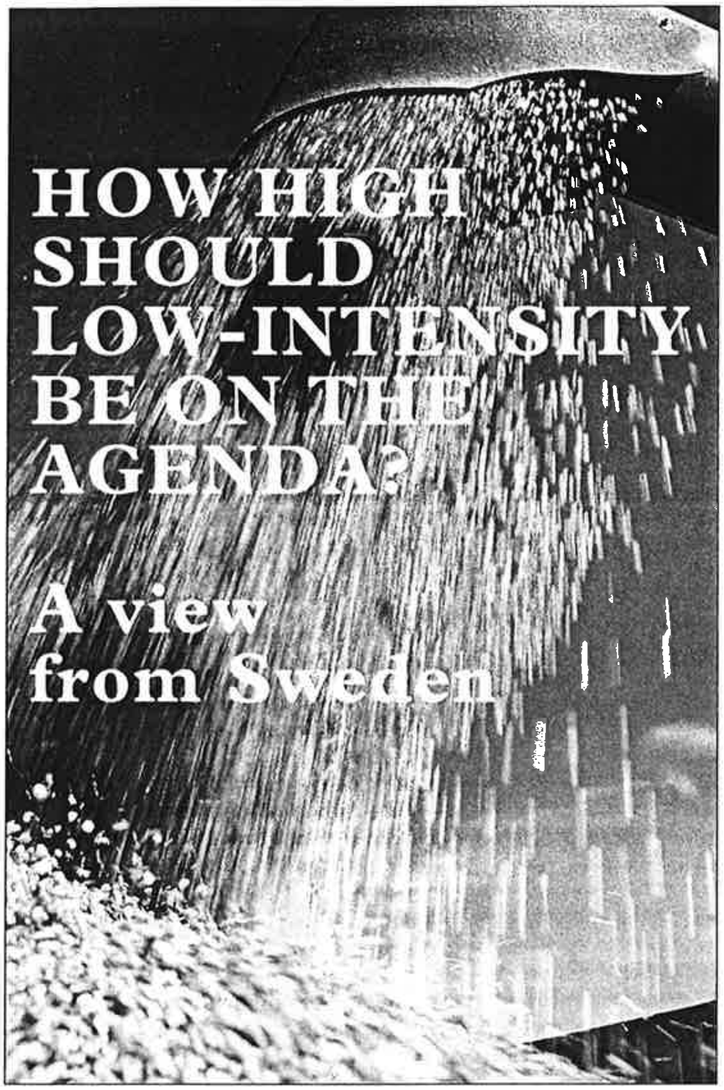


HOW HIGH SHOULD LOW-INTENSITY BE ON THE AGENDA?

A view from Sweden

By Dr. Tom Addiscott

"Well, of course low-input, extensive farming has got to be better for the environment, hasn't it?" At first glance, this assumption looks almost self-evident and few people have thought to question it. But as with many other 'green' issues now under debate, much depends on exactly what you ask.

Göte Bertilsson of Hydro Supra AB of Sweden has taken the important step in a recent Fertiliser Society paper(1), of presenting the issue not just with a few questions, but with a carefully worded questionnaire – a distinction made by R A Fisher in a statistical context. Bertilsson's questionnaire asked the basic question:

"Is it better to farm less land more intensively, using the spare land for 'nature' or bio-energy production, or to farm more land less intensively?"

Much of the debate about farming and the environment centres around energy use by, and emissions from, agricultural systems.

These emissions, or losses, include carbon dioxide, nitrogen oxides, ammonia, nitrate and phosphate. Here again Bertilsson has picked up a key question that has to be asked:

"Should we consider energy use and emissions per unit area of farmed land, or for total production?"

The answer to this second question has a profound influence on the answer to the first. There is an interesting analogy with the question of the relative merits of conventional and organic farming in terms of the introduction of nitrogen into the systems and the leakage of nitrate from them(2).

Most comparisons consider inputs and leakages on an area basis. But we surely need to ask how much new nitrogen has to be introduced into each system, either by fertiliser or nitrogen-fixing bacteria, and how much nitrate is leaked per tonne of grain, litre of milk or other unit of farm production.

Bertilsson wrote against a Swedish background in which both political parties and environmental organisations advocate extensification, meaning, he said, lower yields per unit area.

He perceived the reason to be that for decades agricultural development was guided by economic considerations alone. This resulted in many cases in systems that were both wasteful and polluting, but he pointed out that this trend has now been reversed.

Agricultural practice is now improved and better regulated, while related industries, notably fertiliser production, use energy more efficiently and emit fewer pollutants. He feels that the significant improvements that have been achieved must be taken into account in any discussion of extensification.

Defining the system

The agricultural system that Bertilsson took for his study was no less than Sweden itself. He used Swedish agricultural statistics for farm management planning, including resources use and costs. To this he added nitrogen flows and balances for typical Swedish farms and rotations published by the agricultural faculty at Uppsala University to model Swedish farm production.

Production targets were set as follows:

- Milk and beef from 500,000 cows. Grass/clover leys and feed peas to be produced on the farm.
- Grain for sale: 3.57 million tonnes.
- Potatoes: 9 million tonnes.

The figure for potatoes was set deliberately well above actual production because this crop was reckoned to represent sugarbeet, vegetables and other crops as well as potatoes. And, to make the calculations feasible, oilseeds and pig production were not included. The aim, says Bertilsson, was to produce 'a model in touch with reality, not a description of Swedish agriculture.'

Achieving the target

The core of Bertilsson's study was the assessment of how these production targets could be met with three intensities, or levels, of production: 'normal', 'low' and 'zero-nitrogen'.

A key point was that the area in agricultural production was not fixed so that, where a system used less land than another, the spare land could be devoted to 'nature' or the production of willows for biofuel.

Energy demand and the emissions, or losses, of nitrogen oxides, carbon dioxide, ammonia, nitrate and phosphate were estimated for each intensity of production, taking appropriate account of the area of land that was farmed, using data from various sources in Sweden and other countries.

Scenario

The demand and the emissions included those arising directly from farming operations and from fertiliser and seed production and transport. Bertilsson acknowledges that his Swedish data represent a near-ideal scenario: 'A modern ammonia plant situated within two days of ship transport, ammonium nitrate production with energy recovery and the finished product to be transported for a maximum of 300km.' He adds though that this should be possible in large parts of Europe.

Bertilsson examined his normal, low and zero-rated intensities for rotations producing milk and crops. British farmers may well consider his 'normal' intensity nitrogen use to be relatively modest. But this probably reflects the climatic differences between Sweden and the UK.

The intensities, or levels, were defined as follows:

Milk production system

Rotation: Ley (grass/clover) ley, oats, barley, potatoes, peas, barley, potatoes, barley.

Intensities:
Normal N use: 85kg/ha
Low N use: 25kg/ha
Zero-nitrogen: No fertiliser N and cropping slightly changed to give improved nitrogen husbandry.

Note: Stocking density 0.53 ha per cow. Improved management of farmyard manures throughout all the systems.

Crop production system

Intensities:
Normal N use: 100kg/ha
Low N use: 60kg/ha
Zero-nitrogen: No fertiliser N but clover undersown for green manure.

Note: The use of peas and forage legumes were adjusted in each case to match the requirements of the system. The performance at the three intensities was assessed in the light of data from long-term field experiments and knowledge of the N cycle.

Systems, areas, demands and emissions

Areas:

One key to Bertilsson's calculations lies in the relationship between the milk production and grain production systems (rotations). He assigned a fixed area to the milk rotation, which included grain and potatoes as well as grass leys.

Using less or no nitrogen in the Low Intensity (LI) and Zero-Nitrogen (ZN) systems decreased the yield per hectare of all three commodities (figure 1). Not only was the grain yield lower, but the proportion of the land that could be devoted to grain crops was smaller than in the Normal Intensity (NI) system because more land was needed for leys and potatoes. As a result, the LI and ZN systems needed to import grain from the grain production rotation whereas the NI system was able to export grain.

When the differing intensities were applied to the grain production rotation, the LI and ZN systems not only produced less grain than the NI system – because they received less nitrogen – they also had to export grain to their counterparts in the milk rotation. In contrast, the NI system had its target eased by the export from the milk rotation and therefore needed much less land, leaving appreciably more 'spare land' for 'nature' or the production of willows for biofuel (figure 2).

Energy demand:

The most obvious energy demand in farming is in the form of diesel to power tractors. However, energy is also used in seed processing, the manufacture and maintenance of farm machinery and the upkeep of the farm infrastructure such as roads, drainage and buildings.

To this has of course to be added the energy used in the production of fertiliser, particularly nitrogen. Most of this energy comes from fossil fuel such as oil and gas, but growing willows can offset this resource loss. One hectare of willow can produce 15 tonnes of dry matter in three years, equivalent to about six tonnes of oil, without much input of farm energy.

Looking at the NI, LI and ZN systems in terms of energy demand per hectare farmed shows, as would be expected, that the NI system had much the largest demand and the ZN system the lowest (figure 3).

Considering the energy needed to achieve the target production on the whole farmed area however changed the picture considerably. The ZN system remained the least demanding while the LI system had the highest energy requirement. The situation remained the same if the 'spare' land mentioned earlier went to 'nature', probably as forest. Turning it over to willow production however changed the picture dramatically. The ZN system became the most energy demanding while the LI system became a rather modest energy producer and the NI regime had a significant surplus.

Emissions:

With all emissions, as with energy demand, expressing

Continued on Page 16 ▷

Table 1
Emissions of carbon dioxide, nitrogen oxides (except nitrous oxides), ammonia, nitrogen and phosphate.

	Normal	Low	Zero
Carbon dioxide			
per ha farmed (kgC/ha)	*144*	*113*	*86*
Total production (1000 tonnes C)	216	224	189
With willows	-1448*	-241	189
Nitrogen oxides			
per ha farmed (kgN/ha)	*5.26*	*5.11*	*5.18*
Total production (1000 tonnes N)	7.9	10.2	11.3
Ammonia			
per ha farmed (kgN/ha)	*16*	*12*	*13*
Total production (1000 tonnes N)	24.3	24.3	24.8
Nitrate			
per ha farmed (kgN/ha)	*34*	*29*	*27*
Total production (1000 tonnes N)	50.7	57.7	59.6
Phosphate			
per ha farmed (kgP/ha)	*0.26*	*0.25*	*0.24*
Total production (tonnes P)	395	493	531

* The minus sign indicates a cut in emissions which reflects the saving of fossil fuel CO_2 output. Willows are CO_2 neutral, because the CO_2 fixed by photosynthesis is equivalent to that released on burning for fuel.

Figure 1
Yields of grain, potatoes and ley calculated for normal intensity (NI), low intensity (LI) and zero-nitrogen (ZN) systems, expressed as percentages of the yields at normal intensity.

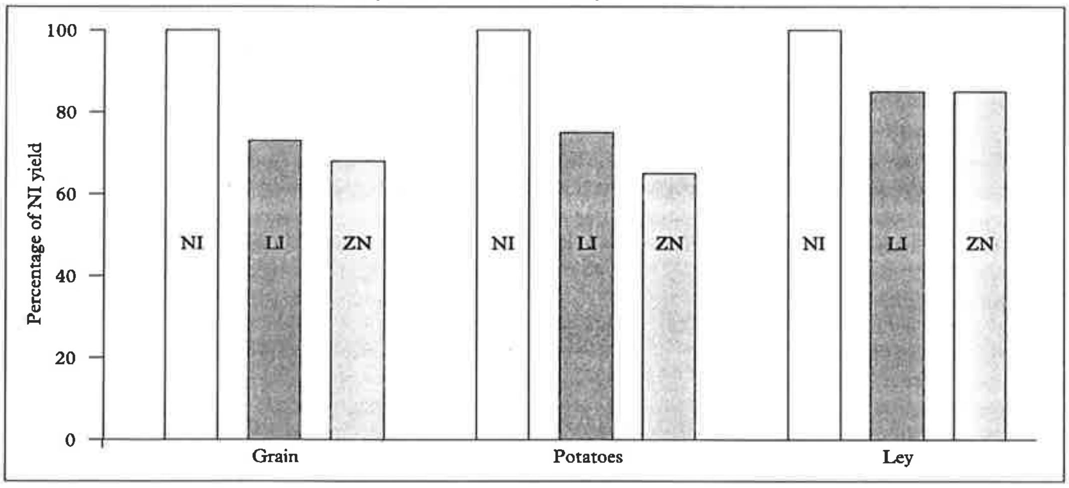


Figure 2
Allocation of the land area in the three systems

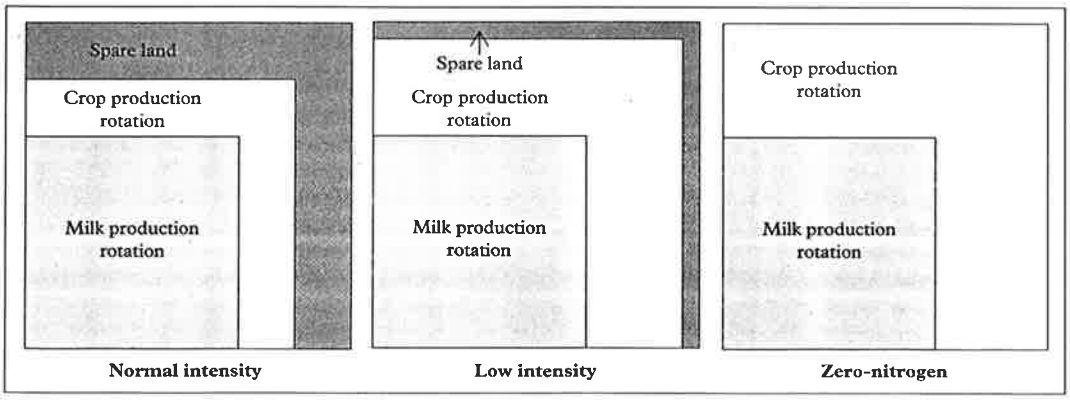
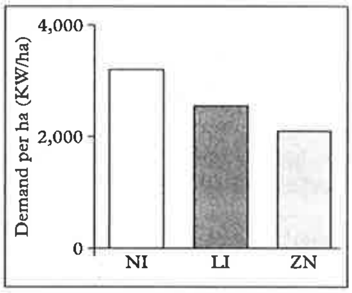
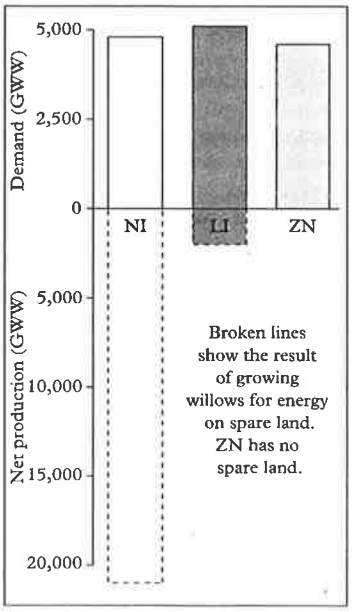


Figure 3
Energy demand per hectare of land farmed



Energy demand(or net energy production) in whole system)



has built up considerable expertise over many years, but we are not limited to where we support work. Since our offices are located at East Malling, we can keep in close contact with researchers.

The main priority running through current breeding, production, protection and storage programmes is to learn how the industry can reduce its dependence on conventional pesticides. This is not because they represent any appreciable threat to consumers, but because of possible consumer or legislative pressure. Sales of fruit could be severely affected should consumers perceive conventional agrochemicals to be a threat. Alternatively, crop protection chemicals could be restricted by the high cost of environmental and safety research now required.

The industry is extremely vulnerable to sudden changes in public perception, whether well-founded or not. Growers must therefore make sure that they can respond.

This is also one of the reasons for APRC to act on one of its lesser known remits, to 'communicate with the public on technical matters.' This is difficult for a small organisation with an annual levy income of about £330,000 a year.

Exhibition

The most cost-effective approach was to set up a permanent exhibition at Brogdale, home of the Brogdale Trust and an existing visitors centre, which has the infrastructure for dealing with the public and plays an important role in informing it about fruit varieties and how they are grown.

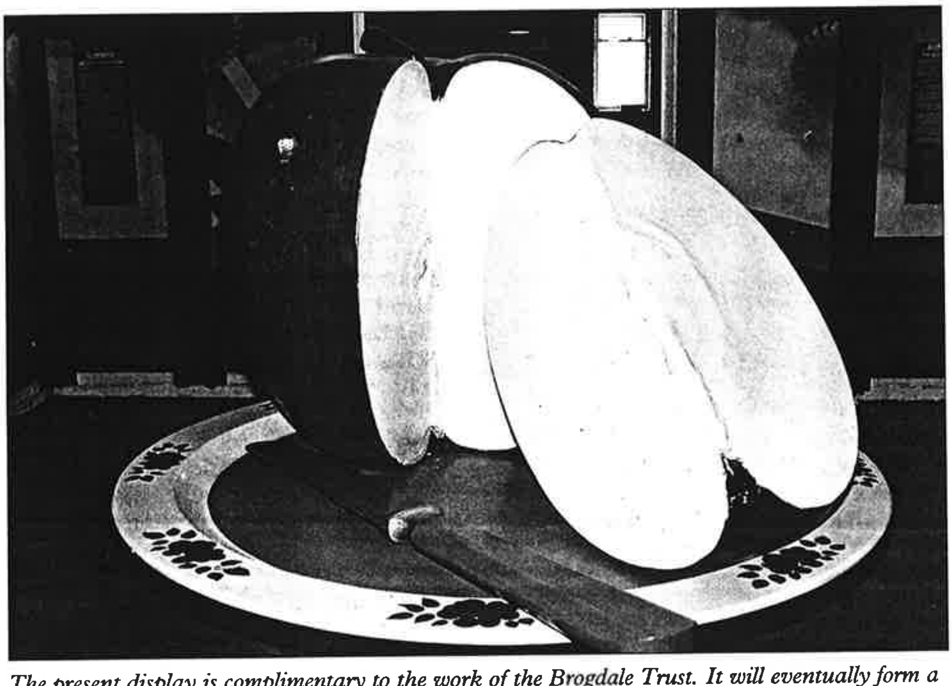
Another display deals with information on nutrition, pests and diseases.

Our activity is therefore complementary to the work of the Brogdale Trust. The new exhibit will concentrate initially on the way apples grow and the problems facing growers in producing high quality, blemish-free fruit demanded by consumers. It will also illustrate how the problems posed by pests and diseases can be tackled and the research carried out to find ever better ways to control them. The exhibition will eventually form a changing display to illustrate to the public the research activities supported by the APRC. □

Table 1
Research projects funded by APRC

Post-harvest rotting and reducing waste in store	HRI & Wye (ADAS)
Fertigation of orchards	HRI
New variety trialling	Brogdale
Improvement of cropping by self-fertile Cox	HRI
Apple canker	Wye College
Control of apple sawfly, summer fruit tortrix & pear sucker	HRI
Temperature-based decision-making models (Pestman)	HRI
Supervised control of scab (Ventem)	HRI

This is just a selection of more than 20 currently supported research projects.



The present display is complimentary to the work of the Brogdale Trust. It will eventually form a changing display to illustrate the research activities supported by APRC.

How high should low-intensity be on the agenda

Continued from Page 5

them per hectare of farmed land gave one picture. However considering emissions in terms of achievement of their target production gave a rather different view.

On the per hectare basis, the NI system was clearly the most conspicuous emitter, particularly of carbon dioxide (table 1). However, in terms of the target production it was found to emit the least phosphate, nitrate andnitrogen oxides and to emit less carbon dioxide than the LI system. All three systems emitted rather similar amounts of ammonia on this basis.

When the spare land went to 'nature', this picture remained broadly similar but, when it was put into willow production, the NI system became a clear net saver of carbon dioxide emissions and the LI system a much less important one.

Getting the questions right

Bertilsson's study is, by his own admission, a simplification and can inevitably be criticised on one or two points. He seems, for example, to have omitted emissions of nitrous oxide, which would probably be greater for the NI system than the other two regimes. Nor does he discuss the use of pesticides, a topic of considerable interest to the general public.

But he must be credited for identifying the key problem in assessing the impact of farming on the environment: that of asking the questions that tell you what you really want to know.

He has also, in passing, re-emphasised the need for government and the public to decide unequivocally what they really want from the farming community. □

Footnote:

(1)"Environmental consequences of different farming systems using good agricultural practices". Paper read at the International Conference in Cambridge, 16-17 December 1992.

(2)"Farming fertilizers and the Nitrate problem." TM Addiscott, AP Whitmore and DS Powlson CAB International pp.

Front Cover: This cartoon, published in Punch in 1882, shows Sir John Bennet Lawes, superphosphate manufacturer, agricultural scientist *par excellence* and philanthropist.
The original caption read:
The Agricultural Lawes, the new Wheel-Barrow-Net, Motto "Laus et Honor".

Trade Marks

® Registered trade mark of BASF.

Cycocel is a registered trade mark of American Cyanamid Company.

Read the label before you buy.
Use pesticides safely.