Organic Yields

1. Introduction

It is a common assumption that the lower yields of organic farming are a major drawback to this method of food production. When the evidence is looked at, however, we can see how advances in organic farming have produced a doubling of yields over the last 40 years, and the differences in organic yields and conventional yields are often not as large as assumed. The most recent broad comparison reported by the Scottish Crop Research Institute notes, "Generally the loss in yields per hectare is 5 - 10 percent for crops and 10 - 20 percent for livestock." Any shortfall in organic yields are compensated for by more efficient use of energy and other resources, higher nutrient levels in the crops produced and strong ecological benefits. Furthermore, observed differences in yield returns between conventional and organic production may not in fact be due to inherent differences in the methods of farming, but may instead be related to the differing levels Research and Development funding for the two methods over the last 50 years.

2. Evolution of organic yields

The first records of yields from organic farming come from the late 1940's and show grain yields of around 2 t/ha and potatoes of around 20 t/ha (***Moore, 1949***). More records of past yields come from the Haughley experiment set up by Lady Eve Balfour. Three adjacent farm systems were compared: organic, mixed crop/livestock and intensive arable. The mean annual yields for the organic cereals between 1952 and 1965 were : wheat 2.9 t/ha : Barley 2.9 t/ha (***Balfour 1976***). Today, average grain yields of organic are about 4 t/ha with potato gross yields at about 40 t/ha cereals (***Lampkin and Measures, 2001***), about double the average yields of the late 1940's. However, over the same period, average non-organic yields have doubled again, to more than 8 t/ha for wheat and 50 t/ha or more for non-irrigated potatoes.

3. Comparative studies on organic and conventional yields

European studies

The Scottish Crop Research Institute report quoted above gives encouraging recent figures for organic yields. Generally, however, European organic farming yields are reported to be 60% to 80% of conventional high-intensity agriculture. These yield differences vary between crops, and to a certain extent also between countries and regions. A review of all existing European data on organic yields (***Economic Performance of Organic Farms in Europe***. Offermann and Nieberg. 2000) produced the following conclusions:

- Cereal yields are typically 60-70% of those under conventional management.
- For most countries studies show a high variation in both the absolute and relative yields of potatoes.

- Vegetable yields are often just as high as under conventional management, but it is difficult to draw general conclusions due to the high diversity of different vegetables.
- Little data is available on pasture and grassland yields in organic farming, reported values lie in the range of 70-100% of conventional yields, depending on the intensity of use.
- In livestock production, performances per head are quite similar to those in conventional farming. But due to lower stocking rates on organic farms, yields per hectare are lower.

Several organic industry studies have tried to show that organic practices can come close to, or even equal, some conventionally grown crops. However, most of these studies are based on acre / unit to acre / unit comparisons with conventional production methods and do not reflect yields over time, lost yield due to crop rotation or green manuring practices (the idling of fields to grow cover crops that are ploughed back into the soil).

US studies

There has been much more research carried out in the US into the comparisons between organic and conventional yields. When reviewing their findings it must be taken into consideration that, absolute yields under conventional management are lower in the US than in Europe. This has the effect of increasing the values of relative organic yields when they are compared to these lower conventional yields. It is, therefore, hard to make direct comparisons between US results and European ones.

- The Rodale Institute of Kutztown, Pennsylvania, recently completed a 15-year study comparing organic farming methods to conventional methods. Its findings were published in the Nov 11, 1998, issue of ***Nature***. The study concluded that yields from organic farming equal conventional yields after four years. And that's with no detriment to soil, water or human health.
- In 1989 G. Stanhill published results of 205 comparisons made of yields from organic and conventional farming systems in north America and Europe. The major finding of the Stanhill study was, on average, and for a wide range of crops, yields within 10 percent (90 percent) of those obtained in conventional agriculture were achieved without the use of agro-chemicals.
- Bill Liebhardt, a sustainable agriculture specialist at the University of California, has gathered scientifically replicated research results from seven major state universities, and two independent research facilities.
  Corn: With 69 total cropping seasons comparing high input and organically grown crops, organic yields were 94% of conventionally produced corn
  Soybeans: Data from five states with 55 growing seasons of data showed that organic yields were 94% of conventional yields
  Wheat: Two institutions with 16 cropping year experiments showed that organic wheat produced 97% of the conventional yields
  Tomatoes: At the University of California, 14 years of comparative research on tomatoes showed no yield differences between conventionally and organically grown crops
  In summary, for a total of 154 growing seasons for different crops, grown in different parts of the US on both rain-fed and irrigated land, organic production yielded 95% of crops grown under conventional high-input conditions.

Developing countries

A couple of reports have highlighted the capacity for organic farming to feed the developing world. Some advantages of organic farming for the developing world, compared to other more hi-tech approaches would be that organic systems require little or no capital investment and on-going expenses for inputs, and do not involve farmers or Governments entering associations with powerful multi-national companies where commercial interests would tend to dominate. Also, malnutrition can often be more significant than inadequate total food supplies at a national level, so crop diversity and local availability of food are important issues.

- A report, "The Real Green Revolution – Organic and agro-ecological farming in the South" (N. Parrott and T. Marsden, Greenpeace, 2002) found that ***o***rganic and agro-ecological farming in the Southern hemisphere produces dramatic yield increases, as well as greater crop diversity and greater nutritional content. For example: Tigray, Ethiopia (composted plots yield 3-5 times more than chemically treated plots), Brazil (maize yields increased 20-250%); and Peru (increases of 150% for a range of upland crops).
- A review of over 200 food production projects involving simple, organic type techniques in different countries, "Reducing Food Poverty with sustainable agriculture: A Summary of New Evidence" (. 'SAFE-World' Research Project. J.N. Pretty and Rachel Hine, 2000), found that they resulted in major yield increases, ranging from 46-150%.

4. Suggestions for increasing organic yields

There are a number of specific areas of organic farming that could be targeted with extra research and development, in order to continue the increases in yields that have been seen since the 1940's:

- Yields could be increased if systems have a wider range of functions. One example is agroforestry in which the production of trees, crops and animals are integrated within the same area. Such systems can also provide a basis for renewable energy generation.
- Planting different varieties of crops in one field - intercropping - can also increase overall yields. For example, work by Reading University has shown that growing a crop of 50:50 winter wheat and field beans requires 30-50% less land to get the same yield than if the crops are grown separately.
- Crop rotations are understood only at an empirical level. There is potential for refining existing systems and for developing alternatives, including for example, inter-cropping and companion cropping. Inter-cropping of non-competitive crops can increase the overall productivity of organic farmland.
- Improved soil quality and nutrition is another important area for development. There is a need for better understanding of the function and dynamics within soil microbial populations. We need to know how these may be modified to improve soil fertility and structure and also the disease and pest resistance of soil.
- There is still much to learn about the development and use of manures and composts from on-farm and off-farm by-products. These vary in quality but need to be more predictable in performance and better targeted for specific needs.
- Soil testing and treatment for mineral deficiencies (often exacerbated by years of intensive conventional cropping) is another area for development.
- There is an urgent need for breeding for populations or varieties specifically adapted for organic production. Characters for selection need to be defined and prioritised. Studies should look to return to old varieties and develop a new breeding path driven by the unique requirements of organic farming. DNA technologies, such as genomics, could be helpful in defining parents and evaluating progress. The methodology should include

assessment of candidates for variety and species mixtures and for inter-cropping.

- Again, there is a need for directed breeding programmes for livestock appropriate to organic farming - DNA technologies may be similarly useful for defining parents and evaluating breeding progress.
- Livestock productivity could be increased by further research into methods for achieving positive health of farm animals.
- It is also worth considering reassessing the definition of yield, moving away from simple measurements of bulk - often distorted by the water content - towards more relevant indicators such as the dry matter or nutrient content of the food produced. Organically produced food has been found to have, on average, higher dry matter and nutrient levels than food produced by conventional methods. Therefore it could be argued that this should be reflected in measurements of their yields – reducing the differences between organic and conventional yields.
- Other factors also need to be considered when assessing the overall efficiency of organic farming. For example, the recently published results of a 21 year Swiss study comparing organic production with conventional has concluded that, although organic yields averaged 20% less than those from the conventional plots, the input of fertiliser and energy was reduced by between 34% and 53%, and pesticide use by 97%. Further work is required to highlight and develop the resource efficiency of organic methods – contributing to lower production costs which can more than compensate for lower yields.

5. Investment in farming systems

Organic yields are accepted to be lower than those achieved by conventional methods. However, this should not be assumed to be solely due to differences in the two methods of farming. Experts have shown that using pesticides does not guarantee increased yields. According to David Pimentel, professor of insect ecology and agricultural sciences at Cornell University, "even with the 10-fold increase in insecticide use in the United States from 1945 to 1989, total crop losses from insect damage have nearly doubled from 7% to 13%".

It cannot be assumed that all of the rapid growth in conventional yields since the 1950s is due an inherent superiority of this form of farming. During the last 50 years conventional farming has received high levels of funding for research and development from the Government and large agro-chemical companies. Whereas organic farming has been neglected by the Government. Until the two million pounds four years ago it has had to make do with small scale Research and Development funding from private organisations. Even with this minimal investment organic yields have doubled since 1940, and there are a number of areas outlined above which have the potential to further increase yields.

Investment in organic farming could help to close the gap between the gross bulk yields of organic and conventional production. This would allow the focus of the debate to shift to other associated aspects of yield production such as nutrient content, input costs and ecological benefits, where organic production displays inherent superiority.

5. Demand for food

A UN report considered several forward projections to 2030 when the world population is expected to be over 8 billion. It concluded that the potential of current agricultural resources and technological knowledge is sufficient to ensure that total crop production "will exceed population growth". This did not include a consideration of GM crops.

If the information above shows that organic farming can potentially feed the developing world, in Europe the question is if organic farming can produce as much food as conventional methods produce now. However, this assumes that everyone will or should continue consuming the same levels of meat as currently. Meat consumption has increased significantly in recent times compared to historic levels, particularly in the US. As livestock eat crops and feed conversion from crops to meat is inefficient, it takes considerably more land to produce meat than cereals. Although extensive livestock production is important for maintaining large areas of semi-natural habitats which are important for biodiversity in the UK, modern intensive livestock production in Europe is reliant on major imports of grain produced elsewhere. Modern high levels of meat consumption are considered unnecessary and often unhealthy, and so a future reduction in meat consumption could be envisaged which would allow for lower yielding and more extensive organic methods to produce a greater proportion of total demand.

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Further Reading

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