conventional fields (Figure 2). Number of shrub, liana and herb species in recorded in hedges/hedgerows were significantly higher in organic fields had mean average of 15±6 (n=15) and conventional fields 7±3 (n=15), P< 0.05. Organic farming is associated with higher levels of plant and animal biodiversity. Flora abundance/non-crop trees and weeds were higher in field margins than in the mid-field under both organic and conventional systems (Hald, 1999; Kay and Gregory, 1999). Number of ornamental species in organic fields was 1±3 and conventional fields were .5±1.

Shannon and Simpson Diversity index values for organic fields were 3.14 and 0.05 and for conventional fields 1.13 and 0.43 respectively (Table 2). These diversity and density index clearly states that organic farms are significantly highly diverse and dense, as compared to inorganic farms by ANOVA with an F= 2.17 (P < 0.005) and one tailed t valve = 3.3 (P < 0.005).

Food

Groundnut, paddy and lady's finger were cultivated in rotation from September 2008 to October 2010. The yield and income generation (B: C ratio 5-12) was gradually increasing in organic fields throughout year by year after their conversion and decrease in production and B: C ratio (8-1) in conventional fields year to year was observed. Yields and profit in the organic systems were 28 to 32% higher than those in the conventional plots mainly due to input of manually prepared organic fertilizers and their time being application (Poyyamoli and Padmavathy, 2011).

Apart from this, a total of 25 species (herbs to trees) out of 55 were consumed as food. *Artocarpus heterophyllus, Cocos nucifera, Lantana camara, Leucas aspera, Mangifera indica, Musa paradisiacal* and *Psidium guajava* are found in both organic and conventional fields. In organic fields *Murraya koenigii* (8), *Phyllanthus emblica* (7.3) and *Psidium guajava* (8) had highest ratio and in conventional fields *Psidium guajava (3)* was highest in B: C. From organic fields total gross annual income from food sources was Rs. 15,990-Rs. 42,835/ha/yr and in conventional fields Rs. 5670-Rs. 12,710/ha/yr.

Fodder

Thirteen species used as fodder. *Albizzia lebbek*, *Artocarpus heterophyllus*, *Borassus flabellifer*, *Gisekia pharnaceoides*, *Leucas aspera*, *Tephrosia purpurea* and

Table 1. Species name, typical yield, price of the main product of each plant species and cost benefit ratio in Organic and conventional agricultural fields.

Scientific name	Nature	Food	Fodder	Fuel	Timber	Medicine	Ornamental	Organic fields	Conventional fields
								C:B ratio	C:B ratio
Acalypha indica L.	H	**	**	**	**	5kg @140/yr	**	3	—
Acanthus ilicifolius L.	H	**	**	**	**	6kg @180/yr	**	3	—
*Achyranthes aspera L.**	H	**	**	**	**	5kg @190/yr	**	4	3.2
*Albizzia lebbek**	T	**	410kg @2150/yr	50kg @1750/yr	2 m3@ 2500/10yr	5kg @130/yr	**	2.7	2
Aloe vera	H	55kg @550/yr	**	**	**	79kg @120/yr	**	2	—
Alternanthera sessilis L.	H	36kg @1980/yr	**	**	**	25kg @115/yr	**	4	—
Amaranthus blitoides	H	42kg @2480/yr	14kg @560/yr	**	**	26kg @158/yr	**	3	—
Ananas comosus	S	3 nos@ 125/yr	**	**	**	3 nos@ 125/yr	**	5	—
Annona squamosa	T	25 nos @ 200/yr	**	**	**	15 nos @ 120/yr	**	4	—
*Artocarpus heterophyllus**	T	37 nos@ 1850/yr	30kg @950/yr	40kg @1500/yr	2 m3 @5560/7yr	8kg @850/yr	**	5.2	4
Azadirachta indica A. Juss.*	T	**	**	**	2 m3 @3,000/10yr	15kg @135/yr	**	7.5	5
Bambusa bambos	T	3 kg@ 125/yr	220kg @1550/yr	50kg @1750/yr	2 m3 @2500/1yr	15kg @185/yr	**	5	—
Boerhaevia diffusa L.	H	**	11kg @360/yr	**	**	6 kg @440/yr	**	3	—
*Borassus flabellifer L.**	T	**	12kg @380/yr	**	**	8kg @750/yr	**	5	2
Calotropis gigantea (L) R.Br.ex.Ait	S	**	**	**	**	3 kg @140/yr	**	3	—
Carica papaya	T	135 nos @ 4050/yr	**	**	**	50 nos @ 1500/yr	**	8	—
Catharanthus roseus L. and G.Don.	H	**	**	**	**	8kg @1950/yr	**	3	—
Cynodon dactylon	G	**	**	**	**	4kg @250/yr	**	2	—
Cissus quadrangularis L.	L	36kg @490/yr	**	**	**	16kg @200/yr	**	3	—
Citrus limon	T	600 nos @1800/yr	**	4kg @150/yr	**	50 nos @ 100/yr	**	3	—
*Cocos nucifera L.**	T	345nos@2070/yr		40kg @1050/yr	**	50 nos @ 500/yr	**	3.45	2
Cyperus rotundus L.*	G	**	**	**		3 kg @40/yr	**	1	1
*Dactyloctenium aegyptium** L and P. Beauv.	G	**	**	**		6 kg @210/yr	**	2	—
Desmodium trifolium L. and DC.	H	**	**	**	**	6 kg @1200/yr	**	2	—
Gisekia pharnaceoides L.*	H		12kg @380/yr			3 kg @80/yr	**	1	1
Lantana camara L.*	L	2 kg@ 20/yr	**	11kg @360/yr		2 kg @30/yr	**	1	1
Leucas aspera Willd*.	H	1 kg@ 5/yr	7kg @240/yr	**	**	6 kg @410/yr	**	2	2
Mangifera indica *	T	110 nos @ 1600/yr		14kg @380/yr		50nos @ 250/yr	**	2.6	2.2
Manilkara zapota	T	25 kg @450/yr	**	**	**	10 kg @200/yr	**	4	—
Manihot esculenta	S	45 kg @450/yr	5kg @50/yr	3kg @30/yr	**	15 kg @150/yr	**	3	—
Mimosa pudica L.	H	**	**	**	**	5kg @280/yr	**	1	—
Moringa oleifera	T	45 kg @850/yr	5kg @80/yr	11kg @440/yr	**	10 kg @200/yr	**	7	—
Murraya koenigii	T	30kg @650/yr	**	**	**	3kg @70/yr	**	4	—
*Musa paradisiacal**	T	30 nos@3000/yr	**	**	**	10 nos @300/yr	**	5	3

Table 1. Contd.

Oldenlandia umbellata L.	H	**	5kg @50/yr	**	**	4kg @70/yr	**	2	—
Opuntia stricta (Haw.) Haw	S	**	**	**	**	5kg @80/yr	**	1	—
Pedalium murex L.*	H	**	**	**	**	3kg @20/yr	**	1	1
Phyla nodiflora (L.) Greene	H	**	**	**	**	4kg @80/yr	**	2	—
Phyllanthus emblica	T	35 kg@ 550/yr	**	**	**	15 kg@200/yr	**	7.3	—
Pongamia pinnata (L.) Pierre	T	**	**	12kg @380/yr	**	**	**	5	—
*Psidium guajava**	T	35 kg@ 400/yr	**	12kg @380/yr	**	5kg @80/yr	**	8	5
Punica granatum	T	15 nos @ 200/yr	**	**	**	**	**	4	—
Ricinus communis	S	**	**	**	**	8kg @1050/yr	**	3	—
Sorghum halepense	S	2 kg @30/yr	**	**	**	**	**	2	—
Solanum nigrum	H	35 kg@ 400/yr	**	**	**	15 kg@200/yr	**	1	—
Tamarindus indicus	T	135kg@7500/yr	**	14kg @380/yr	**	**	**	7	—
Tectona grandis	T	**	**	**	2 m3@12,500/10yr	**	**	10	5.4
*Tephrosia purpurea** (L.) Pers.	H	**	7kg @36/yr	**	**	3kg @20/yr	**	1	3.2
Thespesia populnea * (L.) Soland ex corr.	T	**	31kg @750/yr	40kg @1050/yr	2 m3@4200/5yr	2 kg @30/yr	**	10	3
Tribulus terrestris L.	H	**	**	**	**	4kg @120/yr	**	2	—
Vitex negundo L.	T	**	**	**	**	4kg @70/yr	**	3	—
Jasminum sambac	S	**	**	**	**	**	1 kg@ 800/yr	3	1
Jasminum sp. 1	S	**	**	**	**	**	1.5kg@500/yr	3	—
Jasminum sp. 2	L	**	**	**	**	**	1 kg@ 800/yr	3	1
Crossandra infundibuliformus	S	**	**	**	**	**	.5 kg@ 100/yr	1	—

Thespesia populnea are found in both organic and conventional fields. In organic fields *Thespesia populnea* (10) and *Artocarpus heterophyllus* (5.2) had highest ratio and in conventional fields *Thespesia populnea (3.2)* was highest in B: C. From organic fields total gross annual income from fodder sources was Rs. 7450- Rs. 3520/ha/yr and in conventional fields Rs. 1120- Rs. 2800/ha/yr.

Fuel

Thirteen species used as fuel. *Albizzia lebbek*, *Artocarpus heterophyllus, Cocos nucifera, Gisekia pharnaceoides Lantana camara, Mangifera indica, Psidium guajava* and *Thespesia populnea* are found in both organic and conventional fields. In organic fields *Thespesia populnea* (10), *Psidium guajava* (8) and *Artocarpus heterophyllus* (5.2) had highest ratio and in conventional fields *Thespesia populnea* (3.2) was highest in B:C. From organic fields total gross annual income from fuel sources was Rs. 10,320- Rs. 5140/ha/yr and in conventional fields Rs. 1040- Rs. 1230/ha/yr.

Timber

Six species used as timber. *Albizzia lebbek*, *Artocarpus heterophyllus, Azadirachta indica* and *Thespesia populnea* are found in both organic and conventional fields. In organic fields *Thespesia populnea* (10), *Tectona grandis* (10) and *Azadirachta indica* (7.5) had highest ratio and in conventional fields *Thespesia populnea* (3.2) and *Azadirachta indica* (5) was highest in B:C. From organic fields total gross annual income from timber sources was Rs. 13150- Rs. 26,110 /ha/yr and in conventional fields Rs.5040 - Rs. 10350/ha/yr.

Medicine

Fifty-one species can be used as medicine.

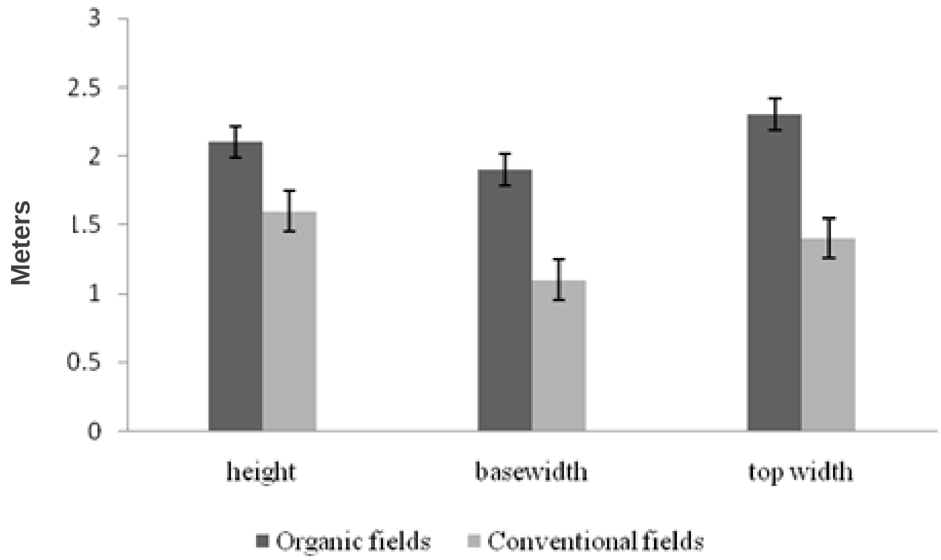

Figure 2. Hedgerows parameters comparison between organic and conventional agricultural fields.

Table 2. Mean species abundance and diversity per field in organic and conventional fields.

Farming type	Mean number of species/field	Diversity and density indices	
		Shannon	Simpson
Organic fields	15±6	3.14	0.07
Inorganic fields	7±3	1.13	0.43

Achyranthes aspera, Albizzia lebbek, *Artocarpus heterophyllus, Azadirachta indica, Borassus flabellifer, Cocos nucifera, Cyperus rotundus, Gisekia pharnaceoides, Lantana camara, Leucas aspera , Mangifera indica, Musa paradisiacal, Pedalium murex, Psidium guajava* , *Tephrosia purpurea* and *Thespesia populnea* were found in both organic and conventional fields. In organic fields *Thespesia populnea* (10), *Tectona grandis* (10) and *Azadirachta indica* (7.5) had highest ratio and in conventional fields *Thespesia populnea* (3.2) and *Azadirachta indica* (5) was highest in B: C. From organic fields total gross annual income from medicine sources was Rs. 9100 - Rs. 4550/ha/yr and in conventional fields Rs.1140 - Rs. 2800/ha/yr. All these medical plants were taken internally with additives such as oil (sesame, castor and coconut), milk and milk products (butter milk and ghee), common salt, jaggery and honey or applied externally in the form of infusion, decoction, paste or powder. Most of the plants used in medicines are either mixed with other ingredients or single. All these species are known to be used in various treatments like for curing Jaundice, hepatitis, mumps, eczema, cut, healing wounds, throat infection, diarrhea, itches, skin diseases, cure headache, stomach ulcer, tumor, ear-ache, eye pain, diabetes, colds and coughs in general.

Ornamental

Four species can be used as ornamental. In organic fields *Jasminum sambac, Jasminum* sp*. 1* and *Jasminum sp. 2* were highest ratio of 3 each and in conventional fields *Jasminum sambac* and *Jasminum sp. 2* was highest B:C -1 each. From organic fields total gross annual income from ornamental sources was Rs. 1010 - Rs. 2020/ha/yr and in conventional fields Rs.510 - Rs. 960/ha/yr.

Among the observed 55 species, majority of them was trees (22) and herbs (18), shrubs were moderate with 9 species, and least were liana and grasses with three species each. In this list only two species (tree) were for five purposes like food, fodder, fuel, timber and medicine. Four species (3 tree and 1shrub) used for four purposes, seven species (four trees, two herbs and one liana) for three purposes, 18 (nine trees, seven herbs, one shrub

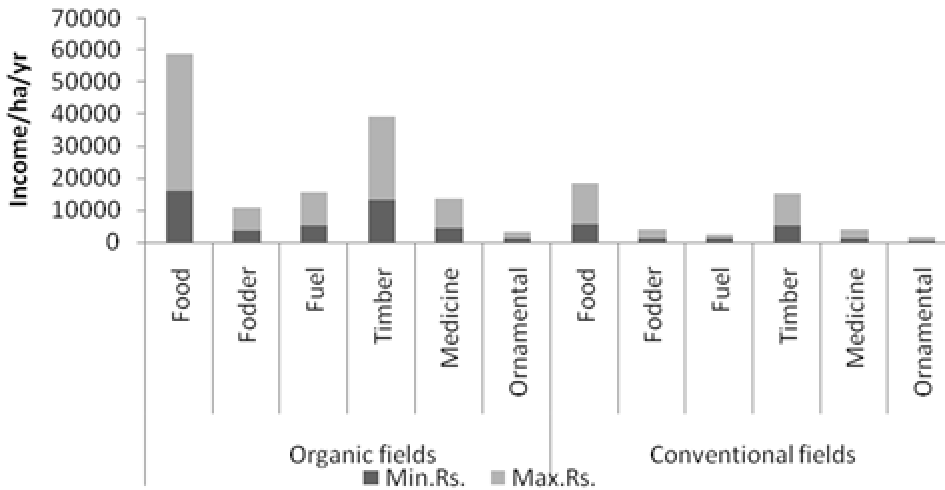

Figure 3. Provisioning ecosystem services income extend comparison between organic and conventional agricultural fields in Puducherry-India.

and one liana) species for two purposes and 24 (nine herbs, seven shrubs, four trees, three grasses and one liana) species for a purpose were used. Organic fields resulted an annual gross income per ha is approximately ranged from Rs. 43,360- Rs. 91,120 (US$ 942-1980; US$1 = 46 in 2010) and conventional fields resulted annual gross income approximately Rs. 14,490-Rs.30, 850 (US$ 315-670) per ha; depending upon density and diversity the multi-purposes species. In provisioning services income generation from food was the highest, followed by timber, fuel and medicine, least income generation was from fodder and ornamental plants (Figure 3). Income and diversity/density were significantly positively correlated in organic fields (n = 15, Pearson's correlation coefficient 0.031, P< 0.01) than in conventional fields (n = 15, Pearson's correlation coefficient 0.091, P< 0.05) as they lack sufficient density and diversity. When both organic and conventional fields were compared in terms of provisioning services annual gross income they showed a significant difference ANOVA, P = 0.03, P< 0.05 and in t-test 0.02, P< 0.05. The result with higher income generation coincides with some previous other studies which involves the biodiversity rich multiple cropping and cultivar traditional farming systems (Padmavathy and Poyyamoli 2011a, b; Poyyamoli and Padmavathy, 2011). Average net monetary benefit to guava-based agro forestry systems in Meghalaya was Rs 20,610/ha (US$ 448.00) and for Assam lemon-based agro forestry systems, Rs 13,787.60/ha (US$ 300.00) (Kumar et al., 2004; Pandey 2007). For instance, a five-year field experiment of tree mixtures for agroforestry system in tropical southern India involving mango (*Mangifera indica*), sapota (*Achrus sapota*), eucalyptus (*Eucalyptus tereticornis*), casuarina (*Casuarina equisetifolia*) and leucaena (*Leucaena leucocephala*) found that it can exchange the growth of the crops by 17% (Pandey 2007).

Conclusion

Sustainable agricultural practices like organic farming are ecologically and socio-economically feasible. Biodiversity extend is comparatively higher in organic fields than conventional fields, there was significant difference between these systems in terms of environment product-ion, biodiversity, food quality, sustainable production and soil quality maintenance for a long term, so it is necessary to popularize such unique systems among the farmers and it is an important option for livelihood improvement, climate change mitigation and sustainable development.

ACKNOWLEDGMENTS

The authors are grateful to Kalangium NGO and local farmer communities who were very co-operative and helpful in the works.

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