Sustainability issues for the arable industry

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Introduction

That slippery, elusive concept - sustainability - it has us all balancing, juggling, evaluating in the pursuit of a solution - some kind of ultimate state. But perhaps we are missing the point if we focus on that end-point. Perhaps it's the *process*, by focusing on key *issues*, that's more important. So, in *pursuing* sustainability or adopting a sustainable ethic in the arable industry, where better to begin than the arable production unit.

Putting on a holistic mind set we could picture the arable farm as being part of an agro-ecosystem, a system that's a combination of soil, microclimate, management systems, fauna and natural flora. The package is unique and determines the productivity of a particular area. That agro-ecosystem is also a sub-set of the regional environment. Some aspects of this environment (in the broadest sense) are under the control of the farmer - things like personal management style and choice of crop. But other aspects are strongly influenced by social and economic factors - exchange rates, consumer preferences and so on. Repercussions for the wider environment include the effect of stubble being burnt, groundwater being polluted by leached nitrate, or increased costs because of competition from urban development.

At a third sphere of consideration, the regional environment is a sub-set of the global environment. Again, there are resource or product flows between the regional and global environment, such as carbon dioxide emissions to the atmosphere or the introduction of disease organisms from another region.

So, how do we manage this complex system of interactions? The FAB model principles (Smyth and Dumanski, 1993) seem to provide the best outline of just what sustainability is:

- productivity - so that services are maintained or enhanced;
- security - so that production risks are minimised;
- protection - so that soil and water quality are not degraded and the potential of the natural resource is maintained;
- liability - so that the system is economically viable; and
- acceptability - so that activities are socially and culturally acceptable.

Interactions between these principles and trade-offs that must be made between them are the key to identifying some kind of, more or less, sustainable state in any sector.

Issues Facing the Arable Sector

The arable sector is unusual compared to other New Zealand primary sectors for several reasons. The sector produces staple foodstuffs, wheat, rice, maize and barley. These are four of the seven major staple foods which together provide 75% of total human nutrition. Secondly, grains are not perishable and can easily be transported. So the grain market is truly international and supply and demand relationships are crucial in determining price. The world's population is increasing, but the amount of productive land for arable crops is declining. Asian diets are becoming Westernised, and the demand for meat is expanding rapidly in Asia. Societies are becoming more industrialised and farmers are ageing as a demographic group.

Since 1930 the arable area per capita has approximately halved, but fortunately grain yields have more than doubled (Roberts, 1992). Nevertheless the world grain supply is the tightest for 20 years (Rees, 1996) and world grain stocks are at their lowest level for that period. The Chinese are predicting a shortfall of grain production of 40 million tonnes by the year 2000 and 50 million tonnes by 2025 (Tracey, 1996). It has been said in reference to the interlinking of the world's financial markets and their relative sizes that when Wall Street sneezes, New Zealand catches a cold. It's a good analogy for the grain industry. If a major country like China swallows, then most of the world grain industries at least hiccup, because of the direct link between supply and demand internationally in the arable sector.

So increased productivity on a global scale is a critical issue facing the arable sector in the decades ahead.

If we take a more domestic focus now - the major issues for the sustainability of New Zealand's arable sector are:

- soil degradation
- water availability and quality
- energy availability and efficiency
- production systems

Soil Degradation

All three types of soil degradation - physical, chemical and biological - are cause for concern. Soil must be maintained if the productive capacity of the land is to be maintained, yet we all know the statistics. A widely quoted figure internationally suggests that in the US, by 1977 it was believed that 6 tonnes of soil were lost for each tonne of grain produced (Raeburn, 1995.) Such physical losses of soil by wind, or by water, are major and serious issues. In New Zealand, as well as the water-induced erosion that's well publicised, there can be significant losses of soil through wind. In Canterbury dust clouds from spring nor'westers are not uncommon. Research has shown that substantial nutrient losses can take place; for example in North Canterbury losses of phosphate equivalent to 73 kg of superphosphate/ha (Hunter and Lynn, 1988) have been recorded. Degradation of the soil's physical structure has numerous effects: it can increase cultivation costs, reduce germination and vigour, delay sowing causing uneven growth, increase disease, and generally reduce yield and quality. The major cause of the reduction in soil physical structure in New Zealand is the reduction in organic matter - another issue of considerable importance if we are to manage our environment sustainably.

Chemical degradation is another process leading to a potential loss of nutrients through leaching, or volatilising, or by the harvesting of crops. The facts are compelling - an average 5.1 t/ha wheat crop removes over 100 kg nitrogen/ha and over 75 kg of potassium/ha (Goh and Nguyen, 1992). Furthermore, loss of nitrogen by leaching over winter can be very high. Early ploughing of the grass/legume pasture can result in leaching losses of 169 kg/ha of nitrogen (Haynes and Francis, 1992).

Biological degradation is also an important issue because organisms, and especially micro-organisms, play key roles in soil processes. Earthworms are critical in determining infiltration rates and turnover of nutrients. We know that their numbers build up in crop rotations under a pastoral phase, and then decline substantially during the cropping phase, at least under conventional cultivation techniques. New Zealand farmers need to know that the soil micro-fauna must be left undisturbed as much as possible. Careful soil management can reduce biological degradation.

In many countries, loss of natural flora through arable cropping is a major issue. In New Zealand it's less of an issue because all of the crops are grown in areas where important native plants are not particularly common, or threatened. However, the micro-fauna in the soil may well be a case where biodiversity preservation is an important issue for New Zealand to consider in the future.

Quite apart from soil *degradation*, we ought to be concerned by issues such as increasing competitive pressure for the best soils which is forcing growers to work marginal soils with consequent reliance on inputs. A build-up in soil-borne diseases is also a threat to sustainable production as is the practice of straw burning. The dogged pursuit of increasingly specified quality requirements by processors and consumers whilst maintaining yields is putting immense pressure on farmers and their production systems.

Water Availability

Arable agriculture is a major consumer of water internationally; for example, it is estimated that 85% of water consumption in a year is by agriculture, and, contrary to many other water uses that enable water to be recycled, most of that water is evaporated/transpired into the atmosphere. It has been estimated that almost 10 million litres per hectare are required for irrigated maize production in the United States and of course paddy rice needs even more (Raeburn, 1995). Continuing availability of water is important for productivity. In China, the volume of water per capita is estimated to decrease by 1.3% per year during the nineties (Rees, 1996). The consequences for agriculture of this are unknown. If that rate continues then they are likely to be very significant.

In some parts of the world groundwater storage is being depleted - the rate of extraction is considerably greater than the rate of recharge. By and large this is not a problem in New Zealand. However, the availability of irrigation water is an issue because of competition from other uses. Recreational and conservation requirements already reduce the availability of water in some parts of New Zealand. This competition can only increase as the population grows and it will become more of a concern as environmental awareness increases. In other more heavily populated parts of the world the requirements of agriculture for water are being overruled by the needs of industry or of communities. In Malaysia, for example, I have heard of a case where a major agricultural production area is losing its water supply to develop an electronics industry in a neighbouring area. One has to wonder how sustainable such an arrangement is.

Water Quality

Loss of nutrients by leaching, particularly nitrogen, is an economic loss as well as an environmental threat. Enrichment of water bodies with nutrients can cause nitrification, decrease water clarity and reduce dissolved oxygen levels with drastic consequences for other life forms in the water. High nitrate levels are also considered a health hazard in groundwater. Some agricultural practices have been changed, particularly in Europe, because of legislation to protect water quality. In Canterbury, nitrate levels exceed World Health Organisation guidelines following ploughing of pastures before winter (Haynes and Francis, 1992). Ironically, fertiliser nitrogen applications in arable production systems don't normally cause the same problems or at least to the same extent if they are applied at the correct rates during the growing season where they are utilised effectively by the growing crop. In more intensive cropping systems, particularly where vegetables are being grown out of season, leaching of fertiliser nitrogen is undoubtedly a significant problem.

Energy Efficiency and Availability

Agriculture in New Zealand has developed on the basis of increasing labour efficiencies and more mechanised systems. Such systems depend on energy supplies, particularly petroleum fuel-based energy. Studies by Smith and McChesney (1979) on energy usage in New Zealand farms show there is a positive net energy (the energy output has been subtracted from the energy input needed to modify the particular systems) from growing grains. Estimates are in the order of 50 Gigajoules produced per hectare. However, transportation and processing use much more energy than that and although the energy ratios for grain farming (energy output divided by energy input) might be 6:1 at the farm gate, the whole food system often returns less energy than it consumes.

So it's critical that management strategies that minimise energy inputs are explored, even on the farm. Methods of tillage, the way rotations are put together and the use of other inputs and, in particular, fertiliser, pesticides and water all influence the energy efficiency of the system.

There are two looming problems/issues related to energy for international arable production. The challenge is to feed an ever increasing population from a static or declining land area. This will require more intensive production systems which almost invariably consume more energy. These issues are a major challenge for those concerned with sustainable management in the future.

Production Systems

FAB principles and the interactions and trade offs between them become critical once we start contemplating production systems. The message for producers is conflicting. It is clear that there are increasing demands for producers to satisfy the hunger of increasing populations, but there is increasing pressure from a much more environmentally aware public that those production systems must not damage the environment. Yet, there are constraints on resources - there is only so much land, so much clean water and so on. Meeting the FAB protection, security and acceptability principles often conflicts with the viability principles.

While there's a demand for 'soft' production systems, they will only be achieved by using some 'hard' science to get there. To date there are few meaningful ways of comparing the suitability of alternative production systems in New Zealand. What evidence there is indicates that all farming systems need some inputs to sustain them (Goh and Nguyen, 1992) although the form of those inputs and their quantities may vary. And while evidence indicates that certain alternative systems, particularly organic systems, are economically viable when they are aimed to produce for the top end of the international market, it is unlikely that those "niche" market returns can provide for the demands for future population growth.

There is a huge challenge facing the world in maintaining environmental quality and feeding these people. The challenge for us, as scientists, is to feed future generations without sacrificing environment quality. Modern technology has much to contribute - from crop modelling systems, integrated approaches to pest and disease management, to biotechnology - this conference is a celebration of the valuable contribution that sensitively applied technology is making to resolving the issues that challenge us.

Conclusion

The issues facing those working in New Zealand's arable industry are different in degree, not in kind, from those faced in the rest of the world. But if we are to meet the needs of international markets we need to do so without compromising our own environmental quality. We must keep a wary eye on new pests and diseases by monitoring our borders. We must watch out for signs of resistance amongst weeds, pests and diseases. We must be mindful of the ever narrowing genetic base in a typical agro-ecosystem and its consequent vulnerability. We must use fertilisers wisely and water efficiently.

The important thing is that we ask ourselves "how sustainable is this system, this practice, this approach?" Only then we progress towards a more sustainable system of environmental management and only then can we claim to have adopted a sustainable ethic.

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