An Overview of EM technology in New Zealand

Mike Daly
New Zealand Nature Farming Society
nznfs@paradise.net.nz

Abstract

I first imported EM into New Zealand I994, while working fulltime as a government agricultural scientist. After thoroughly testing EM in crop production trials and publishing the results, I moved to the formation of a trust, The New Zealand Nature Farming Society, to take EM technology into New Zealand.

The development of EM in New Zealand has moved quite slowly but non-the less steadily, since we first began making EM1 in 1998. The approach we have taken has been to operate under a low cost structure, to maintain a low product price for EM. This approach has relied on allowing model farms and projects to provide the advertising for EM. This approach has lead to a relatively slow uptake, but has meant that the price for the product has remained low.

Some of the achievements made in New Zealand have helped the spread and acceptance of EM internationally, particularly in Europe and the USA. Two notable achievements were; 1) achieving organic registration in 1999 for EM from the national certifying authority, Bio-Gro NZ. This gave official credibility and assurance of the naturalness of EM. And 2) a credible publication in an international science publication in 1998, describing for the first time in this forum the composition of EM, and presenting sound research on the effects of EM on crop production (Daly & Stewart 1998). Gaining acceptance in a peer reviewed Journal, gave enormous credibility to EM in the science community.

Over the last 10 years, the biennial IFOAM conferences (the largest International organic farming conference) have heard about our research and experiences in New Zealand with EM. This has contributed to spreading the word and gaining acceptance for EM technology in the wider international organic community.

In New Zealand we have had success with our number one model farm (Harts Creek Farm), receiving awards for " Best organic farm in NZ", and more recently "Most Innovative use of Technology" in the NZ sustainable farming awards. The innovative technology, being of course, EM technology! This demonstration farm is our most important form of advertising.

We have many and varied uses of EM technology in New Zealand, from treating wastewater and kitchen food waste to growing crops and uses in animal systems. I will share as many of these projects as time will allow in this presentation.

These will include our most recent highlights; 1) our first organic wine and olive oil produced using EM and soon to be to exported to Japan. 2) A major production of

organic carrot seed produced successfully using EM technology and destined for export into Europe this year.

Introduction

About New Zealand -The Country

New Zealand lies in the south-west Pacific Ocean and consists of two main (North and South Islands) and a number of smaller islands whose combined area of 270,500 square kilometres is similar to the size of Japan or the British Isles. The nearest largest land mass is Australia, some 1,600 kilometres to the West

The climate described as temperate, is largely influenced by New Zealand's shape and form. Being a long narrow mountainous country surrounded by a large expanse of ocean, means quite large extremes in climatic conditions, characterised by sudden changes in temperature and weather conditions. The main mountain chain in both Islands has a major effect on climatic conditions giving rise to generally wetter, milder conditions in the west and drier and often hotter conditions in the east. Overall, the climate is very suitable for many agricultural farming activities, particularly livestock production which allows outdoor grazing all year round.

New Zealand has a relatively small population (3.9million), green countryside and an abundance of clean clear rivers and lakes giving it a reputation of a clean environment devoid of industrial and agricultural pollution, which is common in many European countries.

About New Zealand -The Agriculture

Traditional farming has centred on sheep and cattle to produce sheep meat, beef, wool, dairy products and hides, although in recent years new types of livestock have included deer for meat (venison) and antler (velvet) production, and goats for meat (chevron) and fibre (mohair) production. Cereal crops, predominantly wheat and barley are grown on a limited scale, mainly for the home market. In addition process crops such as pea's carrots and beans and onions are grown increasingly. Land used for meat and wool farming is mainly hill country and rolling downs. The lowlands and coastal plains support dairy, arable and horticultural production..

New Zealand's agriculture, particularly its sheep, cattle and deer systems are characterised by relatively low inputs, particularly of pesticides and nitrogenous fertilisers. The pastures are clover-based and provide in most cases, all of the nitrogen requirement by N fixation. Superphosphate is the most common input used in these systems and animal health remedies for external and internal parasites. These inputs are not permitted under a registered organic system (Bio-Gro NZ). Because our conventional agriculture is low input and managed in grassland out-door environment, the gap between conventional and organic farming is not considered great.

The history of EM in New Zealand

EM was imported into New Zealand from Japan for research purposes in 1994. Scientists from Government research institutes, AgResearch and HortResearch, conducted research from 1994 to 1997 on EM Technology, and the results were presented at conferences both internationally and within New Zealand. The research was based on using EM on our relatively large scale extensive agricultural systems, which have typically, lower labour inputs and higher mechanisation than many of the Asian countries that EM has been researched. Positive results using EM were obtained (Daly 1996, Chamberlain *et al*., 1997, Daly & Stewart 1999). This encouraged New Zealand researchers and growers to seek the further development of EM technology in this Country.

Approach taken for EM expansion in New Zealand

To facilitate the development and expansion of EM Technology in New Zealand, a charitable trust was established in 1997. This trust called the New Zealand Nature Farming Society (NZNFS) is administered and directed by farmers and aims to make, distribute and promote the use of EM Technology and Nature farming principles in New Zealand. In early 1998 an EMRO Technical Officer from Japan came to New Zealand and facilitated the setting up of a production plant to make EM. Since that time the New Zealand Nature Farming Society have been making EM and distributing it within New Zealand.

The approach to spread the technology has been to, identify and work with successful farmers using the technology and pick one each representing the various main types of agricultural production, such as sheep farming, crop production, vegetable production, dairy pigs and chickens and fruit production. These 'key' farmers are selected on their skills and success in farming, so that they are respected by their peers and recognised as good leaders. The key farmers are then taught how to use EM on their farms and encouraged to set-up on-farm experiments. Farmers are the best teachers to other farmers and this group of farmers then become the platform for expansion and uptake of EM technology throughout the region and country.

The NZNFS are active in extension, holding workshops and field days. In 2002, NZNFS hosted the very successful 7th International Conference on Kyusei Nature Farming with 250 delegates attending from all over world.

Where is EM being used in New Zealand?

The application and use of EM technology in NZ is wide and varied:

- From crops like peas, wheat, linseed to onions, potatoes, carrots and beans.
- From sheep, cows and deer, to pigs and chickens
- From wine grapes and olives to saffron and lavender
- From recycling food waste in restaurants and schools back to gardens
- From household food waste to larger office blocks and Universities collecting lunchtime food waste.
- From small composting toilets in holiday homes to large composting toilets in mountain chalets for trampers and mountaineers.
- From controlling odours at commercial and large municipal composting sites to controlling odours and improving water quality at vineyards treating their own wastewater.

Whilst initially the use of EM was confined to Agriculture, in recent times the growth sector has been vineyards and waste management.

I am going to describe in more detail, how EM is used in 3 quite different systems.
Case Study 1: An Arable Farm
Case Study 2: A Vineyard and Olive grove
Case Study 3: An animal meat processing plant

1) An Arable Farm

"Harts Creek Farm" has been our most successful "Key" farm and has the history of the longest use of EM (10 years) in NZ!. This farm featured in much of our early research on EM and has been reported on in detail before (Daly, 1996, Chamberlain *et al.* 1997, Daly & Stewart, 1999).

Table 1. Details of Harts Creek Farm 2004 and local climatic data

Size:	300 ha (160 ha owned, 140 ha leased)
Average field size:	6 ha
Number of fields:	45
Latitude	43^0
Altitude:	20m above sea level.
Rainfall	600mm evenly distributed through year
Temperature range	January mean 16.4°C July mean 5.7°C.
Soils (Kear et al. 1967)	Temuka silt loam over clay (40cm topsoil), high natural fertility
Irrigation	Overhead sprinklers from underground wells
Crops:pasture	55:45 ratio
Crops 2004	Carrot Seed, Fresh Carrots, Onions, Radish Seed, Spinach, Barley leaf, Linseed, Dandelion
Livestock	Sheep (1100)

This farm has very good arable soils and is also has a history of long-term organic certification (18 years). The farmed area is 300 ha, which includes 140 ha of leased land. A wide range of arable seed and vegetable crops are produced and also has sheep and cattle for wool and meat production. All produce off the farm attracts a premium for its organic certification. EM technology is well integrated into many of the farming operations. Harts Creek Farm uses around 500 litres of EM1 per year turning this into 10,000 litres of activated EM (EM-A.) litres and applying this around the farm, in the following operations.

Crops

- Seeds
  EM is added to seed coating treatments to enhance seed germination and seedling survival (0.1%)
- Crop residues.
  The crops residues are sprayed with EM-A just prior to cultivation (20l/ha)
- Weed seed
  During cultivation EM-A is sometimes sprayed on the soil surface to induce weed seed germination, which can be then cultivated to develop a "clean" seedbed (20l/ha).
- Crop growing phase

EM-A is applied either by boom sprayer unit or injected into the irrigation water to the crops at varying timing and frequency during the growth cycle of the crops (20l/ha).
Fermented plant extract (FPE) is made using garlic and used in circumstances when disease and pest pressure is high (20l/ha or 1%).

- Weeding
  Spraying equipment has been mounted on weeding equipment to apply EM-A during the weeding phase of the crops, as the weeds are undercut they receive EM, and are speedily recycled back as organic matter to the soil (20l/ha).
- Harvest
  Onions and some other crops are sprayed with EM-A to enhance storage of the crop (0.1%)

Sheep and Cattle

- Pastures are sprayed with EM-A during gazing
  When grazing EM-A is sprayed onto herbage (20 litres/ha EM-A)
- Probiotic Medicine
  Administered as an oral drench combined with other ingredients such as cider vinegar (EM combined with garlic and cider vinegar). (dosed at 5-20ml per animal depending on size of animal).

Harts creek farm in recent years has developed in high value crops such as barley leaf, and vegetable seed production. A success story has been Carrot seed. This crop grown for seed production is very high value, but difficult grow organically. Carrot grown for seed is very susceptible to aphids which spread virus, and is also susceptible to fungal diseases like sclerotinia. This past year (2004) Harts Creek farm successfully grew 10ha of carrot seed (for export to Europe). This organic crop was sprayed weekly during the growing season (from November to March) with EM-A and FPE. The crop performed as well as the conventional carrot seed crops grown in the same region, and these are intensively managed with pesticides. This excellent performance by Harts Creek Farm, generated a lot of interest within the Seed Company buying the seed, which is the largest producer of carrot seed in NZ. Harts Creek Farm will grow 30 ha of carrot seed for 2005 harvest.

This farm has been using EM for almost 10 years and the performance of the farm has increased from year to year, (Chamberlain, *et al*. 1999) The farmer reported in year 4 after starting EM, the following observations (Daly *et al.* 2000).

Farmer observations after 4 years use of EM:

1. soil structure improving
2. yields improving and stabilising
3. weed management improving
4. quality and storage of produce improving

Since then, this farm has won 5 major awards in national farming competitions

In 2000 it was awarded the “Best Organic farm”
In 2003 it was awarded several prizes in a competition with an environmental theme. Most relevant was the award were given for “The most innovative use of a new technology”, The new technology judged on, was EM. This farm is regarded as a

leading example in the farming industry and is a great endorsement for EM technology in Canterbury and NZ.

2) A Vineyard and Olive Grove

Seresin Estate is a well-known 172 ha vineyard in the Marlborough Region, owned by the "world famous" New Zealand film producer, Michael Seresin (produced the "Harry Potter" movie). Michael has placed great emphasis on creating a vineyard that works in Harmony with Nature, taking advantage of the natural contours and landforms to produce unique quality wines and extra virgin olive oils. The Vineyard encompasses some distinctive landscapes, and waterways that are enhanced by native plantings. The management uses a "hand tended" approach under Organic and Biodynamic principles, and has been using EM technology extensively for over 4 years.

Table 2. Details of Seresin Vineyard and Olive Grove 2004 and local climatic data

Size:	114 ha
Established	1992
Organic Certification	May 2000
Latitude	41^0
Altitude:	100m above sea level.
Rainfall	650mm evenly distributed through year
Temperature range	Summer average 27°C, Winter average 13°C. (high sunshine 2448 hrs/yr
Soils (Kear et al. 1967)	2 distinct types, Waimakarriri alluvial loam well drained (45-75cm depth), Renwick stony alluvium loam, high % rock fragments, recent glacial formed.
Vineyard Production	600 tonnes expanding to 1000 tonnes
• varieties	Savaugnon Blanc, Chardonnay, Pinot Gris, Riesling, Pinot Noir
Olive Grove Production	15 tonnes expanding to 30 tonnes
• varieties	Frantoio, Lecchino, Minerva, Pendalino (All Tuscan)
Olive growing plantings	5000+

How is EM being used around the vineyard and Olive plantings?

EM1 is expanded and activated at 5% to make EM-A, and then used in the following ways:

Enhancing fertiliser efficiency

- EM-A is added to foliar fertilisers such as seaweed at 2 litres per ha.

Understorey management

- When the understorey is mown and prunings mulched. EM-A is applied to the fresh cut mulch at 10-20 litres per ha EM-A

Compost making

- In the compost making process. EM-A is added to the compost at 1-2 lites/cubic metre of compost

Vine health

- EM-A is applied at 1% concentration as a foliar spray to enhance vine health and assist in disease control

Waste water treatment

- EM-A is added to the waste water system to control smells and make the system work more efficiently. The water is then recycled onto amenity planted areas for irrigation.

Compost Trial at Seresin

A common waste product at Vineyards is the Grape pomace (skins seeds and bunch stems). This waste product is being turned into valuable compost.

To test the effectiveness of EM in the compost making process. Two separate compost batches were made in 2003.

Compost Treatments

Around 50 cubic metres of each compost type was made. Both treatments had the same base ingredients. 50% grape pomace, 25% wood chips, and 25% paper waste, a small quantity of rock phosphate and elemental sulphur was also added.

The EM compost received 1 litre of EM-A/cubic metre, applied to the ingredients as they were mixed. The compost was rolled down, then immediately covered with a black plastic sheet and left to ferment.

The standard compost was left uncovered and turned regularly as normal practice for aerobic compost.

After 12 weeks both composts were sampled and sent away for independent analysis and growth comparisons. There was a significant visual difference between the 2 compost treatments. With the EM treated compost looking more fully composted.

Results from Independent Growth Tests conducted by the Biological Husbandry Unit at Lincoln University were reported as follows;

Glasshouse Experiment Compost comparison

"On 23/09/03 a standard seed raising mix was made up in three batches and bulked together. This mix was made up of the following ingredients sieved through a 6mm sieve, three parts composted bark, 1 part steam sterilised soil and 1 part pumice. Samples from composts A (EM compost) and B (standard compost) passed through a 6mm sieve and added as 10% of the final blend to the respective treatments. The control treatment C contained just the blend, with no added compost."

"Composts were placed in Flight 60 cell trays. One half of each tray i.e. 30 cells, were planted with one radish seed of the cultivar 'French Breakfast' and the other 30 cells with one seed each of 'green crop' mustard. On 17/10/03 the plants were harvested. Tops only for mustard were harvested level with the potting mix. For radish, tops were abscised at the top of the hypocotyl with 'roots' being the material below this point after the removal of the fine roots. Fresh weight was recorded immediately on harvesting, as was the number of plants present (total of 12 possible).

Data was analysed using ANOVA on Minitab and means separated where appropriate using Fischer's protected LSD."

Results Compost comparison

Table 3. A comparison of EM compost; Influence of grape compost amendment on Mustard and Radish components; number, fresh weight means (plants/tray and g/plant) as a function of treatment

Compost	Number		Top fwt		Root fwt
(description)	Mustard	Radish	Mustard	Radish	Radish
A. (EM grape- compost)	9.8	11.4 ab	0.65 a	0.68 a	0.753 a
B. (Standard grape-compost)	10.2	11.6 a	0.55 b	0.54 b	0.471 b
C. (No compost)	10.8	10.4 b	0.54 b	0.65 ab	0.524 b
Significance	ns	$p < 0.01$	$p < 0.01$	$p < 0.01$	$p < 0.1$

"The EM grape-compost produced significantly higher fresh weights for both mustard and radish than the standard grape compost in the seed raising experiments." Table 3.

Field Experiment Compost comparison

"On 3/10/04 composts A and B were applied volumetrically at rates of approximately 40 tonne per hectare to 5 plots each of approximately 0.75m^2. A third control treatment of no compost application was applied. After application the treatments were lightly cultivated. Lettuce cultivar "Triumph" was planted at 5 plants per plot and 25cm spacings to assess the effect of the treatments on yield.Lettuces were harvested on 10/12/03 and the total number surviving and total yield were measured. From this the mean weight of plants at harvest was derived.Data was analysed using ANOVA on Minitab and means separated where appropriate using Fischer's protected LSD"

Results Compost comparison

"Compost A proved more effective than Compost B though both composts performed the same as the nil control." Table 4.

Table 4. A comparison of EM compost; Influence of grape compost soil amendment on yield characteristics of lettuce variety 'Triumph (g/plant)

Compost	Number	Mean weight
A. (EM grape- compost)	4.4	0.58 a
B. (Standard grape- compost)	4.0	0.43 b
C. (No compost)	3.8	0.49 ab
Significance	ns	$p < 0.05$

"

Results Compost comparison

“On the whole Compost A performed the best with a clear win against Compost B and control in mustard fresh and dry weights, a win against Compost B in radish tops fresh weight, a combined win with control against Compost B in radish tops dry weight, and a win against compost B for field grown lettuces.”

“Previous experiments have demonstrated the efficacy of EM Bokashi, particularly in pot trials, but not with a direct comparison with aerobic compost from the same materials. This experiment demonstrates the efficacy of the EM inoculated compost over the ‘non EM’ product. It is also interesting to note that there is much less loss of carbon during the EM process than the aerobic process. So, as products were applied at the same rate, the EM treated product not only increased plant growth more than the ‘non EM’ product but also allowed the initial residue to be spread over a larger area.”
As can be seen by the above report on the compost performance, the addition of EM to the composting process produced much higher quality compost at Seresin.

Achievements at Seresin
“Seresin wins in the USA”! ……The Los.Angeles. County Fair award is the largest of its kind in the world, with top extra virgin olive oils entered from all over the world. Eleven gold medals were awarded to New Zealand Olive Oils of which Seresin received three.

Seresin’s reputation for creating a unique quality wine and olive oil has continued to build within New Zealand and around the world since using an EM programme. Seresin continue to achieve top prices for their wines and olive oils and demand is exceeding supply.

The first export of Seresin wine and olive oil to Japan through EM Corporation is in progress, and will see these fine wines and extra virgin olive oils available to the world, for those wanting quality healthy products, produced using EM technology.

Treating Winery processing waste water

Although Seresin is using EM in its waste treatment system to improve smell and function, we have not collected any data on this process. However, at another vineyard (Canterbury Wine House), we have been using EM to control smell and improve the function without the use of chemical, and will present data from there.

The Winery had a smell problem associated with irrigating its treated and processed wastewater. The processed water is used for irrigation onto the feature gardens in front of the main reception and restaurant areas of this well known and prestigious Vineyard. This smell problem was not good for business!

The wastewater from the winery contained a number of winemaking chemicals and sediment and residues from cleaning out ferment tanks and barrels. The process for treating this acidic waste water, was through a biological multi-tank system with aeration in the process. Caustic soda was added to raise the pH.

Table 5. Comparison between Caustic soda and EM for pH adjustment, smell, costs, and benefits (Canterbury House Winery 2004)

The System has 6 tanks with controlled flow and aeration in tank 5		
Statistics	Caustic Soda treatment (original process)	EM treatment (new process)
pH initial of waste water (lees)	3-4	3-4
pH final of processed water for irrigation	6-8	6-7
dose	nr	50 litres per week
Cost/month	$200	$100-$150
Volume water treated	7000-9000 litres/day	
Benefits of EM/over chemical treatment	• Safe to use • Cheaper • Effective smell control...better public relations! • Improvement to the plants in irrigated amenity area	
Unknown risk	• Potential for cross contamination of EM with winemaking process (perceived risk by winemaker)	

The Winery Manager is extremely happy with the results to date, they have reported excellent odour control and improvements are evident in the gardens where the water is applied. The Winery management are keen to extend EM technology to compost making, utilising the solid waste material (pomace) and returning this to the vineyard.

3) A Meat Processing Plant

Ashburton Meat Processors Ltd, a medium size abattoir has been processing farm animals for the retail meat Industry for over 100 years.

The company owns farmland surrounding the processing plant and irrigates the wastewater onto this land, which produces pasture forage that is cut and removed as silage or hay.

The company was until recently disposing of its ‘paunch’ waste off site at great cost, and has recently developed a large-scale worm-farm, in association with EM technology to process the waste on site.

EM is activated on-site and EM-A is automatically metered into the waste screening process inoculating both the water for irrigation, and the solid waste going to the worm farm.

Table 6. Statistics of a Meat Processing Plant using EM technology

<table>
<tr><td>Process</td><td>Number</td><td>Detail</td></tr>
<tr><td>Staff number</td><td>70</td><td></td></tr>
<tr><td>Animals processed</td><td>700/day</td><td>Pigs, sheep, cattle</td></tr>
<tr><td>Waste water Irrigated to Land</td><td>350,000 litres</td><td>Overhead travelling Irrigators</td></tr>
<tr><td>Land area</td><td>25</td><td>Growing grass forage for hay/silage</td></tr>
<tr><td>Paunch waste to Worm farm</td><td>4.5 tonne/day</td><td>Stomach contents, pig hair</td></tr>
<tr><td>Worm farm size</td><td>450 cubic metres</td><td>600 metre long windrows (1.5m wide)</td></tr>
<tr><td>EM-A application</td><td>20 litres/day</td><td>By injector when screening waste from water</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td colspan="3">Benefits of On-site waste processing using a worm farm plus EM</td></tr>
<tr><td colspan="3">Cost savings per year ….$76,000 No longer paying for off site disposal of waste
Smell is significantly reduced
EM is being applied to the land via water, therefore benefits can be expected in;
Soil improvement
Forage production</td></tr>
</table>

The project has been running for 12 months and has been well received by management and local authorities.

Achievements at Ashburton Meat Processors

The management are very happy with progress made, the odour is controlled and big cost savings are being made with this new approach. A recent environmental award for the region was awarded to Ashburton Meat Processors for their initiatives.

Final Summary

The progress made in New Zealand has been very good in terms of research, and developing innovative ways of integrating EM into many different systems.

The uptake of the technology is gaining momentum, as the technology becomes known through the demonstration of good projects like the 3 mentioned in this paper.

I would like to thank in particular APNAN, for all the support in developing the programme here, to INFRC for support and inspiration and philosophy, and to EMRO for technical support in the development of EM technology in New Zealand.

References

Chamberlain, T.P. Daly, M.J. & Merfield, C.N 1997. Utilisation of Effective Microorganisms in Commercial Organic Agriculture - A Case Study from New Zealand. Proceedings of the 5th International Kyusei Nature Farming Conference, Bangkok, Thailand pp120-123.

Chamberlain, T.P. Donaghy, R. Daly, M.J. 1999. The Development of Harts Creek Farm- a commercial scale organic farm, using effective microorganism (EM) Technology in New Zealand. Proceedings of the 6th International on Kyusei Nature Farming Conference, Pretoria, South Africa. Poster paper.p327

Daly, M.J., Chamberlain, T.P., Donaghy, R. 2000: The Development of a large-scale commercial organic mixed cropping farm using EM (effective microorganism technology in New Zealand. Proceedings of the 13th international IFOAM scientific Conference, Basel, Switzerland. 28-31 August 2000. ISBN 1 58603 087 6(IOS Press).pp266.

Daly, M.J. 1996: Effective micro-organisms (EM) in broadacre organic vegetable production on New Zealand farms. 11th IFOAM Conference Copenhagen, Denmark.

Daly, M.J. Stewart, D.P.C. 1999. Influence of “effective microorganisms” (EM) on vegetable production and carbon mineralization - A preliminary investigation. Journal of Sustainable Agriculture Vol.14 (2/3).

Kear, B.S. Gibbs, H.S. Miller, R.B. 1967. Soils of the Downs and Plains Canterbury and North Otago New Zealand, Soil Bureau Bulletin 14. DSIR; Wellington.