Existing systems of farmers and agri businesses' involvement in organic cereals research

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Cereal varieties for organic production: Developing a participatory approach to seed production and varietal selection

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1. Introduction

This paper will examine the existing systems of farmer involvement in research and dissemination. Through interviews with farmers, advisors, seed suppliers, grain buyers and food processors, the key issues that end users want to be researched will be identified and the types of informal research and innovation will be documented. This research project will be part of a wider programme: Cereal varieties for organic production: Developing a participatory approach to seed production and varietal selection. This paper follows a previous literature review on farmer particpatory research with particular emphasis on the UK.

2. **Types of research and experimentation involving farmers and other businesses**

While there are many similarities between organic and convention agriculture, organic farmers have to cope with a larger number of variables because they cannot control the environmental conditions with agrochemicals. Instead farmers have to find ways of preventing problems occurring rather than controlling them once they have emerged. Furthermore, farmers interviewed stated that they have two adapt ideas to their specific conditions as each farm is very different.

> "I think the big difference is that as far as conventional farming is concerned you could just buy what you wanted out of a packet from the laboratory or somewhere else whereas with organic farming the laboratory is more or less your farm – you've got to get everything working for you onsite … you see how different people are doing everything differently – nobody is right and nobody is wrong, but they are trying to adapt what they are doing to their particular soil types, weed burdens, climatic conditions.." (int 8).

All farmers interviewed were found to be doing some form of experiment, research or trying new activities: "usually each year we try 2 or 3 things, just something a little bit different to just try and sort of push the boundary a bit a see whether we can come up with something."(Int 4.5). A wide range of subjects for experimentation were found and every farm was found to be comparing varieties to other fields, previous years, or other farms. Similarly, agronomy advisors are continually making comparisons between varieties grown on each farm and comparisons between farms. Farmers may also be stimulated to experiment after learning of the results of other existing research, either by scientists or by other farmers. One grain trader aimed to promote varietal experimentation through their newsletter.

Table 1. Types of varietal experiments

- Growing specific varieties for beers eg Plumidge archer
- Growing mixed crops and varieties for whole crop silage
- winter wheat varieties,
- oat/triticale,
- wheat and volunteer vetch - combined,
- Oats and vetch with a biograin treatment before animal feed
- wheat and volunteer beans
- Maris W and Petchworth
- Stanwell and Maris bean
- Wheat and triticale (2 types)

- Wheat, triticale, barley, rye and peas
- Comparison of different varieties and harvest times for disease

Other types of experiment are documented in annex 1.

However, some farmers were more risk averse and unwilling to try varieties that were not well established:

"we grow 40 acres of corn, say we put in 10 acres of a new variety and it absolutely fails, you've lost 25% of your corn. Whereas with the old variety there's less risk of failure because at least you know it's performed before at your farm. But then somebody's going to test it and give it a try".

Seed dealers were found the carrying out trials in partnership with seed growing farmers, with an agreement that if the trial failed there would be compensation. Seed dealers are also carrying out informal trials through comparing different varieties on different farms and noting different growing conditions:

A major problem I face is coping with seed borne diseases. But sometimes like with this Deben, I inspected it and it looked good , and I got a good sample , and I had faith in it. But then I found out that it had to high an infection rate of Septoria. You can have hugely varied results and some crops on the same farm are as different as chalk and cheese. I don't think it is related to particular weather but anything that is late harvested is more variable. But was this because it was planted late or because of the weather before the harvest and the ripening weather?

I've also got a problem with ergot through wild grasses. I think it is worse when open flowering and when there is a wet summer, and there are fields enclosed by trees. But then , last year , …… was the worst , and that does not have these conditions.
I was given this seed treatment stuff , which is seed dressing and a bit like the seaweed stuff , but I gave it away to people to use , and they did not see any difference.
How do you follow up with those people you gave it to try?
I ask them now and again , but in this hectic summer ….(int 14)

Marketing of the cereals is an area where there has been the range of different innovations and approaches being tested. While this was not raised by many farmer interviewees, it was a primary concern of grain buyers. These enterprises were particularly concerned with the lack of interest of farmers in meeting market demand in terms of crops produced and quality /consistency of products::

"The trouble is that farmers tend not to be very market-driven, that's what we worry about ….. it's fascinating to grow but if you can't sell it ….. good luck to make, this is a commercial job…. The simple fact is that whatever business you're in, you've actually got to have customers that are prepared to buy your product. And farmers of whatever elk are incredibly bad at marketing. They're not actually interested in marketing, the CAP [Common Agricultural Policy] of course gave them an absolute reason not to even bother to think about marketing because they've got a reasonable crop, they could shovel it into a store They sort of start to think about markets when it starts to get difficult. …..Organic farmers are tending to grow crops that nicely fit organic rotations or are easy to produce." (Int 16)

"It's the arrogance of it. There are still a lot of organic ones that seem to think, well we've grown it, you've got to take it. So there needs to be better liaison between the producer of the crop and buyer of the crop. A lot of organic farmers want to grow triticale because it's

easy to grow, it's cheap to grow and it's simple to grow. Nobody ever thought about what they're going to do with it once they've grown it. And the quality of it is not as consistent as wheat." (grain buyer Int 17)

Some farmers are starting to sell directly to other farmers, while a group of larger farmers have set up their own trading organisation (Organic Arable Marketing Group). Conventional grain traders are also trying out new approaches to market organic grain such as Organic Grain Link (partnership between Saxon Agriculture and Norton Grain). There has been some public sector grant support to encourage these innovations, although this has raised questions from competitors who have not had the support. These trading organisations are also carrying out their own market research to assess the supply and demand.

Marketing of cereal mixtures is an area of particular interest at the moment. One farmer was working with a local miller to try out milling mixtures while another farmer had been able to sell some of his mixed variety crop to a feed manufacturer on the condition that he bought feed in return. Farmers have to decide whether they sell to grain traders who buy large amounts as a commodity, and those who buy smaller amounts for specialist/craft food production.

3. Design of farmers' own experimentation

This study also explored how farmers carried out experiments so that participatory resear4ch approaches could be developed that are based on what farmers are already doing. The design of farmers' trials can be a conscious decision at the beginning of the farming season or it can take place during the season as farmers react to specific problems, growing conditions or accidental treatments. The case below is an example of relatively unique research minded farmer running a large number of experiments.

Terry Bird has started trials of 16 winter wheats, 5 winter barleys, 5 oats, 12 winter oats, spelt wheat, winter lupin, a sping wheat, 4 spring barleys, two spring beans, 4 spring lupins, as well as beet, soya beans, peas. The objective is to identify the most appropriate varieties for a 1300 acre arable farm in Norfolk that he is in the process of converting to organic. "I don't believe in following the pack. We have to go down that route that best serves us and if others benefit then that is fine". He carried out similar trials on his farm in France. All trials are replicated on 3 sites with a random mix of plots of equal size and sowing density in each. He uses a professional trial harvester and weighing combine "so that we can have more credibility". In addition to yield he also looks at tillering, and its ability to suppress weeds. He is also looking at the effect of fertility from previous crops and a top dressing of compost: "we are very flexible. It is science but we are not governed by the same things. For example I had not planned to top dress with compost, but the crop looked sad and so I thought we could try that because we were going to trial compost next year".(Int 1)

The case above shows how farmers can combine a more scientific approach to experimentation but the practice of farming means that variables have to change through the season. In many other cases farmers do not have clear hypotheses at the start and the nature of the trial became apparent partway through the season as the

farmer reacted to particular events constraints. For example one farmer was short of quality forage for his livestock and with the lower price of wheat decided to turn a cereal crop into a whole crop silage. Another farmer tried mixing peas with triticale (instead of the usual barley) because barley was so expensive at that time (6.6). The design of trials may come about by accidents occurring through the farming season or having to respond to particular problem:

"I have tried different drilling times, but often by accident,… just by circumstance. I found that the later sown crops out yielded others so I am convinced. The temptation is to put it in early, especially when there is a mild autumn. But now I've tried to go later. "(Int 2).

Another interviewee had had accidental mixtures of crops in a field due to a mistake during sowing but the crops had grown very well and he repeated it in future years.

4. Analysis of the results of farmers' own trials

Farmers will evaluate according a very wide range of criteria, although yield is of most importance. This is assessed by using weighing in grain dryers, scales in combines and time taken to fill a combine, or the number of trailer loads (especially for forage crops).

One farmer grew a blend of wheats last year: Maris Widgeon and Petchworth. He assessed it through the season noticing that Maris Widgeon's tall straw, resulted in competition for weeds on a bit of land that was previously 'very dirty'. Compared to his other crops, the mixture gave the best yield (he used a dryer that can also weigh) and the best quality for milling, seen from the agber count. "It has to look good. I do not want it over flowing with weeds, because we have to pay for that further down the line and I want it to look good for the people coming around." (Int 2)

Taking measurements can be time consuming and inconvenient

"If you want to treat half of an organic wheat field and then assess the yields at the end of that, its just more trouble. Our combine doesn't weigh yield as it goes along as some of the new combines do. So what we have to do is weigh it as it goes through our dresser."9.8

Yield can also be assessed by a general feeling of how the combine is coping with the crop. Tractor drivers and farm workers can therefore play an important role in assessing experiments as described by two interviewees: "I changed the seed rate , and the chap on the combine will know if it is any different. It is an anecdotal pointer but you can use that." (Int 2). " I had weeds in the lupins and went around the field twice with a tiny weeder … When we combined it the combine driver assessed it and he just said 'there ain't a lot of difference between the outside of the field and the inside.'"

Advisors play a key role in setting up trials and making cross farm comparisons. Many recently converted farms have retained their agronomists (advisors) as they have a long standing knowldege of each field in terms of soil type and weed pressures.

In one case an organic inspector was also found to be very useful for giving advice

"there's also the soil association advisor and he's our inspector as well and I've known him probably for about 10 years - I got to know him through [a regional farming group]. So he's somebody I can just ring so I'm quite lucky like that. I've often said to him that I ought to be paying for this and he says, "don't worry about it," its only about twice a year. But when you're doing things like making decisions about your rotations you do need good quality

advice from people who understand your situation, your rotations and so on. You really need, because otherwise you're guessing really and that isn't a good situation

One farmer stated: "I share ideas with other farmers and …. our advisor comes around every six months and we chew the fat and throw around ideas." (Int 2). Informal networks of farmers and farm walks are important sources of comparisons of crops with different treatments:

"I might be thinking about doing something that can be completely of the wall and I can say 'look I've been thinking about doing this, do you know anybody who might be doing this, or do you think this is completely daft?' Its quite interesting to hear that you're not the only one doing it or that somebody else is trying to resolve it another way. With the new things we are doing, we've talked 'bout it and that perhaps we ought to be trying to quantify it more than we have been because we've probably been down the subjective route so far and perhaps we'd like to try to be a bit more objective about it.

The most common form of analysis of experiments is through comparisons to previous years, crops on adjacent land or crops sown at the same time. The farmers have a detailed knowledge of some of the factors that might have caused the difference, based on years of experience of working the land and building up local knowledge of how each field might respond to different conditions. However, farmers knowledge can be limited or even wrong. Through reducing the possible variables and excluding the treatments and conditions that were similar, farmers can start to attribute cause and effect.

"If there is a big difference between two fields, the first thing I suppose would be to look at what had we done to it. So in term of drilling dates, seed rates, cultivation's seed bed preparation, more weeding on one, some muck on or not….All those sorts of things, try and, ok well we did that on that field and didn't do it on that one or whichever. Then look at obvious things would be soil type, soil analysis……timeliness of harvest. Yeah, I guess those would be the obvious things and then if that throws anything up it would dictate whether I thought oh gosh there's a difference here or maybe its just the way it is."

For specific treatments farmers commonly leave part of the field untreated to see if there is any effect. Examples of this were found regarding sub-soiling and weeding (see the case below). These forms of trials are important for assessing whether the treatments work on a particular piece of land that has a particular weed pressure or a particular type of soil. In this way, farmers are trialing technologies in order to develop a strategy that meets the needs of a particular locality or ecological situation.

This year, or last autumn, we did [weeded] one field in colyuptar stage, which I've never done before and was absolutely terrifying….you know these little white shoots…so no leaves, so what I do is I put a piece of glass and prop it up in the 4 corners standing, and obviously that speeds up the germination. And when that is up then I go up on the rest of the field…its only to tell me when I can start. So you know you get weeds and the very early stage and if you wipe them out then. Also it boosts the Nitrogen I suppose.
how will you know if you should try it again next year or not?
I suppose that I, we look at the content we get. Because I've got 2 fields of triticale and I weeded one and I didn't weed the other so it'll be interesting to see. The other one is a weedier field, I always try and do a control in everything. So if I weed a field I don't do it all, I

leave a strip or two just to see if it makes a difference and I'm still weeding so it must have made a difference.
So, which one's weedier?
I think, the one that I have done as the colyuptar stage. That's what it looks like at the moment, provided of course that it may not be later on. I think the weed content is important, because that affects the yield. I mean ultimately that's what it's about - the yield. (int 7.3)

5. Implicit assessments

The actual assessment of crops may not be done formally: One farmer stated "It just doesn't feel like it is research it's just, ….I mean over the years we might see the difference" (int 9.8). Other interviewees denied doing any experimentation until part way through the interview and they had reflected on why they were carrying out their operations as they were.

Much of the innovations concerning machinery are referred to as 'tinkering' and involve applying tacit knowledge held by farm workers or technicians, rather than farm managers: "I just knew about 85%. I know it sounds big headed but I just know" (int 12.3)
The assessment may not be explicitly acknowledged until asked the question*; "So how will you know that it is working?"*
"That a very good question… Very subjective analysis I'd imagine. What will I be looking for, [pause] very interesting…… I will compare that with what came from stuff that we grew last year, then I guess it'll be just a visual monitoring, the important bit will be yield, the important bit will be whether one comes down with a load of disease that the other one didn't, how does it germinate, all those sort of things. I don't think I'll be doing it particularly scientifically necessarily, it'll just be a overall impression that, that worked or it didn't work. (int 4)

The example of the case below shows that farmers may carry out the assessment almost subconsciously.

"we've just changed to use a contractor who has two drills and we have one too. We also tried a demonstration drill for about forty hectares. *How do you know which is better?* I guess it'll be to do with seed placement and coverage …..number of cultivations…germination....; you just sort of log these things away I think as you go around but then ….. it might then prompt you to actually go back and try to be a little bit more scientific. But I guess because it is in the back of your mind it's just for your own personal use, so you don't tend to record it all and say "oh right that's how to justify XYZ". It's more of a sort of, I think… its driven by something you notice yourself and then you think … ah maybe I better try and put a bit more of a handle on it." Int 4

Another farmer stated: "I don't do replications. You can have a strong feeling but you can't say hand on heart. I try to use the information I have, or part of it".(Int 2). Similarly a seed dealer was encouraging seed growers to try new varieties and assessed them while walking the fields:
"I will get a feel of it when I do the crop inspection , and if I don't like it I won't grow it again. I will ask , does it impress me? and I know the circumstances."

6. Innovations and learning by buyers or cereals

One farmer had worked with a grain miller, in order to assess the quality of a mixture of varieties grown together. The miller reluctantly tried half a ton and was surprised at how well it ground and what the flour looked like. A manufacturer of feed compounds reported that they are regularly adjusting their formulations in response to changing supplies of raw materials. While designing the formulations is based on nutritional science, the person responsible stressed the importance of experience and the need to test new formulations with a small group of farmers. There were selected because of their close relationship with the feed manufacturer, the quality of their operation, and the ability to monitor the results. The farmers will then report back on their experiences with the new formulations, noting its effect on animals in terms of weight gain, milk yield, milk quality as well as other observations: “When you look and see what comes out the back end, if that’s loose or oily you now something is not right.” (Int 17). While some monitoring can be done, to a large extent the feed manufacturer is reliant on the farmers’ ‘gut feelings’, perceptions and other implicit assessments.

A similar combination of rigorous scientific method combined with gut feelings was reported by a manufacture of organic breakfast cereals. They have ‘ drive teams’ made up of food technologists, market specialists and a production manager. However, they have to find ways of coping with the inconsistency in the size of oat grains and knowing what thickness to roll the oats

> “So we have our own in house test to check that the oats we are using absorb …. All this happens if it is organic or not, but there is better control in the conservation grade and even more control in the conventional oats. It is regimented by the growing – if you can use inputs then you can reduce the difference…. If we don’t get it right then the oats go to the bakers and they say it is puddingy – it is a bit of an art form in some regards. The bakers are making it day in day out and they might say it is too crumbly, even once we have gone into production .. and so we can go back to redevelopment and find a different thickness or a mix of oats of different thickness.”

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7. Interactions with scientists

Scientific researchers and farmers have differing objectives and agendas that need to be better understood in order to promote co-operation and participation. To a large extent scientific knowledge is disseminated to farmers through intermediaries, such as technical advisers or agronomists. These individuals can act as bridges between the differing cultures. The previous section showed that interaction between farmers and scientists can be beneficial but it requires a greater understanding from both parties. Organic farms are balancing economic and environmental objectives as they are running a commercial business and at the same time many have specific interests in the conservation of the rural environment.

Within organic agriculture, there is very little research in commercial sector as seed breeding companies do not consider the size of the organic seed market to be viable for a specific organic breeding programme. Some commercial breeders are promoting conventional varieties that are well suited to organic systems, and have an interest in organic farming because of an interest in disease resistance, and for public relations. This tends to be the smaller organisations that do not have an interest in developing

agrochemicals and are content to capture small proportions of the market with varieties that meet specific needs of farmers or users. Conventional agriculture also benefits from the research funding from the levy boards (such as HGCA), while the total levy on the sales of organic crops is too small to fund any research projects.

Where farmers have been involved with researchers, there appeared to be considerable misunderstanding present with both sides becoming frustrated. Farmers can be highly critical of research projects they feel have not been relevant:

> We had a research project and we sat around the table , with professors and PhDs and when I mentioned anything off the beaten track they just….. they wanted to do research on their own topics. They did not understand organic systems so it was a huge waste. Some of the stuff was really bad. There was lots of money but I had the feeling that this was a jolly. I was a bit disillusioned. Then at the end they said they had run out of money , so could not write it up. No one else could say that get away with it. If it was a business , you would not run it that way. I used to bleat mildly, but now in retrospect I would make more fuss. Then I was sitting there with all these high powered people. They're not like xxxxxxx. He is an academic with wisdom- he was saying that we have to have the anecdotal, with the scientific. But then this view, got filtered down to the lower academics, and they went on their own way……they were very airy fairy. In this case it was hijacked. (int 2)

> "I think there's almost the sort of science for its own sake. …they've got a theory that they want to prove and depending on how you do it you can get anything to prove what you want it to prove if you sort of catch the experiment in the right way. And you know you just sort of wonder quite where they're coming from. …. so what does that mean for me……, that doesn't mean anything".(Int 4)"

> Some scientists are very bigoted and use the research to find what they want to achieve. Some scientists do what they say and some companies are better than others: independent trials are better as long as they are done by people with no axe to grind. For example an independent organisation can be paid by a company to show some of the merits of this company's stuff and then they stop the trial at a time when it is advantageous. They need a code of honour. But there are some people in companies that don't ever act dishonestly because if they twist the rules, they lose their credibility. But it depends on the staff at that time.

There was some concern over the reliability of results coming from commercial trials:

> "Sometimes you find that places like that aren't commercially laid, if you know what I mean. Anything that's commercially laid is usually, well it's done for the money and that's basically what it's about. Sometimes you find these experimental farms that aren't quite always run efficiently if you know what I mean. ……Its good when things are tested on a farm in a sort of commercial situation, rather then being tested in say a research station or somewhere that's funded by a private pile of seed breeders. It's always the fact of getting somebody whose going to tell the truth and say exactly what they've done to something….. Sometimes it's…. how can I say …. done by big companies and they do the research and it doesn't matter where they do the research their product is always better then everybody else's. Because basically if there's 5 in a group and theirs beats 3, they'll show you the ones they beat, they wont show you the one that actually beat them (int 6)

Research coming out of universities and research stations is often criticised by farmers and other businesses in food chain for its lack of validity in the ' real-world'. A common complaint is that scientists are not working in the commercial context and lack knowledge about the organic food industry making the results of their research less valid. In part this issue is due to the reductionist methods (such as small plot trials and the rigour associated with the need for statistics) that allows scientists do more basic research. Commercial research institutes are increasingly having to follow this agenda as well in order to demonstrate the quality of their work to public sector funding organisations.

"What farmers want is messages, they want very simple, very clear messages. The problem with these refereed papers …they've got things like, 'this maybe probably means that', it's all sort of 'ifs' and 'buts' because you can never be 100% sure. But farmers don't want that, they want to hear that we've done it and we believe this is the way that this will do well" (Int 22).

However, research scientists in universities and research centres that were interviewed were aware of these criticisms and stated that they are under increasing pressure to publish work in journals targeted at other academics and are therefore written in way that may not be usable by farmers. Particular challenges arefaced by those trying to publish work that was not based on replicated trials:
" Systems work does not have replications and in the science world this becomes very difficult. They complain that we are only looking at one farm and the replication is only over several years. We hawked a paper around several journals but the editors said they could not accept it in the end because there were no replicates." (Int 24)

Those scientists in research institutes dependent on funding from BBSRC and NERC are also being encouraged to do more fundamental rather than applied research, with their careers based on the number and quality of their publications. This limits the amount of work they can do on specific crops and on problems that are directly relevant to farmers.

The criticism of lack in relevance is also based on the lack of dissemination of results. A lack of satisfaction in the existing forms of disseminating results to farmers was voiced by four of the interviewees and was the conclusion of a recent meeting of farmers and scientists.
'there is quite a lot of knowledge and information out there and sometimes it's not necessarily about doing experiments in their own right its more about collating that information and actually making it available.' (Int 4)

The process of dissemination can also stimulate more farmer experimentation and encourage farmers to talk to other farmers about their experiences of dealing with those issues:
"lets have some new ways where farmers can poke around with crops as farmers do and say, 'bloody hell you might like it mate I don't' and 'you ain't seen my farm', 'what about the yield' , you know all of that."(Int 16).

8. Examples of farmer-scientist collaborations

This small survey has identified twenty cases of farmer-scientist collaboration. These different forms of interaction range from those where the scientists control the design and analysis to those where farmers have more control.

Researcher managed and implemented

The most commonly reported and most easily observable forms of interaction are on-farm and on station trials that are designed and analysed by researchers. The types of trials reported in this survey were predominantly varietal trials. While the objective of these trials is to generate statistical information that has relevance to other locations, farmers can gain information from observing them and seeing what is relevant for their particular farm. Information can also be gathered by those people visiting farm such as advisers and seed inspectors who reported that they go out of their way to examine trials on the farms they visit in order to build up their knowledge. Farmers and other stakeholders can also interact in researcher managed trials by being on steering groups and advising on selection of research questions and types of treatment to be assessed.

Three of the farmers interviewed had had Elm Farm Research Station trials on their land. They stated that they benefited the getting access to the results which are relevant to the fields that they use. Researchers decide the varieties, sow and harvest, and farmers are consulted on the appropriate location from them. One farmer was also keen to encourage trials on farms so that they had more relevance for all farmers, particularly when treatments are the same as the rest of the farm.

> "To all intents and purposes it's treated exactly the same because I think it's quite important that the experiment and the results are all relevant to us who are actually farming in the real world if you see what I mean. Without being too scathing on scientific results, you can have an awful lot of things that work on the trial plot or on the greenhouse and then when you come to put it out on the field it's not quite the same" (Int 4).

Similarly farmers and other related businesses such as seed dealers are invited onto research stations or 'experimental farms' belonging to seed breeding companies or independent research stations. This gives them the opportunity to pick up new information, gather stimulating ideas for their own experimentation and, in return, provide the researchers with feedback on their existing varieties and ideas for future research.

> "These breeders asked me to come and see their new varieties. I know a bit that they know so much more. I stand there in awe, and keep my mouth shut. I was interested in a variety because it has some resistance to Septoria and because of its agronomy. I want a leaf and that is flat and good canopy, so it can help we weed suppression. My hunch proved right, because there is a bigger wheat plant and the angle of leaf means there is more canopy cover. When you go to seed breeders, it stimulates things." (Int 14).

Feed manufacturers and millers can also be involved in some aspects of variety development in order to identify specific needs in terms of nutrition and identify varieties for specific purposes.

"We have worked a relationship with the seed breeding companies for trying new varieties because I think in the past new varietal developments had been driven very much by yield and disease resistance - all of which are really agronomic aspects…… We'd like to go down a route that looks for things like starch structure and protein values." (Int 19)

Researcher managed and farmer implemented

A number of on-farm research projects have been designed by researchers but carried out by farmers on their own land as part of their normal farming practice. Examples include variety trials, bird surveys, pollution of water sources and weed control. These types of trials are being on designed as trials or the researcher involvement may involve monitoring what farmers are doing and the impact this has. The latter type of trials may have minimal farmer involvement (such as surveys of the bird populations on organic and conventional farms) although they attempt to encourage greater farmer participation in analysing the results. The case below demonstrates how a research team managed to encourage greater farmer participation.

Case study of researching with farmers
The project concerned monitoring nitrates in water sources near organic farms. The researchers wanted to get good-quality results while at the same time involving the farmers. They had a background in laboratory based studies and faced a struggle to work on farms because of multiple interactions. They also faced the problem of getting the farmers to join in the work:
"I found that if I was doing monitoring of farmers and I could not just launch into asking for data but had to do the general chit-chat with them and show empathy. I realised that I had to have icebreaker like knowing what the farmer is likely to be doing that day and to show some appreciation of their business.

I wanted the farmers to be involved in the explanation because we needed the history and story behind the system. To keep the farmers involved in the analysis of the results I had to find a way of getting them to come together. I knew that farmers are competitive and like the peek around other farms and so I used this competition to bring them together. I got them to feel part of the team because I was doing lots of winter fieldwork and I think this commanded respect because they were always seeing us go out to collect samples in bad weather conditions. I set up annual meetings to get the farmers together - lunch was very important in attracting them as was beer. I showed then the peaks in nitrates on specific farms and asked them for reasons. Once one person had given a reason then the others admitted that they had also had that problem on their farm, and camaraderie was built up.

I learned so much from this but it was hard to get the results into a scientific environment because there were so many explanations. I had real problems trying to publish it in xxxxx Journal but after three years of a going backwards and forwards the editor said that I should try out research on small trial plots. I just took it away. My reward is getting ideas transferred to farmers." (Int 21).

Getting farmers involved in research was also a challenge to another project looking the economics of organic farming in different locations.

> We initially wanted 6 farmers to come together, to discuss with them as a group looking at best tactics. But they didn't want to do that. ….. they were worried about confidentiality of information. I think they're worried about being seen to be doing something stupid, and if they did something really well and got a good market they don't want to give away their secrets.
> Another problem was trying to suss out the economics of their farming from their accounts especially when they had a number of enterprises and money was moved between accounts. We wanted more participation from them, we wanted more of their time and we realised we had to pay them. Certainly the ones we've got now enjoy it; it's also a chance for them to meet with a few colleagues they value. There is no problem with getting conversation going. Its stopping them that's the problem. You cant get them away at the end of that day because they all know each other well and we have very, very good discussions.

A university based research centre also had to find ways of ensuring farmers continue to participate.

> The centre carries out on farm field trials, we tend to work with model farmers, those defined as being more forward looking and risk takers. When you first start working together you need to adapt to them and they need to adapt to you. You don't begin with a risky hypothesis the first time because if it is risky it might fail and farmers will not wish to work you again. It is important to develop a relationship of trust with the farmers so that they would be willing to continue on to new projects, rather than do one trial and then to give up.

Three of the farmers interviewed had had Elm Farm Research Station trials on their land. They stated that they benefited the getting access to the results which are relevant to the fields that they use. Researchers decide the varieties, sow and harvest, and farmers are consulted on the appropriate location from them. One farmer was also keen to encourage trials on farms so that they had more relevance for all farmers, particularly when treatments are the same as the rest of the farm.

> "To all intents and purposes it's treated exactly the same because I think it's quite important that the experiment and the results are all relevant to us who are actually farming in the real world if you see what I mean. Without being too scathing on scientific results, you can have an awful lot of things that work on the trial plot or on the greenhouse and then when you come to put it out on the field it's not quite the same" (Int 4).

Farmer managed with researcher involvement

The third type of farmer-researcher interaction relates closely to farmers' own research, but involves researchers feeding ideas to farmers. Examples of this include seed breeding companies providing seed to one farmer who is carrying out a range of varietal trials. Commercial scientists were also found to be suggesting varieties to seed dealer who in turn asked farmers to try them out. Researchers can also be involved in advising farmers directly with regard to specific questions concerning soil quality and nutrient levels. Further examples of this are discussed in previous sections of this report.

9. Conclusion

This study has identified a number of key issues and implications that will be used to shape the participatory approaches developed and tested over a three year period. Based on the detailed interviews with the farmers agri-businesses and scientists a number of conclusions can be drawn.

- Almost all farmers appear to be doing some for trials and experimentation although some are more active and less risk averse. Other agri-businesses are also found to be doing experimentation particularly with regard to manufacturing.

- Advisors, seed dealers and other farmers encourage farmers to carry out their own experiments.

- Most experimentation concerns production with very little evidence of marketing experimentation despite the pleas from grain traders for farmers to be more responsive to market demands.

- Some of farmers' own research is similar to the scientific method with replicates but farmers often have to adjust their treatments during the trial to avoid loosing the crop.

- Farmers can use a wide range of criteria to asses a trial in a holistic manner. Analysis is carried out through comparisons to previous years, other fields/farmers or untreated parts of the same field.

- Farmers may also make tacit assessments implicitly using gut feelings. They may not recognise that they have carried out an experiment or done anything different until asked to reflect on what they are doing. Knowing how farmers do these types of experiments and build up tacit knowledge is necessary for understanding how farmers learn and develop new ideas.

- Many farmers are critical of existing public sector funded research for selecting irrelevant topics, and using small plot trials that are very different to the commercial context of farming. Scientists recognise this issue but reported that they are under pressure to publish in academic journals that demanded the rigor derived from replicated plots trials.

- Farmers were also sceptical of results of research that had been funded by the private sector, particularly those developing technology and carrying out plant breeding.

- Four types of farmer-scientist interactions were identified: Scientist managed research on farmers' land, farmers invited onto research stations, scientific monitoring of farmers own operations, Farmers' own research with researchers involved in providing ideas.

Implications

- Farmers do experiment and adapt their farming systems to their ecological context using criteria that they feel are important. These approaches can be built on and harnessed by participatory approaches.

- While some farmers (and other agri-businesses) do have experiments that follow the scientific methods, others make holistic assessments using multiple criteria in a way that is not possible in conventional scientific reductionist research. Farmers may set hypotheses explicitly before starting the experiment or they may use gut feelings and be experimenting without acknowledging it. The scientific method, the holistic and the implicit approaches all have a contribution to make to participatory research.

- Farmers may not pursue scientific rigor and may change treatments during the experiment. Where rigorous detailed statistics are required, a more reductionist approach with greater researcher control may be needed.

- There are a range of key stakeholders who encourage farmers and agri-businesses to experiment with new ideas. Participatory research should work with these advisors, input sellers and crop buyers.

- Research questions and design should be decided with farmers and other agri-businesses to ensure they are appropriate.

- Participatory research can include different approaches with differing balances of control between scientists and farmers/agri-businesses depending on the type of information required. Best results are more likely to come when topics are addressed by combining farmers' own research with research on farms controlled and managed by scientists. Farmers have differing motivations to scientists and should not be expected to design, manage and collect data from trials that attempt to be statistically rigorous.

Appendix 1. Preliminary results of interviews with farmers and other businesses in organic cereals

1. Introduction

Through interviews with farmers, advisors, seed suppliers, grain buyers and food processors, the key issues that end users want to be researched will be identified and the types of informal research and innovation will be documented.

2. Research questions identified by farmers and businesses

2.1 Varieties

Farmers views
Yield potential
Weed suppression – so prefer longer straw
Disease resistance – especially fungal diseases in the South West
Use of mixtures and educating buyers

Grain buyers views
Too much barley and triticale and not enough wheat –
Need for milling wheat that does not require applications of nitrogen
Rye – estimated to be a £1/2 million although most is imported
Nutrition especially of feed wheat – starch structure, protein, amino acids and high levels of lysine.
Require triticale with higher protein levels and resistance to ergot and other diseases
Other protein crops to be grown in UK such as lupins
Consistency – problem as supplies come from lots of sources, impurities and different nutirional properties, poorly stored and dried. Cases of rat droppings and weeds
Oats for muesli – too much variation in UK oats grain size – causes processing problems , breaks up differently, can be puddingy
Need greater yields as better to buy more from UK markets as it is traceable

2.2 Weeds and agronomy
Roe hoeing
Evaluate different equipment from the continent
Controlling perennial weeds such as cooch and dock
Sterile brome
What level of weed tolerance is best
How to control weeds with minimum tillage
What seed rate under different conditions to use to suppress weeds
Use of varietal and crop mixtures to reduce weeds and other benefits
Cleaves, wild oats, wild radish in seed crops
Timing of cultivations and drilling
Closest rotation to make money and be sustainable

2.3 Soil fertility management
Rates if using compost, timing, benefits of reducing brown rust and other disease

Use of manure and in particular top dressing of poultry manure
Nutrient balances of p, k and trace elements

2.4 Pathology
What types of plants should be in beetle banks
Control of bunt
Control of ergot
Control of pests in storage

2.5 Seed quality
Reducing risk of disease in own saved seed when can't use treatments
Cleaning seed for grains with seed borne disease

2.6 Marketing
Futures markets and forward contracts
Research on the extent and types of demand for organic cereals
Finding new markets for mixes of varieties
Finding ways to encourage farmers to respond to the market
Feasibility of cooperatives for selling
Research on nutritional quality of organics. It may damage the market if shows no benefit and if shows a benefit then the FSA is worried that not everyone will be able to afford organics if they are proven to be better.

3. Types of research and experimentation involving farmers and other businesses

3.1 *Farmers own research on v*arieties
Selecting varieties – every farm found to be comparing to other fields, previous years, other farms
Terry Bird trials of 16 winter wheats, 5 winter barleys, 5 oats, 12 winter oats, spelt wheat, winter lupin, a sping wheat, 4 spring barleys, two spring beans, 4 spring lupins, as well as beet, soya beans, peas. Replicated on 3 sites
Growing specific varieties for beers eg Plumidge archer
Growing mixed crops and varieties for whole crop silage

winter wheat varieties,
oat/triticale,
wheat and volunteer vetch - combined,
Oats and vetch with a biograin treatment before animal feed
wheat and volunteer beans
Maris W and Petchworth
Stanwell and Maris bean
Wheat and triticale (2 types)
Wheat, triticale, barley, rye and peas

Get millers to ground a mixture and ask them to assess it

3.2 Farmers own research on Weeds and agronomy

Adjusting the settings of finger weeders

Inter hoe weeding
Harrow combing and increase of growth
Harrow combing but encouraged weeds
Undersowing with comb harrow
Assessing when to weed by accelerating germination in a small patch under glass
Broadcasting compared to drilling
Drilling at different dates and comparing spring and winter crops for weed control
Different types of cultivators and harrows

'Messing around with 4 types of drills, seed placement and seed rates
Change seed rates and ask combine driver to comment
Depth of ploughing

3.3 Farmers own research on Soil fertility management

Encouraging earth worms
Top dressing with poultry manure
Nitrogen fixing green manure
Subsoiling
Rates of using compost and trying to get milling wheat
Running sheep over land to improve soil and next years yield
Trying minimum tillage
Mustard short break on set aside before sowing rye to lift nutrients and sterilise the soil

3.4 *Farmers own research on* pathology

Use different types of grass on headlands and beetle bank strips

3.5 Farmers own research on Seed quality
Use of own saved seed

3.6 Farmers own research on Marketing
Market research for new butchers shop
Milling own flour for local bread
Selling through a cooperative
Buy feed from miller and require them to buy our grain

3.7 Research by other businesses
Seed cleaners - Developing seed cleaning equipment, reducing seed borne diseases

Feed manufacturers – mixing new rations and changing ingredients based on changes prices and customer demands
Sourcing organic proteins such as lupins – but could not have consistent supply

Jordans – 'drive teams' with food technologists, sales people, marketing people, production managers, packaging experts, tasting panels

Grain traders – research into the demand from different types of grain users

Seed dealers – ask faremrs to grow up some varieties, assess new varietites when walking across other farmers. Causes of seed born disease, organic seed treatments, ergot coming from wild grasses

Appendix 2. Methodology for assessing existing systems of innovation and interaction

The survey involved interviews with a sample of 30 farmers and other agri-businesses. These were selected purposely to ensure a cross section of types of farmers and other businesses. Farmers were selected from the farmer groups participating in the project, those working with EFRC, conventional farmers working with private seed companies, and other farmers who may not be so well networked. Interviews were also be carried out with seed producers/dressers/sellers, grain buyers/millers, and other end users. Seven scientists were also be interviewed. These included people working for organic research stations, public sector funded research stations and private sector research stations.

Semi structured interviews followed a check list of questions while allowing the interviewee to explore some issues in detail, such as the processes by which farmers do their own research. Many of the interviewees were encouraged to participate in the research trials and so the interviews also play a role in building up a relationship with them and explaining the objectives of the project.

Interviews will be taped and partly transcribed. A particular challenge is to identify and gather data on types of tacit research and innovation. This requires particular care in the conduct and analysis of interviews. Interviewees will be asked to describe the reasons why things happen, talk about particular instances (critical incident analysis (Chell et al, 1998)). Tacit knowledge can be identified when people have to think for some time, laugh at a question or make statements such as “ oh yes, that’s right” or Aha, I hadn’t realised that” or “I’ve never really thought about that” (Ambrosini and Bowman, 2001). The use of metaphors, similes and analogies were also be noted as these can be ways of giving tacit knowledge a voice when explicit language cannot explain it (Ambrosini and Bowman, 2001)

Appendix 3 Interview Checklists

Interview Checklists for Farmers, agri-businesses, advisors

(for interviews with farm owner/manager, family members working on farm, employees)

Are you doing anything different this year? Or have you done anything new over the past few years?

> Farmer interviews: Probe: new varieties, mixes, seed rates, timing of cultivation, machinery, disease and pest control, marketing seed treatment, rotations

For each new thing
Why are you doing it? What caused it to happen?
Where did you get the idea from? Probe: intentional, forced or accidental

> If through a **network**: probe:
> Who is in the network? What size or scale?
> how often do you meet?
> how was it started?
> how do you know you will benefit?
> How do you know others will share information and co-operate?

Who else is involved in it?
How will you know if it is working? What factors will you consider?
What measurements will you take and how?
What will you be comparing it to?
How will you know that it is caused by the changes you made (how can you attribute cause and effect)

Have you shared the results with anyone else? Who? Why?

Links to Scientists
What links or contact have you had with scientific researchers in the past?

For each link:
Why did you have the contact? What did you get out of it?
What did the scientists get out of it?
How did you get to know about them? Who approached who?
What was the result?

For trials – who decided what was in the trial?
Who monitored and took measurements? Describe.

What is your view of organic research at present?
How are research priorities decided?
How have you found out about the research results?
What research do you think is needed?
How should it be carried out? Who should do what?
In your view, what are the different types of scientists?

General Questions

What sort of advice do you get for your cereals farming?
Why did you choose them?
How did you fin them?
How do you know they are good value?
Do you pay for it? If subsidised, what percentage do you pay, and who pays the rest.
Do the advisors try out new things or learn things from your farm?
Do they carry out any research on your farm?

What associations and groups are you involved in?
Are these involved in sharing new ideas or developing new ideas
Would you ever pay for research?

In your view, what are the different types of organic farmers

Interview Checklist for Scientists

What research are you doing now?

For each project:
Who is funding it?
Who are the target audience?
How did you decide to do this topic?
What outputs are required by the project?
What other outputs do you want get out to satisfy your institution ?
What other outputs do you want get for your career?
What involvement of farmers and other businesses ?
Are you doing research off station? Describe
What are the roles for farmers and other businesses?
In what way are farmers and other businesses involved in the research?
What constraints do you find working with farmers and other businesses?
How supportive is your institution for working closely with farmers and other businesses?

In your view, what are the different types of agricultural scientists?
Is there a clear division between pure and applied scientific research?

In your view, what are the different types of farmers you come across?
(if relevant, what are the different types of organic farmers?)

What is your view of the direction of agricultural research in the UK?
How should it me different?
How is research policy and priorities decided?
What are the roles for scientists, pressure groups, civil servants and farmers/other agricultural businesses?
What is your view of organic farming research?

Appendix 4. List of interviewees

Organic farmers

- Terry Bird– Suffolk
- David Wilson : Duchy Home Farm, Broadfield Farm, Tetbury, Gloucestershire GL8 8SE. Tel: 01666 505298
- Christopher Musgrave : Temple Farming, Temple Farm, Marlborough, Wiltshire, SN8 1RU. Tel 01672 514428.
- Mr. John Newman, Abbey Home Farms, Preston Field Barn, Stow Road, Cirencester, Gloucestershire, GL7 5HA. Tel 01285 643419.
- Mr. Martin Viner, Sheepdrove Organic Farm, Lambourn, Berkshire, RG17 7UN. Tel 01488 71659.
- Mr A. Westaway, Organic Farmer, Philham Farm, Chumliegh, , Devon, EX18 7EQ
- Mr D, Ursell, Organic Farmer, Aller farm, Dolton, Winkleigh, Devon, EX19 8PP
- Mr, Deleval, Astley, Organic Farmer, Wood Farm, Barney, Fakeham, , NR21 ONN, 07850 205 499
- Mr , Edward , Cross, Organic Farmer, Abbey Farm, Flitcham, Kings-Lynn, Norfolk, PE31 6BT, 01485 600227
- Ian and Linsey Shears, Highfield farm, Clift road, Topsham, Exeter, EX3 0BY

Organic advisors / Inspectors

- Abacus Organic Consultants. Mr. Stephen Briggs: Tel 01780 721019. Mobile 07855 341309. Email stephen.briggs@abacusorganic.co.uk
- Bill Starling, Suffolk

Seed producers and cleaners

- CYO Seed Ltd. (Clean–your-own-Seed), Lime Tree Farm, Chilton, Didcot, OXON OX11 0SPTel. 01235 834421 Fax. 01235 820075. Mob 0780 2214630 Email: info@cyoseeds.co.uk
- Barry Gill, Sherburn Processing (Rosedown Farm), Dorset

- Mr Roger Wyartt, Wyartt Seeds Ltd/ Organic Seed Producers:., Stone Cottage, Beyton, Bury St. Edmunds, Suffolk, IP30 9AF. Tel 01359 270410. Mobile 07702 062474.

- **Grain buyers and millers**

- Andrew Trump, Elm Farm Research Centre, Hamstead Marshall, Near Newbury, Berkshire RG20 0HR. Tel 01488 658298. Email andrew.t@efrc.com.

- John Norton Grain Marketing Ltd: Castlings Heath Cottage, Groton, Sudbury, Suffolk, CO10 5ES. Tel 01787 210899

- Mole Valley Farmers Ltd. Mr Ian Tremain. Huntworth Mill, Marsh Lane, Bridgewater, Somerset, TA6 6LQ. Tel 01278 444 829.

- W. & H. Marriage & Sons Ltd.: Chelmer Mills, New Street, Chelmsford, Essex, CM1 1PN. Tel 01245 354455. http://www.marriagefeeds.co.uk/organic.htm

- Robert King, Crisp Maltings

- BOCM Pauls: http://www.bocmpauls.co.uk/bocmpauls/main/cattle/organic.jhtml

- Jordans, Biggleswade, Beds

Researchers

- Lois Phillips. Elm Farm Research Centre, Hamstead Marshall, Near Newbury, Berkshire Rg20 0HR. Tel 01488 658298. Email lois.p@efrc.com. (FPR for weed management, wide row spacing with Richard Steel, and man mod project?)

- ADAS: Bill Cormack, Norfolk

- Professor Carlo Leifert. Tesco Centre for Organic Agriculture, Nafferton Farm, Stocksfield, Northumberland, NE43 7XD. Tel 01661 830222.

- Dr. John Conway. Royal Agricultural College, Stroud Road, Cirencester, Gloucestershire, GL7 6JS Cirencester. Tel 01285 652531. Email john.conway@royagcol.ac.uk. Course director for MSC in Organic Agricultural Systems.

- Eddie Arthur, John Innes Centre, Norwich

- Bill Angus – Nickersons

- Richard Summers – Monsanto, Cambridge