A Matter Of Scale

A study of the productivity, financial viability and multifunctional benefits of small farms (20 ha and less)

2017

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Supported by
the Centre for Agroecology, Water and Resilience (CAWR)

This report should be cited as:

Laughton, R. (2017) A Matter of Scale: A study of the productivity, financial viability and multifunctional benefits of small farms (20 ha and less). Landworkers' Alliance and Centre for Agroecology, Coventry University.

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Photo Credits: Rebecca Laughton, Lucy Otto, Mary Durling and Jyoti Fernandes

Proof Reading: Page Dykstra

Layout design: Rosie Gibbard

Funders: The A Team Foundation

Acknowledgements

The "A Matter of Scale" (AMOS) study extended far beyond the creation of this report, and included the organisation of six regional Landworkers' Alliance meetings, visits to eight farms for the creation of five short films and the hosting of a "Skill Share Day". Many people have been involved and my warm thanks extend to you all for your enthusiasm and practical support for the AMOS venture. I would especially like to thank:

The Landworkers' Alliance (LWA) Core Group, for adopting this initiative and supporting me to obtain funding, involve LWA membership in the survey and surrounding events, and for encouragement from beginning to end.

Michel Pimbert, for recognising the value of researching the productivity of small farms and creating the opportunity to undertake such work as part of the Centre for Agroecology, Water and Resilience (CAWR) at Coventry University; Colin Anderson and Ulrich Schmutz for academic input, and Csilla Kiss and Annelie Bernhart for administrative support and encouragement throughout the process of planning, undertaking and writing the report; Tim Sparks (Coventry University) for help with survey design and statistical analysis; Ben Cook, for patiently leading me through the new territory of planning, creating and editing the accompanying AMOS films; The A Team Foundation, for providing the funding that has made this entire project possible;

Charles Scott (Farm Business Survey) for advice on survey design and measurement of productivity; Jayne Dyas (British Growers' Association) for providing comparative yield data. The Organic Growers' Alliance, and World Wide Opportunities on Organic Farms (WWOOF) for helping to advertise the regional meetings and the survey, and for continued interest and encouragement for collecting the metrics of productivity and viability; All who hosted regional meetings, and helped identify farmers to invite to the meetings.

Chris Smaje, Julia Wright, Matt Lobley, Zoe Wangler, Dan Powell, Jyoti Fernandes, Adam Payne, Dee Butterly, Lynne Davis, Ashley Wheeler and Ellen and Adam Simon, for providing a sounding board for early ideas and giving comments on subsequent drafts of the report and films;

All those who took time out of their busy lives to take part in the survey and share their figures with me, especially those who agreed to take part in the films, and generously shared their time and knowledge and hosted us when visiting their farms: Ruth Hancock (Fresh and Green); Ashley Wheeler (Trill Farm Market Garden); Steve Friend (The Trading Post); Jyoti Fernandes and Ele Saltmarsh (Fivepenny Farm); Charles Dowding and Stephanie Hafferty (Homeacres), Ida Fabrizio, Amy Yates and Shoriét (Castle Climbing Centre), Marina O'Connell (Apricot Centre); Mark Stay, Mary Healy, Jeremy Taylor, Matt Dale, Dan Betterton, Ria Rode and Antoine Baudron (North Aston Organics), and Mark Harrison, Sam Hardiman, Richard Tait, Jessie and Meghan Marcham (Stroud Community Agriculture);

Dan Powell (LandBase) and the team at Monkton Wyld, for organising and hosting the Skill Share Day in October 2016;

Finally, I would like to offer heartfelt thanks to all the friends and family who have patiently supported and encouraged me throughout the journey from concept to completion of the "A Matter of Scale" initiative, which at times must have seemed never ending.

Executive Summary

A survey of 69 small, agroecological farms showed a diverse and vibrant sector, which attracts new entrants and incubates entrepreneurs. Many of the holdings were five hectares or less and, while some were focussed on horticulture, others were operating several different enterprises including eggs, meat and micro-dairy. Key findings include:

- Productivity data for 18 indicator vegetable crops showed small farm yields being higher than non-organic field-scale yields for those which benefit from more intricate husbandry and hand picking (e.g. salad leaves, French beans, kale leaf-beet and chard). At a few established market gardens vegetable yields were much higher than average non-organic yields.

- The prevalence of integrated, mixed farms, means that inputs and waste are reduced compared to monoculture farms. Such diversity may also lead to resilience, by spreading economic risk, improving ability to cope with extreme weather and increasing resistance to disease.

- Despite low average net farm income levels, when compared to average UK farm incomes the 'A Matter of Scale' (AMOS) sample were performing well financially. 78% were receiving no farm subsidies, and subsidies made up less than 20% of the income for 19% of those who were receiving subsidies.

- Most of the farms were adding value either by direct marketing or processing their produce into cheese, juices or preserves. Vegetable box schemes, farmers' markets and community supported agriculture schemes enable better incomes, while building customer trust through provision of fresh and sustainably produced food. Many holdings supplemented income with off-farm employment, or had diversified by running courses, campsites or holiday lets.

- An average of 2.3 full time equivalents work on each holding, with the average per ha being 3.2. This is much higher than the mean for the UK of 0.026 annual work units (AWU) per hectare (Eurostat 2011, p. 5). Workers are attracted by the meaningful nature and variety of agroecological farm tasks. Despite this, labour issues were frequently mentioned as a limiting factor in increasing productivity.

- Other barriers to productivity included: lack of capital to invest in equipment and infrastructure, meaning the efficiency of some holdings was less than optimal; affordability of land and accommodation; and lack of technology suitable for small scale farmers.

- Small farmers are highly motivated to provide environmental and social benefits. Care of the soil, water and biodiversity, reduction of greenhouse gas emissions, as well as provision of public education about farming and the building of community were cited as multifunctional benefits generated by the farms.

Until now, little research has been conducted into the productivity and viability of small-scale, agroecological farms in the UK. This study shows that they deserve closer attention by both policy makers and academics as they simultaneously address many of the challenges facing twenty-first century food production, including efficient UK provision of vegetables and fruit, fulfilling employment opportunities, reduction of greenhouse gas emissions and food waste, and the re-building of rural communities.

Contents

Chapter 1 – Why study small farm productivity?

In the battle for hearts and minds that underlies most public discussion about food and agricultural policy, the issues of food security and environmental management are used to support most perspectives. A debate about whether or not organic farming can feed the world has raged since the early days of the organic movement. Meanwhile, the sustainable intensification and industrial farming lobbies argue that more people can be fed from less land and fewer resources if we adopt technologies such as precision farming and genetically modified crops. These two perspectives feed into the 'Land sharing versus land sparing debate', in which integration of production with ecological management is differentiated from maximising productivity on some areas to free up land for wildlife conservation (Fischer et al. 2014). Productivity underlies all these arguments, and 'agricultural efficiency' is seen by many as a holy grail to be sought at all costs.

The impact of scale, or farm size, has been an important aspect of this debate. Large farms are often viewed as more efficient because they can achieve economies of scale through using larger machinery and bulk buying inputs, giving an advantage when competing in a low-price environment (Rosset 2006, p. 10). Small farms are often viewed as an old fashioned, romantic anachronism – unprofitable, inefficient and not to be considered as serious contributors to food security or rural economic growth. Small farms are at best considered to be niche – producing 'high end' products for an elite market – and at worst to be simply 'hobby farms'.

This dismissive attitude to small farms ignores the fact that 70% of the world's food is produced on small scale, family farms (ETC 2009, p. 1) and evidence that in many countries there is an inverse relationship between farm size and productivity (Cornia 1985). Peter Rosset (1999) documented the multiple functions and benefits of small farms both in the United States and worldwide and argued that even in industrialised countries small farms can outperform larger ones in terms of productivity and economic viability. It is hard to find evidence of productivity comparisons between small and large farms in the UK, despite the fact that a growing small farm sector is providing food for local people and livelihoods for farmers. Small farms are more often lauded for the wide range of environmental and social benefits they generate. However, producing food is the most important function of agriculture and all farms, large and small, need to be more than just parks for biodiversity conservation and landscape aesthetics.

The purpose of this study is to discover how much food small scale farms (20 ha and less) in the UK are producing, as well as to ascertain their financial viability, and set these findings within the context of the multifunctional benefits they deliver. Measuring performance of small farms in terms of productivity, economic viability and delivery of public goods will provide evidence for policy makers about the role that small scale farms have in the UK food system and indicate how policy can support the growth of this sector. The study aims to prompt debate and encourage others to build on this work with further research on the role of small farmers in UK food system.

Chapter 2 – Background Information

2.1. Agroecology in the UK

Although used in relation to tropical agriculture since the 1980s, agroecology in the UK is a relatively recent phenomenon (Wezel et al 2009). In contrast to the longer established UK organic movement, agroecology combines an understanding of the complex ecological relations in a field with a social perspective, which recognises the influence on the agroecosystem of wider social factors, such as a collapse in market prices or changes in land tenure (Hecht 1995, p. 5). There are interesting parallels between agroecology and the UK permaculture movement, in which design principles incorporate 'people care' and 'fair shares' alongside 'earth care' (Whitefield 2004, p. 5). While organic and biodynamic agriculture are legally defined terms, requiring a system of inspection and certification to be labelled as such, the boundaries of what is permissible within agroecology are more fluid. Thus it can be viewed as 'a development pathway from input-intensive industrial systems through to highly sustainable, ecological systems', whereby industrial systems become increasingly efficient before progressing through input substitution and system redesign towards sustainable food systems (Lampkin et al 2015, p. 10). Hence, agroecology is more accessible to small scale producers, who are often unable to afford the high cost of organic certification, yet whose diverse, integrated and resource efficient production systems and short supply chains clearly locate them within the definition of agroecology.

2.2. Can Britain feed itself using agroecological methods?

In 2007 Fairlie undertook a desk top study to compare the ability of five different systems of agriculture, including organic and chemical farming with and without livestock, to provide enough food for the British population. It concluded that a 'permaculture livestock system', which most closely equates to a small scale, diverse agroecological farm, could feed a UK population of 60.5 million on 7.5 million ha arable and 5.9 ha pasture by operating a more integrated crop and livestock system, in combination with a reduction in meat consumption. Such a finding reflects how, in contrast to traditional organic farming whose yields are typically 75–80% of conventional agriculture, wider social changes of behaviour (like reduced meat consumption) along with agroecological farm system innovations such as multi-cropping, have the potential to close the yield gap and meet UK dietary requirements (Lampkin et al. 2015).

At present there is a significant trade gap between imports and exports for all major food groups, with the level of imported fruit and vegetables being particularly significant. The UK is 58% self-sufficient in vegetables and 11% self-sufficient in fruit (Schoen and Lang 2016, p. 12). 76% of UK vegetable imports and at least 18% of fruit imports come from EU countries (Defra 2015, p. 101). The impending departure of the UK from the European Union brings the question of domestic self-sufficiency into sharp relief, when it is noted that, as well as being reliant on the EU for imported fresh produce, the UK industrial horticulture industry is reliant on a high level of casual labour, including some EU migrants (Schoen and Lang 2016, p. 20). Farmers report finding it difficult to recruit more local labour, yet growing numbers of people are keen to work on organic and agroecological holdings, due to the meaningful work they offer (Fairlie 2012/13; Timmerman and Felix 2015).

2.3. The role of smallholders in global food security

Debate about the relationship between farm size and productivity has a long history, with studies in the 1950s providing empirical evidence of an inverse relationship between farm size and productivity

in both Asian and Latin American countries (Cornia 1985, p. 515). Cornia (1985) sums up these trends by observing that greater deployment of labour enables higher yields for four main reasons:

(i) a *more intensive use of labour in each crop activity,* whereas larger farmers tend to deploy more capital in the form of machinery;
(ii) *cultivation of a higher proportion of the available land on the farm,* compared to larger farms where large areas are allocated to low intensity uses or put down to fallow;
(iii) *more intensive use of the land during the year (*double or at times triple cropping more frequent on small farms);
(iv) a *choice of labour-intensive crops,* such as *v*egetables and other crops where the role of mechanization remains limited.

A more recent report by Grain (2014), reviews the available figures on land distribution, farm size and food production in 15 countries from Latin America and Africa to Eastern Europe and Russia. In each country, small farms have access to less than half of the land, yet produce over half of the food. For example, in Kazakhstan just over 97% of farms are small and operate on 46% of the land, producing: 98% of fruits and berries, 97% of milk, 95% of potatoes, 94% of melons, 94% of vegetables, 90% of meat, 78% of sugar beet, 73% of sunflower, 51% of cereals and 42% of eggs, while in Kenya using just 37% of the land, small farms produced 73% of agricultural output in 2004 (Grain 2014, p12).

2.4. Agroecological production on UK small farms

Of the 98,000 holdings of under 20 ha that are operating in the UK there are 637 farms of 20 ha and less that are legally certified as organic and biodynamic by UK bodies (Defra 2016, p. 7; pers. comm. with UK organic certification bodies). This, however, does not reflect the true number of agroecological farms, as many small farms operate organically, or according to broader agroecological principles, and find it too expensive to certify as organic, or unnecessary due to short supply chains.

It is tempting to extrapolate the phenomenon of the 'inverse relationship' between size and productivity to farms in the UK, but claims that small farms in developed countries can be more productive than larger ones tend to be backed only by financial data, rather than data about the physical productivity (yields or total output). For example, Rosset (1999) shows how small farms (27 acres and less) have more than a ten times greater dollar output per acre than larger farms. This is in large part due to the fact that smaller farms tend to specialize in high value crops like vegetables and flowers, but also that more labour and inputs are applied per unit area, and the use of more diverse farming systems. Eurostat figures for the UK suggest that the Standard Gross Margin/ha for smaller farms is 839 Euros and for larger farmers it's 142 Euros, indicating smaller farms are financially more productive by a magnitude of 5.9 (Martins and Tosstorf 2011, p. 4).

Studies of small farms in the UK have been polarised between the micro level and the traditional family farm. Sustain (2016) measured the total yields of allotments, community gardens and urban farms over two years, but no equivalent study of commercial small scale farms appears to have occurred. A study into the future of small, family farms carried out by Winter et al. (2016), took their definition of 'small' from Defra's Standard Labour Requirement (SLR), in which they employ between one and two full time equivalents (FTE). With this size definition, farms with a large acreage could be included, due to low labour requirements of an extensive grazing system or highly mechanised arable one. Furthermore, the focus of Winter et al. was traditional family farms, most of

which are non-organic mixed, cereal and livestock farms, rather than agroecological ones. While studies quoted implied that 'there is an underlying tendency for larger farms (in financial terms) to be slightly more economically efficient than smaller ones' (2016, p. 40) due to producing more output per unit input, this is only apparent when 'compounding factors', such as unpaid labour (charged at the full economic rate) are included. They note that 'there is a *very large* level of variation within this relationship, and the top performing small farms are more efficient than *many* larger farms' (2016, p. 40). Due to the complexities of the farm size-intensity relationship, Winter et al. conclude that there is no simple, unequivocal answer. In recognition of the fact that the definition of 'small farm' varies according to the type of farming being discussed, the Landworkers' Alliance have taken a values based approach to defining what is meant by 'small farm' (see text box below)

Small Farm Values

The Landworkers' Alliance represents UK small-scale, ecological and family farms. Members' farms are distinguished from industrial farms by the values that are central to their organisation.
Ecology – Nature is the primary resource of all production. Small farms put ecology at the centre of farming because a healthy soil and a diverse ecology is the foundation for producing nutritious food.
Autonomy – Autonomy is an essential part of a farm's resilience and viability. Small farms work to reduce reliance on bought-in inputs, limit dependency on borrowed capital and keep decision making in the farmers' hands.
Cooperation – Cooperation is at the heart of our farming culture. Small farms work together to share ideas and resources, and maintain access to the industry for new entrants and successors.
Community – Farms are a central pillar of rural communities and culture. They play an essential role in maintaining the fabric of rural life by creating jobs, providing services and maintaining culture.
Livelihood – Small farms value the local distribution of healthy food above the production of commodities for export. The small farm works to create markets that ensure both fair prices for farmers and good food for customers.
Accountability – Small farms take pride in producing high quality products that are healthy, nutritious and made with integrity. Supply chain traceability is important and creates public confidence in quality farming.

2.5. Measurement of productivity

When the question of productivity is examined in detail it becomes apparent that there are multiple ways to measure it. Rosset (1999) critiques the use of yield (output of a single crop per unit area) as a measurement, and advocates instead the concept of 'total output', in which yields for single crops may be lower than average, but are exceeded by the combined output of different crops from a unit land. This yield advantage, from growing multiple crops together, or 'poly-cropping' is usually expressed as the Land Equivalent Ratio (LER), which relates the monoculture land area required to produce the same amount as one hectare of polyculture using the same plant populations (Altieri 1995, p. 112).

Further refinements occur when the unit against which the output is measured are varied. Garnett (2013) compares three perspectives adopted in the sustainability debate, 'Efficiency', 'Demand Constraint' and 'Food System Change', and shows how the use of different metrics in Life Cycle Analysis lead to varying conclusions about the merits of different farming systems. Likewise, Smaje (2011) applied seven measures of efficiency and sustainability in the comparison of an industrial farm of 100 ha with an agroecological one of 6 ha. His findings were that industrial agriculture produces more macronutrients (though not more food) per unit area and per unit labour, whereas agroecological

smallholding produces more food and more macronutrients per unit green house gas (GHG) emissions and per unit energy used. He concludes that both types of farming are efficient in their own ways, and the question should be which type of efficiency do we wish to emphasise? Contemporary understanding of agricultural efficiency places emphasis on labour efficiency as opposed to land use efficiency, with the result that the agricultural workforce has declined dramatically over the last seventy years (Devlin 2016, p. 3).

While each of these measurement methods has its strengths, a traditional quantitative measurement of yield was chosen for this study, on the basis that it would be easier to compare this with other data sources. However, survey respondents were also asked qualitative questions about the number of enterprises they operate, the eco-management systems they employ and the multifunctional benefits they aim to deliver, to provide a wider context for the output of the farm as a whole.

2.6. Multifunctional benefits of small farms

Identifying the strands of the extensive literature about the multifunctional benefits of organic and agroecological farms which relate directly to scale is a complicated process due to the frequent association between smaller scale operations and those that apply agroecological or organic management systems. A comprehensive analysis of benefits attributable to agroecological farms can be found in IPES Food (2016), while Rosset (1999) discussed many social and environmental benefits arising from small scale farms in the US and further afield.

Environmental benefits can be summarised under the following broad headings: Efficient use of natural resources; Biodiversity and ecosystems services; Soil and water care; Greenhouse gas emissions and energy efficiency. Very little of the literature on environmental benefits focuses specifically on scale, although, D'souza and Ikerd's (1996) paper 'Small Farms and Sustainable Development: Is Small *More* Sustainable?' addressed the issue head on. It concluded that in the new post-industrial paradigm for American agriculture, from a sustainability perspective, the smallest effective size will be the most competitive size for farms, as for other knowledge-based enterprises of the future (1996, p. 81).

2.6.1. Efficient use of resources – Agroecological systems are characterised by cyclical, rather than linear systems, that minimise the use of external inputs by integrating crop and animal systems to make efficient use of natural resources (IPES Food 2016, p36). For example, fertilisers are replaced by composted plant waste or animal manures, and few, if any, pesticides and herbicides are used.

2.6.2. Biodiversity and ecosystem services – Griggs (2012, p. 54) lists a number of practices common at small scale, agroecological market gardens that enhanced functional biodiversity, leading to healthy ecosystems which keep pests at manageable levels. Wider research has shown that practices such as conservation of wild biodiversity, polycropping, crop rotation and a general movement away from monoculture have a positive impact both on wild biodiversity and the incidence of pest and diseases within crops (IPES Food, p. 35–36).

2.6.3. Soil management – Practices common with small-scale growers such as zero or minimum tillage, use of permanent beds, mulches or shallow cultivations with machinery, have multiple beneficial impacts on the soil including a reduction in soil erosion, soil compaction, damage to earthworms and germination of weed seeds (Hall and Tolhurst 2006, p. 26–28; Dowding 2007). The combination of livestock with arable and horticultural crops on mixed farms has further benefits for

soil, compared to pure arable farms, adding animal manure to enhance soil health, fertility and carbon sequestration, although use of green manures can have the same effect (IPES Food, p. 36).

2.6.4. Energy efficiency and greenhouse gas emissions – The short supply chains which characterise the marketing strategies of many small scale agroecological farms bring further reductions of CO_2 equivalents through reduction of transport and refrigeration (Griggs 2012, p. 46). Small farms using agroecological techniques may be two to four times more energy-efficient than large conventional farms, in terms of total energy input/output ratios (IPES Food, p. 34).

Turning to the social benefits, Pretty (2002) has argued that 'social connectedness, trust and participation in community life was greater where farm scale was smaller' (qtd. in Winter et al. 2016, p. 42). By contrast, Winter et al. (2016) focus on the changing role of farmers in society in response to agricultural restructuring. They note the withdrawal of farmers from community and civic life as demands on their time grow due to increasing farm size, leaving less time for community engagement, and report isolation due to longer hours of work, and having to reduce the labour force in order to streamline the farm business. These are seen as a source of loneliness, stress and loss of work satisfaction among small farmers in the modern context. The SW Farm Survey showed that when asked how satisfied they were with life in general compared to 12 months ago, 47% of famers with 200 to 250 ha and 35.9% of farmers with over 250 ha reported feeling less satisfied compared to just 17.9% of farmers with 50 ha or less (Winter et al. p. 43–47). By contrast, Timmerman and Felix (2015) report greater engagement and satisfaction with work on agroecological farms.

Claims to provision of healthier food by small, agroecological farms can fall into two main categories: Those relating to the food being fresher and less processed, and physical differences brought about by organic/agroecological management compared to non-organic husbandry. Small scale farmers tend to sell their produce direct to the customer, rather than via long food chains, meaning that it is usually fresher when it reaches the customer (Griggs 2012, p. 46), while focus on using organic methods of production brings potential benefits in the nutritional quality of the produce (Leifert 2014). Grigg's study of agroecological market gardening in the UK is also notable for its focus on community involvement in growing, which brings additional mental and physical health benefits, alongside increasing the affordability of fresh produce to low income groups.

Small farms also bring economic benefits to rural areas. Rosset (1999, p. 11) points to studies highlighting how in towns surrounded by family farms, income circulates in the local economy generating further jobs and a thriving community characterised by more local businesses, schools, newspapers and a more thriving civic society. He also notes how radical land reform in Japan, Taiwan and South Korea enabled thriving small farmers to provide the guaranteed domestic markets for fledging industries that led to the 'miracles' of economic development in these countries post second world war (Rosset 1999, p. 14).

Winter et al. (2016) used employment as an 'approximate measure of rural community well-being' (Midmore and Dirks qtd. in Winter et al. 2016, p. 37), because *paid* employment is the most important means of achieving other ends. They found that farms of under 50 ha employed a mean of 7.72 FTE/100ha, compared to farms of 200–250 ha, which employ 2.27 FTE/100ha and those of over 250 ha which employ 1.23 FTE/ha (Winter 2016, p. 38). Maynard and Green (2004) show how organic farming creates 140% more jobs than non-organic farming, highlighting that small, organic farms with an average size of 36 hectares supported the greatest number of jobs (5.23 jobs per farm). Likewise, drawing from older studies, Hird (2015, p. 21) quotes two studies that show an employment

dividend from conversion to organic farming practices. Organic farms are able to offer more secure year-round employment, due to their diverse, mixed nature and direct marketing activities (Hird 2015, p. 27), greater contentment with work, and optimism about the future of the farm (Maynard and Green 2006, p. 53). Timmerman and Felix (2015, p. 528) contrast the skilled and meaningful work provided by agroecological systems to the lack of opportunity for skilled workers on large industrial farms, which leads to less stable rural communities as workers are forced to migrate. Devlin (2016) confirms that such trends exist in the UK, where casual seasonal labour represented 5% of the agricultural labour force in 1980, 7% by the mid-1990s and had risen to around 14% by 2014.

Chapter 3 – Methodology

The 'A Matter of Scale' (AMOS) study was composed of three research phases:

- An online questionnaire survey
- Filmed visits and semi-structured interviews at eight of the holdings found to be most productive when the survey results were analysed
- A one-day skill share workshop

3.1. Definition and recruitment of sample

An area-based definition of 'small farm' was selected over Defra's definition, which is based on the number of full time equivalent workers, to allow for the variety of management systems and levels of labour intensity anticipated among small scale, agroecological farms. While the area which is considered to be 'small scale' varies with the type of farming (horticulture uses less land than grazing of livestock) and the Land Workers' Alliance's (LWA) value based definition of small farm is based on a suite of qualitative factors, an area based definition was considered to be simpler for potential respondents to be able to understand. For the purposes of the AMOS study, 20 ha (50 acres) and under was chosen as the definition for small farms as this is large enough to allow the inclusion of livestock farms as well as horticultural holdings. Respondents were requested to be commercial, rather than producing entirely for subsistence. Recruitment for the survey took place at six regional LWA meetings, as well as via as articles and advertisements placed in magazines, newsletters and at events targeted at potential respondents.

3.2. Questionnaire design

The survey was designed to collect quantitative data on yields, enterprise diversity and financial viability, as well as information about the variables that might influence productivity, and qualitative information about barriers to productivity, trends and environmental and social benefits. It was designed in consultation with a statistician and a representative of the Farm Business Survey, to ensure that the results could be compared with data for large organic and non-organic farms. In formulating the questionnaire, a number of differences were discovered in the frameworks of reference for defining holding size, output and labour used by Defra, which made comparisons more difficult than initially anticipated, and these are discussed later in the report (See Chapter 11).

3.3. Online surveys

An initial online survey was run in Spring 2015, and was followed by a second in Autumn 2015. Results were analysed using spreadsheets and descriptive statistical methods, while responses to qualitative questions were grouped by theme.

3.4. Filmed interviews and farm visits

Eight farms were selected for in-depth visits and interviews, based on their high ranking yields, financial viability and the different types of enterprise and marketing method they demonstrated. Story boards, focussing on five themes arising from the survey results, were devised to provide a framework for the interviews. A set of interview questions consisting of generic ones and questions tailored to each farm, enquired how the holdings succeed in being so productive and financially viable, and explored the themes of employment, barriers to productivity, and multifunctional benefits. At each farm, a filmed interview was carried out, followed by a farm walk during which interviewees were invited to discuss and show specific approaches used to increase productivity/viability. Footage

was then logged, integrated and edited into five short films on the themes of productivity, financial viability, employment, barriers to productivity and multifunctional benefits.

3.5. Skill share day and other peer review meetings

At various points during the research, results were presented to groups with interest and knowledge in agroecological methods, providing opportunities for discussion of findings and input of new perspectives.[1] This facilitated the triangulation of information with a wide section of actors, as well as peer review of research perspectives, the results of which honed final analysis of the data and presentation of the films. The most significant event was the Skill Share Day (October 2016), a one-day event to which all respondents from the survey were invited. It combined a first showing of the films, and presentation of results with the opportunity to take part in enterprise focussed workshops to share details of good practice and how barriers to productivity have been overcome.

[1] Meetings/conferences where such presentations took place included the Democratising Agricultural Research Conference (DARE4) at Monkton Wyld (July 2015) and the International Permaculture Conference (September 2015).

Chapter 4 – A Profile of Small Farmers in the Twenty-First Century

4.1. Geographical distribution

A total of 69 smallholders responded to the questionnaire. Most respondents were from the south of England, especially the south west, with 32 (46%) being located there, and 15 (21%) being in the south east. Only one holding from the east of England took part and five to six from the Midlands, north west and north east. Wales and Northern Ireland returned one holding each, and four were in Scotland.

4.2. Sizes of holding

The distribution of the sizes of holdings taking part in the survey can be seen in Figure 4.1. 64% of the holdings were under five ha, with 19% (of the full dataset) being less than one ha. 14% were between five and 10 ha, 10% falling in the 10–15 ha class and 12% in the 15–20 ha class. Of the sample of 69 holdings, 54 (78%) were using less than five ha for food production, including 24 (35% of total sample) who were using less than one ha. Seven holdings (10%) were using 5–10 ha and eight holdings (12% of sample) were using 10–20 ha for food production.

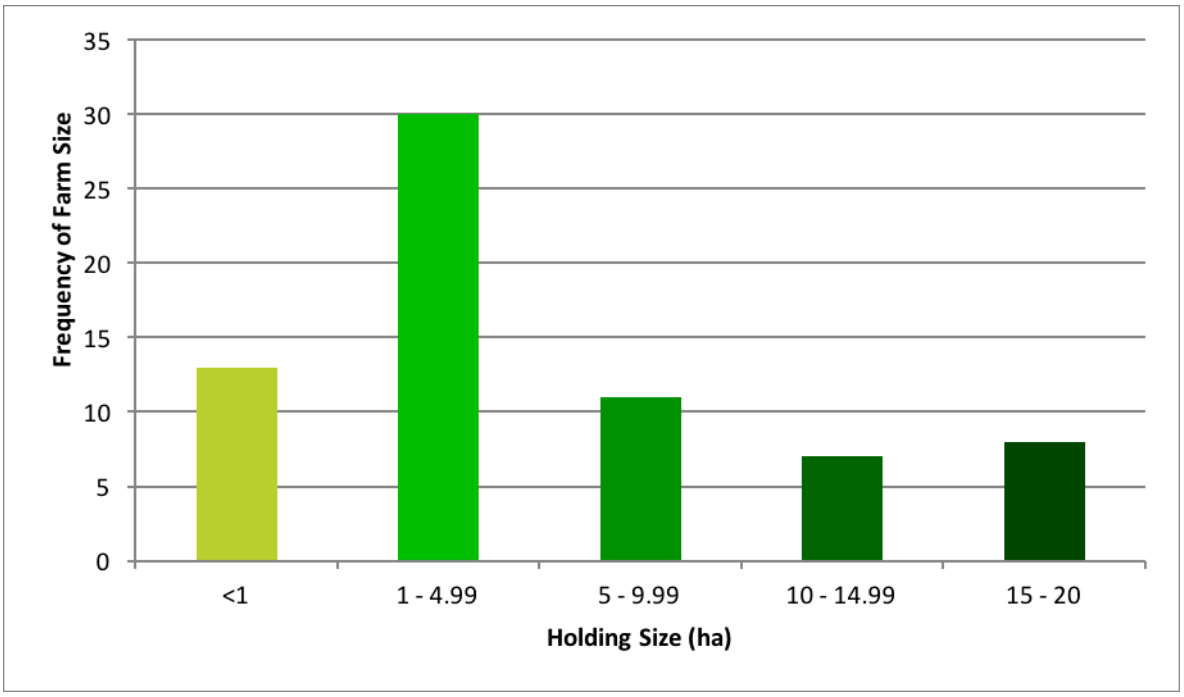


Figure 4.1. Distribution of holding sizes

4.3. Enterprise diversity

A wide diversity of different enterprises was represented among the respondents (see Figure 4.2). Not surprisingly, horticulture, poultry and pigs were commonly represented, since these are less land hungry than ruminant livestock. Other goods reported as being produced included: cut flowers (6); firewood/coppice (3); honey/bees (4); mushrooms (2); hops (1); a fruit tree nursery (1); medicinal herbs (1), alpaca fibre (1) and herbal teas (3). One striking feature of the dataset was the number of different enterprises that many holdings were operating. Nearly 47% were operating only one or two enterprises, and often these were horticulture, 23% were operating three to four enterprises, 21% five to six enterprises, 7% seven or eight, and 2% more than eight enterprises. These highly diverse businesses included holdings of less than five hectares.

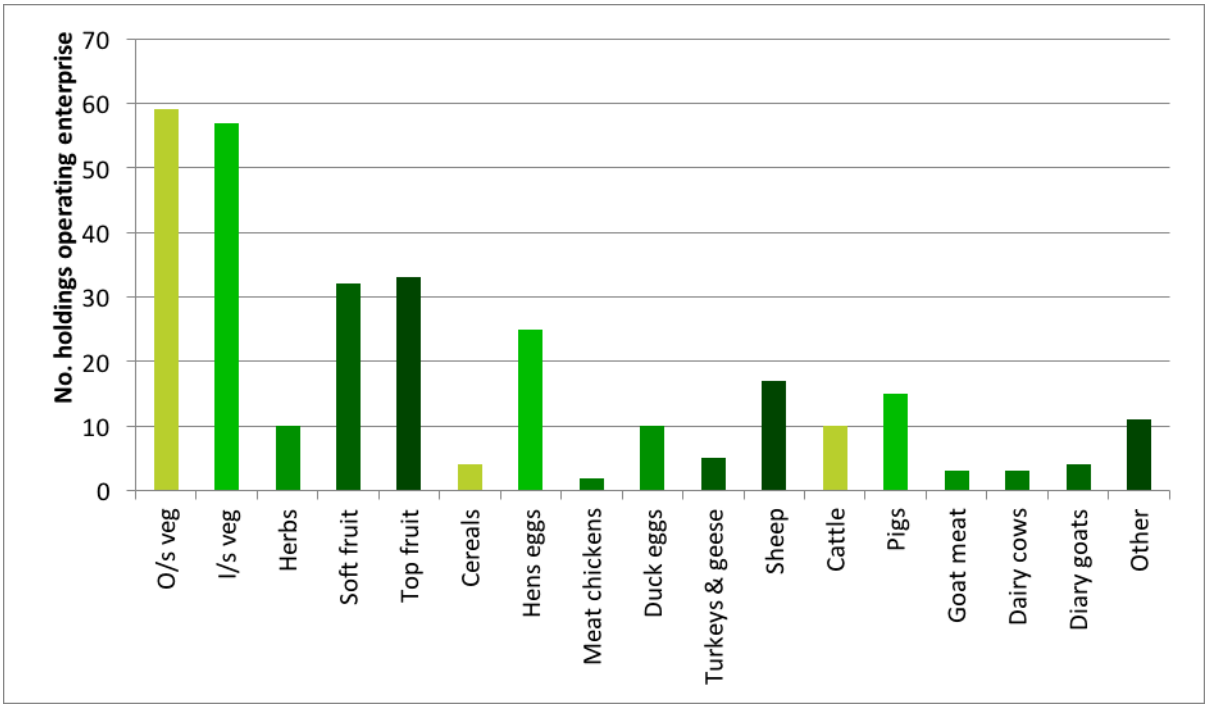


Figure 4.2. Frequency distribution showing how many holdings were operating each enterprise (O/s veg refers to vegetables grown outside, I/s veg refers to vegetables grown under cover)

4.4. Eco-management systems

The answers to the question 'What eco management system do you use for your farm?' were diverse and respondents were allowed to give more than one answer. While organic, both certified (42%) and non-certified (43%), dominated the answers, permaculture was mentioned by 14% of respondents, agroforestry, forest gardening or no dig/no till (9%) and biodynamic (7%). The following were mentioned by one or two respondents each: stock-free organic, bio-intensive, biochar and companion planting. One respondent stated that he followed conventional methods.

4.5. A youthful sector

The age profile of the sample was youthful, with 20% under the age of 39 (see Figure 4.3), compared with 3% of UK farmers being under the age of 35 years. Likewise, only 13% were over the age of 60, compared to 34% of UK farmers being 65 years and over (Defra 2015, p. 9). It is notable that many of the businesses were recent start-ups, with 42% having been running for five years or less and 22% having been running for 6–10 years (total of 64% running for 10 years or less). Seven businesses (10%) had been running for over 30 years, and the remaining 26% for 11–25 years. Furthermore, the results showed a marked tendency towards the new entrant end, with 23% being in their first five years of farming or growing, and 52% being in their first 10 years. Only 14% had more than 25 years of experience and 70% of respondents did not come from a farming family.

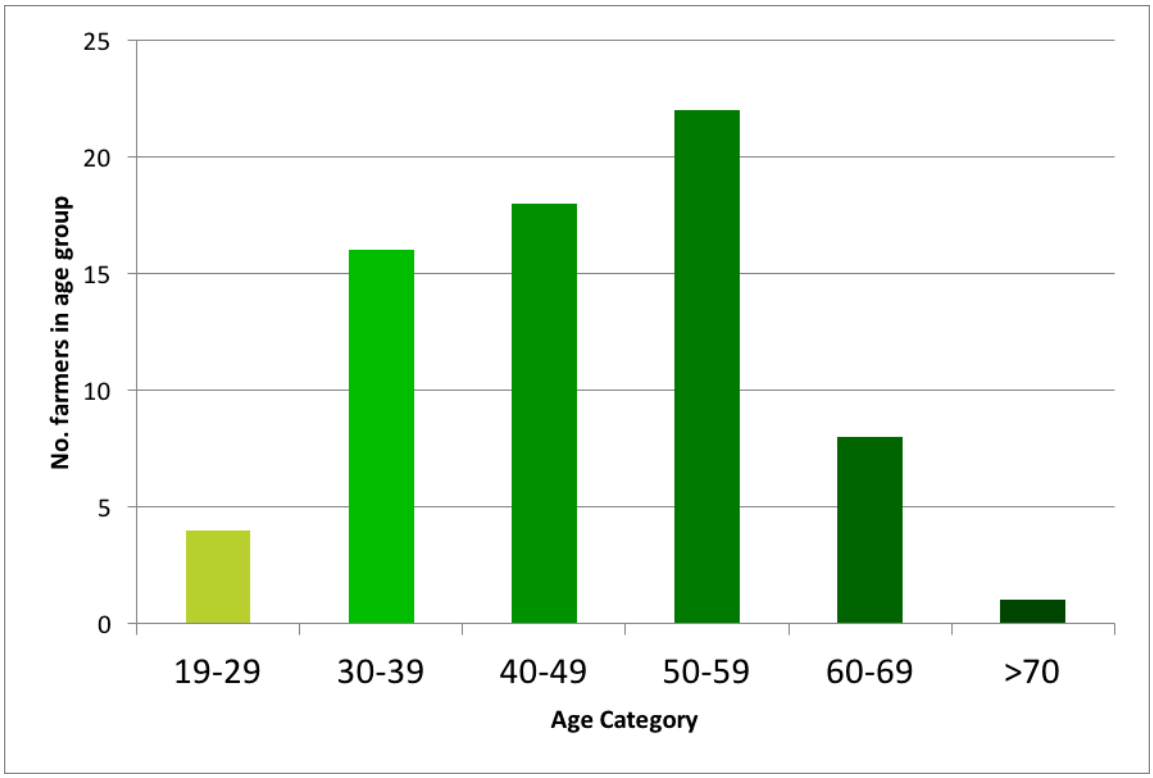


Figure 4.3. Age profile of AMOS sample

Chapter 5 – Productivity

5.1 Vegetable productivity

Vegetables were the most popular enterprise, being grown by 59 respondents while vegetable yields were the simplest to collect and provided the largest and most robust dataset. 86% of respondents were producing between 11 and 40 different types of vegetable, with most producing around 30. Yield data was collected for 18 indicator vegetables, and is summarised in Table 5.1 below, with more detail in Appendix 2 (Tables A2.5–A2.6). For most vegetables, the dataset was characterised by some very high yielding holdings at one end, with a larger number of lower yielding holdings. For such a skewed data set, the mean (calculated by adding all values together, and dividing by the number of values) was overly influenced by the highest yielding holdings, and thus did not provide an accurate representation of the average yield. For this reason, the median (middle) average, rather than the mean was used when comparing yields with standard organic and non-organic data. An adjustment was made to account for the fact that some of the survey did not specify whether paths should be included in the growing area recorded and it is assumed that some of those growing on raised beds will have omitted paths. For comparison with field scale data, which includes access land, all median and mean yields were multiplied by 0.85. This figure was chosen on the basis that paths typically take up 25% of a growing area (for each 0.75 m bed there is a 0.25 m path), but increased to allow for the fact that respondents growing row crops were instructed to measure from mid-points between rows for their growing area figures.

Table 5.1. Vegetable yields (kg/square metre) for small farms survey, compared with average data for organic and non-organic farms

	2014/2015 Median AMOS yield	2014/2015 Median AMOS Yields (w/ path adjustment * 0.85)	2014/2015 Mean AMOS Yields (w/ path adjustment * 0.85)	Organic (kg/sq m) (from OFMH 2014)	Non-Organic (kg/sq m) 2012
Potato	2.1	1.8	2.2	2.3	4.5
Tomato	4	3.4	4.4	n/a	40.7*
Carrots	2.2	1.9	2.7	2.5	6.1
Leeks	3.3	2.8	3.7	1.2	2.1
Broad beans	1.5	1.3	1.7	n/a	0.4
Squash	2.1	1.8	2.4	n/a	4
French beans	1.8	1.5	1.6	n/a	0.9
Chard	3.0	1.5	2.8	n/a	0.8
Kale	1.7	2.3	1.9	n/a	0.9
Salad	3.1	2.6	2.1	n/a	0.6
Parsnip	2.6	2.2	2.5	1.8	2.6
Beetroot	2.9	2.4	3.2	2.5	3.7
Onions	3.1	2.6	2.2	2.5	4.2
Calabrese	1	0.9	1.0	0.5	0.9
Cabbage	2.8	2.4	2.6	2.5	3.0
Courgette	4.0	3.4	3.3	0.5	2.5
Sweetcorn	0.7	0.6	1.2	2.5	n/a

Notes: *This is for heated tomato production – A figure for conventional, unheated production was not available

The 85% figure arguably disfavours the AMOS data when compared to other sources, but this is considered better than over-estimating AMOS yields. It is a fundamental flaw in the questionnaire design that growers using a fixed/raised bed system were not clearly instructed to include paths in their growing area, and it should be a priority in any future productivity research to ensure that such an error is not repeated.

When the AMOS results are compared with standard organic yields, the average yields for all but sweetcorn are higher in the AMOS sample, with differences especially pronounced for crops such as leeks, parsnip, beetroot and courgette.

When the AMOS dataset are compared to non-organic standard data, (see Figure 5.1 below). The yield differences are more varied, with small farm yields being higher than non-organic yields for some crops (leeks, broad beans, French beans, leaf-beet and chard, kale and salad, while for other crops (potatoes, carrots, squash and onions) yields were lower. Several of the former crops are those which benefit from more intricate husbandry and hand picking (e.g. salad leaves, French beans), while the crops that benefit from mechanisation and economies of scale (e.g. potatoes, carrots and onions) gave highest yields in the non-organic data set.

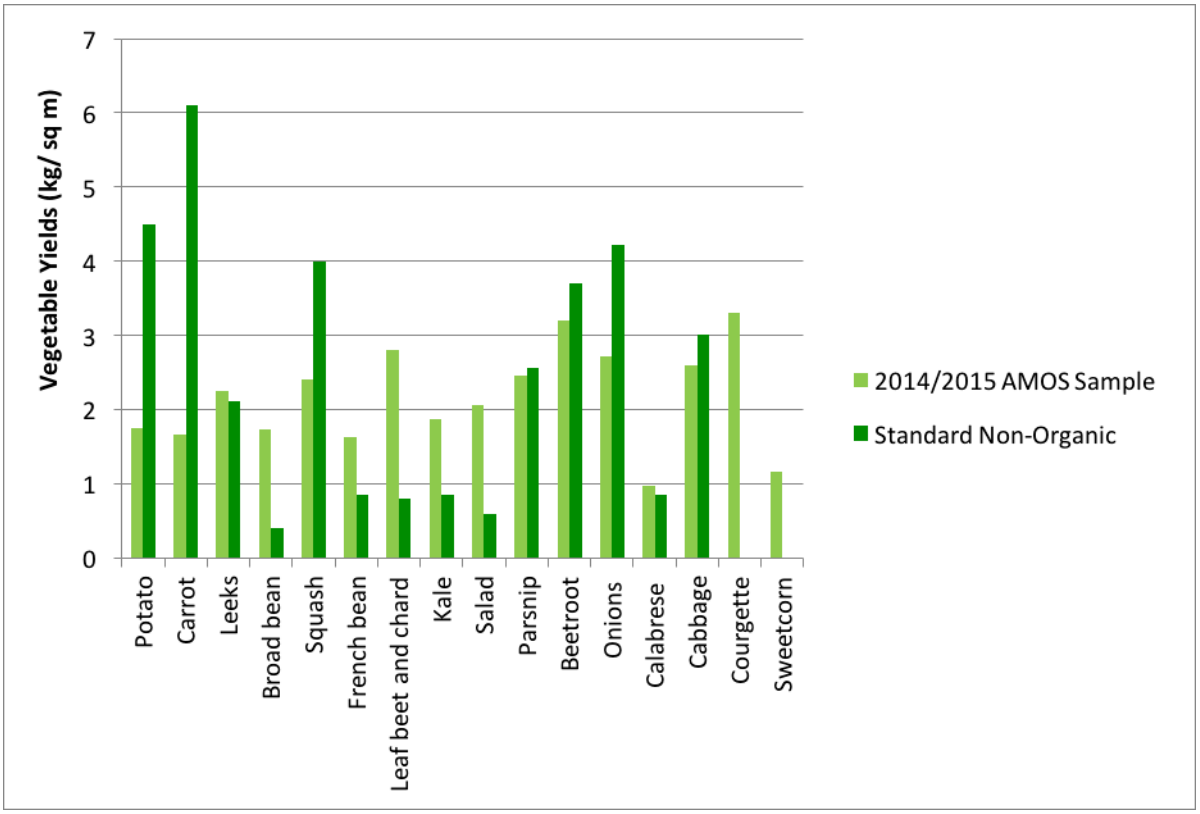


Figure 5.1. Comparison of yields (kg/m^2) from 'A Matter of Scale' survey with data for non-organic producers (British Growers' Association, pers. comm.)

5.2. Other enterprises

The small size of samples for other enterprises made it hard to draw any meaningful conclusions about productivity, as did the lack of scale appropriate organic and non-organic data with which to compare AMOS yields. However, the following descriptions show the diversity, scale and integrated nature of the holdings.

5.2.1. Livestock – Nine different types of livestock being kept for meat or egg production, but the size of flock/herd varied greatly (see Appendix 2 for tables of results). Furthermore, the complexities of mixed holdings, where livestock are rotated between different areas, and closely integrated with vegetable, fruit or cereal enterprises, created complications in allocating yields to specific areas. Of the livestock data, the egg-laying hens provided the best data since it is relatively simple to calculate an egg/bird figure which can then be compared to industry averages. The dataset (n=26) was variable, with flock sizes ranging from 3 to 150 hens, and it was interesting that the three highest laying rates (>300 eggs/hen) came from smaller flocks (see Appendix 2).

5.2.2. Dairy – As well as meat and eggs, six dairy producers responded, four of whom kept Jersey cows (1–3) and two kept goats (4–5). The average annual yield per cow of one respondent exceeded the industry average for non-organic channel island breeds, but on the whole yield per cow was lower than both organic and non-organic standard yields. All dairy producers were processing the milk into cheese, yoghurt or ice cream and had direct markets for their produce.

5.2.3. Fruit and cereal crops – Although fruit was the second most frequent enterprise after vegetables, produced by 33 respondents, data provided was patchy and productivity variable. On the whole yields for top fruit were poor compared to mean organic and non-organic field scale yields. AMOS yields for general soft fruit were better (mean 2014 – 1.4 kg/sq m, 2015 – 1 kg/sq m), but no standard figures were available for comparison. In 2014 the AMOS mean yield for strawberries of 1.27 kg/sq m, exceeded the standard of 0.73 kg/ha for organic field scale crops (Measures et al. 2014), but in 2015 it fell to 0.35 kg/sq m. Both years fell below the standard non-organic field crop yield for strawberries, of 2.1 kg/sq m. Most notable was the variety of both top fruit and soft fruit being grown, with 12 types of each being mentioned at least once, including unusual fruits such as apricots, logan berries and kiwi fruit. Five holdings were growing cereals or field beans, mainly for on-farm feed.

5.2.4. Productivity Trends – When asked, 'How would you say productivity has changed on your holding over the years?' the majority (76%) reported an increase, with over a third of those saying it had increased considerably. 12% reported that it had stayed the same, 7% that it had declined. The most common reasons given for increasing productivity were increased skill and experience and improvements in various aspects of soil quality.

5.3. What made some farmers productive?

The interview phase of the research was designed to collect examples of best practice and the question 'what distinguishes the top ranking growers from the rest of the sample?' formed a central line of enquiry during the visits to the most productive holdings. The following points, provide a summary of key findings from the interview responses:

- *Harvesting and marketing systems* – Hand picking of crops allowed for a longer harvesting period than a 'once through' mechanised harvest, and reduced crop wastage as vegetables could be selected and handled more carefully. Direct sales provided a better market for the variety of sizes and quality of produce, due to diversity of customer preference.
- *Efficient systems* – Thoughtfully designed systems ranged from field scale, tractor cultivated vegetables to small scale raised beds. Minimum tillage and no-dig techniques were sometimes employed to reduce weed seed germination and protect soil.
- *Skilful combination of machinery and hand labour* – Technology appropriate to small-scale operations was employed within systems designed to combine handwork and machinery use to maximise efficiency.
- *Good soil and aspect* – Some of the high yielding growers benefitted from grade 1 or 2 agricultural land, with good soil and a south facing aspect or shelter from a walled garden.
- *Experience and training* – Many top ranking growers had at least 10 years experience, providing time to develop skills, improve soil, establish good systems for cropping, pest and weed control. Several had also benefitted from formal agricultural or horticultural training.
- *Secure land tenure* – All of the high yielding farms had sufficiently secure land tenure to give them the confidence to invest in infrastructure, such as buildings, irrigation equipment and fencing, thereby increasing the efficiency of their holding.
- *High inputs* – Some systems were using high rates of either physical inputs, such as municipal compost or wood chip, or labour in the form of volunteers.

5.4 The challenge of quantifying diverse, integrated systems

The quantification of the productivity of small-scale, agroecological holdings, so as to compare their output with larger operations, highlights the limitations of using the yields of individual crops as a way to measure productivity. Rosset (1999, p. 5–6) suggests the concept of 'total output', the sum of everything a small farmer produces, is preferable to that of yield, when comparing smaller farms with large ones. For, 'while yield almost always biases the results toward larger farms, total output allows us to see the true productivity advantage of small farms'. As the following quotes demonstrate, to take a narrow definition of yield is to ignore the sophistication and complexity of what agroecological systems are capable of producing.

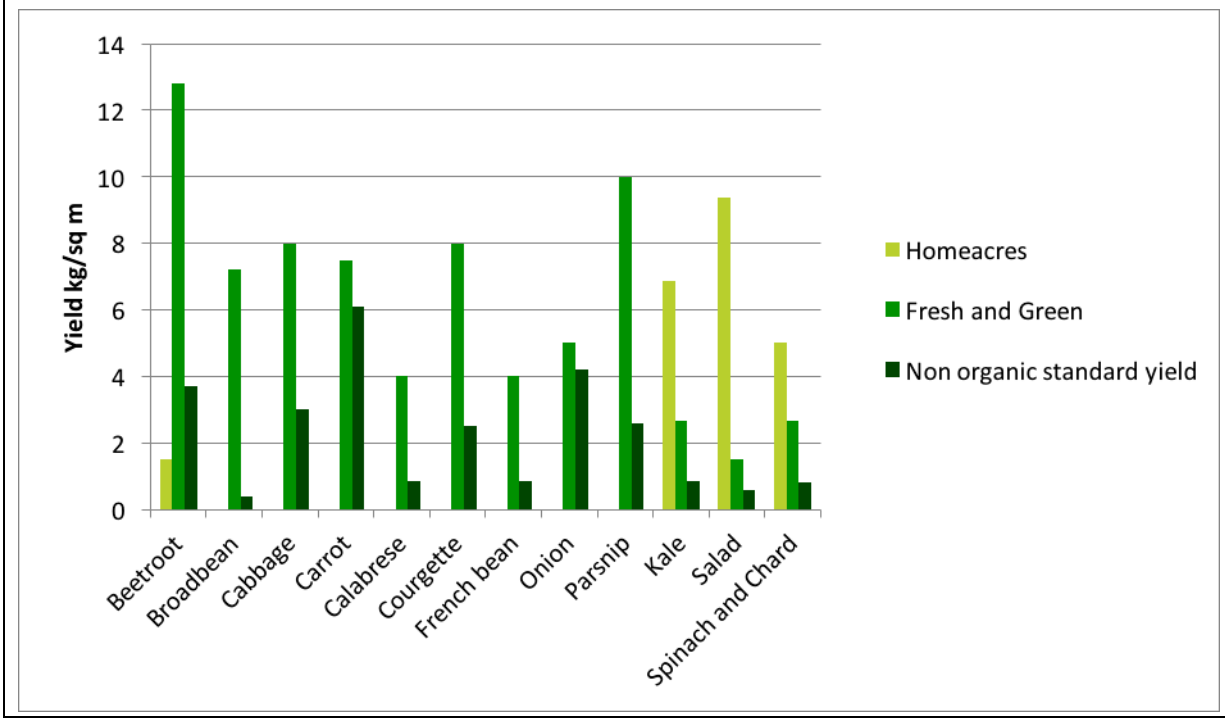
> *'I don't always look at yields in terms of tonnes per hectare. We're looking to give our customers a good variety of things. I often grow vegetables that aren't necessarily the most productive, so what I'm looking for is healthy plants that are giving us vegetables when we need them.'*
>
> Mark Stay, North Aston Organics (5 ha market garden supplying 260 boxes per week)

> *'When I think of productivity in the context of this garden, first of all I'm thinking how much can we produce in the time that we have, as we are working part time and managing volunteers. We think of productivity as being consistent with how much we can give the café. Every week we are harvesting something, according to the season. The volunteers and also the staff, they come out here to learn, so its productivity in terms of knowledge. And also its how people enjoy the site, the value of just being outdoors, with nature in an urban environment'.*
>
> Ida Fabrizio, Castle Climbing Centre (0.4 ha urban mixed use garden)

One of the reasons Cornia (1985) gives for the inverse relationship between holding size and productivity recorded in tropical countries is the more intensive use of land, with double or sometimes triple cropping on one piece of land in the same year. A study focussed on fewer holdings could employ the concept of Land Equivalent Ratio (LER), which calculates the total land needed to grow two crops in monoculture to achieve the equivalent yield from a single hectare grown in polyculture (Liebman 1995, p. 206–207). However, this level of detail was beyond the scope of the AMOS survey, which aimed at a larger dataset.

What is Possible?

A good system, combined with experience and reasonable land can result in organic holdings producing significantly higher yields than non-organic averages. Several horticultural holdings stood out as having outstandingly good yields, due to the factors mentioned above. The results for two such holdings are shown below. Fresh and Green is a 4.98 ha mixed holding in Devon (Grade 1 land), supplying 95 weekly vegetable boxes alongside laying hens and pigs. Homeacres is a 0.1 ha no-dig garden in Somerset specialising in salad (Grade 2 land). Both are run by growers with over 25 years of experience.



Instead, a qualitative approach was used to identify instances of polycropping, by asking, *'How do you use your land in ways which result in two or more crops from the same land in a given year?'* A wide range of practices were reported (see Appendix 2 for table summarising results), but by far the most common was succession cropping, or growing two to three crops sequentially within a season. This was sometimes achieved by starting one crop in modules, so it was ready to plant out as soon as the previous crop was harvested. Such tight cropping schedules are characteristic of the successful

Canadian grower Curtis Stone, who distinguishes between 'High Rotation' (HR) and 'Bi Rotation' (BR) beds. In the HR beds, he grows quick crops such as rocket, spinach and radishes, aiming to get four crops per year, whereas the BR beds are for the 'slow and steady' crops such as tomatoes or kale, which will also be preceded or followed by a quick crop (Stone 2016, p. 17–18).

The polycropping principle of 'stacking' was in evidence at several holdings in different forms (see "Productivity Film" below). In its most traditional UK form, this included under-grazing orchards with sheep, chickens or geese. At one farm, multiple enterprises (cider and desert apples, sheep, chickens both for eggs and meat, and pigs) are integrated spatially to maximise the yield coming from a total area. Another farmer uses the leaf fodder which is a bi-product of coppicing or pollarding hazel as a supplement to the diet of his cattle. In the forest garden at Castle Climbing Centre, a diverse range of standard fruit trees, shrubs such as black currents and gooseberries, and groundcover herbs and strawberries grow together, with the walls of the Castle also being used to support vertical growth of climbers such as kiwi fruit. Such a complicated integrated system requires an intense and knowledgeable input of labour, to find and efficiently pick the fruits which are then processed by the café into cordials, cakes and deserts. The herbs are harvested on a regular volunteer day each week, and dried in a solar drier, processed and mixed into blends, which again are served at the café. Arguably, a system this diverse is only viable because of the high input of volunteer labour, and the fact that the garden manager is employed by the Climbing Centre rather than self-employed (see Chapter six), yet the education and pleasure gained by the volunteers is also counted by the garden manager as a form of productivity.

Video 1: A combination of experience, good soil and aspect, system design and specific production details are the ingredients for success in achieving productivity at a small scale. Available here: https://vimeo.com/222364577

5.5 Relationship between inputs and outputs

The AMOS survey has focused on outputs, not inputs. The decision not to ask detailed questions about inputs was deliberate, since this would have added to the length of the questionnaire. The aim

was to collect data from a large sample and the response rate would have been lower if detailed input data had also been asked for. Since one of the selection criteria for the study was that farms should be operating under some form of agroecological management system, it was taken as given that most would be aiming to minimise inputs.

Some data on inputs was collected, including an indication of the percentage of animal feed and forage that was produced on farm and bought in. While for sheep and cattle, the majority of holdings were producing 80–100% of their feed and forage on farm, for pigs and poultry, a much higher proportion of bought in feed was being used. This reflects standard practice throughout pig and poultry farming, including on many organic farms, since the tendency is to feed these non-ruminant animals a more grain based diet, which is more complicated to produce on farm than grass forage. Nevertheless, there was some variation in the balance between farm produced and bought in feed, and the high yields of one highly productive livestock farm were reliant on a higher proportion of bought in feed, even for the cattle and sheep.

An input that did not show up on the questionnaire, yet had a significant influence on the yields, was compost. At least one of the highly productive farms was using high applications of municipal compost in a no-dig system (applied 10–15 cm deep annually) on a quarter acre plot. Others mentioned buying in animal manure from other farms as a fertility input for horticultural systems. Compost, manure and animal feed represent significant imports of nutrients from another system. Such reliance on 'outside' fertility represents an extension to the 'boundary' of where the 'small farm' begins and ends, since it is relying on land elsewhere to grow the animal feed and compost/manure. The use of some 'bought in' compost, animal feed and other inputs by AMOS respondents should be viewed within the broader context of industrial agriculture, in which the majority of inputs are bought in. It was suggested at the Skill Share day that employing an Ecological Footprint approach to the study of small farm productivity might be a way to measure inputs and compare these with larger farms. This would, however, require a significantly more detailed approach than was within the scope of 'A Matter of Scale'.

5.6 How to measure productivity

Throughout the two-year period of conducting, analysing and presenting initial results of the 'A Matter of Scale' survey, the question of how productivity should be measured has been considered. At a workshop early in the process, the idea of 'productivity as a ratio of outputs per inputs' was introduced, which led to an understanding that there are various parameters against which productivity can be measured – land area (space), fossil fuels (energy), subsidies/capital (money) and labour (time). Such parameters represent either scarce or abundant resources and in aiming for sustainable food production, productivity or efficiency should be measured against the scarce resources, such as land or fossil fuel energy. Another suggestion was that the percentage of organic matter in the soil should be a core parameter against which yield should be measured. All of these, alongside the indicators highlighted in the literature review, are valuable measures. However, to be meaningful, any measure of productivity must be sufficiently commonly used as to enable comparability with other systems. Since a key purpose of 'A Matter of Scale' was to find out whether (or not) small farms could be as productive as larger ones, it was necessary to use a unit of measurement which would be well understood and comparable within the tradition of measuring yield. Hence, for all its weaknesses, the measurement of productivity by yield against unit land area retains value, within a broader understanding of total output, diversity and agricultural systems.

Chapter 6 – Financial Viability

6.1. A financial struggle

Analysis of the mean income and costs data for three years showed a tendency towards low net farm incomes, with 72% of those providing financial data having a net income of £10,000/year or less. Even when the value of subsistence produce consumed on the holding was included, 63% of those providing financial data appeared to be generating £10,000/year or less net income. On the other hand, three holdings were generating a net income of over £25,000, and this rose to four when subsistence is included. A further 10–13 holdings, representing 22% of the sample who provided data, were generating an income of £10,000–£20,000. It was interesting that the most financially successful farms were not the same as those that consistently produced the top yields, which could be due to the labour costs on highly productive farms. The top earning holdings were all selling via box schemes (two vegetables and one meat), which provide a reliable market and confidence to invest to produce a high volume of produce.

Analysis of mean net income hides the fact that many individual holdings were showing a progression towards a higher net income, and that some of the larger vegetable box schemes have turnovers of £150,000–£350,000/year. These high turnovers include supplementary, bought in produce (30–50% by value), but the merging of the retail side of the business with the growing side, means it is difficult to isolate financial performance. Furthermore, it became apparent that some farms have included the main growers' wages in the costs, reducing the net farm income, which was assumed to represent the income for the farmer/grower.

The survey asked what percentage of income came from sales of produce; farm subsidies, other employment, tax credit or pension and 'other'. For 'Sales of Produce' there was a relatively even distribution, with nearly half (31) gaining over 40% of their income from farm sales and the others (33) gaining 40% or less of their income directly from farm produce. Of the 12 (19%) earning over 80% of their income from farm produce, four were earning 100% from it. All of these 12 were horticulturalists, with all but one growing on an area of 3.2 ha or less. Those who were earning less than 20% from produce sales were on the whole gaining the rest of their livelihood from other employment, or 'other', with a few having a significant contribution from tax credit or pension. On the whole these people tended to be new start-ups or retirees.

It is notable that 78% were receiving no farm subsidies, and of those who were, 10 gained 5% or less of their income from subsidies, three received 5–20% from them and only one was reliant on subsidies for 80% of their income. 59% of the respondents had some form of extra employment although for 21 (33%) this provided 40% of their income or less. Only 9% were getting more than 80% of their income from other employment and in most cases this was the only additional income besides farm sales. Nearly 60% were not gaining any income from tax credits/pension, and of those who were for nearly two thirds these contributed 20% or less of income.

The diversity of livelihood strategies displayed makes it hard to typify any particular pattern. However, it seems that income from produce sales makes a significant contribution to overall income, with 31% earning over 80% from this. A low reliance on farm subsidies or tax credit/pension is demonstrated, while most small-holders are earning any extra income they need from off-farm employment.

The contribution of subsistence consumption to the livelihood strategy should not be underestimated. 59% of the sample valued produce they consumed at £1000–5000, with another 20% using up to £1000. For those living on their farm, living costs can be further reduced if there is no rent or a mortgage, and energy, water and sewage services are 'off-grid'.

Income data highlights:

Produce sales generate more than 60% of total income for 33% of AMOS sample, 40–60% for 33% and up to 20% of income for 28% of respondents.

50 (78%) receive **no subsidies at all**.

38 (59%) of the respondents had some form of **off-farm employment**, but for over half of these such income represented less than 40% of total household income.

6.2. Small farms compared with national data

Small farms appear to have greater economic resilience and less reliance on subsidies, when financial data from the AMOS survey is compared with farm income data for UK agriculture and horticulture (see Figure 6.1). For 2013/2014, corresponding to the years for which AMOS data was collected, the average contribution to farm incomes from production was £6600, with the bulk (65%) of income coming from Single Farm Payment or agri-environment schemes. For mixed farms, an average annual loss from agricultural production of £10,400 meant 100% of total income was coming from subsidies and 27% from diversification. For comparison with the horticulture dominated AMOS sample, mean UK horticulture production contributed £14,100, representing 42% of overall income, of which another 42% came from diversification and the remainder from subsidies or agri-environment schemes. By 2015/2016, an average loss from production was being made across all farms. Subsidies, including Basic Payment Scheme and agri-environment payments, now constitute 85% of farm business income (Defra 2015 and 2016, p. 8).

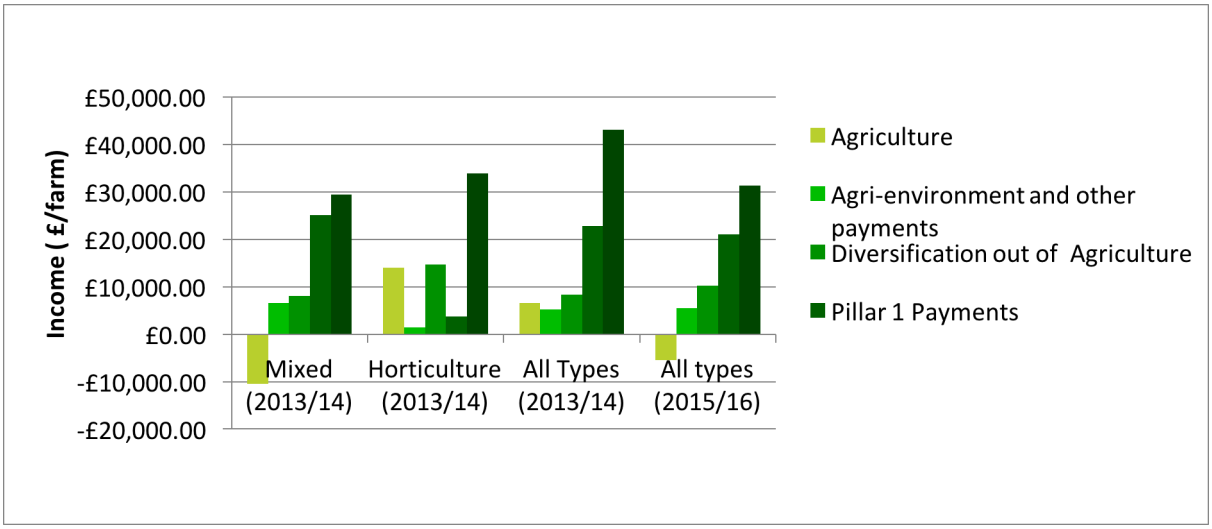


Figure 6.1 UK annual farm business income by farm type (£/farm) summarised from Defra (2015/2016, p. 8)

It is fairly typical for farming households to benefit from an income from 'off-farm' employment. A survey of the distribution of income sources across the south west showed that for farms of less than 50 ha, 44% would come on average from agriculture on that farm, 15.5% from non-agricultural

activities on the farm, 13% from off-farm employment and 20% from pensions, savings and investments (Winter 2016, p. 59). The income distribution farms of 20 ha and less in the AMOS survey appears to be relatively typical, when compared to the farms in the south west survey.

6.3. Adding value

Almost all respondents were adding value in some way, either by processing or direct marketing or both, to compensate for the low prices obtainable for basic produce, reflecting the findings of other studies, for example Maynard and Green (2006). Adding value was a clearly a key ingredient for success in the farms featured in the "Financial Viability" film on page 23. In one interview, the point was made that even salad leaves, when mixed and put in a bag, are elevated from raw vegetable to 'ready meal', for which customers are willing to pay a premium compared to a vegetable which they have to prepare. Other processing activities are more involved, such as cheese making, but despite the labour and time required, the increase in milk value from 20p/litre to £1.50/litre makes the effort worthwhile. Milk processing, as well as the making of jams, chutneys, cordials and juices, has the benefit of converting a perishable product into one with a shelf life, while often also enabling the utilisation of produce which is not cosmetically suitable for retail. The reduction of waste thus achieved has economic as well as environmental benefits, in that a much larger proportion of produce is made saleable.

Adding Value by Processing

Fivepenny Farm Catering

Fivepenny Farm (10 ha) is a highly diverse mixed farm, comprising top and soft fruit production, vegetables, livestock (pigs, sheep and cattle), a micro-dairy and sometimes chicken eggs or meat. The farm succeeds in generating a livelihood through intensive adding of value to the basic produce, much of which is then sold when the farmer caters for weddings and other local events. Fivepenny Farm Feasts are therefore made up of a mouth-watering selection of cheeses, pickles and jellies, processed meats (Parma ham, sausages, chorizo), salads, fresh fruit desserts, cider and cordials all grown or raised and processed on the farm.

Apricot Centre

Over 20 years Marina O'Connell has planted a diverse orchard on 1.4 ha in Essex, resulting in a long cropping season for apples, pears, plums, gages, peaches, currants, gooseberries and other soft fruits. These are sold fresh at an organic farmers' market stall in London, where customers are willing to pay a premium for good quality produce. Surplus and blemished produce is processed into jams, chutneys and cordials and sold alongside the fresh produce, increasing the range and turning potential waste into a high value, non-perishable product.

The most frequently recorded forms of direct marketing were more traditional systems such as box schemes (18) and farmers' markets (11), followed by informal sales through word of mouth (8), farm shops and farm gate sales (5) and community supported agriculture (4). Innovative forms of marketing such as internet sales (2), food co-ops (4) and food assemblies/hubs (2) were less common. One step removed from direct marketing was the most frequent channel of all, wholesale to catering or independent shops, which 26 respondents undertook. While prices obtained are not as high as for direct marketing, a greater proportion of the sale price (50–75%) is obtained compared to sales via a wholesaler or retail multiple (1–10%) (CPRE 2012, p. 22). Such channels bring the convenience of

picking to order and flexibility in what is offered each week. Typically one form of marketing, for example the box scheme or market stall, accounted for 80–95% of produce, with other methods such as wholesale to restaurants and independent shops acting as supplementary markets to sell surpluses.

Prices can be dramatically increased when processing is combined with direct sales. For example, by retailing herbal teas by the mug in the on-site café at Castle Climbing Centre, the value of teas that had been collected, dried and blended from the garden was increased from £800 wholesale value to £2500. On the negative side, such processing and direct marketing takes time away from the running the farm, and thus potentially eats into the time that could be spent producing food. Processing also requires significant investment in infrastructure, since facilities must pass the rigorous inspections of environmental health. At Fivepenny Farm, this obstacle has been overcome by forming a co-operative to obtain funding to build a processing barn comprising a juicing room and catering kitchen, butchery room and dairy which can be rented by the day by members (See "Financial Viability" film below).

Video 2: Most successful small farms achieve financial viability through adding value, whether by processing or direct marketing their produce. Available here: https://vimeo.com/221393133

6.4. Diversification

In contrast to diversification on many larger farms, where a tourist or hospitality enterprise is often a profitable 'add on', but may not even feed guests food from the farm, the diversification activities reported by respondents were closely integrated with the farm. There appeared to be a market for on farm 'experiences', which were providing a valuable income for several holdings. From hosting corporate away days and 'pick, eat and learn' events to running youth development courses, the public appetite to pay for an authentic experience is not only an opportunity to supplement income, but also to educate customers. For example, G and S Organics in Northumberland offer 'Farm Focus Days', which include a tour of the farm, a butchery demonstration and a dinner of meat and vegetables produced on the farm. They also offer wild camping to enable visitors to enjoy a simple and traditional opportunity to 'get away from it all' and enjoy the beauty of the farm and its wider landscape. At least two other holdings were also offering simple camping, and a fourth now offers 'glamping' in a yurt, all inviting campers to pre-order food from the farm to cook over a campfire.

Through such enterprises, the farm is the subject of courses/events, rather than being merely a pleasant venue. The informal education that arises from people being able to spend time on a farm, and maybe understand the economic struggle of running a sustainable farm in the twenty-first century, may result in greater willingness to pay a little more for agroecologically produced food.

6.5. Contrasting strategies

While several farms had deliberately specialised in high value crops like salad leaves or ones that required technical investment, such as hops and cider apples, to become viable at a small scale, others considered that their enterprise diversity provided them with financial resilience against changes in the market and the weather. Furthermore, the interactions between multiple livestock, fruit and vegetable enterprises on some farms enabled costs to be cut as bi-products from one enterprise could become inputs for another. These contrasting strategies for achieving economic viability are interesting and deserve further research.

A Creative Partnership

Castle Climbing Centre in Stoke Newington, London ingeniously integrates a highly diverse, productive garden with a popular sport centre, in such a way that all parties are enhanced and thrive. Since 2009 the acre surrounding the centre has been converted into a mixed use, community garden. While growing food for the Climbing Centre's Café is one objective, the garden has amenity value for staff and climbing centre clients, is a site for wildlife conservation and waste management, and acts as a link with the local community by providing 'mini-allotments' for local families. The garden is managed by Ida Fabrizio, who is employed three days per week by the Climbing Centre, and leads a team of volunteers plus two other staff to grow and process food, make compost from the Centre's kitchen waste and manage the land to achieve its different objectives.

The relationship between the Castle Climbing Centre and its garden opens up possibilities, which alone would not be economically viable. As an employee, paid with income from the climbing centre, Ida is able to devote time to labour intensive and initially non-remunerative activities, such as creating a forest garden and picking berries, which a self-employed farmer/grower would find hard to justify. Equally, as Ida is quick to point out, 'Because we grow high value food, the café wouldn't necessarily buy what I'm growing, because it would cost them a lot of money. For example, we grew 20 kg of apricots, and out of those apricots they've made deserts, they've made cordials, they've dried them and put them into flapjacks. They've added value to what we've given them, but they wouldn't necessarily have bought 20 kg of apricots'. In turn, the green credentials of the climbing centre and the reputation of the café, which serves herbal teas and cordials grown and made on site and meals made from ultra fresh produce from the garden, attract climbers from other more standard sport centres, increasing its profitability.

Chapter 7 – Labour

7.1. Labour patterns on small farms

Across the whole sample, an average of 2.25 full time equivalents (FTE) were working on each holding, with the average FTE per ha being 3.2. This is significantly higher than the mean annual work units (AWU) per hectare for the UK, of 0.028 (Defra 2015, p. 8), or the 0.026 AWU/ha figure Eurostat (2011, p. 5) provide for smaller farms (which include farms of up to 891 ha, according to their system of definition). Although it was anticipated that labour intensity would be higher, since the AMOS sample contains a high proportion of two of the most labour intensive forms of farming (organic, and a predominance of horticulture), the magnitude of increase of labour intensity is surprising.

The labour required by farms in the AMOS sample was largely provided by the farmers/growers themselves and their spouse/family, with 46% of the sample employing no outside labour and 32% of the holdings having over half of the work done by the proprietor. This is in line with general trends for UK agriculture in which 68% of farm labour is family labour (Eurostat 2015, p. 50). Across the data set, the farms were employing an average of 0.7 FTE per holding. The number of FTE employed per hectare was 0.4 FTE/ha. Sometimes the farms generating employment were very small. Of the 10 farms employing two or more FTE, seven were five hectares or less.

The AMOS survey asked respondents about the average number of hours they worked on the farm in the summer and the winter, and from a weighted average of these two figures, a full-time equivalent (FTE) figure was calculated by dividing the average by 40 (taking 40 hours per week to be full-time). To compare employment across the holdings, a FTE per hectare figure was calculated by dividing FTE by total holding size (no. ha). The high figure for FTE/ha can partly be explained by 13 of the 69 holdings being less than one hectare, causing a magnification effect on the employment figure. For example, a 0.2 ha holding employing 0.9 FTE, appears to be employing 4.5 FTE/ha. When holdings of less than one ha are excluded from the average employment calculation, the average FTE/ha figure comes down to 0.68. Nevertheless, the fact remains that very small holdings were generating paid employment at an extremely high level of labour intensity.

The higher labour demand for organic farming is well documented (Maynard and Green 2006; Hird 2015). A survey of 25% of the organic farms in the UK in 2003 found organic farms providing 14% more jobs per 100 hectares than non-organic farms, with small farms (average size of 36 hectares) supporting the greatest number of jobs (5.23 jobs per farm) (Morison, Hine and Pretty 2005). Furthermore, Maynard and Green (2006, p. 25 citing ISEC 2000) state that UK farms under 100 acres provide five times more jobs per acre than those over 500 acres. Within UK agriculture, horticulture accounts for by far the most jobs (0.23/ha), followed by specialist poultry (0.13/ha) and specialist pigs (0.09/ha). Cereals (0.02/ha), mixed farming (0.025/ha) and dairy (0.03/ha) represent the lower end of the employment spectrum (Devlin 2016, p. 11).

7.2. Long hours for low pay

The majority of those working on the farms were self-employed whose payment generally comes from the net farm income. For about half the sample this was less than £10,000 per annum, so it is likely they were paying themselves less than a minimum wage rate, when income was divided by total

hours worked on the farm business (as opposed to time spent on 'non-business' activities). Such long hours for low pay are characteristic of farming, which is often described as a 'lifestyle choice'. It could be argued that long hours without adequate remuneration do not constitute a livelihood. However, as Chapter 6 showed, by a combination of direct marketing, processing and other ingenious solutions, the economic contribution of the farm produce sales to respondents' livelihoods was significant, and shortfalls were made up by subsistence benefits of living on the farm and off-farm employment.

Nevertheless, the imbalance between the high labour demands of small-scale agroecological farming and food prices that do not reflect the costs of production creates a significant obstacle, as reflected by responses to the question about barriers to productivity (see Chapter 8 and Table A1.9 in Appendix 1). Indirectly, the stereotype of 'long hours for low pay' has contributed to a cultural prejudice against farming as a viable livelihood, resulting in a shortage of skilled labour, as young people are deterred by the education system from training in agricultural occupations. Although a couple of respondents reported experiencing difficulties in recruiting skilled labour, the high rate of volunteering indicates that many workers find rewards other than payment motivate them to work on agroecological farms. Such rewards include the acquisition and development of skills, the enjoyment of working with others in a pleasant environment and the satisfaction of contributing towards a meaningful goal. Over 75% of respondents benefited from volunteer labour, with 40% hosting them for less than 100 days per year, and 36% for more than 100 days per year. Reliance on volunteer labour on commercial organic farms is a matter of debate within the organic movement, with some viewing it as an economic weakness or even exploitation, while others as a fair exchange for board and lodging and informal training (Harries 2016, p. 26–27; Keeves 2016, p. 28; Fairlie 2012/13, p. 61–63).

Video 3: There is a growing appetite among young people for the skilled, meaningful and varied land-based work that small farms offer. Available here: https://vimeo.com/221392869

7.3. A meaningful job

While the payment for labour may not be high, a point that arose during the farm visits is the sense of enjoyment and satisfaction that both workers and employers gain from working at a small – or as several of them put it, human – scale (See "Employment" film, on p26). These findings support Timmermann and Felix's (2015) observations of the greater attraction of work on small scale agroecological holdings, compared to large scale industrial agriculture, because it is meaningful, skilled and values the application of the worker's intelligence in overcoming challenges. Specific themes identified in the AMOS interviews included:

- Variety of work – diversity provides day to day interest and more opportunity for year round employment (or at least a longer season).
- Sociable nature of working on a small scale
- Being able to see and understand the whole process
- Training opportunities
- Possible to be more sustainable at small scale.
- Meaningful work – skilful and interesting (problem solving), healthy and safe, contributing to environmental care and societal benefits.

A worker at a market garden selling via a vegetable box scheme (5 ha) specified that while she liked the small scale, she also appreciated the farm being large enough to enable her to do a variety of jobs, harvesting different vegetables throughout the year. She also works at the micro-dairy enterprise on the same estate, where she valued being involved in all the steps from milking to selling bottled milk at the farmers' market. She compared this to a larger farm where she had worked for a couple of months, where 30,000 table birds were fed automatically by tractor and cows were milked with a robot, and expressed a sense of disempowerment about being part of a system that relies on complex machinery that she was unable to fix.

Likewise, an intern at Stroud Community Agriculture (18 ha), who described the farm as 'small-medium size', stated that he valued learning about intensive vegetable production from a small acreage, but also the opportunity to learn about livestock husbandry on the same farm. Another student worker had specifically chosen his farm for it being small scale and organic because he imagined it would be friendlier and the employer would have more time to explain things to him. Even his employer stated,

> *'On big farms its one man to a thousand acres, maybe more, now. I'd hate to be stuck on a tractor, on my own, just driving up and down a field. What we do here is really sociable, and we're not using noisy machinery all the time, so people can have conversations while they're doing their work, whether that be in the field hoeing or hand weeding or in the pack house. We're not in some great warehouse. It's definitely a sociable work that we do here. I think the fact that we've got members of staff who've been with us many years shows that the work is pleasurable and they want to come back.'*

A couple of workers expressed appreciation for the broader issues of working on a small scale agroecological farm, as opposed to an industrial scale monocultural farm. One compared the experience with working for large scale organic farms in the fens growing for the supermarkets:

'It's not farming, its industry. I don't think organic production should happen at that scale because you've just got these vast mono-cropped areas with no real chance for a diverse ecology to evolve. I think that's what works here, and that's why it's so nice to be growing in a well established site, where we've got incredible diversity around us of insects and birdlife and mammals and these things all enable the agroecology to find its balance.'

'I think small-scale, organic farming is the solution for many problems. There's less transport, and maybe if more villages had their own farms, people could talk with the farmer, and have better knowledge about what they are eating'.

These last two quotes point towards a sense of appreciation of working in an environment where the employee's values are in harmony and understanding, rather than at odds, with the work place. The interest and satisfaction of work, consistency of values and working in a pleasant, comprehensible environment and with other people, combine to create a pleasant working experience. Such consistency with values is a factor that motivates many to work for a lower wage than were the work less enjoyable and satisfying.

7.4. Return on employment

Since the Second World War, there has been a drive to minimise agricultural labour, to reduce the costs and provide leisure time to the farmer and to release workers for other more remunerative forms of employment. Timmermann and Felix (2015, p. 353) challenge 'the rationale that the overall reduction of labour in agriculture is something necessarily to be welcomed'. Their concept of 'contributive justice' focuses on the fair distribution of meaningful and interesting work, and views the increased labour demands of agroecology as a benefit, because of increased opportunities to participate in such work. Thus, two major global challenges are confronted: the reduction of the environmental footprint of agriculture and improvements in the quality and security of rural employment.

While hours are long and pay is low, agroecological farmers provide good 'returns' to society on their labour investment. Within the weekly hours noted down, many tasks do not lead directly to a financial return, but instead contribute to their environmental benefits (e.g. management of hedgerows, watercourses, meadows) and social benefits (such as social events for customers, farm walks and informal engagement with visiting customers). These create unpaid for time demands on the farmer/grower. Furthermore, direct marketing adds further time demands, yet shortens supply chains, producing benefits of fresher food, less transport, refrigeration and packaging, reduced waste and greater connectivity between the customer and the farmer/grower.

7.5. Work smarter not harder

While it is argued above that increased labour can be seen as a positive, due to the livelihoods it creates, rather than as a negative 'cost' to the business, it is still necessary for small farms to be economically viable. Inefficient use of labour is a drain on any business, and a feature that distinguished some of the most successful holdings was their attitude to system design and labour allocation. For Charles Dowding, the main motivation to develop a no-dig system was to reduce the weed burden he had witnessed causing massive labour costs to other organic businesses, while at Fresh and Green, Ruth Hancock highlights how machinery and labour are thoughtfully deployed for

different tasks to reduce time demands. This attitude of honing a system to the maximum efficiency is well illustrated by the Canadian grower Curtis Stone, who earns a decent living from half an acre of 'back yard' suburban plots. His detailed record-keeping and strategic systems for time-planning and work distribution, bed management and crop harvesting are central to his success (Stone 2016). Likewise, his colleague from Ontario, Jean-Martin Fortier states that, 'Although persistence, determination and hard work are all key ingredients for successful farming, these qualities on their own are not enough. Careful planning, design, good management practices and appropriate choices of equipment are all essential for developing an understanding of the farm as a whole system' (Fortier 2014, p. xv).

Chapter 8 – Barriers to Productivity

8.1. Labour and skills

By far the most frequently mentioned barrier to productivity related to labour, highlighting the importance of labour as an input on small farms (see Table A2.10 in Appendix 2). Issues raised included insufficient time and energy (21), insufficient labour (18), not being able to afford to hire sufficient labour (13) and lack of skills and experience (3). Not being able to afford labour was frequently linked to the low prices that are paid for food, making this the toughest challenge to address due to its being embedded in the macro-economic and global politics of food trade. Furthermore, the mismatch between the income possible from farming and the cost of accommodation and other living costs was a concern echoed by several respondents. Such themes arise repeatedly in the "Barriers to Productivity" film on page 32.

A couple of holdings reported difficulty in finding sufficiently skilled workers, and one elaborated that the base-line practical skills and common sense of school leavers were so poor that training up such workers was a significant investment. This grower commented that while several French agricultural colleges offer him students on work placement, in 18 years of growing not a single UK college had ever approached him. This could reflect a bias against organic production by UK agricultural colleges or poor connections between colleges and workplaces. Another grower identified a cultural bias in education that discourages bright and able students from pursuing rural training. Nevertheless, a growing number of people in their twenties and thirties are choosing agricultural/horticultural livelihoods, as shown by the younger age profile in this sample, and as discussed in Section 7.5, the skill-developing nature of the work is a key attraction to agroecological and organic production. Inexperience and lack of skill of the respondent themselves was also cited as a limitation and it would be interesting to see whether five years on the yield and viability results would be different when both their land and the skill of the farmers have had more time to develop.

Finally, one grower made a point about the impact of tightening labour legislation on the fluidity of hiring casual labour when it is needed on the farm. In contrast to 20 years ago, when people worked on each other's farms locally when the need arose, the paperwork required to employ casual labour now adds prohibitive demands on the business.

8.2. Investment in infrastructure and equipment

Another frequently occurring theme related to the lack of working capital, which was limiting efficiency by preventing respondents investing in adequate infrastructure and equipment. Often the bulk of start-up capital is spent on land, with insufficient funds being left over to invest in buildings, fencing and machinery. Although people manage and innovate with what is available, inefficiencies resulting from animals escaping due to poor fencing, machinery breaking down when needed and forage being ruined when stored under tarpaulins rather than in a barn were seen as a drain on the business. Lack of capital and time was also limiting developments that could improve resource efficiency, such as the installation of a rainwater harvesting system on the roof of a large barn. A frustrated farmer in one of the films pointed out that New Entrant schemes, offering capital grants to cover start-up costs exist in Scotland, Wales and other countries in the EU, but not in England.

8.3. Access to land and accommodation

The fact that those taking part in the survey generally had access to some land might have precluded 'access to land' arising as an issue. However, lack of space and limitations from the quality of the land were considered barriers to production by 14 respondents. For tenants or others with insecure land tenure, there is a disincentive to invest in long term improvements such as infrastructure, fruit trees or even soil, which can limit the potential productivity of a business. The theme of land affordability and access was developed during the visit North Aston Organics, where a contractor growing for the scheme spoke movingly of his frustration that after farming for 20 years he still could not find affordable land to establish an organic business in Oxfordshire (see "Barriers to Productivity" film on page 32) . He stated that he was a classic candidate to have benefited from a county council farm, but these had all been sold decades ago in Oxfordshire. Along with land being unaffordable, on-site accommodation was even more out of reach financially, causing inefficiencies when producers have to commute from a nearby village. The nature of organic mixed holdings, or even purely horticultural ones, means that the working day cannot be confined neatly between 9am and 5pm and not living on site causes stress, losses when accidents can't be responded to quickly and extra travel related costs.

8.4. Technology suitable for small scale farmers

A theme that arose during the farm visits was the lack of availability of equipment and inputs, particularly seed, appropriate for small scale producers. UK investment in agricultural research and development has focussed on technologies for industrial farming to the exclusion of small and medium scale technology. Hence, growers are forced to rely on old, and sometimes unreliable, machinery, or import equipment such as tractors and flame-weeders from mainland Europe or the United States, where the market has driven on-going development of modern equipment that is of an appropriate scale and price for small farmers. Similarly, the development of commercial plant varieties that accentuate the qualities desired by direct marketing, organic growers, such as flavour and disease resistance, is hampered by cost, regulation and lack of investment. Contrary to the stereotype of 'living in the past', young and technically able small farmers are keen to innovate and improve efficiency, but are hampered by the institutional bias towards high-tech, large scale solutions. As D'Souza and Ikerd (1996) point out, industrialization is being replaced by a 'knowledge based order', and when applying this to the achievement of sustainable agriculture, '"bigger" will be "better" only if the task cannot be done otherwise. The smallest effective size is best for enterprises based on information and knowledge.'(p73)

Video 4: Even the most successful holdings in the survey had had to overcome significant barriers on the journey to financial viability. Without such barriers, many more new entrants might be encouraged into farming. Available here: https://vimeo.com/221392625.

8.5. 'Outside pressure'

Although rather vague, the mention of 'outside pressure' reflects the fact that farming does not occur in a vacuum but within the broader context of people's lives. Pressures such as caring for elderly parents or off-site work, are by no means unique to small farms, but are a reminder that productivity is more than the result of a mere formula of contributing variables, and is influenced by a far more complex set of circumstances relating to family, society and even luck.

Chapter 9 – Multifunctional Benefits

9.1. The impact of scale

The multifunctional benefits of small scale, agroecological farms are well documented, and provision of such benefits was clearly a motivating factor for most of the farms in the survey. Yet it is difficult to isolate the influence of scale on these benefits from the choice of eco-management system. Visits to the most productive farms emphasised the valuable environmental and social benefits generated as a central aspect of running small scale, agroecological farms. The following discussion will attempt to identify where being small scale is an advantage in the delivery of the benefits cited in response to the qualitative questions about multifunctional benefits, summarised in Appendix 2 (Tables A2.10 and A2.11).

9.2. Environmental benefits

The environmental benefits detailed by participants in the survey (see Figure 9.1) reflect those discussed in other literature (Section 2.5), and can be broadly classified as those relating to biodiversity, soil care, efficient use of natural resources, and reduction of greenhouse gas emissions.

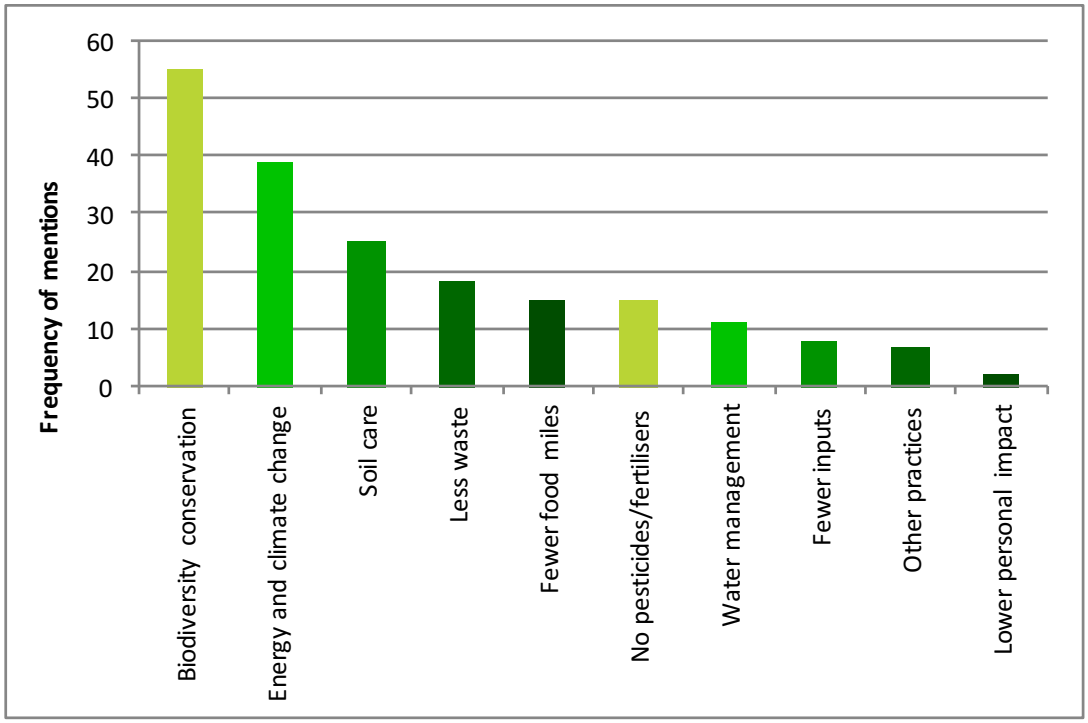


Figure 9.1. Categorisation of responses to the question, 'what are the main environmental benefits of the way you farm'

Biodiversity conservation frequently referred to habitat maintenance or creation, through practices such as hedgerow maintenance, sowing wildflower mixes and leaving wild areas, but the broader benefits of enterprise diversity and conservation of soil biota through organic management should not be ignored. That even holdings as small as five hectares were sometimes operating as many as six difference enterprises, and horticulturalists were growing an average of 30 different vegetables, and often soft and top fruit, reflects a significant difference from the tendency towards monoculture shown on larger farms. Such crop diversity within the production system, in terms of livestock as well as plant crops, has implications for resistance to disease, reducing reliance on pesticides and antibiotics

(IPES-Food 2016, p. 35–36). Furthermore, the beneficial impacts of ecosystem diversity on smaller cropping areas were more likely to be significant than when conservation occurs on the edge of very large fields. During the farm visits several examples were cited of wild predators controlling populations of pest species (see "Multifunctional Benefits" film on p.36). Crop rotations, absence of pesticides and heavy use of organic matter, usually generated by animals on the same farm, brought further benefits to soil biodiversity.

Although some holdings were using machinery for cultivation of vegetable crops, scale of operation enabled others to run no-dig systems using solely hand labour or a combination of the two. Such choices of system and technology use have implications for soil care and resource efficiency, reducing compaction, simultaneously improving water retention and drainage, and minimising fossil fuel use. Furthermore, the direct marketing carried out by the majority of respondents reduced the need for long distance food transport, packaging and refrigeration compared to more conventional, long supply chains. This supports the statement that 'Small farms using agroecological techniques may be two to four times more energy-efficient than large conventional farms, in terms of total energy input/output ratios' (Chappell & Lavalle qtd. in IPES 2016, p. 34).

The soil carbon sequestration benefits of organic farming are a matter for debate (Azeez 2009, p. 140; Audsley et al. 2009, p. 6), but the evidence is clear that the other practices on small, agroecological farms such as non-use of artificial fertilisers, minimal tillage, reduced reliance on soya based feeds for livestock and increased energy efficiency contribute to reduced greenhouse gas emissions (Lampkin et al. 2015, p. 77–85). At the other end of the supply chain the significant reduction in food waste and air freighting of fresh produce brought about through direct marketing has potential to reduce both methane and carbon emissions (Garnett 2006, p. 109–110; Griggs 2012, p. 46). Allen et al. (2013, p. 92) show how changes in land use and reduced meat diet, that are in line with the kind of diverse small-scale farming methods discussed in this report could bring about a 73% reduction in CO_2 equivalent emissions.

9.3. Social benefits

It is interesting that the most frequently cited benefits related directly to productivity of better food. Providing customers with food that is healthy, fresh, flavoursome and produced according to high animal welfare standards appeared to be a primary motivation for a majority of respondents, and linked closely with helping people to understand about how their food is produced, and providing a farm environment that nurtures the health and mental wellbeing of workers and customers alike. The high incidence of educational visits, on-farm courses, therapeutic activities and tourist activities directly integrated with the farm reflected their being safer, more interesting and pleasant places to host visitors than larger industrial ones, where tourist diversification activities are often isolated from the farm operation itself.

While community was directly referred to 46 times, local trade in food, and the educational and therapeutic activities, whether formal, or informal, also combine to form a community strengthening web around the farm, as illustrated in the "Multifunctional Benefits" film on page 36. Customers become friends, recipes are shared, produce is bartered, events are celebrated, children play together and volunteers create bonds through shared achievement. The fact that the small farms employ more people, and many offer volunteering opportunities, means that community can form within the farm workforce, in contrast to the loneliness that is becoming ever more prevalent in rural areas as modern farms shed labour (Winter et al. 2016). Furthermore, while the industrialisation of agriculture and the

increasing scale of farming are doing so much to erode trust, reciprocity and cohesion of rural areas (Winter et al. 2016), it appears that the human scale of small farms is making a positive contribution to re-weaving the fabric of rural areas.

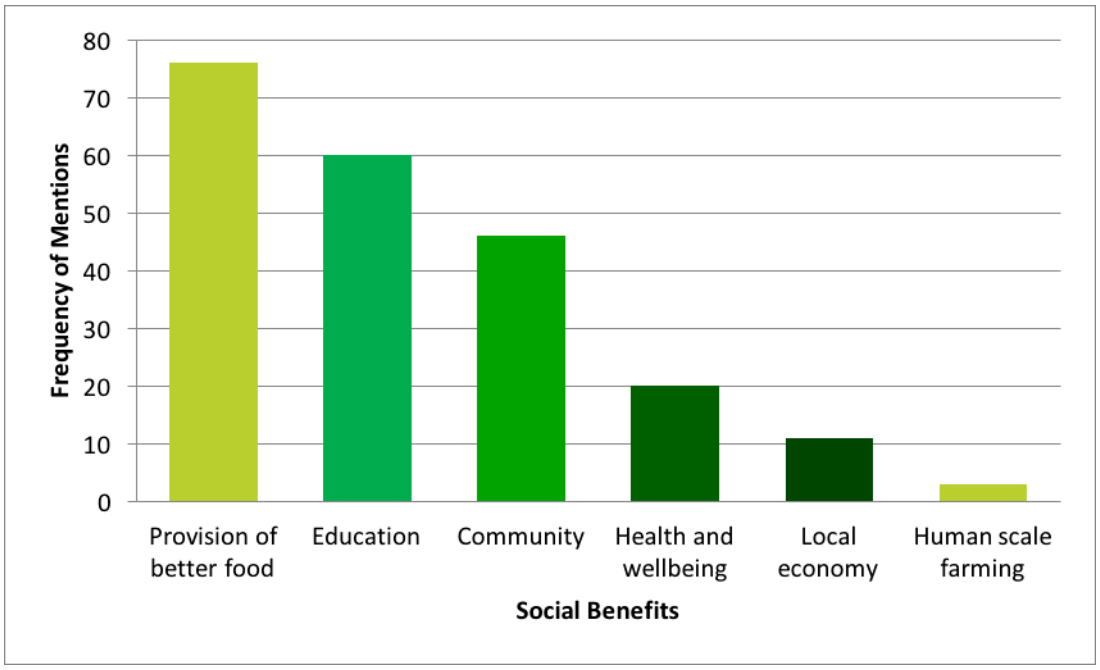


Figure 9.2. Categorisation of responses to the question, 'What are the main social benefits arising from the way you farm?'

9.4. The cost of environmental and social benefits

While some of the benefits discussed above, such as educational courses and campsites, generate a direct income, most are provided as part of the farm's activities with the cost of their provision being born by the farm in the form of the extra time demands on those working at the farm. For example, frequent personal contact with customers, whilst generating good will, takes the farmer away from production, while harvesting from a more diverse poly-cropped system, which encourages biodiversity, takes longer than from a simple monoculture. Although these practices may be rewarded in terms of customer loyalty or greater ecological resilience, the cost is reflected in the long hours that small farmers work, that are often not remunerated financially.

9.5. Inseparable qualities

The growing imperative to address issues such as climate change, anti-biotic and pesticide resistance and biodiversity loss, means that the multifunctional benefits discussed above can no longer be viewed as mere 'beneficial side effects' which come second to yield and viability. However, if any form of agriculture is to gain widespread adoption it is essential that it achieves a balance between productivity and the delivery of environmental and social benefits, which can be seen as three overlapping circles of a Venn diagram (see Wilson 2010, p. 367). Only where the three overlap can 'strong multi-functionality' be said to be achieved, while the environmental and social benefits that don't intersect with productivity are weakened if they can't also deliver economically. Agricultural policy that is aiming for true sustainability must require all three qualities to be met. D'Souza and

Ikerd suggest that in the future the vast majority of sustainable farms will be smaller than today's 'commercial-sized' farm because 'it will take "mind work," not physical or economic muscle, for farmers of the future to find a niche where they carry out their function by means that are ecologically sound, economically viable, and socially responsible' (d'Souza and Ikerd 1996, p. 82). If small scale agroecological farms are able to match larger ones on productivity and financial viability, whilst naturally delivering environmental and social benefits, there is a strong case for encouraging a significant increase of such farms.

Video 5: Small farms offer valuable social and environmental benefits, alongside being productive. Available here: https://vimeo.com/222364134.

Chapter 10 – A Role for Small Farmers in the Twenty-First Century

10.1. A modern mixture

At a time when land is being concentrated into ever larger holdings, to achieve economies of scale and access to global markets, farms of 20 hectares and less could be seen as an anachronism. Yet small farms are in a position to address some of the most pressing environmental, social and economic issues faced by rural areas, whilst providing adequate quantities of fresh and high quality food. Certainly, small farms are no panacea, and the type of agriculture, land quality and climate determines the most appropriate scale. While arable farms and those with poor quality grazing land may need to be larger than 20 ha in the UK, a healthy rural economy, landscape and society needs a mixture of farm sizes. The results of the AMOS survey suggest that small farms could play a significant role in providing healthy food and satisfying employment for the UK population, whilst revitalising rural areas by re-localising trade and re-building community.

10.2. UK fruit and vegetables for all

Since the 1980s there has been a 27% decline in the area given to horticultural production, and the latest available figures show that the UK is 38% self-sufficient in vegetables and 13% self-sufficient in fruit (Schoen and Lang 2016, p. 1; Farm Business Survey 2013/2014, p. 14–15). Fruit and vegetables are by far the greatest source of imports in the UK food system, representing 37% of the UK's total food trade gap of £21 billion in 2014 (Schoen and Lang 2016, p. 2). While many fruits could not be produced in the UK, others such as apples and most soft fruits could, while import substitution of most forms of vegetable would be possible. Schoen and Lang (p. 17) highlight the discrepancy between a health policy, which puts out a message to consume five portions of fruit and vegetables per day, and the lack of a Government strategy to increase domestic supply of fruit and vegetables. A recent meta study indicates that increasing fruit and vegetable intake to 600–800g (10 portions) per day is associated with further reductions in risk of cardiovascular disease, cancer and all-cause mortality (Aune et al. 2017).

The AMOS survey suggests that vegetable production is an area where small growers can produce equivalent yields, compared to national averages for non-organic horticulture, especially of vegetables that are labour intensive to harvest such as beans and leafy crops. A scaling up of the number of small, agroecological market gardens, especially in peri-urban areas, could help reduce the trade gap mentioned above, while providing pleasant and meaningful all year-round employment for local people. Furthermore, respondents in the survey suggested that the health and environmental advantages of vegetables and fruit being produced near to point of consumption and sold directly include freshness, less waste and less energy used in transport. Griggs (2012) outlines a compelling case for government intervention to scale up organic market gardening as a way to increase fruit and vegetable consumption among low income consumers, citing multiple examples of highly productive growing projects that increase accessibility to fresh produce. Similarly, the integrated supply approach taken by Growing Communities in London combines salad and other high value, intensive produce from urban market gardens with field scale crops grown on larger farms in Kent and Essex to supply 1000 households (Growing Communities, pers. comm. February 2017).

10.3. Attracting a new generation of farmers and growers

UK agriculture faces a recruitment issue on two fronts. Firstly, the economic struggles of farming over the last three decades have led many from the current 'working age' generation of farming

families to leave the industry to find easier ways to earn a living. This, combined with the reluctance of older generation farmers to cede 'ownership' of their farms to the active generation means the average age of farm holders in the UK is 59 years (Defra 2015, p. 9). Secondly, industrial horticulturalists struggle to find enough UK workers willing and skilled enough to undertake the manual jobs involved in large scale production horticulture and are reliant on migrant workers from the EU's new member states in Eastern Europe and elsewhere to meet the shortfall in skills and work quality (Schoen and Lang 2016, p. 21).

There is clearly an appetite for work on small-scale agroecological farms, as demonstrated by the younger age profile of the AMOS sample, and the willingness of people to run such holdings for low returns and undertake voluntary work. For agroecological holdings to be economically sustainable as an employment option, they need to be able to develop into businesses that can return a living wage to their workers, and many are already achieving this (Maynard and Green 2006, p. 13). However, the wider motivations to work on or run a small, agroecological farm should also be considered. This study supports the findings of Timmerman and Felix (2015) that work on agroecological holdings offers the opportunity to participate in meaningful, diverse and skill-developing work, as well as providing a congenial social workplace where observation and initiative are encouraged. This is due to organic systems being management-based systems, rather than heavily reliant on inputs (Maynard and Green 2006, p. 12). Since 1957, The Common Agricultural Policy's exhortation 'to increase agricultural productivity by promoting technical progress and […] the optimum utilisation of the factors of production, in particular labour' has been interpreted as maximising production per unit labour (*Treaty of Rome* 1957, Article 39). However, provided the second objective of 'ensuring a fair standard of living for the agricultural community, in particular by increasing the individual earnings of persons engaged in agriculture' is achieved, the provision of meaningful rural employment should be seen as positive, since it provides meaningful livelihoods.

Although the provision of a 'fair standard of living for the agricultural community' is still a struggle in some areas, value adding activities such as direct marketing or processing enable many small farms to offer regular or seasonal employment (Maynard and Green 2006, p. 29). Furthermore, alternative economic structures for farms, such as Community Supported Agriculture or partnerships with other organisations, such as illustrated by Castle Climbing Centre (see p. 21) increase the potential for meaningful employment to be properly remunerated.

The management challenges of farming more sustainably and adding value to make the business viable are already attracting back people who grew up on farms, as well as educated new entrants opting for a career change (Maynard and Green 2006). However, for agriculture, and particularly horticulture, to attract the number of new entrants they need in coming years, the intellectual challenges of agroecology and organic horticulture, with their emphasis on integrated systems (both ecological and economic), resource efficiency and community engagement could provide an added dimension of incentive. With the capital costs of purchasing and equipping a large farm being prohibitively expensive for most new entrants, small farms provide an opportunity to 'get a foot' on the farming ladder, whether through land purchase, tenancies or share-farming arrangements.

10.4. Plentiful food with a positive impact

Small agroecological farms offer multiple environmental and social benefits, whilst simultaneously providing significant quantities of nutritious food and dietary diversity. In conventional agriculture, the provision of agri-environmental benefits is often viewed as a trade-off against productivity, but

many studies show that over the long-term total output from agroecological systems can equate to or even exceed single crop outputs from the same area of land farmed industrially. The yield resilience inherent in agroecology is often a direct result of environment enhancing measures, such as more organic matter in soils helping them to hold water in times of drought or diversity of crops, variety and wild biodiversity enhancing resistance to pest and disease attack (IPES Food 2015, p. 31–34).

No matter how many environmental and social benefits they deliver, it is essential that farms that are addressing the ecological problems brought about by industrial agriculture are also able to produce sufficient food to meet UK requirements. If agroecological farms concentrate solely on their therapeutic and educational benefits, then food has to be produced in some other way and the negative impacts of industrial agriculture will continue. Without agroecological farms striving to be highly productive, they will not be viewed as an alternative for sustainable intensification that relies on high inputs and environmentally and socially damaging high tech solutions, and such practices will continue. This does not necessarily mean producing comparable yields as there is already enough food produced to feed more than the global population of seven billion, if it were not for inefficient industrial livestock, subsidised monoculture energy crops and large amounts of wastage (Schmutz, pers. comm.). One third (1.3 billion tonnes per year) of the edible parts of food produced for human consumption globally are wasted (FAO 2011), and UK households waste 7.3 million tonnes annually (Parfitt et al. 2010). The reduction in waste achieved by the short food chains common amongst agroecological farms could compensate to some degree for slightly lower yields.

Likewise, small scale agroecological farms need to be economically resilient. Chapter 7 showed that many farms in the AMOS survey are performing better than the UK average without the aid of subsidies. However, the economic struggles faced by many small farms arise partly from the fact that they are internalising costs that other farmers do not, and thereby operating on an unlevel playing field by competing on price against non-organic farms operating systems that cause externalities such as soil erosion, biodiversity loss and poor animal welfare. Although the organic premium compensates for this to some degree, it keeps organic food as a niche product only available to those who can afford it. A move away from an area based payment system towards one that rewards delivery of agri-environmental benefits and the production of healthy, affordable food for farms of all sizes would support a thriving small farm sector, while encouraging larger farms to become more sustainable.

10.5. Measures to support small-scale farming

For the benefits delivered by the current minority sector of small-scale agroecological farming to be scaled up, several pre-conditions are necessary. The policy bias towards large scale farming and high-tech agriculture needs to be transformed into a system that recognises the value of different scales and approaches to food production. Market interventions are necessary to support small farms as well as larger ones, to ensure that they can provide secure livelihoods for workers. The area based payments system should be replaced by one that that is size neutral and rewards the delivery of public goods.

A new attitude to farming is needed in the education system, so that students of all abilities are encouraged to consider agriculture and horticulture as fulfilling and remunerative careers for people with initiative and drive. Furthermore, students need to be encouraged to develop practical as well as intellectual skills from an early age. Affordable opportunities to start out in farming could be created by the breaking up of county farms into smaller units, and allowing a planning category for agricultural self-build ‘ecohamlets’. Capital grants or interest free loans to help new entrants purchase equipment and develop infrastructure would enable start up farms to improve efficiency and productivity.

Chapter 11 – Reflections on Methodologies for Measuring and Comparing Productivity

11.1. Lessons from a challenging endeavour

At the outset of the AMOS study it was anticipated that the data would be collected in such a way that it would be comparable with UK standard agricultural data collected by Defra through the June Census and Farm Business Survey (FBS). However, pressures relating to the timing of funding and the need to start the survey during the winter, when farmers/growers would have more time to take part in the survey, meant that insufficient time was spent considering the range of productivity measurement options that could be employed. It was not possible within the time available to undertake a full comparison between AMOS and FBS data. Another insight arising from the challenge of analysing the data was that the survey design and chosen metrics were insufficient to account for the complexity of agroecological systems. Hence, the yield data collected lacks the ability to account for increased productivity arising from poly-cropping, rotations and other agroecological practices, particularly for livestock systems.

11.2. Understanding the parameters of measurement

Over the course of the study, various discussions and farm visits led to a more nuanced understanding of what both farmers and academics mean by productivity, including the variety of parameters against which it could be measured. An early workshop led to understanding of productivity as a relationship between inputs and outputs, which could be either 'traditional' (inputs: capital, fossil fuels, agrochemicals; outputs: food as a commodity, GDP, poor water quality, soil nutrient depletion and CO_2 emissions/climate change) or non-traditional (inputs: skill and knowledge, labour; outputs: pleasure, well-being, health, biodiversity, good food/high nutrients). Such parameters represent either scarce or abundant resources and when aiming for sustainable food production, productivity or efficiency should be measured against the scarce resources, such as land or fossil fuel energy. The concept of productivity as such a relationship is central to the work of Smaje (2011), Garnett (2013) and Brookman (2005) who use concepts such as the comparison of productivity per unit area and per unit labour, and measurement of productivity against greenhouse gas emissions, lifecycle analysis and energy return on investment (EROI). While each of these methods are valuable, they are better suited to focussed surveys on a one or a few holdings, rather the larger sample AMOS aimed to study. Furthermore, they would have had limited value in enabling comparisons to be drawn with larger farms, unless suitable data for such farms had been specially collected, which was beyond the scope of this study.

11.3. Different frameworks of measurement

Advice was sought from the Farm Business Survey to ensure that the questionnaire was designed to deliver such comparable data. The Farm Business Survey is carried out annually to find out who is producing 90% of UK agricultural produce, and how it is being produced. Data is collected from a randomly selected sample from each farming type across different regions of the UK. Participating farms are offered a benchmarking service as an incentive to offer up their data, and give the Farm Business Survey access to their accounts for the relevant data to be extracted. Farm Business Survey data is used in conjunction with statistics collected in the June Census by Defra to provide information on national production. To allow for comparison of UK data with agricultural data across Europe, a common framework is used. It is based on the concept of Standard Output (SO) which is the level of output from an average farm under normal conditions, measured in terms of the financial

value of the main crop plus any bi-product. It varies according to region, to account for land and climate variation, but not method of production. Standard output is presented in the form of tables of co-efficients for each enterprise type. Total SO for each farm is calculated by multiplying its crop areas and average livestock numbers by the appropriate SO coefficient and then summing the result for all enterprises on the farm. SO coefficients are expressed in Euros per hectare of crop and per head of livestock.[2]

Alongside Standard Output, Standard Labour Requirements (SLR) are used to classify farm size. These are standard figures for the labour requirements associated with different livestock and crop types are calculated from a co-efficient based on the labour requirements under typical conditions for enterprises of average size and performance. The co-efficients represent labour requirements in terms of hours per head of livestock or per hectare per year. The number of full-time workers (FTE) required by the farm can be calculated by summing the SLRs for all the enterprises and dividing by 1900 (on the basis that a full-time worker works a 39 hour week and so 1900 hours a year). Defra classifies farms into sizes according to the number of full time equivalents (FTE) employed. A small farm employs 1–2 FTE, a part-time farm 0.5<1 FTE and a spare time farm <0.5 FTE.

Unfortunately, lack of a thorough understanding of how to use the Standard Output framework for comparing the data collected in AMOS meant that this framework for comparison with national data was not fully utilised in the analysis of the data. The advantages of the standardised system used by Defra are recognised as having a valuable function in enabling data to be collected and compared efficiently and accurately, and for enabling comparison with European data. However, the fact that both standard output and standard labour requirements are based on average figures for typical farm types in the UK does not allow for the measurement of variation between different types of management (for example organic versus non-organic). The focus of the AMOS study was the impact of scale and agroecological management methods on the yields, financial viability and multifunctional benefits of farm systems, so it was necessary to select a method of measurement of the actual yields and labour requirements from each farm. Late on in the write-up it was discovered that there would be a way to use the Standard Output system as a tool for comparison, but by then there was insufficient time to reanalyse the data in this framework. A further piece of work could be undertaken to reanalyse data from the AMOS survey in this context.

11.4. Metrics for diversity

Although it was understood from the outset that a distinguishing feature of small-scale, agroecological farms is their diversity, the system of measurement employed was inadequate to quantitatively capture any yield advantages or disadvantages from such systems. A more detailed study of smallholdings from the AMOS survey could have employed techniques such as the Land Equivalency Ratio (LER), which measures the land area required to grow the equivalent yield of three crops separately, as opposed to when they are grown in polyculture (Leibman 1995, p. 205; Lampkin et al. 2015, p. 83). However, the aim was to gather a large quantity of data so results would be statistically significant, and a highly sophisticated system of measurement would have been needed to collect sufficient quality data to apply the LER in the quantity that was aimed for.

[2] Farm Business Survey (2014) Farm Classification in the UK http://farmbusinesssurvey.co.uk/DataBuilder/defra-stats-foodfarm-farmmanage-fbs-UK_Farm_Classification.pdf

One of the biggest challenges was the definition of the area from which a given output of animal products (kilograms of meat, litres of milk, eggs) was produced that would take into the temporal nature of rotation between fields and the integrated nature of enterprises, where output from one system feeds into another (for example whey from cheese-making being fed to pigs). Furthermore, the fact that many pig and poultry enterprises, even on agroecological farms, are largely reliant on bought in feed renders the area in which they actually dwell as meaningless in terms of the land required to raise that quantity of meat or eggs. The latter could be calculated through an ecological foot-printing methodology (Wackernagel and Rees 1996), but as with the Land Equivalent Ratio, such techniques are better suited to studies of a few holdings rather than mass data collection. As outlined elsewhere, it was harder than anticipated to persuade farmers to take part in the survey, but nevertheless carrying out these practices on a dataset of 69 might have proved problematic.

11.5. The challenge of record-keeping

As mentioned above, an aim of AMOS was to attract a large enough sample to make the results statistically significant. The challenge of persuading small-scale farmers and growers to take part in such a survey was underestimated, with the result that the dataset is too small to be properly representative of agroecological farms of 20 ha and less. This could be attributed to the detailed nature of the questionnaire, the completion of which represented a significant time commitment, or a deeper reluctance of growers to keep or share records on productivity and financial viability. Over the course of the AMOS study it has become apparent that the collection of yield and financial data from small-scale growers requires the development of a system that is easy to use and has an in-built motivation, such as benchmarking, to encourage participation (Alderson 2016, p. 16). The AMOS survey, combined with initiatives in other parts of the organic sector, seems to have piqued interest in the issue of yield measurement and financial benchmarking among small-scale producers.

11.6. A trade-off between breadth and depth

On reflection, it is clear that there is a delicate balance to be struck between the sophistication of the system of measuring productivity and keeping a questionnaire simple and brief enough to motivate sufficient respondents to take part. The full complexity of measuring the productivity of diverse agro-ecological farms became apparent throughout the process of designing the questionnaire, conducting the survey and analysing the results. It seems likely that the length of the questionnaire deterred respondents, resulting in a smaller sample size, hence sacrificing breadth. Despite its length, the questionnaire used was still not sufficient to evaluate interesting aspects of small farms such as the impact of polycropping on productivity. Further efforts to research small farm productivity should combine a simpler questionnaire, aimed at motivating a much larger sample to take part, with a number of in depth quantitative case studies to investigate the impact of different cropping practices. Such in-depth studies would enable a better understanding of the productivity implications of integrating livestock and crop enterprises, or facilitate comparisons between simultaneous intercropping and multiple crops grown in succession within a year by using tools such as the Land Equivalent Ratio.

Chapter 12 – Conclusions

The AMOS study has laid the foundation for a more thorough understanding of how to measure the productivity of small holdings. Much work is still required to build on this understanding, to further develop methodology and an effective system for measuring the productivity from diverse and integrated small farms, so that results can be compared to larger farms in a meaningful way. However, a number of key findings can be concluded from this report

12.1. Small farms produce high yields of vegetables, and there is potential for further yield increases as the many new entrants represented become established and develop their skills

Average yields for vegetables that benefit from the labour intensive nature of small market gardens (e.g. salad leaves, beans and kale) are higher than for non-organic field scale operations. Some farms in the study, which were longer established and had more experienced growers, were achieving yields double or even triple those of standard non-organic farms (See Appendix 3). The fact that many of the holdings in the sample are relatively newly established, and run by young or inexperienced growers indicates that there is potential for average yields to increase as skills and experience grow, organic soils develop and the infrastructure of the holdings is refined to increase efficiency.

12.2. Small-scale farms are attracting and incubating a new generation of highly skilled entrepreneurs

A new generation of knowledgeable and motivated workers are choosing small farms as opposed to larger ones, as entrepreneurs, employees and volunteers. Such farms offer an access point for new entrants into agriculture/horticulture with more affordable farms, less investment risk and the opportunity to develop skills 'on the job'. The quality of work environment, which offers interest, meaning and a convivial atmosphere, means people are willing to work long hours for little pay. Although many farms are offering proper paid employment, many of those who are self-employed struggle to generate a sufficient livelihood and have to supplement their farm income with off-farm work. This is not unusual for farms of all sizes. When the financial performance of the AMOS sample is compared to Defra data on farm incomes, a greater proportion of income is derived from food production as opposed to farm subsidies in the AMOS dataset. Nevertheless, the imbalance between low food prices and the high labour demands of small farms creates an immense financial strain, impedes potential productivity increases and sometimes threatens the long term viability of the farm.

12.3. Small farms sell mainly via local supply chains

By selling direct via box schemes, farmers' markets and other short supply chains, food from small farms is fresher when it reaches the customer, as it has usually been picked within a day of delivery. The short time between harvest and delivery reduces waste and the need for refrigeration, while it is possible to sell produce of a greater variety of sizes and cosmetic appearances than supermarket buyers are willing to purchase. Packaging and transport costs are also reduced in comparison to centralised supermarket supply chains, as produce is collected from the farm or delivered within a limited radius of the farm, often using recyclable packaging. The short supply chains build trust and understanding between the farmers and their customers, strengthening community links around the farm.

12.4. Small-scale, agroecological farms deliver more social and environmental benefits than most other farm types

Most of the farmers in the AMOS sample are aiming to create a more sustainable and socially equitable food system. Hence they are naturally motivated to care for the soil and water quality, conserve and enhance diversity (both wild and crop diversity), use natural resources sustainably and reduce greenhouse gas emissions. In comparison to large farms, which often contribute to loneliness and community decline in rural areas, small scale farms are often the focus for strengthening community networks for customers and volunteers, while providing an educational resource for local people.

12.5. Small-scale farms face significant barriers to increasing productivity

The diverse nature and financial pressures of small farms mean success requires overcoming a constant stream of challenges. The cost of agroecological farms delivering environmental and social benefits, for which there is an additional labour cost, is often not remunerated. For example, organic production systems replace herbicide and fertiliser use with manual or mechanical weeding and the use of composts, animal manure and green manures, which have significant labour demands. While a premium price can be achieved for organic food, this does not necessarily cover the additional labour cost of a practice that generates multiple benefits, such as biodiversity and improved soil organic matter. The imbalance between low food prices and the high cost of labour mean a heavy workload for entrepreneurs, especially in the start-up phase. The high cost of land means that gaining secure access is difficult, and capital for investment in infrastructure and equipment, which would improve efficiency, is usually in short supply. Furthermore, UK under investment in appropriate scale technologies and seeds for small, agroecological farmers means they often have to import equipment and inputs from Europe or the United States.

12.6. Small-scale agroecological farms contribute to a healthy diet and lifestyle by producing mostly vegetables and less meat

Small-scale agroecological farms deliver significant quantities of a diverse range of fresh and processed foods, especially vegetables, for which there is a growing demand. Their mixed nature, weighted towards vegetable and fruit production, combined in some cases with high welfare, sustainable animal production, supports the recommended shift towards eating more vegetables and less meat (Schoen and Lang, 2016; Allen et al. 2013). Furthermore, this shift towards less meat and more plant crops, contributes to the changes in land management practices needed to reduce greenhouse gas emissions to 27% of their current levels (Allen et al. 2013). They are doing this largely without the benefit of subsidies, and are naturally delivering environmental benefits and helping local communities to engage with how their food is produced. The potential of such farms to contribute to feeding the UK in the twenty-first century deserves closer attention, since a thriving small farm sector could simultaneously address many of the environmental, social and economic challenges afflicting the food and farming system.

Recommendations for Further Research and Action

1) **A repeat study with methodology improvements**: Revisit the "A Matter of Scale" study in five years from 2014/2015, to identify whether further experience and time for soils to develop has had an impact on yields and financial viability, especially for the newly established holdings in the AMOS study**.** Such a follow up study would enable improved methodologies to be used, and methodological flaws identified in this study to be addressed. These include specifying precisely that the growing area in horticultural systems should include access paths (from mid point to mid point), whether a fixed (raised) bed or row crop system is used. An efficient methodology for collecting input data must be developed, to enable the outputs of different systems to be evaluated in light of different levels of input use. A simpler questionnaire, aimed at attracting a much larger number of respondents combined with in depth studies of fewer holdings, would enable investigation of specific practices that contribute to the productivity of small farms.

2) **Total input and output and diverse systems measurement**: Develop a methodology for measuring the total input and output of diverse small farms that enables them to be compared with large scale farms. The method would need to account for the integrated and cyclical nature of agroecology, rotation of livestock around the holding and distinguish between livestock raised on home produced or bought in feed.

3) **Recordkeeping and benchmarking**: Establish a system for small farmers to record and share productivity data that is simple and easy to use and ties in a benchmarking service to increase motivation to use the data. Work with the Farm Business Survey or Defra to design a system that meets the data needs of small farmers/growers. Defra should provide funding to develop such a system, which could then be used by the Farm Business Survey to expand their activities to take account of the production capacity of small scale and urban, multi benefit agriculture. Future work should continue to take into consideration work done by the Organic Research Centre on horticultural costings, and Sustain on measuring the productivity of urban growing projects.

4) **Quantification of multifunctional benefits**: To strengthen evidence that small scale farms offer environmental and social benefits not present on larger farms, it would be valuable to quantify some of the claims made about multifunctional benefits (including energy sovereignty), and to identify whether it is scale or agroecological/organic management (or a combination of both) that is the causal factor for these benefits. Such quantification would be valuable when collaborating on campaigns with other organisations in providing numerical facts for qualitatively claimed benefits, such as the reduction in food wastage achieved by direct marketing**.**

5) **Policy recognition of the role of small scale farmers:** At present farms of 5 ha and less are not eligible for payments under Pillar 1 of the Common Agricultural Policy, despite the fact that this study indicates that many such farms are producing high quality food in reasonable quantities, generating desirable employment and providing multiple social and environmental

benefits. Agricultural policy should value the role of small farms and urban market gardens as part of the mix of farm scales that is necessary to feed the United Kingdom. A move away from the area based subsidy scheme towards one that rewards public goods on a points based system would remove this inherent bias towards large scale agriculture.

6) **Start-up grants for agroecological farms:** New entrants face significant barriers when establishing farm businesses due to the cost of land, accommodation and capital demands to develop infrastructure and purchase equipment. Provision of grants or interest free loans would enable them to progress faster towards efficiency, productivity and financial success. Scotland and Wales provide such funding, but in England small farmers struggle for years with inadequate equipment and infrastructure due to lack of capital, restricting their capacity to fulfil their potential.

7) **Training and careers advice:** Small scale, agroecological farms already provide desirable employment opportunities due to the varied, skilled and sociable nature of the work. A thriving small farm sector could provide further such employment, attracting UK workers into agricultural jobs. Children should be encouraged from a young age to learn about farming and the practical skills it entails, and provided with informed careers advice about the employment opportunities offered in the agroecological farming sector. Agricultural colleges should provide more training in the highly specific skills required to be a successful agroecological farmer.

8) **Access to land:** The high cost of land and associated accommodation currently restricts the opportunities for new entrants to establish viable businesses. County farms, which traditionally provide a starting point for new entrants, are usually larger than 20 ha and are not appropriate for many of the types of businesses discussed in this study. Dividing some county farms into smaller units, with on-site accommodation, and encouraging land owners to rent or sell small parcels of land to new entrants are two ways in which local and national government could facilitate a rural renaissance.

Appendix 1 – Tables of Production Results

Table A1.1. Summary of meat livestock data

	N=	Average breeding herd/flock size (Range)	Average no. animals sold as meat (range)	Mean total kg meat/year (range)
Cattle	9	3.9 (1-9)	2.68(1-8)	575.38 (100-1760)
Sheep	17	15.77 (3-65)	22.4 (3-80)	496 (20-2000)
Pigs	15	2.9 (2-29)	6.84 (2-29)	416.7(100-2070)
Goat	4	(4-7) n=2	3.5 (2-6) incl. sold as meat stores from one holding	87.5kg (35-140 n=2)
Chickens	3	22.3 (12-40)	15 (both 15)	No data provided
Turkeys/ Geese	5	26 (3-100)	26(3-100)	161.5 (21-560)

Table A1.2. Summary of laying rates of hens, related to flock size

No. eggs per hen	Frequency and flock size
<100 100-199 200-299 300 and over	7 (flock sizes – 5, 32, 20, 10, 25, 50, 4) 6 (flock sizes – 12, 16, 30, 50, 25, 20) 8 (flock sizes – 140, 100, 15, 12, 150, 50, 15, 35) 3 (flock sizes 3, 20 and 50 hens)
N=24 (2 did not provide data)	24

Notes: For comparison, 280 eggs per hen is a standard laying rate for organic systems (Lampkin, M et al. 2014, p. 199), and 312–330 for non-organic (Redman 2015, p. 96).

Table A1.3. Summary of milk yield results from the four dairy holdings

No. milking cows	Total milk yield/yr (litres)	Average yield/cow (litres)	Percentage processed	Additional dairy products
1	2500	2500	75%	Cheese, yoghurt
2	8700	4350	75%	Cheese, yoghurt, cream, ice-cream, Indian sweets
2	3650	1825	30%	Cheese, yoghurt, butter, ice-cream
3	7300	2433	95%	Cheese

Table A1.4. Comparative yield data from organic and non-organic dairy farms (litres/cow/yea

	Organic* (Friesian/ Holstein)	Non-Organic** (Friesian/ Holstein)	Non-Organic Channel Island Breeds**	Organic Yield as % of Non-organic yield	Channel Is. Breed as % of Friesian/ Holstein average
Spring calving	5000	5250-6000 (average 5625)	4150	88%	74%
Autumn calving	No data	7000	5000	No data	71%
All year round calving	6200	8000-9500 (average 8750)	6250	74%	71%

*Notes: *Lampkin et al. 2014, p. 184–186, **Nix Farm Management Pocket Book 2016, p. 4551.*

Table A1.5. Top six yields (kg/m^2) for each of the indicator vegetable in 2014

	Rank of Yield						Mean	Median
	1	2	3	4	5	6	For full dataset	
Potato	8	3.85	3.66	3.2	3	2.9	2.58	1.64
Tomato	15	12.5	10.56	10	9	9	5.13	4
Carrot	10	7.5	5	4	3.3	2.5	3.2	2.5
Leek	12	10	9	6.7	4.2	4	4.37	1.56
Broad bean	7.2	5	4.2	3.6	3.3		2.04	1.03
Squash	11.3	10	7	5.6	5	3.8	2.32	2
French bean	8.4	8	6	4.8	4.6	4	1.92	2.1
Leaf beet and Chard	11.67	10	5.2	5	4	3.8	3.31	1.58
Kale	6.88	4.3	4	2.7	2.6	2.5	2.21	1.15
Salad leaves	9.36	6	4.3	3.3	3	2.7	2.43	1.42
Parsnip	10	3.3	3.2	2.5	2.5	2.4	2.89	2.33
Beetroot	12.8	10	8	5.1	4.5	3.3	3.77	2.95
Onions	6	5	3.6	2.9	2.5	2.15	3.2	2.88
Calabrese	4	2.5	1.67	1	0.6	0.4	1.14	1
Cabbage	10	8	7.5	4	3.6	3.5	3.05	3.25
Courgette	7.35	6.7	6.3	5	3.9	2.6	3.89	2.05
Sweetcorn	2	4	0.9	0.4	0.1	n/a	1.37	0.88

Table A1.6. Top six yields (kg/m^2) for each of the indicator vegetables in 2015

	Rank of Yield						Mean	Median
	1	2	3	4	5	6	For full dataset	
Potato	5.00	3.33	2.88	2.5	2.14	1.63	2.67	2.50
Tomato	17	8.68	7.78	7.5	5	4	5.5	4
Carrot	4	3	2	1.71			2.54	2
Leek	12.8	7.21	5	3.2	2.86	1.5	5.37	5
Broad bean	3.33	2.74	2.64	2	1.88	0.8	1.72	1.94
Squash	4.55	3.33	2.8	2.4	2.2	2	1.22	2.2
French bean	3.07	3	2.13	2	1	0.69	1.51	1.5
Leaf beet and Chard	6	4.68	4.22	2			4.22	4.45
Kale	6	3.11	1.7	1.6	0.2		2.6	2.35
Salad leaves	5	3.63	3	2.5	1.47	0.75	2.73	2.75
Parsnip	4.11	3.2	2.5	2			2.95	2.85
Beetroot	8	4.9	3.5	2.5	2	1.6	3.75	3
Onions	5	3.43	1				3.14	3.43
Calabrese	1						1	1
Cabbage	8	7.5	4	3.61	3.5	3	2.64	2.64
Courgette	6.32	6.25	6.22	6	4.82	2.45	4.81	6
Sweetcorn	1	0.56	0.4				0.65	0.56

Table A1.7. Summary of fruit yields and sample sizes for 2014 and 2015, and comparison with standard organic and non-organic yields

Fruit	N=	2014 Yield kg/sq m Mean (Min-Max)	N=	2015* Yield Kg/sq m Mean (Max-Min)	Organic Yields**	Non-Organic Yield***
Total top fruit	20	1.3 (0-2.5)	4	0.65 (0.02-1)	1.19	n/a
Total soft fruit	19	1.43 (0-13.33)	5	1.02 (0.2-1.67)	0.73	n/a
Apples*	7	0.21 (0-0.8)	4	0.96 (0.02-1.84)	1.19	3.5
Pears*	2	0.75 (0.25-1.24)	1	2	0.8	2.25
Strawberries*	7	1.27 (0-3.75)	4	0.35 (0.2-0.5)	0.73	2.1

Notes: *Autumn survey only ** Lampkin, Measures and Padel 2017, p132-153 *** British Growers Association (pers. comm.)

Table A1.8. Main themes in the answers to the question 'How do you use your land in ways which result in two or more crops from the same land in a given year?'

Method	**Total**
Succession cropping (2 or more crops in one season)	37
Companion planting/Intercropping/Polyculture	19
Green manures/catch crops	6
Rotation within a mixed farm	6
Orchard/Poultry	8
Undersow with legumes	4
Residues used as animal forage crops	3
Woodland coppice/pollard also used as leaf fodder	3
Agroforestry/alley cropping (eg cider apples and annual crops)	3
Stacking/use of vertical space	2
Education	2
Seedlings propagated elsewhere, not direct sown, so can get in extra crop	2
Deep beds	1
Grazing follows hay	1

Table A1.9. Categorisation of responses to the question, 'What are the main barriers that prevent you from increasing productivity?'

		Sub-Total
Time and Labour Issues	Insufficient labour	18
	Can't afford wages because prices too low.	13
	Lack of time	15
	Lack of energy/physical stamina, sometimes age related	6
Total 55	Lack of experience/knowledge	3
Lack of Capital	Inadequate equipment/infrastructure	9
	Insufficient start-up capital	11
Total 22	Lack of CAP payments enabling investment in core production	2
Physical Issues	Land limitations	8
	Lack of space	6
	Weather	5
	Pests and diseases	4
	Weeds	1
Total 26	Accessing manure for fertility	2
Institutional problems	Bureaucracy	2
	Difficulties in marketing produce	4
Total 10	High environmental standards restrict productivity (eg organic)	3
Other	No need to increase productivity/Increasing efficiency is greater	4
Total 3	priority	
	Outside pressures	1

Table A 1.10. Categorisation of answers to the question 'What are the main environmental benefits generated by the way you farm?'

Environmental Practice	**Total No. Mentions**	**Category Total**
Biodiversity		
Generally increased	31	
Habitat creation	8	
Hedges	5	
Tree planting	4	
Hay meadow	1	
Wide headlands/beetle banks	2	
Beneficial insects	4	55
Water		
Rainwater harvesting	1	
Increased water holding capacity of land	5	
Less pollution	5	11
Soil		
General soil care	9	
Improved land fertility/soil structure/soil biological activity	7	
Minimum tillage	2	
Biochar and mulching	2	
Improved sward health/resilience to poaching	2	
Winter cover crops/weeds left as cover	3	25
Other Sustainable Management Practices		
Fewer inputs	8	
Diverse crops	3	
Perennial crops	2	
No pesticides/fertilisers	15	
Low stocking density	1	
Seed saving	1	
Low personal impact	1	31
Energy and Climate change		
Carbon sequestration	25	
Low energy/fossil fuel use	9	
Off-grid	5	39
Food system		
Less packaging	6	
Fewer food miles/shorter supply chain	15	
Less waste	10	
Recycling others' waste as compost	2	
Self-sufficiency	1	34

Table A1.11. Categorisation of answers to the question 'What are the main social benefits generated by the way you farm?'

Social Benefit	**Total No. Mentions**	**Category Total**
Provision of better food		
Fresh food	29	
Healthy food	23	
Good quality/nutrient dense food	3	
Better tasting food	1	
Unusual food (eg Mexican squash)	1	
Affordable	4	
Organic	15	76
Education		
Education	40	
Outreach activities	4	
Maintaining traditional skills and knowledge	1	
Open days/farm walks/open gate policy	15	60
Community		
Community building	19	
Food share with neighbours	8	
Barter (skills, produce)	2	
Farm community	3	
Social events held at farm (meals, bonfires)	2	
Local produce	8	
Fun	1	
Yurt camping	1	
Allotments for local people	2	46
Personal development		
Therapy for mentally ill people/herbal medicine	10	
Opportunity for connection with natural world	7	
Volunteering opportunities	1	
Freedom to think for myself	1	
Challenge	1	20
Local economy		
Job creation	6	
Other businesses located at farm	2	
Support local economy through our agricultural expenditure	3	11
Other		
Keeps farm small/human scale, rather than being swallowed up	3	3

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