INNOVATIVE USE AND ADAPTION OF A MICROBIAL TECHNOLOGY (EM) FOR LARGE SCALE VEGETABLE, ARABLE AND STOCK PRODUCTION ON AN ORGANIC FARM IN CANTERBURY, NEW ZEALAND

Chamberlain, T.P. (1) and Daly, M.J.(2)
(1) Harts Creek Farm,
(2) New Zealand Nature Farming Society,

Abstract
Effective microrganisms (EM) is a technology that was developed over 20 years ago by Dr Teruo Higa in Japan (Higa, 1996). It has gained a reputation on an international scale for enhancing growing conditions of crops and animals under a wide range of soil and climatic conditions.

The New Zealand Nature farming Society (NZNFS) promotes the use of EM technology as a tool to improve the performance of organic farming systems in NZ. Harts Creek farm is an important demonstration unit for the NZNFS, and serves as a model of EM application for this type of farming. The farm has won several awards in recent years for management, innovation, and environment, and has gained a reputation as a leading example in organic farm systems.

Harts Creek Farm is a long-term organic farm owned and operated by the author Tim Chamberlain and his wife Rose Donaghy. This farm has very good arable soils and 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 except wool is sold into specialist organic markets and attracts a premium for its organic certification. EM technology has been used on a large scale for 8 years and is well integrated into many of the farming operations. Harts Creek Farm uses around 1000 litres of EM1 per year turning this into 20,000 litres of activated EM (EM-A.) litres and applying this around the farm, in the many operations. The full extent of these applications will be presented along with a number of innovative application techniques. Farmer observations and some previously published data from on farm research will be discussed.

Introduction

What is EM Technology?

EM short for effective microorganisms, is a complex combination of microorganisms that can be found in nature and the food processing industry. This technology was developed in the 1980s, by a Japanese Professor Dr Teruo Higa. These microbes have been cultured in a special combination and developed as a technology for improving soils and plant growing conditions. In 20 years EM technology has developed into a global technology, and is recognised as a powerful and effective tool both in agriculture and horticulture for crop and animal production systems.

EM technology is used in over 140 countries around the world, and has been used in NZ for 9 years. The main focus in New Zealand has been both in Agriculture and waste management. This paper will focus on the introduction of EM to Harts Creek farm and how the application and use of EM has evolved over 8 years since first beginning large scale use.

How does it work?

EM is a mixed combination of 3 main families of microorganisms. These are Yeasts, Lactic acid bacteria, photosynthetic bacteria and fungi (Daly & Stewart, 1999). These micro-organisms are completely natural and all are found in the environment, with many found also in food processing applications, (eg Lactic acid bacteria in Yoghurt).

The key to the success of EM is not the microbes working in isolation from each other…but the combination and synergistic effect when they are used together. This is what makes EM so effective. The diverse combination of microbes in EM also gives it adaptability. And this is why it works in such a broad range of conditions. The leading roles of each family of microbes will change as the environment applied into, is changed. EM causes a fermentation process when applied to organic matter rather than a putrefying process. EM will compete with and displace, through competitive exclusion other microbes such as pathogenic microbes, some of which cause disease (eg. "Damping off" disease).

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 Table 1. (Daly 1996, Chamberlain *et al*., 1997, Daly & Stewart 1999), some of these research programmes were conducted on Harts Creek Farm. This encouraged the owners to fully integrate EM into the management techniques used on Harts Creek Farm.

Table 1. Published trial results comparing the effect of EM on yields of crops (Daly & Stewart 1999, Daly 1996)

Treatment	Onions 1996 tonnes/ha	Onions 1997 tonnes/ha	Process Peas 1996 tonnes/ha
Control	42	65	6.1
EM + molasses	54	74	8.0
LSDP=0.05	*11*	*8*	*1.4*

The history of Harts Creek Farm

Harts Creek Farm is a 4th generation Mixed Cropping and Livestock Farm. In 1982 the current owners Tim Chamberlain and his wife Rose Donaghy moved onto the farm. Tim after leaving school and doing a Diploma in Agriculture at Lincoln University, spent 3 years

working on Sheep and Beef Properties around New Zealand. Tim spent the next 3 years travelling overseas working in Canada, United States and the UK. On return to New Zealand with Rose and unsure of what form of farming to become involved in, came under the influence of Rose's interest in Organic Agriculture.

The family farm was in 1982 owned and operated by Tim's parents. They were concerned that the farm remained a profitable enterprise and there was considerable concern to the direction Tim & Rose were taking especially as the risk of organics was born by them.
In Tim's view the single best family decision made was to put 25% of the farm into organics. This enabled the farm to run a profitable conventional operation and for Tim to experiment with organics and learn about planning, growing and marketing while not risking the viability of the farm as a whole.

The first certification happened in 1986, 25% of the area, then progressively the whole farm was bought into certification with the last remaining field certified in 2002.
The farm is now fully owned by Tim and Rose, is 100% organic and the area farmed has doubled from the original area in 1986. This was by way of some land purchase, but mainly leasing to get the extra land.

Geophysical data on Harts Creek Farm

This farm has very good arable soils and as mentioned 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 for wool and meat production. All produce except the wool attracts a premium for its organic certification and is sold into specialist markets.

Table 2. Details of Harts Creek Farm 2005 and local climatic data

Size:	300 ha (160 ha owned, 140 ha leased)
Average field size:	6 ha
Number of fields:	45
Latitude	430
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 Plus other lighter soil types like Lismore stony silt loam
Irrigation	Overhead sprinklers from underground wells
Crops:pasture	55:45 ratio
Crops 2005	Carrot Seed, Fresh Carrots, Onions, Beetroot Seed, Spinach, Barley & wheat leaf, Linseed, Dandelion
Livestock	Sheep (1000 Ewes & 300 Hoggets)

EM use on Harts Creek Farm

Following the good trial results on this farm (Table 1), we began on a smaller scale using EM in strategic foliar spray applications to crops. As the confidence increased with the technology, the usage gradually increased and effort was put into application techniques. This was important, as any technology to be adopted has to be efficient, reliable, easy and cheap to operate. We have developed innovation systems that incorporated EM application with other operations, eg. Irrigation, weeding, seed coating.

Irrigation Innovation
EM can be vulnerable in hot dry conditions when applied with a low water rate, and is largely deposited on the leaf and soil surface. To allow maximum penetration to the soil profile, a simple suction system was designed to allow the EM to be applied during irrigation.

Weeding Innovation
A good time to apply EM is immediately after weeds are undercut, so that these are quickly decomposed and converted into food for the crop. A small low pressure sprayer was mounted on the toolbar of the inter-row weeder so that these operations can be combined.

Seed Coating Innovation
Some of the vegetable seeds are coated to provide a uniform size for effective planting with precision seeders. The coating can contain various germination and growth enhancers. By adding EM we expect that we are improving the germination and seedling survival of the coated seed. Although we haven't tested this ourselves, once again we believe this is likely to occur because of other experiences both in New Zealand and overseas.

EM preparation
By taking the original product as supplied and expanding and activating, we can make 1 litre into 20 litres. The original product costs $12.90 but this process of activation which requires 1 litre of molasses, can make the final product for a cost of 70 cents litre. This is the rate normally applied to 1 ha of land; therefore the cost per application is $14/ha.

EM technology is now well integrated into many of the farming operations. Harts Creek Farm uses around 1000 litres of EM1 per year turning this into 20,000 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 sometimes sprayed with EM-A to enhance storage of the crop (0.1%)

Sheep and Cattle

- *Pastures*
  When grazing EM-A is sprayed onto herbage (20 litres/ha EM-A)

- *Probiotic Medicine*
  When animals need treatment for worms or ill thrift an oral drench is used combined with other ingredients such as cider vinegar and garlic. (dosed at 5-20ml per animal depending on size of animal).

These applications and techniques are not used on every occasion, but when thought necessary and a likely benefit would result.

The exact scope of the benefits to the operation at Harts Creek farm is very hard to quantify, the success of this farm is due to many factors and EM just being one of them. The cost of the product equates to 1% of turnover, so a very modest increase in yield is likely to resultant in a profit gain. Considering the yield increases in our trials of 15-28% then a yield increase on this farm is likely to be occurring, along with other benefits. To summarize, the expected benefits from using EM are;

- yield increase
- improvements in soil quality
- more effective utilisation of nutrients, therefore less leaching
- improved storage
- improved animal performance

Although it is difficult to quantify the exact benefits from EM use on this farm, the results from trials both in New Zealand and the extensive work overseas, has given the confidence to maintain a large extensive programme of EM use on Harts Creek Farm. The technical back-up on research and overseas experience is very good and often used through email contact to APNAN, a network based in Bangkok, which supports the EM programme on technical matters in New Zealand

In recent years this farm has won 5 major awards in national farming competitions. In 2000 it was awarded the Lincoln University Foundation RaboBank "Organic farmer of the year" In 2003 it was awarded prizes in the Balance Farm Environment Awards, ANZ Grow Award, BFEA Harvest award and Gallagher Innovation award for Effective use of Micro Organisms. This farm is regarded as a leading example in the farming industry and is a great endorsement for EM technology in Canterbury and NZ.

Final Summary

Harts Creek Farm has developed from a traditional arable cropping farm into a specialist organic farm growing a greater percentage of high value crops like vegetable seed crops and that fresh crops for the organic local and export markets.

EM is a vital tool in the production system on Harts Creek Farm. As we increase our exposure with biennial seed crops and their increased disease risk we are having to look at more innovative ways of using EM, and products that can be combined with EM, particularly in the disease and pest control area.

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).*
Higa, T. 1996. Effective microorganisms - Their role in Kyusei Nature Farming. In: J.F. Parr, et al. (eds.), *Proceedings of the 3rd International Nature Farming Conference. USDA; Washington, 20-23.*
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.*