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EDITORIAL: ORGANIC PRODUCTION AND GLOBAL FOOD SECURITY

Dr Terry Kelly (tckelly17@gmail.com), Co-Editor, Journal of Organic Systems
30 August, 2010

“Agroecology outperforms large-scale industrial farming for global food security,” was the headline of a recent news release on the findings from an international meeting on agroecology in Brussels, 21-22 June 2010. It was held under the auspices of the UN Special Rapporteur on the Right to Food, Olivier De Schutter, and it featured many international experts on this subject. One conclusion was that “agroecological farming, which improves food production and farmers’ incomes while at the same time protecting the soil, water and climate, could feed an estimated world population of nine billion people by 2050 and go a long way to save the climate, if implemented now.”

We are heartened, not only with the findings from this meeting, but that we again see more evidence on the real relevance of organic and ecological farming in a global sense – it’s not just for the well-off who can afford to pay premium prices! Organic farming is an important way forward for alleviating global food insecurity, and for addressing a diverse range of interrelated issues from health and wellbeing to sustainability and climate change.

However, the industrial chemical-based agriculture proponents continue to fight this notion – their arguments are summarised by Robert Paarlberg, a political scientist, who writes that the organic community’s wishes for farmers to abandon the use of synthetic chemicals would force farmers to use not only more labour, but also much more land. Such a change would, in effect, push “them back into 19th century practices.” He dismisses such “all-natural” approaches as the products of romanticised views of old agrarian lifestyles. The principal objections to the proposition that organic agriculture can contribute significantly to global food security are low yields and insufficient quantities of organically acceptable fertilizers. These are tired arguments promulgated by Dennis Avery of the Hudson Institute back in the early 1990s.

Such arguments ignore at least three crucial elements: the environmental damage caused by our industrial agricultural systems, the considerable external subsidies used to support high-input farming (e.g. energy, research and funding), and that organic systems are not merely substitution systems, but are systems that have been redesigned to meet goals of wellbeing and sustainability, while also preventing problems. Their arguments also ignore the growing body of evidence that shows that organic farming systems can be as productive as their conventional counterparts, particularly in developing countries; and that organic sources of nitrogen are more than adequate to replace synthetic sources (Badgley et al., 2007, Pretty et al., 2006). Parott and Marsden (2002) and Pretty and Hine (2001) have also identified many examples of increased yields following the application of sustainable agricultural practices (cited in Li Ching, 2008).

Badgley et al. (2007) estimated average yield ratios (organic:non-organic) of various food categories for the developed and the developing world, and found that in most cases the average yield ratio was slightly less than one for the developed world and greater than one for the developing world. Their research further suggests that organic methods could produce enough food globally to sustain the current human population; and potentially an even larger population, without increasing the agricultural land base. Pretty et al. (2006) found that by adopting resource-conserving, sustainable agricultural technologies, farmers were able to not only reduce adverse effects on the environment and contribute to important environmental goods and services, but also increase yields.

Furthermore, food production is only one part of the food insecurity crisis; availability, access, stability and utilisation are the four main dimensions of food security, and actual food production is only one of many factors that impact on these dimensions. Key attributes of organic and ecological farming – use of local resources, local control of production and distribution processes, and more benign impacts on the environment –positively affect all four of the dimensions of food security.

The worthy goal of feeding the world is not being achieved currently by mainstream agricultural methods. Today, at least one billion people go hungry in the world; and, according to the UN Food and Agriculture Organization (FAO), at least two billion people suffer from micronutrient deficiencies. While many don’t get enough to eat, even more don’t get enough good quality food. This has been exacerbated by the recent financial crisis and continued high food prices; people ate less, and ate less well, as they switched to cheaper, less nutritious food. A shift to local, ecologically-based organic food systems would better address
this poor-quality food issue, which currently affects nearly one-third of the world population. This shift also would be consistent with the growing emphasis on a ‘right to food’ approach to addressing world hunger.

As part of the key principles of the ‘right to food’ approach, the UN Special Rapporteur argues that “Sustainable modes of production based upon agro-ecology and smallholder farming should be supported as a matter of priority” (De Schutter, 2010). This argument arises out of a recognition that the key obligations to respect, protect and fulfil (facilitate and provide) people’s right to food must be preserved. Sustainable ecologically-based agriculture can contribute to all three of these obligations, and help to make small farm families self-sufficient in food, or even net food sellers instead of net buyers, at the mercy of price shocks and shrinking affordable food supplies. Reliance on local inputs such as manure, compost, and organic fertilisers, and on techniques such as rainwater harvesting, biological control, and the use of leguminous trees to fertilize the soils are particularly well suited to the needs of farmers who have little access to credit, work on the poorest soils, and who have limited or no access to basic infrastructure.

In the previous issue of the Journal of Organic Systems, we noted that organic systems can ameliorate the effects of climate change. The smaller environmental footprint of organically produced food and fibre is already well appreciated. Add to these positive features the potential for organic systems to feed a growing world population, and it becomes even more obvious that ecologically-based organic systems offer an important way forward in addressing food insecurity, poverty, and environmental impacts in the world.

References
AN EVALUATION OF THE INFLUENCE OF BIODYNAMIC PRACTICES INCLUDING FOLIAR-APPLIED SILICA SPRAY ON NUTRIENT QUALITY OF ORGANIC AND CONVENTIONALLY FERTILISED LETTUCE (LACTUCA SATIVA L.)

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Abstract

Evidence for the role of silica in plants is reviewed with respect to the application of silicate based sprays in biodynamic agriculture. There is research indicating improved resistance to pests, disease, drought and other stresses on plants from application of silica fertilisers and sprays. There is also evidence of improved nutrient uptake.

Experiments with field grown lettuce were undertaken to evaluate the effects of the biodynamic field-spray preparations and organic composts on lettuce yield, nutrient uptake, nitrogen metabolism, antioxidant activity and soil organism activity. Higher fresh yields of field lettuce were observed with organic composts than with a mixture of diammonium phosphate and calcium ammonium nitrate applied at similar N and P application rates.

Although lettuce yields were higher when the compost and plants were treated with biodynamically prepared silica sprays, the variation in lettuce fresh yield in the field was high (c.v. 28%) and the effects of the sprays were not statistically significant (p 0.05). Irrespective of fertiliser source, composts or soluble fertiliser, silica sprays produced lettuce at harvest (47 DAT) with higher dry matter content and crude protein in fresh leaves. However, application of silica spray had no statistically significant effect on lettuce fresh head yield, N uptake, plant sap nitrate concentrations, NO₃ to TKN ratio, and amino acid content.

Further investigation of management practices, such as the use of biodynamic field sprays, which may contribute to nutrient uptake and assimilation and improved product quality within an organic system, is recommended.

Keywords: Biodynamic; organic; compost; lettuce; light absorption; nitrate; protein; silica;

Introduction

Adoption of organic and biological systems is increasing, as farmers recognise their contribution to farming sustainability and because they can often obtain price premiums for certified organic produce. Organic producers work with whole systems. This involves many factors such as climate, improving soil conditions, and cultivation timing, rather than treating a crop independently of its surroundings. One of the reasons for adopting an organic system is that many people assume that using an organic system should lead to more nutritious plant and animal products. However, from numerous comparative research trials that measured product nutrient content, results have been very variable and inconclusive. Some reasons for this are the many factors involved in managing whole systems, including soil type, climate, planting and harvest date, all of which can affect nutritional value irrespective of farming system (Bourne, 1994). Past studies have used different methodologies; some compared the whole system of growing over a number of years, whereas many others compared different treatments of various organic and soluble fertilisers (Woese et al., 1997). Further consideration is needed of what management factors within a whole system might make a difference to nutritional value, and what parameters should be measured to assess this.

Bloksma et al. (2001) investigated many plant growth and food quality parameters in apples, and they postulated that good food quality requires integration of the growth processes that result in high yield and the differentiation processes that lead to fruit and seed production and formation of secondary metabolites (e.g., antioxidants). Most organic growers focus on growth processes through improving soil health, whereas a biodynamic system works with both these growth processes; and with the wider environmental influences of planets and stars on plant differentiation and quality.

A biodynamic system incorporates organic practices such as composting to build and maintain soil health. These are supplemented with applications of biodynamic preparations. Some of these preparations are
aimed at enhancing soil organism activity; others to enhance plants’ sensitivity to influences of the sun, moon, planets and stars. The art of using these preparations is to regulate the growth processes coming mainly from the soil, with the differentiation processes coming mainly through sunlight, for achieving optimum productivity and quality.

Silica (SiO\textsubscript{2}) has traditionally been applied to plants by biodynamic growers in the form of horn-silica (preparation 501) spray\textsuperscript{1}. Horn-silica is applied in a very dilute concentration (1g/37L/ha) of colloidal silicon dioxide as a spray above the plant; at a very low application rate compared to the more conventional amendment applications. Horn-silica is claimed to enhance flowering, ripening and flavour of products (Pettersson, 1977). However, few specific effects of the silica spray have been recorded, because it is generally only applied after the other biodynamic preparations (preparation 500 and the compost preparations\textsuperscript{1}) have been applied to the land.

**Review of research on the effects of silica on plant growth**

Silicon has been applied to crops in a variety of forms and application modes, but its effects on plant growth are still debated. Fauteux *et al.* (2005) reviewed the existing evidence and concluded that silicon (Si) is not only involved in structural and physiological plant processes, but also plays an important role in plant resistance to pathogenic fungi. This role is one that has long been recognised by practitioners of biodynamic agriculture (Remer, 1995).

A considerable amount of research on the application of silica to crops has been carried out in recent years, particularly in South Africa, Australia and Asia. Much of the research has focussed on using silica to increase plant resistance to disease. Silica has been found to alleviate various stresses ranging from biotic (e.g., disease and pests) to abiotic (such as gravity and metal toxicities; Epstein, 2008). It has also been found to alleviate UV-B radiation stress (Shen, 2008). Hodson and Evans (1995) reviewed evidence that silica reduces aluminium toxicity in plants.

It is now well-established that silicon fertilisers increase yields in silicon-accumulator plants such as rice and sugarcane (Kingston, 2008). Improved yields of sugar cane and rice have been recorded after calcium silicate was applied to strongly weathered, silica-deficient soils (Berthelsen *et al.*, 2001). Lynch (2008) reported that silicon has consistently outperformed high-analysis fertilizer in broadacre cereal production – measured as increased protein levels, increased yields, decreased screenings, and increased grains/head – and there are many case histories of increased quality of fruit and vegetables. There appear to have been fewer scientific trials reporting on the effects of silica on nutrient uptake and nutritional quality of crop products, particularly in dicotyledon plants. Pre-treatment of seeds, application to the soil, or spraying with a silica compound improved yield and vitamin C content of mangold (chard), daikon (Japanese radish) and lettuce (Yanishevskaya and Yagodin, 2000).

The mechanisms by which silica reduces stress in plants have been explored. Liang (2008) summarised the key mechanisms of silica mediated alleviation of water-deficit stress in higher plants as: (1) enhancement of plant growth via improved leaf photosynthesis and root activity, (2) alleviation of osmosis stress by reducing transpiration and/or improving water retention, (3) stimulation of antioxidant defence activity and reduction of lipid peroxidation, and (4) improvement of plasma membrane and tonoplast structure, integrity and vital functions. For example, Agarie *et al.* (1998) showed that application of silica in the nutrient solution reduced rate of transpiration through stomatal pores of rice leaves. Foliar application of potassium silicate stimulated antioxidant superoxide dismutase activity and increased photosynthetic capacity and chlorophyll content in bentgrass, especially under a high fertiliser regime (Schmidt *et al.*, 1999).

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\textsuperscript{1} The biodynamic preparations have been developed from recommendations made in 1924 by Rudolf Steiner (1993). Horn-silica (Biodynamic Preparation 501) is made by grinding quartz crystals to a very fine dust, making it into a slurry with water; this is then inserted into a cow horn. The cow horn is then buried in fertile, organically-managed soil for about six months during summer (Procter, 1995). After removal from the horn, the substance is stirred in water, and then applied in early morning as a fine spray in the air over the plants to be treated.

\textsuperscript{2} Biodynamic preparation 500 is made by filling a cow horn with fresh cow manure and burying it in soil for about six months during winter. The finished product is stirred in water, and then applied to soil or pasture in late afternoon at the rate of 65g/33litres water/ha. The compost preparations 502 to 506 are made by decomposing particular plant parts in specific animal parts, which are then buried in soil. About 1g of each of these is placed separately in a compost heap or liquid fertiliser to bring order to the decomposition process. Preparation 507 is a plant extract made from Valerian blossom juice; this is sprayed over the heap.
Further effects of silica on plant physiology that have been reported include that silicon assists the incorporation of inorganic phosphate into ATP, ADP and sugar phosphates in sugarcane (Marschner, 2002). Total amino acid concentration and the proportion of asparagine to other amino acids were higher in rice plants grown in nutrient solutions that included silicon dioxide (Watanabe et al. 2001). Lower sucrose concentration in phloem sap of plants grown with silica indicated that loading and/or unloading of sucrose into phloem could be affected by silica nutrition. Silicon compounds made from polycondensate boiler waste (94-96% CH₃SiOCl₃), applied with nutrients in a hydroponic system, increased intensity of respiration processes, activity of oxido-reductive enzymes, and the accumulation of carbohydrates and free amino acids (the latter by over 100%) in leaves of two Arum plant varieties (Zaimenko, 1998).

Several writers have reported that silica is more effective if used in an activated form. Matichenkov and Bochannikova (2008) tested several types of new-generation silica fertilisers that included other ingredients known to have synergic effects on the active Si, and extremely high contents of plant-available silica. A liquid complex silica fertiliser containing concentrated monosilicic acid and specific organic substances was tested on wheat in a field trial. Treatment at the time of seed planting at a rate of 0.4 L silica fertilizer per hectare (dilution 1:1000) increased the yield from 2.9 to 4.6 t/ha, and improved the quality of the wheat. Diatomaceous earth was also found to be effective.

When such activated silica is applied, lower concentrations of silica can be more effective in improving plant mineral uptake than larger concentrations. For example, Tesfagiorgis et al. (2008) found that using doses of 1-50 kg/ha of active Si substance on zucchini plants as seed treatment, or foliar application, was more effective than larger doses. The total accumulation of P, Ca, and Mg in plants was maximal when Si was supplied to the nutrient solution at lower rates (i.e., 50 mg ℓ⁻¹), and extra applications had no or negative effects. However, when Si was applied at >50 mg ℓ⁻¹, then the P level of the fruit was reduced by 50%.

It appears that there are a wide range of physiological effects of applying silica to plants, with greater improvements in mineral uptake and yield from applying small quantities of activated silica.

**Biodynamic horn silica**

The biodynamic horn silica, which is applied in very low concentrations, appears to act as an activated form of silica. Some of its reported effects appear to be similar to those of other silica fertilisers. For example, horn-silica spray application reduced leaf surface area, stomatal opening and transpiration rates, increased chlorophyll content, and diameter of roots, but did not affect photosynthesis rate in bush beans (Tegelhoff, 1987 in Koepf, 1993). Preparations 500 and 501 applied several times together (500 in the evening, 501 in the morning) increased relative leaf surface in upper, younger leaves, reduced overall leaf area, increased net CO₂ assimilation, and reduced stomatal oscillations; but 501 only decreased CO₂ assimilation (Koenig, 1988). Remer (1995) found that a D7 solution of the horn-silica preparation (nine parts of carrier mixed with one part of active substance, repeated 7 times) increased concentrations of some amino acids in Savoy cabbage, possibly by promoting the formation of enzymes responsible for acid metabolism. Application of the biodynamic preparations increased pure protein as a percentage of crude protein (by 3-5%), dry matter content and essential amino acids, particularly methionine, but reduced total crude protein content in potatoes compared to applying soluble fertilisers (Granstedt and Kjellenberg, 1996). Concentrations of essential amino acids, as constituents of total crude protein, are a well established measure of food nutritional quality (Young and Borghena, 2000). Beans grown using the biodynamic preparations contained higher levels of most amino acids, compared to beans grown hydroponically. Methionine and cysteine contents were 26.61 and 25.69 mg/g protein respectively, and their chemical scores (FAO, 1973) were 76% and 74% respectively (Stolz et al., 2000).

Koepf (1993) observed that plants sprayed with horn-silica spray look as though they have grown in more intense light than those not sprayed. He compared visual and compositional characteristics of such plants with plants grown in the shade and plants grown with high levels of nitrogen fertiliser. Plants grown in the shade, or with more nitrogen, had larger, more elongated leaves then plants grown in intense light or when horn silica had been applied. The ‘light-grown’ plants also had higher true protein and vitamin C content, and better taste.

Bloksma et al. (2001) described a similar finding from comprehensive studies of apple trees and carrots. Plant physiological processes were divided into those that promote growth and those that lead to differentiation. Applying the biodynamic field-sprays 500 and 501 favoured the differentiation processes that promote fruit, seed and secondary metabolites production. Fritz et al. (1997) reported that treatment with horn-silica significantly improved post-harvest storage quality of lettuce in shaded plants, but reduced storage quality of unshaded plants, with effects similar to those from gibberellin application.
Plant effects caused by foliar application of a very dilute silica spray could result from silica being assimilated by the plant, changes in light wavelengths above the plant, or from residual leaf silica causing changes in light interception by the plant. Apart from a direct effect on photosynthetic rate, light is important in triggering many plant processes, e.g., white light promotes activation (dephosphorylation) of nitrate reductase, possibly through concentration of sugar phosphates in leaves, and/or by enhancing the activity of protein phosphatases, which appear to be regulated by redox control (Lillo and Appenroth, 2001). Small changes in light wavelength may also affect nitrate reductase gene expression, which affects the rate of assimilation of nitrates into more complex compounds such as amino acids. Effects through cell signalling of small changes in light absorption could explain why a very low concentration of silica, as in horn-silica spray, could affect plant physiology.

Kingston (2000) stated that it is not clear that responses to foliar applications of potassium silicate are due to ‘in planta’, or merely topical effects, as similar responses occur with non-Si products, and incorporation of foliar applied Si in leaf tissue is contrary to our current understanding of Si uptake, transport and deposition.

**Methods: investigation of effects of biodynamic practises on plant growth and nutrient composition**

Effects and possible mechanisms of the application of horn silica to plants were investigated in trials conducted in 2002-3. The experimental work was designed to determine relationships through which application of composts and biodynamic field sprays 500 and 501 could affect plant growth and nutrient composition. There was a particular focus on whether effects of the biodynamic field-spray preparation’s effect on nitrogen metabolism could be detected by measuring concentrations of elements, nitrates, amino acids and antioxidants concentrations in lettuce leaf tissue.

**Design and treatments**

Lettuce (*Lactuca sativa* L. cv. Canasta) plants were grown in a field trial in volcanic sandy loam soil near Tauranga, New Zealand (latitude 37.7°S, longitude 176.3°E, altitude 20 m above sea level). The soil had been managed organically for at least 12 years. A factorial design with 6 treatments was used in setting up 24 plots of 1.4m x 1.4m in 4 blocks. Plots were amended with composts, soluble fertilisers or no fertiliser. At seed-bed preparation, the organic (Org) and biodynamic (Bd) composts were applied at 8.3 kg/m² (wet weight), giving approximately 60 g/m² N and 4 g/m² P. Diammonium phosphate and calcium ammonium nitrate (treatment code DC) were also incorporated at this stage in the soluble fertiliser plots to supply the same quantities of N and P in g/m². No K was applied as this was already oversupplied in the soil. Plots in each amendment treatment were either sprayed (Sp) twice with biodynamic field preparation 500 at 1 and 38 days after transplanting (DAT), and three times with preparation 501 at 5, 9 and 39 DAT (sprayed plots), or they were sprayed with water at the same times (unsprayed plots). Treatments were replicated four times. At transplanting, gravimetric analysis of wet and dried soil samples indicated a soil water deficit of approximately 70mm. Seedlings were irrigated weekly to maintain the soil water deficit between 30 – 50 mm.

**Measurements**

Regular observations of leaf and root growth were made. At intervals, lettuce leaf nitrate concentrations were measured using Merck nitrate test strips to analyse leaf cell sap, and by Technicon autoanalyser after acetic acid extraction from dried leaf material (Prasad and Speirs, 1984). Sap was extracted from young mature leaves from two plants/plot; this was done by chopping the leaves, mashing them by using a pestle and mortar, placing them in a piece of thin polyethylene film, and then squeezing the sap through pinholes.

Roots and shoots were harvested at 28 and 47 DAT and dried and weighed. Total N and P were extracted from dried leaves by Kjeldahl digestion (McKenzie and Wallace 1954), followed by analysis using a Technicon autoanalyser (Twine and Williams, 1971). Amino acid concentrations were also measured in dried leaf material by a method similar to that of Fierabracci (1991), and using the Ferric Reducing Ability of Plasma (FRAP) assay (Benzie and Strain 1996) respectively. Measurements were made of soil microbial activity by soil respiration *ex situ* to determine relationships between treatments and soil biological activity.

Results were analysed for variance by SAS. Treatment means were compared by t-test and by Tukey’s multiple comparison procedure. Residual variance was examined for normality and constant variance.

**Results and discussion**

High variability between plants within treatments, and small differences between treatment means for most parameters measured, prevented many statistically significant differences or relationships being found. It
seems likely that there was high variability in the lettuce plants used, and soil composition variability within plots was also possibly high. In the field trial, fresh head yield at 47 DAT had a cv of 28% (Table 1). Composted plots produced significantly higher fresh head yields of lettuce than other plots; this is probably attributable to more available nitrogen being taken up between 28 and 47 DAT from composted soils. Regular soil moisture measurements indicated higher soil moisture contents in compost-treated soil. The spray appeared to have different effects on plants depending on whether they grew in composted or uncomposted treatments. After the second spraying, a growth check in sprayed plants was clearly observable; this is reflected in plant weights measured.

Table 1. Fresh weight and dry matter (DM) % of lettuce heads and roots at 28 and 47 days from transplanting (DAT). Means of 8 plants (28 DAT) and 12 plants (47 DAT) shown for each treatment.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant fresh weight (g)</th>
<th>Head DM (%)</th>
<th>Root DM (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28 DAT</td>
<td>47 DAT</td>
<td>28 DAT</td>
</tr>
<tr>
<td>Ctrl (n = 4)</td>
<td>28.9 cd</td>
<td>202.8 bc</td>
<td>6.2 b</td>
</tr>
<tr>
<td>C + sp</td>
<td>22.3 d</td>
<td>174.2 c</td>
<td>7.4 a</td>
</tr>
<tr>
<td>DC</td>
<td>36.8 bc</td>
<td>214.9 bc</td>
<td>6.4 b</td>
</tr>
<tr>
<td>DC + sp</td>
<td>27.4 cd</td>
<td>160.2 c</td>
<td>7.2 a</td>
</tr>
<tr>
<td>Org</td>
<td>43.8 ab</td>
<td>279.4 ab</td>
<td>6.2 bc</td>
</tr>
<tr>
<td>Bd</td>
<td>47.4 a</td>
<td>315.1 a</td>
<td>5.5 c</td>
</tr>
</tbody>
</table>

Fertiliser

| None (n = 8) | 25.6 b | 188.5 b | 6.8 a | 6.0 a | 7.1 a | 10.4 b + |
| DC | 32.1 b | 187.6 b | 6.8 a | 5.9 a | 7.7 a | 11.9 a |
| Compost | 45.6 a | 297.2 a | 5.8 b | 5.8 a | 6.5 a | 10.5 ab |

Spray*

| No sprays | 32.8 a | 208.8 a | 6.4 b | 5.7 b | 6.8 a | 10.9 a |
| Sprays (n =8) | 24.8 a | 167.2 a | 7.4 a | 6.1 a | 8.0 a | 11.4 a |

Treatment codes: Ctrl = Control, C+sp = Control + biodynamic field sprays, DC = soluble fertilisers DAP + CAN, DC + sp = soluble fertilisers + Bd field sprays, Organic (Org) = compost, Biodynamic (Bd) = biodynamic compost +sprays

* Means of control and DC treatments only
Different letters indicate significant difference by t-test at 0.05% level. + indicates significant difference by Tukey test at 0.05% level.

At 28 DAT the percentage NO₃-N of dry lettuce leaves was significantly higher for the compost treatment than other treatments. This difference was absent just prior to harvest at 47 DAT (Table 2), and was not apparent in the sap values measured (Merck strip) at 39 and 45 DAT; however, the Merck-strip NO₃ value was higher in the DC treatment at 39 DAT. Neither test (Merck strip nor acetic acid) demonstrated any effects of sprays on the nitrate content of lettuce leaves at or near harvest (45 – 47 DAT). There was poor correlation between NO₃ determined by acetic-acid extraction of dried leaves and Merck-strip analysis of fresh-leaf cell sap. The acetic-acid extraction, however, did show that the lower nitrate concentration in sprayed plants at 28 days was significant, but this difference was again not evident at 47 DAT.

Table 2. Mean nitrate concentrations in leaf sap 39 DAT at 7pm (Merck strip) and in dried leaf material of field grown lettuces at 28 and 47 DAT and nitrate N: total N ratios Treatment codes as for Table 1.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>NO₃ mg/l in cell sap (Merck strip) 39 DAT</th>
<th>%NO₃-N in dry leaves (acetic acid extracted) 28 DAT</th>
<th>NO₃-N :tot TKN* 28 DAT</th>
<th>47 DAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ctrl</td>
<td>633.3 ab</td>
<td>825.0 a</td>
<td>0.20 a</td>
<td>0.14 a</td>
</tr>
<tr>
<td>C + sp</td>
<td>433.3 c</td>
<td>850.0 a</td>
<td>0.15 b</td>
<td>0.19 a</td>
</tr>
<tr>
<td>DC</td>
<td>700 a</td>
<td>1050.0 a</td>
<td>0.18 ab</td>
<td>0.20 a</td>
</tr>
<tr>
<td>DC + sp</td>
<td>600 ab</td>
<td>975.0 a</td>
<td>0.13 b</td>
<td>0.18 a</td>
</tr>
<tr>
<td>Org</td>
<td>500 bc</td>
<td>900.0 a</td>
<td>0.21 a</td>
<td>0.18 a</td>
</tr>
<tr>
<td>Bd</td>
<td>533.3 bc</td>
<td>875.0 a</td>
<td>0.23 a</td>
<td>0.14 a</td>
</tr>
</tbody>
</table>

Fertiliser

| Control | 533.3 b | 837.5 a | 0.17 b | 0.17 a | 0.05 ab | 0.04 a |
| DC | 650 a | 1012.5 a | 0.16 b | 0.19 a | 0.04 b | 0.05 a |
| compost | 516.7 b | 887.5 a | 0.22 a+ | 0.16 a | 0.05 a | 0.04 a |

Spray**

| No sprays | 666.7 a | 937.5 a | 0.19 a | 0.17 a | 0.05 a | 0.05 a |
| Sprays | 516.7 a | 912.5 a | 0.14 b | 0.19 a | 0.04 a | 0.05 a |
The ratio of $\text{NO}_3$ to TKN in dried leaf material (Table 2) provides an indication of relative difference between rates of nitrate uptake and rates of assimilation of nitrate into amino acids, protein and other nitrogenous compounds. No fertiliser or spray treatment caused any significant differences in the proportion of N present as $\text{NO}_3$ in lettuces at final harvest (47 DAT). The high variability between nitrate and total-N concentrations in individual plants within treatments meant that differences between treatment-ratio means would have to exceed 0.017 (47% of the lowest treatment mean) for a significant result to have been found. As the soil was initially high in $\text{NO}_3$, lettuces of all treatments may have taken up nitrate preferentially to ammonium, and most plants contained high concentrations of nitrate.

Compost treatments took up significantly more N than the control and DC treatments between 27 – 47 DAT. Plant percentage TKN was converted to g crude protein/100g fresh leaves, and sprayed plants appeared to contain significantly more protein than unsprayed plants. This significant difference is generated by small treatment differences in plant dry weight: fresh weight ratio (Table 3). Total N percentage (Kjeldahl N – not including $\text{NO}_3$–N, TKN) of leaf dry matter was significantly higher in lettuce plants from compost treated plots at 28 DAT (Table 3); however, by 47 DAT there were no significant differences between treatments in total percentage N.

Table 3. Nitrogen and protein content of lettuce leaves at 28 and 47 DAT. Treatment codes as for Table 1.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% TKN (dry wt)</th>
<th>N uptake (mg/plant/day)</th>
<th>Protein content (mg/100g fresh wt)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28 DAT</td>
<td>47 DAT</td>
<td>28-47 DAT</td>
</tr>
<tr>
<td>Control</td>
<td>3.81 abc</td>
<td>3.75 a</td>
<td>16.91 ab</td>
</tr>
<tr>
<td>C + sprays</td>
<td>3.55 c +</td>
<td>3.99 a</td>
<td>16.12 ab</td>
</tr>
<tr>
<td>DC</td>
<td>3.85 abc</td>
<td>3.84 a</td>
<td>14.53 b</td>
</tr>
<tr>
<td>DC + sp</td>
<td>3.58 bc</td>
<td>3.84 a</td>
<td>13.77 b</td>
</tr>
<tr>
<td>Org</td>
<td>4.09 a +</td>
<td>3.81 a</td>
<td>20.69 ab</td>
</tr>
<tr>
<td>Bd</td>
<td>4.01 ab</td>
<td>3.77 a</td>
<td>26.11 a</td>
</tr>
<tr>
<td><strong>Fertiliser</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>3.68 b</td>
<td>3.87 a</td>
<td>16.51 ab</td>
</tr>
<tr>
<td>DC</td>
<td>3.71 b</td>
<td>3.84 a</td>
<td>14.15 b</td>
</tr>
<tr>
<td>Compost</td>
<td>4.05 a +</td>
<td>3.79 a</td>
<td>23.40 a</td>
</tr>
<tr>
<td><strong>Spray</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No sprays</td>
<td>3.83 a</td>
<td>3.79 a</td>
<td>15.72 a</td>
</tr>
<tr>
<td>Sprays</td>
<td>3.561 a</td>
<td>3.91 a</td>
<td>14.94 a</td>
</tr>
</tbody>
</table>

*Means of control and DC treatments only.
Different letters indicate significant difference by t-test at 0.05% level. + indicates significant difference by Tukey test at 0.05% level.

P uptake between 28 and 47 DAT was significantly higher for lettuce plants in the Bd treatment than those in both DC treatments (Figure 1 and Figure 2). This related well to the greater root mass measured in the Bd treatment. The cause of the higher P uptake in the Bd treatment requires further investigation, as the effect is not a simple effect of spray application; this is because differences in P uptake compared for sprays vs. non-sprays (grouped treatments) were not significant. It is possible that some interaction between composts and sprays produced the higher P uptake in the Bd treatment. It is likely that P mineralisation by soil organisms enabled more P uptake in the Bd treatment, whereas added inorganic P may have been made non-plant available by sorption onto soil surfaces, or the added P (DC) may have inhibited the quantity of net P mineralisation.
Figure 1. Percentage P in leaf dry matter for field lettuces harvested at 28 (■) and 47 (▲) days after transplanting. Error bars represent standard error of means. Treatment codes are shown in Table 1.

Figure 2. Phosphorus uptake by lettuce head (mg P per day per plant head) for the growth period between 28 – 47 days after transplanting. Error bars represent standard error of means. Treatment codes are shown in Table 1.

Analysis of amino acid concentrations in leaves was not carried out on sufficient replications to show any significant differences (Figure 3). The apparent 10 - 20% higher concentrations of amino acids in silica-treated lettuce plants were lower than the 25 – 100% differences in amino acid concentrations between Savoy cabbages sprayed or not sprayed with a D7 solution of preparation 501 recorded by Remer (1995). Higher amino-acid levels, such as for arginine and histidine (6 times and 2.3 higher respectively), were found by Zaimenko (1998) after treating Anthurium plants with a boiler-waste silica compound. Amino-acid concentrations in trial lettuce plants were similar to the values reported in the USDA amino-acid content database for lettuce (Figure 3). Further investigation is needed to establish to what extent the silica spray might affect nitrogen assimilation and metabolism in plants.
Soil microbial activity, measured by soil respiration \textit{ex situ} at 28 DAT, was highest in composted plots and lowest in sprayed plots (Figure 4).

![Graph](image)

**Figure 4.** Carbon dioxide respiration in soil samples taken from each plot 28 days after transplanting. Bars represent standard error of means. Treatment codes shown in Table 1.

**Conclusions**

There is now a large body of research indicating improved resistance to pests, disease, drought and other stresses on plants from the application of silica fertilisers and sprays. There is also evidence of improved nutrient uptake.

Higher fresh yields of field lettuce were observed when a volcanic sandy loam was fertilised with organic composts than with a mixture of diammonium phosphate and calcium ammonium nitrate, applied at similar N and P application rates. Although lettuce yields were higher when the compost and plants were treated with biodynamically prepared silica sprays, the variation in lettuce fresh yield in the field was high (coefficient of variation $= 28\%$), and the effects of the sprays were not statistically significant. Irrespective of fertiliser source (composts or soluble fertiliser), silica sprays produced lettuce with higher dry matter content; but the application of silica spray had no statistically significant effect on lettuce fresh head yield, N uptake, plant-sap nitrate concentrations and amino-acid content.

The challenges of high variability encountered when conducting trials with living plants and soil are increased when attempting to make trials relevant to a whole systems context. However, further investigation in this area would address the debate about whether there are nutritional and health advantages from eating organic produce. No progress can be made in this debate unless the management factors that could contribute to such an advantage can be identified and measured. The concept of identifying practices that integrate growth and differentiation processes in plants introduced by Bloksma \textit{et al.} (2001) is relevant to the question of how plant nutrient uptake and assimilation can be regulated within an organic system to optimise product quality. In view of the increasing evidence of benefits from application of activated silica to crops, the effects of application of biodynamic field sprays should be further investigated. In any such investigation, interactions between foliar treatments, plant metabolism, and plant interface with soil and soil organisms need to be taken into account.

**Acknowledgements**

Assistance with experimental work and analysis by Prof Mike Hedley and the late Dr Neil Macgregor at Massey University Soil and Earth Sciences Department is gratefully acknowledged.

**References**


SOYABEAN MEAL SUPPLEMENTATION TO MANAGE PARASITES IN LAMBS GRAZED ON ORGANIC PASTURES IN NORTH EAST VICTORIA

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Abstract
Over 20,000 organic lambs are produced from southern Australian farming systems each year. Internal parasite infection of organic sheep and lambs is the most common production issue mentioned by producers. In organic systems, anthelmintic drenches are prohibited under current Australian organic standards, so producers rely on cultural methods such as lower stocking rates and rotational grazing. Recent research investigated the use of supplementary protein in the management of parasites in lambs. Experiments were conducted in 2005 and 2006 to investigate the use of soyabean meal as a source of supplementary protein to reduce faecal egg count (FEC) in lamb finishing systems on either annual or perennial organic pastures. Lambs were supplementary fed with organic soyabean meal equivalent to 2.4 MJ/kg DM ME per head per day and 51g/head/day CP in 2005, and in 2006, 2.1 MJ/kg DM ME per head per day and 61 g/head/day CP; this was compared to non-supplemented lambs grazing pasture only. Soyabean meal supplementation did not reduce FEC, with the exception of only one from a total of 14 samplings in the two pasture systems over two years. This was likely due to high CP in the pasture, rotational grazing practice and limitations with the FEC methodology. Soyabean meal supplementation improved lamb growth rates in both finishing seasons on annual pasture, but final liveweight was only increased in 2006. Soyabean meal supplementation did not improve growth rate or final liveweight on perennial pasture in either season. Soyabean meal supplementation resulted in heavier (P<0.05) Hot Standard Carcase Weight in lambs grazing annual pasture in 2005. Soyabean meal supplementation of lambs grazing pasture is unlikely to be effective in seasons and under pasture conditions similar to those tested in this study.

Key words: soyabean meal supplementation, lambs, parasites, organic

Introduction
Over 110,000 lambs are produced from Australian organic farming systems each year, with at least 20,000 lambs being produced from Victoria, South Australia and Tasmania (Hannigan 2007). One of the most common issues affecting organic lamb production in southern Australia is gastrointestinal nematode parasite infection. In a telephone survey of 75 organic sheep producers in Victoria, South Australia and southern New South Wales, where producers were asked to list the issues that were affecting their production system, parasite infection was the most cited production issue (Smith, pers. comm. 2004). This result concurs with other published data that regard parasite infections as being the most significant factor contributing to health problems in sheep and lambs (Cabaret et al. 2002, Besier and Love 2003). The annual cost of internal parasite infection in sheep is estimated at $369 million nationally, or $5.11 per head in the winter rainfall dominant production areas (Sackett et al. 2006).

In the high rainfall zones of southern Australia, the main species of parasitic worm affecting sheep and lambs are Black Scour Worm (Trichostrongylus spp.) and Brown Stomach Worm (Teladorsagia circumcincta) (Besier and Love 2003). Parasitic infection in sheep and lambs can negatively impact weight gain and skeletal growth, along with decreased milk and wool production (Coop and Holmes 1996). In the high rainfall zone, lambs are typically finished on annual pasture after autumn lambing, or on lucerne-based pasture systems after spring lambing.

In organic sheep production systems, anthelmintic drenches are prohibited under current Australian organic standards (NASAA 2004, BFA 2006). The focus in organic livestock systems is to minimise health problems through the adoption of specific health management strategies (Vaarst et al. 2004). There is a range of cultural management strategies that can be used to reduce the effect of parasites in sheep (Barger 1997), including varying stocking rates, timing of reproductive events, clean pastures, rotational grazing, alternate grazing by hosts, use of forage crops or hay/silage, varying the proportion of adult and young livestock,
choice of pasture species (Morley and Donald 1980), and breeding for resistance to parasite infection (Eady et al. 1996). In southern Australian organic sheep systems, producers concentrate on rotational grazing strategies and ensuring clean pastures, lower overall stocking rates, monitoring the level of worm infection, and selecting livestock for resilience to worm infection (Wynen 1992). Even with these cultural practices, parasite infection is still a major issue for sheep producers in southern Australia, and additional non-chemical control measures are required.

Protein is an essential component of the diet of ruminants; and the requirement for growth in weaned lambs is estimated to be 11-13% crude protein at 10.5-11.0 MJ/kg DM metabolisable energy (Freer 2007). Organic lamb is produced from pasture-based systems but, due to the seasonal changes in the growth and quality of pasture species, these systems often do not supply sufficient dietary protein for weaned lambs to achieve production targets. If there is insufficient dietary protein, growth rates of lambs (Liu et al. 2003) and resistance to parasite infection (Datta et al. 1998) can be negatively affected. This is because the immune response to parasitic infection competes for nutrient resources with other functions in the body (Coop and Kyriazakis 1999), so lambs that are growing rapidly may have increased susceptibility to infection (Datta et al. 1998).

Recent research has investigated the use of supplementary protein in the management of parasites in lambs (Datta et al. 1998, Kahn 2003, Steel 2003, Keatinge et al. 2004). It is suggested that a diet that increases the supply of metabolisable protein may allow Merino lambs to exhibit improved resistance against worm burdens without compromising growth rates and production (Steel 2003). Additional organic protein can be supplied via a supplementary feed source such as organic soyabean meal. It has been shown that soyabean meal supplementation can reduce faecal egg counts of Haemonchus contortus in Hampshire down lambs at specific times during the finishing phase after artificial infection (Wallace et al. 1995). In a similar experiment using Scottish blackface lambs, which are considered to be genetically resistant to helminths (Wallace et al. 1996), soyabean meal supplementation did not result in statistically different faecal egg counts from non-supplemented lambs. In the Scottish Blackface study, lambs receiving supplementation had higher weight gains and their carcases were leaner than lambs without supplementation (Wallace et al. 1996).

The aim of our study was to investigate the effect of organic soyabean meal supplementation, as a protein source, on the growth and worm resistance of weaned crossbred lambs within two organic, pasture-based finishing systems. It was hypothesised that lambs receiving protein supplementation would have increased growth rates and reduced faecal egg counts (FEC).

Materials and Methods

Site details
Our experimental site was located at the Department of Primary Industries (DPI) Rutherglen Centre (36°06'45.67"S; 146°31'20.17"E; elevation 177 m), north east Victoria between January 2005 and February 2007. The soil type was classified as Chromosol, sub order brown (Isbell 1996).

Experimental design and treatments
Two experiments were conducted during 2005-07 to determine the effectiveness of organic soyabean meal as a protein supplement for increasing lamb growth rate and reducing faecal egg counts in lambs grazed on annual (Experiment 1) or perennial (Experiment 2) pastures. The factor tested was soyabean meal as a protein supplement (supplement). Experiment 1 commenced at lamb weaning in August 2005 and concluded in October 2005, and was repeated in 2006 from August to November. Experiment 2 commenced at lamb weaning in October 2005 and concluded in December 2005, and was repeated in 2006 from October to January. Prior to the experiments commencing, ewes and lambs grazed on mixed pasture in an adjoining paddock to the experimental site.

Experiments 1 and 2 consisted of eight plots, each with six (3 ewes and 3 wethers) second cross 4-months old lambs (first cross ewe [Merino*Border Leicester] ram [*White Suffolk]) allocated to each plot. Lamb liveweight (straight off feed) at lamb weaning was used to stratify the lambs for allocation to the plots. Four of the eight plots in each experiment were allocated for supplementary feeding and four plots allocated for nil supplementation. The allocation was performed using the CDESIGN procedure in GenStat 11 (Payne et al. 2008a).

Each plot was 0.64 ha and was subdivided into three sub-plots of 0.21 ha to allow for rotational grazing. Lambs were rotated through the sub-plots when feed on offer was reduced to 1100 kg DM/ha or when a
maximum period of three weeks had lapsed. The stocking rate was determined following the recommendations of Saul and Kearney (2002).

Supplementary feeding

The supplement provided to the lambs was a certified organic soyabean meal (KR Castlemaine™ 64 Richards Road, Castlemaine, Victoria). Supplemented lambs were fed 1.98 kg fresh weight soyabean meal/plot (6 lambs) three times per week to provide an average allocation of 141 g/head/day. All supplement feed was consumed by the lambs. Nil supplemented lambs grazed pasture only with no additional supplementation.

Based on the nutritional value of the soyabean meal (Table 5a), in 2005 the rate of supplementation was equivalent to 2.4 MJ/kg DM ME per head per day and 51g/head/day CP, and in 2006 was equivalent to 2.1 MJ/kg DM ME per head per day and 61 g/head/day CP. This rate of supplementation was aimed at providing supplemented lambs on both pasture systems an average of 20% more CP than non-supplemented lambs. It is recognised that the variable nature of pasture growth, which is dependent on rainfall, nutrient availability and grazing pressure, will influence the effectiveness of the supplementation. The rate of supplementation was calculated at the start of the experiment using the liveweight of the lambs (22 kg), the daily requirement for pasture DM (1.4 kg), the CP of the pasture system (19.2% annual and 16.7% perennial) and the soyabean meal (38%). Previous studies (Wallace et al., 1996) have increased crude protein via soyabean meal in excess of 40% over the basal diet, but the nutritional analyses on the pasture systems for this experiment indicated crude protein at sufficient levels (193 g/kg DM), so an increase of only 20% using soyabean meal was used. Lambs on annual pasture receiving supplement were fed via troughs (1.45m × 0.4m) in plot groups from 8 August until 24 October in 2005, and from 14 August until 14 November in 2006. Lambs on perennial pasture receiving supplement were fed via troughs (1.45m × 0.4m) in plot groups from 31 October until 17 December in 2005, and from 30 October 2006 until 29 January 2007. In the 2006-07 finishing season on perennial pasture, poor pasture growth due to drought conditions required that animals receive supplementary feeding with oaten hay from 18 until 30 January 2007. Lambs in perennial pasture blocks received 6.3 kg oaten hay/head/week; this supplied 64% of their estimated daily intake of 1.4 kg DM/day.

Animal measurements

Faecal egg count (FEC) was measured from samples taken directly from the rectum and analysed according to the method of Whitlock (1948). FEC sampled from experimental lambs were not tested for individual worm species because of funding constraints. Prior to the experiment commencing, however, FEC was measured on the ewes as a mob to determine the worm species that were present; these were Nematodirus spp. (Thin Necked Intestinal Worm), Oesophagostomum spp. (Large Bowel Worm), Ostertagia spp. (Brown Stomach Worm) and Trichostrogylus spp. (Black Scour Worm). Lambs were weighed (full, not fasted) at weaning, and on each rotational cycle during the finishing periods. A timetable of FEC and liveweight assessment is shown in Table 1.

Table 1. Start and finish dates, and FEC sampling and liveweight assessment, shown by days during the experiment.

<table>
<thead>
<tr>
<th></th>
<th>2005 Expt. 1</th>
<th>2005 Expt. 2</th>
<th>2006 Expt. 1</th>
<th>2006 Expt. 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>6 July - Day 1</td>
<td>17 Oct - Day 1</td>
<td>4 July - Day 1</td>
<td>20 Oct - Day 1</td>
</tr>
</tbody>
</table>

Lamb growth rate from weaning to final liveweight (g/day) was calculated by subtracting weaning live weight from final live weight, and dividing this number by the number of days between weaning and final liveweight. All lambs in the experiment were slaughtered when the average liveweight in each finishing group reached 45 kg (full). This weight was used as being indicative of required market liveweight to achieve maximum return to producers. Hot Standard Carcase Weight (HSCW) was also analysed for treatment differences.

Pasture composition and management

The annual pasture plots, established in June 2004, consisted of subterranean clover (Trifolium subterraneus L. cvs. Goulburn and Riverina) and annual ryegrass (Lolium rigidum Gaud. cv. Wimmera). The
perennial pasture plots, also established in June 2004, consisted of lucerne (*Medicago sativa* L. cv. Genesis), phalaris (*Phalaris acquatica* L. cv. Sirosa), plantain (*Plantago lanceolata* L. cv. Tonic) and chicory (*Chicorium intybus* L. cv. Grouse). All pasture blocks were top-dressed with 20 kg P/ha (172 kg/ha as Guano™); they had not been grazed prior to the start of the experiment.

**Pasture measurements**

Total dry matter (DM) of pasture (t/ha) was assessed using a falling plate disk (Bransby *et al.* 1977), before and after each grazing rotational cycle on one sub plot in each plot. Dry matter contribution of dominant pasture species was assessed using the dry-weight-rank method according to ‘T Mannetje and Haydock (1963). Dry matter was assessed seven times during the 2005 finishing period on 27 June, 4 July, 29 August, 10 October, 17 October and 12 December, and on 8 February in 2006. Dry matter was assessed five times during the 2006 finishing period on 3 July, 8 August, 10 October and 28 November, and on 13 February in 2007.

Pasture samples for nutritive characteristics were collected from each plot (15/plot) using a ring quadrat (30 cm diameter); this was thrown randomly, the pasture was cut using shears to obtain a sample close to ground level, and then bulked for annual or perennial pasture Feedtest assessment. Pasture samples for both annual and perennial were taken in 2005 on 27 June, 29 August, 11 October and 12 December, in 2006 on 10 July, 15 August, 6 October and 28 November, and in 2007 on 8 January.

Herbage samples were analysed (Feedtest, Hamilton, Department of Primary Industries, Victoria) for CP (nitrogen concentration × 6.25), neutral detergent fibre (NDF) and dry matter digestibility (DMD). Values were estimated for all samples using near infrared spectroscopy (NIR). Metabolisable energy (ME) (MJ/kg DM) values were calculated from predicted DMD values using the formula: ME = {0.164 (DMD% + EE) – 1.61} where EE = Ether Extract (% of DM), but assumed to be 2% for all types of fodder (AFIA 2002).

Daily pasture intake of the lambs was not measured because of project constraints. However, the total DM of pasture was measured for each plot during the finishing periods to obtain average feed on offer.

**Statistical analysis**

To assess the significance of difference between supplementation and no supplementation, the plot-level data for each characteristic (final liveweight, growth rate (weaning to final), HSCW and total FEC) were analysed using analysis of variance (ANOVA) appropriate for a split-plot design (where sex was used as the split/blocking variable). The analyses involving weight and growth rate were adjusted for the lamb’s initial birth weight (used as covariate) to account for any variability in birth weight that may impact on liveweight and growth rate. FEC data were summed at each sampling time, as repeated measures of ANOVA yielded the same results as summed data. Post-ANOVA residuals-based diagnostic plots also showed that, for each characteristic, the data reasonably met the ANOVA assumptions. Total FEC was log-transformed prior to analysis to normalise variances. All statistical analyses were performed in GenStat 11 (Payne *et al.* 2008b).

**Results**

**Effect of soyabean meal supplementation on faecal egg count**

Soyabean meal supplementation did not reduce FEC in either experiment over the two years. Worm numbers in Experiment 1 reflected the increasing trend in epg associated with the onset of milder and moister spring conditions (Figures 1 and 3). In both experiments, worm numbers were higher in the 2006 finishing season than in the 2005 finishing season. In 2006 in Experiment 1, worm numbers were elevated (not significant) during August through to October (average of 486 epg), although no clinical signs of parasite infection were observed in the lambs. Soyabean meal supplementation reduced (P<0.05) FEC in only one sampling from a total of 14 samplings from the two experiments over the two years (107 vs. 150 epg lsd 38; 9/1/07 Experiment 2) (Figure 2). Worm numbers were below 300 eggs per gram of faeces (epg) in Experiment 2 in both years; this reflected the decreasing trend in FEC with the onset of warmer, drier conditions (Figures 2 and 3).
Figure 1. FEC (epg) in Experiment 1 in 2005 and 2006; no significant differences with soyabean meal supplementation on annual pasture.

Figure 2. FEC (epg) in Experiment 2 in 2005 and 2006; lsd 2006, Jan 9=38 on perennial pasture.
Effect of soyabean meal supplementation on lamb growth rate and final liveweight

In Experiment 1, soyabean meal supplementation improved (P<0.05) lamb growth rate from weaning to final liveweight in both finishing seasons (Table 2). Final liveweight was only increased (P<0.05) in Experiment 1 in the 2006 finishing season. In Experiment 2, there was no effect of soyabean meal supplementation on growth rate or final liveweight in either finishing season (Table 3).

Table 2: Growth rate (g/day) and live-weights (kg) during the finishing period for lambs grazing annual pasture (Experiment 1) in 2005 and 2006

<table>
<thead>
<tr>
<th>Measurement</th>
<th>2005 finishing season</th>
<th>2006 finishing season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Growth rate weaning to final</td>
<td>Live weight final</td>
</tr>
<tr>
<td>Supplement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td>232</td>
<td>50.77</td>
</tr>
<tr>
<td>NO</td>
<td>196</td>
<td>46.53</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>32</td>
<td>4.65</td>
</tr>
</tbody>
</table>

Table 3: Growth rate (g/day) and live-weights (kg) during the finishing period for lambs grazing perennial pasture (Experiment 2) in 2005 and 2006

<table>
<thead>
<tr>
<th>Measurement</th>
<th>2005 finishing season</th>
<th>2006 finishing season</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Growth rate weaning to final</td>
<td>Live weight final</td>
</tr>
<tr>
<td>Supplement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td>273</td>
<td>45.84</td>
</tr>
<tr>
<td>NO</td>
<td>240</td>
<td>43.20</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>35</td>
<td>3.56</td>
</tr>
</tbody>
</table>

Effect of soyabean meal supplementation on hot standard carcase weight (HSCW)
Soyabean meal supplementation resulted in heavier HSCW (P<0.05) only in Experiment 1 in the 2005 finishing season (Table 4). In Experiment 2 there was no effect of soyabean meal supplementation on HSCW in either finishing season (Table 4).

Table 4: Hot Standard Carcase Weight (HSCW) (kg) of lambs finished on annual and perennial pasture systems in 2005 and 2006

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Experiment 1. Annual pastures</th>
<th>Experiment 2. Perennial pastures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supplement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>YES</td>
<td>22.97</td>
<td>22.50</td>
</tr>
<tr>
<td>NO</td>
<td>20.67</td>
<td>20.97</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td>2.01</td>
<td>1.77</td>
</tr>
</tbody>
</table>

**Feed on offer and pasture nutritive characteristics**

Feed on offer in both experiments ranged between two and eight t DM/ha over the two finishing seasons (Figure 4). Pasture production was high in spring 2005 as a result of unusually high rainfall from September to December (Figure 3). Feedtest analysis of the soya bean supplement is shown in Table 5a. The CP of the pasture in Experiment 1 averaged 13.9% in 2005 and 12.5% in 2006 (Table 5b), and in Experiment 2, averaged 18.2% and 15.4% respectively for the two finishing seasons (Table 5c), demonstrating that the pastures where lambs were not supplemented had sufficient CP available for liveweight gain. ME in Experiment 1 was 10.1 and 8.5 MJ/kg DM for the 2005 and 2006 finishing seasons respectively, and in Experiment 2, was 9.2 and 8.4 MJ/kg DM (Tables 5b and 5c).

![Figure 4. Total pasture mass (t DM/ha) on supplemented and non-supplemented plots during Experiments 1 and 2 from September 2004 until February 2007.](image-url)
Table 5a. Feedtest™ analyses of organic soyabean meal and oaten hay

<table>
<thead>
<tr>
<th>Test</th>
<th>Soyabean meal 2005</th>
<th>Soyabean meal 2006</th>
<th>Oaten hay</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein (% DM)</td>
<td>42.1 (38)*</td>
<td>46.2</td>
<td>9</td>
</tr>
<tr>
<td>Neutral detergent fibre (% DM)</td>
<td>-</td>
<td>-</td>
<td>55.1</td>
</tr>
<tr>
<td>DM digestibility (% DM)</td>
<td>90.7</td>
<td>90.1</td>
<td>65</td>
</tr>
<tr>
<td>Metabolisable energy (MJ/kg DM)</td>
<td>18.2</td>
<td>15.8</td>
<td>9.6</td>
</tr>
<tr>
<td>Fat (Ether extract)</td>
<td>18.5</td>
<td>9.9</td>
<td>-</td>
</tr>
</tbody>
</table>

* 38% crude protein recorded on bag and used for supplement calculation

Table 5b. Feedtest™ analyses for annual pasture (Experiment 1) during finishing periods in 2005 and 2006.

<table>
<thead>
<tr>
<th>Test</th>
<th>27/6/05</th>
<th>29/8/05</th>
<th>11/10/05</th>
<th>12/12/05</th>
<th>10/7/06</th>
<th>15/8/06</th>
<th>6/10/06</th>
<th>28/11/06</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein (%DM)</td>
<td>19.2</td>
<td>16.9</td>
<td>12</td>
<td>7.4</td>
<td>15.4</td>
<td>16.3</td>
<td>9.4</td>
<td>8.8</td>
</tr>
<tr>
<td>Neutral detergent fibre (%DM)</td>
<td>50.6</td>
<td>44</td>
<td>44.9</td>
<td>61.8</td>
<td>63.8</td>
<td>55.7</td>
<td>54.9</td>
<td>74.8</td>
</tr>
<tr>
<td>DM digestibility (%DM)</td>
<td>69</td>
<td>76.1</td>
<td>74</td>
<td>54.2</td>
<td>58.3</td>
<td>63.9</td>
<td>67.3</td>
<td>46</td>
</tr>
<tr>
<td>Metabolisable energy (MJ/kg DM)</td>
<td>10</td>
<td>11.5</td>
<td>11.1</td>
<td>7.7</td>
<td>8.4</td>
<td>9.4</td>
<td>10</td>
<td>6.3</td>
</tr>
</tbody>
</table>

Table 5c. Feedtest™ analyses of perennial pasture (Experiment 2) during finishing periods in 2005 and 2006.

<table>
<thead>
<tr>
<th>Test</th>
<th>12/7/05</th>
<th>29/8/05</th>
<th>11/10/05</th>
<th>12/12/05</th>
<th>10/7/06</th>
<th>15/8/06</th>
<th>6/10/06</th>
<th>28/11/06</th>
<th>8/1/07</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crude protein (%DM)</td>
<td>16.7</td>
<td>23.5</td>
<td>16.5</td>
<td>15.9</td>
<td>15.9</td>
<td>19.5</td>
<td>16.5</td>
<td>12.5</td>
<td>12.6</td>
</tr>
<tr>
<td>Neutral detergent fibre (%DM)</td>
<td>61.3</td>
<td>38.6</td>
<td>45.2</td>
<td>49</td>
<td>62.5</td>
<td>47.8</td>
<td>48</td>
<td>70.4</td>
<td>70.9</td>
</tr>
<tr>
<td>DM digestibility (%DM)</td>
<td>48.5</td>
<td>72.6</td>
<td>68.6</td>
<td>60.7</td>
<td>49.1</td>
<td>68.6</td>
<td>69.5</td>
<td>48.1</td>
<td>55.7</td>
</tr>
<tr>
<td>Metabolisable energy (MJ/kg DM)</td>
<td>6.7</td>
<td>10.9</td>
<td>10.2</td>
<td>8.8</td>
<td>6.8</td>
<td>10.2</td>
<td>10.3</td>
<td>6.7</td>
<td>8.0</td>
</tr>
</tbody>
</table>

Discussion

Faecal egg count was not reduced by soyabean meal supplementation; there are several reasons that could explain this result. Firstly, it is important to acknowledge the limitations in the FEC data as a result of experimental design, the small number of animals and the low levels of FEC measured. The FEC method has large variation and error (Miller et al. 2006), so the comparison that can be made between supplemented and non-supplemented lambs is limited. However, this method was employed to make the best use of available resources for organic producers.

Secondly, the CP content of the pasture in both experiments and years was in excess of what is required to meet the nutritional requirements of growing lambs (114 g [11.4 %] CP/kg DM for a 30 kg lamb growing at 200 g/day; Freer 2007), except for the last month of Experiment 1 in both years. In Experiment 1 in 2005, CP ranged from 19.2 % to 12 % during the finishing period, and in 2006 it ranged from 15.4 % to 8.8 %. In Experiment 2 in 2005, CP ranged from 23.5 % to 15.9 %, and in 2006 it ranged from 19.5 % to 12.5 %. These protein levels may have masked any effect that additional protein might have had on FEC. The success of reduced FEC from supplemented protein has generally been in circumstances where there has been nutritional stress and high worm burdens (Wallace et al. 1996, Datta et al. 1998, Louvandini et al. 2006). In the north east Victorian environment, where annual pasture based on subterranean clover has dominated in the past, protein would not normally have been limiting in the spring season; however, climate variability in the last 10 years has resulted in numerous failed spring seasons during which subterranean clover has died and protein from these pasture systems may have been limiting. In this context we considered that supplementary protein was worthy of investigation.
A 30 kg lamb consuming 1.4 kg DM/day and growing at 325 g/day requires a daily ME requirement of 12 (MJ/kg DM). Experiment 1 had ME levels ranging from 11.5 to 7.7 MJ/kg DM in 2005, and in 2006, ME ranged from 10 to 6.3 MJ/kg DM. In Experiment 2, ME ranged from 10.9 to 8.8 MJ/kg DM in 2005, and in 2006, ranged from 10.3 to 6.7 MJ/kg DM. These energy levels are lower than what is required, but lambs in both experiments increased in liveweight during the finishing period. Lambs not receiving supplement grew at an average rate of 221 g/day in Experiment 1 and 219 g/day in Experiment 2. High fibre content in the pasture may have restricted intake, but this was not reflected in liveweight gain. Those lambs receiving supplementation acquired additional energy from the soyabean meal (all consumed), which had ME in 2005 and 2006 of 18.2 and 15.8 MJ/kg DM respectively. This may have contributed to significantly higher growth rates in this treatment.

Thirdly, rotational grazing and the use of clean pastures can reduce the level of intestinal parasite infection (Besier and Love 2003). In the first finishing season (2005) for both experiments, sub-plots were considered to be of low risk for worm infection, having had no grazing since early 2004. The experiment was conducted using rotational grazing practice, whereby lambs were rotated through three sub-plots every two to three weeks. This allowed for a period of at least four weeks before lambs were returned to a grazed pasture. In terms of the life cycles of the major worm species, this amount of time is insufficient to prevent re-infection. Southcott et al. (1976) have demonstrated that the main worm species can persist over 12 months in a temperate environment. Whilst strict grazing management practice to avoid parasitic larvae consumption has been recognised as an important non-chemical method for managing internal parasites (Larsen 1991, Eysker et al. 2005), it is not practical or viable for most producers to have multiple paddocks such that grazing occurs at extended intervals of months. The grazing period was, however, sufficient for new pasture growth to occur such that lambs were easily able to browse the herbage (Hodgson 1979) without having to graze close to ground level where the potential for ingestion of larvae is higher.

Supplementary soyabean meal resulted in increased growth rates in three out of four finishing seasons. According to SCA (1990) guidelines, lambs (30 kg liveweight) require 1.4 kg DM/day, and this can return a growth rate of 325 g/day, providing that the dry matter meets CP and ME requirements. Lambs receiving supplement on the annual pasture grew an average of 221 g/day, whilst those without supplement grew an average 191 g/day. Lambs receiving supplement on the perennial pasture grew an average 241 g/day, whilst those without supplement grew an average 220 g/day. Although there was variation in ME during the finishing periods, it is likely that lambs receiving supplement were more able to meet the required intake of CP and ME to grow faster than lambs without supplement.

Lambs were finished on the two pasture systems in quite contrasting seasons, and this may have had an effect on the results. Rainfall during the finishing period (July – October) of the annual pasture system in 2005 was 297 mm, and in 2006 it was 88 mm. In the perennial pasture system in 2005, rainfall during the finishing period (October – December) was 232 mm compared with 51 mm in the equivalent period in 2006. The very wet season in 2005 would usually have meant a greater potential for parasite burdens for lambs, but levels were kept low due to the ‘low risk’ (no grazing for 12 months) nature of the pasture systems. In 2006, which was exceptionally dry, FEC was elevated during the annual system finishing season, irrespective of the dry weather. This raises the issue of whether the grazing system would have been sustainable in terms of FEC given a wetter spring season. Seasonal variation cannot be avoided when conducting a field experiment. The experimental design was conservative, being based on average pasture growth where CP was not expected to be high. With regard to the higher rainfall in 2005, and increased pasture growth, stocking rate could not have been increased to account for this growth because of animal ethics requirements and project budget constraints. Future experiments should incorporate flexibility in design to allow for variable stocking rates.

Soyabean meal supplementation resulted in increased liveweight in lambs in the north east Victorian environment, but did not result in reduced FEC. Although a direct comparison between the annual and perennial finishing systems cannot be made, higher final liveweight was recorded in lambs finished on annual pasture, but faster growth rates were recorded in lambs finished on perennial pasture. The financial viability of supplementary feeding with a high value protein source such as soyabean meal would have to be evaluated against the likely return from extra growth achieved and higher carcase weight of certified organic lamb product. There are risks for organic producers in finishing lambs during the spring on annual pasture systems, especially if pastures are not initially ‘clean’, and if there is average spring rainfall to allow for parasite life cycle development. Longer periods of time for pasture to become clean after grazing are generally not practical in many farming businesses, so organic producers could reduce this risk by finishing lambs on perennial pastures during the summer months when the risk of internal parasite infection is lower.

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Abstract
Organic farming is becoming popular in Southeast Asia as part of sustainable agriculture systems. This study aims to compare the opinions and attitudes towards organic farming systems by organic rice farmers (OF) and non-organic rice farmers (NOF) in Surin province, north-eastern Thailand. The comparison was drawn from opinions of OF and NOF interviewees who are engaged in jasmine rice farming. The data presented were based on information collected from 100 OF interviewees and 100 NOF interviewees. The interviews enabled us to compare their attitudes towards organic farming based on four aspects, namely: organic farming knowledge, environment, marketing, and costs and benefits. Comparisons were made not only of socio-economic indicators, but also their opinions. Chi-square and t-test were employed to quantify correlations in this study. It was found that there was a correlation of attitudes of both OF and NOF interviewees in the four aspects examined. Additionally, educational level, farm holding and extension-worker contact affected opinions and attitudes of OF interviewees. Among NOF interviewees, their farming experiences affected their attitude towards organic farming.

Keywords: Comparison, farmers, organic farming, north-eastern Thailand, sustainability

Introduction
Organic farming is being promoted and is gaining acceptance all over the world, especially in Southeast Asia, as part of the latest efforts to encourage agriculture systems that are both socially and ecologically sustainable. The system is based on minimising the use of costly external inputs, such as synthetic fertilisers and pesticides, by increasing and efficiently utilising farm-based resources (Ramesh et al. 2005). Organic methods have been adopted more rapidly in most industrialised countries (Lampkin and Padel 1994) than in the Third World (Scialabba 2000).

In Thailand, five different farming systems are perceived by the government as being sustainable: integrated farming, organic farming, natural farming, agro-forestry, and ‘New Theory Farming’ (Jitsanguan 2001, Suksri et al. 2008). Integrated, organic, natural and agro-forestry farming systems have been slowly gaining acceptance among Thai farmers. This has resulted in multiple socio-economic benefits to farmers, and has contributed to environmental protection (Tipraqsa et al. 2007). The so-called ‘New Theory Farming’ was first proposed in 1993 by His Majesty the King Bhumiphol Adulyadej, with the explicit goal of improving agricultural self-sufficiency. The concept is aimed towards helping disadvantaged farmers with limited farm sizes, and lacking access to irrigation facilities, by introducing farm crop diversification in order to lessen dependence on single crops, thus ensuring a more steady income. The details of this revolutionary royal scheme have been outlined by Suksri et al. (2008) and Chainuvati and Athipanan (2001). Taken together, these five sustainable systems aim at improving soil fertility, ecosystem services and the wellbeing of people within systems characterised by harmonious co-existence of man and the environment. They rely on natural ecological processes, local biodiversity and regulated anthropogenic inputs that are adapted to local conditions, rather than on the use of ecologically incompatible inputs with generally adverse effects. The use of organic farming involves both basic and advanced knowledge in science, coupled with traditional know-how that emphasises the promotion of a better quality of life (IFOAM 2008).

Since the 1990s, the global market for organic products has continuously and rapidly grown at around 20 – 25% per year, reaching an estimated US$33 billion in 2005 (Ellis et al. 2006). Consumers worldwide have come to regard organics to be superior overall compared to conventionally grown produce (Byrne et al. 1991). In the urban centres of Thailand, organics are gaining acceptance among consumers, who believe such produce to be healthier and more environmentally friendly (Roitner-Schobesberger et al. 2008). The resultant increasing demand has driven a similar increase in the growth of organically managed farmlands. Approximately 306,000 square kilometres (30.6 million hectares) worldwide have been devoted to organic farming, representing about 2% of the total world farmland. In addition, in 2005 organic wild products were produced on about 62 million hectares of farms (Willer and Yussefi 2007).
In Thailand, organic farming following the traditional definition is not really a recent phenomenon, as Thai farmers have been practicing traditional farming for years. Such practices have been developed based on environmentally sustainable ways of farming; and this has been enriched through farmers’ local agro-ecological knowledge handed down through the generations. Despite the rapid expansion of modern agricultural technology, traditional farms have existed and are solidly grounded based on the local knowledge of sustainable farming. These farms can be considered as the precursors of the revitalised, modernised organic farming systems seen today. Since the 1980s, modern Thai organic agriculture has become a large movement initiated by farmers and local non-government organisations (NGOs). Since then, the movement has been strongly supported by consumers’ preferences for organics. One of the positive outcomes was the establishment of the Alternative Agriculture Network (AAN) in 1984 as a national network providing lessons through experiences, as well as advocating policy for the establishment of sustainable agriculture, including organic farming. In 2003, it was estimated that 8,958 ha of farmlands were under organic management throughout the country (Panyakul 2003). This represents around 0.04 % of the country’s total farmlands. Thus, organic farming in Thailand is still at an early developmental stage. The main organic products are rice and fresh vegetables (Panyakul 2003).

Agriculture is the primary economic driver in north-eastern Thailand, generating around 22% of its gross regional product (DOAE 2008). This is much higher than the country’s average, which is 8.5% of the gross domestic product. Beneath this seemingly glossy statistic, however, is the reality of the poor agronomic and socio-economic situation of the region. Soil in north-eastern Thailand is generally sandy, saline and acidic, with low organic matter content and low water retention. Soil erosion is common as a result of uncontrolled deforestation activities. Unstable rainfall patterns falling on sloping terrain make irrigation impractical; therefore rain-fed agriculture is often the only option (Mitsuchi et al. 1986).

It is widely acknowledged that agriculture in Thailand has continuously reduced its importance in economic terms since the 1970s due to low agricultural productivity. Unfortunately, no significant manufacturing investments can be set up in the north-eastern region, primarily because it is far from the main seaports (Suksri et al. 2008). The maintenance of economic and social infrastructures also lags behind other regions, resulting in widespread poverty among its inhabitants. The small household farmers in north-eastern Thailand are subjected to conditions of environmental restrictions and rapid economic change. They have to rely on many external inputs, which impact on the agricultural productivity, while per capita income of the region remains far below the national average of 62,300 Baht (approximately 35 Thai Baht [ThB]=US$ 1, citing 2008 figures; DOAE 2008).

In the middle of the 20th century, high yielding varieties (HYV) and intensive use of mineral fertilisers for increasing production and raising productivity have been introduced throughout the country. These ‘green revolution’ technologies bring benefits to a limited number of farm households. However, for poorer farmers, who rely on a few improved crop varieties, the inefficient and misguided use of the external financial inputs, such as credit facilities, makes them vulnerable to market realities. As a result, they incur increasing debt burdens (Tiprasha et al. 2007). To earn the money needed to pay the rising costs for procuring external inputs, farmers often leave their families for several months to work off farm. There are many farmers who take up loans to buy fertilisers and pesticides, only to subsequently renege on their financial obligations. When they fail to harvest, the loans often cannot be repaid. Such is the reality facing many Thai farmers in the north-eastern region today. The increasing need for money for sustaining daily subsistence and farm productivity has forced a large number of farmers to move from the countryside to the cities (Chouichom 2001).

A voluntary shift to a sustainable agricultural scheme like organic farming is expected to solve some of the problems of the small-scale farmers who are using external inputs. Some farmers have perceived the many advantages of organic farming system via various information sources, while some still have negative opinions towards it. Such opinions are influenced by a variety of factors. In most developed countries in Europe and North America, environmental concerns have been the most compelling influence on farmers’ opinions (e.g., Dubgaard and Sorensen 1988, Svensson 1991, Milder et al. 1991). These are grounded in well-publicised information, specifically on the positive effects of organic systems, as well as on the multiple deleterious environmental effects brought about by unsustainable farming practices. The shift from conventional to organic systems in these countries is often guided by ethical concerns. In less developed countries, on the other hand, economic considerations are among the strongest factors shaping farmers’ opinions (e.g., Scialabba 2000, Jitsanguan 2001, Bonny and Vijayaragavan 2001, Isin et al. 2007). In these countries, the practice of agriculture is often deeply rooted in age-old farming traditions that form the backbone of rural societies there. Greater resistance to change and innovation can be reasonably expected, and it usually requires a more vigorous effort for new knowledge and practices to gain a foothold. Set against
a backdrop of rural poverty, any effort toward change must be based on tangible economic returns, as well as other benefits.

Most rice-growing societies are concentrated in the tropical regions of South and Southeast Asia. In many of these regions, rice production volume often dovetails with rice consumption figures, leaving little surplus each year for export or for security against episodes of crop failure. With the growing demands for farm products grown under environmentally friendly conditions, and the burgeoning organic food market that creates yet another economic niche, rice producers everywhere are being challenged to meet these demands, albeit in a slow and calculated manner. In these rice producing countries, the important role of technology transfer and agricultural extension cannot be overemphasised. The crucial role of extension agents has undergone critical changes lately, from the classical ‘bringer of messages’ to a more pro-active role as catalyst and partner for farmers (Phillips-Howard 1994). The success of any adoption program relies to a large extent on this dynamic partnership between farmers and extension workers, as documented by previous studies.

In view of the above, farmers’ attitudes and opinions towards organic farming systems (OFS) should be evaluated to identify their actual perceptions about OFS. Both their viewpoints and decision-making patterns for adopting organic farming, whether positive or adverse, should be determined for developing effective extension methods in the delivery of sustainable agricultural practices. Hence, the specific objectives of this study were designed to analyse and compare the opinions of organic farmers (OF) and non-organic farmers (NOF) towards organic farming, and also to determine the relationship between both groups of farmers’ opinions and their socio-economic profiles towards OFS in north-eastern Thailand.

**Methods**

**Study area**

The survey was conducted in three districts of Surin province, north-eastern Thailand: Maung, Srikhonrapoom, and Kwaosinnarin districts. The province has a total land area of 8,124,056 km². In 2008, the area devoted to rice farming amounts to 3,172,132 rai (1 rai = 1,600 m²), or around 71.52% of the entire provincial agricultural land (3,631,421 rai). Surin ranks 10th in terms of human population among the 76 provinces of Thailand, with a total population of 1,404,252. The province is divided into 17 districts (amphoe) with 158 Sub districts (tambon) consisting of 2,119 villages (moobaan). The number of farming households is estimated at 189,139. About 92.8% of the total population lives in the rural area, and most of them do rice farming. The above-mentioned three districts were selected for this study because of their extensive cultivation of organic rice (DOAE of Surin 2008).

**Data collection**

The research was carried out in September 2008 after a pre-test conducted in August. Yamane’s formula (1973) was adopted to acquire the appropriate sample size for this research, which involved 400 farmers engaged in rice cultivation. As of 2008, these farmers had at least three years experiences of rice cultivation. As a sub-sample, 200 out of 400 farmers were selected, consisting of 100 practitioners in each of OF and NOF, so as to compare their opinions of organic farming. OF interviewees, in this study, used no chemicals on their farms. The study employed a semi-structured and structured questionnaire. In order to complement both quantitative and qualitative data, more information was collected through focus group discussions. This study used a population-based survey to determine the opinions of farmers about organic farming. Interviews were conducted both on the farm-sites and in their households. The 400 respondents were classified in terms of areas and numbers as follows: Maung district (243 farmers), Srikhonrapoom district (121 farmers) and Kwaosinnarin district (36 farmers). The interviews included both open-ended and closed questions, and some questions also elicited quantitative data. The modified interview details include four main aspects of opinions regarding organic farming. The responses were scored on a five-point Likert’s scale ranging from ‘strongly agree (5)’ to ‘strongly disagree (1)’ (Likert 1932).

**Data analysis**

All data were analysed with the SPSS (Statistical Package for the Social Sciences) for Windows. Descriptive statistics was applied to analyse percentage, arithmetic mean and standard deviation. To test the differences between opinions in organic farming of both OF and NOF farmers, T-test and chi-square statistics were conducted. A significance of $p < 0.05$ was set for statistical significance.
Results and discussion

Demographic characteristics of OF and NOF interviewees

The comparison between socio-economic and demographic characteristics of OF and NOF by mean values is shown in Table 1. The average age of OF interviewees (48.6) was higher than for NOF interviewees (43.7); and OF interviewees also had higher level of education than NOF interviewees. Thai farmers with higher education levels tend to adopt OFS more readily, as has been found in most other countries (Lampkin and Padel 1994). Among the Thai farmers surveyed, it is likely that a combination of longer farm experience (partly evidenced by higher age) and higher educational experience are strong factors supporting OFS adoption. Isin et al. (2007) underscored the important role of education as the most influential social factor in the adoption of organic agriculture, although the educational attainment of Thai farmers is still lower than the current Thai national compulsory education of 9 years (OBEC 2009). Illiteracy can certainly affect decision-making patterns associated with OFS adoption anywhere.

Moreover, both OF and NOF interviewees employed almost equal number of combined family and hired labourers, 7.7 and 7.6 persons, respectively, but OF cultivated a smaller farming area of 14.97 rai, whereas NOF planted on 18.41 rai. This would indicate that OFS are more labour intensive. NOF interviewees used more convenient agricultural machinery, such as two wheeled tractors and small water pumps, than OF interviewees. This could be because of the declining access to agricultural labour experienced in countries like Thailand (Hussain and Doane 1995); this may have resulted in labour-intensive activities such as animal herding to be abandoned in some areas (Tipraqsa et al. 2007).

Based on our findings, the total agricultural annual income and monthly savings of OF interviewees was found to be ThB 54,049.24 and ThB 2,835.75, respectively, whereas NOF interviewees earned an annual income of ThB 43,305.57 and saved ThB 1,480.24/month. This is supported by the fact that most OFS require less financial input, but they are more dependent on available manpower and local natural resources (Scialabba 2000). However, OFS, on average, require more hand labour than conventional farms, but the labour is spread out more evenly over the growing season (Pimentel et al. 2005, Badgley et al. 2007).

From this field survey, which compared the costs and output of rice farming using conventional and organic methods, we discovered that organic farming costs were ThB 24,450.36/rai, whereas conventional methods were more expensive at ThB 30,741.91/rai. Comparing harvests and market prices, however, the results are not significantly different: conventional farmers harvest 454 kg/rai, which fetches a market price of ThB 16/kg for unmilled rice (ThB 7,264), whereas organic farmers realise 448 kg/rai, which is sold at ThB 19/kg (ThB 8,512). Although differences in rice market prices do not vary greatly between organic and conventional rice, it seems that the difference in farming costs cited above is one of the factors that influenced these farmers' decision to farm organically.

Additionally, most of the OF interviewees have had more experience in ordinary rice farming (28.7 years), whereas NOF have had less experience (21.4 years). With respect to OFS, OF interviewees had 8 years experience, whereas NOF interviewees had not had this amount of experience. The OF interviewees surveyed in this study had more contact with agricultural extension officers concerning OFS issues relating to rice farming (6.5 times) than the NOF interviewees (merely 3.8 times). The training courses offered by extension workers are quite effective for OFS dissemination in the study area. However, we found that the NOF dealing with general rice farming topics did not pay much attention because they were not ready to transform their rice farming towards OFS, and also they were concerned about the low rice productivity in the first and second years when farmers are starting OFS. In addition to obtaining technical information from field extension agents, Wheeler (2007) observed that this can also be obtained from cooperatives, unions and other organisations. Extension worker contact can generally help reduce the risks brought about by change, provide better assurances and solve some agricultural problems due to lack of some specific knowledge and know-how (Hawkins and Ban 1996).
Table 1. Demographic and socio-economic profiles between organic farming (OF) and non-organic farming (NOF).

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>OF (n=100)</th>
<th>NOF (n=100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>48.6</td>
<td>43.74</td>
</tr>
<tr>
<td>Education (year)</td>
<td>8.5</td>
<td>6.3</td>
</tr>
<tr>
<td>Hired labour (persons)</td>
<td>4.5</td>
<td>3.2</td>
</tr>
<tr>
<td>Family labour (persons)</td>
<td>3.2</td>
<td>4.4</td>
</tr>
<tr>
<td>Farm holding (1 rai = 0.16 hectare)</td>
<td>14.97</td>
<td>18.41</td>
</tr>
<tr>
<td>Two wheeled tractors (number)</td>
<td>0.54</td>
<td>0.97</td>
</tr>
<tr>
<td>Small water pumps (number)</td>
<td>0.74</td>
<td>0.91</td>
</tr>
<tr>
<td>Total annual farm income (ThB/year)</td>
<td>54,049.24</td>
<td>43,305.57</td>
</tr>
<tr>
<td>Saving (ThB/month)</td>
<td>2,835.75</td>
<td>1,480.24</td>
</tr>
<tr>
<td>Total cost rice production all year (ThB/year)</td>
<td>24,450.36</td>
<td>30,741.91</td>
</tr>
<tr>
<td>Rice farming experience (years)</td>
<td>28.74</td>
<td>21.42</td>
</tr>
<tr>
<td>Extension worker contact (times/month)</td>
<td>6.5</td>
<td>3.8</td>
</tr>
<tr>
<td>Average rice product (Kg/rai)</td>
<td>448</td>
<td>454</td>
</tr>
</tbody>
</table>

Opinions of OF and NOF interviewees towards organic farming

Farmers’ opinions towards OFS were analysed based on four aspects: organic farming knowledge (OFKA), environmental effects (EA), marketing (MA), and cost and benefit aspects (CBA). The levels of opinions of these aspects and sub statements were measured on a five-point scale with the interpretative meanings of ‘5’ strongly agree, ‘4’ agree, ‘3’ somewhat agree or disagree, or neutral, ‘2’ disagree, and ‘1’ strongly disagree.

**Organic farming knowledge aspect (OFKA)**

Significant differences between OF and NOF interviewees concerning six expressions of general OFS knowledge are shown in Table 2.

These indicated that organic farming knowledge is virtually tied to favourable opinions towards sustainable farming development. The OF interviewees thought that OFS had become less complicated because they had received more training, knowledge and practice in organic farming. In contrast, the NOF interviewees believed that the OFS is really an intricate agricultural system with a corresponding economic risk during conversion. It was indicated that some OFS production processes were ineffective in enticing NOF interviewees to start organic farming.

Moreover, most of the NOF interviewees thought that organic farming requires more organic fertilisers and tedious procedures for soil treatment. The OF interviewees need to select and use the best quality rice seed for cultivation in their organic farms. The OF interviewees did not use chemical and pesticides in their rice farms, whereas the NOF interviewees use these products frequently, and any shift is likely to encounter resistance. The thought that NOF have to enhance soil conditions by using only organic fertilisers and natural materials for at least three years left the respondents concerned about income instability and other uncertainties. As a result, NOF interviewees developed a lukewarm attitude and were not interested in OFS, particularly in relation to the management of water and soil resources, and in the use of organic fertilisers. These are some of the reasons given as to why NOF show a reluctance towards adopting OF immediately.

In a study of alternative rice farming in southern Philippines, Baconguis and Cruz (2005) found that large inputs of technology among alternative farmers are widely regarded as being essential if profits are to be maintained. Thangata and Alavalapita (2003) observed that NOF may not have learned from the experiences of successful and contented OF. One underappreciated aspect is the reduced use of chemical fertilisers that cuts down farm production cost. Since wealthier households can afford using costly chemical fertilisers, there is less pressure for them to adopt OFS technologies. More established farmers using conventional rice farming methods do not see the need for greater and more modern technology inputs (Baconguis and Cruz 2005).

The OF interviewees had more access to special training courses and activities concerning the promotion of OFS. These courses and activities had been conducted by governmental agencies and NGOs in the form of field trips, seminars, trade fairs, and exhibitions outside the community. In this way, these farmers can acquire farming know-how to better manage and harvest organic rice products through their enhanced agricultural knowledge. Programs focusing on technological advances and environmentally friendly practices generally have greater acceptance (Baconguis and Cruz 2005). The research of Ghanim and Panell (1999) found that farmers who can access more technical information through their contact with extension workers
have more accurate knowledge on the techniques of OFS. The statistical tests in this research showed that agricultural extension-worker contact was significantly correlated with the organic farming knowledge aspect (OFKA) of the OF interviewees at the 1% level (Table 3). It could be inferred that the OF interviewees who received more organic farming information from agricultural extension workers gained more organic knowledge to improve their farms. Yet another important result showed that there is a difference between OF and NOF interviewees’ opinions in OFKA at the 5% level (Table 5). This could be interpreted that the two groups of farmers have different opinions in OFKA, and they would therefore also have differences in organic farming awareness and level of organic farming knowledge.

Environmental aspect (EA)
Regarding the environment, the OF interviewees’ ideas were more favourable than those of the NOF interviewees towards OFS, especially with respect to the environmental effects of farming practices (Table 2). The OF interviewees considered that adopting OFS would lead to better soil conditions in their farms. They also stressed that soil condition in farms is a finite natural resource that is easily vulnerable to deterioration due to agricultural activities such as the application of pesticides and chemicals. Moreover, these inputs were quite expensive and have long-term detrimental effects on the wellbeing of the farms. A number of OF interviewees believed that they could enhance the soil quality of their farms by shifting to organic farming, a belief shared by rice farmers in southern Philippines (Baconguis and Cruz 2005). Pimentel et al. (2005) also indicated that soil organic matter (soil carbon) and nitrogen were higher in OFS, providing many benefits to the overall sustainability of organic agriculture.

In addition, the OF could conserve water resources on their farms and, at the same time, maintain a healthy environment by reducing the use of chemical fertilisers and pesticides. As a result, non-target farm organisms such as fish and edible plants are more likely to increase when some of the NOF reduce their chemical use and instead use organic and natural fertilisers, as practiced by OF. Most NOF interviewees complained about the poor quality of their soil; because they did not understand the real effect and indirect results of chemical fertilisers. However, the NOF interviewees were not concerned about the conservation of natural resources, as most of them focused more on mass agricultural production, plus increasing productivity to better meet market demands.

It is noteworthy that there was a correlation between educational levels of the OF interviewees and their opinions on organic farming at the 1% level (Table 3). This means that the OF who have higher levels of education tend to have more OF knowledge, and they want to conserve the environment around their rice farms. McCann et al. (1997) noted that organic farmers have a better awareness of, and concern for, environmental difficulties associated with agriculture than conventional farmers. Organic farmers also articulated their concern about some effects of pesticide residue on food, air pollution, pesticide drift, and their lack of control over these dilemmas. There was also a difference between the opinions of the OF and NOF interviewees concerning environmental aspects (EA) at the 5% level (Table 5). It could be inferred that the two groups of farmers have different opinions and point of views in EA in which they would also have differences in environmental awareness and concern for organic farming.

Marketing aspect (MA)
According to the survey (Table 2), we found that the OF interviewees could get a slightly higher price for their organic rice (THB 2-3/Kg more than the ordinary price) than the NOF interviewees got for their rice (THB 15/Kg in the Surin City Market in 2008). The NOF interviewees claimed that whereas their conventional rice products were sold only in wholesale markets, the OF products could be sold directly to supermarkets in big cities, where they fetch higher prices. Pimentel et al. (2005) confirmed that organic foods fetch higher prices in the marketplace, with the net economic return per hectare often equal to or greater than that of the crop from conventional farms.

However, a large number of NOF farmers still thought that there was not a large gap in terms of farm-gate price between organic and non-organic rice, so they did not have a strong motivation and preference to cultivate organic rice. Both the OF and NOF interviewees expected that the government would establish a policy for promoting organic agriculture production with increased financial support for all of them. One way to support rice marketing at the community level in Surin province is the national program to identify and promote unique and indigenous products, called OTOP (One Tambon One Product). Hom Mali rice from Surin province, being a top-rated agricultural commodity throughout Thailand, was chosen as the banner-product for Surin under the OTOP program. This innovative OTOP branding of organic rice puts an indelible trademark of product excellence that serves to jump-start Hom Mali rice reputation and sales, and one that encourages tourists to preferentially seek out this type of rice.

Statistical analysis found that there was a correlation between farming experience of NOF interviewees and their opinions toward OFS at the 5% level (Table 4). This indicated that the NOF interviewees who have
more farming experience tend to be more interested in OFS, specifically for organic rice. Moreover, the results of our survey illustrated that there is a difference between OF and NOF interviewees’ opinions in MA at the 5% level (Table 5). Both OF and NOF interviewees had different opinions in MA, and they probably access different marketing channels. The study of Roitner-Schobesberger et al. (2008) explained that organic products in Bangkok are still marketed by targeting both the upper classes and foreigners. Therefore, it is necessary to cause the distribution of more information on organic products to consumers in the middle and lower social classes in order to improve and broaden the local market base. There is a growing trend worldwide towards organic products due to the many environmental and health benefits that these products bring to consumers (Byrne et al. 1991, Magnusson et al. 2003).

Cost and Benefit aspect (CBA)
We found that most OF interviewees could reduce farm operating expenditure by using their own organic fertilisers, and also by employing green manures (Table 2). Furthermore, employing family labourers and hiring labourers from their communities could decrease their farming costs. Two-wheeled tractors could reduce the needs for hired manpower, i.e., they could involve their children and other family members in using farm animals such as buffaloes to work on their farms. Pimentel et al. (2005) found that although labour inputs average about 15% higher in OFS, they are more evenly distributed over the year than in conventional production systems.

Table 2. Opinion and attitude towards organic farming.

<table>
<thead>
<tr>
<th>Statements</th>
<th>OF (n=100)</th>
<th>NOF (n=100)</th>
<th>t-test (p &lt; 0.05)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organic farming knowledge</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OF is more complicated than chemical farming</td>
<td>3.21</td>
<td>3.57</td>
<td>2.65</td>
</tr>
<tr>
<td>OF requires prior soil treatment</td>
<td>4.23</td>
<td>3.91</td>
<td>5.37*</td>
</tr>
<tr>
<td>Water resources have to be clean and without any pollutants</td>
<td>4.49</td>
<td>4.13</td>
<td>6.46*</td>
</tr>
<tr>
<td>Only good quality seeds of known source can be used in organic farming</td>
<td>4.35</td>
<td>4.11</td>
<td>4.19*</td>
</tr>
<tr>
<td>OF requires adding organic fertiliser</td>
<td>4.16</td>
<td>3.98</td>
<td>2.99*</td>
</tr>
<tr>
<td>OF does not require the use of pesticides and herbicides in the farm</td>
<td>4.29</td>
<td>4.10</td>
<td>4.05*</td>
</tr>
<tr>
<td><strong>Environmental aspect</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OF will result in better soil conditions</td>
<td>4.11</td>
<td>3.73</td>
<td>5.23*</td>
</tr>
<tr>
<td>OF will conserve water resources compared to ordinary farming</td>
<td>4.05</td>
<td>3.77</td>
<td>4.58*</td>
</tr>
<tr>
<td>OF does not generate poisonous fumes in the air</td>
<td>4.05</td>
<td>3.78</td>
<td>5.31*</td>
</tr>
<tr>
<td>Organic fertiliser used in farm does not affect one’s health</td>
<td>4.03</td>
<td>3.75</td>
<td>5.24*</td>
</tr>
<tr>
<td>NOF will destroy soil, water and natural resources surrounding farm</td>
<td>3.81</td>
<td>3.55</td>
<td>2.79*</td>
</tr>
<tr>
<td><strong>Marketing aspect</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumers tend to buy more organic agricultural products than products farm using chemical</td>
<td>4.15</td>
<td>3.84</td>
<td>4.83*</td>
</tr>
<tr>
<td>Consumers can buy organic agricultural products readily from the farm</td>
<td>2.75</td>
<td>2.67</td>
<td>2.69</td>
</tr>
<tr>
<td>Consumers from both inside and outside their communities like to buy organic products from you</td>
<td>3.93</td>
<td>3.72</td>
<td>3.39*</td>
</tr>
<tr>
<td>Agricultural products and marketing gain more support from the government</td>
<td>4.19</td>
<td>3.88</td>
<td>5.24*</td>
</tr>
<tr>
<td>Organic rice product is cheaper than ordinary rice product (How many THB/Kg?)</td>
<td>3.22</td>
<td>2.89</td>
<td>4.21*</td>
</tr>
<tr>
<td><strong>Benefit and cost aspect</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total OF cost is higher than chemical farming cost</td>
<td>2.93</td>
<td>2.72</td>
<td>1.97</td>
</tr>
<tr>
<td>OF can give more profit than products from chemical farming</td>
<td>3.34</td>
<td>3.37</td>
<td>2.86*</td>
</tr>
<tr>
<td>OF can translate into decreased expenditure by using own organic fertiliser and own family labour</td>
<td>3.86</td>
<td>3.64</td>
<td>2.73*</td>
</tr>
<tr>
<td>OF and NOF products are the same prices</td>
<td>2.93</td>
<td>2.69</td>
<td>3.58*</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3.62</td>
<td>3.41</td>
<td>2.78*</td>
</tr>
</tbody>
</table>

* 4.50-5.000= strongly agree, 3.50-4.49=agree, 2.50-3.49=neutral, 1.50-2.49=disagree and 1.00-1.49= strongly disagree (John 1963)
We found that chemical rice farming costs are higher than OF costs (Table 1). Examining the operation costs among NOF, the highest production cost was allocated for chemical fertilisers, as it is easier to utilise them thereby bringing a higher yield even if production cost is expensive. For example, in European field experiments, it was found that the yield of organic wheat and other cereal grains averaged 30% to 50% lower than for conventional cereal grain production (Mäder et al. 2002). These lower yields appeared to be caused mainly by lower nitrogen (N) inputs into the OFS. In New Zealand, yields of wheat were reported to average 38% lower than those in conventional systems (Nguyen and Haynes 1995).

In our survey, all of the OF interviewees planting organic rice generally received a greater price for their rice products than did the NOF. Similarly, the marketplace price for organic corn and soybeans frequently ranged from 20% to 140% higher than for conventional corn, soybeans, and other grains (Dobb 1989; Bertramsen and Dobb 2002, New Farm Organization 2003). Therefore, when the different market prices were factored in, the net difference between the organic alternative and conventional crops would be relatively small; in most cases the return on the organic crops would be slightly greater. Most of the OF interviewees in our survey were able to obtain more farm cash supplemental benefits from planting and harvesting some Thai culinary herbs, such as lemon grass (Cymbopogon sp.) and galangal (Alpinia sp.), which were cultivated on the levee of their farms.

Compared to OF, many NOF used, and consequently paid more for, harvesting device rental (around ThB 700/rai excluding fuel costs). Tillage can lead to a decrease in the use of herbicides, but may cause an increase in the use of diesel fuel for operating tractors. The recent increase in the cost of diesel has made traditional tillage unprofitable in farming systems in the north-western USA (Nail et al. 2007). This same situation can be expected in farm systems in other parts of the world, especially when farmer-owned machinery, as opposed to rented machinery, incurs repairs and depreciation costs (Padel and Lampkin 1994).

Farm size of OF was significantly correlated to the cost and benefit aspect (CBA) at the 5% level. Those farmers who have larger farms are likely to receive more benefits and incur decreased expenditure as a result of organic farming (Table 3). The research conducted by Selfa et al. (2008) supported this observation that the farmers who are concerned about conserving farmland were more likely to practice organic farming or sustainable agriculture. Nevertheless, there was a difference between the opinions of OF and NOF in terms of CBA at the 5% level (Table 5). OF will possibly incur higher costs, but derive greater benefits in the end by realising higher rice production.

### Table 3. Organic farmers’ personal traits and their attitude (n=100).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Education level</th>
<th>Farm size</th>
<th>Total annual income</th>
<th>Farming experience</th>
<th>Extension worker contact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>p</td>
<td>p</td>
<td>p</td>
<td>p</td>
<td>p</td>
</tr>
<tr>
<td>1. OF knowledge</td>
<td>1.78</td>
<td>1.22</td>
<td>1.87</td>
<td>2.74</td>
<td>10.60**</td>
</tr>
<tr>
<td>2. Environment</td>
<td>9.16**</td>
<td>2.00</td>
<td>1.87</td>
<td>3.21</td>
<td>2.65</td>
</tr>
<tr>
<td>3. Marketing</td>
<td>1.78</td>
<td>1.65</td>
<td>1.35</td>
<td>1.83</td>
<td>2.11</td>
</tr>
<tr>
<td>4. Cost &amp; benefit</td>
<td>1.97</td>
<td>4.87*</td>
<td>1.98</td>
<td>2.91</td>
<td>2.78</td>
</tr>
</tbody>
</table>

* p < 0.05 and ** p < 0.001 (based on Pearson Chi-Square test)

### Table 4. Non-organic farmers’ personal traits and their attitude (n=100).

<table>
<thead>
<tr>
<th>Variables</th>
<th>Education level</th>
<th>Farm size</th>
<th>Total annual income</th>
<th>Farming experience</th>
<th>Extension worker contact</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>p</td>
<td>p</td>
<td>p</td>
<td>p</td>
<td>p</td>
</tr>
<tr>
<td>1. OF knowledge</td>
<td>0.65</td>
<td>0.72</td>
<td>1.14</td>
<td>1.48</td>
<td>0.53</td>
</tr>
<tr>
<td>2. Environment</td>
<td>0.74</td>
<td>1.11</td>
<td>2.57</td>
<td>2.34</td>
<td>1.12</td>
</tr>
<tr>
<td>3. Marketing</td>
<td>0.61</td>
<td>0.40</td>
<td>2.34</td>
<td>3.96*</td>
<td>1.32</td>
</tr>
<tr>
<td>4. Cost &amp; benefit</td>
<td>1.21</td>
<td>0.58</td>
<td>1.13</td>
<td>1.25</td>
<td>1.34</td>
</tr>
</tbody>
</table>

* p < 0.05 (based on Pearson Chi-Square test)
Table 5. Overall comparison of opinions between organic and non-organic farmers.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Opinion (mean)</th>
<th>t-test *</th>
<th>p &lt; 0.05</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Organic farmers</td>
<td>Non-organic farmers</td>
<td></td>
</tr>
<tr>
<td>1. OF knowledge</td>
<td>4.06</td>
<td>3.27</td>
<td>6.93*</td>
</tr>
<tr>
<td>2. Environmental</td>
<td>3.97</td>
<td>3.06</td>
<td>5.39*</td>
</tr>
<tr>
<td>3. Marketing</td>
<td>3.83</td>
<td>2.98</td>
<td>4.11*</td>
</tr>
<tr>
<td>4. Cost &amp; benefit</td>
<td>3.67</td>
<td>3.01</td>
<td>3.32*</td>
</tr>
</tbody>
</table>

Conclusions

This project investigated some essential factors influencing the opinions of farmers towards OFS. By comparing the opinions and attitude of OF and NOF interviewees, we found that there were remarkable differences regarding levels of knowledge about OFS, its environmental effects, marketing outcomes, and costs and benefits. The OF interviewees showed a greater favourable attitude towards organic farming, whereas the NOF interviewees showed somewhat reluctant attitudes, mainly because of their general lack of motivation. The statistical tests showed that the OF interviewees, with their higher educational levels, larger farms, and greater contact with extension workers, were more likely to adopt and develop organic farming methods on their farms, grounded in their knowledge of OF systems, market costs and dynamics, and the environmental benefits to the farm. Additionally, the statistical test showed that the NOF interviewees who had more rice farming experiences tended to have positive attitudes towards applying organic rice farming on their farms, especially when considering advantageous marketing and rice production. The most interesting result of this study resides in the observed differences between OF and NOF interviewees’ opinions in all of the four aspects. NOF interviewees generally lacked the essential awareness concerning the multiple benefits of OFS. This study has gained some inroads into the socio-economic factors that have shaped the opinions and attitudes of farmers towards organic agriculture. It would be enlightening to study the socio-cultural aspects affecting the adoption of organic farming, as they are likely to play a significant role in the same manner as found by Baconguis and Cruz (2005) among rice farmers in southern Philippines. The important role of technical information dissemination and extension agents is highlighted in this study.

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BOOK REVIEW

Dr Kristen Lyons (kristen.lyons@uq.edu.au)
30 August, 2010


The current crisis in agriculture and food systems has brought us to a crossroad. A culmination of the environmental, oil, financial and food price crises has provided the impetus to engage in broad debate over the future of agriculture and food systems, including a debate regarding the role of science and technological innovations in shaping this future. What will be the outcome of these debates? Will we see a tinkering at the edges of productivist agri-food systems, limping into the future via a series of technological-fixes? Alternatively, will we see a transformation of agriculture and food systems via the expansion of agro-ecological and organic farming systems? Jack Heinemann argues in his recent book that the future direction of agriculture and food systems should be guided by the International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD: http://www.agassessment.org/). In ‘Hope not Hype’, Heinemann focuses explicitly on the science in the Assessment related to modern biotechnology – an area that has been at the centre of controversy related to the IAASTD (demonstrated in Syngenta’s ‘walk out’ of the process and CropLife International’s rejection of the Assessment Report). On the basis of the science presented in the Assessment, Heinemann calls for a radical shift in agriculture and food systems; including the centralisation of agro-ecology and organic agriculture, farmer participation and a significant increase in research and development (R & D) investment for alternative agriculture.

For those readers of the Journal of Organic Systems unfamiliar with the IAASTD, or the Assessment as Heinemann refers to it; it was the culmination of over 400 scientists from around the world (including the editors, at that time, of JOS). The Assessment offered an evaluation of science and technology as it was applied to agriculture and food systems. The Assessment was approved at the 2002 World Summit on Sustainable Development in South Africa, and received support from the United Nations and other intergovernmental and international organisations. It was financially supported by the OECD and included stakeholders from both high-income and low-income countries – though Scoones (2009) has critiqued the IAASTD’s effectiveness in delivering on its goals of participatory and inclusive engagement, especially related to the inclusion of voices from the low-income countries. Heinemann’s evaluation of the peer-reviewed science points to the human health and environmental problems associated with modern biotechnologies, the largely undelivered promises related to modern biotechnologies (including promises related to increased yields and reduced pesticide use), and the extension of a privatised agricultural model that leaves non-privatised and therefore less profitable ‘orphan’ system and crops to be neglected and/or abandoned in terms of R & D investment and support.

‘Hope not Hype’ is presented in eight chapters, including a Preface and Afterword. Heinemann begins by differentiating traditional and modern biotechnology. Traditional biotechnology can be taken to include “any intentional human manipulation of biological factors for some purpose” (p.5), and may include nitrogen fixing cover crops, integrated pest management, the use of chemical herbicides and pesticides, and the selection of land races. In contrast, modern biotechnology refers to “manipulations that result in unlikely or naturally unprecedented combinations of genetic material, such as DNA, or RNA, or any activity that releases genetic material from its normal physiological constraints inside a cell or virus and then returns it to an organism” (p. 6). The most obvious example is genetic modification (GM). Heinemann notes at least three attributes of modern biotechnologies that differentiate them from traditional biotechnologies, and which strike at the heart of concerns related to their application across agriculture and food systems: (1) they produce new and novel organisms, and with unknown human and environmental health impacts; (2) they are protected by international biosafety laws and regulations, offering substantial economic returns via Intellectual Property Rights to patent holders; and (3) they have attracted significant R & D investment, dwarfing investment in other technologies, especially appropriate technologies that would be more relevant to smallholders in low-income countries.

In light of the health, safety, legal and environmental problems associated with modern biotechnologies, alongside their failure to deliver on claims related to yield and pesticide use, a suite of other technologies and approaches are widely recognised as being more appropriate in building socially and environmentally sustainable, and food secure, agri-food systems. The science presented in the Assessment demonstrates that agro-ecology and organic agriculture can be competitive with, and in many instances surpass, the productivity of conventional and GM-based agricultural systems. Heinemann cites evidence from a University
of Michigan study that concluded: “agro-ecological agriculture (including organic methods) may be capable of feeding the world and re-building depleted agricultural lands in time” (p. 85). He also drew from scientific sources that demonstrated it will be necessary to engage a diversity of approaches to address the complex environmental, economic and social crises: “making agriculture more productive under times of impending climatic change and other challenges, while simultaneously reducing its ecological costs, will require multiple rather than ‘one size fits all’ approaches” (p. 86). The Assessment also found that modern biotechnologies have failed in their relevance for poor and subsistence farmers; those most vulnerable in the face of growing food insecurity. On the basis of this science, Heinemann provides a number of recommendations to support the expansion of agro-ecological and organic agriculture: redress the balance in funding between GM and agro-ecological research; establish workable policies for farmer participation in research and innovation; and eliminate subsidies for agriculture intended for export.

For those interested in the future of agriculture and food systems, the Assessment represents a profoundly important document; presenting, as it does, a detailed critique of productivist agriculture, and the high-tech and capital intensive science and technological innovations that underpin it. Heinemann’s book, ‘Hope not Hype’, makes an important contribution in making transparent the science on which the Assessment was based. ‘Hope not Hype’ presents often complex and inaccessible scientific knowledge claims in a comprehensive and easily understood way, and in so doing, presents a call to radically re-think the role of science and technology in shaping the future of agriculture and food systems.

While an important and significant document, the IAASTD is not without critique. Amongst criticisms directed at the Assessment include concerns regarding its effectiveness in engaging with diverse stakeholders, including voices from low-income countries, as well as the gaps in its analysis – for example, it had little to say about nanotechnologies and molecular biology, two fields which are set to radically alter agriculture and food systems, and offered little gender analysis, despite the profound importance of gender in shaping access to land, labour, extension services and agricultural technologies. ‘Hope not Hype’ would benefit by acknowledging these, and other gaps, in the Assessment.

Overall, ‘Hope not Hype’ will be a very useful resource for policy and decision makers in government, R & D institutions, as well as scientists, teachers, farmers and the broader public. Indeed, by highlighting scientific knowledge claims in a broadly acceptable way, Heinemann is contributing towards building public understanding, or what Toumey (2006) has referred to as the public’s ‘technological literacy’. Technological literacy will be a precursor to the democratic development of new technologies, and will play a vital step in ensuring a democratic debate about the future of agriculture and food.

References