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The organics iceberg and the tyranny of organic certification

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The existence of an 'organics iceberg' is a hypothesis rather than a fact. Nevertheless, reports in *The World of Organic Agriculture* that there are 37,245,686 certified organic hectares worldwide and that this accounts for 0.86% of global agriculture (Willer, Lernoud & Kilcher, 2013) are lower bounds, in fact underestimates, of the size and the achievements of the organics movement. While such statistics are seductively precise, they are merely the countable manifestation of a larger phenomenon, and perhaps a much larger phenomenon, which may be - an organics iceberg.

Just how large is the uncounted 'world of organic agriculture', as compared to the counted world of certified organic agriculture, is a matter of speculation, but its existence is doubtless. In a study in India comparing the experience of organic farmers (N=350) and chemical farmers (N=200), all of the organic farmers lacked certification (Sudheer, 2013). The reasons given for that absence of certification were the cost of certification, the lack of information to achieve certification, and the size and scale of the operation (Sudheer, 2013).

My favourite tea, at least for the moment, is Rooibos (*Aspalathus linearis*), from South Africa, and the packet states that it is "organically grown" (Just Roibos, 2013). Such a claim is usually code for falling at the last hurdle to certification - being packed at a facility that is organically certified. A local bottle of Pinot Noir wine carries the narrative: "We nurture our vines with a focus on soil health and biodiversity following biodynamic and organic principles" (Roberts & Roberts, 2010). On their website, the Moorilla Winery of the Museum of Old and New Art (MONA) declares that "Our winery focuses on a small, very high-quality output ... to make boutique, ultra-premium wines from sustainable, organic and bio-dynamic estate-grown fruit" (MONA, 2013). These are three examples of the non-certified world of organic agriculture.

What has passed as reportage of the worldwide organics movement over the past fifteen annual reports (beginning with Willer & Yussefi, 2000) takes advantage of the uptake of organics certification, the infrastructure of organics certifiers, and the attendant auditing and data gathering. Yet, organics certification is a relative latecomer to the organics movement, a movement that dates back to Rudolf Steiner's call, in 1924, for an agriculture differentiated from chemical agriculture (Paull, 2011; Steiner, 1924).

There are reasons to be organic and there are reasons to be certified organic - and they are different reasons. Organics certification generally postdates the 1972 founding of the International Federation of Organic Agriculture Movements (IFOAM) (Paull, 2010). In Australia there has been active and structured advocacy of organic agriculture from the founding, in 1944, of the Organic Farming and Gardening Society (Paull, 2008), but organics certification in Australia dates from the founding of organics certifiers beginning

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from 1987 (Paull, 2013). Certified organic food and agriculture is a subset of organic food and agriculture.

Africa appears skeletal on a map of the world of organic agriculture where territory sizes are presented according to their reported organic agriculture hectares (Paull & Hennig, 2013) since Africa accounts for less than 3% of global certified organic hectares (Willer et al., 2013). However as Bouagnimbeck (2013) points out “it should be noted that much organic production ... takes place in Africa without certification. There are many African organic farmers for whom formal certification does not have any advantages: this is true for farmers who practice subsistence farming and do not engage in the market at all, and for farmers for whom the organic claim has little or no marketing value. These groups engage in organic agriculture because of benefits such as increased productivity and resilience, lower production costs, a healthier working environment, and other social, environmental, and economic sustainability considerations. Non-certified organic agriculture might also be a first step on the way to certification. There are no statistics on this type of organic production” (p.167).

Historically, the organics sector has been a broad church and variety has been embraced. However, the development of organics certification has fostered an exclusionary approach and disengagement with some of the organics family. This reaches an apotheosis in the USA where, for example, it has become illegal to label produce ‘organic’ unless it has the imprimatur of the United States Department of Agriculture (USDA). This encroachment denies that organic has been part of the commonwealth of agriculture in the USA since at least the first issue of Jerome Rodale’s periodical *Organic Farming and Gardening* (Rodale, 1942) and it ignores the brutal experience that historically the UDSA could hardly be characterised as either friend or advocate of organics (Gross, 2008). The USDA in control of US organic standards and certification may seem to some to be akin to putting Dracula in charge of the blood bank. As a response to the disenfranchisement of the grassroots organics movement there has been “a backlash against the federal takeover of the organic program in 2002, Certified Naturally Grown has expanded over the past decade to include more than 700 farms in 47 states” (Reighart, 2013).

Circling the wagons in an ever tightening defensive formation is not a means for the organics movement to conquer the world. There are diverse reasons for being certified organic, including health, environment, market opportunity, and profit. But a fortress organics mentality denies the reality that there are many reasons to be non-certified organic, and they include cost, access, and size of operation (Sudheer, 2013), lack of market advantage (Bouagnimbeck, 2013), and there is a plethora of other reasons including independence, privacy, bother, paper-work, intrusion, bio-security, and farm sovereignty. Black-letter organics has its place, but it is a place at the organics table and it is not the whole table. There are organics fellow travellers, and the diverse kith and kin of the organics movement, that can and do advocate and innovate practices and ideas.

Consumers can differentiate between ‘organic’ and ‘certified organic’. In a study of Australian consumers (N=221), consumers valued food labelled ‘organic’ at a premium of 8% and food labelled ‘certified organic’ at a premium of 16%. So, for consumers, half of the organics price premium is attributed to the ‘organic’ claim and half is attributed to the ‘certified’ claim (Paull, 2009).

The organic spinach in my front yard and the organic cherries in my back yard are foreseeably never destined to be certified organic. Jerome Rodale, after the first issue of his periodical *Organic Farming and Gardening* (May 1942) promptly inverted the title to read *Organic Gardening and Farming* (for the December 1942 issue), having realised that there were potentially far more organic gardeners than organic farmers. The success of the world's longest running organics periodical testifies to the wisdom of Rodale's insight. Much urban agriculture is organic and much of the world's food is from backyards (Benson, 2012) although the numbers are elusive.

It has been observed that "not everything that can be counted counts, and not everything that counts can be counted" (Cameron, 1963, p.13). While the certified organic world can be counted, since each entity has been audited by a certifier, the metrics of the non-certified world of organic agriculture is a greater challenge since it is not amenable to the collation of any existing data. Population measurements in ecological studies typically resort to strategies other than a full population census, and for the world of non-certified organics we likewise need to be content with population estimates, rather than full population counts. There is also the issue of where to 'draw the line'. For example, a study of the effectiveness of poultry manure on crop growth (Shiyam & Binang, 2013), while reported appropriately in the Journal of Organic Systems, might fail commercially to achieve organic certification because the manure may need to have been sourced from certified organic chickens, and applying urea may preclude certification (OISCC, 2013). Organics in Korea avoids the typical dichotomy of organic/non-organic by having four categories of organics certification.

The development of a rice bred specifically for organic farming (Vanaja, Mammootty & Govindan, 2013) is an example of the kind of research that needs to be expanded if the organics movement is to achieve its destiny as imagined by its founders and pioneers. Reported at just 0.86% of global agriculture, the organics sector is a precariously and insecurely positioned niche.

The captain of the Titanic, Edward Smith, may have wondered "Perhaps there is an iceberg?" In *The World of Organic Agriculture*, we may be getting a good view of the tip but how much 'berg' are we disregarding? It is time to move beyond the tyranny of certification to embrace, celebrate and foster the diversity of the organics diaspora. A fuller and broader metrification of the world of organic agriculture will be a challenging enterprise and would undoubtedly introduce a greater degree of fuzziness into the metrics, nevertheless, accounting for a world of certified and non-certified organic agriculture would be a timely enterprise that can lay the basis for warranting more organics research, more organics research funds, greater recognition for organics, greater consideration for the organics enterprise, and more shelf space for organics produce.

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Influence of the biofertiliser *Seasol* on yield of pepper (*Capsicum annuum* L.) cultivated under organic agriculture conditions

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Abstract

The experiment was carried out in 2009-2011 on the certified organic farm of the Agroecological Centre at the Agricultural University, Plovdiv (Bulgaria). The research aimed to examine the impact of biofertilisers on the productivity of pepper, cv. Kurtovska kapiya 1619, cultivated under organic agriculture conditions. The tested biofertiliser was Seasol (Earthcare) (Seasol International, Australia), which was applied during vegetation (i.e. at the pepper growing stages of flower buds and mass fruit-set) on the top of basic-fertilisations, namely the solid 'Lumbrical' and 'Boneprot'. Seasol was applied in optimum concentrations and in concentrations reduced by 50%. The biofertiliser applications were in compliance with the list of permitted soil additives by the European Regulation (EC) No. 889/2008. The use of biofertilisers led to increase in yield of the pepper by 8% to 39%. The results showed that the percentage of non- standard production decreased upon the application of organic fertilisation. The increase in the standard yield was stronger in comparison with the non- fertilised (control) plants upon the combined application of the biofertiliser Seasol on the basic fertilisation Boneprot and the basic fertilisation Lumbrical, as an average from the three years ($p<0,1$). The biofertiliser Seasol had a positive effect on number of fruits per plant compared to non- fertilised (control) plants. The combination of the biofertiliser Seasol as an amendment to the basic fertilisation with Lumbrical had a favourable effect and resulted in increase in the standard yield. The research results provided grounds for recommending this combination to the existing fertilisation schemes for ensuring optimum productivity and environment protection when growing organic pepper.

Key words: biofertilisers, biofertilizers,biofertilisation, biofertilization, organic farming, productivity, yield, Bulgaria, Europe.

Introduction

Agricultural policy in Bulgaria is directed towards implementing the European Model of Agriculture and building a highly efficient, competitive and stable agriculture that is in conformity with the requirements and principles of the Common Agricultural Policy of the European Union (Vasileva, 2006). Organic agriculture is a new perspective for Bulgaria (Karov, et al. 1997) where distinctive agricultural conditions exist for the development of efficient and ecologically- friendly agriculture (Topalov, et al. 1993) The organic certification of agricultural land in Bulgaria has so far achieved modest results (Paull & Hennig, 2013) with 25,022 hectares certified for organic agriculture along with 543,655 ha certified for organic wild collection (Willer, Lernoud & Kilcher, 2013).

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Dincheva, et al. (2008) state that vegetable production must be directed not only towards obtaining maximum yield, but also towards optimisation of fertilisation systems in order to ensure the stable ecological environment, economic production and ecological products. In recent years there has been an increase in demand for vegetables of high ecological value, which has contributed to the expanding use of organic fertilisers (Boteva & Cholakov, 2010). In our country, sweet pepper is one of the most competitive vegetables intended for fresh consumption (Cholakov, et al. 1996).

Organic products containing beneficial microorganisms are an alternative to the large quantities of mineral fertilisers and therefore some authors call them 'biofertilisers' (e.g. Tringovska & Naydenov, 2003; Davari, Sharma & Mirzakhani, 2012). Biofertilisers are low- cost, effective and renewable source of plant nutrients to supplement chemical fertilisers. Microorganisms, which can be used in biofertilisers, include bacteria, fungi and blue green algae. These organisms are added to the rhizosphere of the plant to enhance activity in the soil (Boraste, et al. 2009). Use of liquid biofertilisers is one of the practices of organic agriculture that aims to achieve balanced plant nutrition. As a result, higher yields are expected with no significant cost increases (Alves, et al. 2009). Organic manure contains higher levels of readily-available nutritional elements which are essentially required for plant growth (El-Sayed & Elzaawely, 2010). The use of biofertilisers is an 'environmentally-friendly' opportunity when searching for alternative solutions to improving the food regime of pepper cultivation.

Objectives

This research aimed at investigating the impact of vegetative feeding with biofertilisers on production capacity of pepper grown under organic agriculture conditions.

Materials and Methods

The experiment was carried out in 2009 - 2011 on the certified organic farm of the Agroecological Centre at the Agricultural University - Plovdiv (Bulgaria).

The agro-climatic resources of Bulgaria are determined by its geographic location, the relief and the influence of nearby sea- basins i.e. the Mediterranean Sea and the Black Sea. Considering climate, Plovdiv is a part of the Transitional continental climatic sub-region of Bulgaria to the European continental climatic region and a climatic region of East - Middle Bulgaria (Ahmed, 2004).

Soil features included an alluvial soil type of clay-sandy composition and having relatively soft structure with approximately 2% of humus (by Turin methodology), mineral nitrogen (NH_4-N + NO_3-N) by distillation, i.e. 1.8 mg/ 100g of soil; mobile P_2O_5, i.e. 18.2 mg/100g and mobile K_2O i.e. 16.4 mg/100g of soil (by Egner - Ream method), and soil $pH_{/H2O/}$ of ~7.5 determined by the potenciometric method.

The treatments with biofertilisers were as follows:

1. Control (non - fertilised)
2. Basic fertilisation with Boneprot (optimum concentration)
3. Basic fertilisation with Boneprot (50%) + Seasol
4. Basic fertilisation with Lumbrical (optimum concentration)

5. Basic fertilisation with Lumbrical (50%) + Seasol

The research included pepper of cv. ‘Kurtovska Kapiya 1619’. The pepper was cultivated by using the existing technology for mid-early field production, in conjunction with the principles of organic agriculture. Pepper is a demanding crop culture with regard to the preceding crop. Suitable preceding crops are vegetable varieties from the family *Fabaceae* and the family *Cucurbitaceae* (Panayotov, et al. 2007). The present research used bean as a preceding crop during the three vegetation years of the experiment.

Fertilisation

Two basic fertilisations were used, namely: Lumbrical and Boneprot, applied into the soil through incorporation prior to planting of the seedlings on the field. The biofertilisers were applied in two concentrations, i.e. optimum (400 L/da for the basic fertilisation with Lumbrical and 70 kg/da for the basic fertilisation with Boneprot) and optimum concentrations reduced by 50%. Biofertiliser Seasol was introduced in soil as an amendment in concentration 1:500, i.e. 0.3 - 0.4 L/da during the vegetation and at the pepper growing stage ‘flower bud’ and ‘mass fruit-set’ (Vlahova, 2013).

The pepper seedlings were planted on a permanent field during the third decade of May on a high-levelled seed-bed, according to a sowing scheme 120 + 60 x 15 cm. The experiment was done according to the method of long plots, in four replications with a size of a test plot of 9.6 m^2.

Table 1: Specifications of chemical content of biofertilisers (in %) used in the study.

№	Biofertiliser	N				P_2O_5	K_2O	Recommended dose (per ha)
		Organic N	Total N	NH_4N	NO_3N			
1.	Lumbrical	n/a	2.21	0.0033	0.00305	0.141	0.191	4000 L
2.	Boneprot	4.5	n/a	n/a	n/a	3.5	3.5	700 kg
3.	Seasol	n/a	0.10 ± 0.05	n/a	n/a	0.05 ± 0.02	2.0 ± 0.5	3-4 L

Note: n/a = data not available.

Major features of the biofertilisers used in the study

This study included following three proprietary commercially available biofertilisers - Lumbrical, Boneprot and Seasol (Earthcare) (Table 1), the active ingredients of which are in the list of permitted substances for organic farming according to European Regulation (EC) No. 889/2008.

Lumbrical (private producer, village Kostievo, Plovdiv region, Bulgaria) is a product obtained from processing of animal manure and other organic waste by the Californian red worms (*Lumbricus rubellus* and *Eisenia foetida*) and consists of their excrements. The commercial product has humidity of 45 - 55% and organic matter content of 45 - 50%. Ammonium nitrogen (NH_4N) is 33.0 ppm; nitrate nitrogen (NO_3N) is 30.5 ppm; P_2O_5 and K_2O are 1410 ppm and 1910 ppm respectively, MgO is 1.8%. It contains useful microflora 2 x 10^{12} pce/g, humic and fulvic acids, nutritional substances. The product has a pH of 6.5 - 7.0 (pH in H_2O).

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Boneprot (Arkobaleno, Italy) is a pellet organic fertiliser and has following composition: (organic nitrogen (N) - 4.5%; phosphorus anhydride (P_2O_5) total - 3.5%; potassium (K_2O) - 3.5%; calcium (CaO) - 5 - 8%; magnesium (MgO) - 0.8 - 1%; organic carbon (C) of biological origin - 30%; humification rate (HR) - 10 - 13%; degree of humification (DH) - 40 - 42%; humification index (HI) - 1.3 - 1.4%; humidity - 13 - 15%; pH in water - 6 - 8. Boneprot is entirely organic fertiliser consisting mainly of cattle manure collected from farms which do not use antibiotics and are subject to controlled fermentation for a period of about one year.

Seasol (Earthcare) from Seasol International Pty Ltd. (Australia) is an extract of brown algae *Durvillaea potatorum*. Seasol is a 100% liquid natural seaweed extract. It contains 60% of alginic acids. The commercial product contains as follows: raw protein (2.5 ± 0.1% w/w); alginates (6 ± 2% w/w); total solidity (10.0 ± 0.5% w/w), and pH (10.5 ± 0.5% w/w) and has a variety of mineral elements and traces of Ca (0.05 ± 0.03% w/w), Mg (0.01 ± 0.005% w/w), N (0.10 ± 0.05% w/w), P (0.05 ± 0.02% w/w), K (2.0 ± 0.5% w/w), Cu (0.3 ± 0.2% w/w) and cytokines.

Parameters studied

The following parameters were investigated:

1. Yield (standard and non-standard) in kg/da (i.e. kg/0.1ha).
2. Economic productivity of plants:
   a) Average number of fruits per plant - (pcs/plant) - 10 plants per treatment were analysed.
   b) Average mass of fruits (g) - 10 fruits per treatment were analysed.
   c) Pericarp thickness (mm) - (pcs/plant) - 10 plants per treatment were analysed.

Statistical data processing was done using Microsoft Office Excel 2007; SPSS; Biostat; and STATISTICA - StatSoft Treatment 9.0. One-way analysis of variance (ANOVA) was used to analyse the differences between treatments (SPSS treatment 7.5). All data were analyzed by using Duncan's multiple range test (Duncan, 1955) at $P<0.05$ level. In the tables below, different letter(s) within a column indicates a significant difference by Duncan's multiple range-test. BIOSTAT was used to compare the results (treated compared to the control (untreated)).

Results

1. Yield

Dynamics of the standard yield of the pepper cv. 'Kurtovska Kapiya 1619' in the experimental period 2009- 2011 are reported on Table 2. The overall increase of yield compared to non-fertilised (control) was detected after basic fertilisation with Boneprot. It ranged from 16.6% to 35.1% in 2009, from 23.2% to 26.0% in 2010, from 8.3% to 22.3% in 2011. After basic fertilisation with Lumbrical the increase ranged from 21.1% to 28.5% in 2009, from 35.1% to 38.7% in 2010 and from 13.1% to 26.1% in 2011.

The highest yield was reported after additional feeding with the biofertiliser Seasol on the basic fertilisation Lumbrical, i.e. 1520 kg/da (2010) and 1450 kg/da (2011) respectively. The yield increase compared to the control was by 38.7% and 26.1% respectively. The difference between treated and control plants was significant (at $P_{0.1\%}$). The positive impact confirmed suitability of combination of both biofertilisers on the yield. This can be attributed to seaweed extract in biofertiliser Seasol and rich content of organic substance 45 - 50% in Lumbrical.

Table 2. standard and non - standard yield (2009 - 2011), (Duncan's Multiple Range Test, P<0.05)*.

No	Treatments	2009 Standard Yield (kg/da)		2009	2010 Standard Yield (kg/da)		2010	2011 Standard Yield (kg/da)		2011	Average for the period
		Mean; St. Dev.	GD	Non-standard Yield (kg/ da)	Mean; St. Dev.	GD	Non-standard Yield (kg/ da)	Mean; St. Dev.	GD	Non-standard Yield (kg/ da)	
1.	Control	987 ± 13.53 ^{d}	Base	41.2	1096 ± 316.16 ^{e}	Base	31.0	1150 ± 137.98 ^{g}	Base	36.3	1177.7
2.	Boneprot (optimum)	1151 ± 84.22 ^{cd}	ns	40.8	1381 ± 349.74 ^{d}	++	25.4	1245 ± 66.46 ^{fg}	ns	22.5	1259.0
3.	Boneprot (50%) + Seasol	1334 ± 380.23 ^{abc}	+	38.9	1350 ± 321.29 ^{d}	++	47.3	1407 ± 21.63 ^{e}	+++	21.5	1363.7
4.	Lumbrical (optimum)	1269 ± 545.35 ^{bcd}	ns	58.4	1481 ± 155.23 ^{cd}	+++	43.6	1301 ± 14.73 ^{f}	++	35.2	1350.3
5.	Lumbrical (50%) + Seasol	1196 ± 248.69 ^{cd}	ns	29.6	1520 ± 99.14 ^{bcd}	+++	41.5	1450 ± 71.46 ^{de}	+++	44.8	1388.7
	GD $_{5\%}$		295.92			169.44			97.74		
	GD $_{1\%}$		403.59			231.09			133.30		
	GD $_{0.1\%}$		546.15			312.72			180.38		

* Values not sharing a common superscript (a, b, c, d, e, f, g) differ significantly (Duncan's Multiple Range Test).

The second best effect on yield was shown by biofertiliser Lumbrical applied in an optimum concentration, respectively 1269 kg/da (2009) and 1481 kg/da (2010), where the increase as compared to the control was by 28.5% and 35.1% respectively. The difference between treated and control plants was significant (at $P_{0.1\%}$). The stimulating effect of Lumbrical on the yield can be attributed to its physical and chemical composition, which makes it more easily assimilated by plants and increased their vegetative growth by improving the level of productivity of pepper.

It was found that combination of biofertilisers Boneprot and Seasol had a positive effect on increase of yield. This effect may be attributed to biofertilisers' composition. Seasol contains auxins and alginates and Boneprot release slowly nutrients in soil during the vegetation and the plants gradually uptake these.

The stimulating effect on the pepper yield was shown by another combination. The additional treatment with the biofertiliser Seasol on basic fertilisation with Boneprot yielded 1334 kg/da (2009) and 1407 kg/da (2011). Compared to non-treated (control) plants, the increase was by 35.1% and 22.3%, respectively. When testing the single application of basic fertilisations, the highest yield was shown by basic fertilisation with Lumbrical compared to basic fertilisation with Boneprot (2009, 2010, 2011).

On average for the experimental period, the highest yield was reported for treatment with Seasol on basic fertilisation with Lumbrical i.e. 1388.7 kg/da, followed by the treatment with Seasol on basic fertilisation with Boneprot i.e. 1363.7 kg/da.

The multi-factorial ANOVA (Statistica, StatSoft) applied for analysing the standard yield is presented in Figure 1.

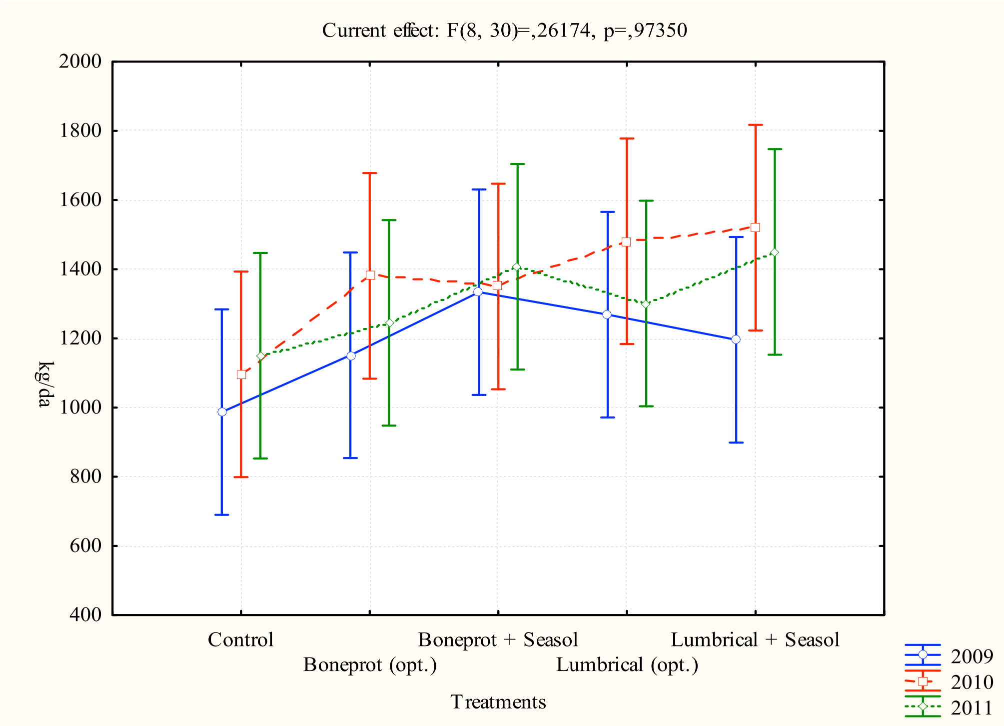

Figure 1. Effect of the interaction of the main fertilisation factors on the yield - 2009 - 2011.

It was found that increase of standard yield of treated plants was significant ($P<0,1$, Figure 2) compared to non - treated (control) plants under combined application of biofertiliser Seasol on basic fertilisation with Boneprot and basic fertilisation with Lumbrical (as an average from the three experimental years).

The highest average standard yield was shown in 2010 followed by 2011 and 2009. The high 2010 standard yield found was positively impacted by the favourable agro-meteorological conditions during pepper's individual stages growth.

The largest diversions in meteorological conditions were reported in the second half of the pepper vegetation in 2011. In this period of June (a month that is usually the rainiest according to statistics) conditions were extremely dry with temperatures exceeding the average by 2°C. It had a negative effect on the progress of the flower bud stage and on the realized standard yield respectively.

In 2009, the entire period of vegetation from April until end of September was dry. This in combination with average monthly temperatures above average and rainfalls below average had an unfavourable effect on productivity and on obtained standard yield respectively.

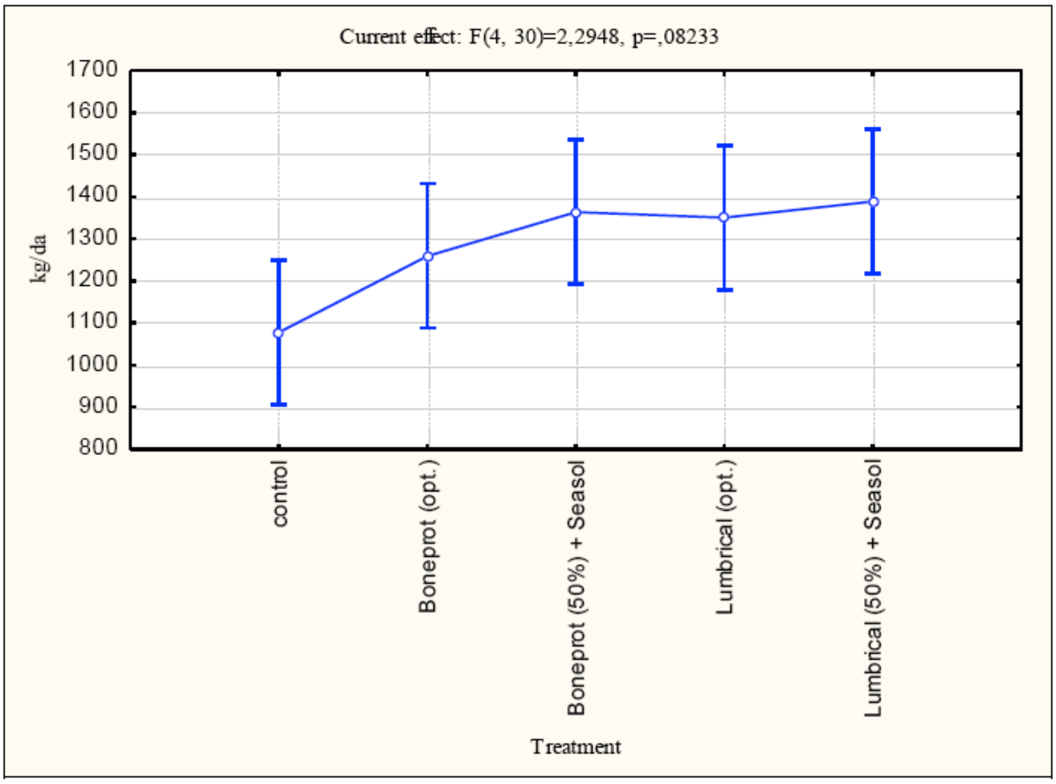

Figure 2. Differences in standard yield between variants after a combined application of biofertilisers (as an average from the three experimental years).

2. Economic productivity of plants

a) Average number of fruits per plant

The yield rate was mostly determined by the number of fruits on plants. The results on the influence of the applied biofertilisers on the number of fruits for the period of experiment 2009 - 2011 are presented in Table 3.

It was found that the number of fruits of treated with biofertilisers plants exceeded those of the non - treated (control) plants. The highest total number of fruits per plant was reported for the combination of Seasol on basic fertilisation with Lumbrical i.e. 7.6 pcs/ plant (2010) and 6.0 pcs/plant (2011). The difference between the average values of treated and non- treated was significant at $P_{0.1\%}$. The results confirmed previous findings that additional vegetative feeding with the biofertiliser Seasol can increase pepper productivity. This is apparent for application of Seasol on basic fertilisation with Lumbrical in comparison with the basic fertilisation with Boneprot. This can be attributed to the physical and chemical composition of Lumbrical, which provides nutritional substances in an easily accessible form thus resulting in higher productivity.

Good results were also achieved upon treatment with Seasol on basic fertilisation with Boneprot i.e. 6.2 pcs/plant (2009) and 6.4 pcs/plant (2010). The difference between the average values of treated compared to control plants was significant at $P_{0.1\%}$. For the 3

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years of study, the combined treatments (i.e. Seasol on basic fertilisation Boneprot) had higher values of the number of fruits than the treatments with a single optimum concentration of the basic fertilisations. During the latter, a highest number of fruits were detected after a basic fertilisation with Lumbrical.

Table 3. Number of fruits per plant, cv. Kurtovska kapiya 1619, (Duncan's Multiple Range Test, P<0.05)*.

No	Treatments	2009		2010		2011		Average number for the period
		Mean; St. Dev.;	GD	Mean; St. Dev.;	GD	Mean; St. Dev.;	GD	
1.	Control	4.3 ± 0.707^{f}	Base	4.2 ± 0.833^{g}	Base	4.3 ± 1.225^{f}	Base	4.3
2.	Boneprot (opt.)	5.4 ± 0.882^{de}	++	6.0 ± 0.500^{f}	+++	4.8 ± 0.667^{ef}	ns	5.4
3.	Boneprot (50%) + Seasol	6.2 ± 0.972^{cd}	+++	6.4 ± 0.882^{ef}	+++	5.6 ± 0.527^{cd}	++	6.1
4.	Lumbrical (opt.)	7.9 ± 0.782^{ab}	+++	6.6 ± 0.726^{ef}	+++	5.8 ± 1.093^{cd}	+++	6.8
5.	Lumbrical (50%) + Seasol	5.3 ± 0.500^{e}	+	7.6 ± 0.527^{abcd}	+++	6.0 ± 0.707^{abc}	+++	6.3
	$GD_{5\%}$		0.78		0.67		0.69	
	$GD_{1\%}$		1.06		0.91		0.95	
	$GD_{0,1\%}$		1.43		1.24		1.28	

* Values not sharing a common superscript (a, b, c, d, e, f, g) differ significantly (Duncan's Multiple Range Test).

b) Average mass of fruits

The volume of the yield was affected not only by the number of fruits per plant, but also by their mass. The effect though was not unidirectional during the three years of study. The largest mass of fruits was detected for variants treated with Seasol on the Lumbrical basic fertilisation i.e. 73.7 g (2010) and 72.5 g (2011), thus confirming the conclusion about the larger number of fruits during the same period (Table 4).

The application of the biofertiliser Seasol on both basic fertilisations had a stimulating effect reflecting in the increase in the number of fruits and their mass. Another stimulating effect was shown only once by the variant with an optimum concentration on Boneprot basic fertilisation, in parallel with highest value of mass of fruits. A positive effect on the increase of the mass of fruits was found for the variant with biofertiliser Seasol on Boneprot basic fertilisation with an average of 70.7 g for the 3 - year study period.

The greater thickness of the fruits pericarp was found for the variants treated with Seasol on both basic fertilisations. It confirmed expectations that a combined fertilisation (basic fertilisation plus vegetation feeding) has a better effect than a single application of the biofertiliser in the form of basic fertilisation (Table 5).

The highest value of the pericarp thickness was reported upon application of Seasol on Boneprot basic fertilisation throughout the entire period of the experiment i.e. 5.51 mm (2009), 5.58 mm (2010) and 5,09 mm (2011). The average value for the period was 5.41 mm. The influence on additional application of Seasol was positive when applied on Lumbrical basic fertilisation, i.e. 5.21 mm for the three year study period.

Table 4. Mass of fruits, cv. 'Kurtovska kapiya 1619', g., (Duncan's Multiple Range Test, P<0.05)*.

No	Treatments	2009	2010	2011	Average for the period
		Mean; P<0.05	Mean; P<0.05	Mean; P<0.05	
1.	Control	66.5 [c]	69.2 [d]	69.1 [b]	68.3
2.	Boneprot (opt.)	68.3 [bc]	70.5 [cd]	69.6 [ab]	69.5
3.	Boneprot (50%) + Seasol	67.8 [ab]	72.8 [abc]	71.6 [ab]	70.7
4.	Lumbrical (opt.)	67.1 [abc]	71.3 [bc]	70.2 [ab]	69.5
5.	Lumbrical (50%) + Seasol	67.4 [a]	73.7 [ab]	72.5 [a]	71.2

* Values not sharing a common superscript (a, b, c, d) differ significantly (Duncan's Multiple Range Test).

c) Pericarp thickness

Table 5. Thickness of pericarp of pepper fruits, cv. 'Kurtovska kapiya 1619', mm, (Duncan's Multiple Range Test, P<0.05)*.

No	Treatments	2009	2010	2011	Average for the period
		Mean; St.Dev.	Mean; St.Dev.	Mean; St.Dev.	
1.	Control	4.37 ± 0.699 [c]	4.10 ± 0.307 [d]	4.53 ± 0.28 [d]	4.33
2.	Boneprot (opt.)	4.58 ± 0.706 [bc]	4.81 ± 0.283 [c]	4.61 ± 0.47 [d]	4.67
3.	Boneprot (50 %) + Seasol	5.51 ± 0.651 [ab]	5.58 ± 0.560 [ab]	5.09 ± 0.23 [b]	5.41
4.	Lumbrical (opt.)	5.15 ± 0.562 [abc]	5.03 ± 0.494 [c]	4.73 ± 0.39 [cd]	4.97
5.	Lumbrical (50%) + Seasol	5.46 ± 0.820 [ab]	5.12 ± 0.630 [bc]	5.04 ± 0.46 [bc]	5.21

* Values not sharing a common superscript (a, b, c, d) differ significantly (Duncan's Multiple Range Test).

Discussion

The summarised results for the three - year study period provide grounds to conclude that the combined application of biofertiliser Seasol on Lumbrical basic fertilisation had a stimulating effect resulted in an increase of standard yield, yield features and pericarp thickness, in comparison to the results after a single application of basic fertilisation.

The present research is in conjunction with other research findings (Atiyeh et al., 2001; Vermany, 2007) that shows *combined fertilisation* of biofertilisers provides an opportunity for plants to receive a balanced feeding (distribution of the nutritional substances) during the vegetation, thus supporting better pepper productivity (the number of formed fruits). It was indicated by the high standard yield, the higher number of fruits and a larger fruit mass in comparison with the untreated plants (control). The research also confirms the findings of Cabanillas et al. (2006), who stated that biofertilisers increase the mass and the number of the fruits. Szafirowska & Elkner (2008) point out the reports of Clark et al.

(1999) with respect to their success in high tomato yielding from organic production owing to compost application.

The results from investigation on pepper standard yield showed an increase in treated compared to non- treated (control) plants. Such result can be attributed to the influence of additional nutrients of applied biofertilisers as well as to combined effect of agro-technical methods and agro-meteorological conditions in the region. During the course of investigation, it was shown that agroecological conditions of the region of the city of Plovdiv are favourable for growing pepper, which combined with the biofertilisation, the agro-technical measures and the preventive and timely biological plant protection provides stimulating environment for developing the biological potential of pepper under organic farming.

Because biofertilisation is a major factor for optimal growth and sustainable yields, the amounts and the forms of macronutrients (i.e. N, P, K) in biofertilisers is of a major importance. The comparison (Table 1) showed that the organic nitrogen and phosphorus (P_2O_5) are of a highest content in the biofertiliser Boneprot. As the addition of nitrogen is directly connected with the increase of the vegetative mass, the supply of high levels of P_2O_5 influences the level of pepper fruitfulness, i.e. a higher number of fruits per plant and overall standard yield. The relatively high amounts of total nitrogen in the biofertiliser Lumbrical also had a positive effect on the pepper vegetative growth.

The superior combinations of biofertilisers, i.e. Boneprot plus Seasol, and Lumbrical plus Seasol, may also be applied on other large-size-fruit peppers, i.e. ssp. macrocarpum, e.g. type Ratund - var. *ratundum*, type Dolma - var. *dolma*, and type Conoid - var. *conoides*, as well as on other crops of the *Solanaceae* Family (e.g. tomatoes and eggplant). Fertiliser doses should be applied in conjunction with the specific requirements of the crops.

Conclusions

In modern agro-ecosystems that use environment-friendly technologies, there is an increasing demand for research based on holistic investigations and examining the effect of systematically-connected agro-ecological factors with the purpose of obtaining optimum production at a lower ecological risk for the environment. This research tried to use such a holistic approach.

The results of the present study regarding the scale of impact of selected biofertilisers on the yield of pepper cv. ‘Kurtovska kapiya 1619’, showed that under organic farming the combination of biofertiliser Seasol as an addition to the biofertiliser Lumbrical as a basic fertiliser had a favourable effect which resulted in an increase of the standard yield and pericarp thickness, in comparison to growth after a single application of basic fertilisation. The present research established that the combined fertilisation provided more balanced distribution of the nutritional substances for the plants during vegetation (i.e. at the pepper growing stages of flower buds and mass fruit-set). It was indicated by the higher standard yield, the higher number of fruits and a larger fruit mass. In parallel, the combined biofertilisation might have introduced sufficient quantity of nutritional substances to the soil without accumulation of toxic compounds to the entire phytocenoses, including soils and underground waters.

The above conclusions provide grounds for recommending this combination for fertilisation schemes of pepper cultivated under organic agriculture conditions.

The research also found that the biofertilisers used in the experiment had a positive effect on the biochemical parameters of pepper fruits produced under the conditions of organic agriculture. The application of the biofertiliser Seasol on both basic fertilisations (Boneprot and Lumbrical) had a positive effect on the vitamin C content in the pepper fruits (Vlahova & Popov, 2013).

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Development of organic indica rice cultivar (*Oryza sativa* L.) for the wetlands of Kerala, India through new concepts and strategies of crop improvement

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Abstract

Developing crop varieties that are less dependent on the heavy application of synthetic fertilizers is essential for the sustainability of agriculture. Here we report the development of a new rice cultivar, the first of its kind possessing the general criteria for an organic rice variety, at the same time suitable for chemical agriculture as well, and with favourable cooking and nutritive qualities. The method adopted for cultivar development was a combined strategy of pedigree breeding, organic plant breeding, and farmer participatory breeding approaches. Considering its high grain and straw yield potential even under organic management and unfavorable soil conditions, and its other favorable quality and organic varietal traits, farmers have started large scale cultivation of this cultivar even before its commercial release. The cultivar, namely culture MK 157, is at the pipe end of variety release in the Kerala state of India.

Keywords: Organic farming, organic plant breeding, organic rice, sustainable agriculture, participatory plant breeding.

Introduction

A ecological aim for the present era is fostering an evergreen revolution focusing upon organic farming for health as well as for environment protection. Organic farming systems aim at resilience and buffering capacity in the farm eco-system, by stimulating internal self regulation through functional agro-biodiversity in and above the soil, instead of external regulation through chemical protectors (Bueren et al., 2002). As organic farming management and environments are fundamentally different from chemical, organic farmers need specific varieties that are adapted to their lower input farming system and can perform higher yield stability than conventional varieties (Bueren et al., 2002). Many breeding programs took yield potential as the primary target. However, with the increasing living standards and the improvements in cooking, the eating and appearance quality of the rice grain has become a priority (Zhang, 2007.) For further optimization of organic product quality and yield stability, new varieties are required that are adapted to organic farming systems (Bueren et al., 2002).

In the current agricultural scenario, varieties having traits amenable for organic farming (organic varieties) are the missing link in the organic production chain. As organic agriculture is at its development stage, it is currently reliant on conventionally bred

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varieties developed for farming systems in which artificial fertilizers and agro-chemicals are widely used. Further, most of the current new varieties are derived from a limited number of parental lines and are thus genetically related to each other. Broadening the genetic basis becomes important when we want to search for adaptation to organic farming.

It is an advantage of breeding within organic systems to be able to select for individual traits like weed tolerance, nutrient use efficiency, and field resistance against pests and diseases, as well as interactions among these traits. In the short and middle long run, the organic market segment can utilize the best available varieties among the existing conventionally bred varieties which can also be propagated organically. But in the long term, breeders can influence further improvement of organic seed production by integrating organic varietal traits in varieties (Bueren et al., 2002).Here we report the development of an organic indica rice variety which is at the pipe end of commercial variety release.

Materials and methods

A combined strategy of pedigree breeding, organic plant breeding (IFOAM, 2002; Bueren 2003) and farmer participatory plant breeding (PPB) approach (Morris & Bellon, 2004) was followed during the entire variety development programme. As available research institutional set ups were not tuned at that time of 2002 to take up organic farming, and fields of research stations were of fertilized by chemical fertilizers, farmers' fields being maintained under organic management were selected as the experiment site for raising all filial generations, initial and preliminary yield trials. In the hybridization program one of the parents of crosses effected was two land races namely, 'Kuthiru' and 'Orkayama' for a broader genetic basis as a source for adaptation ability (Heyden & Bueren, 2000) and which are adapted to a unique organic saline prone ecosystem of Kerala, India called, 'Kaipad' (Vanaja & Mammootty, 2010). Further, these land races have good cooking and nutritive qualities ,and resistance to major pests and diseases in the field condition. Two other parents included in the breeding programme were the varieties, 'Jaya' and 'Mahsuri' which are usually cultivated by farmers under low input conditions.

Hybridization between these four parents in all possible combinations under organic conditions was carried out. Out of all possible cross combinations between the four rice varieties/ land races, F_1 seeds were obtained only from six cross combinations. In organic agriculture, as the variety has to expect a large plant x environment x management interaction under the lower (organic) input conditions, the most efficient way is to select progenies from the filial generations, under organic farming conditions, as early in the selection process as possible (Bueren et al., 2002; Jongerden et al., 2002). Hence, 6292 F_2 progenies obtained from the six cross combinations were raised in farmers' fields under organic management.

Seventy four promising F_2 progenies were selected out based on yield, lodging resistance, plant stature, and other subjective traits. Single plant pedigree selection was followed in the F_2 generation. In the succeeding filial generations, only those progenies responding well to organic management were carried forward to initial and preliminary yield trials. Separate comparative yield trials for organic and chemical management practices were conducted to select out the genotype which performs best under both managements. Close farmer–researcher collaboration was ensured to produce more benefits than the traditional global breeding for easy and early adoption of the cultivar by the end user. The design used for replicated trial was a randomised block design (RBD) with three replications for preliminary yield trials (PYTs) and four replications for comparative yield trials (CYTs). As organic farmers prefer yield stability to higher yield, Multi location/ Farm trials under organic management were carried out for several seasons and locations.

Since organic farming demands higher quality, detailed cooking quality and nutritive quality analyses were also conducted. As crop health has to be given due consideration in the case of variety developed for organic agriculture, pest and disease screening was started parallel to the initial yield trials itself. Initially, absolute screening for pests and diseases was conducted for 12 cultures which were evaluated in the initial yield trials under organic management. Those cultures which showed better biotic stress tolerance, yield performance and belong to different parental combinations were carried forward to further yield trials under both organic and conventional managements. Once again screening for biotic stresses was done to select out the best culture which shows better tolerance for biotic stresses, at the same time stable yielding under both management practices. Standard evaluation system for rice was used for evaluating and description of cultures, and for scoring pest and disease incidence (IRRI 1988).

Results and discussion

Grain yield

The average grain yield data of 12 cultures in Initial yield trials (IYTs), preliminary yield trials (PYTs) and comparative yield trials (CYTs) along with their parentage are presented in Table 1.All the cultures evaluated under IYTs and PYTs were subjected to biotic stress screening. Those high yielding cultures which showed better biotic stress tolerance and belong to different parental combinations were carried forward to comparative yield trials under both organic and conventional managements. Accordingly, cultures MK 157, JK 14 and JK 59 were carried forward to CYTs. The culture MK 157 which showed the highest yield in CYTs under both managements was carried forward to multi location or on- farm trials. The result of multi location/ farm trials conducted in various districts of Kerala under both organic and conventional managements are presented in table 2. The culture MK157 showed the highest grain yield under both organic and conventional managements along with very high straw yield. Higher yield of both grain (18%) and straw yield were seen under conventional management than under organic management. Twenty to thirty percentage yield reduction have been reported in the case of winter and spring wheat in the Netherlands under organic farming (Spiertz,1989, Mader et al., 2002), and in legumes (Seufert et al., 2012) .Yields in organic agriculture can be 20% lower due to a lower nitrogen input and no split application of nitrogen, and in some cases due to pests and diseases (Mader et al., 2002). Further, in organic agriculture yield should be expressed in economic return instead of Kg/ha which is for organic farmers the optimal combination of grain production and the premium price for high grain quality (Bueren & Osman, 2002). Organic farmers prefer yield stability to higher yields. They need a reliable variety which can cope up with the fluctuations in weather conditions and disease pressure without large fluctuations of yield and quality of both grain and straw. Organic farmers aim to optimize yield while satisfying the conditions of organic production, and natural principles and methods are applied (Bueren et al., 2002).

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Table 1. Parentage and grain yield of different cultures in IETs, PYTs and CYTs.

Name of culture/ variety*	Parentage	IET (t ha^{-1}) Organic management	PYT (t ha^{-1}) Organic management	CYT (t ha^{-1})	
				Organic management	Conventional management
MK 157	Mahsuri x Kuthiru**	9.0	6.5	6.0	5.8
MK 129	- do-	6.0	4.3	-	-
MK 121	- do-	5.5	3.9	-	-
MK 134	- do-	5.5	3.7	-	-
MK 130	- do-	4.9	4.2	-	-
MK 125	- do-	4.0	3.6	-	-
MK 132	- do-	3.9	4.5	-	-
MK 136	- do-	4.0	3.9	-	-
JK 14	Jaya x Kuthiru	5.0	5.5	4.0	1.2
JK 59	- do-	2.8	4.8	3.7	1.6
JK 28	- do-	3.9	3.7	-	-
JO 74	Jaya x Orkayama**	2.5	5.3	-	-
Jyothy		-	2.0	-	-
Mahsuri		-	2.1	-	-
Athira		-	-	5.5	2.4
Uma		-	-	3.9	1.7
Varsha		-	-	4.7	2.1
CD(0.01)		-	0.89	1.20	1.54

* Cultures are organically bred & varieties are conventionally bred;
** Land races of a naturally organic ecosystem;
IET= Initial yield trial (wet and dry seasons 2006);
PYT = Preliminary Yield Trial (wet and dry seasons 2007);
CYT = Comparative Yield Trial (dry season 2009 and wet season 2010).

Table 2. Grain and straw yield of culture MK 157 in multi location/farm trials.

Culture/ variety*	Pooled grain yield and straw yield in parenthesis under organic management[1] (t ha^{-1})	Pooled grain yield and straw yield in parenthesis under conventional management [2] (t ha^{-1})
Culture MK 157	4.9 (8.4)	5.8 (11.7)
Check variety-Jyothy	2.1 (1.9)	3.1 (2.9)
Check variety- Uma	3.3 (4.3)	3.6 (5.6)
Check variety- Athira	2.8 (2.6)	3.5 (3.5)

* Culture is organically bred, variety is conventionally bred.
[1] Pooled over seven seasons at eight locations.
[2] Pooled over four seasons at five locations.

With crop cultivars bred within and adapted to the distinctive conditions inherent in organic systems, organic agriculture will be better able to realize its full potential as a high yielding alternative to conventional agriculture (Spiertz, 1989). In farm trials, the average yield and the potential yield exhibited by the culture under organic management was 4.9 t/ha (Table 2) and 6.6 t/ha, respectively. The ‘potential yield’ reported here is the maximum yield recorded across the seven seasons and eight locations. Conventionally bred different check varieties were used in on-farm trials (OFTs) depending upon the popularity of the variety in that locality. The average grain yield of culture MK 157 in farm trials under organic and conventional managements was 48% and 61% more than the highest yielding check variety, respectively. The result of initial yield trials, comparative yield trials and farm trials from different farmers field shows that, the yield performance of conventionally bred varieties used in this experiment widely varies with seasons and locations under organic management and conventional management unlike the organically bred culture MK 157 which shows a stable yield irrespective of season and location under both managements.

The fact that all organically bred cultures need not perform well under conventional management is also evidenced from the result of comparative yield trials. Hence, the strategy followed may be, among the organically bred hybrid derivatives, that selection should be done for those progenies responding equally well for both managements in order to have a wider use to satisfy both organic and conventional farmers. This result reiterates the opinion of Bueren et al.(2002) that organically bred varieties in the future will benefit not only organic farming systems, but also for conventional systems moving away from high inputs in nutrients and chemical pesticides. The average straw yield of culture MK 157 in farm trails was 95% and 109% more than the best check variety under organic management and conventional management respectively.

The results of comparative yield trials (Table 1) and farm trials (Table 2) using chemical fertilizers indicate that the culture is also suited for conventional systems moving away from high inputs of nutrients and chemical pesticides, which is the added advantage of this new organically bred culture as organic agriculture is only in the development stage in the state of Kerala, India.

Cooking quality

In the sensory evaluation, culture MK 157 out ranked the popularly consumed conventionally bred variety ‘Jyothy’ of Kerala, for all the parameters tested (Table 3). The taste and acceptability of cooked rice were confirmed through an organoleptic test conducted by a team involving farmers, consumer representatives, millers, extension officials and scientists. The milling recovery of the culture in the commercial mill was 74.4% with 62% head rice recovery. Similarly, it was characterized by good cooking qualities (Table 4) having higher volume expansion (68%), water uptake (270%), and kernel elongation (33%) than the check variety ‘Jyothy’ (Table 4). In addition to the excellent cooking qualities, which are very much appreciated by farmers who did OFTs, they also certified that it is very good for making ‘temple prasadam’ and ‘Payasam’ (sweet gruel). Farmers who did OFTs replaced their regular rice varieties with culture MK 157 for consumption.

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Table 3. Sensory evaluation score of culture MK 157 in comparison with the popularly consumed conventionally bred variety 'Jyothy'.

Name of culture/ variety	Taste(score out of 10)	Flavor (score out of 10)	Stickiness	Appearance (score out of 10)	Over all performance (score out of 10)
MK 157	6.73	5.0	Non sticky	6.9	6.6
Jyothy	6.70	4.9	Non sticky	6.5	6.3

Nutritional quality

The culture has comparatively very good nutritive qualities (Table 4),having 121.8% higher iron, 33.3% more protein, 33.6% more calcium, and 22.4% more potassium content than 'Jyothy' variety, which may be a combined effect of inheritance from its male parent 'Kuthiru' which is a land race, and may be due to organic breeding and management practices. Similar case of enhanced quality traits was experienced by Heyden & Bueren (2003) in their organic breeding program of cabbage, and Kunz & Karutz (1991) in organic wheat breeding.

Table 4. Cooking and nutritive qualities of culture MK 157.

Cooking /Nutritive qualities	Culture MK 157	Jyothy*
Cooking qualities Volume expansion	4.0	2.4
Kernel elongation ratio	1.6	1.2
Water uptake	2.11	0.57
Alkali spreading value	4.0	4.0
Amylose content	25.7	25.7
Shape of milled rice	Bold	Medium
Nutritive qualities Protein (% by wt.)	0.4	0.3
Total sugar (% by wt)	0.6	0.6
Total fat(% by wt)	2.4	1.7
Total carbohydrate (% by wt.)	83.9	82.2
Starch (% by wt.)	26.1	24.8
Phosphorus as P(mg/100g)	195	240
Crude fiber (% by wt.)	10.2	10.9
Iron (mg /Kg)	165	74.4
Zinc (mg/Kg)	24	32.7
Potassium (mg/Kg)	10130	8279
Calcium(mg/Kg)	183	137
Magnesium(mg/Kg)	733	754

* Popularly consumed conventionally bred variety in Kerala.

Pest resistance

In all experiment fields of the culture MK 157, there was field resistance for most of the pests. The mean score for pests and diseases when evaluated for absolute resistance is presented in Table 5.The culture MK 157 showed resistance to leaf folder and case worm, moderate resistance to gall midge, whorl maggot, sheath blight, brown spot, but was susceptible to blast. The resistance might have transferred from the male parent, 'Kuthiru', and the blast susceptibility might have inherited from its female parent 'Mahsuri'. Swer et al. (2011) reported significant positive correlation between fungal populations and organic carbon in a maize–french bean organic trial. That there was no root disease or pest attack in any of the experiment or farm trials is consistent with the report of Bruggen (1995) that in organic crop production, root disease and pests are generally less of a problem than foliar diseases, because foliar disease development is much more determined by climatic factors.

One of the central tenets of organic farming is to improve soil health and productivity by increasing soil carbon levels, particularly humus and such practices can increase water use efficiency (Leu, 2009). The consequences of losses due to pests and diseases in organic farming systems differ considerably depending on region, crop, and farm structure. In the case of wheat, Tamis & Brink (1999) reported that the disease pressure in organic wheat production is in most years lower than in conventional systems, but in some years the disease pressure can be larger than in conventional systems.

Table 5. Reaction of culture MK 157 to important pests and diseases when screened for absolute resistance.

Culture/ Variety	Gall midge (% SS)		Leaf folder (% DL)		Whorl maggot (% DL)		Case worm (% DL)		Score (0-9 SES scale)			
	30 DAT	50 DAT	30 DAT	50 DAT	30 DAT	50 DAT	30 DAT	50 DAT	Sheath blight	Brown spot	BLB	Blast
MK 157	0	12.2	0.80	0.88	16.4	4.0	4.0	3.5	1.7	1.7	3.7	4.0
Jyothy	0	5.26	1.66	8.84	18.9	11.2	7.8	2.7	5.0	4.0	5.0	5.7

Note: DAT = Days After Planting; SS = Silver Shoots, DL = Dead Leaves; BLB = Bacterial Leaf Blight; SES: Standard Evaluation System; < 10% infection = resistant, 10 -30% infection = moderately resistant, >30% infection = susceptible, Score 1 = resistant, Score 2 & 3 = moderately resistant.

The height of seedlings of the culture is short, making transplantation an easy process including transplanting by machine, but two months after transplanting the height of the seedlings increases suddenly and forms a thick canopy over the soil. The dense crop canopy influenced by its canopy architecture of long and broad leaves, leaf stiffness and leaf shape, and its robust nature with large number of tillers improves the crop's ability to compete with weeds. The weed suppressive ability of varieties can contribute to the self regulation principle of the organic farming system. Organic farmers require varieties that have a rapid juvenile growth with a good tillering ability and the ability to cover or shade the soil in an early stage of crop development to outcompete weeds for light. It was also observed that the culture comes up well in those wetlands which are shaded at the border due to conversion of paddy land for other plantation crops or for construction purposes. The culture is characterized by a long stay green index of the upper leaves, expressing the ability to use all available nutrients and light efficiently which is an important criterion for organic varieties (Bueren & Osman, 2002).The plant architecture of culture MK 157 with its taller erect leaf canopy and drooping panicles is of a more productive type in terms of photosynthesis (Yuan, 2001).

In the fields of MK 157 under organic management, the crop was seen to resist lodging, but in some conventionally managed trials the crop is seen partially lodged. A similar case has been reported in the case of wheat (Tammis & Brink,1999). In the organic farming fields of the culture MK 157, there was immense growth of micro-organisms on the soil which satisfies the organic varietal characteristic to interact with beneficial soil micro-organisms. During the 2010 wet season, in Arayidam padasekharam of Kannur district, Kerala which has been an organic farming tract for several years and one of our farm trial fields, we raised culture MK 157 along with a conventionally bred rice variety. The bad weather conditions during this period adversely affected the conventionally bred variety but culture MK 157 remained unaffected. Similarly in an iron-toxic field, when a conventionally bred high yielding variety showed reduced root growth and thereby yield reduction, the culture showed healthy roots and better yield. In a farmer's field which was left uncultivable due to secondary salinization, this culture showed better production. Hence, the culture satisfies the criteria of being a 'reliable variety' for organic farming (Bueren et al., 2002).

A comparative study of yield component traits of conventionally bred varieties and the newly developed organically bred culture, under organic and conventional management revealed that, in the case of cultures developed through organic plant breeding, the difference in measurement of traits under organic and conventional management is comparatively less. But in the case of varieties developed through conventional breeding, there is much difference in measurement of traits under organic and conventional managements with high value for conventional management (Data not given).

The other favourable traits of the culture certified by farmers are: less chemical fertilizer required for conventionally managed crop, and excess fertilizer causes deleterious effect; less chaff production; high germination percentage; possible for ratoon crop; parboiling time 20 minutes less than other varieties; and lightly scented at the time of flowering and seedling. As the major part of the experiment was conducted in farmers' fields adopting participatory plant breeding, the farmers expressed favourable views of the yield potential, quality, and suitability of the culture to organic agricultural practices in wet land conditions. Due to its yield potential, and considering its good cooking quality and taste, there is a demand from farmers for the seeds. Farmers very well accepted the newly developed rice culture for large scale cultivation under the control of scientists before its commercial release, and at present the culture is in the pipe end of variety release in the Kerala state of India.

Salient characteristics of the organic rice cultivar

Culture MK 157 is a high yielding, photo insensitive, rice cultivar giving high yield under both organic and conventional management regimes, and is resistant to leaf folder and case worm, moderately resistant to gall midge, whorl maggot, sheath blight and brown spot. It exhibits increased rooting density leading to adaptation to organic soil fertility management (low input), and also adverse soil conditions. However, it responds very well to chemical fertilizers also. The short seedling height of the culture becomes suddenly tall two months after transplanting and forms a thick canopy over the soil which suppresses weed growth. The plant is tolerant to lodging with robust plant architecture (Figure 1a), there is a large number of strong sturdy culm with average height of 119cm, the long and broad leaves, with a nice and vibrating leaf canopy and drooping panicles, offer a favourable architecture against pest attack, and the cultivar has a comparatively high straw content. MK 157 has long, compact panicles with a large number of comparatively small grains with lemma and palea colour - gold furrows on straw back ground (Figures 1b & 1c), and attractive bold white kernel which can be very specifically distinguished from other varieties (Figures 1d & 1 e). Other favorable traits of this organic rice culture are, long stay green index of upper leaves even at harvest stage with attractive plant stature, tolerant to shade in the wetland, and it is lightly scented at the time of seedling and flowering stages.

(a) (b)

(d) (e)

Fig 1. Characteristic features of culture MK 157

(a) Crop in farmer's field having robust plant architecture with taller stem and erect leaf canopy (b) Long, compact panicles with large number of comparatively small grains with long stay green index of upper leaves even at the time of harvest (c) Small grains with lemma and palea colour- gold furrows on straw back ground which can be very specifically distinguished from other varieties (d) &(e) Attractive bold parboiled and raw rice with appealing appearance.

Conclusion

Culture MK 157 is the first organic wetland rice cultivar suitable for both organic farming and conventional farming, developed through the combined plant breeding strategies of pedigree breeding, organic plant breeding and participatory plant breeding. It possesses the general criteria for desirable variety characteristics for organic farming systems. It is a medium duration cultivar (125-130 days for wet and 115-120 days for dry seasons) having high grain and straw yield and yield stability, with tall plant stature during wet seasons and medium tall stature during dry seasons, comparatively very good cooking and nutritive qualities than the popularly consumed conventionally bred variety of Kerala.

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Effect of poultry manure and plant population on productivity of fluted pumpkin (*Telfaiaria occidentalis* Hook F.) in Calabar, Nigeria

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Abstract

Field experiments were conducted during the 2010-2011 cropping season at the Crop Science Research Farm of the University of Calabar, Nigeria (04o 57' N and 08o 18' E; 37 meters above mean sea level) to investigate the effect of poultry manure application (0, 6, 12 and 24 t ha-1) and plant population densities (10,000, 20,000 and 40,000 plants ha-1) on leaf productivity of fluted pumpkin (*Telfaiaria occidentalis* Hook F), a vine grown as a leaf vegetable in west Africa. The experimental design was a 3× 4 factorial in a randomised complete block design replicated four times. Results indicated significant (P = 0.05) increase in vine length, leaf proliferation, fresh leaf weight/plant and dry matter production. Longest vines with 256 cm length, bearing 181 leaves/plant, with highest fresh leaf weight of 5,435 kg ha^{-1} and correspondingly highest dry matter yield of 183.5 kg ha^{-1}, were obtained by applying poultry manure at 24 t ha^{-1} to 20,000 plants ha^{-1}. This indicates that the application of poultry manure at 24 t ha^{-1} and a plant population density of 20,000 plants ha^{-1} in fluted pumpkin (*Telfaiaria occidentalis* Hook F) seems optimal and leads to increased vegetative growth and leaf productivity of fluted pumpkin in the Calabar area of Cross River State, Nigeria. Overall, crop management adopting the optimal poultry manure application and the optimal plant population density can boost fluted pumpkin productivity for poverty reduction and improved livelihood of resource poor farmers in Nigeria and comparable socio-agro-economic environments in Sub-Saharan African countries.

Keywords: Fluted pumpkin, poultry manure, organic fertiliser, organic farming, plant population, leaf weight, leaf productivity, Calabar, Nigeria, Sub-Saharan Africa, Africa.

Introduction

There are growing concerns about the long-term agricultural sustainability and meeting global food needs with the global population projected to exceed 7.5 billion by the year 2020 and 9.2 billion by 2050 (Ghrun et al., 2000). The main challenge facing many Sub-Saharan African countries, including Nigeria, is how to increase agricultural production to meet the food and fibre requirement of the growing population without further damage to the already fragile/degraded ecosystems (Henao & Baanante, 2006). Soil quality is of fundamental importance in agricultural production and soil fertility management has become a key issue in food security, poverty reduction and environmental management.

Soils in Sub-Saharan Africa are inherently infertile and characteristically low in soil organic matter content. and cannot support intensive cultivation due to the rapid rate of fertility decline under intensive cultivation (Shiyam et al., 2007). Over the years, traditional farmers have ignorantly resorted to the indiscriminate application of inorganic inputs as a strategy to raise farm yields without consideration of the environment. The sole use of

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inorganic fertilizers is often not a viable option of soil fertility management as it may lead to yield gain in the short term but usually it is uneconomical to the resource-poor farmers and does not sustain good yields in the long term. The prolonged abuse of synthetic fertilizers is hazardous to human health, soil productivity, water quality, aquatic life and environmental safety. The adoption of corrective and sustainable cropping practices such as organic farming is desirable to achieve increased agricultural productivity and to solve some problems associated with an over-reliance on external inputs by small scale farmers. Organic agriculture is a low-input sustainable agricultural production management system that promotes the environmentally, socially and economically sound production of food, fibre, timber etc (IFOAM, 2008). Farming organically helps to prevent environmental degradation and can be effectively employed to regenerate degraded land. Organic soil management is guided by the philosophy of 'feed the soil to feed the plant' to achieve the goal of increased food production, food security and safety, economic development, resource conservation, ecological balance, and environmental protection (Henao & Baanante, 2006; Gaskell et al., 2007). Increased soil organic matter makes nutrients more available to the crops, buffers and neutralizes soil pH, improves soil structure, raises soil biological activities, enhances water infiltration and retention, and decreases soil erosion (Brian, 2005).

A traditional source of soil organic matter and primary nutrients for vegetable crops has been animal manures. Poultry farming is also gaining ground in Nigeria and vegetable growers are now frequently using poultry manure as a source of plant nutrition to vegetables, but there are no evidence-based crop-wise recommendations on the optimum poultry manure application. On the other hand, planting of inappropriate plant densities in fluted pumpkin is also common among commercial vegetable farmers who may erroneously believe that high plant populations can increase crop yield indefinitely. Optimum plant population depends primarily on the morphology of the crop while the right quantity of organic resources is determined by the nature of the soil and its fertility status, as well as the source and nutrient composition of the material used and the type of crop grown. The present study aimed at assessing the optimum poultry manure application rate and appropriate plant population density for enhancing the productivity of a vine grown in western Africa as a leaf vegetable, fluted pumpkin (*Telfaiaria occidentalis* Hook F), in a sandy Ultisol soil in the Calabar region of Nigeria.

Materials and Methods

The experimental site was at the Crop Teaching and Research Farm of the University of Calabar, Nigeria (04^{o} 57'N latitude & 08^{o} 18'E longitude; 37 metres altitude above mean sea level). The rainfall in the area is bimodally distributed with the highest peak in July and the lesser peak in September, sandwiched with a short dry spell in August, usually referred to as the 'August Break'. The rainfall commences in March/April and terminates in October/November. Total annual rainfall is about 2500–3000 mm with maximum and minimum temperatures of 30^{o} C and 23^{o} C, respectively; while the relative humidity is about 70–80% throughout the year.

The field was previously under intercropping with cassava, maize, melon and water leaf (*Talinium triangulare* L.) and fluted pumpkin (*Telfaiaria occidentalis* Hook F.). Surface soil (0–15 cm depth) samples collected randomly were bulked into a composite sample, air-dried and crushed to pass through a 2 mm sieve. Particle size distribution was determined by the hydrometer method (Bouyoucos, 1962) and the soil pH (soil:H2O) was

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determined in 0.01M $CaCl_2$. Soil organic carbon and the total N were evaluated by the Walkey & Black (1963) method and the micro-Kjeldahl digestion method (Bremmer & Mulvaney, 1982), respectively. Available P was extracted by the method of Bray and Kurtz (1945), while exchangeable bases (Ca, Mg, K and Na) contents were extracted with neutral 1M NH_4OAc at a soil solution ratio of 1:10 and measured by flame photometry. Magnesium was determined with an atomic absorption spectrophotometer (AAS). Exchange acidity was determined by titration of IM KCl extract against 0.05M NaOH using phenolphthalein as indicator (McLean, 1982). The nutrient profile of the poultry manure used was also analyzed using the relevant procedures.

The land was cleared and tilled flat manually using a spade and demarcated into unit plots measuring 2.0 m × 3.0 m (6.0 m_2). Four poultry manure rates (0, 6, 12 and 24 t/ha) combined with three plant populations (10,000, 20,000 and 40,000 plants/ha) of fluted pumpkin (*Telfaiaria occidentalis* Hook F.) were investigated in a randomized complete block design replicated four times. Seeds were planted at 1.0 m × 1.0 m spacing at 1 seed/hole, 1.0 m × 1.0 m spacing at 2 seeds/hole, and 0.5 m × 0.5 m spacing at 1 seed/ hole to achieve 10,000, 20,000 and 40,000 plants/ha, respectively.

Field planting was done during the early or main planting season, on 5th April, 2010 and 9th April, 2011. Cured poultry manure was incorporated into the soil during tilling for rapid decomposition and nutrient release to the crop. All plots were fertilized with urea at 80 kg N/ha in two equal splits i.e. at four weeks after planting and four weeks later. Data collected on vine length, leaf number/per plant, fresh leaf weight and dry matter yield were analysed statistically using analysis of variance (ANOVA) technique (Wahua, 1999). Means were tested using the least significant difference (LSD) at 5% level of probability.

Results and Discussion

The physico-chemical properties of the pre-sowing and post-harvest soil at the experimental site and the nutrient content of the poultry manure used are presented in Table 1. The result showed that the soil is a sandy clay, highly acidic and very low in organic C, total N, and exchangeable bases, but contained moderate P, indicating low fertility status. The poultry manure contained high amounts of plant nutrients indicating that maize being a heavy feeder would benefit from application of the fertilizer.

Table 1. Physico-chemical properties of the pre- and post-cropping soil and nutrient content of the poultry manure fertilizer.

Parameter	**Values**		
	Pre-cropping	Post-cropping	Poultry manure
pH (1:H_2O)	4.9	5.2	6.5
Org.C (%)	1.16	1.19	40.3
Total N (%)	0.09	1.02	7.1
Basic Cations (cmolkg^{-1})			
Ca	1.0	1.3	4.8
Mg	0.6	0.3	3.0
K	0.8	0.2	0.17
Na	0.2	0.8	1.0
ECEC	6.45	2.13	19.2
Base Saturation (%)	45	51	43
Particle Size Analysis (%)			
Sand	80.0	80.0	-
Silt	7.7	7.8	-
Clay	12.3	12.2	-

Fluted pumpkin vine length responded positively to the application of poultry manure at all plant populations (Table 2). Vine growth increased with increasing rates of poultry manure with highest magnitude in plots fertilized with poultry manure at 24 t ha^{-1} and least in non-manure plots. With the application of poultry manure at 24 t ha^{-1}, the longest vine length was exhibited in plots with a plant population density of 40,000 plants/ha, followed by those planted at 20,000 plants/ha. At other levels of poultry manure, vine length was longest at a plant population density of 20,000 plants/ha, followed by 40,000 plants/ha and least in 10,000 plants/ha. Enhanced vine growth was obtained at the plant population density of 20,000 plants/ha across all levels of poultry manure with significantly ($p = 0.05$) longest vines produced by applying poultry manure at 24 t ha^{-1} (Table 1).

Table 2. Influence of poultry manure rates and plant populations on vegetative growth and yield of fluted pumpkin (*Telfaiaria occidentalis* Hook F).

	Poultry Manure Rates (t/ha)			
Plant Population	0	6	12	24
	VINE LENGTH (cm)			
10,000	173	214	230	265
20,000	176	257	268	288
40,000	192	214	258	258
Mean	180	228	238	270
LSD (0.05) A	Ns	Ns	Ns	Ns
B	9.9	9.9	9.9	9.9
A x B	Ns	Ns	Ns	Ns
	LEAVES/PLANT			
10,000	30	64	84	89
20,000	42	88	106	144
40,000	38	54	86	96
Mean	40	69	92	107
LSD (0.05) A	5.6	4.0	4.0	4.0
B	6.5	4.7	4.7	4.7
A x B	6.5	4.7	4.7	4.7
	FRESH LEAF YIELD (kg/ha)			
10,000	202.3	251.0	337.1	372.8
20,000	269.3	414.4	658.0	734.1
40,000	199.2	316.2	489.2	579.2
Mean				
LSD (0.05) A	5.5	7.2	56.6	65.2
B	6.4	8.3	68.4	72.4
A x B	6.4	7.9	64.4	83.0
	DRY MATTER YIELD (kg/ha)			
10,000	66	75	102	107
20,000	64	113	193	210
40,000	93	96	131	142
Mean	75	95	143	157
LSD (0.05) A	5.5	5.6	5.6	5.6
B	6.4	6.4	6.4	6.4
A x B	6.4	6.4	6.4	6.4

Leaf production followed a similar trend with vine elongation and increased with increasing rates of poultry manure applied with more leaves produced in a plant population density of 20,000 plants/ha across all poultry manure levels. The highest leaf

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production was obtained by applying poultry manure at 24 t ha^{-1}, followed by poultry manure at 12 and 6 t ha^{-1} and least in the non-manured plots. Leaf production increased by 46, 64, and 102 leaves/plant corresponding to 110%, 152% and 243% increase in plots treated with poultry manure at 6, 12 and 24 t ha^{-1}, respectively. Enhanced vine growth and leaf production obtained by fertilizing 20,000 plants/ ha with poultry manure at 24 t ha^{-1} might indicate availability of balanced plant nutrients and optimum plant population and obvious favourable growing conditions. Increased leaf production in okra attributed to beneficial effect of poultry manure has been reported (Umoetok et al., 2007).

Fresh leaf yield varied significantly ($p = 0.05$) in all treatment combinations and increased with increasing poultry manure rates, and was highest at 24 t ha^{-1} of poultry manure in all plant populations. Like vine length and number of leaves per plant, fresh leaf yield was higher in the plant population density of 20,000 plants/ha, than in other plant populations at the corresponding poultry manure rates. In this plant population, fresh leaf yield was significantly highest in plots applied with poultry manure at 24 t ha^{-1} and lowest in the zero input plots. Across plant populations, fresh leaf production increased from plant population density of 10,000 plants/ha up to 20,000 plants/ha, and declined as the plant population density was increased to 40,000 plants/ha.

The dry matter (DM) yield was also enhanced by the application of poultry manure at 24 t ha^{-1} across all plant populations. Highest DM was obtained in the population density of 20,000 plants/ha, followed by 40,000 plants/ha, and least in 10,000 plants/ha, representing an increase of 108 and 68 kg/ha in DM yield by increasing the plant population from 10,000 to 20,000 and 40,000 plants/ha, respectively. Across the poultry manure levels, DM yield in plant population density of 20,000 plants/ha increased by 69, 129 and 146 kg/ha by raising the quantity of poultry manure to 6, 12 and 24 t/ha, respectively.

The positive interaction effect of poultry manure and plant population on vegetative growth and DM production occurred at all levels of the organic nutrient application and in all plant populations (Table 3). The most beneficial effect of the poultry manure on foliage production and DM yield was obtained by incorporating the manure at 24 t ha^{-1} in plots containing 20,000 plants/ha. Leaf production and DM increased by increasing the plant population from 10,000 plants/ha to 20,000 plants/ha, and declined across all poultry manure levels when raising the plant population to 40,000 plants/ha. Sub-optimal plant density might account for poor productivity of the crop in plant populations lower than 20,000 plants/ha, while the suppressed yield obtained in the plant density of 40,000 plants/ha could be attributed to the adverse effects of over-crowding and competition for space, light, plant nutrients, and water; while optimum plant density might have resulted in reduced competition leading to increased shoot and root parameters, and enhanced photosynthesis efficiency besides better source–sink relationships (Choudhary & Suri, 2013). The decline of crop yields in the traditional farming systems has been attributed largely to soil-related constraints (Aihou et al., 1988, Juo, et al., 1995) and highly variable plant densities including inappropriate cropping practices. Balanced fertilization of soils through synchronized supply of adequate nutrients to growing crops as well as soil organic matter enrichment with long-term usage are major gains realized through the application of organic resources.

Table 3. Interaction effect of plant population and poultry manure on dry matter yield (kg/ha) at 10 weeks after planting.

	Poultry Manure (kg/ha)				
Plant Population Density	0	6	12	24	Mean
10,000	12.1	15.3	20.8	27.1	18.8
20,000	12.1	29.5	40.9	51.7	33.5
40,000	16.2	20.6	37.2	45.8	29.9
Mean	13.5	21.8	32.9	41.5	
LSD (0.05)	6.4	7.8	6.8	2.8	

Conclusion

Poultry manure improved the vegetative growth and dry matter production of fluted pumpkin (*Telfaiaria occidentalis* Hook F) . The application of poultry manure at 24 t ha^{-1} and a plant population density of 20,000 plants ha^{-1} were observed as the optimum agronomic interventions to harness the highest foliage production and dry matter yield, and to thereby boost fluted pumpkin productivity for poverty reduction and improved livelihood for resource poor farmers in Nigeria and comparable socio-agro-economic environments in Sub-Saharan African countries.

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Economics of organic versus chemical farming for three crops in Andhra Pradesh, India

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Abstract

To tackle the challenge of food grain production and food security, chemical agriculture advocates call for the continuing or higher use of chemical fertilizers and synthetic pesticides. However, the continuous use and higher reliance on these inputs can lead to a reduction in crop productivity, deterioration in the quality of natural resources and the eco-system. Organic farming offers a solution for sustainable agricultural growth and safeguarding the ecosystem. A conversion from chemical farming to organic farming can be a lengthy process, and during its course the farmer may incur a loss in income. The farmer will switch over only when he is convinced that in the long run, the benefits from organic farming are more than from chemical farming. A study of the economics of organic versus chemical farming may help policy makers to take appropriate measures for the spread of organic farming, which in turn has a bearing on the incomes of farmers, health conditions of the people and the environment. The present study compared the economics of organic farmers (N=350) and chemical farmers (N=200) for three crops, paddy, redgram, and groundnuts, in the state of Andhra Pradesh, a south eastern coastal state of India. It was found that organic farmers are earning a gross income of 5%, 10% and 7% more compared to the chemical farmers of paddy, redgram and groundnut, respectively, and with lower input costs the profits earned by the organic farmers are higher by 37%, 33% and 59% for the selected crops respectively. Organic farming is generally more profitable in terms of financial costs and returns than chemical farming, irrespective of the crop or the size of farm (the exceptions being small redgram farms and large goundnut farms). An analysis of the farmers' perception of organic farming reveals that electronic media (television) is the prime motivator for farmers to adopt organic practices. Farmers believed that organic farming improves soil fertility and their profits in the long run.

Keywords: Organic farming, conventional farming, organic agriculture, organic certification, eco-system, sustainable agriculture, paddy, redgram, groundnuts.

Introduction

Agriculture is the backbone of the Indian economy and India ranks second worldwide in farm output (CIA, 2012). Agriculture and allied sectors including forestry and logging accounted for 16% of the Gross Domestic Product (GDP) in 2010, employed 52% of the total workforce and despite a steady decline of its share in the GDP, it is still the largest economic sector and plays a significant role in the overall socio-economic development of India. To tackle the problem of food grains production, the Indian government has launched several programmes and of them, the Green Revolution of the mid 1960s has been regarded as the most successful. However, although the so called Green Revolution resolved some issues of food production, it made most of the Indian farmers dependent on chemical fertilizers and pesticides, and has degraded soil fertility and the environment.

The negative consequences of the higher use of chemical fertilisers and pesticides include a reduction in crop productivity and deterioration in the quality of natural resources (Pretty & Ball, 2001). Some studies have pointed out that the environment will be effected by the carbon emissions of the agricultural system as agriculture releases about 10-12% of the total green house gas emissions which is accounted for as about 5.1 to 6.1 Gt CO2 (Cole et al., 1997; Joshi, 2010).

A response to the uptake of agricultural chemicals, has been the search for ways to move beyond the problem of heavy usage of chemical fertilizers and pesticides. Organic farming is a proposed remedy to the problem of chemical input dependency and also for achieving the sustainability of the agricultural sector in the long run. Organic agriculture also has the potential to reduce the emission of greenhouse gases by crop management agronomic practices. Nitrogen application rates in organic farming are reportedly 62-70% lower than chemical agriculture (Kramer et al. 2006). Further, it is reported that yields of crops grown under organic farming system are comparable to those under a conventional system and greenhouse gasses emissions from organic farming are 36% lower than a chemical system of crop production (Nemecek et al., 2005).

The area certified under organic crops in India has grown from 1,711 hectares to 1,180,000 ha. during the decade 2001-2011, a 68,900% increase, and only Uruguay showed a faster uptake over this period (Paull, 2011). However the proportion of the area under organic crops is only 0.6% of the total agricultural land (Willer, Lernoud & Kilcher, 2013). The growing demand for organic agricultural products in the advanced countries paves the way for developing economies to grow their export market for organic agricultural products. By international standards, conversion of a chemical farm into an organic farm will take three years and during the first two years, the farmer may incur a loss in farming production (Wyss, 2004). In this context, a study of the economics of organic farming as compared to chemical farming may throw light on the problems in the spread of organic farming. The main objective of this study is to analyse the cost of and returns from organic farming vis-à-vis chemical farming practices in the Indian context.

Review of Literature

Charyulu & Biswas (2010) in a study of four states in India (Gujarat, Maharashtra, Punjab and Uttar Pradesh) concluded that the unit cost of production is lower in organic farming in the cases of cotton and sugarcane (compared to chemical farming), whereas it is higher for paddy and wheat. Acs et al., (2006) have developed a dynamic linear programming model to analyse the effects of different limiting factors on the conversion of chemical to organic farming process of farms over time. The modelling developed for a typical arable farm in the Netherlands central clay region, is based on two static linear programming models (conventional and organic), with an objective to maximise the net present value over a 10-year planning horizon. The results reported are that organic farming is more profitable than chemical farming. Raj et al. (2005) concluded that the profitability of organic cotton was significantly higher than that of chemical cotton, the major contributing factor being reduced expenditure on pest control management (PCM).

Prasad (2005) in an account of organic farming vis-à-vis modern agriculture in the Indian context stated that during 2003 organic farming was practiced only on 4800 ha in India. This has resulted in earning Rs. (Rupees) 89 crores of foreign earnings through exports and the study also pointed out that Indian exports of organic products constitute only 0.8% of the global organic produce market (Prasad, 2005). However, India is now a world leader in organic agriculture, following the recent uptake of organic agriculture, and is now number five in the world on the basis of certified organic hectares (Paull, 2011).

Methodology and Sample Design

This study is based on primary data collected from farmers. The sample households were selected by using a multi-stage stratified random sampling technique. The State of Andhra Pradesh is the study area and three major crops, one each from cereals, pulses and oilseeds viz., paddy, redgram and groundnut, have been selected based on the proportion of area under organic farming. Among the 23 districts of Andhra Pradesh, the districts of East Godavari, Mahabubnagar and Anantapur have been selected as they are predominantly cultivating the selected crops under organic farming. In the second stage 250 paddy cultivating households comprising 150 organic farmer households and 100 chemical (sometimes called ‘conventional’) farmer households have been selected from East Godavari District. From Mahabubnagar District, 150 redgram cultivating households comprising 100 organic farmer households and 50 chemical farmer households have been selected. From Anantapur District 150 Groundnut cultivating households comprising 100 organic farmer households and 50 chemical farmer households have been selected (Table 1). The selection of sampling units in each district for each crop is based on the stratified random sampling technique. A pre-tested schedule has been canvassed among the selected sample holdings to elicit information on the cost of cultivation and returns etc. The reference year of the study is 2010-11.

Table 1: Distribution of Sample Households by Crop, Farm size and Farming Practice.

Organic Farmers				
Crop	Small	Medium	Large	All Farms
Paddy	55 (36.67%)	66 (44.00)	29 (19.33)	150 (100.00)
Redgram	38 (38.00%)	34 (34.00)	28 (28.00)	100 (100.00)
Groundnut	35 (35.00%)	41 (41.00)	24 (24.00)	100 (100.00)
Total	128 (36.57%)	141 (40.29)	81 (23.14)	350 (100.00)
Chemical Farmers				
Paddy	39 (39.00%)	36 (36.00)	25 (25.00)	100 (100.00)
Redgram	14 (28.00%)	25 (50.00)	11 (22.00)	50 (100.00)
Groundnut	16 (32.00%)	22 (44.00)	12 (24.00)	50 (100.00)
Total	69 (34.50%)	83 (41.50)	48 (24.00)	200 (100.00)

Note: Figures in parentheses indicate percentages to totals.

Concepts used in the Study

Small Farms: Farms with the size up to 5.0 acres have been treated as Small Farms.

Medium Farms: Farms with the size from 5.01 to 10.00 acres have been treated as Medium Farms.

Large Farms: Farms with the size above 10.01 acres have been treated as Large Farms.

Concepts of Cost of Cultivation

Cost A_1: Cost A_1 includes:

- Value of hired human labour
- Value of owned and hired bullock labour
- Value of owned and hired machine labour
- Value of owned and purchased seed
- Value of owned and purchased manures
- Value of fertilisers and pesticides
- Depreciation on farm implements, farm buildings etc.
- Irrigation charges
- Interest on working capital
- Land revenue, cess (local government taxes, e.g. water) and other taxes paid, and
- Other miscellaneous expenses.

Cost A_2: Cost A_1 + Rent paid for the leased-in land.

Cost B_1: Cost A_1 + Interest on the value of owned capital assets (excluding land).

Cost B_2: Cost A_1 + Rent paid for the leased-in land + Rental value of the owned land (net of land revenue).

Cost C_1: Cost B_1 + Imputed value of family labour.

Cost C_2: Cost B_2 + Imputed value of family labour.

Concepts of Income

Gross Income: Synonymous with value of output (both main and by products).

Farm Business Income: Gross Income – Cost A_2

Family Labour Income: Gross Income – Cost B_2

Net Income: Gross Income – Cost C_2

Farm Investment Income: Net Income + Rental value of own land + interest on owned fixed capital.

The standard concepts of costs and returns from farming as used in the Farm Management Studies (FMS) sponsored by the Directorate of Economics and Statistics, Ministry of Agriculture (Government of India, 2010), have been adopted in the present study, and the results are analysed and the perceptions of farmers on various issues relating to organic farming are presented.

Cost of Cultivation

The cost of pesticides, which constitute a major share in the total costs for Indian farmers, may be negligible for organic farming compared to chemical farming, since organic pesticides may be homemade for Indian farmers and prepared with locally available herbs. As a result, the organic farmers can potentially achieve higher returns compared to their counterparts. In addition, chemical fertilisers are not supposed to be used in the case of organic farming and this exclusion can result in further input savings. Though some other studies treated farm yard manure (FYM) as a component of chemical fertilisers, the present study considered FYM as organic fertiliser. Except for this minor difference, costs of remaining components that are necessary for calculating various cost concepts as per the Farm Management Studies (FMS) are used in the present study.

For studying the intensity of resource-use pattern, the total cost i.e. Cost C_2 has been adopted. Cost C_2 is considered as the total cost and it includes the expenditure incurred on all the paid-out costs including seed, hired human labour, bullock labour (owned and hired), machine labour (owned and hired), farm yard manure (owned and purchased), chemical fertilizers, pesticides, irrigation charges, rent paid on leased-in land, etc., and imputed costs including depreciation on farm capital assets, interest on working capital, interest on farm fixed capital, rental value of owned land, and the imputed value of family labour etc.

Resource Use Pattern

To ascertain the relative importance of different inputs in the cost structure, an item-wise breakup of the total cost is computed. The details for organic and chemical holdings on the basis of per acre for different size groups of farms are presented in Table 2.

The total cost per acre on organic farm holdings of the three selected crops viz., paddy, redgram and groundnut worked out to be Rs.21,549/-, Rs.7,717/- and Rs.17,903/- respectively, whereas on chemical holdings these values are Rs.23,989/-, Rs.8,468/- and Rs.21,349/- which clearly showed that the cost of cultivation for chemical holdings is higher by 11%, 10% and 19%, respectively, compared to organic farming households for the three selected crops (Table 2).

Among the various inputs, hired human labour, machine labour, farmyard manure, pesticides, seed and bullock labour appeared to be predominant in the cost structure for both organic and chemical farms, for all the three selected crops (Table 2).

In the case of organic paddy farms, apart from the imputed costs, the proportion of expenditure incurred on human labour accounts for about 32% of the total cost (Table 2). This is followed by the proportion of expenditure incurred on organic fertiliser (10%), machine labour (8%), pesticide (2%), seed (2%) etc. A similar pattern with minor variations in the proportions could be observed among different size groups of farms. It could be also observed that the proportion of expenditure on human labour to total cost has exhibited a direct relationship with farm size.

As far as the cost structure of the organic redgram farms is concerned, again the expenditure on human labour appeared to be predominant (30%) and this is followed by organic fertiliser (14%), pesticides (8%), bullock labour (7%), machine labour (3%) and seed (2%) (Table 3).

With regard to organic groundnut farms, the expenditure on human labour constitutes about 38% of the total cost and it is followed by seed (12%), bullock labour (8%), organic fertiliser (7%), pesticides (6%) and machine labour (2%) (Table 4).

On the other hand, in the case of chemical farms, of the three selected crops, the proportion of expenditure to total cost incurred on human labour is the highest, viz. 28%, 29% and 34% for paddy, redgram and groundnut respectively (Tables 1, 2 and 3).

With regard to the other components of the total cost for chemical paddy farms, the expenditure on human labour is followed by machine labour (8%), fertilisers (6%), pesticides (2%), seed (2%) and farm yard manure (2%). With regard to the conventional redgram farms, the expenditure on human labour is followed by fertiliser (11%), pesticides (7%), bullock labour (6%), machine labour (3%) and seed (2%).

With regard to the chemical groundnut farms, the expenditure on human labour is followed by pesticides (12%), seed (11%), bullock labour (7%), fertiliser (5%) and machine labour (4%).

Table 2: Cost of Cultivation of Paddy

(Value In Rupees (Rs.))

Farm Resources	Organic				Chemical			
	Small	Medium	Large	All Farms	Small	Medium	Large	All Farms
Human Labor	6030 (27.08%)	5958 (28.68)	8029 (36.41)	6870 (31.88)	7931 (30.07)	6561 (26.85)	6617 (28.88)	6812 (28.40)
Bullock Labour	385 (1.73%)	32 (0.16)	125 (0.57)	124 (0.58)	478 (1.81)	70 (0.29)	128 (0.56)	166 (0.69)
Machine Labour	1577 (7.08%)	1883 (9.06)	1646 (7.47)	1735 (8.05)	1920 (7.28)	1874 (7.67)	1910 (8.34)	1900 (7.92)
Seed	455 (2.04%)	476 (2.29)	452 (2.05)	462 (2.15)	587 (2.22)	509 (2.08)	518 (2.26)	526 (2.19)
Organic Fertilisers/ Fertilisers	2250 (10.11%)	2213 (10.65)	2058 (9.33)	2151 (9.98)	1813 (6.88)	1774 (7.26)	1792 (7.82)	1790 (7.46)
Organic Pesticides/ Pesticides	466 (2.09%)	537 (2.58)	407 (1.85)	470 (2.18)	836 (3.17)	683 (2.80)	393 (1.72)	563 (2.35)
Others	476 (2.14%)	546 (2.63)	345 (1.56)	448 (2.08)	624 (2.37)	668 (2.74)	310 (1.35)	482 (2.01)
Interest on working capital	728 (3.27%)	255 (1.23)	245 (1.11)	320 (1.49)	887 (3.36)	759 (3.11)	729 (3.18)	765 (3.19)
Depreciation	624 (2.80%)	308 (1.48)	249 (1.13)	329 (1.53)	680 (2.58)	687 (2.81)	697 (3.04)	691 (2.88)
Rent Paid on Leased-in land	0 (0.00%)	0 (0.00)	0 (0.00)	0 (0.00)	689 (2.61)	1905 (7.80)	749 (3.27)	1129 (4.70)
Interest on Fixed Capital	1301 (5.84%)	626 (3.01)	742 (3.37)	775 (3.60)	1304 (4.94)	443 (1.81)	779 (3.40)	751 (3.13)
Rental Value of Owned Land	7500 (33.68%)	7500 (36.10)	7500 (34.01)	7500 (34.80)	8000 (30.33)	8000 (32.74)	8000 (34.91)	8000 (33.35)
Imputed Value of Family Labour	477 (2.14%)	439 (2.11)	251 (1.14)	363 (1.68)	625 (2.37)	499 (2.04)	291 (1.27)	415 (1.73)
Total	22270 (100%)	20773 (100%)	22051 (100%)	21549 (100%)	26373 (100%)	24432 (100%)	22914 (100%)	23989 (100%)

Source: Primary survey. Note: Figures in parenthesis denote percentage.

Table 3: Cost of Cultivation of Redgram

(Value In Rupees (Rs.))

Farm Resources	Organic				Chemical			
	Small	Medium	Large	All Farms	Small	Medium	Large	All Farms
Human Labor	2106 (29.73%)	2468 (31.65)	2348 (29.96)	2350 (30.45)	2360 (28.61)	2475 (28.88)	2397 (28.47)	2429 (28.68)
Bullock Labour	447 (6.31%)	524 (6.72)	545 (6.95)	524 (6.80)	496 (6.01)	525 (6.13)	527 (6.25)	522 (6.17)
Machine Labour	199 (2.80%)	233 (2.99)	242 (3.09)	233 (3.02)	221 (2.68)	233 (2.72)	234 (2.78)	232 (2.74)
Seed	119 (1.68%)	140 (1.79)	145 (1.85)	140 (1.81)	133 (1.62)	140 (1.64)	139 (1.65)	139 (1.64)
Organic Fertilisers/ Fertilisers	894 (12.62%)	1048 (13.44)	1090 (13.91)	1049 (13.59)	1187 (14.39)	1428 (16.66)	1165 (13.83)	1291 (15.23)
Organic Pesticides/ Pesticides	497 (7.01%)	582 (7.46)	606 (7.73)	583 (7.55)	554 (6.71)	584 (6.81)	585 (6.95)	581 (6.86)
Others	447 (6.31%)	524 (6.72)	545 (6.95)	524 (6.80)	496 (6.01)	525 (6.13)	527 (6.25)	522 (6.17)
Interest on working capital	294 (4.15%)	345 (4.42)	345 (4.40)	338 (4.38)	340 (4.13)	369 (4.31)	348 (4.14)	357 (4.22)
Depreciation	170 (2.39%)	228 (2.92)	255 (3.25)	234 (3.04)	230 (2.78)	240 (2.80)	242 (2.88)	240 (2.83)
Rent Paid on Leased-in land	0 (0.00%)	0 (0.00)	0 (0.00)	0 (0.00)	249 (3.02)	347 (4.05)	525 (6.23)	408 (4.82)
Interest on Fixed Capital	364 (5.14%)	108 (1.39)	102 (1.30)	142 (1.84)	391 (4.74)	102 (1.19)	130 (1.55)	149 (1.76)
Rental Value of Owned Land	1250 (17.64%)	1250 (16.03)	1250 (15.95)	1250 (16.20)	1250 (15.15)	1250 (14.59)	1250 (14.85)	1250 (14.76)
Imputed Value of Family Labour	298 (4.21%)	349 (4.48)	363 (4.64)	350 (4.53)	342 (4.14)	350 (4.09)	351 (4.17)	350 (4.13)
Total	7086 (100%)	7798 (100%)	7837 (100%)	7717 (100%)	8249 (100%)	8569 (100%)	8419 (100%)	8468 (100%)

Source: Primary survey. Note: Figures in parenthesis denote percentage.

Table 4: Cost of Cultivation of Groundnut

(Value In Rupees (Rs.))

Farm Resources	Organic				Chemical			
	Small	Medium	Large	All Farms	Small	Medium	Large	All Farms
Human Labour	8006 (37.22%)	7251 (37.02)	6021 (37.80)	6699 (37.42)	7111 (33.8)	6993 (34.41)	7620 (34.24)	7314 (34.26)
Bullock Labour	1786 (8.30%)	1617 (8.26)	1343 (8.43)	1494 (8.35)	1333 (6.34)	1311 (6.45)	1429 (6.42)	1371 (6.42)
Machine Labour	431 (2.00%)	390 (1.99)	324 (2.04)	361 (2.01)	815 (3.87)	801 (3.94)	873 (3.92)	838 (3.93)
Seed	2648 (12.31%)	2398 (12.24)	1992 (12.50)	2216 (12.38)	2321 (11.03)	2282 (11.23)	2487 (11.18)	2387 (11.18)
Organic Fertilisers/ Fertilisers	1540 (7.16%)	1394 (7.12)	1158 (7.27)	1288 (7.20)	1385 (6.58)	1362 (6.70)	1484 (6.67)	1424 (6.67)
Organic Pesticides/ Pesticides	1386 (6.44%)	1255 (6.41)	1042 (6.54)	1159 (6.48)	2548 (12.11)	2506 (12.33)	2731 (12.27)	2621 (12.28)
Others	1176 (5.47%)	1065 (5.44)	885 (5.55)	984 (5.50)	1111 (5.28)	1093 (5.38)	1191 (5.35)	1143 (5.35)
Interest on working capital	1061 (4.93%)	961 (4.90)	798 (5.01)	888 (4.96)	1039 (4.94)	1022 (5.03)	1113 (5.00)	1069 (5.01)
Depreciation	575 (2.67%)	526 (2.68)	528 (3.31)	533 (2.98)	389 (1.85)	589 (2.90)	741 (3.33)	642 (3.00)

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Rent Paid on Leased-in land	0 (0.00%)	0 (0.00)	0 (0.00)	0 (0.00)	161 (0.77)	259 (1.28)	290 (1.31)	264 (1.23)
Interest on Fixed Capital	1164 (5.41%)	1060 (5.41)	282 (1.77)	662 (3.70)	987 (4.69)	279 (1.37)	393 (1.77)	414 (1.94)
Rental Value of Owned Land	1000 (4.65%)	1000 (5.11)	1000 (6.28)	1000 (5.59)	1000 (4.75)	1000 (4.92)	1000 (4.49)	1000 (4.68)
Imputed Value of Family Labour	739 (3.44%)	669 (3.42)	556 (3.49)	618 (3.45)	840 (3.99)	826 (4.06)	900 (4.04)	863 (4.04)
Total	21513 (100%)	19587 (100%)	15927 (100%)	17903 (100%)	21041 (100%)	20323 (100%)	22253 (100%)	21349 (100%)

Source: Primary survey. Note: Figures in parenthesis denote percentage.

The figures reveal that the proportion of expenditure on organic fertilisers is higher for organic paddy farms when compared with the expenditure on fertilisers on chemical paddy farms. However, the total cost per acre on organic farms is lower than that on chemical farms due to the lower expenditure on other inputs. A similar picture with slight variations in proportions can be observed with regard to the redgram and groundnut producers (Tables 2, 3, 4).

Returns from Farming

The per acre returns from cultivation in both categories of farms are analysed by calculating the following concepts of returns: gross returns, farm business income, family labour income, farm investment income, and net income. The details for the selected three crops, viz. paddy, groundnut and redgram, are presented in Table 5.

Gross Income

Gross income per acre for all organic (paddy, redgram and groundnut) farmers is Rs. 30,221/-, Rs.13646/- and Rs.26335/- respectively and for chemicall farmers it is Rs. 28,717/-, Rs.12387/- and Rs.24626/- respectively, which indicates that the organic farmers are earning 5%, 10% and 7% more income compared to the chemical farmers of paddy, redgram and groundnut. Except for the large farmers of groundnut and the small farmers of redgram, all the other groups of farmers from the organic category are earning more income per acre compared to their counterparts in the chemical category. Gross income per farm is also higher for the organic category farms compared to the chemical category farms. The size group wise analysis also shows the same picture though with slight variations in the amounts. It can be concluded that the gross income per acre is generally greater for the organic category irrespective of the farm size or the crop - the exceptions being the small redgram and the large groundnut farms (Table 5).

Farm Business Income

Farm business income represents returns to the farmer’s land, family labour, fixed capital and management. It is calculated by deducting the Cost A_1 or A_2, as the case may be, from the gross returns. Table 5 reveals that the farm business income per acre for organic farms is Rs.16568/-, Rs.7671/- and Rs.10713/- for the three selected crops respectively and it is 16%, 26% and 48% higher than the chemical farm holdings. The size group wise analysis exhibits similar picture with slight variation in percentages except the small farmers of redgram. The small farmers of organic redgram are getting lesser farm business income compared with the other groups of farmers and with other crops of farms also (Table 5).

Table 5: Different Types of Returns of Cultivation Per Acre for Three Crops

(Value In Rupees (Rs.))

	Organic					Chemical				
Farm Size	Gross Returns	Farm Business Income	Family Labour Income	Farm Investment Income	Net Income	Gross Returns	Farm Business Income	Family Labour Income	Farm Investment Income	Net Income
	Paddy					Paddy				
Small	28818	16128	8628	16952	8151	28733	12288	4288	12966	3663
Medium	30502	18342	10842	18342	10403	29252	13761	5761	13705	5262
Large	30424	16693	9193	17184	8942	28353	14509	6509	14997	6218
All farms	30221	16568	9068	16981	8706	28717	13895	5895	14231	5480
	Redgram					Redgram				
Small	12721	7548	6298	7614	6000	13905	7639	6389	7689	6047
Medium	13494	7403	6153	7403	5804	12013	5146	3896	4897	3545
Large	13971	7850	6600	7589	6237	12360	5672	4422	5451	4071
All farms	13646	7671	6421	7463	6071	12387	5667	4417	5466	4067
	Groundnut					Groundnut				
Small	31022	12413	11413	12838	10674	24000	5785	4785	5932	3945
Medium	27454	10597	9597	10597	8928	24102	5884	4884	5337	4058
Large	24460	10369	9369	10095	8813	25194	5234	4234	4728	3334
All farms	26335	10713	9713	10757	9095	24626	5554	4554	5105	3691

Family Labour Income

Family labour income gives the return to the family labour and management of the crop enterprise, which is arrived at by deducting Cost B_2 from gross returns. Table 5 reveals that the family labour income per acre is positive for both the organic and chemical farmers and registered as Rs.9,068/-, Rs.6,421/- and Rs.9,713/- for the selected three organic crops respectively, and Rs.5,895/-, Rs.4,417/- and Rs.4,554/- for the selected three chemical crops. Family labour income for all size groups of farmers of the selected crops was greater for the organic farmers (with the exception of the small redgram farms) (Table 5).

Farm Investment Income

Farm investment income represents income retained with the farmer for their investment and it comprises the rental value of own land, interest on own fixed capital, and returns to the management.

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The farm investment income per acre for organic farmers is reported as Rs.16,981/-, Rs. 7,463/- and Rs.10,757/- for the three selected crops respectively, while it is Rs.14,231/-, Rs.5,466/- and Rs.5,105/- respectively for chemical category farmers, which reveals that organic farmers in the study area are getting 16%, 27% and 53% higher farm investment incomes compared to their counterparts. The farm investment income for all the size-groups and for all the three crops is higher for the organic category (except for the small redgram farms) (Table 5).

Net Income

Net income indicates the profit or loss from farm business. It is the residual of gross income after deducting total cost viz., Cost C_2 from it. Table 5 reveals that the farmers of all size groups of the selected crops under both organic and chemical category are achieving profits, but the profits earned by the organic farmers are higher by 37%, 33% and 59% for the selected crops respectively. A similar picture can be seen for the different size groups of farms except for the small farmers of redgram, where the organic farms are achieving less net income per acre.

The farm net income for all the size-groups and for all the three crops is higher for the organic category (except for the small redgram farms) (Table 5).

Perceptions of Organic Farmers

The analysis of costs and returns of organic farming vis-à-vis chemical farming indicates that the organic farmers are accruing higher income compared to the chemical farmers. An attempt is made to analyse the experiences and perceptions of organic farmers to elicit information on the perceived advantages or otherwise of organic farming, by whom they were motivated to adopt organic farming, and the impact of organic farming on environment etc.

Experience

Eighteen percent of the sample of organic farmers have been practicing organic farming since 2001 with the rest being more recent adopters. All of the selected organic farmers have passed the conversion period of three years for organic farming (Table 6).

Table 6: Experience in Organic Farming

Adoption	≤2001	2002	2003	2004	2005	Total
Paddy	32 (21.33%)	33 (22.00)	24 (16.00)	36 (24.00)	25 (16.67)	150 (100%)
Redgram	17 (17.00%)	19 (19.00)	25 (25.00)	26 (26.00)	13 (13.00)	100 (100%)
Groundnut	13 (13.00%)	18 (18.00)	22 (22.00)	31 (31.00)	16 (16.00)	100 (100%)
All Crops	62 (17.72%)	70 (20.00)	71 (20.28)	93 (26.58)	54 (15.42)	350 (100%)

Table 7: Motivation for Adopting Organic Farming

Motivation	Extension Worker	Fellow Farmer	Village Leader	Village Co-operative	Print Media	Electronic Media	Total
Paddy	24 (16.00%)	21 (14.00)	29 (19.33)	12 (8.00)	28 (18.66)	36 (24.00)	150 (100%)
Redgram	16 (16.00%)	9 (9.00)	11 (11.00)	29 (29.00)	13 (13.00)	22 (22.00)	100 (100%)
Groundnut	12 (12.00%)	14 (14.00)	13 (13.00)	26 (26.00)	18 (18.00)	17 (17.00)	100 (100%)
All Crops	52 (14.86%)	44 (12.57)	53 (15.14)	67 (19.14)	59 (16.86)	75 (21.43)	350 (100%)

Table 8: Advantages from Organic Farming

Advantage	Increases the Soil Fertility	Lower Cost of Production	Good for Health	Yield is Constant Higher	Total
Paddy	45 (30.00%)	49 (32.67)	35 (23.33)	21 (14.00)	150 (100%)
Redgram	33 (33.00%)	46 (46.00)	4 (4.00)	17 (17.00)	100 (100%)
Groundnut	41 (41.00%)	35 (35.00)	15 (15.00)	9 (9.00)	100 (100%)
All Crops	119 (34.00%)	130 (37.14)	54 (15.43)	47 (13.43)	350 (100%)

Source: Primary Survey. Note: Figures in parenthesis denotes percentage.

Motivation

Electronic media has more impact on the switching over to organic farming than other sources of agency, with 21% of farmers nominating this agency, followed by village cooperative (19%), print media (17%), village leaders (15%), Agricultural Extension workers (15%), and fellow farmers (13%) (Table 7). Electronic media for these farmers means predominantly television programmes, such as agricultural programmes including Annadata, Ryutumitra, and Gramadarshini (Telugu Daily Programmes between 6.30 to 7.00 am).

Advantages

The sample farmers of the study area based on their experience in organic farming reported advantages of organic farming which are consistent with the results of previous studies. Around 34% of them reported that the fertility of soil is being increased because of organic farming. Around 37% of them reported that the cost of cultivation has come down (due to non-usage of synthetic fertilisers and pesticides). Further around 15% of them reported that the organic produce is good for health, while another 13% of them have reported that they are getting higher and regular returns from organic farming (Table 8).

Certification

It is disappointing to note that out of the selected organic farmers none has obtained certification, although all have been practicing organic farming since 2005 or earlier. Most of the farmers expressed that they are not planning on getting certification for their

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organic produce. The reasons as expressed are, it is highly expensive (66%), followed by lack of information on the certification process (27%) and small size of farm holdings (7%) (Table 9).

Table 9: Reasons for not getting Certification for Organic Produce

Reason	Highly expensive	Lack of sufficient information	Small size of farm	Total
Paddy	95 (63.33%)	45 (30.00%)	10 (6.67%)	150 (100%)
Redgram	71 (71.00%)	23 (23.00%)	6 (6.00%)	100 (100%)
Groundnut	65 (65.00%)	28 (28.00%)	7 (7.00%)	100 (100%)
All Farms	231 (66.00%)	96 (27.42%)	23 (6.58%)	350 (100%)

Table 10: Problems of Farmers in Organic Farming

Problem	Marketing the produce	Difficulty in getting certification	Lack of government support
Paddy	143 (95.33%)	150 (100%)	150 (100%)
Redgram	92 (92.00%)	100 (100%)	100 (100%)
Groundnut	97 (97.00%)	100 (100%)	100 (100%)
All Farms	332 (94.85%)	350 (100%)	350 (100%)

Table 11: Farmers Suggestions for Spread of Organic Farming

Suggestion	Subsidies of organic inputs	Govt. support for certification and marketing	Department of agriculture for technical support
Paddy	140 (93.34%)	150 (100%)	150 (100%)
Redgram	85 (85.00%)	100 (100%)	100 (100%)
Groundnut	89 (89.00%)	100 (100%)	100 (100%)
All Farms	314 (89.71%)	350 (100%)	350 (100%)

Source: Primary Survey.

Problems

When information was elicited as to the other problems almost all respondents reported that they have been facing problems in marketing their produce as their product lacks certification. All of them reported difficulties in certification (Table 10).

Suggestions by Farmers

Suggestions as made by the sample farmers to encourage organic farming are presented in Table 11. All the sample farmers opined that organic farming will spread, if the government. provides subsidies on organic inputs and support for getting certification and marketing the produce. In addition, they suggested that any technical support from the department of agricultural will also be quite helpful for them. As a whole, the farmers felt that it is in the hands of government to encourage organic farming on a wider scale.

Conclusions

Overall, the study found that organic farming is more profitable for farmers, in terms of costs and returns, than chemical farming. However, the variation in profits is smaller for small farmers of redgram and large farmers of groundnut. This improved profitability of organic farmers in the present study is despite the fact that these farmers (N=350) are not reaping a premium price for their produce since they are not certified organic and their produce is sold undifferentiated in the market, that is, it is sold without labelling and at 'normal' prices. An analysis of the farmers' perception of organic farming reveals that electronic media (mostly television agricultural programmes presented in the local language) is the prime motivator for them to adopt this method and all the organic farmers in the sample have been practicing this method for over six years. Organic farmers believed that organic farming improves soil fertility and their profits in the long run. They expressed the view that the certification process is very difficult and expensive. Certification would allow them to potentially sell their produce at a premium price. Organic farmers indicated that government support services are needed for marketing their produce through special markets and that targeted support services and awareness programmes would be welcomed.

Policy Suggestions

There is a role for governments in motivating farmers to convert to organic farming. Some of the suggestions for expansion of organic farming are:

- Creation of separate 'green channels' for marketing of organic foods.
- Announcement of premium prices for organic staple food crops in advance of crop season.
- Creation of demand by more consumer awareness programmes.
- Provision of input/conversion subsidies for encouraging organic growers.
- Investment of more funds on research and development on organic farming.
- Initiation of cheaper and quicker certification processes for organic producers.
- Farmers in the study area reported that they are not getting any assistance either from the Agricultural Department or from other government agencies. As such, the intervention of NGOs is very much needed in this regard.

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Organic food: Exploring purchase frequency to explain consumer behaviour

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Abstract

In order to identify some barriers preventing expansion of the organic food market, this paper reviews current literature on consumers' buying behaviour. This reveals low levels of actual purchasing, yet fails to provide conclusive evidence regarding the reasons. The aim of this paper is to investigate whether an analysis that 'unbundles' the homogenous organic consumer - based on frequency of purchases - could provide insights into the reasons for this. Results from a demographically representative sample who completed an online survey in Australia (N=1011) indicate that consumers vary in their frequency of organic food purchases, from a relatively small proportion who purchase it regularly - around one in ten, to many more who have never purchased it - around one in four. The trend is towards younger consumers, those on above average incomes, and with higher levels of education being more dedicated to purchasing organic food. This includes students and the unemployed with those in full-time employment. There is a lot of 'churn' in the organic food market, with most who trial it – around one in five, stopping after a relatively short period of time – less than one year. For all organic food consumers concern for the natural environment is the most important motivation, followed closely by health, with product quality being of less importance. From the perspective of increasing sales the key challenge appears to be finding ways to convince existing consumers to purchase more organic products. Persuasive and targeted marketing communications will assist in achieving this, however structural issues in the organic industry, such as its massive diversity; in range in products, geographic spread and size of operations, make it hard to present consistent marketing communication messages.

Keywords: organic food, consumer behaviour, purchase frequency, Australia

Introduction

Achieving environmental sustainability for the global food system has been identified as a grand challenge for this century. Research has identified that one of the greatest threats to sustainability is conventional industrial agriculture due to the high energy and material cost it requires to function (Zepeda & Nie, 2012). There is a growing body of research emerging across various disciplines dedicated to finding the most effective ways to reform the food system. One of the most promising alternatives proposed is the production of food using organic methods (Seufert, Ramankutty & Foley, 2012). An increasing number of consumers are expressing their concerns about personal health and the environmental impact by seeking out organically produced food. Over the last 50 years the organic food movement has developed into the most visible brand for a healthier and more environmentally sustainable food system. Although it has increased in

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size and popularity over recent decades, it still retains a marginal market share at around 1% relative to chemically produced products (Willer and Kilcher, 2011).

In many developed countries consumer's 'basket' of food purchases includes a few organic products (Kesse-Guyot et al., 2013). For example, in Australia it has been reported that two out of every three (65%) consumers purchase organic products, however, in a similar fashion to the global situation, the market share of organic products is around 1% (BFA, 2012). That report provides an analysis of the amount of household food spend - with most (58%) rarely purchasing organic food (spending less than 10% of the budget on organic food), some (28%) being occasional (spending 20 to 50%) and only a few (14%) being regular purchasers (spending more than 50%) (BFA, 2012). Hence the amount of organic food in an organic food buyer's diet varies significantly.

A recent article has highlighted limitations of conclusions from research that bundles a 'once in a year' consumer of organic food along with those for whom it is the majority of their diet (Oates et al., 2012). Whilst achieving a 100% organic diet is theoretically possible, in practice it is difficult and extremely rare, and those authors proposed that having 65% or more being organic is a realistic threshold for research investigating dedicated organic food buyers (Oates et al., 2012).

This paper continues by reviewing literature on buying behaviour of organic food consumers in an attempt to explain the relatively low levels of purchases. It then presents empirical evidence that explores whether purchase frequency can provide helpful insights into organic food buyer behaviour.

The contribution from literature on buying behaviour of organic food consumers

Over the last 20 years, a significant body of research focusing on the marketing of organic food has emerged from countries around the globe (Table 1).

Table 1: Selected journal articles investigating marketing of organic food.

Year	Country	Method	Contribution	Author(s)
2012	Australia	Questionnaire N=318	65% organic food is realistic threshold for dedicated consumer	Oates et al.
2012	USA	Questionnaire N=956	Environment and health are important to organic consumers	Zepeda et al.
2011	Global literature	Review of literature	Most consumers switch between organic and conventional	Pearson et al.
2010	China	Questionnaire N=432	Income and trust are important to explaining organic purchases	Yin et al.
2009	Global literature	Review of literature	Values and attitudes of organic consumers vary	Aertsens et al.
2009	Taiwan	Questionnaire N=470	Health and environment are important to organic consumers	Chen
2007	Global literature	Review of literature	Organic consumers are not demographically homogeneous	Hughner et al.

2005	England	Focus groups and interviews N=181	Motive and barriers vary between products for organic consumers	Padel et al.
2002	Greece	Questionnaire N=1612	Profiles 'not aware', 'aware non buyers' and buyers' of organic food	Fotopoulos et al.
2002	England	Focus groups N=28	Animal welfare is important for some organic consumers	Harper et al.
1998	Netherlands	Questionnaire N=271	Health is important to organic consumers	Schifferstein et al.
1995	Ireland	Questionnaire N=2185	Environment and health are important to organic consumers	Davies et al.

The aim of the present study is to contribute to this literature by investigating the extent to which organic food buyers vary according to their purchase frequency and to explore whether this provides insights into explaining low levels of purchasing.

From a marketing perspective, organic food may be conceptualised as a 'new' product. A number of models, most of which are based on the work of cognitive psychologists and behavioural theorists, are available to assist in understanding consumer behaviour in relation to new products. Within marketing, commonly used models are the 'AIDA' (attention–interest–desire–action) (Strong, 1925) and the 'diffusion of innovation' (Rogers, 1962). The AIDA model assumes that purchase behaviour (i.e.. action) will occur once the consumer is exposed to a marketing communication message and develops an interest in the content of the message which grows into a desire to get the product. In contrast, the diffusion of innovation model discusses consumers' product adoption processes and includes five different stages: awareness, interest, evaluation, trial and adoption. The implication for marketing communications that emerge from both of these models is that each distinct phase could be addressed with a targeted and sequential communication message.

The level of awareness amongst all consumers about organic food would appear to be high in many countries. For example, in Australia it has been reported that in excess of 90% of food buyers know that organic food is produced without the use of synthetic chemicals (Pearson, 2001), and the level of consumer awareness is likely to have increased since this research was completed. However, awareness (or attention in the AIDA model previously discussed) alone does not result in purchase, interest and desire must be added before purchase (or action) occurs.

It is possible that the low purchase rates of organic food can be attributed to the relative inadequacy of information available. It has been reported that, for some consumers, a lack of information about organic food acts as a barrier to them purchasing more of it (Harper and Makatouni, 2002; Yin et al., 2010). As a result, a number of studies emphasise the importance of additional marketing communications that aim to popularise organic foods amongst the target consumer groups (Hughner et al., 2007; Latacz–Lohmann and Foster, 1997; Pearson & Henryks, 2008; Pearson et al., 2007).

In order to develop the most effective ways to target marketing communications, a number of theoretical approaches have been used. These different approaches may broadly be classified into demographics, marketing mix variables, product attributes, and values and attitudes.

Consumer demographics is one of the most commonly used analytical tools for investigating organic food purchases (Davies, Titterington & Cochrane, 1995; Fotopoulos & Krystallis, 2002; Padel & Foster, 2005; Thompson, 1998; Wier & Calverley, 2002). These studies provide some evidence that generally wealthy families and 'empty nesters' (being a couple whose children are independent and have left home) tend to the more frequent buyers of organic food. It is suggested that this may be because they have more disposable income (Padel & Foster, 2005). In addition, demographic studies have revealed that women tend to be core buyers of organic food (Davies et al., 1995) although health conscious men are also found to be increasingly interested in organic foods.

Another area of research has investigated organic food purchases from the marketing mix perspective. This approach considers the product, its price, promotion (i.e. using a variety of different marketing communication techniques) and physical distribution. Some of these studies (Pearson & Henryks, 2008; Pearson et al., 2007) have found that the relatively high product prices are important as both a deterrent and an incentive. To some consumers the high price of organic food is indicative of superior quality which is attractive to them, while others are discouraged by higher cost due to priorities set in their budgets.

Other issues revealed by marketing mix studies relate to consumer confusion about which foods are organic and which are not. This is exacerbated by the multiple organic certification organisations many of whom use their own logo or brand on products (Henryks & Pearson, 2010). In addition to identification of the product there is the issue of associations created around the brand or logo. Marketing communications are often used to make emotional appeals in relation to specific product attributes. Such strategies are supported by empirical research, as a number of studies have found that consumers' 'like' of organic food, compared with conventional, increases in the presence of marketing communications providing information on the label about the nutritional information and origin of production (Caporale & Monteleone, 2004; Johansson et al., 1999; Kihlberg et al., 2005; Schutz & Lorenz, 1976). It should be noted that this is not universal across all consumers and all products (Poelman et al., 2008).

The final contribution from the marketing mix approach is that structural issues impact on the consumption of organic food. There is still limited distribution of organic products in some areas, although this is becoming less of an issue as organic products become available in major supermarket chains. The limited range of organic products does, nonetheless, remain an issue. In the long term, political factors such as regulations and government initiated market development activities (Thøgersen, 2010) have been shown to have a major impact on the availability of organic food for consumers.

Product attributes are another theoretical approach that has been used in a number of studies. The results from this area of research have identified that the three most common reasons for purchasing organic foods are, in declining order of importance, seeking healthy food products, concern for the natural environment, and desire for superior food quality (Hughner et al., 2007; Pearson & Henryks, 2008; Shepherd, Magnusson & Sjödén, 2005).

The scientific evidence to support some of these consumer perceptions, such as the superior health claim, is inconclusive (Smith-Spangler et al., 2012). For marketing purposes it is useful to segment consumers who are motivated by perceived health benefits. As such, they have been divided into those who are proactive about their health in contrast to those who are reactive to a negative situation (Pearson et al., 2011). Proactive consumers believe that organic food will have a positive impact upon their wellbeing because it is healthier than conventionally produced food. Conversely, some consumers purchase organic food as a reaction to an adverse health situation, for example, someone who is ill and believes organic food may assist in their recovery.

The desire for high quality, including taste for some products, as a driver of organic food purchases has been found to be less consistent across different products and cultural contexts than health drivers. For example, in the context of Taiwan it has been found that consumers experience of the taste of some organic foods was below the expectations created by conventional products and consequently they considered organic foods as a fraud and inferior (Chen, 2009). In contrast, other research has found that organic foods were perceived to have superior taste for Dutch consumers (Schifferstein & Oude Ophuis, 1998). The reasons for cross–cultural taste discrepancies are explored in several studies (Bourn & Prescott, 2002; Poelman et al., 2008). The primary explanation given for these cultural discrepancies is that different varieties of organic foods and their different growing conditions influence the types of organic food available in different countries. In addition, product freshness and the recipes used could also contribute to different perceptions of taste.

Consumer values and attitudes have also been a theoretical focal point of studies investigating the marketing of organic food. These studies are based on the assumption that the motives for consumer intentions emerge from a small number of relatively stable values, which in turn form attitudes. The linkage between values, attitudes and intentions is constructed through the Theory of Planned Behaviour (TPB), and it derivatives, along the chain of values–attitudes–behaviour. The current literature in this area is inconclusive, with some research finding a positive relationship between values and attitudes that support organic food and purchase intentions (Aertsens et al., 2009; Chen, 2007; Lodorfos & Dennis, 2008; Michaelidou & Hassan, 2008) whilst others did not find this (Chen, 2009; Shepherd et al., 2005; Vermeir & Verbeke, 2008).

A personal value, being a stable construct, is unlikely to shift as a result of any marketing communication messages and may be seen to be one of the antecedents to purchase decisions (Aertsens et al., 2009). The specific personal values (also referred to as attitudes in some of the literature, and in the context of this paper are synonymous with product attributes previously discussed), that have been identified as being important to organic food buyers are those relating to the individual (e.g.. longer life, personal health, satisfaction), family (e.g.. family health and well–being) and society (e.g.. environment, rights of the animal and their welfare) (Makatouni, 2002). Thus, marketing communication that focuses on these values may increase purchases of organic food.

In summary, the literature fails to explain consumers' relatively low levels of organic food purchases. Consumers appear to prefer organic foods for several reasons, such as health and environmental concerns. However, consumers' actual purchases of organic food remain low. This paper continues by providing information using the frequency that

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consumers purchase organic products as a variable to explore differences amongst them.

Methodology

This paper reports the findings from one section of a larger Australian study investigating the role of marketing communications in consumer satisfaction with organic foods. A structured questionnaire was developed and revised by the authors of this paper. This included a pre-test with 12 respondents to assess its suitability, readability, and time taken for completion. The questionnaire was standardized and undisguised for all the respondents.

A pilot study was conducted by a research agency with a sample of 37 subjects. Following discussions between the authors of this paper and representatives of the research agency who were engaged to collect the data, minor adjustments were made. These included decreasing its length to reduce response fatigue (Burchell & Marsh, 1992) as well changing the wording in several questions for greater clarity.

The online survey method was considered most appropriate due to its advantages including access to unique populations and ability to accommodate large sample sizes at relatively low costs in a short amount of time (Wright, 2005). A total of 1011 respondents were recruited by a market research agency to provide a demographically representative sample (in terms of age, gender and geographic location) of the Australian adult population. The only qualifying prerequisite for respondents was that they had to have purchased organic products sometime in the past. Data was collected during November 2012.

Results

The specific areas investigated are organic consumer demographics, length of time they have been purchasing organic products, and rating of organic food attributes that are important to them.

Purchase frequency

The frequency of organic food purchases varies significantly, from a relatively small proportion of consumers (one in ten) who purchase it 'Regularly - at least once per week' to many (one in four) who 'Have never bought' it. In between these extremes there are those who purchase organic food 'Often - around once per fortnight' (one in five), 'Occasionally - around once per month' (one in every three), and those who have 'Stopped buying' it (around one in ten) (Figure 1). Identification of this latter group – that is those who have stopped buying – is a contribution to the literature and offers an area for further research to gain understanding as to why this has happened, and the implications of this for marketing organic food.

In summary, based on our sample, just over half (two in every three) consumers of the total population are currently purchasing organic food (ranging from regularly through to occasionally).

Demographics

The following results compare different purchase frequency groups based on demographic variables, commencing with those that show a significant difference prior to mentioning those where this is not the case. As previously noted, this sample has been selected to be demographically representative of the Australian population.

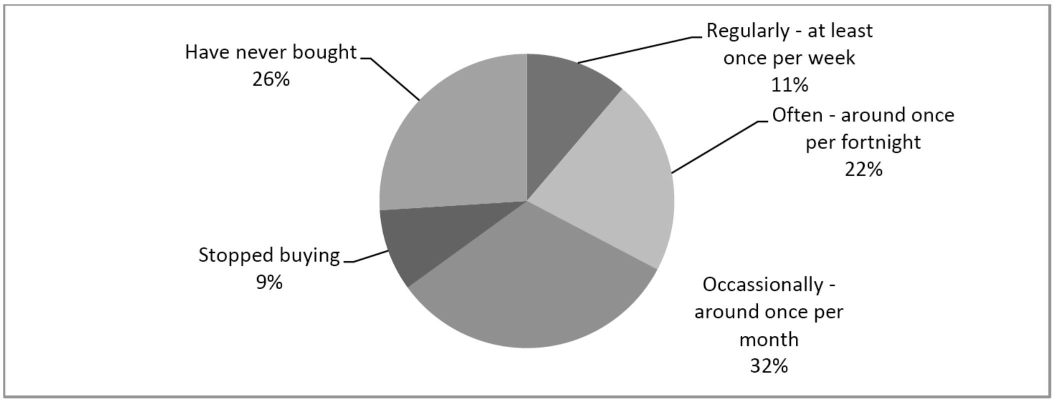

Figure 1: Frequency of organic food purchases (Source: Results from Questionnaire for those at various levels of purchasing organic food including having stopped buying N=1011, and BFA 2012 for those who have never bought organic food). (At a 95% confidence level these differences are significant $\chi2=313$).

Age

There is a general trend towards younger consumers being more dedicated to purchasing organic food (Figure 2). For example, many (over 60%) of 20 to 29 year olds purchase 'Regularly' or 'Often' which reduces dramatically (to around 30%) for 70+ year olds. These results are in contrast to other studies where organic food buyers tend to be dominated by the older age categories (Davies, Titterington & Cochrane, 1995; Fotopoulos & Krystallis, 2002; Padel & Foster, 2005; Thompson, 1998; Wier &Calverley, 2002).

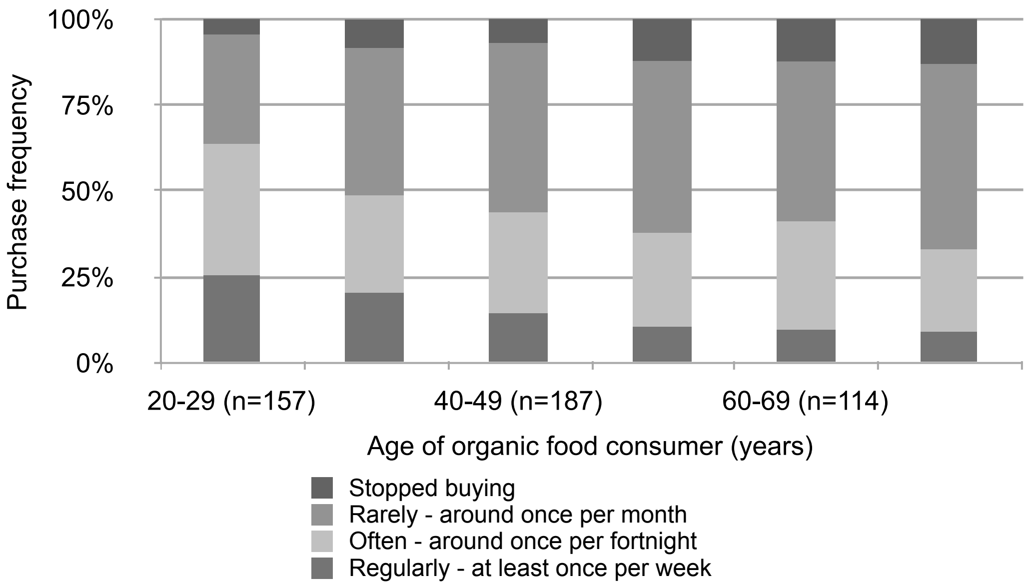

Figure 2: Frequency of organic food purchases in relation to Age (Source: results from Questionnaire. N=1011). (At a 95% confidence level the only significant difference for 'Regularly' or 'Often' is age 20-29 years $\chi2=18.8$).

Income

Low income households are less likely to purchase organic products (the lowest category in this research was below AU$45 000 which is equivalent to the average household earnings in Australia (ABS, 2011)). For example, there are significantly less low income households (just under 40%) in the below $45 000 category who purchase ‘Regularly’ or ‘Often’ than in the higher income categories (just under 50%)(At a 95% confidence level χ^2=3.9). These low income households are also the ones most likely to have ‘Stopped buying’ (15%).

Purchase frequency is consistent for all household income levels above the average household earnings. These results support the often implicit assumption that organic food is purchased by higher income households, as they are more readily able to absorb the generally higher price of organic products (Padel & Foster, 2005). However, it does raise an unanswered question as to why purchase levels do not continue increasing above the average income.

Employment

‘Students’ have the highest purchase frequency (‘Regularly’ or ‘Often’ being over 60%). Those who are ‘Self-employed’, in ‘Full-time employment’, or ‘Unemployed’ having the next highest purchase frequency (‘Regularly’ or ‘Often’ being around 50%) (Figure 3). Identification of the relatively high purchase frequency amongst ‘Students’ and the ‘Unemployed’ is a contribution to the literature and would benefit from further research that explored the reasons for this.

Figure 3: Frequency of organic food purchases in relation to Employment status (Source: results from Questionnaire. N=1011). (At a 95% confidence level none of the differences for ‘Regularly’ or ‘Often’ is significant χ^2=1.8).

Qualifications

Higher levels of education are associated with higher levels of purchasing organic food (Figure 4). For example, over half (just under 60%) with ‘Post graduate’ qualifications purchase ‘Regularly’ or ‘Often’ in contrast to only one third (under 40%) for those without formal qualifications.

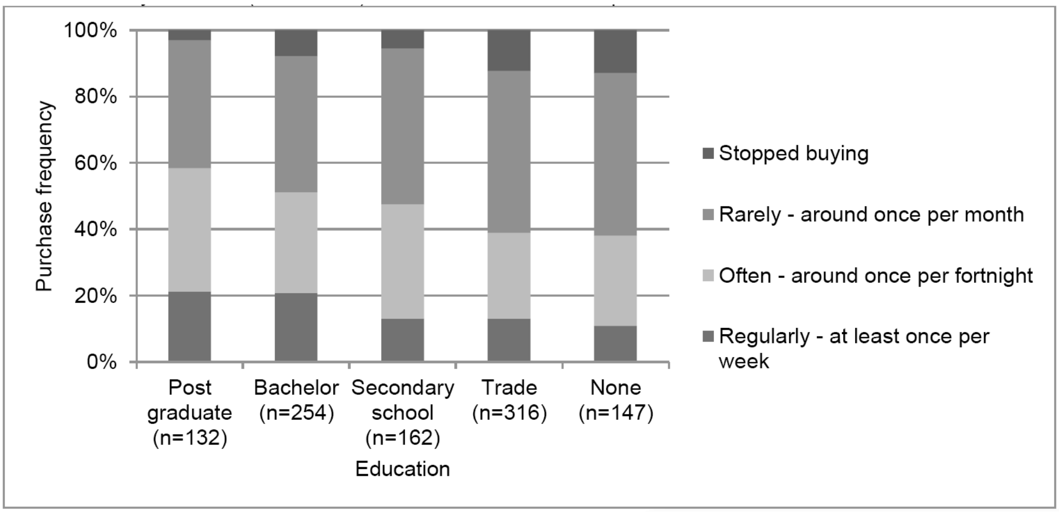

Figure 4: Frequency of organic food purchases in relation to Education (Source: results from Questionnaire. N=1011). (At a 95% confidence level the only significant differences for 'Regularly' or 'Often' are between 'Post graduate' and 'Trade' χ^2=20, and 'Post graduate' and 'None' χ^2=10).

Gender

Gender did not have a significant difference in terms of behaviour around how often consumers purchase organic products (at 95% confidence level χ2=2.5).

Living arrangements

Having children, and/or having a partner did not have a significant difference on the frequency of organic food purchases (at 95% confidence level χ2=1.1).

Length of time purchasing organic food

A solid core of organic food buyers (almost half, n=442, out of a total of N=1011) reported purchasing for a long time ('3+' years) (Figure 5). Many organic food buyers (almost one in five) are new entrants having being purchasing for less than one year.

Most of these new entrants are trialling organic products (as the purchase frequency for over two out of every three of them is 'rarely') and some (10%) have already stopped purchasing organic products. The remaining new entrants contribute to a net increase in the total number buyers (estimated to be between 2-5% per year in Australia - derived from BFA, 2012) as both the population and market share of organic products increases gradually.

Those who continue purchasing organic food after their first year, on average, increase their purchase frequency and this remains constant in subsequent years (Figure 5). For example, only (just over 20%) of those the new entrants (purchasing for '<1 year') are in the 'Regularly' or 'Often' category, in contrast to around half (ranging from 50-55%) of consumers who have been purchasing for a year or more being 'Regularly' or 'Often'.

Organic food attributes that are important to consumers

Concern for the 'Environment' was the most important motivation, followed closely with 'Health', and 'Quality' being of less importance (For example with consumers who purchase 'Regularly' the 'Rating' of 'Environment' is 60%, 57% and 48% respectively)

(Figure 6). This is consistent across all levels of purchase frequency. Insights from an analysis of the reasons for purchasing organic food, as perceived by consumers, suggest that continuing to focus on positive environment and health messages in marketing communications will be most effective in increasing sales.

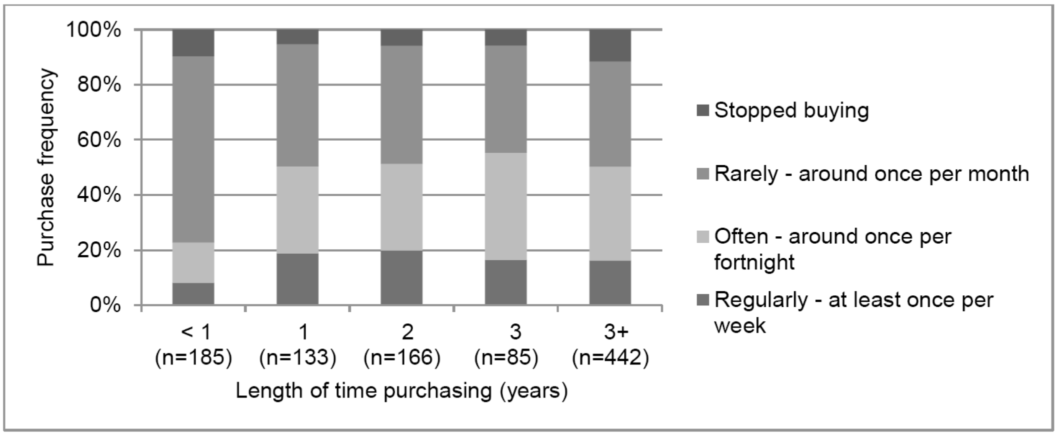

Figure 5: Frequency of organic food purchases in relation to Length of time purchasing (Source: results from Questionnaire. N=1011). (At a 95% confidence level significant differences exist for 'Regularly' or 'Often' between '<1' and all other year categories $\chi 2=45$).

Although these three attributes maintain the same ranking across all levels of purchase frequency, as it declines, so does importance of these attributes. This is consistent with the assumption that higher purchase frequency results from a higher importance being placed on the attributes that differentiate organic products from alternatives sourced from chemical production methods.

The fact that those who have 'Stopped buying' organic products rate attributes higher than those who purchase 'Rarely', but below those who purchase 'Often', suggests that other factors, such as changing life circumstances which may result in shifts towards issues such as less time or more difficult access to organic food, are the dominant drivers for them.

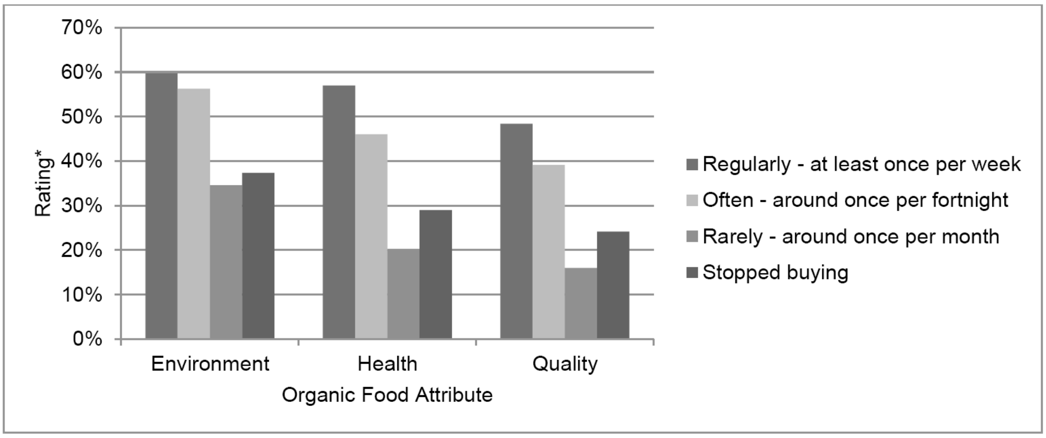

Figure 6: Frequency of organic food purchases in relation to rating of organic food attributes that are important to consumers (Source: results from Questionnaire N=1011).
*Based on percentage of respondents who 'strongly agreed' or 'agreed' that the attribute was important on a seven point scale that spanned to 'strongly disagree'. The specific questions were: Organic food is good for the environment, Organic food enhances my health, Organic foods have superior quality.

Discussion

Expansion of the organic food market over recent decades can largely be attributed to consumers choosing it as an expression of their concern for their own health and a heightened awareness over the impact of the food system on the environment. Other factors such as increased consumer affluence, greater product diversity and availability have assisted consumers to make this choice. Despite overall increases in organic food consumption, most consumers remain resistant to purchasing large amounts of it. Although consumers have a positive attitude towards organic food, they only purchase it some of the time. Around two in three consumers purchase organic food, yet its market share is only 1%.

The frequency of organic food purchases varies, with two in every three of the population currently purchasing organic food. However, only a relatively small proportion of consumers (one in ten) are purchasing it a least once per week. A similar proportion (around one in ten) have stopped purchasing it during the past year, which offers an area for further research aimed at gaining an understanding of the implications of this for marketing organic food.

In relation to the demographic profile of organic consumers there is a general trend towards younger consumers, those on above average incomes, and those with higher levels of education being more dedicated to purchasing organic food. The inclusion of students and the unemployed, with those in full-time employment, as consumers who purchase organic food on a regular basis would benefit from further research to understand the role of organic food in their lifestyles.

Although organic food sales are maintained by a core of dedicated long term consumers, there is a lot of ‘churn’ in the organic food market, with most who trial it stopping after a relatively short period of time.

Concern for the natural environment is the most important motivation to organic food consumers, followed closely with health, and superior product quality being of less importance. Hence continuing to focus on these in marketing communications may be most effective in increasing sales.

Foremost, the findings indicate that the key challenge for increasing organic food sales will be to convince consumers of the superior ‘value’ of organic products. Results show that people are consuming organic products across most demographics, irrespective of education or profession. Higher purchase frequency across all demographic categories may be achieved if greater importance is placed on the positive attributes that differentiate organic from conventional products, namely, health and environment.

The findings also draw attention to a number of factors that may be preventing higher purchase frequency. Results showed that a noticeable number of consumers (around one in ten) had bought organic food in the past but have stopped. Further research could be conducted to discover why this is the case. It is likely that this will include those reasons previously identified for non-purchase being limited distribution, intermittent availability and high prices, however, further research may identify other factors that explain this change in behaviour.

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There are a number of methodological issues associated with analysing the market for organic products that may distort results. In particular, most studies, including this one, rely on consumer self-reporting to gather data, rather than observation of actual purchases. Hence these results show what consumers report that they do, rather than what they may actually do.

Conclusion

This paper provides insights into organic food consumer behaviour by ‘unbundling’ the assumed homogeneous organic consumers into segments based on their purchase frequency.

The findings show that, from a demographic perspective, consumers who are young, highly educated, and students are most likely to be regular purchasers of organic foods. Conversely there is a reduction in the frequency of organic food purchases amongst older consumers and those with lower levels of education.

Recognition and pro-active management of these findings could contribute to more effectively targeted research into consumer food purchasing motivations, and subsequently the development of more sophisticated marketing strategies for the organic food industry. However with its diverse constituency, ranging from global corporates through to local production and consumption, it is going to be a challenge for the organic sector to achieve the coordination required to develop these. Hence activities are likely to continue to be led by larger commercial organisations and government bodies.

And finally, it is likely the organic food consumers will provide fertile ground for further research as industry players seek market growth opportunities, and Government agendas aim to achieve human health and environmental sustainability within an informed consumer choice policy framework.

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