The increasing flexibility of machinery and labour inputs to UK farming

A. Errington

Etud. Rech. Syst. Agraires Dév., 1998, 31 : 371-385

The increasing flexibility of machinery and labour inputs to UK farming

Prof. Andrew ERRINGTON

Research Chair in Rural Development, Department of Land Use and Rural Management, The University of Plymouth, Seale-Hayne Campus, Newton Abbot, Devon TQ12 6NQ, UK; Tel.: +44 1626 325664 – Fax : +44 1626 325657; E-mail: aerrington@plymouth.ac.uk.

Abstract

This article reviews the evidence that labour and machinery inputs to UK farming are becoming increasingly flexible with the growth of agricultural contracting and machinery rings. The increased opportunity for farmers to make marginal adjustments to labour and machinery inputs tends to erode some of the economies of size with important implications for economically optimum farm structures. The article first describes and explains the increasing flexibility of the inputs before going on to examine the evidence for systematic variation in labour and machinery costs by enterprise size. The analysis suggests that economies of size persist, particularly among the beef and sheep enterprises. The strongest evidence of the erosion of economies of size is found on the cereals and other cropping enterprises. It is concluded that smaller farms and smaller farm enterprises will continue to face the fundamental problem of higher unit costs for the foreseeable future. The problem is likely to be greatest on those farms (small farms involved in beef and sheep production) and in those areas (LFAs, Objective 1, Objective 5b) where farming appears to display its most beneficial externalities in social and environmental terms.

Keywords: farming; costs of production; machinery; labour; farm structures

Résumé

L'élasticité croissante des intrants en main d'oeuvre et en machinisme dans l'agriculture britannique. *L'article analyse l'élasticité croissante des intrants en main d'oeuvre et en machinisme dûs au recours de plus en plus fréquent à la sous-traitance et aux coopératives de machinisme agricole (« machinery rings »). La possibilité grandissante qu'ont les agriculteurs de réaliser des réajustements à la marge des intrants en main d'oeuvre et en machines tend à entraîner l'érosion de certaines économies d'échelle avec des conséquences importantes pour les structures d'exploitation qui apparaissent optimales du point de vue économique. Dans un premier temps, l'article s'attache à décrire et à expliquer les causes de l'élasticité grandissante de ces intrants puis examine en détail les variations des facteurs main d'oeuvre et machinisme qui apparaissent systématiquement en fonction de la taille des exploitations. L'analyse laisse entrevoir la persistance des économies d'échelle, particulièrement dans les exploitations bovin-viande et ovines. Ceci amène à conclure que dans un avenir proche, le problème fondamental des coûts de production unitaires élevés continuera de se poser pour les les exploitations et les entreprises agricoles les plus petites. Il est probable que ce problème sera plus marqué dans les exploitations d'élevage bovin et ovin et dans les zones défavorisées (Objectif 1 et Objectif 5b), là justement où l'agriculture semble apporter le plus d'avantages sur le plan social et environnemental.*

Mots-clés : *Agriculture, coûts de production, machinisme, main d'oeuvre, structures des exploitations*

Introduction

Conventional farm management accounting practice in the UK makes a major distinction between so-called « fixed » and « variable » costs. Fixed costs are usually defined as those which (a) are not easily allocated to a particular enterprise on farms with a mix of enterprises and (b) do not vary with marginal changes in enterprise size. Variable costs, on the other hand are easily allocated to enterprises and do change with marginal changes in the enterprise. Accounting conventions usually dictate that feed, seed and fertilisers, contract charges and casual labour are treated as variable costs while regular labour and machinery are treated as fixed (MAFF 1977). These conventions have served the industry well over past years facilitating the development and use of planning techniques that concentrate on change at the margin by focusing attention on the gross margin of the enterprise i.e. enterprise output less variable costs.

In the construction of enterprise accounts and the calculation of the profitability of individual enterprises there is on-going debate over the concept of the « net margin » of farm enterprises. The debate surrounds the treatment of fixed costs in enterprise accounts. Some fixed costs - specialist machinery (such as a pea-viner or potato harvester) or specialist labour (such as a dairy cowman) - can be readily allocated to specific enterprises while the costs of some other items (such as a tractor driver or the tractor itself) may be allocated to enterprises on the basis of some standard procedure such as hourly usage. Giles (1986) suggests that « net margin » is the appropriate label for the resulting accounting item, namely enterprise output less all variable and *allocatable* fixed costs. However, in monitoring the profitability of farm enterprises for policy purposes there is an increasing tendency in the UK to allocate the remaining fixed costs of the business (insurance, office expenses, professional fees etc) to enterprises in some more or less arbitrary fashion to arrive at a single measure which is also labelled « net margin ». In using published « net margin » data it is therefore important to check on what definition has been used in generating that data.

The on-going debate over accounting terms may seem of little relevance to the farm sector as a whole but it in fact highlights some fundamental changes in the input markets faced by UK farmers. The most significant of these changes is the increasing « flexibility » of labour and machinery inputs which makes it increasingly feasible to bring about marginal changes in these inputs, which have traditionally been regarded as « fixed ». Indeed, it may be argued that in promoting the efficient operation of the market economy, insufficient attention is paid to the development of markets for farm inputs (such as land, labour, machinery and management) as against the markets for farm outputs. This relative neglect is of particular significance in the newly emerging market economies of eastern and central Europe where the development of these input markets will be crucial to the future prosperity of the agricultural sector.

The ability of markets to deliver increasingly flexible inputs of labour and machinery to farm and horticultural businesses also has important implications for the existing countries of the European Union since it may affect what should be regarded as « good » farm structures. Since the inception of the CAP the prevailing definition of « good » (i.e. economically efficient) farm structures has been couched in terms of enterprise and farm-size. In particular, it is assumed that there are significant economies of size both in the individual farm enterprise and the farm as a whole. Under this assumption, one of the main attractions of enlarging the farm is therefore to spread fixed costs over the larger area and so reduce unit costs. This assumption lay at the heart of the persistent attempts to « improve » farm structures in the 1960s and '70s by policies designed to encourage farm growth through amalgamation (see, for example, the UK Small Farmer Scheme of 1959 and EC Directives 72/159 and 72/160).

However, evidence from recent studies funded by the Ministry of Agriculture, Fisheries and Food (MAFF) in the UK (Wright and Bennett 1993; Errington and Gasson 1996) suggests that significant changes in labour markets coupled with the development of agricultural contracting and machinery « rings » may mean that labour and machinery inputs are becoming progressively less « fixed ». Inasmuch as this is the case, it can no longer be assumed that the optimum size of the farm business will continue to rise. Moreover, the case for securing the continued existence of the smaller farm, at present articulated largely in terms of its perceived environmental and social advantages (Harrison-Mayfield 1996; Raven and Brownbridge 1996), may have a significant economic strand.

This article begins by summarising the evidence from the recent UK studies to review the increasing flexibility of machinery and labour inputs to farming. It then draws on the findings of two national surveys to examine the current relationship between farm and enterprise size and these two major costs of production.

1. The increased demand for agricultural contracting services in the UK

While empirical evidence is rather sparse there is general agreement (Ball, 1987, Errington 1988, Wright and Bennett 1993, Errington and Gasson, 1996) that agricultural contracting[1] has become increasingly important in the UK. For example, in 1995 contract charges comprised 9.6 % of the total variable costs of farms participating in the Farm Business Survey (FBS) in central southern England, compared with only 4 % in 1981 (Ansell and Vaughan 1997). The same survey showed that on farms classified as « predominantly cereal; 150 hectares or less » contract charges accounted for as much as 20 % of the total variable costs.

Why has the use of agricultural contractors increased so markedly in recent years? The answer probably lies in a combination of factors, some of which have influenced the demand for contracting services while others have affected their supply. However, it is important to recognise that agricultural contractors supply the operator as well as the machine itself and explanations for the increased use of contractors must therefore consider changes in both the demand for and the supply of farm labour as well as that of farm machinery.

Where farm machinery is concerned, continuing technological advances in farming methods, embodied in ever-larger and complex machinery and equipment, have raised the break-even point at which farmers can justify their purchase. In the period of agricultural recession and high real interest rates in the 1980s and early 1990s, following hard on the heels of the removal of 100 % first year capital allowances, many UK farmers looked much more critically at their machinery expenditures. Many turned to contractors to carry out their cultivations, spraying, silage-making or harvesting operations. Though the average size of UK farms continued to grow, the break-even point for machinery purchase rose even faster and there was therefore a growing demand for agricultural contracting services.

Another significant development over the same period was the increase in the number of very small, often part-time farms, owned by newcomers to the industry (Gasson, 1988; Errington, 1992). Many of these newcomers, motivated more by the residential attractions of the farmhouse than the potential profits from farming drew heavily on the skills and machinery provided by agricultural contractors when farming their land.

[1] Throughout this article the term « agricultural contracting »" is taken to include the occasional hiring of contract services by farm operators to cover specific farming operations rather than the less common practice of delegating the whole operation of the farm to a contractor.

Where the provision of farm labour is concerned, the past two decades have seen a significant increase in the requirement for « flexible » labour inputs.

Farming has always required a high degree of flexibility in its labour inputs to deal with the seasonal fluctuations in demand that derive from differences in the rate of crop and grass growth caused by seasonal changes in temperature, day-length and rainfall. The progressive intensification of production methods has tended to reduce this seasonal variation in labour requirements either by providing a more controlled production environment (as in glasshouses or poultry sheds) or by requiring progressively more crop treatments with a variety of agrochemicals throughout the year. However, the simultaneous trend of most farms towards greater specialization in fewer enterprises has more than compensated for this, and the arable farmer now faces increasingly « peaky » labour profiles as the complementary livestock enterprises which used to fill out troughs in the labour profile have disappeared from the farm.

While the dimensions and even the timing of peaks and troughs in the labour profile will vary to some extent from one year to the next, these seasonal fluctuations are reasonably predictable. However, the dependence of farming on the manipulation of complex biological systems means that the unpredictability of livestock and the weather also combines with that of staff and machines to produce periodic emergencies that must also be covered by flexible labour inputs, often at very short notice. This is a second reason why farming has always had a much greater demand for flexibility in its labour inputs than have many other sectors of the economy.

But even where labour requirements are both stable and predictable, there may still be a need for flexibility. The long interval between milkings and the need to keep dairy cows, pigs, poultry and glasshouse crops under surveillance means extending normal working hours beyond the 8-hour day and 5-day week, as well as providing cover for absence during holidays. On smaller holdings, farm family members may provide the necessary cover, particularly at weekends and over public holidays (Errington and Gasson, 1994). Where the labour force is very large, as on some mushroom or poultry farms, there may be separate teams of evening or weekend staff. But on many farms other solutions such as variable shift-working are required.

There are therefore three distinctive types of flexibility required of farm labour inputs - to cover *seasonal* variation in labour requirements, to provide cover in *emergencies*, and to provide *regular* cover outside normal working hours. The requirement for these different types of flexibility is illustrated in table 1 which shows that there is considerable variation between livestock and arable enterprises.

	Seasonal (%)	Emergency (%)	Regular (%)	Total (%)
Foremen	26	10	64	100
Dairy cowmen	5	10	85	100
Other stockmen	12	10	78	100
Tractor drivers	47	10	43	100
General farm workers	44	10	46	100
Horticultural workers	8	10	82	100

Source: Gasson and Errington (1994: 63)

Table 1: Distribution of total overtime according to type

A number of other economic, social and technological factors common to a wide range of industries have tended to increase the demand for labour flexibility in farming in recent years. In the first place, greater flexibility has been sought to reduce the costs of production. The greater use of overtime, and of part-timers, seasonal workers, casual workers and contractors can ensure that the permanent workforce is used to full capacity, with the minimum of slack. This is not unique to agriculture. As Meager explains when reviewing the employment practices of a wide range of organisations: « Employers who in the past absorbed fluctuations by keeping permanent manning levels up to peak load requirements, are now aiming for numerical flexibility by keeping their permanent establishments down to the 'off-peak' level, and manning up with temporaries during the peaks » (Meager, 1985: 39).

An OECD report (1986) points to the « need to deal with new social problems » as another factor contributing to the need for more flexible labour inputs. One such problem stems from the process of capital:labour substitution which leaves many small firms increasingly vulnerable to accident or illness. One worker absent in a workforce of five is an inconvenience, in a workforce of two it is an emergency and in a workforce of one it can spell disaster. For peace of mind, farmers need some kind of guarantee that a competent person will be available to step in at short notice if they themselves are incapacitated. This is a growing social problem because the farming population is thinner on the ground, which means there are fewer people in a given locality to help a neighbour in an emergency, and because the workload per person, in terms of cows to be milked for example, is so much greater than it used to be. The relentless labour demands of the small business also have implications for the quality of life of the owner-manager. With most of the population enjoying shorter working hours and more leisure, and with the increased awareness of this fact through the all-pervasive mass media, owner-managers and their families are looking for more regular time off and the chance to take holidays. With little slack in the permanent workforce, there is again a need for regular relief workers, as well as for emergency relief. These were some of the influences which led to the setting up of the relief labour co-operatives in dairying regions of The Netherlands (Helder, 1993) and to the establishment of commercial relief milking agencies such as *LKL* in the UK.

Yet another factor related to changing social « norms » is the effect on family firms of increased female participation in paid employment. Historically, the small family business could respond to fluctuating demands for labour by temporarily diverting family members from household activities. Indeed, this has been a source of considerable competitive advantage to the farm family business (Gasson and Errington, 1993). However, with farmers' wives increasingly employed off the farm there may be a growing number of cases where farmers must resort to flexible hired labour inputs to meet such fluctuations in demand.

A final factor tending to increase the demand for more flexible labour inputs is the pace of technological change. To keep up with the technological treadmill, businessmen are obliged to adopt innovations, or risk being left behind. They therefore require a workforce capable of adjusting successfully to as yet unknown types of change in product or process (Atkinson, 1984). This points up the requirement for flexibility within the core regular workforce which must be prepared to develop new skills and perform tasks different from those for which they were originally recruited - what Atkinson (*op cit.*) calls « functional flexibility ». But an alternative strategy is simply to hire in the additional expertise on a contract basis and this may be particularly attractive to the smaller business which is otherwise denied access to specialised skills.

Finally, rapid developments in information technology may have played a significant role in reducing the transactions costs associated with the acquisition of flexible farm inputs, and the resulting reduction in their effective supply price might have increased the demand for agricultural contracting

services. Improvements in telecommunications and access to business directories such as British Telecom « Yellow Pages » mean that farmers need no longer rely on personal networks to source their specialist labour and machinery needs. The 1970s adage that « the modern farmer needs only land, a telephone and a cheque book » is itself beginning to look outdated in the age of the *Internet* and of *Switch* transactions. At the same time the ready availability of PC-based invoicing systems and databases have played a crucial role in the development of innovative schemes such as machinery rings (Rix, 1994) and labour sharing rings (ATB-Landbase, 1993) which supply flexible machinery and labour inputs to farmers and growers.

2. The supply of agricultural contracting services in the UK

On the supply side, the National Association of Agricultural Contractors (NAAC) quotes a figure of 5,000 agricultural contractors operating in the UK (Custance, 1987). Following a MAFF survey of a large sample of farms in 1992, Wright and Bennett (1993) suggest that the NAAC figure may be a fairly realistic estimate of the numbers of agricultural contractors *excluding those whose main occupation is farming.* However, their own estimates of the proportion of farms in England and Wales undertaking some contracting services are in the region of 16-22 per cent. At 16 per cent this would amount to nearly 29,000 farmer-contractors. The possible implication of these figures - that the bulk of agricultural contracting work is done by other farmers rather than specialist contractors - appears to be supported by a recent pilot survey of labour use on UK farms (Turner and Fogerty, 1994). In 1992, on the 258 farms covered in their survey, a total of 40,764 hours of labour input was provided by agricultural contractors but during the same period, the regular workforce engaged on those farms spent a total of 26,368 hours in contract work on other farms. This suggests that as much as two-thirds of all agricultural contract work may be performed by other farmers. Indeed, it seems likely that a growing proportion of agricultural contracting services are provided not by specialist agricultural contractors but by farmers with spare machinery and labour capacity.

The spare machinery capacity is explicable in terms of the ever-larger and more sophisticated machines that must earn their keep by covering more hectares more quickly. Even if the home farm only justifies part of a machine the additional hectares required to reach and surpass the break-even point may come from selling contract services to other farmers.

The existence of spare labour capacity may be less easy to explain in the face of declining agricultural employment but there is evidence that some farms are acting as an « employment refuge » for children no longer able to find work in the ancillary industries or elsewhere (Fasterding, 1984; Blanc, 1987; Errington, 1988). In these circumstances, a contracting business can at least earn some return to the surplus labour capacity and probably at an implicit wage-rate that undercuts many a specialist agricultural contracting firm.

3. Costs of production

The analysis to date has suggested a number of reasons behind the increased demand for, and supply of, flexible farm inputs in the UK[2]. Inasmuch as these changes have reduced the extent to which farm machinery and labour inputs can still be regarded as « fixed » we would expect the advantages of large-scale production to have been eroded over this time. Two MAFF projects of recent years provide useful

2 It will, of course, be recognised that the demand for flexible inputs varies between different types of farm - see Errington and Bennett (1994) for a fuller discussion of this point.

information to explore the relationship between farm and enterprise size and machinery and labour costs. The first used survey methods to estimate the plant, machinery and buildings costs for a range of farm enterprises and to estimate the residual farm overhead costs for these items; a second survey sought to provide similar estimates of labour input but this time in terms of annual hours rather than monetary value. In each case it is possible to use the resulting data to examine the relationship between input usage, enterprise size (measured in hectares or livestock units), farm size (measured in hectares) and farm-type (using the eight « robust farm-types » devised by MAFF (MAFF, 1993)).

Before presenting this analysis, it is important to bear in mind both the scope and the limitations of the two studies.

In 1992/3, The University of Reading coordinated a national study of « The use of plant, machinery and buildings on farm and horticultural holdings in England and Wales » (Wright and Errington, 1995). The study gathered data about the use of these inputs on 1,046 businesses participating in the Farm Business Survey (FBS) in England and Wales. Table 2 shows the number of observations for each of the main farm enterprises available from this survey.

Enterprise	Number of observations
Dairy cows	301
Beef suckler cows	281
Other cattle	644
Sheep	468
Pigs	78
Poultry	61
Cereals	553
Oilseed Rape	141
Peas and Beans	129
Linseed	88
Potatoes	126
Sugar Beet	112

Table 2: Selected enterprises included in the plant, machinery and buildings study: Number of observations

Since it concentrated on cost items already collected in the FBS no additional instructions regarding the cost categories themselves were required. However, guidelines were prepared for the allocation of costs between enterprises and the treatment of overheads.

A fundamental aspect of the guidelines was the division of costs into « enterprise-specific » and « non-enterprise-specific » categories. Having identified enterprise-specific items in the farm inventory, the depreciation associated with these items was allocated to the relevant enterprises. For example, a farm combine would be entered as « enterprise-specific » and its depreciation apportioned between the combinable crops as appropriate. Similarly, a cow cubicle building would be included as enterprise specific, and allocated to the dairy enterprise.

Where possible, repair costs relating to specific items were identified with the allocation of the balance being made in consultation with the cooperator. Total repair costs were then allocated between the enterprises using the depreciation worksheets as a guide. Fuel for vehicles and tractors was identified separately and allocated between enterprises on the same basis as the depreciation associated with the particular vehicle or tractor.

In recognition of the fact that a proportion of the costs associated with both machinery and buildings cannot be attributed to specific enterprises, provision was made to record overhead use e.g. hedge-cutting, ditching and general farm maintenance. Similarly, on some farms an element of machinery and buildings costs are associated with activities (such as contract work, letting of buildings etc) that are neither attributable to the (traditional) farm enterprises nor classified as « overheads ». These were included as « other activities » and, where applicable, a portion of the total farm costs were allocated to this category[3].

[3] In view of the exploratory nature of this study, the authors of the original report urge caution in the use of the data produced. However, the ability to cross-check aggregate costs for the individual enterprises with the whole-farm total gathered

In 1992, the University of Exeter coordinated a national pilot study of « Labour Use on UK Farms » (Turner and Fogerty 1994). The study sought to test alternative ways in which detailed information on farm labour-use could be collected. It also sought to gather initial information on the allocation of labour between farm enterprises for research and advisory purposes and to assist in updating standard man-day (SMD) coefficients, last updated in 1976.

To test the feasibility of a larger scale study, 275 farms were covered in a pilot survey. An interview-based approach collected ex-post estimates of total labour-use and its allocation from the farmer-cooperator in an approach very similar to the plant, machinery and buildings study described above. The final dataset made available for re-analysis by the present author contained information on 258 farms[4].

Enterprise	Number of observations
Dairy cows	70
Beef suckler cows	79
Other cattle	158
Sheep	118
Pigs	26
Cereals	121
Oilseed Rape	32
Peas and Beans	24
Linseed	17
Potatoes	21
Sugar Beet	16

Table 3: Selected enterprises included in the pilot labour study: Number of observations

Table 3 shows the main agricultural enterprises covered in the study and shows the number of observations available for subsequent analysis. As in the plant, machinery and buildings study, all holdings reporting the particular enterprise were included in this analysis irrespective of the size of that enterprise, provision was made to record overhead labour-use and separate provision made for the labour-use associated with « other activities ».

4. Findings

4.1. Plant and Machinery Costs

Table 4 shows the total allocated machinery costs per hectare for a number of cropping enterprises. The total includes depreciation, repairs and fuel; it does not include contractors charges which were unfortunately not gathered in this survey. In each case, the means and standard deviations are shown for four sub-groups of farms - small, medium, large and very large. Size-group categories were selected which divided the observations roughly by quartile and these are shown in the footnote to the table. For each enterprise, each sub-category was compared with the other three and differences significant at less than the 5 % level according to T-tests were noted.

No statistically significant differences were found in the case of cereals, peas and beans, and sugar beet. The difference between medium and large oilseed rape enterprises was significant, but as the values in table 4 show, the larger enterprises had higher costs than the medium-sized enterprises - the opposite result from that anticipated. A similar result was also observed for potatoes, where the difference between machinery costs on large farms was significantly larger than on medium-sized enterprises. However, in this case the costs on the very large enterprises were significantly lower than those on the large enterprises (but not significantly different from those in the « medium » category).

independently from the farm accounts in the Farm Business Survey provided the opportunity to validate the approach and gave the researchers added confidence in the results obtained.

[4] The author is very grateful to colleagues in the Agricultural Economics Unit at the University of Exeter for making this data available.

Size-Group[1]		Cereals	Oilseed Rape	Peas & Beans	Potatoes	Sugar beet
small	Mean	136.46	131.32	141.96	600.15	208.53
	Std Devn	113.35	69.89	165.30	760.83	145.46
	N	144	38	32	28	29
medium	Mean	126.85	106.10	143.52	407.71	261.50
	Std Devn	70.3	45.27	63.82	252.43	146.35
	N	147	42	36	34	30
large	Mean	135.45	130.97	118.44	597.02	225.28
	Std Devn	65.44	46.90	47.98	443.94	91.03
	N	125	32	34	33	21
very large	Mean	136.17	119.85	122.16	378.03	265.50
	Std Devn	48.99	53.29	61.82	161.38	142.37
	N	137	29	27	30	32
All farms	**Mean**	**133.61**	**121.37**	**132.05**	**493.67**	**242.14**
	Std Devn	**78.78**	**55.36**	**96.09**	**458.93**	**136.73**
	N	**553**	**141**	**129**	**125**	**112**

[1] In each case the sample has been divided into roughly equal segments as follows:
Cereals: (<20 ha); (20<50 ha); (50<100 ha); (100 or more ha).
Oilseed rape: (<15 ha); (15<25 ha); (25<50 ha); (50 or more ha).
Peas and beans: (<7.5 ha); (7.5<15 ha); (15<25 ha); (25 ha or more).
Potatoes: (<3.5 ha); (3.5<7.5 ha); (7.5<20 ha); (20 or more ha).
Sugar beet: (<12.5 ha); (12.5<25 ha); (25<40 ha); (40 or more ha).

Table 4: Machinery costs (£s per hectare) for selected arable enterprises (Great Britain, 1992)

The results of this analysis show no evidence of economies of size for machinery costs among these cropping enterprises and they are therefore consistent with the hypothesis that the development of agricultural contracting services providing more flexible machinery inputs has eroded some of the advantages previously enjoyed by larger farm enterprises. However, this MAFF study did not collect information on the contract charges associated with each enterprise on the farms surveyed. It is still possible that the inclusion of such costs would reveal some systematic differences in total costs if contractors charges were also included (see, for example Davidson and Asby, 1995: 22-23).

Table 5 considers the machinery costs for a number of livestock enterprises. Once again, the observations for each enterprise were divided into four sub-groups by enterprise size, each sub-group was compared with the other three and differences significant at less than the 5 % level according to a T-test were noted. In this case, size was defined in terms of the standard measure, Grazing Livestock Units (GLUs).

The T-test showed no significant differences in the case of the dairy enterprise. In the case of the beef enterprise there were significant differences between the enterprises categorised as small (less than 12 GLUs) and the remaining three categories. However, there were no significant differences between these three categories. The sheep enterprise showed a similar pattern, though in this case there was also a statistically significant difference between the medium and the very large categories.

These findings show a stronger inverse relationship between enterprise size and the unit costs of machinery and equipment on the beef and sheep enterprises as compared with the cropping and dairy enterprises. This is consistent with survey findings about the use of agricultural contractors. For example, Figure 1 (taken from Errington

Size-group[1]		Dairy	Suckler beef	Sheep
Small	Mean	49.98	51.44	49.52
	Std Devn	23.28	45.02	57.31
	N	81	61	127
Medium	Mean	48.22	38.91	27.31
	Std Devn	25.81	24.41	24.06
	N	72	80	112
Large	Mean	57.55	33.02	22.96
	Std Devn	33.78	19.94	15.5
	N	76	62	124
very large	Mean	52.93	34.09	21.37
	Std Devn	27.07	27.70	17.78
	N	72	78	105
All Farms	**Mean**	**52.18**	**38.99**	**30.85**
	Std Devn	**27.81**	**30.79**	**35.95**
	N	**301**	**281**	**468**

[1] In each case the sample has been divided into roughly equal segments as follows:
Dairy cows: (<50); (50<85); (85<130); (130 or more).
Beef suckler cows (Grazing Livestock Units (GLUs)): (<12); (12<24); (24<40); (40 or more).
Ewes (GLUs): (<25); (25<50); (50<90); (90 or more).

Table 5: Machinery costs (£s per grazing livestock unit) for selected livestock enterprises (Great Britain, 1992)

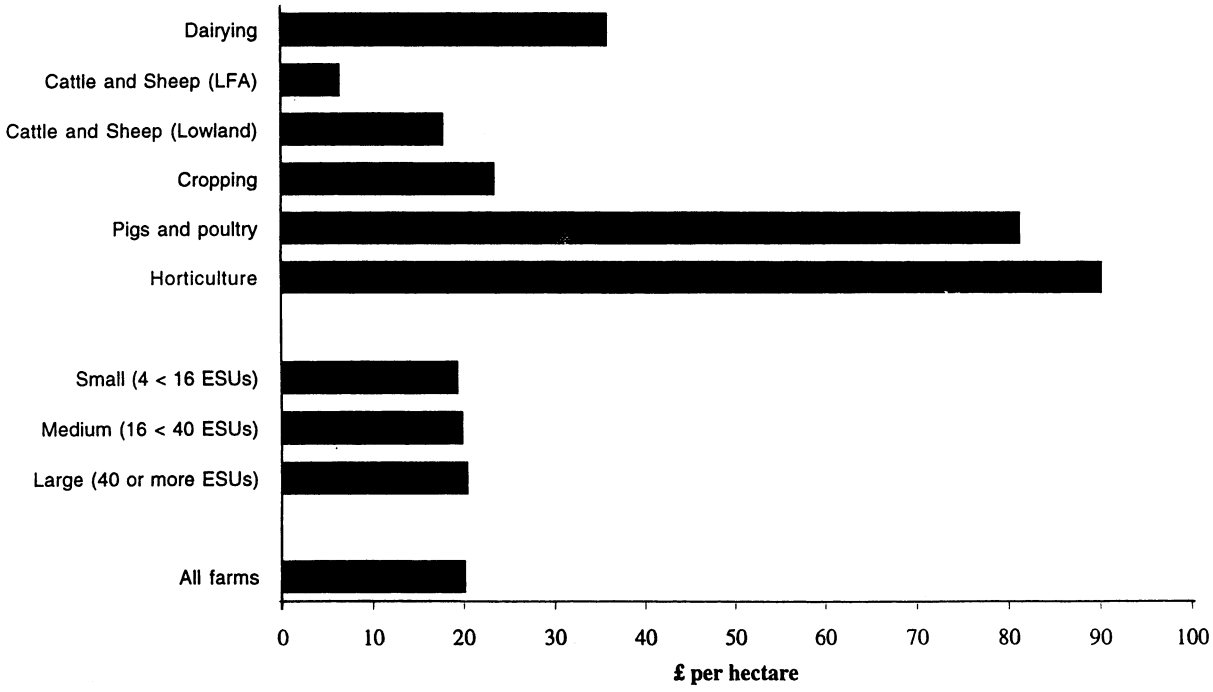

Figure 1: Annual expenditure on agricultural contracting

and Bennett, 1994) shows that agricultural contracting plays a larger part in the provision of machinery inputs to specialist dairy and cropping farms than it does to livestock, and particularly LFA livestock farms. Where agricultural contractors do play a larger role in the provision of machinery (or labour) inputs, there is likely to be a weaker relationship between fixed machinery (or labour) costs and the size of the enterprise since the contractor's services can be used to provide for the marginal increments in these inputs between the « stepped » increments associated with « lumpy » investments in machinery and equipment (or indeed regular labour) by the farm itself.

Why then should agricultural contractors play a larger role in the provision of services to dairy or cropping enterprises than to cattle and sheep enterprises? One of the most likely explanations is the distinctive nature of the flexible inputs required by the different enterprises. Agricultural contractors are best suited to meeting the regular and reasonably predictable seasonal variation in the demand for machinery (and labour) associated with operations such as cultivations, harvesting and silage-making and these operations are more commonly found in cropping and the dairy enterprises.

Another explanation lies in the nature of the farm labour resource. Beef and sheep enterprises are more commonly associated with the family-worked farm with a greater proportion of underemployed family labour whose opportunity cost is very low. In these circumstances there will be less incentive to employ agricultural contractors whose charges cover the labour as well as the machinery they provide.

The findings to date suggest that by providing the means to effect marginal changes in machinery and labour inputs, the increased use of contractors might have eroded the economies of size for certain types of farm enterprise. This is consistent with Davidson and Asby's (1995: 21) finding regarding the cereals enterprise. Having pointed out that it is easier to demonstrate the diseconomies of size among small enterprises than continuing economies of size among very large enterprises, they note that between their two previous surveys of the cereals enterprise in the UK (1979 and 1985) there was clear evidence that the area required to avoid diseconomies had increased and « with the pace of change » (in the size, capacity and cost of most farm equipment) « which occurred between 1979 and 1985 it seemed reasonable to assume that by 1993 the area of cereals required to avoid diseconomies of size would have again increased. In fact this does not appear to have happened. »

But if the increased use of agricultural contractors has tended to alleviate the continuing pressures towards increasing economies of size where the machinery costs of the individual crop and dairy enterprise are concerned, we must not ignore the overhead component of machinery costs. As explained above, the MAFF survey also gathered information on the non-allocatable overhead costs of machinery. Table 6 shows how these overhead costs varied by farm size and type.

In this case, there are clearer indications of the economies of size but these are again much more marked in the case of livestock farms where, as we have explained, the type of flexibility required in both labour and machinery inputs is significantly different from the seasonal flexibility required by cropping farms. The clearest picture of decreasing machinery overhead unit costs associated with increasing farm size appears among farms classified in the robust farm-type « Cattle and Sheep (LFA) ».

Among both the specialist cereal farms and those classified as « General Cropping », the T-test showed statistically significant differences only between those farms with 200 or more hectares and the remaining three size-groups; there were no statistically significant differences between farms in the other three size-groups themselves. In the case of the dairy farms and those classified as « Cattle and Sheep (Lowland) » the T-test showed statistically significant differences only between those farms with less than 50 hectares; there were no statistically significant

UAA Size-group (ha)		Cereals	General cropping	Dairy	Beef and Sheep LFA	Beef and Sheep Lowland
Less than 50	Mean	32.48	44.40	53.54	28.31	60.09
	Std Devn	16.02	39.46	37.51	22.94	85.46
	N	9	16	59	14	22
50<100	Mean	29.46	34.99	41.63	25.85	27.96
	Std Devn	23.02	25.50	28.19	17.61	12.62
	N	36	19	80	56	47
100<200	Mean	29.53	32.36	34.60	19.30	23.99
	Std Devn	17.17	19.95	20.73	15.19	16.11
	N	30	33	34	63	39
200 or more	Mean	17.58	20.16	32.64	8.90	28.02
	Std Devn	6.61	14.09	12.21	8.02	18.18
	N	48	33	5	61	19
All Farms	**Mean**	**25.06**	**30.77**	**43.98**	**18.57**	**32.32**
	Std Devn	**17.10**	**24.75**	**30.87**	**16.43**	**39.59**
	N	**123**	**101**	**178**	**194**	**127**

Table 6: Machinery overhead costs (£s per hectare). Great Britain 1992.

Size-group[1]		Cereals	Dairy	Beef suckler	Sheep
small	Mean	20.64	69.18	54.66	73.01
	Std Devn	16.57	22.35	59.54	51.84
	N	30	22	21	52
medium	Mean	15.58	44.38	50.27	47.61
	Std Devn	6.52	13.38	35.14	21.10
	N	35	15	20	31
large	Mean	14.60	39.19	24.65	38.30
	Std Devn	8.27	13.21	20.69	16.99
	N	33	19	18	21
very large	Mean	11.12	26.10	24.36	23.37
	Std Devn	4.97	6.30	12.57	8.84
	N	29	14	30	16
All Farms	**Mean**	**15.50**	**47.11**	**37.39**	**53.75**
	Std Devn	**10.41**	**22.47**	**37.51**	**40.75**
	N	**127**	**70**	**89**	**120**

[1] In each case divided distribution into roughly equal segments and provide mean, sd and N.
Cereals: (<20 ha); (20<50 ha); (50<100 ha); (100 or more ha).
Dairy cows: (<50); (50<85); (85<130); (130 or more).
Beef suckler cows (GLUs): (<12); (12<24);(24<40); (40 or more).
EWES (GLUs): (<25); (25<50); (50<90); (90 OR MORE).

Table 7: Labour-use (annual hours per hectare or per grazing livestock unit) for selected enterprises (Great Britain, 1992)

differences between farms in the other three size-groups themselves. Only in the case of farms classified « Cattle and Sheep (LFA) » was a clear pattern found of steadily-reducing overhead machinery costs per hectare with statistically significant differences between each of the size groups.

4.2. Labour Costs

Table 7 shows the total allocated labour-use, measured in annual hours. The means and standard deviations are again shown for four sub-groups of farms - small, medium, large and very large - but on this occasion using the same size-groups as tables 4 and 5. For each enterprise, each sub-category was compared with the other three and differences significant at less than the 5 % level according to T-tests were noted.

In all cases, the data suggest decreasing labour-use per hectare or per GLU with increasing size of enterprise and are thus consistent with the assumption of economies of size. However, in the case of cereals the only statistically significant differences were between the very large size-group and the others.

In the case of the livestock enterprises most of the differences were found to be statistically significant at the 5 % level. In the case of the beef enterprise, the only differences that were *not* were between the small and medium size-groups and between the large and very large size-groups. In the case of both the dairy enterprise and the sheep enterprise the only difference that was *not* statistically significant was between the medium and the large size-group.

The evidence suggests that the increasing flexibility of labour inputs has not yet eroded the economies of size to the extent that it has with the machinery inputs, probably because of the importance of family labour as a fixed input on most farms. However, the data again suggest that the erosion may have been greatest where cereal production is concerned and least among the ruminant livestock enterprises.

Conclusion

This article has suggested that labour and machinery inputs to UK farming are becoming increasingly flexible and that this is eroding the usual assumption that there are significant economies of size in farming. The evidence from a number of different surveys reviewed above suggests that while the more flexible labour and machinery inputs provided by agricultural contractors are certainly becoming an increasingly important feature of UK farming, there is still considerable evidence of persistent economies of size. Where it is occurring, the erosion of the relative economic advantage of size is greatest where machinery (rather than labour) costs are concerned and among cropping enterprises; it is least evident among beef and sheep enterprises and on farms classified as « Cattle and Sheep (LFA) ».

Though a number of trends, such as the increasing availability of agricultural contractors, the development of machinery and labour « rings » and the technological developments reducing the transactions costs associated with their operation are likely to continue to erode the economies of size, smaller farms and smaller farm enterprises will continue to face the fundamental problem of higher unit costs, at least for the foreseeable future. Moreover, the problem is likely to be greatest on those farms (small farms involved in beef and sheep production) and in those areas (LFAs, Objective 1, Objective 5b) where farming will continue to display its most beneficial externalities in social and environmental terms.

Acknowledgements

Much of the empirical work upon which the article is based derives from research projects funded by the Ministry of Agriculture, Fisheries and Food (MAFF). The author is grateful to MAFF for their financial support. However, it is emphasised that the views expressed in this article are not necessarily those of MAFF. The author is also grateful to

Ruth Gasson, John Wright, Richard Bennett, David Hallam, Alastair Bailey, Philip Jones and Martin Turner whose collaboration in a number of projects over recent years has fostered the insights upon which this article is based; and to Charlotte Dawson for translating the abstract. However, the author alone is responsible for any errors or omissions that remain.

References

Ansell D.J. and Vaughan R.L., 1997. *Farm Business Data.* Reading, The University of Reading Department of Agricultural and Food Economics, 61 p.

ATB-Landbase, 1993. The Cumbria Skills Ring. *Landbase*, Winter 1993, Kenilworth, ATB-Landbase, National Agricultural Centre.

Atkinson J., 1984. *Flexibility, Uncertainty and Manpower Management.* Brighton, University of Sussex, Institute of Manpower Studies, IMS Report No. 89.

Ball R.M., 1987. Agricultural contractors: some survey findings. *Journal of Agricultural Economics* 38(3): 481-7.

Blanc M., 1987. Family and employment in agriculture; recent changes in France. *Journal of Agricultural Economics*, 38: 289-301.

Custance P.R., 1987. *The prospects for farm contracting in the UK* Newport, Shropshire, Harper Adams Agricultural College Centre for Agri-Food Marketing Studies.

Davidson G. and Asby C., 1995. *UK cereals 1993/94.* Cambridge, Agricultural Economics Unit, Department of Land Economy, Special Studies in Agricultural Economics Report No. 28, 66 p.

Errington A.J.,1988. Disguised unemployment in British agriculture. *Journal of Rural Studies* 4: 1-7.

Errington A., 1992. The changing size and structure of the agricultural and horticultural workforce in England and Wales. Agricultural Economics Society Annual Conference, Aberdeen (UK), 2-6 April 1992.

Errington A.J. and Bennett R., 1994. Agricultural contracting in the UK. *Farm Management*, 8: 405-412.

Errington A.J. and Gasson R.M., 1994. Labour use in the farm family business. *Sociologia Ruralis*, 34: 293-307.

Errington A.J. and Gasson R.M., 1996. The increasing flexibility of the farm and horticultural workforce in England and Wales. *Journal of Rural Studies.*, 12: 127-141.

Fasterding F., 1984. Entwicklung der Bestande an Familienarbeitskraften in landwirtschaftlichen Betrieben. Braunschweig, ISBL Braunschweig-Volkenrode.

Gasson R.M., 1988. *The economics of part-time farming.* Harlow, Longman.

Gasson R.M. and Errington A.J., 1993. *The Farm Family Business.* Wallingford, CAB International, 304 p.

Gasson R.M. and Errington A.J., 1994. *The flexibility of the working week in agriculture.* Unpublished report to sponsors. Reading, Department of Agricultural Economics and Management, The University of Reading, 65 p.

Giles A.K., 1986. *Net Margins and all that.* Reading, The University of Reading Farm Management Unit, Study No. 9, 50 p.

Harrison-Mayfield L.E., 1996. The local economic impact of small farms: a spatial analysis. *Tijdschrift voor Economische en Sociale Geografie*, 87 (5): 387-398.

Helder J., 1993. Arbeidsbehoefte en arbeidsvoorziening in de land- en tuinbouw in Noord-Holland Noord. Mededeling 494, Den Haag: Landbouw-Economisch Instituut.

MAFF, 1977. Definition of terms used in agricultural business management. Booklet 2269, London, HMSO, 38 p.

MAFF, 1993. Farm Incomes in the United Kingdom. London, HMSO.

Meager N., 1985. *Temporary Work in Britain: Its Growth and Changing Rationales.* Brighton, University of Sussex Institute of Manpower Studies Report No. 106.

OECD, 1986. Labour Market Flexibility. Paris, OECD.

Raven H. and Brownbridge M., 1996. Why small farmers? *In* : Carruthers S.P. and Miller F.A. (eds): *Crisis on the family farm: ethics or economics?* Reading, Centre for Agricultural Strategy Paper 28, pp 38-47.

Rix, P.J., 1994. *The Role of Machinery Rings in the Mechanisation Policies of UK Farms.* Reading, Department of Agriculture, The University of Reading, unpublished dissertation.

Turner M. and Fogerty M., 1994. *Labour Use on UK Farms: A Pilot Study.* Exeter, Agricultural Economics Unit, University of Exeter, Special Studies in Agricultural Economics Study No. 24.

Wright J. and Bennett R., 1993. *Agricultural Contracting in the United Kingdom.* Reading, The University of Reading Department of Agricultural Economics and Management, Special Studies in Agricultural Economics Report No. 21.

Wright J. and Errington A.J., 1995. *The use of plant, machinery and buildings on farm and horticultural holdings in England and Wales.* Reading, The University of Reading Department of Agricultural Economics and Management, 35 p.