AMELIORATING THE EFFECTS OF CLIMATE CHANGE WITH ORGANIC SYSTEMS

Andre Leu[1]
Chair, Organic Federation of Australia

Introduction
Experts expect that climate change will have a negative effect on our food supply as a result of more frequent adverse weather events leading to increasing crop failures. This is particularly relevant in several of the world's major food producing regions, including temperate Asia, China, Northern India, Sub Saharan, North and Southern Africa, Southern North America, the temperate and subtropical regions of South America, Mediterranean Europe and temperate Australia.

Many of the predicted weather scenarios such as increases in prolonged droughts and short intense rain events are already a fact of life and causing significant crop failures. The security of our food supply concerns all of us.

So what has organic agriculture to do with climate change? One of the central tenets of organic farming is to improve soil health and productivity by increasing organic matter (carbon) levels, particularly humus. In doing this organic farming can remove significant amounts of the carbon dioxide ($C0_2$) from the atmosphere and increase water use efficiency.

Several studies have shown that organic farming systems are more resilient to the predicted weather extremes. Organic systems have achieved higher yields than conventional farming systems in weather extremes such as floods and droughts because of their superior water use efficiency and improved soil structure. Their higher soil humus levels give them better water holding capacity (Drinkwater et al. 1998, Welsh 1999, Lotter 2003, Pimentel 2005, Wynen 2006, Posner et al. 2008).

Organic Systems Use Water More Efficiently
Humus is one of the most important components of organic matter. It stores from 20 to 30 times its weight in water. This enables rain and irrigation water to not be lost through leaching and evaporation; but rather stored in the soil for later use by the plants (Handrek 1990, Stevenson 1998, Handrek & Black 2002).

Organic systems have been shown to use water more efficiently because of their superior soil structure and higher levels of humus and other organic matter compounds (Lotter 2003, Pimentel 2005). *'Soil water held in the crop root zone was measured and shown to be consistently higher by a statistically significant margin in the organic plots than the conventional plots, due to the higher organic matter content in the organic treated soils'* (Lotter 2003).

The open structure of organically managed soils allows rainwater to quickly penetrate the soil, resulting in less water loss from run off and higher levels of water capture. *'The exceptional water capture capability of the organic treatments stood out during the torrential downpours during hurricane Floyd in September of 1999. The organic systems captured about twice as much water as the CNV* [conventional] *treatment during that two day event'* (Lotter 2003).

Greenhouse Gas Abatement
Organic agriculture can also ameliorate some of the main causes of climate change. Studies in North America and Europe have shown that best practice organic agriculture emits less greenhouse gases than conventional agriculture, and that carbon sequestration from increasing

[1] chair@ofa.org.au

ISSN 1177-4258

soil organic matter can result in a net reduction in greenhouse gases (Mader et al 2002, Pimentel 2005, Reganold, et al 2001).

Two long-term comparison trials (21 and 22 years) of conventional and organic systems have found that the organic systems use less fossil fuels and therefore emit significantly lower levels of (around 30% less) greenhouse gases (Mader et al. 2002, Pimentel 2005).

A long-term apple comparison trial in Washington DC found that the organic system was more efficient in it energy use. *'When compared with the conventional and integrated systems, the organic system produced sweeter and less tart apples, higher profitability and greater energy efficiency'* (Reganold et al. 2001).

Nitrous Oxide

One of the most significant of the greenhouse gases emitted by agriculture is nitrous oxide (NO_2). One NO_2 molecule is equivalent to 310 CO_2 molecules in its greenhouse effect in the atmosphere.

The biggest contributor to anthropogenic NO_2 pollution is the use in conventional agriculture of synthetic nitrogen fertilisers such as urea and ammonium nitrate. This is on top of all the CO_2 and NO_2 that is emitted in the production of these energy-intensive soluble fertilisers.

Most governments do not factor the CO_2 emissions that result from the production of these synthetic fertilisers into the greenhouse gases levels caused by agriculture.

Although several governments, including the Australian government, are developing policies and initiatives for CO_2reduction schemes, nearly all proposals are silent on NO_2.

Nitrous oxides are the great 'sleeper' in the climate change debates; and much greater attention needs to be paid to them.

Research from North America and Europe shows that organic systems are around 30% more efficient in using fertilizer nitrogen than conventional farming systems. Significantly because of this efficiency very little nitrogen leaves the farms as greenhouse gases or as nitrate that pollutes aquatic systems (Drinkwater et al. 1998, Mader et al. 2002).

Carbon Sequestration in Soil

A significant tenet of organic agriculture is to build up soil fertility by increasing the levels of organic carbon compounds in the soil. This is primarily achieved by using photosynthesis to convert atmospheric carbon dioxide, and by using management techniques that convert these plant materials into soil organic matter. *'Sufficient organic material should be regenerated and/or returned to the soil to improve, or at least maintain, humus levels. Conservation and recycling of nutrients is a major feature of any organic farming system'* (National Standard 2005).

Organic agriculture helps to reduce greenhouse gases by converting atmospheric CO_2 into soil organic matter. Some forms of conventional agriculture have caused a massive decline in soil organic matter, due to oxidizing organic carbon by incorrect tillage, the overuse of high nitrogen fertilizers and from topsoil loss through wind and water erosion.

According to Dr Christine Jones (2006), one of Australia's leading experts on carbon sequestration: *'Every tonne of carbon lost from soil adds 3.67 tonnes of carbon dioxide (CO_2) gas to the atmosphere. Conversely, every 1 t/ha increase in soil organic carbon [OC] represents 3.67 tonnes of CO_2 sequestered from the atmosphere and removed from the greenhouse gas equation.'*

'For example, a 1% increase in organic carbon in the top 20 cm [8 inches] of soil represents a 24 t/ha increase in soil OC which equates to 88 t/ha of CO_2 sequestered.'

Thus, a 100 hectare farm that had a 1% increase in organic matter would be removing 8,800,000 kgs of CO_2 from the atmosphere. A million hectares = 88,000,000,000 kgs.

Burning 1 litre petrol produces 2.3 kg of CO_2. Thus, a 1% increase in organic matter per hectare is equivalent to sequestering the carbon from 38,260 litres of petrol.

In the case of my car, it is equivalent to 1000 tanks of fuel. If I used one tank a week it is the equivalent of all the fuel I would use over 20 years. If as a farmer I can sequester 1% over 10 hectares it would be equivalent to removing the CO_2 from the use of 200 years of fuel.

Another way of looking at it would be that 1 hectare equals the equivalent of 20 cars in a year; a million hectares equals the emission of 20 million cars per year.

These figures are ballpark figures because the variability of dynamic systems makes it virtually impossible to give precise numbers. These are rounded off to make them easy to understand, yet they are accurate enough to provide an understanding of the concepts.

Can Soil Carbon Sequestration be Achieved in Practice?

Data from the Rodale Institute's long-term comparison of organic and conventional cropping systems (Rodale 2008) confirms that organic methods are effective at removing CO_2 from the atmosphere, and for fixing it as beneficial organic matter in the soil.

In this study it has been demonstrated that organic farming practices can remove about 7,000 kilos of CO_2 from the air each year and sequester it in a hectare of farmland.

Thus, if all of America's 100 million hectares of cropland were converted to organic practices, it would be the equivalent of taking 217 million cars off the road. This is nearly 88 percent of all cars in the USA and more than a third of all the cars in the world.

Dr Paul Hepperly, Research Director at The Rodale Institute and Fulbright Scholar, stated: "We've shown that organic practices can do better than anyone thought at sequestering carbon, and could counteract up to 40 percent of global greenhouse gas output" (Rodale 2008).

The important point about this research is that the amount of CO_2 sequestered is based on what has actually been achieved through current organic farming practices. This is not a theoretical estimate, in contrast to many of the claims associated with tree plantation models; or unproven like the millions of dollars being spent in relation to clean coal developments, and for mechanical geo sequestration trials.

References

Drinkwater, L.E., Wagoner, P. & Sarrantonio, M. 1998. Legume-based cropping systems have reduced carbon and nitrogen losses. Nature 396: 262 - 265.

Handrek, K. 1979; rpr. 1990. Organic Matter and Soils, CSIRO, ACT.

Handrek, K. & Black, N. 2002. Growing Media for Ornamental Plants and Turf, UNSW Press, Sydney, NSW.

Jones, C.E. 2006. Balancing the Greenhouse Equation – Part IV, Potential for high returns from more soil carbon, Australian Farm Journal, February 2006, pp. 55-58.

Lotter, D.W., Seidel, R. & Liebhart, W. 2003. The performance of organic and conventional cropping systems in an extreme climate year. American Journal of Alternative Agriculture 18(3): 146–154.

Mader, P., Fliessbach, A., Dubois, D., Gunst, L., Fried, P. & Niggli, U. 2002. Soil fertility and biodiversity in Organic Farming. Science 296: 1694-1697.

National Standard 2005. National Standard for Organic and Bio-Dynamic Produce, *Edition 3.1, As Amended January 2005,* Organic Industry Export Consultative Committee, c/o Australian Quarantine and Inspection Service, GPO Box 858, Canberra, ACT 2601.

Pimentel, D., Hepperly, P., Hanson, J., Douds, D. & Seidel, R. 2005. Environmental, energetic and economic comparisons of organic and conventional farming systems, Bioscience 55(7): 557-582.

Posner, J.L., Baldcock, J.L. & Hedtcke, J.L. 2008. Organic and conventional production systems in the Wisconsin integrated cropping systems trials: I. productivity 1990-2002, Agronomy Journal, 100: 253-260

Reganold, J, Elliott L. & Unger Y. 1987. Long-term effects of organic and conventional farming on soil erosion, Nature 330: 370 - 372; doi:10.1038/330370a0

Reganold, J.P., Glover, J.D., Andrews, P.K., & Hinman, H.R. 2001. Sustainability of three apple production systems. Nature 410: 926–930.

Rodale 2008. Farm Systems Trial, The Rodale Institute, 611 Siegfriedale Road, Kutztown, PA 19530-9320

Stevenson J. 1998. Humus Chemistry in Soil Chemistry, Wiley. New York, p.148

Welsh, R. 1999. The Economics of Organic Grain and Soybean Production in the Midwestern United States, Henry A. Wallace Institute Policy Studies Report No. 13, May 1999.

Wynen, E. 2006. Economic management in organic agriculture, *in* Kristiansen, P., Taji, A. & Reganold, J.P. (Eds.): Organic Agriculture - a Global Perspective, Chapter 8, CSIRO Publishing, Melbourne, VIC, p. 236. http://www.elspl.com.au/OrgAg/Pubs/Pub-A-FP/OA-FP-A22-CSIRO-Chapter%2010.pdf.