

Conversion to Organic Farming: A Typical Example of the Diffusion of an Innovation?

Susanne Padel

The adoption/diffusion model, developed in the United States by rural sociologists (Rogers 1983), is a very important model describing a process of change, i.e. the diffusion of an innovation into a community. It attempted to predict the adoption behaviour of individuals by looking at their personal characteristics, the time factor and the characteristics of the innovation itself. The model was, for a long time, the main theoretical model for agricultural extension and the development of agricultural advisory services (Albrecht 1980; Vanclay and Lawrence 1994).

At first, the model appears ideally suited to the process of adoption of organic agriculture. However, some doubts arise if the background of the adoption research is considered. It was developed at the height of the productivity paradigm for agriculture and the 'green revolution.' Organic farming, on the other hand, is a challenge to this productivity paradigm, with a wide range of environmental and sustainability objectives, and one of the main areas of criticism of the model was concerned with its suitability to study environmental change in agriculture (e.g. Buttel et al. 1990; Heffernan 1982; Nowak 1982) (see below).

The intention of this paper is to review a large number of studies of organic farmers carried out in several countries over a period of approx. 20 years and critically assess whether or not the results appear to fit the framework of the adoption model. If this is the case the model could help to improve the understanding of the diffusion of organic farming into the farming community and how this process can be supported, for example through organic farming information and advisory services. If this is not the case, the analysis might highlight potential weaknesses of the model.

After a summary of the adoption/diffusion model and a short description of organic farming and its development in Europe, the next section compares the results of studies of organic farmers with the personal and social characteristics of the categories of early adopters of other innovations. This is followed by a section about organic farming compared to other innovations that were the focus of adoption research. After a short summary of the main criticisms of the adoption model, the paper finishes with some tentative conclusions and recommendations.

Summary of the adoption/diffusion model

Rural sociologists with the intention of helping extension workers in the promotion of agricultural innovations by better targeting their activities developed the adoption/diffusion model. In one of the early adoption studies (Ryan and Gross 1943), the wave character of the adoption curve as shown in Figure 1 was identified, which can also be shown as the typical S-curve of the cumulative numbers of adopters. This curve form has subsequently been found to be typical for many kinds of innovations. It was further assumed that when adoption has reached 15 to 20 per cent of the community the process will continue on its own (Albrecht 1974; Rogers 1983).

According to the adoption model the *innovators* and *early adopters* can be characterized as being different from the later adopters. Innovators are venturesome, have cosmopolitan relationships and communicate with a clique of other innovators, often despite considerable distance. They must be able to cope with a high level of uncertainty and may not be respected by other members of the social system. Early adopters are more integrated into their local community than innovators. They usually have a degree of opinion leadership and have intensive contact with information sources. Their role in the diffusion process is to make the innovation acceptable in the community. The later adopters can be divided into two categories: the *early majority* adopts new ideas just before everyone else does, whereas the *late majority* remains rather skeptical.

Time is a very important factor in adoption/diffusion theory. The individual decision to adopt takes time, early adopters are different from late adopters, and a longer time period is required for an innovation to spread amongst all potential adopters (Rogers 1983). Criticism of the model highlighted the lack of consider-

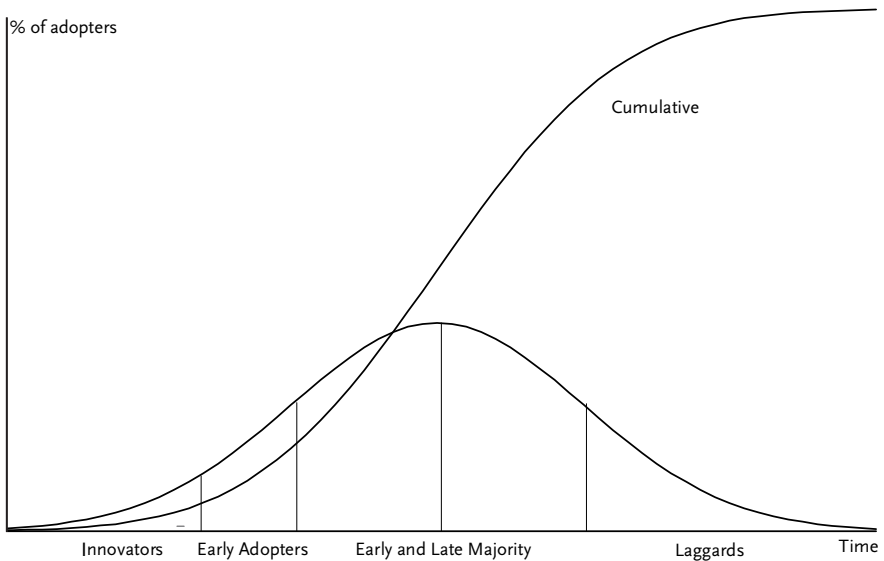


Figure 1: Phases in the adoption process

Source: Rogers (1983), amended

ation for the economic, structural and institutional environment of farming and the pro-innovation bias (see below), but the model remains important, for example, in agricultural extension and marketing theory, and it appears therefore interesting to see whether it can be applied to the diffusion process of organic farming.

Organic farming and its development in Europe

The development of organic farming began early this century on the basis of a range of ideas about farming, such as R. Steiner's agricultural course (1924) as the basis for bio-dynamic agriculture, Sir Albert Howard's *Agricultural testament* (1943) and Lady Eve Balfour's *Living soil* (1943) that led to the foundation of the British Soil Association, the theory and practice of organic-biological farming that was developed by the Swiss couple Maria and Dr. Hans Müller and the German doctor H.P. Rusch and taken up by farmers in Switzerland Austria and Germany (Neuerburg and Padel 1992). Despite some differences between the different schools the main aim of organic farming can be summarized as to create a sustainable agricultural production system. The term 'sustainable' is used in a wide sense, including environmental, economic and social sustainability. Maximum reliance is placed on self-regulating ecological or biological processes and renewable resources, whereas reliance on external inputs, whether chemical or organic, is reduced as far as possible (IFOAM 1998; Lampkin 1994). The term 'organic' is best thought of as referring to the concept of the farm as an organism rather than the type of inputs used. This was also used by one of the founders of German farm management theory, Aereboe, at the beginning of the last century (Dabbert 1990a). In other European countries, organic agriculture is known as ecological or biological agriculture, reflecting the reliance on ecosystem management and biological regulation processes rather than external inputs.

A number of environmental benefits have been attributed to organic farming and were confirmed on the basis of available European literature in the area of soils, the farm ecosystem, ground and surface water protection, and farm inputs and outputs (Stolze et al. 2000). Unlike other methods of sustainable agriculture, organic farming clearly also uses market mechanisms through the existence of a special market for organic produce attracting premiums from the consumer although the market should not be seen as a means in itself, but a means to an end (Lampkin 1999).

The development of organic farming was mainly driven by the first organic farmers themselves with the help of the few pioneers, and knowledge and information was distributed through informal networks at first. This was followed by the establishment of organic farming organizations, sometimes facilitated by people with some interest in agriculture or rural development. Research, otherwise seen as an important driving force in agricultural development, played only a minor role.

In 1985, despite the long historic development, the area of organic production accounted for just 6,300 holdings on 100,000 hectare in the whole of the EU, or less than 0.1 per cent of the total number of farms. More than half of all the organic farms were located in France and Germany. Since then organic farming has gained much greater importance. By the end of 1999, the number of farms in the EU had increased to more than 127,000 holdings on 3.3 million hectares, nearly 1.5 per cent of all holdings or 2.4 per cent of the total agricultural area (see Figure 2) (Lampkin 2000). The total number of farms was chosen as a known reference point about

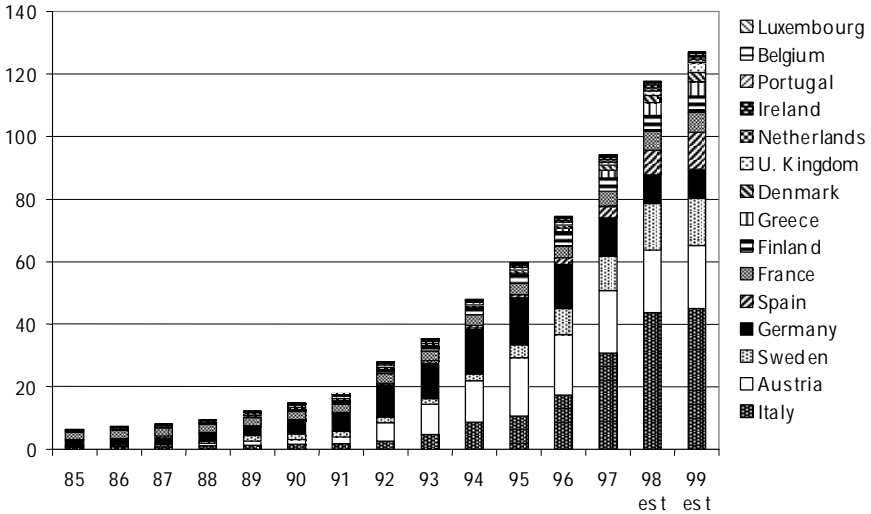


Figure 2: *Development of number of organic farms in the EU (x 1000)*

Source: Lampkin (2000) and own calculations.

the level of diffusion in the general farming community, but not to imply that all farmers are potential adopters of organic farming. It is not possible to theoretically determine how many farmers may convert to organic farming in the future, as diffusion may stop at any level, but it appears as if organic farming in Europe currently maintains a continuous phase of strong growth.

Organic farmers as innovators or early adopters

A relationship between socio-economic status, such as education, income level, farm size and commercial orientation and innovativeness was generalized from many adoption studies in the adoption model (Rogers 1983). Several studies of conversion to organic farming have also looked at some aspects of the socio-economic status of organic farmers, such as farm size, farming background, social relationships and motivation to convert. In comparing the results it is important to consider the level of adoption of organic farming in the respective countries at the time of their publication. In particular, the earlier studies of organic farmers were undertaken when organic farming was at a very early stage of diffusion. The first organic farmers studied would therefore have fallen into the categories of innovators or, in some later studies, potentially in the category of early adopters.

Education, social status and gender

According to innovation theory, innovators are better educated than later adopters and tend to have more social contacts outside their local community. This can be partly attributed to opposition to the innovation and the innovators. In contrast, early adopters tend to be better accepted in their social community and the category includes so-called opinion leaders (Buttel et al. 1990; Rogers 1983).

Among organic farmers a high proportion of people with urban backgrounds, high levels of general academic education, younger farmers and less farming experience was found (Burton et al. 1997b; Duram 1999; Harris et al. 1980; Henning et al. 1991; Lockeretz 1997; Murphy 1992; Tovey 1997; Vartdal 1993; Vogtmann et al. 1993). Earlier studies reported a lack of social acceptance as a consequence of the conversion (Fischer 1982; Kramer 1984; Wernick and Lockeretz 1977), but later studies regarded this point as less important (e.g. Lockeretz and Madden 1987; Maurer 1997). Organic farmers experience a good relationship with consumers, an indication of a different social support structure (Vogtmann et al. 1993). Urban people who start farming organically might be better prepared for this challenge, because they are less dependent on acceptance in the rural community (Richter 1990), but on the other hand their example might count for less because they are not regarded as real farmers.

There is some indication that gender is a factor in the decision to convert to organic farming, although the role of women in organic agriculture in general and in the decision making in particular has not been studied in detail. On several of the 100 organic farms whose motives to go organic were studied in a qualitative social study in Switzerland, the initial 'organic' ideas came from the woman (Fischer 1982). Organic methods were tried at first in the vegetable garden, which is traditionally the woman's domain, before they were introduced on the whole farm (Dettmer 1986; Fischer 1982; Fisher 1989). Women's influence is also likely to be important where reasons of family health are cited, as traditionally it is the women's role to look after nutrition and health of the family. Ashmole (1993) reported the case of a woman who had an organic livestock enterprise on her husband's otherwise conventional farm. She confessed to buying organic onions, although her husband was growing onions on the farm. Burton et al.'s (1997) survey of organic and conventional horticultural producers in the UK concluded gender to be important, based on their finding of a higher than conventional proportion of female growers among organic horticulturists (Burton et al. 1997a), but overall the empirical evidence on gender issues is scarce.

Farm size

Rogers (1983) concluded from adoption research that earlier adopters have larger-sized operations than later adopters. In contrast, in most countries the average farm size of organic farms was smaller than conventional farms (e.g. United States: Harris et al. 1980; Lockeretz and Anderson 1990; Denmark: Dubgaard and Soerensen 1988; Canada: Henning et al. 1991). Dubgaard found a relatively large number of holdings under 5 ha (23.1 per cent of organic holdings compared with 7.5 per cent of total Danish agriculture) and pointed to the importance of small horticultural and subsistence holdings in the organic sector. Similarly, Murphy (1992) found 43 per cent of all organic holdings in England and Wales were under 5 ha, and 40 per cent of all farms were horticultural holdings. Burton et al. (1997) found smaller holdings among organic horticultural producers compared to conventional. It is likely that this is related to the urban backgrounds, as such people are less likely to have the same inherited land and capital resources as established farming families.

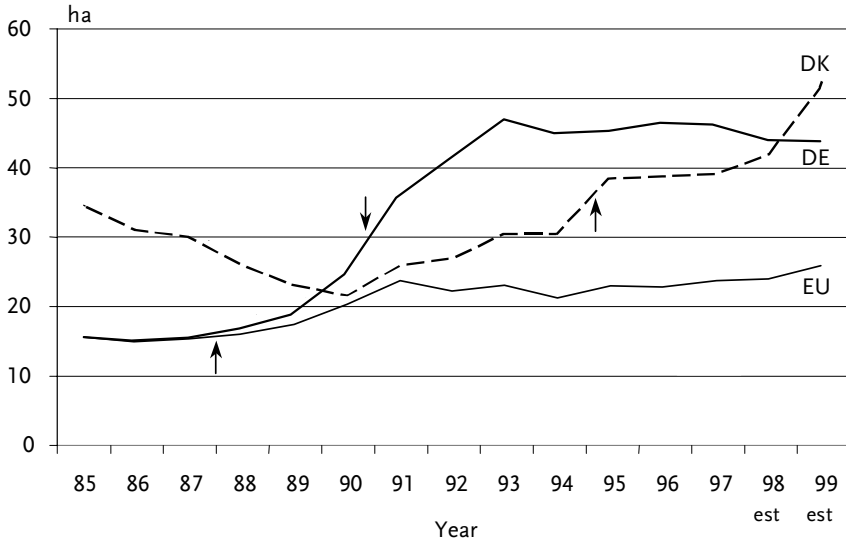


Figure 3: Average farm size of organic farms in the EU, Germany and Denmark, 1985-1999
Sources: Own calculations based on Lampkin (2000). Arrows show the point where the farm size becomes larger than the conventional average size for holdings for 1995

However, several older German studies and one study from the USA found organic farms to be larger than conventional holdings (Boeckenhoff et al. 1986; Dabbert 1990b; Wernick and Lockeretz 1977). In a recent review of comparative data on organic farming across the EU, Offermann and Nieberg (2000) found the average size of organic farms to be larger than comparable conventional ones. The development of the average size of organic producers in the EU, and Germany and Denmark as two contrasting examples, is shown in Figure 3. The figure shows a trend towards bigger holdings across the whole EU and in Germany. Average organic holding size decreased in Denmark between 1985 and 1990, but has increased ever since. Across the EU the average size of organic holdings has been larger than for conventional farms (based on average holding size calculated on the basis of the 1993 census) since the late 1980s, in Germany this point was reached in the early 1990s and in Denmark in middle of the 1990s. Overall this leads to the general hypothesis that the average organic farm size increases during the process of diffusion, but it is possible that this is related to changes in the structure of the agricultural industry in general and that a point of stabilization of farm size may occur. Further research across a wider range of countries would be needed to confirm this.

Motivation to convert to organic farming

Adoption research led to the general conclusion that earlier adopters were orientated more towards commercial than subsistence farming (Rogers 1983). Pampel and van Es (1997) and Taylor (1978) found early adopters of soil conservation not so profit oriented, which led some researchers to seek new ways of understanding the uptake of soil conservation outside the adoption framework (Buttel et al. 1990),

whilst others suggested modifications and refinements (e.g. Taylor and Miller 1987; Nowak 1982, see also the discussion of the limitations of the adoption model below).

Although there is little direct research about the goals of organic farmers in general, their motives for conversion have been studied frequently and appear to have changed over time. However, direct comparison of the studies is difficult as the categories of answers vary from study to study. Commonly reference to farm related and personal goals is made (see Table 1).

Table 1: *Motivations to convert to organic production*

Farming related motives	Personal motives
Husbandry and technical reasons animal health problem soil fertility and erosion problems	Personal health own and family health problems ergonomic reasons
Financial motives solve existing financial problems secure future of the farm cost saving premium marketing	General concerns stewardship food quality conservation environmental rural development

The farming-related motivations can be split into husbandry and financial reasons. In earlier studies the husbandry related concerns appear more frequent, whereas in later studies financial reasons are more dominant. Several earlier studies found between 30 and 75 per cent of their sample mentioning problems with conventional farming, e.g. soil erosion or deteriorating animal health as an important reason for the conversion (Fischer 1982; Vine and Bateman 1981; Vogtmann et al. 1993; Wernick and Lockeretz 1977; Wynen 1990). In two recent studies from Switzerland and the USA, husbandry is also mentioned, but the farmer mention the professional challenge in going organic rather than problems with conventional systems (Duram 1999; Maurer 1997).

Financial reasons include attempts to solve existing problems as well as the desire to secure the long-term existence of the farm. They cover cost saving through organic production as well as premium price marketing (Brighton et al. 1988; Conacher and Conacher 1982; Fisher 1989; Lockeretz and Madden 1987; MacRae et al. 1990; Svensson 1991; Vogtmann et al. 1993; Wynen 1990). Although the aim to secure the future of the farm has been frequently mentioned in earlier studies, financial motives such as the incentive to sell for a premium and the view to see organic farming as a means to cut costs are more dominant in later studies. This may be related to the generally more difficult financial situation of farming. Padel (2000) argued that at least among British organic dairy producers a qualitative shift towards more financial motivations took place long before the introduction of conversion aid payments in 1994, possibly in 1992/1993 when organic premiums on milk became more widely available in the UK. However, a fairly recent survey of 237 organic and conventional horticulture producers in the UK (Burton et al. 1997b) found non-economic aspects widely present in the decision to go organic, which may reflect the importance of lifestyle related goals for organic growers from urban backgrounds (see above).

Personal reasons can be divided into personal health experiences and more general concerns. Personal health reasons and ergonomic concerns (relating to the health risk from applying chemicals) are widely mentioned throughout (Dettmer 1986; Fischer 1982; Rantzau et al. 1990; Svensson 1991; Vine and Bateman 1981; Vogtmann et al. 1993). With general concerns there appears to have been a shift from religious and philosophical concerns in the earlier studies to the greater prevalence of environmental and political ones in later studies (Ashmole 1993; Brighton et al. 1988; Buchdahl 1982; Burton et al. 1997, Conacher and Conacher 1982; Dettmer 1986; Fischer 1982; Halpin et al. 1984; Rantzau et al. 1990; Svensson 1991; Vine and Bateman 1981; Vogtmann et al. 1993; Wernick and Lockeretz 1977).

In a relatively new study from Switzerland, farmers with low and moderate input use were more likely to consider conversion, and new converters aimed to stay actively involved in general agricultural networks (Maurer 1997). This was also expressed in a new study of American organic producers who resented the attitude of what the organic farmers called 'radical environmentalists' as hampering the establishment of good relationships with conventional producers (Duram 1999).

In all studies reviewed, the organic farmers expressed a wide variety of motives for the conversion and on the basis of this it can be hypothesized that the goals of organic farmers consist of a mixture of non-financial and financial ones, and for agriculture traditional as well as other objectives (Zerger 1995). It appears that earlier organic farmers were more strongly motivated by husbandry problems and religious concerns, whereas 'newer' organic farmers are concerned about the environment, have economic reasons and increasingly see organic farming as a professional challenge.

Comparing early organic farmers with typical innovators

Most of the studies of organic farmers reviewed here were undertaken when organic farming was (and in some countries still appears to be) at a very early stage of diffusion. The results show that the farmers studied clearly share some characteristics with typical innovators, such as a good education and a wide social network. In some countries a relatively high proportion of early organic farmers and growers from urban backgrounds was found and women seem to play a more active role although empirical evidence is very limited. Average farm size was found to be smaller in most countries than for conventional farms, which may reflect the high proportion of lifestyle and self-sufficiency oriented farmers in the organic group. Across Europe a trend towards increases in average organic holding size can be observed. Aspects of lifestyle are also reflected in the more personal motivations to convert to organic farming. Organic farmers generally do not have purely financial motives for their conversion, although these are more frequently mentioned in later studies. In this respect they differ from farmers adopting other commercial innovations early, but show similarities with innovators and early adopters of other environmental innovations (e.g. Taylor and Miller 1978; Vanclay and Lawrence 1994).

Much of the research of organic farmers reviewed here was carried out to show similarities between organic and other farmers, so it could be proven that organic

farming had a wider relevance than just for a small group. However, it was frequently found that the organic farmers studied were different from the average farmer. They were better educated, had less farming experience, had in some studies smaller farms and placed less emphasis on profit maximization. The discussion of conversion studies in the adoption/diffusion framework throws an interesting new light on these results, as the difference can be interpreted as that between earlier and later adopters.

The results of other surveys of organic farmers converting since the late 1980s, such as the better social integration of more recent adopters, an increasing average farm size and the increased importance of financial motivations, suggest that in some countries the stage of early adoption may have been reached. On the basis of the model it could be expected that the farmers adopting in this stage, the early adopters, would show again different personal characteristics. Fisher (1989) tried to establish a difference between earlier and later adopters of organic farming in New Zealand, but did not succeed. Given the small numbers of organic farms in New Zealand at the time of his study (a total of 200 certified farms (Crowder 1991)) the lack of success is not surprising.

A Norwegian sociological study found three different categories of organic farmers in Norway, labeled as: *Anthroposophists*, *Ecosophists*, and *Reformists*. The Anthroposophists were influenced by biodynamic agriculture and Rudolf Steiner and showed some similarities to the innovators of the adoption model, such as a very strong commitment to their ideas. Farmers in the second cluster of Ecosophists were motivated by green ideas. They were part of the environmental and back to the land movement and Vartdal (1993) argued that they showed some similarities to early adopters. In both categories a non-farming background was widespread. The Reformists were described as 'normal' farmers with a pragmatic approach to organic agriculture and were described as corresponding to the early majority in the adoption model (Vartdal 1993). This confirms the applicability of the model, although some of Vartdal's results seem to suggest that Reformists might represent the early adopters category of agricultural opinion leaders, whereas the two other groups would fall into the category of innovators.

This difference between the 'early idealists' and the later 'profit oriented pragmatists' is heatedly debated in the organic movement in various countries. This conflict is also reflected in some studies of the organic farming movement. Vartdal (1993), for example, took the perspective of an interested conventional farmer, seeing the early organic farmers and their organizations as gatekeepers, who protected 'their' innovation and therefore made it more difficult for conventional farmers to adopt. Gerber et al. (1996), on the other hand, positioned themselves as part of the 'old' organic movement in Germany and discussed any pressure to reduce the requirements in the standards as coming from the outside and claimed that the true organic movement had to protect its identity. Allowing a greater number of farmers to participate was seen as a threat to the principles. Tovey (1997) discussed a similar process in the Irish organic movement, which according to her consisted of many members that were not food producers. Again she emphasized the danger that with an increasing number of farmers and the need for larger organizations, such as the establishment of certification procedures, the organic movement may be in danger of losing its identity.

Organic farming compared with other innovations

Organic farming differs in several respects from other innovations that have been the focus of adoption research. According to the adoption model an innovation has to fulfill certain criteria to be easily adopted, such as having obvious and economic advantages. Furthermore, an innovation should be simple and understandable, divisible as a practice, associated with low risk and compatible with the current values and norms (Albrecht 1974; Buttel et al. 1990).

Potential barriers to the adoption of organic farming were studied by Blobaum (1983) in the Midwestern United States when only very few conventional farmers had adopted organic methods, whereas there was a substantial proportion of organic producers who considered themselves always to have been organic. Blobaum presented the results of his survey using the terms of the adoption/diffusion model, and identified problems with access to information, access to markets, farm structure problems and the availability of necessary organic inputs, problems with landlords and banks, and technical problems. In a broader context of environmental innovations, Vanclay and Lawrence (1994) argued that for farmers the non-adoption of such practices may be a very rational choice, because of the characteristics of the innovations, such as the complexity and need for a whole system change, economic disadvantages (although that might not apply to all environmental changes), higher risk, conflicting information, indivisibility and reduced flexibility in management decisions, and incompatibility with other aspects of the farming system.

The following section aims to explore whether organic farming as an innovation shows similar characteristics to other environmental innovations that may represent potential barriers to the conversion.

Complexity and divisibility

Organic farming is a complex system and the conversion to organic management affects the whole farming system, not only single enterprises. For example, the design of the crop rotation has an influence on forage production, fertility building and weed and pest control. The application of the adoption model to such a system change is unusual, since most adoption research has been carried out on the adoption of single techniques, like the use of hybrid seed corn in Iowa (Ryan and Gross 1943). On the other hand, however, the decision to adopt reduced-input systems does not seem to be more complicated than the decision to introduce irrigation on the farm (Lockeretz 1991).

In adoption research it was further discovered that farmers often experiment on one field before they introduce a new technology on the whole farm (Ryan and Gross 1943) and it was therefore concluded that innovations are more easily adopted if the practice is highly divisible, i.e. can be tried on a small scale (Buttel et al. 1990). This also seems to be true for organic farming, which is tried at first either in the vegetable garden (Fischer 1982; Fisher 1989), or by converting a small section of the holding, so the farmer gain some experience with the new techniques (Lampkin 1993). Conventional farmers have indicated their willingness to try organic farming on parts of their farm (Clarke 1991; NatWest 1992).

Trying organic farming on parts of the farm can lead to difficulties because of the complexity of the system. Just one field of the farm will not show the full potential of crop performance under organic management on that specific location, if no fertility-building phase is incorporated. Therefore (and because of difficulties in carrying out inspection of such small units) most organic standards do not allow certification of individual fields, although under the EU regulation 2092/91 the certification of designated units of a larger farm is possible (EC 1991).

However, in-depth interviews with eight British dairy farms Padel (2000) about their experiences with the conversion process showed that the majority had engaged in a range of related activities prior to or during the conversion phase, but before they had made a final decision to convert the whole farm. These included experiments on a small block of land or with an organic vegetable enterprise, or using certain management techniques of organic systems prior to the conversion, such as clover farming and homeopathy, and conversion planning. Farmers had also set particular tests that the organic system had to pass, such as produce enough silage for the winter. It appeared as if, despite all the information and support they had received, the farmers needed to develop experiences with the system on their own farm in order to gain the necessary confidence, before they could make a final commitment. In several cases a staged conversion strategy where fields are converted over several years had also been chosen for this reason, but allowed in addition the risk of conversion to be spread over several years.

Economic advantages and disadvantages

An innovation needs to have distinct advantages in order to be adopted. Advantages could be financial in nature, but could also be in the area of soil fertility, animal health or human health, or general benefits to the environment. However, unlike some other environmental innovations, organic farming does show some potential for improved financial performance of the farming system, although the conversion period as such might be costly and most studies of organic farmers appear to show a range rather than a single motive for the conversion.

As far as the financial situation is concerned it is clear that the conversion period to organic farming itself is, in many cases, costly (Padel and Lampkin 1994a) and does not always lead to improved profits afterwards. In this sense, organic farming differs from technological innovations that are commercially beneficial, but shows similarities to other environmental innovations. The implications of this difference in terms of the objectives and goals of early adopters have already been mentioned. However, cases where organic farmers achieve a better financial return after the conversion period have also been identified (Padel and Lampkin 1994b). These are likely to become more widespread with a better development of premium markets for organic products (Michelsen et al. 1999) and more widespread support through governments in terms of conversion aid and organic farming subsidy programmes (see Lampkin et al. 1999, for details).

For some farmers the conversion clearly has commercial benefits. On the basis of an extensive review of comparative economic studies of organic farming in Europe Offermann and Nieberg (2000) concluded that, on average, the decision to convert to organic farming had proven to be financially successful. However,

they advised caution against generalizations, because several studies had identified lower profits and the differences between farms within a sample and between samples were considerable. Clear differences were also observed between farm types, with higher relative profits for arable and dairy farms, and lower relative profits on horticultural and beef and sheep producing farms (Fowler et al. 2000; Offermann and Nieberg 2000). It is possible that the higher uptake of organic farming in some countries and by some farm types might be related to a comparably better financial performance of such systems. However, the low uptake among arable producers in several countries despite a relatively better financial performance at least in model calculations seems to contradict this (Padel et al. 2000). This may indicate that, in this context, the *perception* of relative profitability is more important than the actual values.

Less clear appears to be the relationship between payment rates and uptake of conversion aid schemes. Padel et al. (1999) could not establish a clear relationship between the level of payment rates under the organic farming options of the agri-environment programmes and the uptake of organic farming across Europe, although that to some extent uptake of the schemes was higher in the countries with better rates and more favourable conditions of the scheme.

Low risk is regarded as one factor that characterizes innovations that are easily adopted. The perceived risk of conversion to organic farming is mentioned as a major obstacle in survey of conventional farmers (e.g. Chadwick and McGregor 1991). On the basis of the available literature it is difficult to assess whether or not this risk is perceived or real. Two contradictory opinions about risk associated with conversion to organic farming could be identified: Firstly, diversification going hand in hand with conversion to organic farming is a strategy to reduce risk (MacRae et al. 1989). Secondly, risk has been associated with conversion due to yield reductions and mistakes leading to complete crop failure (Lampkin 1993). Furthermore, conversion is likely to be risky for particular farm types, for example intensive pig or poultry production or intensive fruit production, but in this context the perception of risk is almost more important than the real risk.

The available evidence suggests that the economic advantages of conversion may historically have not been very clear, but may have increased over time, particularly for some farm types where markets are well established and in countries where conversion aid payments and ongoing support of organic farming are available. However, for some farm types and in some countries conversion to organic farming may be associated with an economic penalty due to the costs of conversion and a potential loss of revenue thereafter. It is likely that the perception of lower profit and a high risk may be an important barrier to the conversion.

Organic farming – an information based innovation

Rogers (1983) differentiated between the 'hardware' and 'software' aspects of an innovation. In 'hardware' he included the necessary technology, whereas 'software' referred to the information on how to use the technology, and evaluative information about its performance. The model considered the availability of information about the innovation as an important pre-condition for its wider diffusion and adoption researchers studied the information sources that farmers use in greater detail (Buttel et al. 1990; Lionberger 1960).

Using this classification organic farming would be a mainly 'software' based innovation. Farming organically requires new management skills, like planning of a diverse rotation and techniques to manage biological resources to achieve regulation of pests and diseases as well as the use of mechanical or biological control methods for weeds, pests and diseases. The requirements for new inputs and new machinery are limited, although there may be some need for investment during the process of conversion, such as new weeding equipment or manure spreaders (Padel and Lampkin 1994a). Generally, low-input systems have been described as information intensive, but the information requirements of low-input farmers have not been studied in detail (Lockeretz 1991).

In this sense organic farming differs from other, technology based innovations for which the adoption model was developed. However, if availability of information is regarded as important in the diffusion of technological innovations, it is likely to be even more important for a knowledge-based or 'software' innovation. This hypothesis is supported by the results of a survey of conventional farmers in the UK. They would like to see more independent information on the subject, especially in the area of financial performance (Chadwick and McGregor 1991). This gives a clear indication that evaluative information about the performance of organic farming, especially about the financial implications, is needed in addition to technical knowledge.

Evaluations of the information sources of organic farmers show the importance of other organic farmers (Burton et al. 1997b; Luley 1996; Padel 2000; Wynen 1990). This may in part be due to the characteristics of typical *innovators*, who stay in touch with each other, despite a considerable distance (Rogers 1983), but may also indicate a self-help approach in the absence of other support (Luley 1996). However, prior to or in the early stages of the conversion process the converting farmers appear hesitant to visit or contact other organic producers, unless contact had been arranged, for example, through a farm walk. Although open to each other, the community of organic producers appears as a relatively closed network, which newcomers might find difficult to enter (Padel 2000).

The studies also seem to indicate that the farmers prefer information sources that specifically addressed the issues from an 'organic' perspective (organic farmers, specialist magazines and publications, organic advisors) to well-established sources that are typical for the agricultural industry in general (farming press and consultants) (Burton et al. 1997b; Fersterer and Gruber 1998; Luley 1996; Padel 2000; Wynen 1990).

Support in the agricultural sector and rural values

Promotion of innovations through agricultural extension was a typical feature of the 'green revolution,' and of the innovations that were studied in adoption research, but it is not clear whether this is an essential condition for its application. It has been further suggested that innovations are adopted more easily if they correspond with the rural value system (Albrecht 1974).

Agriculture in the developed world has undergone two major changes in the last century. The first was the introduction of scientifically based production methods and the use of external inputs in order to maximize productivity after the Second World War, the so-called 'green revolution.' Governments set up extension agencies

with the clear goal to increase agricultural productivity by promoting the adoption of the new techniques amongst farmers (Röling et al. 1981), and the framework of the adoption/diffusion model was considered the most important theoretical background for agricultural extension (Vanclay and Lawrence 1994). This led to a reduction of the subsistence element in farming, and optimization, as it was realized that increases in productivity alone did not automatically lead to financial income for the farmers (Michelsen 1997). Farming became a business and improving the financial management in order to increase the profitability of farming was a challenge not only to farmers, but also to the agricultural extension services which in turn lead to commercialization of the extension services in many countries (e.g. Harter 1992). The most recent challenge of agriculture is to increase sustainability and to adapt production so that environmental impact can be reduced, wildlife protection and nature conservation on farmland can be improved and an increasing consumer demand for 'greener' products can be met (Bawden 1991; Pretty 1995; Webster 1999). Sustainable agriculture is on everybody's agenda and a major priority of policy makers in developed countries (OECD 1991) and organic farming has received more public recognition in this context.

Organic farming differs from many other innovations in the sense that, at least in the past it did not have the unilateral support of governments and agricultural extension agencies. Especially in the early stages farmers went organic despite considerable opposition in the agricultural sector and without any professional backup or infrastructure. The first organic farmers converted their farms on the basis of ideas, such as Rudolf Steiner's (1924) agricultural course, Dr. Hans Müller's organic-biological farming school and Sir Albert Howard's (1943) agricultural testament or Eve Balfour's (1943) living soil. Few practical management techniques had been developed. The farmers struggled to find solutions for the practical problems they were faced with, mostly with no support other than from organic farmers. Consequently, lack of information frequently featured as a barrier to conversion, and increased the risk associated with conversion (Clarke 1991; Fisher 1989; Henning et al. 1991; Lockeretz and Madden 1987; Wynen 1990). A range of other institutional barriers within the agricultural sector have also been identified in previous studies, such as land-lord objections, refusal of loans and insurance, problems with grant applications and certification constraints (Blobsaum 1983; Henning et al. 1991; MacRae 1990).

Several earlier studies also reported the social isolation in their villages of people who converted (e.g. Fischer 1982). In the past, the main promotion of organic farming was based on pointing out problems in conventional agriculture, at least among consumers. Because of the criticisms of conventional farming, organic farming and organic farmers were, and to some extent still are, seen as an attack on the rural identity: conventional farmers felt the need to defend themselves and this prevented any positive approach to organic farming (Kölsch 1988).

However, it is likely that alongside the changes in the socio-economic environment of agriculture (surplus production, poor economic returns and environmental pollution in agriculture and a generally poorer image of chemicals) the rural value system is also undergoing a process of change. Recent studies, for example, from Switzerland and the United States seem to confirm that the image of organic farmers has improved over time and social isolation as a result of the conversion is

a less widespread experience (Duram 1999; Maurer 1997). Nevertheless, it is likely that the opposition in the agricultural sector may have had implications for the diffusion process of organic farming.

Comparing organic farming with other innovations

If organic farming is compared with other innovations that were the focus of adoption research a range of differences has to be noted. Organic farming is a complex innovation that requires a strategic or system change on the part of the farmer. It is difficult for farmers to experiment with the organic management system on small parts of the farm, although such experiments seem to be very important in the farmers' decision-making process.

For some farm types the conversion to organic farming may imply economic penalties, while for other farmers the transition has, through a combination of cost saving, premium price marketing and subsidies, led to better profitability. However, financial disadvantages and a perception of risk involved with the conversion clearly exist, although because of the importance of the markets, organic farming differs from other environmental innovations, which may have no economic benefits to the farmers at all.

Organic farming is a mainly information-based or 'software' innovation. The availability of information is likely to be crucial to its diffusion process and difficulties with access to information have been frequently noted as a barrier. Organic farmers seem to prefer specialist organic information sources such as other organic farmers, but this may make it difficult for newcomers to enter into such a closed network. However, the information requirements of organic farmers and particularly those considering a conversion have not been studied in great detail.

Furthermore, some references seem to suggest that organic farming has been interpreted as a threat to the rural value system and some studies have reported the social isolation of the first organic farmers, although recently a better image of organic farmers in rural communities has been observed. Unlike other innovations in adoption research, organic farming has developed through a self-help approach, in opposition to the mainstream agricultural sector, with only the support of a few pioneers.

Overall it can be concluded that organic farming is in many ways not a typical innovation. However, nothing in the adoption model itself seems to imply that it cannot be applied to such a complex, bottom-up innovation, but it is likely that this implies a very slow diffusion rate, which has indeed historically been observed in most countries, rather than a complete rejection of the model.

The limitations of the adoption/diffusion model

The adoption/diffusion model should not be applied to the process of conversion to organic farming without considering some of the main points of criticism of the model. Several people have discussed the limited applicability to environmental innovations. For example Pampel (1977) rejected the adoption model for such innovations, whereas Taylor and Miller (1978) proposed changes to better predict the adoption of soil conservation techniques, such as the greater importance of lifestyle and subsistence goals amongst early adopters.

Other critics suggested that, instead of just focusing on the personal characteristics of the farmers, more attention should be paid to the economic, structural and institutional environment of farming in general (Heffernan 1982; Nowak 1982) as this is likely to influence individual adoption decisions. This point is clearly relevant to any application of the diffusion theory and equally to the diffusion of organic farming. Changes in markets or agricultural policy, such as availability of organic premiums or the introduction of a conversion aid programme, have an impact on the development of the sector. Similarly, changes that affect the conventional sector, such as price reductions, food scares or other crisis, are likely to have an impact on the adoption of organic farming (Michelsen et al. 2000). The model therefore does not appear suitable for predicting the likely adoption rate of organic farming in different countries.

A common explanation for the poor transfer of some technologies among extension agents on the basis of the model was the 'lagging farmer' and his 'barriers' to adoption, or the lack of information about the innovations, rather than the technology itself. Focusing only on the farmers and their barriers implied a pro-innovation bias of the extension agency (Heffernan 1982). Altieri (1987) observed that, where green revolution technology had not been adopted, native agricultural approaches often showed a deep understanding of the regional ecology. He concluded that the adoption rate of a technology could be seen as the true test of its quality.

A third and widely expressed area of criticism related not to the actual adoption/diffusion model itself, but to the technology transfer approach that resulted from the application of adoption theory in the area of agricultural extension. Diffusion was seen as a 'God-sent' autonomous process, which assured the trickle down of income and welfare generating ideas, and thereby guaranteed the distribution among all members of the population (Röling et al. 1981). It was recommended that extension agents should aim to work for a self-continuing diffusion process, which might be expected to happen when 10 to 20 per cent of farmers have adopted the innovation (Albrecht 1974). This, it was argued, could be achieved by supporting the innovators and the early adopters and establishing examples of successful adoption of the innovation until a certain threshold had been reached. As a consequence, extension activities focused only on so called innovative farmers, who commonly had good access to information anyway, and the needs of other farmers were ignored (Russel et al. 1989). This approach to agricultural extension became known as the Technology Transfer Approach.

Related to this is the criticism that science was seen as the only source of all innovations, which is frequently also addressed at the adoption model (Russel et al. 1989), but would also be better aimed at the Technology-Transfer approach. In this sense organic farming clearly differs from other innovations, as the system was developed by farmers mainly supporting each other, and by other pioneers, and was opposed or ignored by the majority of agricultural scientists. An alternative, a close, two-way communication link between farming, research and extension, similar to the Farming Systems Research approach, has been suggested by many authors and would appear more suitable in supporting the development of organic advisory services than the Technology Transfer approach (e.g. Chambers et al. 1989; Lanyon 1994; Röling and Jiggins 1998; Russel et al. 1989; Scarborough et al. 1997). However, nothing in the adoption/diffusion model itself seems to suggest that it cannot be applied to 'bottom-up' innovations and the naming of the category 'Innovator'

in the original adoption literature indicates that the importance of farmers in the development of innovations was recognized.

Concluding remarks

It was the intention of this paper to consider whether the 'adoption/diffusion model' can be applied to the diffusion of organic farming by comparing studies of organic farmers from different countries and published over a period of time with the framework of the model. Most of the studies reviewed, particularly the earlier one, were carried out at a time when the organic sector was small and the diffusion of organic farming was at the so-called innovation stage. The first organic farmers showed similar characteristics to innovators of other environmental innovations and faced problems that were typically associated with this stage, such as opposition in the farming community and social isolation.

Several similarities between the studied organic farmers and early adopters of other innovations were identified and the overall conclusion appears therefore justified that the model can be used to gain some further understanding of the diffusion processes of organic farming and the individual adoption or conversion decision.

Most authors reported differences between organic and the 'average' farmer in farm related and personal characteristics. On the basis of this, critics of organic farming have often argued that the system is not suitable for all farmers. On the background of adoption theory this argument does not stand up very well. The common occurrence of differences between the first organic and conventional farmers should instead be interpreted as the difference between innovators and later adopters.

Some of the later studies reviewed seem to imply that more recent converters fall into the category of early adopters, suggesting that the diffusion process is moving towards the early adoption stage. According to the model, this stage implies the involvement of opinion leaders, greater acceptance in general agriculture and closer links with agricultural institutions, which indeed appears to take place in some countries (see Michelsen and Lynggard, this volume). If the model is true, and that has to remain in place as a caution, it is likely that future organic producers will be different again from those are adopting currently. However, very few studies have attempted to carry out a rigorous comparison of earlier and later adopters in terms of farm and personal characteristics and any conclusions should therefore be treated with care.

Although organic farming is in many ways not a typical innovation, this implies rather a slow diffusion rate than an outright rejection of the model. According to the model, easily adoptable innovations have obvious advantages, involve little or no risk and allow for experiments on parts of the farm. Conversion to organic farming, on the other hand, is a complex system change. Its principles challenge aspects of common agricultural practices and its values, and it may imply lower profitability and a high risk. In addition, structural and economic trends in the agricultural industry in general have a clear influence on the diffusion process. The conversion decision of the individual farmer cannot be explained on the basis of traditional personal characteristics of the adopters alone; other factors need to be considered, such as policy support and the development of the markets as well as the attitude towards organic farming in the agricultural community and the institutional development. And, because of the bottom-up character of organic farming, the technol-

ogy transfer extension approach that is frequently associated with adoption research has to be rejected. Instead a broad vision of a knowledge network with the involvement of producers, advisors and researchers should be aimed for.

However, this does not imply that the adoption model itself cannot be used to provide some recommendations for the future development of support services of organic farming. On the basis of the review the following are presented as a basis for further debate.

Promotion should be based on the advantages of the organic system and on new management approaches rather than criticism of conventional agriculture, which would help to minimize the negative reactions amongst conventional farmers.

The sector bodies involved in standard setting and certification should allow on-farm experimentation with organic farming for converting producers (for example by allowing partial certification of specified units within a whole farm) as this is an important step in the farmers' decision-making process. It should be explored further whether conversion planning could support or even replace this process. More widespread conversion planning could also help to reduce the risk that is associated with a conversion.

According to the model, farmers in the same category of adopters share similar values and characteristics and are therefore likely to be interested in the adoption of a particular innovation at the same time. For innovations that improve profits, Early adopters are likely to value profit making highly, whereas for environmental innovations they might share other values. The organic farming system may best be placed in the middle ground, as it includes broader environmental as well as financial goals and indeed farmers appear to be converting to organic production for a range of motives, reflecting its broad range of aims.

Advisors and others involved in organic farming organizations and sector bodies need to recognize that a shift in motives, farm and social characteristics among those converting to organic farming is a typical feature of any diffusion process, and not an inherent shortcoming of those currently converting. As the diffusion process of this in some ways untypical innovation has shown the innovators teach themselves and learn with the support of other innovators or through direct access to primary information sources. Those that convert at a later stage are more likely to make more use of advice. For them the further adoption/diffusion process of organic farming as a knowledge-based innovation may depend critically on the wide availability of credible information, about the principles as well as the likely financial implications, although more research is needed to better understand their information requirements. It is the challenge for advisors and the organic farming sector to develop strategies how they can be met so that those farmers converting at a later time in the diffusion process can receive information and advice that is targeted to their particular needs.

References

- Albrecht, H. (1974) Die Verbreitung von Neuerungen – der Diffusionsprozess. *Der Förderungsdienst* 22 (2) pp. 33–40
- Albrecht, H. (1980) Diffusion processes and social structure: Review of research within rural sociology. Pp. 39–51 in H.J. Hummel and W. Sodeur eds, *Modelle für Ausbreitungsprozesse in sozialen Strukturen* (Bad Homberg: Verlag der Sozialwissenschaftlichen Kooperative)

- Altieri, M.A. ed (1987) *Agroecology: the scientific basis of alternative agriculture* (London: Intermediate Technology Publications)
- Ashmole, A. (1993) *The organic values of agriculture*. PhD-thesis (Edinburgh: University of Edinburgh)
- Balfour, E.B. (1943) *The living soil* (London: Faber & Faber)
- Bawden, R.J. (1991) System thinking and practice in agriculture. *Journal of Dairy Science*, 74, pp. 2362–2373
- Blobaum, R. (1983) Barriers to conversion to organic farming practices in the midwestern united states. Pp. 263–278 in W. Lockeretz ed., *Environmentally sound agriculture* (New York: Praeger)
- Boeckenhoff, E. et al. (1986) Analyse der Betriebs und Produktionsstrukturen sowie der Naturalerträge im alternativen Landbau. *Berichte über Landwirtschaft* 64 (1) pp. 1–39
- Brighton, R.B. et al. (1988) *The production, distribution and marketing of organic produce*. A local collaborative project in the West Midlands (Hindlip: Worcestershire College of Agriculture)
- Buchdahl, D. (1982) *Organic farming in Vermont*. Rural Monograph vi1 (Burlington, Vermont: Centre for Rural Studies, University of Vermont)
- Burton, M. et al. (1997a) Sustainable agriculture technologies: A quantitative analysis of adoption. Paper presented at the Agricultural Economics Society Annual Conference (Edinburgh)
- Burton, M. et al. (1997b) Why do UK organic horticultural producers adopt organic techniques? *NENOF* (6) pp. 7–10
- Buttel, F.H. et al. (1990) *The sociology of agriculture* (Connecticut: Greenwood Press)
- Chadwick, L. and M. McGregor (1991) Non-organic farmers' perceptions of and attitudes towards organic farming. Pp. 104–112 in Anon, *Organic farming centre annual report 1990* (Edinburgh: Organic Farming Centre, School of Agriculture)
- Chambers, R. et al. eds (1989) *Farmer first: farmer innovation and agricultural research* (London: Intermediate Technology Publications)
- Clarke, R. (1991) *Farmers' attitudes to organic farming practices in Victoria*. Research report series (Victoria: Department of Agriculture)
- Conacher, A. and J. Conacher (1982) *Organic farming in Australia*. Occasional Paper of the Dept of Geography Geowest No 18 (University of Western Australia)
- Crowder, R.A. (1991) New Zealand – The clean green image. *Ecology and Farming* 1991 (2) pp. 29–30
- Dabbert, S. (1990a) Der Begriff des Betriebsorganismus. *Lebendige Erde* 90 (5) pp. 333–337
- Dabbert, S. (1990b) *Zur optimalen Organisation alternativer landwirtschaftlicher Betriebe – Untersucht am Beispiel organisch-biologischer Haupteinwerbsbetriebe in Baden-Württemberg*. PhD-thesis (Hohenheim: University of Hohenheim)
- Dettmer, J. (1986) *Motive und sozial-ökonomische Probleme der Umstellung auf ökologischen Landbau aus der Sicht von ökologisch wirtschaftenden Bauern*. Studien zur ländlichen Humanökologie (Göttingen: Institut für rurale Entwicklung, Georg-August Universität)
- Dubgaard, A. and S.N. Soerensen (1988) *Oekologisk og biodynamisk jordbrug – en statistisk undersøgelse*. Rapport, 43 (Copenhagen: Statens Jordbrugsoekonomiske Institut)
- Duram, L.A. (1999) Factors in organic farmers' decision making: Diversity, challenge, obstacles. *American Journal of Alternative Agriculture* 14 (1) pp. 2–9
- Ec (1991) Council Regulation (EEC) No 2092/91 of 24 June 1991 on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs. *Official Journal of the European Communities* L198 (22.7.91) pp. 1–15
- Fersterer, S. and A. Gruber (1998) *Beratungsstrukturen für die biologische Landwirtschaft in Österreich im Vergleich mit ausgewählten Europäischen Ländern* (Wien: Mecca-Environmental consulting)
- Fischer, R. (1982) *Der andere Landbau: Hundert Bio-Bauern und Gärtner berichten über ihre Beweggründe, Arbeitsweisen und Erfahrungen* (Zürich: Verlag Buchhandlung Madliger-Schwab)

- Fisher, P. (1989) *Barriers to the adoption of organic farming in Canterbury*. MSc Thesis (Lincoln, New Zealand: Centre for Resource Management, Lincoln University)
- Fowler, S. et al. (2000) *Organic farm incomes in England and Wales, 1995/96–1997/98*. Unpublished (Aberystwyth: Institute of Rural Studies, University of Wales Aberystwyth)
- Gerber, A. et al. (1996) Das Wissenssystem im ökologischen Landbau. *Berichte über Landwirtschaft* 74, pp. 591–627
- Halpin, S. et al. (1984) Results of the conversion questionnaire, The New Farm, March/April 1984. Unpublished mimeograph (Kutztown, PA: Rodale Research Centre)
- Harris, C.K. et al. (1980) Myth and reality in organic farming: a profile of conventional and organic farmers in Michigan. *Newsline* 8 (July) pp. 33–44
- Harter, D. (1992) Commercialisation of the British extension service: an American view. *Farm Management* 8 (4) pp. 179–185
- Heffernan, D.W. (1982) Assumptions of the adoption/diffusion model and soil conservation. Paper presented at the 'RCA Symposium: Future Agricultural Technology and Resource Conservation.' (Washington D.C.)
- Henning, J. et al. (1991) *Organic farmers in Quebec: Results of a survey*. Department of Agricultural Economics (Quebec: McGill University)
- Howard, A. (1943) *An agricultural testament* (London: Oxford University Press)
- IFOAM (1998) *Basic standards for organic production and processing* (Tholey-Theley: International Federation of Organic Agriculture Movements)
- Kölsch, O. (1988) Soziale Probleme bei der Umstellung auf ökologischen Landbau. Pp. 149–156 in H. Gödde and D. Voegelin eds., *Für eine bäuerliche Landwirtschaft*. Schriftenreihe Bd 14 (Kassel: Fachbereich Stadtplanung, Landschaftsplanung der GhK)
- Kramer, D. (1984) *Problems facing Canadian farmers using organic agricultural methods* (Willowdale, Ontario: Canadian Organic Growers)
- Lampkin, N. (2000) *Eurodata for organic farming* (Aberystwyth: Institute of Rural Studies, University of Wales)
- Lampkin, N. et al. (1999) *The policy and regulatory environment for organic farming in Europe*. Organic farming in Europe: economics and policy, 1 & 2 (Hohenheim: University of Hohenheim)
- Lampkin, N.H. (1993) *The economic implications of conversion from conventional to organic farming systems*. PhD Thesis (Aberystwyth: Department of Economics and Agricultural Economics, University of Wales)
- Lampkin, N.H. (1994) Organic farming: sustainable agriculture in practice. Pp. 454 in N.H. Lampkin and S. Padel eds, *The economics of organic farming: an international perspective* (Wallingford: cab International)
- Lampkin, N.H. (1999) Organic farming in the European Union: Overview, policies and perspectives. Pp. 23–30 in *Organic farming in the European Union – Perspectives for the 21st Century, Proceedings of a joint EU and Austrian conference, 27–28 May* (Baden/Vienna: Avalon Foundation and EuroTech Management)
- Lanyon, L.E. (1994) Participatory assistance: An alternative to transfer of technology for promoting change on farms. *American Journal for Alternative Agriculture* 9 (3) pp. 136–141
- Lionberger, H.F. (1960) *Adoption of new ideas and practices* (Ames, Iowa: Iowa State University Press)
- Lockeretz, W. (1991) Information requirements of reduced chemical production methods. *American Journal of Alternative Agriculture* 6 (2) pp. 97–103
- Lockeretz, W. (1997) Diversity of personal and farm characteristics among organic growers in the Northeastern United States. *Biological Agriculture and Horticulture* 14 (1) pp. 13–24
- Lockeretz, W. and M.D. Anderson (1990) Farmer's role in sustainable agriculture research. *American Journal of Alternative Agriculture* 5 (4) pp. 178–180
- Lockeretz, W. and P. Madden (1987) Midwestern organic farming: a ten-year follow-up. *American Journal of Alternative Agriculture* 2 (2) pp. 57–63

- Luley, H. (1996) *Information, Beratung und fachliche Weiterbildung in Zusammenschlüssen ökologisch wirtschaftender Erzeuger* (Weikersheim: Markgraf Verlag)
- MacRae, R. et al. (1989) Agricultural science and sustainable agriculture: a review of the existing scientific barriers to sustainable food production and potential solutions. *Biological Agriculture and Horticulture* 6 (3) pp. 173–219
- MacRae, R.J. (1990) *Strategies to overcome institutional barriers to the transition from conventional to sustainable agriculture in Canada: the role of government, research institutions and agribusiness* (PhD Thesis, McGill University, Montréal)
- MacRae, R.J. et al. (1990) Farm-scale agronomic and economic conversion from conventional to sustainable agriculture. *Advances in Agronomy* 43, pp. 155–198
- Maurer, J. (1997) Umstellung auf Biolandbau in der Schweiz – Motivation und Hemmnisse. Pp. 523–529 in U. Köpke and J.A. Eisele eds, *Beiträge zur 4. Wissenschaftstagung zum ökologischen Landbau, 3–4 March 1997* (Bonn: Verlag Dr. Köster)
- Michelsen, J. (1997) Institutional preconditions for promoting conversion to organic farming. Pp. 265–282 in J. Isart and J.J. Llerena eds, *3rd ENOF workshop, Resource use in organic farming 5–6 June* (Ancona: European Network of organic farming Research)
- Michelsen, J. et al. (1999) *The European market for organic products: growth and development. Organic farming in Europe: economics and policy 7* (Hohenheim: University of Hohenheim)
- Murphy, M. (1992) *Organic farming as a business in Great Britain* (Cambridge: Agricultural Economics Unit, University of Cambridge)
- NatWest (1992) *National farm survey* (Coventry: National Westminster Bank)
- Neuerburg, W. and S. Padel eds (1992) *Organisch-biologischer Landbau in der Praxis*. (München: BLV-Verlag)
- Nowak, P.J. (1982) Adoption and diffusion of soil and water conservation practices. Paper presented at the RCA Symposium: 'Future Agricultural Technology and Resource Conservation' (Washington D.C.)
- OECD (1991) *Agricultural and environmental policy integration: principles, progress and new directions*. Environment Committee Ad Hoc Group on Agriculture and the Environment (Paris: Organisation for Economic Co-operation and Development)
- Offermann, F. and H. Nieberg (2000) *Economic performance of organic farms in Europe*. Organic farming in Europe: Economics and policy 5 (Hohenheim: University of Hohenheim)
- Padel, S. (2000) Unpublished research in progress (Aberystwyth: University of Wales)
- Padel, S., K. Hofer and C. Foster (2000) Austria and United Kingdom. Pp. 21–42, 82–105 in Michelsen, J. et al. eds, *Institutional factors influencing variations in the rate of conversion to organic farming in Europe 1985–96: In-depth studies of selected nations/regions*. Unpublished report to the EU commission (FAIR3-ct96-1794) (Esbjerg: University of Southern Denmark)
- Padel, S. et al. (1999) Influence of policy support on the development of organic farming in the European Union. *International Planning Studies* 4 (3) pp. 303–315
- Padel, S. and N.H. Lampkin (1994a) Conversion to organic farming: An overview. Pp. 295–313 in N. Lampkin and S. Padel eds, *The economics of organic farming: An international perspective* (Wallingford: CAB International)
- Padel, S. and N.H. Lampkin (1994b) Farm-level performance of organic farming systems: An overview. Pp. 210–219 in N.H. Lampkin and S. Padel eds, *The economics of organic farming: An international perspective* (Wallingford: CAB International)
- Pampel, F. and J.C. van Es (1977) Environmental quality issues of adoption research. *Rural Sociology* 42 (1) pp. 57–71
- Pretty, J. (1995) *Regenerating agriculture* (London: Earthscan Publication Ltd)
- Rantau, R., B. Freyer and H. Vogtmann (1990) *Umstellung auf ökologischen Landbau*. Angewandte Wissenschaft, 389 (Münster-Hiltrup, FRG: Landwirtschaftsverlag)
- Richter, F. (1990) *Du merkst auf einmal, dass es nicht nur ein Traum ist*. Diplomarbeit (Witzenhausen: Gesamthochschule Kassel, Fachbereich Landwirtschaft)
- Rogers, E.M. (1983) *Diffusion of innovation* (New York: The Free Press)

- Röling, N. et al. (1981) The diffusion of innovations and the issue of equity in rural development. Pp. 225–236 in B.R. Crouch and S. Chamala eds, *Extension, education and rural development, 1. International experience in communication and innovation* (New York: John Wiley and Sons)
- Röling, N.G. and J. Jiggins (1998) The ecological knowledge system. Pp. 283–311 in N.G. Röling and M.A.E. Wagemakers eds, *Facilitating sustainable agriculture* (Cambridge: Cambridge University Press)
- Russel, D.B. et al. (1989) *A critical review of rural extension – theory and practice* (Faculty of Agriculture and Rural Development, University of Sydney, Social Ecology Centre and Australian Wool Corporation)
- Ryan, B. and N.C. Gross (1943) The diffusion of hybrid seed corn in two Iowa communities. *Rural Sociology* 8 (1)
- Scarborough, V. et al. (1997) *Farmer led extension* (London: Intermediate Technology Publications)
- Steiner, R. (1924) *Agriculture: a course of eight lectures* (London: Rudolf Steiner Press/Bio Dynamic Agricultural Association)
- Stolze, M. et al. (2000) *The environmental impact of organic farming*. Organic farming in Europe: Economics and policy 6 (Hohenheim: University of Hohenheim)
- Svensson, I. (1991) *Statligt stöd till alternativ odling 1989*. Alternativ odling 7 (Uppsala: Research Committee for Alternative Agriculture)
- Taylor, D.L. and W.L. Miller (1978) The adoption process of environmental innovations: A case study of a government project. *Rural sociology* 43 (4) pp. 634–648
- Tovey, H. (1997) Food, environmentalism and rural sociology: On the organic farming movement in Ireland. *Sociologica Ruralis* 37 (1) pp. 22–37
- Vanclay, F. and G. Lawrence (1994) Farmer rationality and the adoption of environmentally sound practices: A critique of the assumptions of traditional agricultural extension. *European Journal for Agricultural Education and Extension* 1 (1) pp. 59–90
- Vartdal, B. (1993) *Motivatsjon og meistring av omlegging til oekologisk jordbruk* (Trondheim: Sentre for bygedforskning and norsoek)
- Vartdal, B. and A.K. Loes (1994) Farmers approaches to organic farming: Motivations, barriers and different strategies. Paper presented at the NFF seminar 'Converting to organic agriculture' (St Michel, Finland)
- Vine, A. and D. Bateman (1981) *Organic farming systems in England and Wales: Practice, performance and implications* (Aberystwyth: University College of Wales, Aberystwyth)
- Vogtmann, H. et al. (1993) Conversion to low external input farming: a survey of 63 mixed farms in West Germany. Paper presented at the conference 'Agroecology and Conservation issues in temperate and tropical regions' (Padua)
- Webster, P. (1999) The challenge of sustainability at the farm level: Presidential Address. *Journal for Agricultural Economics* 50 (3) pp. 371–387
- Wernick, S. and W. Lockeretz (1977) Motivations and practices of organic farmers. *Compost Science* 77 (6) pp. 20–24
- Wynen, E. (1990) *Sustainable and conventional agriculture in south-eastern Australia: A comparison*. Economics research reports 90.1 (Victoria: School of Economics and Commerce, La Trobe University)
- Zerger, U. (1995) *Der Betriebsvergleich als Mittel zur Analyse betriebswirtschaftlicher Fragestellungen im ökologischen Landbau* (Hamburg: Verlag Dr. Kovac)