ELM FARM
RESEARCH CENTRE

ELM FARM RESEARCH CENTRE CONFERENCE

DOES ORGANIC FOOD HAVE AN 'EXTRA QUALITY'?
New Research, New Perspectives and New Insights

A record of the Conference held on TUESDAY, 23RD NOVEMBER 2004

This Conference was sponsored by Sheepdrove Trust
in collaboration with

FQH
Organic Food Quality & Health

sustain
the alliance for better food and farming

FQH (International Network for Food Quality and Health)
Sustain (the alliance for better food and farming)

ELM FARM RESEARCH CENTRE
The Organic Research Centre
'For organic principles and best practice'

HAMSTEAD MARSHALL
NEWBURY
BERKSHIRE, UK
RG20 0HR

TEL: +44 (0)1488 658298
FAX: +44 (0)1488 658503
E-MAIL: elmfarm@efrc.com

www.efrc.com
www.organicresearchcentre.com

PROGRESSIVE FARMING TRUST LTD
t/a Elm Farm Research Centre
.
Registered Charity No. 281276

Published April 2005

For further information please contact the Director, Elm Farm Research Centre.

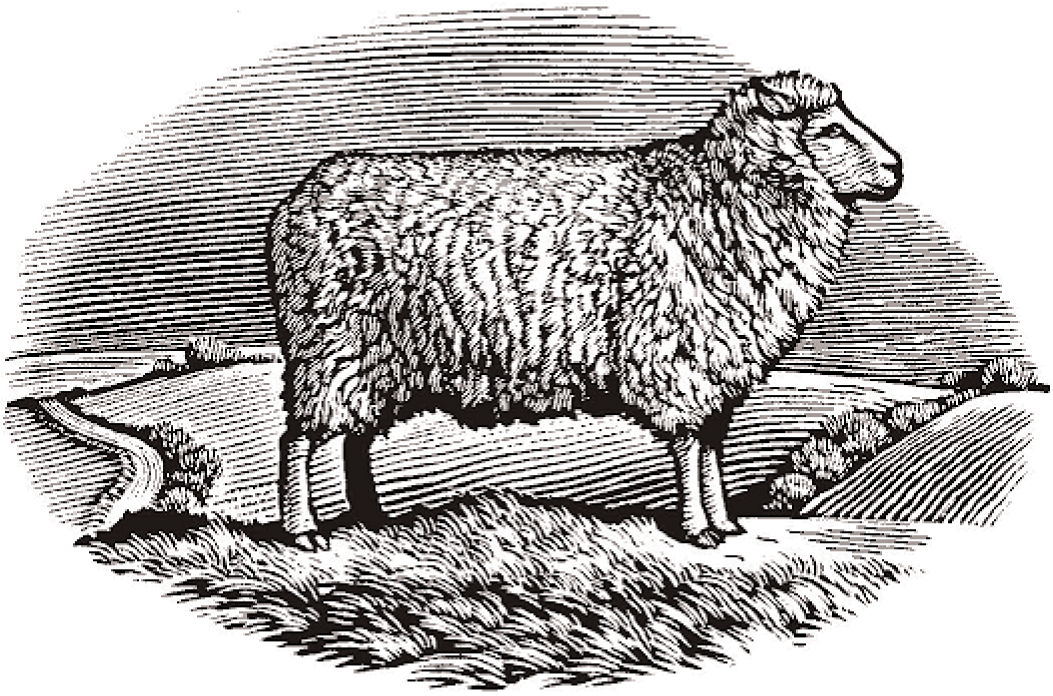
ACKNOWLEDGEMENTS

A special acknowledgement

We acknowledge and thank the Sheepdrove Trust for its financial support towards this Conference which allowed the use of the beautiful setting of the Kindersley Centre and its excellent facilities

The Kindersley Centre

Sheepdrove Organic Farm



ACKNOWLEDGEMENTS

Acknowledgements

We would like to thank **all** those who participated in the Conference on 23rd November 2004 - those who gave presentations, those who chaired, those who responded and those who participated in asking questions and the discussions.

We also thank the team that organised the event so effectively.

The production of these proceedings has been supported by:

promar International

"Stressing the importance of differentiating between accepted dogma: "Organic food is better for you" and what is actually "true", i.e. the scientifically proven, Dr Brandt's interesting and balanced paper highlighted the need for a consistent approach and common understanding if claims about organic food are to be accepted.

The science that proves the "extra qualities" of organic food, or equally that demonstrates the detrimental effects of "conventionally-produced" foods, on our health is still developing, as shown by other speakers. But Dr Brandt concluded that organic farming, which has distinct benefits for the environment and food produced, has that "extra quality" that was the Conference's theme.

For consumers, the key benefit of organic produce may simply derive from the fact that positive choices are made in food purchasing that enhance a sense of individual value and well-being".

Alara Wholefoods

"Projects that give statistically robust nutritional differentiation between organic and non-organic food are very welcome by organic food manufacturers".

Duchy Home Farm

UNDERSTANDING THE RELATIONSHIP BETWEEN PRODUCTION METHODS AND FOOD QUALITY USING MAINSTREAM SCIENTIFIC CONCEPTS

DR KIRSTEN BRANDT, UNIVERSITY OF NEWCASTLE

Edited from transcript of the presentation by Lawrence Woodward.

There are different ways of looking at how science can investigate aspects of food quality. I don't really like to see this question as an issue of using reductionist or holistic methods, but there clearly are differences in the type of methods people use and I am quite happy to represent what I have here defined as a mainstream scientific concept. Of course, within this concept there are some shortcomings, nonetheless in my view you don't actually need to step outside of this concept but you may need to challenge some of the dogmas which have found there way into the field. I am going to give examples of how I see that it is possible to define some ways of understanding what is happening in terms of agriculture, food quality, health and still stay within the mainstream scientific concepts.

I will address the following issues:

- Definition of "mainstream scientific concepts".
- Shortcomings of traditional mainstream science in the food and health area.
- Documentation of differences between foods indicating consequences for health.
- Examples of "under-utilised" topics relevant to food and health research.
- Specific suggestions for future work.

A definition of "mainstream scientific concepts".

- Based on a common understanding of the laws of nature, including evolution.
- Requires consistency with observations on all levels.
- Observations _ hypothesis _ predictions _ testing _ revision _ predictions _ etc.
- Predictions must match reality.
- When new observations appear, all relevant hypotheses should be re-evaluated.

Mainstream scientific concepts, as I see it, is science which is based on a common understanding of the laws of nature including evolution and one of the requirements in scientific concept is that you need to have consistency with the different observations on all levels - including the level of the whole and the level of detail. If you think of astronomy: it doesn't work to have one type of physics for what happens inside a star, and another type for the universe - they have to be consistent. This means that there is in fact a holistic concept, but sometimes people forget about it when they get too caught up with the detail of one particular issue.

The main principle of mainstream science is that you start out with some observations, you then make a hypothesis and from this hypothesis you make some predictions and from these predictions you make some new observations e.g. an experiment, which allows you to test the hypothesis. If this testing shows that you seem to be on the right track then you just go on in that way. If your testing shows that you did not get the same outcome as you have predicted then there is something wrong with the hypothesis and you have to revise the hypothesis. You can make new predictions and so on and so on and so on ….
Very importantly, those predictions must actually match reality. It doesn't work if you make a laboratory experiment, which shows for example this thing if you eat it will kill you, and then you have reality showing that people are happily eating this stuff and they are not dying - well then there must be something wrong with your hypothesis and your predictions.

Of course science develops and new methods and new observations emerge. Then it is part of the concept to go back and re-evaluate whatever you have done before. For example in astronomy; five years ago everybody thought the universe had ceased its expansion and then some observations showed that it is still expanding, consequently the whole field of cosmology has completely changed.

Mainstream scientific concepts do not accept:

- Theories involving "intelligent design" or other ideas based on faith rather than data.
- Theories that require acceptance of mechanisms, which cannot be integrated with the presently accepted laws of nature.
- Theories based on data that cannot be replicated by others.

In contrast, challenge of established scientific dogmas is actively encouraged!!

Nonetheless, dogma finds its way into and "dogs" mainstream science in the following ways:

- Traditional mainstream science contains numerous elements that have not undergone rigorous testing by its own rules.
- Most of these dogmas or "common understandings" are hypotheses that have become generally accepted since they appear logical and are difficult to test.
- Some are commercially or politically useful.
- Such generally accepted theories are often confused with scientific knowledge.

There are hypotheses that appear logical and seem to fit nicely with recognised concepts but might be difficult to test or are politically or commercially expedient. After a time they become accepted and it is forgotten that they haven't been tested. This is especially so with the literature citation game where papers are cited over and over again until the point where an untested hypothesis becomes an accepted fact through repetition. Food science is not especially bad, but it does have some rather bad examples of this.

Shortcomings of traditional mainstream science in the food and health area.

The following are examples of untested "dogmas" relating to food and health:

- A diet with adequate levels of all known nutrients and minimal levels of all known toxins is optimal for health.
- Carcinogens increase the cancer risk proportionally to concentration at any level ("no threshold").
- Food components can (or should) neither prevent nor cure diseases ("food is not medicine").
- All natural or synthetic toxins with similar physiological effects are similarly dangerous to human health.

All of these are often cited but there is little or no data showing that they are actually true. For the most part the work has not been done, merely assumed. Of course, we do not have scientific proof that, for example, a particular food has medicinal properties so you cannot go out and make a medicinal claim but the fact that the science does not exist to base such a claim on doesn't mean that there is never any medicinal properties in food - just that the work has not been done.

- Almost all research on food and health has been focused on **avoiding harmful extremes**, either **deficiencies** or **toxic effects.**
- Other effects have rarely been investigated.
- Due to this we know **almost nothing** about the **consequences** for health of differences in **food composition**, in contexts where it is clear that neither deficiencies nor toxic effects are involved.

Which is why we can make measurements of components such as minerals, vitamins and toxins but it doesn't tell us much about health. That doesn't mean that it cannot be investigated, it just means that it hasn't been investigated - not yet.

UNDERSTANDING THE RELATIONSHIP BETWEEN PRODUCTION METHODS AND FOOD QUALITY USING MAINSTREAM SCIENTIFIC CONCEPTS

DR KIRSTEN BRANDT, UNIVERSITY OF NEWCASTLE

Differences between foods indicating consequences for health.

We know and it is accepted that analysis shows up differences between foods produced in different production systems. What is unclear is how important these differences are for health. The differences listed below (see box), it is now widely agreed, tend to be found when analysing some - but not all - organically and conventionally produced foods.

Traditional conventional view of how different production systems are important for human health

Organic		Conventional
	Plant foods have more:	
- Dry weight %, minerals		- Nitrate
- Vitamin C		- Protein
- % essential amino acids		- -carotene
- Natural pesticides		- Synthetic pesticides*
	Animal foods have more:	
- Unsaturated fatty acids, CLA		- Resistant bacteria
	Processed foods have more:	
		- Food additives*

The two main areas of difference are synthetic pesticides and food additives found in conventional food but as with nitrate levels there is a good deal of controversy and an uncertain level of agreement about there impact on health.

All of the things listed are relatively easy to measure but are not what is necessarily important for health. For example vitamin C; it is fine if a food has more vitamin C but in this part of the world 95% of the population already get all the vitamin C they need, so they are not going to benefit anything from getting 20% more from, say, an organic carrot. On the other hand, 20% more is not so much it is harmful so it is concluded that extra vitamin C in organic carrots makes no difference to health.

My view is that if we want to understand something about the connection between the way we produce our food and our health, we need to look at other aspects where there are larger and more consistent differences between organic and conventional products; and which can be studied within mainstream scientific concepts. Listed below are some aspects of the production systems which are much more consistent and much more differentiating than the earlier examples; and where I think can be found some differences which have real importance for health and quality whilst still staying squarely within mainstream scientific concepts.

Un-traditional view (still within mainstream scientific concepts) of who different production systems may be important for health

Organic		Conventional
	Plants have more:	
- Intrinsic resistance to diseases and pests		- Easily available nutrients
- Resilience to stress		- Susceptibility to post-harvest infections
	Animals have more:	
- Exercise		- Stress
- 'Green' fodder		- Susceptibility to infections
	Processed foods have more:	
		- Low quality raw materials

I would now like to illustrate this with some examples.

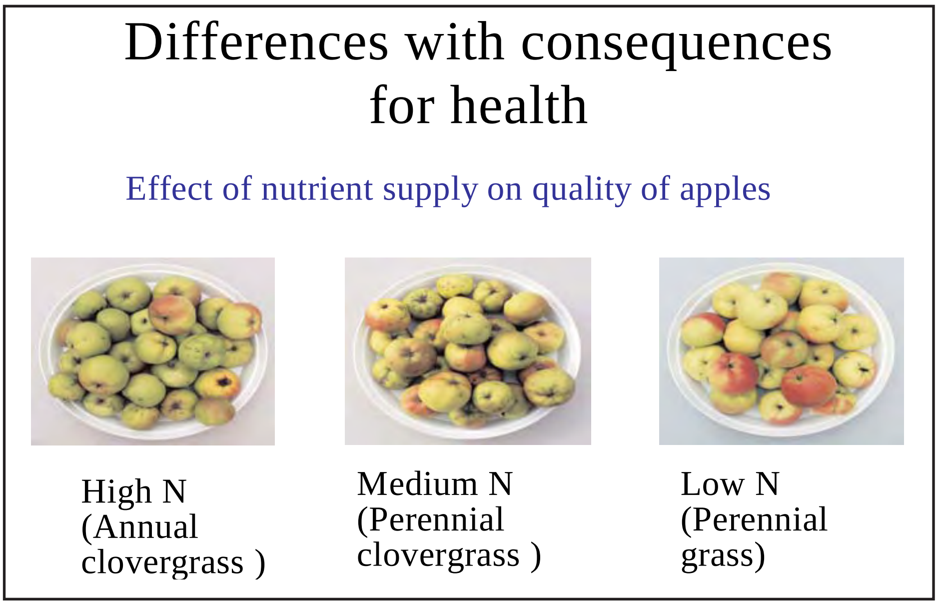
UNDERSTANDING THE RELATIONSHIP BETWEEN PRODUCTION METHODS AND FOOD QUALITY USING MAINSTREAM SCIENTIFIC CONCEPTS

DR KIRSTEN BRANDT, UNIVERSITY OF NEWCASTLE

<u>Example 1 - Apples</u>

Figure 1 is from an apple experiment. These apples are all certified organic but are grown under different conditions where they have surplus of nitrogen or a little deficiency of nitrogen.

Figure 1.



You should be able to see that the apples look different. On one side they are bigger and more mature and the other they are smaller, clearly more attacked by disease. This is an issue of simply the nitrogen content. These were not sprayed with anything and they did not receive any synthetic fertiliser
Analysis for phenolic compounds (Figure 2) showed small differences but not big enough to explain to explain the observable quality difference.

Figure 2.

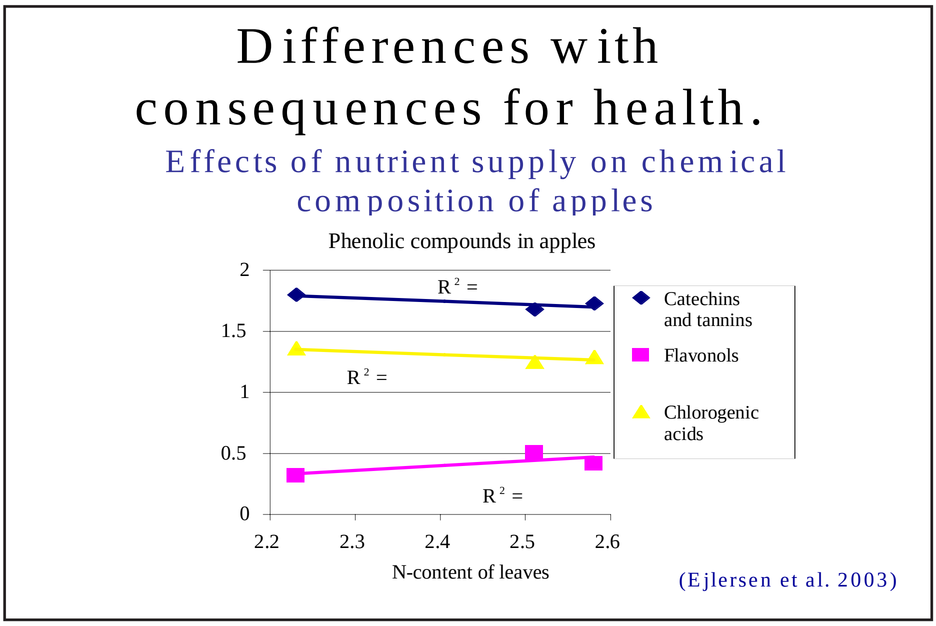


Figure 3 reveals some differences in terms of diseases and attacks by pests. These are quite large differences, which I interpret as indicating that there is some other secondary metabolite than the phenolic compounds which are having an influence, although there may of course be other explanations.

Figure 3.

Differences with consequences for health.

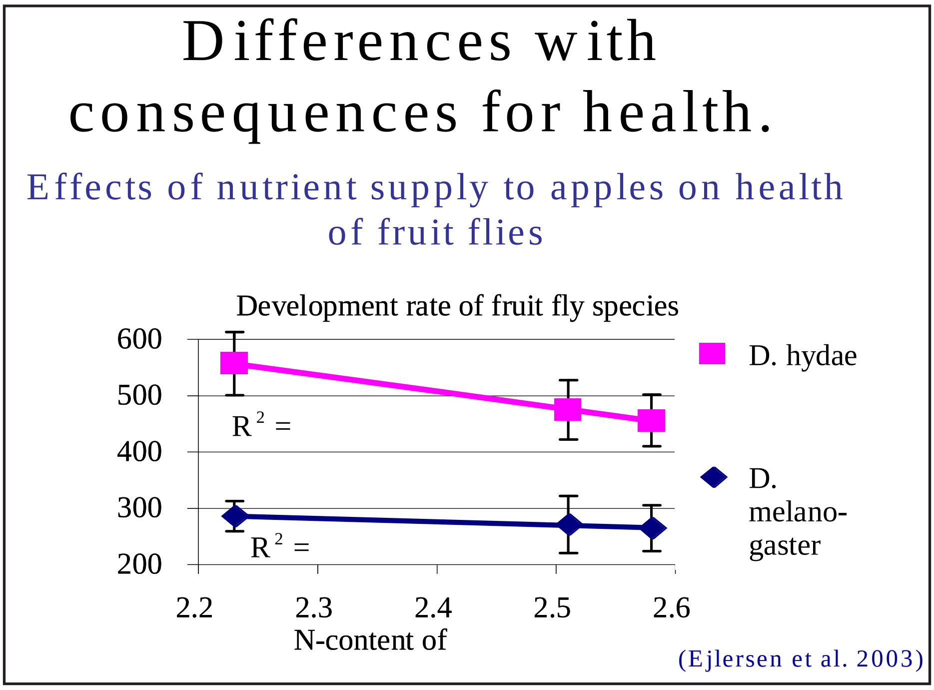
Effect of nutrient supply to apples on resistance to diseases and pests

Treatment % of fruit with:	Annual clover grass (high N)	Perennial clover grass (medium N)	Perennial grass (low N)
Apple scab	17.9	8.9	2.3
Sooty blotch	11.8	8.7	8.0
Apple saw fly	8.4	5.8	4.6

(Berthelsen & Pedersen 2002)

But what does all this mean for health? It is difficult to make experiments with humans but relatively easy to experiment with animals or insects which have a very short life cycle. Figure 4 shows what happens when those apples from different nitrogen regimes were fed to fruit flies.

Figure 4.

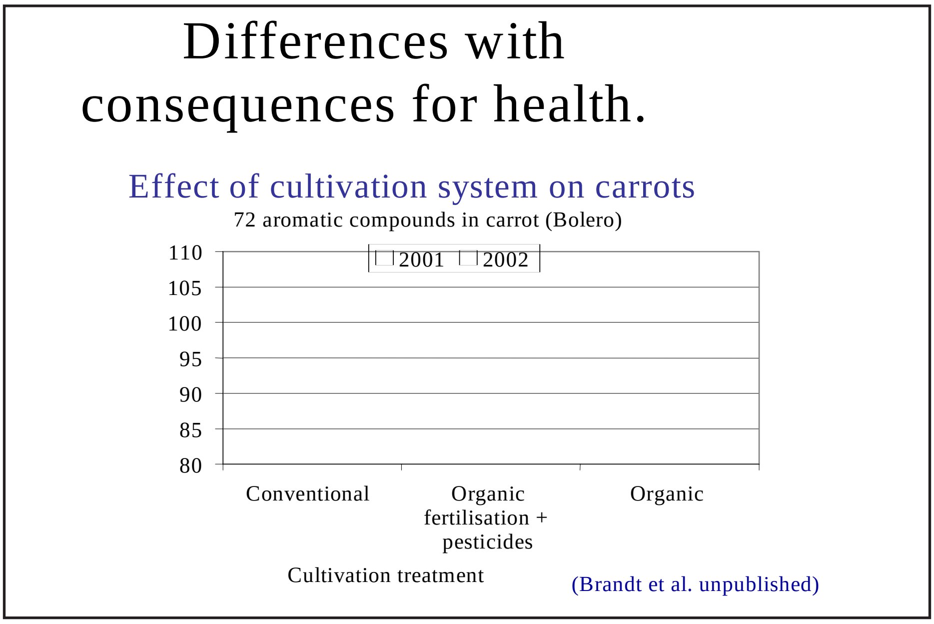


It is clear that the life cycle of the fruit flies is affected significantly, not just by 5-10% as with the phenolic compounds. Of course these apples were actually all organic so whilst the example shows that the way plants are grown does impact on health, it also shows that merely being certified organic is not enough. In this case, having too much nitrogen in the system - even if it is from an approved source - can still deteriorate quality and results in a product that looks very much like the conventional.

Example 2 - Carrots

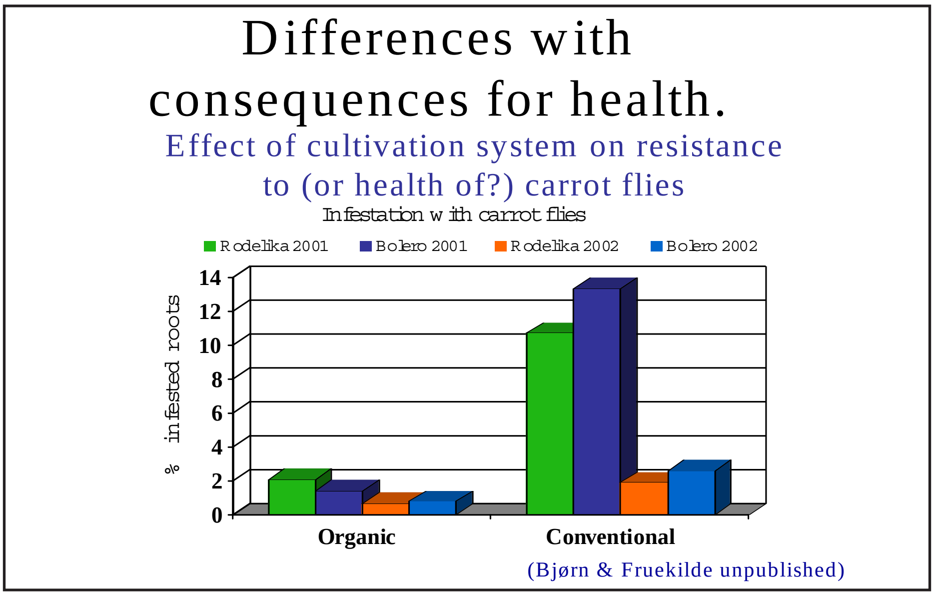
In a two-year experiment measuring aromatic compounds in carrots we found clear and definitive differences favouring organic production (see Figure 5).

Figure 5.



These compounds are important for taste but they are also known to defend the carrots against diseases and pests. This is demonstrated below in Figure 6 in another experiment.

Figure 6.



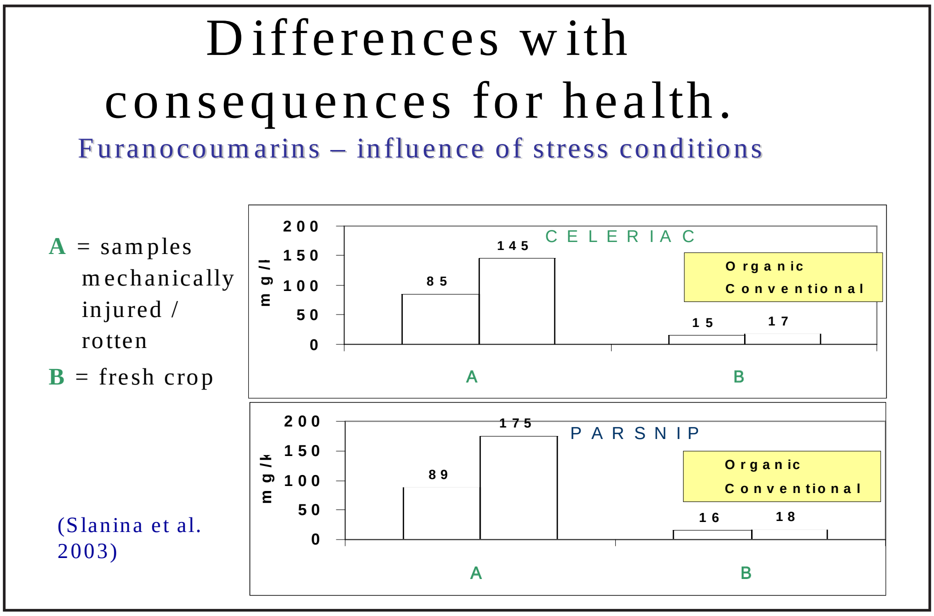
There is significantly less infestation of organic carrots even though some of the conventional ones were actually sprayed with pesticides. It is not possible at this moment to say what this means for health but it is important to know about this significant difference. There is something there, which I believe we can investigate using mainstream laboratory methods to find which compounds are responsible for the difference.

Example 3 - stress conditions in celeriac and parsnip

Organic plants seem to be more resilient to stress and in this context show differences of natural toxin levels to conventional plants. This can be seen in figure 7 where a very strong type of toxin called furanocumarin is produced in differing levels in organic and conventional celeriac and parsnip.

Here the normal crop showed no difference in furanocumarins between the organic and conventional. However in damaged plants the conventional ones rose to much larger toxin levels than the organic ones, actually to levels which are clearly above what is normally is accepted as safe in food. I interpret this as showing greater resilience to stress.

Figure 7.



All of these are examples where mainstream scientific methods have revealed consistent and highly significant differences between organic and conventionally produced food. We do need to add to this body of information but we also need to investigate what relevance these differences have to health.

Examples of "under-utilised" topics relevant to food and health research.

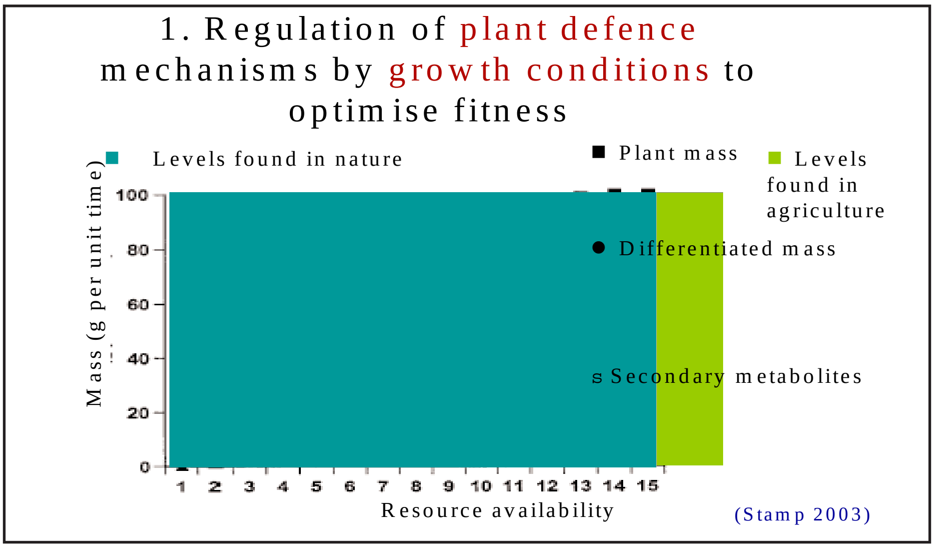
Two areas that may help in this task which have been under-utilised are:

- Regulation of **plant defence** mechanisms by **growth conditions** to optimise fitness,
- Combined with **dose-response** relationships of plant defence compounds on.

Both areas relate to natural toxins; the first is about understanding how plants defend themselves, how is that regulated by growth conditions; secondly whether the compounds produced by the plant's defence mechanisms affect human health.

Figure 8 is taken from a recent review on plant defence mechanisms. It is not specifically about organic or even agriculture in general but about what happens in nature.

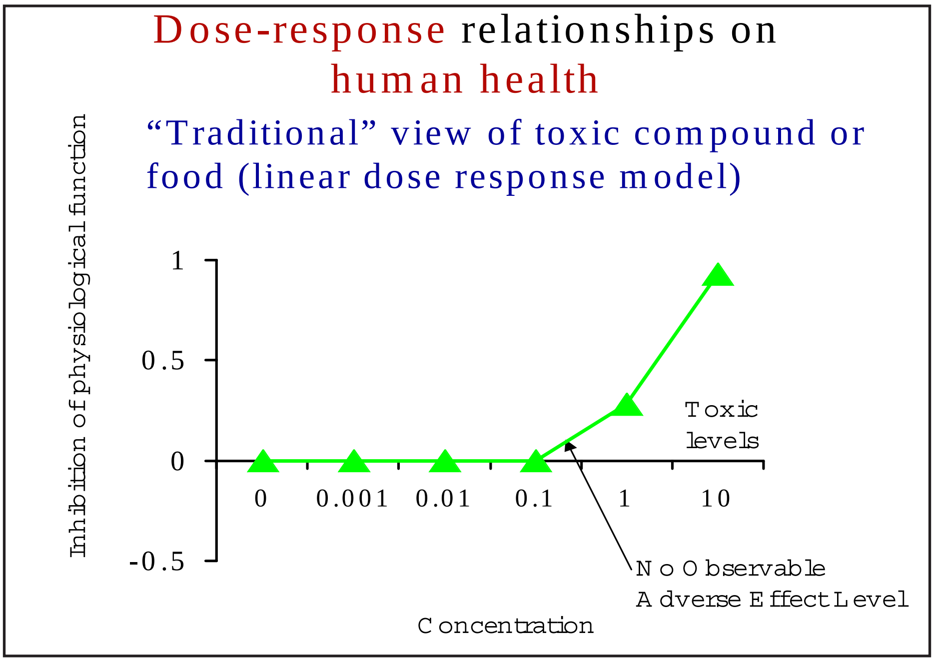
Figure 8.



It shows the relationship between nutrient resources - mainly nitrogen - and secondary metabolites, which represent the plant's defence mechanisms. Increased availability of nutrients leads to a higher productivity of plant mass but at the same time to a lower content of secondary metabolites. As nutrient levels reach those found in agriculture the dropping away of secondary metabolites is most marked.

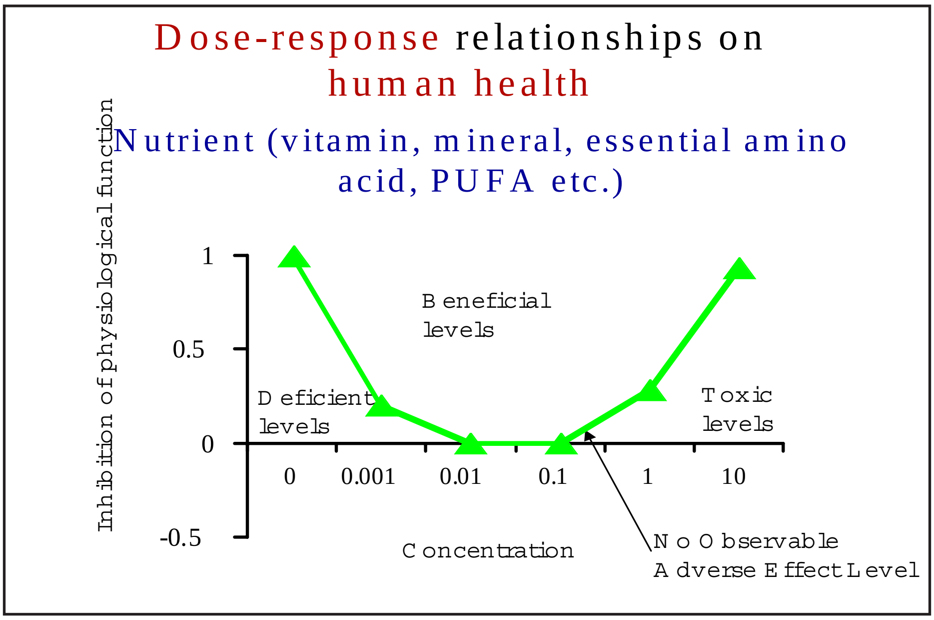
But how do these compounds actually affect human health? The traditional view of toxins is the linear dose response model where a compound is regarded as toxic at high levels but has little or no effect at low levels (see Figure 9). This is the model on which almost all safety evaluations for pesticides, is based.

Figure 9.



For nutrients - vitamins, minerals, essential amino acids etc - a different model is used (see Figure 10).

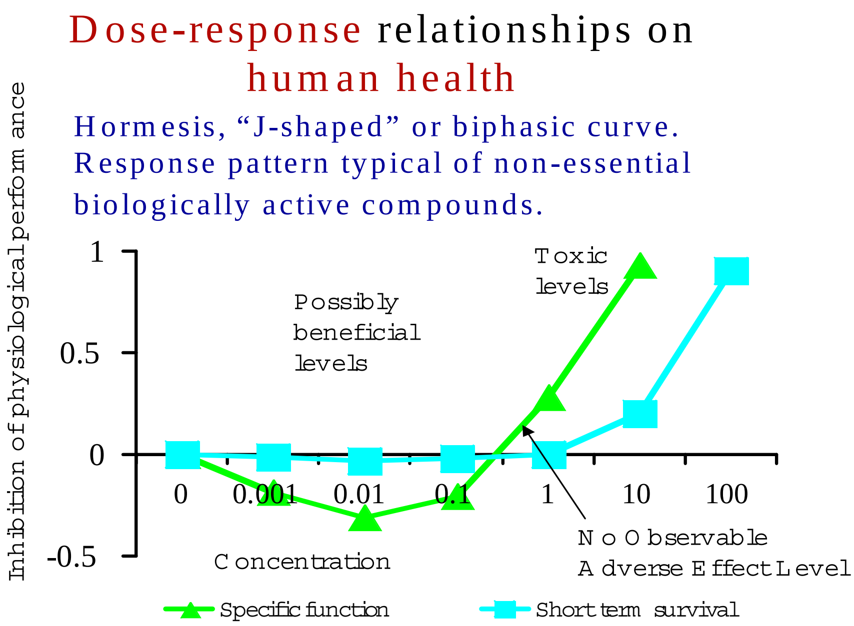
Figure 10.



Here low levels are seen as deficient and certainly not positive for health. But there is also a maximal level above which adverse effects are found. In fact, you have too much of a good thing.

However, relatively recent research has shown that biologically active compounds - such as secondary metabolites or natural toxins - that are adverse at high concentrations can still be good for you at certain low concentrations. This is called hormesis (see Figure 11). A very good and well-known example is alcohol where it has been shown that if you have one or two units of alcohol per day it is better for your health and in particular cardiovascular disease, than no alcohol at all.

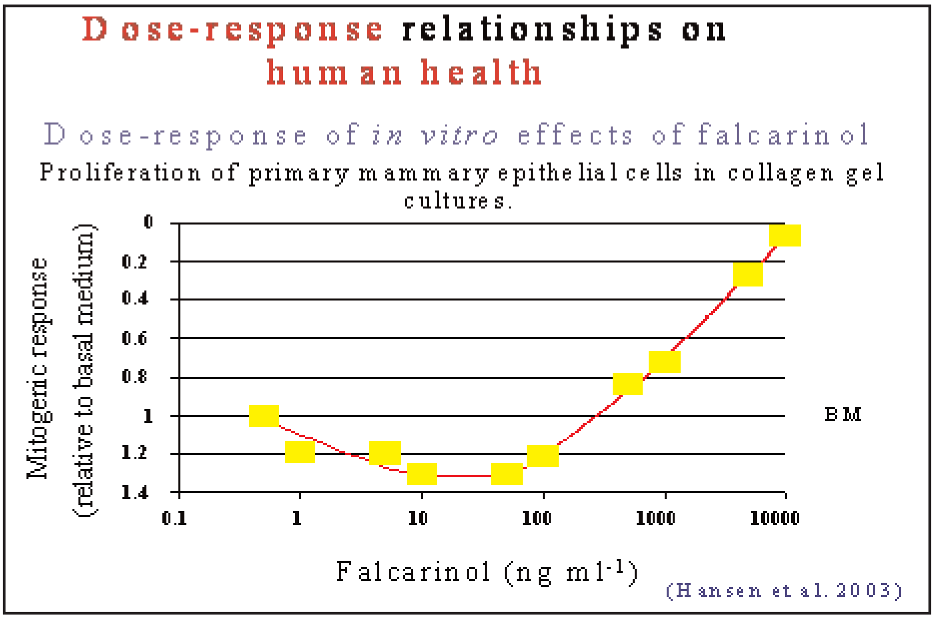
Figure 11.



Very little work has been done on most things which are, might be, important for health so we do not know what is the best level we can get. However, there is a growing belief amongst toxicologists that this is the way that all compounds work.

An example is falcarinol, which has been traditionally seen as a toxic compound in carrots. Figure 12 shows falcarinol some cell culture where you can measure both positive and negative effects.

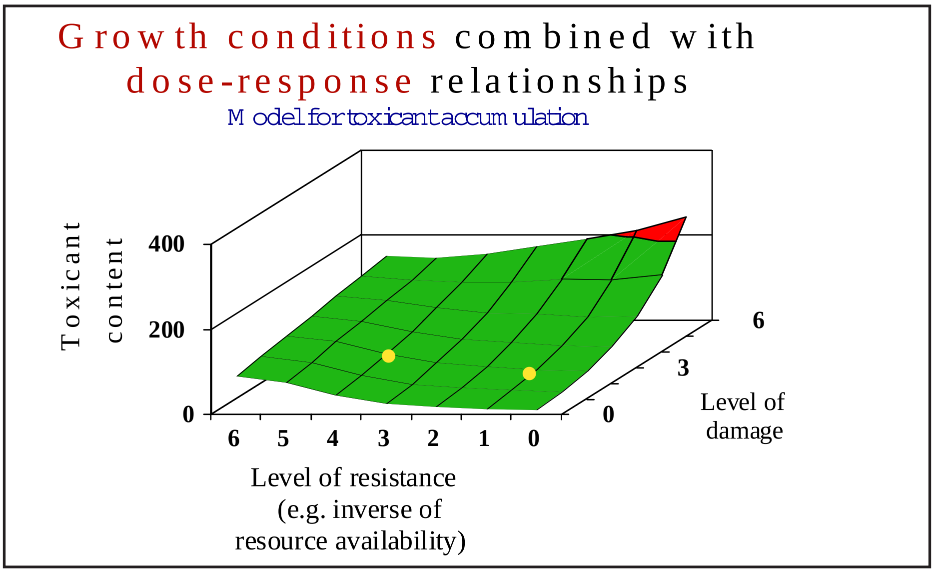
Figure 12.



This shows that there is a benefit at the highest and lowest concentration. In fairness, I should point out that the same experiment with betacarotene did not give these results.

Figure 13 is a model to show toxicant accumulation. Toxic compounds at dangerous high levels are shown in red on the curve while the green areas are where we don't know the dangerous levels and what might be levels that are beneficial. Using data for intrinsic resistance and plant stress, it shows that if you have plants that have a low intrinsic resistance and are subjected to a lot of stress, they would reach high, even dangerous, levels of toxic compounds. Whereas plants with high intrinsic resistance, even subjected to stress would have low levels of toxins that would not be dangerous and might be beneficial.

Figure 13.



Much work needs to be done on this but it might be the case that differences between organic and conventionally produced plants could be highlighted through this approach.

Suggestions for future work.

It seems to me that to understand food and health it is necessary to find out what actually is important and then look at how the farming systems can deliver. It is therefore important to:

- Use the full spectrum of available knowledge!
- Make a conscious effort to develop methods for neutral assessment of observations; avoiding the filters of traditional assumptions, political correctness and existing legally defined procedures.
- Identify the food components with highest actual impact on health.
- Identify the aspects of farming systems that influence these components.
- Promote the individual's own responsibility for safety (and other aspects of food quality)!

Mainstream scientific concepts and methods are an essential part of this task and should not be dismissed or disregarded.

Thanks to:

- **J. Hajslová, V. Schulzová, R. Peroutka**
  Institute of Chemical Technology, Prague, Czech Republic.
- **G. K. Bjørn, R. Nørbæk, A.M. Fruekilde, L.P. Christensen, S. Purup**
  Danish Institute of Agricultural Sciences, Aarslev, Denmark
- **P. Slanina, C. Andersson, A. Stromberg**
  National Food Administration, Uppsala, Sweden.
- **A. Ejlersen, M. Kobæk**
  University of Southern Denmark, Odense.

Elm Farm Research Centre (EFRC) is one of the UK's leading research, development and advisory institutes for organic agriculture.

For more than 20 years EFRC has played a central role in the development of policy and standards for organic farming and food within the UK, EU and internationally.

The Centre's alliance of practice and policy – on-farm and desk research and consultancy and advice is unique.

We acknowledge and thank Sheepdrove Trust for its financial support towards this Conference and the use of the beautiful setting of The Kindersley Centre and its facilities.

Elm Farm Research Centre, Hamstead Marshall, Nr Newbury,
Berkshire RG20 0HR United Kingdom
Tel: +44 (0) 1488 658298 Fax: +44 (0) 1488 658503 Email: elmfarm@efrc.com
www.efrc.com
Charity No. 281276