Appendix 5:
Agricultural Trends and the FBS:
Measuring Changes in Performance and Intensity

(Work Package 3.4)
3 April 2000

Sandra McNally

1. Introduction

The objective of this paper is to contribute to an overview of changes in agriculture in the past decade. The larger overview will provide a useful context in which to consider the environmental changes reported in CS2000. It will also suggest some potential areas of future research in exploring the drivers of countryside change.

This overview draws mostly on information available in the Farm Business Survey for England and Wales. This is an annual survey of about 2,700 farm businesses and gives detailed information on farm characteristics. Our discussion here will be selective, not dealing with national changes in land use, which are more appropriately examined using June Census data. This information is provided in another module. However, this survey is useful for allowing us to examine trends in farm performance and agricultural intensity. Although measures of intensity are whole-farm measures (and therefore quite crude), the survey allows us to examine the context in which intensity has taken place over the last decade. In particular, it will be relevant to know how measures of intensity have changed on different farm types over time. This can further be linked to region and environmental zone, since we know the relative importance of different farm types within these categories.

The report is in three main sections. We first describe some broad characteristics of changes in agricultural performance over time. Then in section 2, we briefly describe the Farm Business Survey for England and Wales and the methodological issues involved in using it to analyse farm-level changes. We show the relative importance of different farm types by environmental zone and Standard Statistical Region. In section 3, we discuss changes in measures of intensity for the different farm types.

2. General changes in agricultural performance

2.1 Net Farm Income

Fig. 2.1 to 2.8 shows trends in average Net Farm Income for different farm types. This information is derived from the Farm Business Survey for England and Wales. The volatility in annual farm income is striking. However, it can be seen that for many farm types, the general trend was upwards for much of the previous decade, most strikingly for mixed farms, cereal farms and general cropping farms between 1993 and 1995. However the dramatic surge in profitability for some farm types between these years is at least matched by the sudden fall in Net Farm Income after 1995.

Net Farm Income is influenced by many factors including output prices input prices, yields, subsidies and technological change. However, it is useful for giving us some idea about the general profitability of different farm types and thus incentives to invest and decisions to enter/exit particular industries. For example, it is clear that there were incentives to expand any business type involving cropping enterprises over much of the previous decade. However, the slump in incomes at the end of the decade is likely to have caused exit out of agriculture for farms that could not withstand the prolonged downturn.

2.2 Price changes

Producer prices are known to be a very important factor influencing farmer behaviour, both in the choice of enterprise and the intensity of production. For example, if the price of root crops increase, one would expect farmers to devote relatively more of their arable area to this crop and to intensify production of this crop to the most profitable level.

Figs. 2.9 to 2.15 show trends in the producer price of some important agricultural commodities. Trends for the following commodities are shown: cereals; root crops; fresh fruit; fresh vegetables; eggs; animals (for slaughter and export); and milk. Although most of the price series show considerable volatility, the general trend up to 1995/96 is one of stability or increase relative to price levels in the 1980s. For example, one can see that for cereals, producer prices were increasing between 1990 and 1993, followed by a small downturn in 1994, an increasing trend up to 1996 and then a sudden and severe fall of about 30%. For animals (slaughter and export) the fall between 1995 and 1997 is closer to 40%.

Clearly, the producer price is not the only factor governing the decision as to what and how much to produce. Other factors such as input prices, prices of other commodities, subsidies and regulations (such as set-aside; quota) are important. Also, one would not expect all farmers to react in the same way to price changes. For example, since there are fixed costs of entering a new type of farm business (e.g. from livestock to arable), higher prices for root crops are not necessarily going to affect livestock producers in any way. Furthermore, returns from production will vary according to factors such as soil quality, which will therefore influence the type of production and intensity.

In Fig. 2.16, we show the ratio of the producer price index to the purchase price index. This has been computed from an index of average producer prices and average purchase prices for all commodities. This ratio has been very stable for much of the decade. However it fell by 20% between 1995 and 1998. However this indicator is very general: what is of most relevance to individual producers is relative producer and purchase prices within particular sectors.

2.3 Subsidies

A major change following the 1992 reforms of the Common Agricultural Policy (CAP) was some substitution towards direct payments and away from price support. In the arable sector, the major change was the introduction of Arable Area Payments and a commitment for most producers to set-aside a proportion of eligible land. An important feature of this scheme is the linking of subsidies to land area. While a farmer can alter his/her payment through the cropping pattern (different rates of subsidy are payable on different types of crop), the level of subsidy does not depend on the intensity of production.

In contrast, for producers of cattle and sheep, direct payments are linked to livestock numbers. While there are some restrictions on intensity of production (e.g. maximum stocking rates; a quota limiting subsidy claims), the system still generates incentives to increase livestock numbers up to the limit (as long as the revenue obtained does not exceed the variable cost of increasing numbers).

Some brief details of the schemes are provided in Appendix 1. In table 2.1, we show a summary of total expenditure on various types of subsidy in the UK Aggregate Agricultural Account between the years of 1992 and 1999. One can see that huge amounts of expenditure are involved in granting direct payments to farmers. In the arable sector, expenditure on arable area payments is particularly high for wheat, barley and oilseed rape (422 million; 256 million and 175 million respectively in 1999). Regarding livestock subsidies, the greatest expenditure is on the annual ewe premium (326 million in 1999), followed by the livestock 'over 30 month scheme'; suckler cow premium and beef special premium (267 million; 260 million and 257 million in 1999). There is also high expenditure on hill livestock compensatory allowances in LFA areas.

Although expenditure on agri-environment schemes has increased dramatically over the decade (from 24 million in 1992 to 165 million in 1999), this is only a small proportion of total expenditure on agricultural subsidies. Nonetheless, it is largely a reflection of the increase in schemes and designated areas over the decade.

2.4 Other changes

One aspect of reforms of the CAP was the introduction of quota for livestock producers, which limits claims on subsidies. These quotas are tradeable so those producers who would like to reduce production have an opportunity to sell or lease their rights to subsidy to another producer. Figs 2.17 and 2.18 show some trading in rights to claim subsidy - most dramatically for leasing out of Suckler Cow Premium from 1997. Fig. 2.19 shows the trend in the leasing out of milk quota. This has a much longer history (since 1984). During the 1990s, there continued to be a steady upward trend. The trading of quota in this way indicates structural change going on within the agricultural sector. Economic theory would predict that over time, quota becomes more concentrated in the control of relatively more efficient producers.

Finally, Fig. 2.20 shows a measure of productivity for the agricultural sector over the decade. The trend in the period 1990-99 is more stable than the previous decade (increasing between 95.9 and 103.9 between 1990 and 1999; between 85.4 and 95.9 between 1980 and 1990). However, the graph shows that despite the problems in the sector, particularly at the end of the decade, on average the amount of output that can be produced per unit of inputs is still increasing.

3. The Farm Business Survey for England and Wales

The Farm Business Survey (FBS) for England and Wales is an annual survey of about 2,700 farm businesses. The survey is conducted by nine Universities and Colleges of Agriculture on behalf of MAFF. The survey is a stratified random sample of farm businesses above eight Economic Size Units (i.e. a measure based on area of cropping and livestock enterprises and Standard Gross Margin calculated for different enterprises in a base year). This excludes about 40% of holdings that fall below this threshold, although they only account for a very small fraction of agricultural production. This is in contrast to the June Census, where only minor holdings (e.g. farms less than 6 hectares) are excluded.

The survey is a panel of farm businesses. This means that each business can stay in the survey for a maximum of 15 years. Prior to 1989/90, there was no time limit on the number of years businesses could stay in the survey.

The survey contains detailed information on many aspects of the farm's production and detailed financial data. This makes it a very good source of information on which to base an analysis of farmer behaviour. For example, it has been used to estimate the supply response of dairy producers to price (Colman and Solomon, 1998) and to examine the relationship between off-farm labour and agricultural subsidies (McNally, 1999). A particularly useful feature of the data is its panel aspect. This enables one to examine relationships 'within groups' of farmers. The point of this is to remove the variation in statistical relationships that is attributable to unobserved differences between farmers. This affects how regression results can be interpreted.

However, when using such a survey to analyse trends, several potential problems arise. Firstly, the FBS is not a representative sample of all farms, but only 'full-time' farm businesses (in the sense of passing the threshold of eight ESUs). This would pose a problem if one believed that farmers operating below the threshold behave very differently to those included in the survey with regard to the variables of interest. However, there is no reason to expect that farmers operating smaller holdings are not also responsive to changing prices, subsidies etc. There is no strong *a priori* reason for stating that the general trend in measures of intensity should not be similar for farms within and outside the survey population covered by the FBS.

Secondly, the panel aspect of the FBS presents a potential problem for describing change in the general population. This arises from the fact that the sample is not drawn at random every year. This poses a problem if farms remaining in the sample become less representative of the general population of farm businesses. A related problem arises if farms drop out of the survey due to some non-random process.[1] For example, if the probability of small farms leaving the survey increases over time, then average farm size in the survey statistics would appear to increase, even though there may be no change in average farm size for all the farms (i.e. those in the survey and leaving the survey). Hence misleading conclusions can be drawn if this problem is ignored. We check is this is a problem in our analysis by examining trends for all farms and for farms remaining in the sample between 1991 and 1997. In general, the trends are very similar, but there are some exceptions that we discuss below.

Although, there are problems with the FBS (as with all data sets), it is one of the best sources of information on farm businesses in the UK. We focus on four main farm-level measures of agricultural intensity: fertiliser expenditure per hectare of cropping area; pesticide expenditure per hectare of cropping area; grazing livestock units per hectare of area in grass, fodder crops and rough grazing; expenditure on animal feed per livestock unit. The expenditure measures are deflated by relevant annual price indices.[2] Thus, movements in the price of these inputs are removed from these trends

[1] Although farm businesses are allowed stay in the survey for a maximum of 15 years, many drop out before this time has elapsed.

[2] Expenditure on fertiliser, pesticides and animal feed are deflated by the price index for fertiliser and soil improvers, plant protection products and animal feedingstuffs respectively. Price indices are provided by MAFF on Website (as with other MAFF data used in this paper).

in intensity. Clearly, these measures of intensity are not equally relevant to all farm types. We analyse movements in fertiliser and pesticide intensity for the following farm types: Cereals; General Cropping; Mixed; Horticulture. We analyse measures relevant to livestock for the following farm types: Cattle and Sheep Lowland; Cattle and Sheep LFA; Mixed; Pigs and Poultry and Dairy.

The trends in intensity (and also performance measures discussed above) are also not equally relevant to all regions and environmental zones within England and Wales. Tables 3.1 and 3.2 show the proportion of different farm types in the Standard Statistical Regions of England and Wales and the proportion of different farm types in each ITE Environmental Zone.

The vast majority of farms in upland areas are classified as "Cattle and Sheep LFA" farms. In other zones, the distribution of farm types is more balanced, though in the Eastern Lowlands, there is a bias towards cropping farms (Cereals and General Cropping account for about 46%), while in the Western Lowlands, there is a bias towards livestock enterprises (Cattle and Sheep LFA, Cattle and Sheep Lowland and Dairy account for about 59%). This type of pattern is also reflected in the relative importance of different farm types within Standard Statistical Regions. Clearly, there are not enough observations of every farm type within each region to allow an analysis of how measures of intensity changed over time by every farm type in every region. However, we would expect changes in intensity for a particular farm type to be most relevant to those regions/environmental zones that contain a high proportion of the farm type.

4. Measures of agricultural intensity

4.1 <u>Fertiliser expenditure per ha of total main products</u>

We consider this measure of intensity for the following farm types: Cereals; General Cropping; and Mixed. Mean fertiliser intensity is reported for the first three types in table 4.1 and shown graphically in Figs. 4.1.1-4.1.3. The three farm types show a very similar trend in fertiliser intensity over the decade. There is a fairly stable trend until about 1991, with a decline observed in 1992, followed by a substantial increase up to 1996. The increase between 1992 and 1995 is very similar for the three farm types (20%, 28% and 33% for Cereal, General Cropping and Mixed farms respectively). It should be remembered that the expenditure measure has been deflated by the fertiliser price index. So changes reflect variation in volume rather than price.

However after 1995, there is a decline in mean fertiliser intensity for all three farm types. The decline between 1995 and 1997 is 12.8%, 20% and 21% for Cereal, General Cropping and Mixed farms respectively. This brings the mean fertiliser intensity down to a similar level (or slightly lower) than at the beginning of the decade. The increase in fertiliser intensity for all three farm types coincides with the steep rise in Net Farm Income occurring between 1993 and 1995 for these farm types. This suggests that high returns from cropping gave rise to the increase in fertiliser intensity that occurred about this time. Similarly, the decline in mean fertiliser intensity coincides with a fall in returns from cropping (as suggested by the decline in Net Farm Income).

The trends generated in this data are not mainly driven by outliers. The trends in the mean value for fertiliser intensity look very similar to trends in the median. Also, the trend between 1991 and 1997 is very similar for all farms in the survey and only those farms remaining in the survey between 1991 and 1997. Thus there has not been non-random attrition from the survey which affects these trends.

By regresing the log of fertiliser intensity against a time trend, we can compute the annual average rate of change between 1988 and 1997. For the period as a whole, there is an annual rate of increase of 0.7%, 0.6% and 1% for Cereal farms, General Cropping farms and Mixed Farms respectively. However, as the below table shows, the pattern of change is certainly not even between years. Another point worth mentioning is that fertiliser intensity appears to be considerable higher on Mixed farms. The level is more similar for Cereal and General Cropping farms, though higher on the latter farm type.

4.2 <u>Pesticide expenditure per ha of total main products</u>

We refer to 'pesticide expenditure per ha of total main products' as a measure of pesticide intensity. However, there are some comments that should be made about this measure before proceeding. First, in the FBS, the expenditure measure is referred to as 'crop protection expenditure'. We assume that much of this measure reflects use of pesticides and that it is a reasonable proxy. Secondly, we interpret this variable to reflect changes in the intensity of pesticide use. The variable is deflated by the price index for plant protection products. However, to the extent that there is variation in the type of plant protection products purchased by farmers in the FBS (and their corresponding environmental impact), there are some problems in interpreting the variable. For example, a farmer purchasing a relatively more expensive and less damaging type of product may appear (in our analysis) to be more intensive than another farmer using a less expensive product over the same land area. However, for the purposes of this paper, we assume that the general trend in 'pesticide expenditure per ha' reflects intensity of use rather than changes in the type of products purchased by farmers.

We also consider this measure of intensity for Cereals; General Cropping; and Mixed farm types. Mean pesticide expenditure per ha of total main products is reported for the first three types in table 4.2 and shown graphically in Figs. 4.2.1-4.2.3. Again the trends are very similar for the three farm types, though there seems to be higher mean pesticide expenditure per ha on General Cropping farms than on the other two farm types. On average, the trend within each of the farm types has been upwards. Regressing the log of pesticide intensity against a time trend for each farm type shows that this measure has increased on average by a rate of 0.5%, 0.9% and 0.9% per annum for Cereal, General Cropping and Mixed farms respectively between 1988 and 1997. The main increase occurs between 1992 and 1995, with a decline in 1996 and 1997. In this respect, the trends are very similar to the measure of fertiliser intensity. This strengthens our interpretation of 'pesticide expenditure per ha' as a measure of changes in the volume of intensity (rather than in the type of products purchased by farmers). Also, the increase occurs at a time of very high Net Farm Incomes within each sector. As expected, farmers become more intensive when returns to production increase. The trends shown are very similar to trends in median values and trends in mean values for farms staying in the survey between 1991 and 1997.

4.3 A note on Horticultural holdings

Horticultural holdings are also intensive users of fertiliser and pesticide. However, the measures reported above may not be as relevant for this farm type because fertiliser and pesticide may be used intensively in green-houses rather than spread over land. However we report trends in fertiliser and pesticide per ha of total main products. Even if the measure is less meaningful, it does show how fertiliser and pesticide use have increased over time for farms in the FBS. Trends are shown in Table 4.3 and Figs. 4.3.1. and 4.3.2. Mean and median values are reported in Table 4.3.1. because of the very marked difference between the magnitude of these summary statistics. However, the trends are quite similar showing a very high rate of increase over the decade. The trends are broadly similar for farms remaining in the survey between 1991 and 1997.

4.4. Grazing livestock units per ha of grass, fodder crops and rough grazing

We consider this measure of intensity for the following farm types: Cattle and Sheep LFA; Cattle and Sheep Lowland; Mixed; and Dairy.

With this measure of intensity, there are some significant differences between trends in average measures for all farms and for only those farms remaining in the survey between 1991 and 1997. This is most evident for Cattle and Sheep LFA farms. Fig 4.4.1 illustrates this and average values for both groups are reported in table 4.4.1. While there is an upward trend in GLUs per ha for all farms (by 16% between 1988 and 1991), the trend is fairly static for only those farms remaining in the sample between 1990 and 1991.[3] In table 4.4.1, we also show trends in the area of land in grass, fodder crops and rough grazing for both groups; and Grazing Livestock Units for both groups. The difference between the two groups is consistent with the possibility that large farms are more likely to leave the survey or that small farms are more likely to be included in the survey over this time period. This problem might indicate some sort of structural change going on within this farm type over the period. It is interesting the trends in the number of Grazing Livestock Units diverge after 1993 - the year of a major policy reform. However, the problem may be just a quirk of the data.

This problem is also apparent in trends for Cattle and Sheep Lowland farms. However, for this farm type, both groups (i.e. all farms and farms in the survey between 1991 and 1997) show smaller percentage changes over time. The median measure of GLUs per ha (which is similar for both groups) shows a slight decreasing trend of about 3% between the two years of 1988 and 1997.

The measure of GLUs per ha is higher on lowland than on upland farms. In absolute terms, the level of GLUs per ha may seem fairly low.[4] However, the denominator is likely to be an overestimate of the forage area.

[3] The same pattern is observed if we consider median values.
[4] For example, the Suckler Cow Premium is subject to a maximum stocking rate of 3 livestock units per forage hectare in 1994; 2.5 in 1995; 2 in 1996).

Trends in GLUs per ha for dairy farms and mixed farms are broadly similar for farms that remain in the sample between 1991 and 1997 and for all farms. In the case of mixed farms, there is a noticeable increase in stocking density between the years of 1993 and 1995 (about 14%), with a decrease in subsequent years (Fig. 4.4.2). However, the change in the median value over time is much less dramatic (table 4.4.3).

For dairy farms, the change over time in stocking density is very modest - there is only about one per cent difference between the two years of 1988 and 1997. The fairly static trend is shown in Fig. 4.4.3). Mean GLUs per ha on dairy farms are considerably higher than for the other farm types.

In general, this farm-level measure of agricultural intensity does not suggest big changes over time. While mean Grazing Livestock Units have increased over time for all farm types except mixed farms, there has generally been a commensurate increase in land used for grass, fodder crops and rough grazing. However, if animals are being concentrated in particular parts of 'land in grass, fodder crops and rough grazing', then this indicator may not be strongly related to actual changes in intensity on the farm. Also, environmental damage could be related to the type of livestock on the farms. So if farmers are substituting sheep for cattle, the same level of GLUs per ha could be associated with different amounts of environmental damage. Nonetheless, this analysis suggests that if there is environmental damage on livestock farms, this is not likely to have been caused by an increase in overall intensity occurring between 1988 and 1997. Indeed, one would expect the CAP measures of linking livestock payments to maximum stocking rates to have prevented much increase in the overall level of intensity (see appendix).

4.4 Expenditure on animal feed per Livestock Unit

Finally, we briefly consider this measure for all livestock farm types. This is shown in Figs. 4.5.1 to 4.5.5. Clearly, the highest expenditure per livestock unit is found on Pig and Poultry farms. The figures for all the other farm types are much lower - and lowest for Cattle and Sheep LFA farms.

For most farm types, there is some upward trend in the mid-90s which declines in 1996/97. However, for the decade as a whole, the level of expenditure on animal feed is similar in 1997 to its level in 1988. Cattle and Sheep Lowland farms are the only farm type that appears to show a downward trend for most of the decade. The trend shows most variation for the Pig and Poultry farm type. In general, it appears fairly stable on Mixed farms, Cattle and Sheep LFA farms and on Dairy farms.

There may be a link between this measure of intensity and production of P in animal manure. This is more of an issue on Pig and Poultry farms (and also some large dairy units). The graphs indicate that this measure of intensity is no worse in 1997 than it was in 1988. The annual rate of change for Pig and Poultry farms is negative - though not statistically significant.

5. Conclusion

For many farm types, especially for those involving cropping enterprises, the past decade has been a fairly buoyant period for Net Farm Income up until about 1995.

However, trends in income show great volatility. Part of the increase in income reflects increasing returns from production. This appears to be reflected in measures of fertiliser and pesticide intensity. Both measures show an average annual rate of increase.

The trends in measures of stocking density are harder to interpret. However, the analysis in this paper does not suggest very dramatic changes over the decade. The reforms of the CAP are likely to have contributed to limits on the overall level of intensification (e.g. maximum stocking rates as a condition for livestock subsidies). Similarly, for most farm types, changes in expenditure on animal feed per livestock unit have been modest.

References:

Colman, D., and Soloman, A., (1998), Direct estimation of supply response by milk producers, Agricultural Economics Society conference. March 1998. University of Reading.

McNally, S., CAP reform and off-farm labour: panel data analysis in England and Wales (1988-1996). Working paper: presented at Agricultural Economics Society conference (March, 1999) and European Population Economics Society conference (June, 1999).

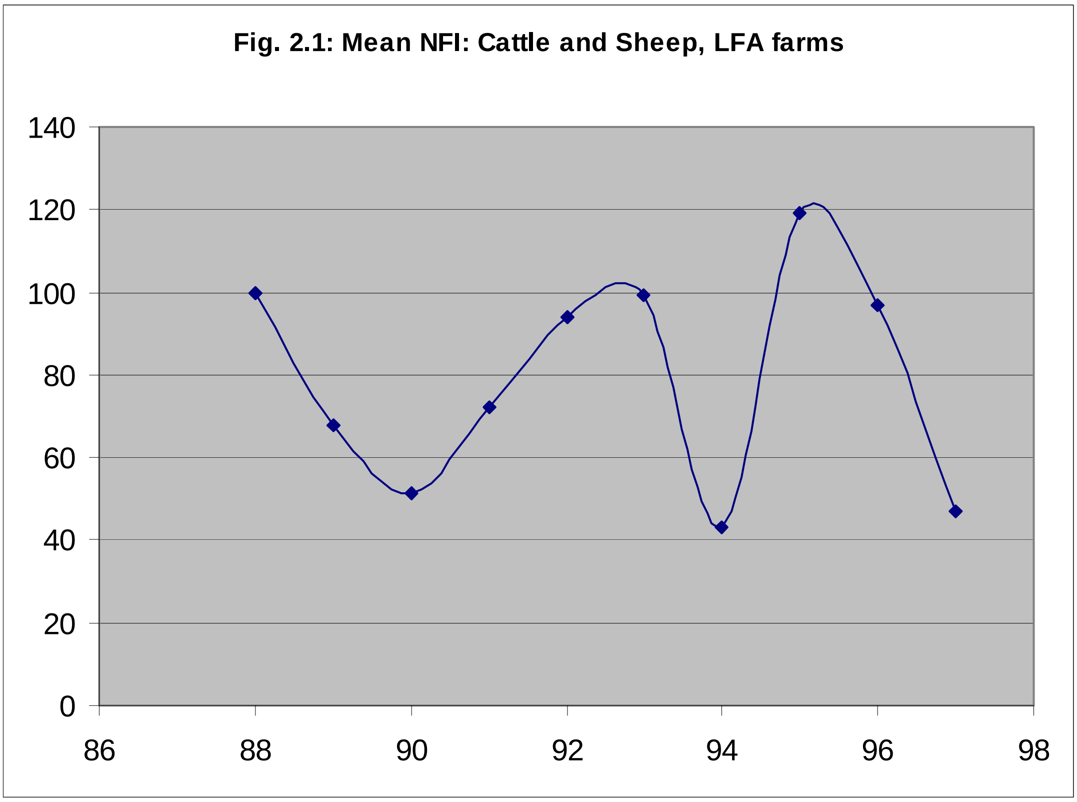


Fig. 2.1: Mean NFI: Cattle and Sheep, LFA farms
140
120
100
80
60
40
20
0
86
88
90
92
94
96
98

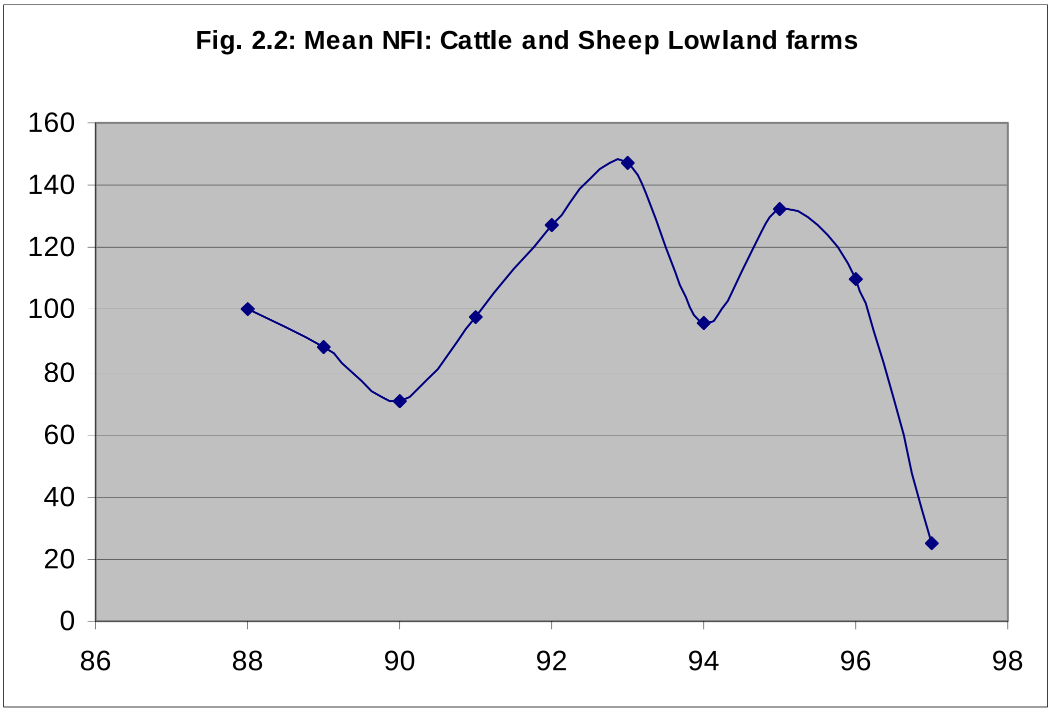


Fig. 2.2: Mean NFI: Cattle and Sheep Lowland farms
160
140
120
100
80
60
40
20
0
86
88
90
92
94
96
98

Fig. 2.3: Mean NFI: Mixed farms

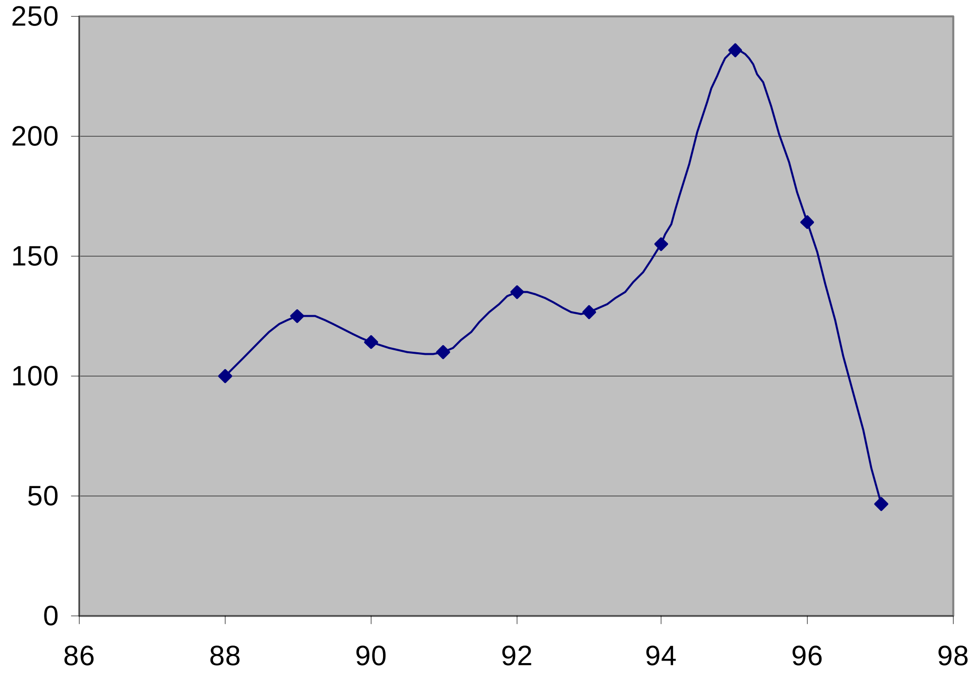
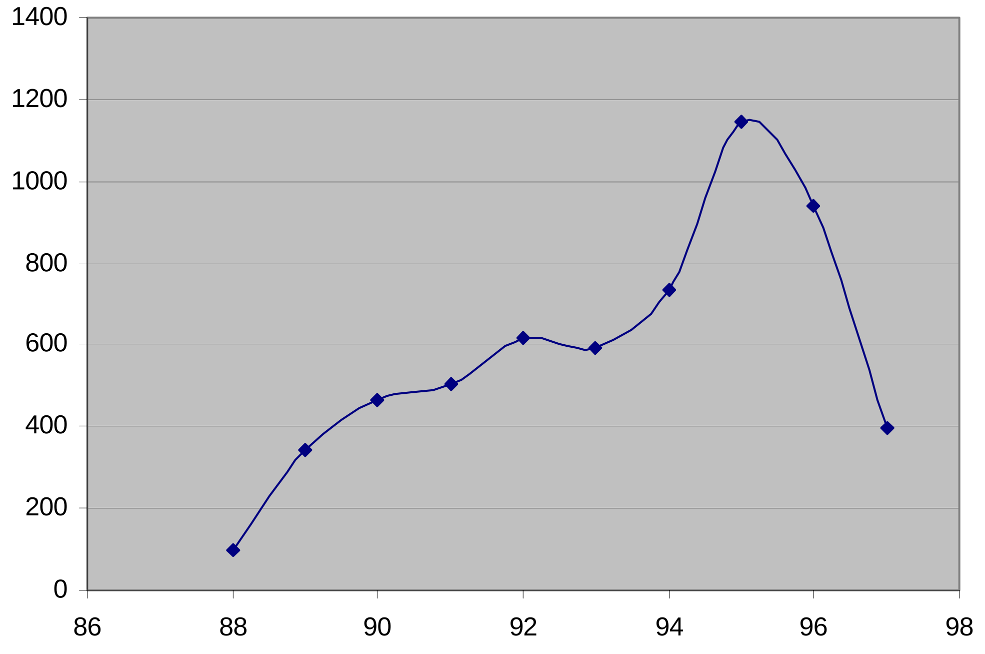


FIg. 2.4: Mean NFI: Cereal farms



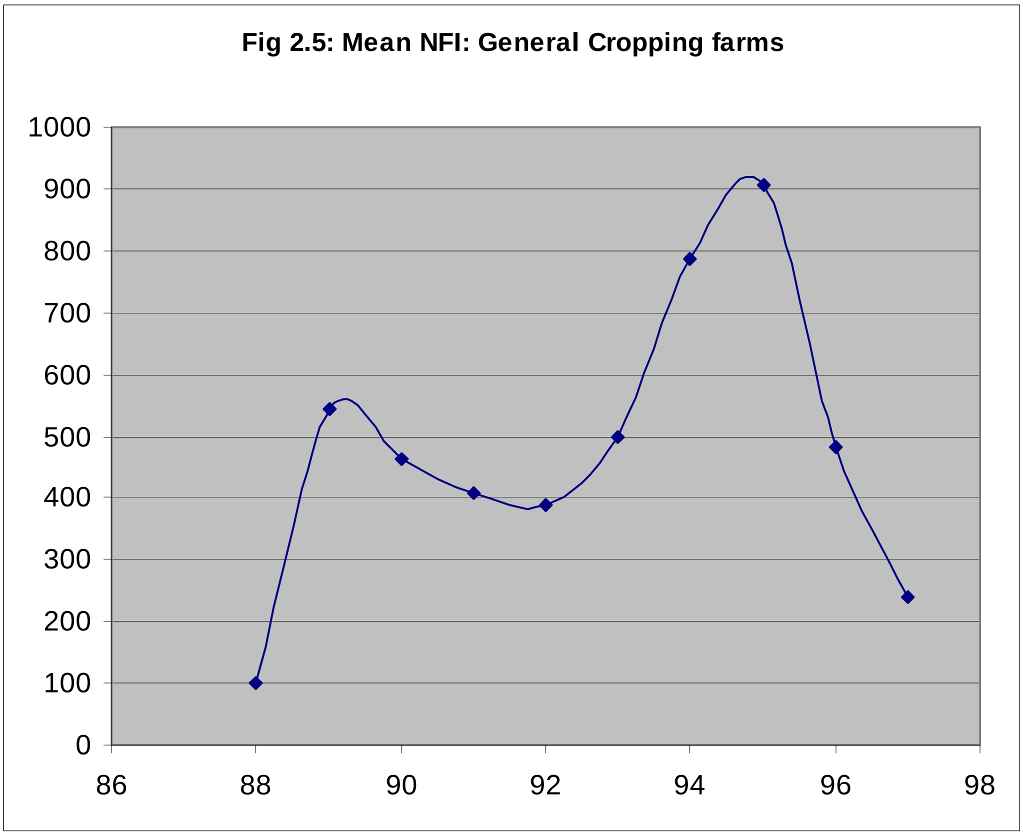


Fig 2.5: Mean NFI: General Cropping farms
1000
900
800
700
600
500
400
300
200
100
0
86
88
90
92
94
96
98

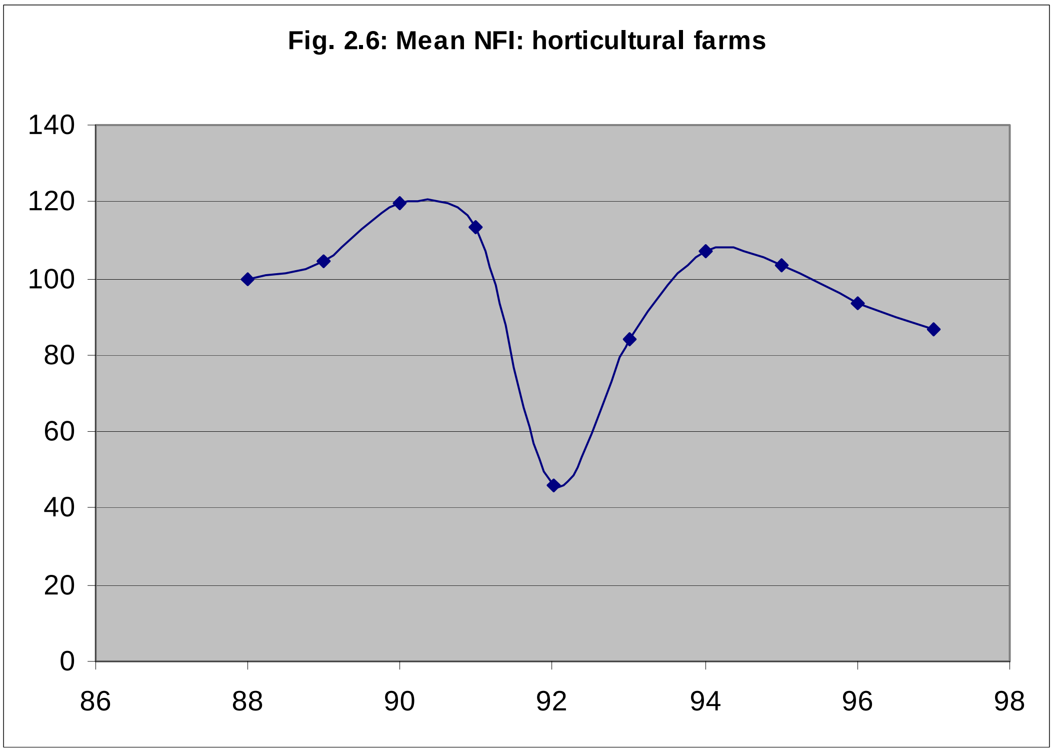


Fig. 2.6: Mean NFI: horticultural farms
140
120
100
80
60
40
20
0
86
88
90
92
94
96
98

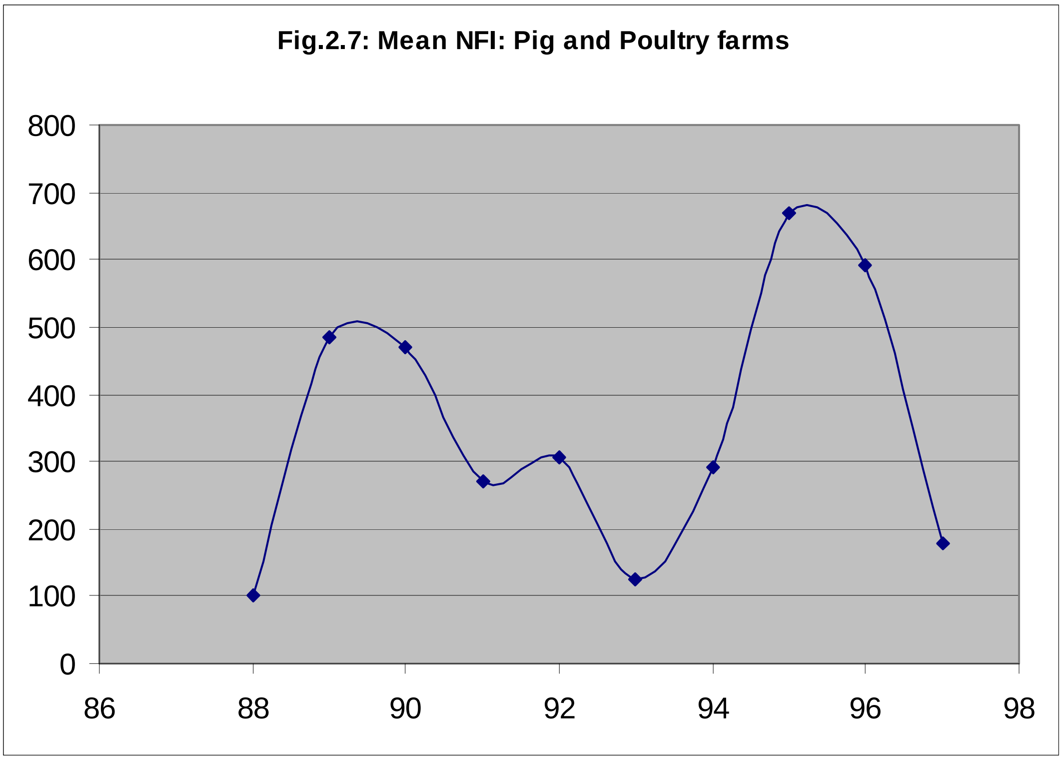


Fig.2.7: Mean NFI: Pig and Poultry farms
800
700
600
500
400
300
200
100
0
86
88
90
92
94
96
98

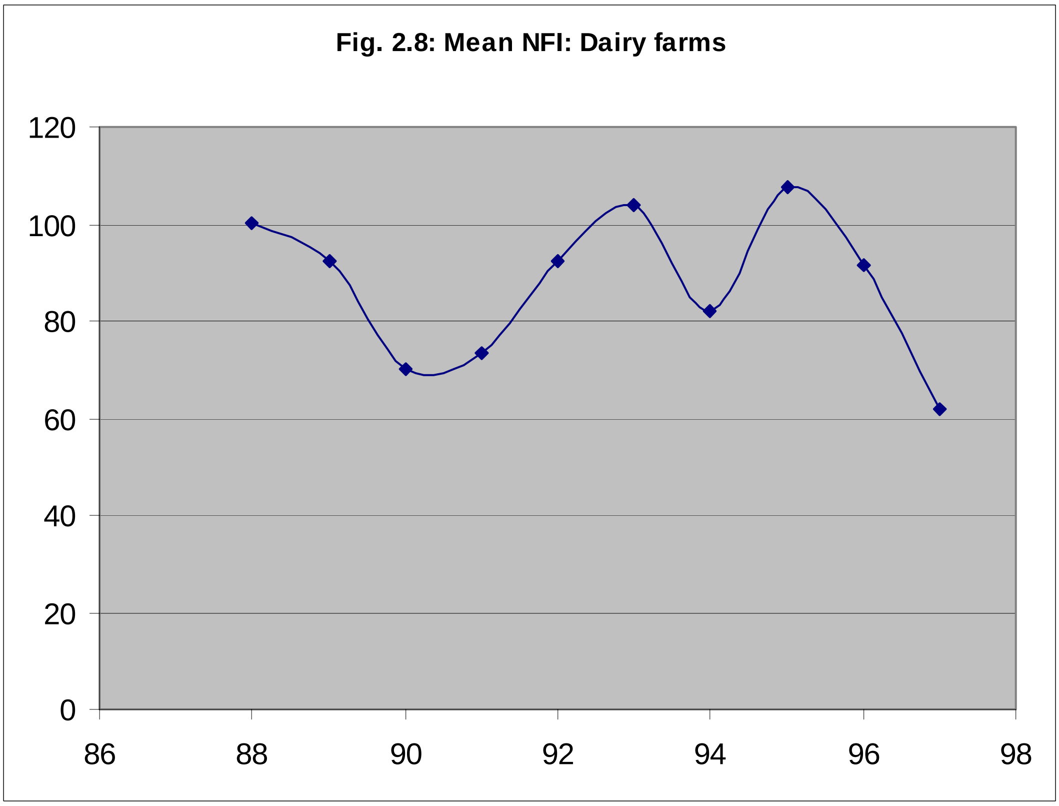


Fig. 2.8: Mean NFI: Dairy farms
120
100
80
60
40
20
0
86
88
90
92
94
96
98

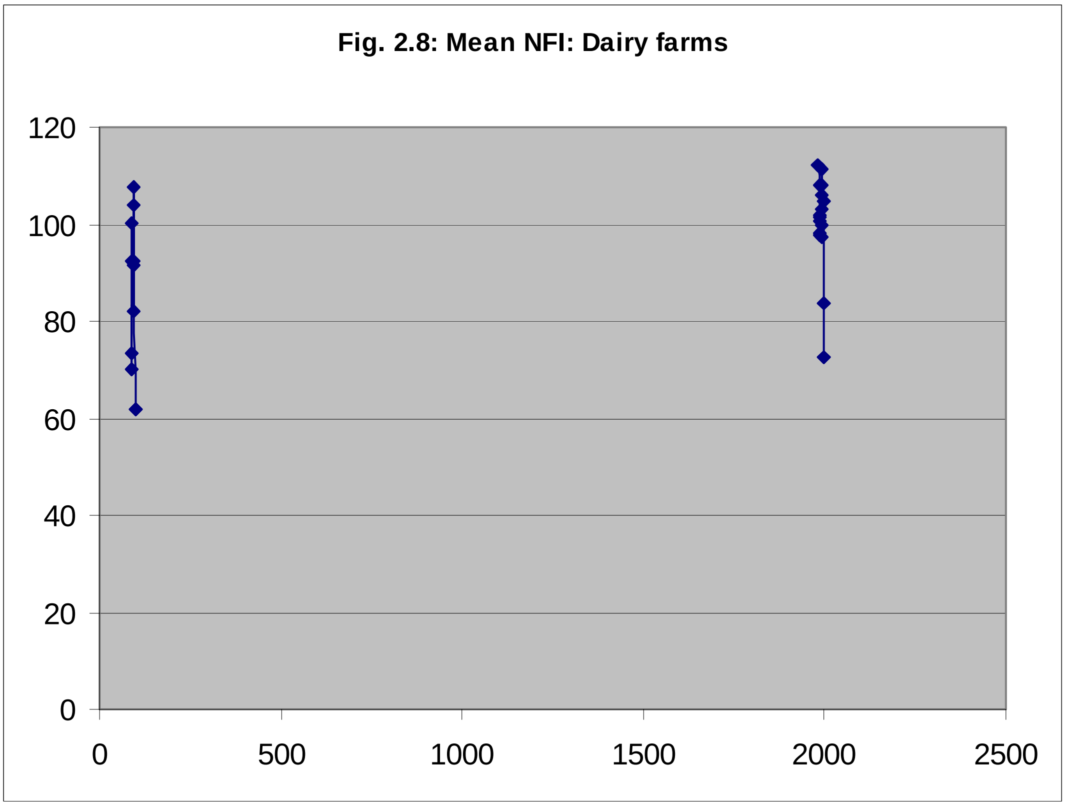


Fig. 2.8: Mean NFI: Dairy farms
120
100
80
60
40
20
0
0
500
1000
1500
2000
2500

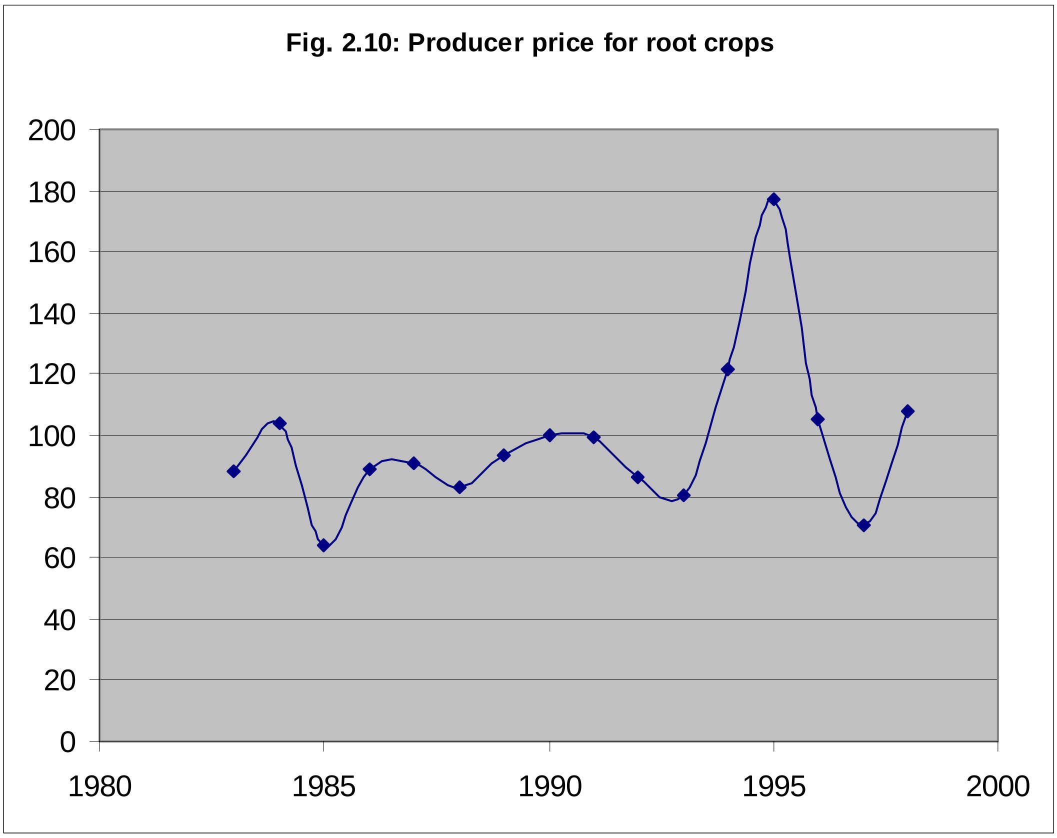


Fig. 2.10: Producer price for root crops
200
180
160
140
120
100
80
60
40
20
0
1980
1985
1990
1995
2000

Fig. 2.11: Producer prices for fresh fruit

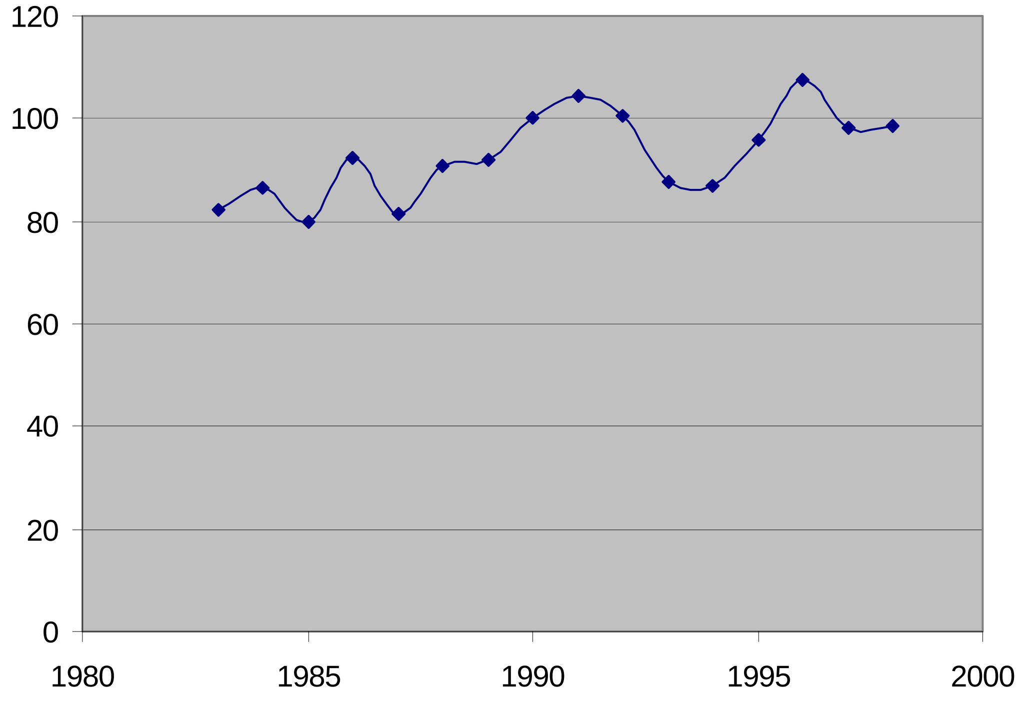


Fig.2.12: Producer price for fresh vegetables

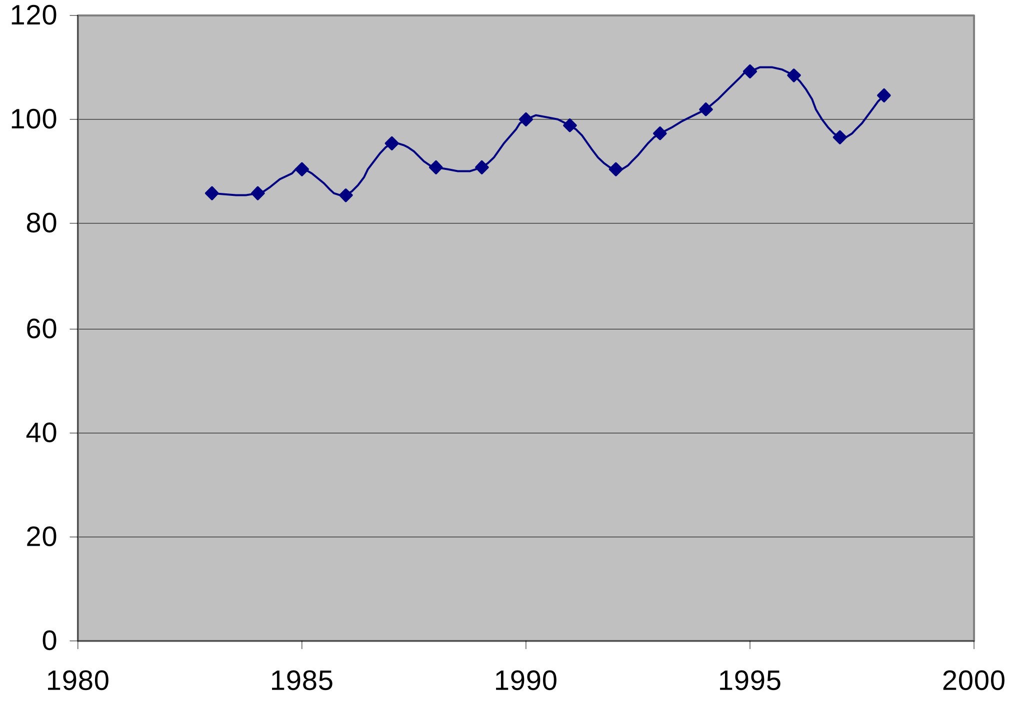


Fig. 2.13: Producer price for eggs

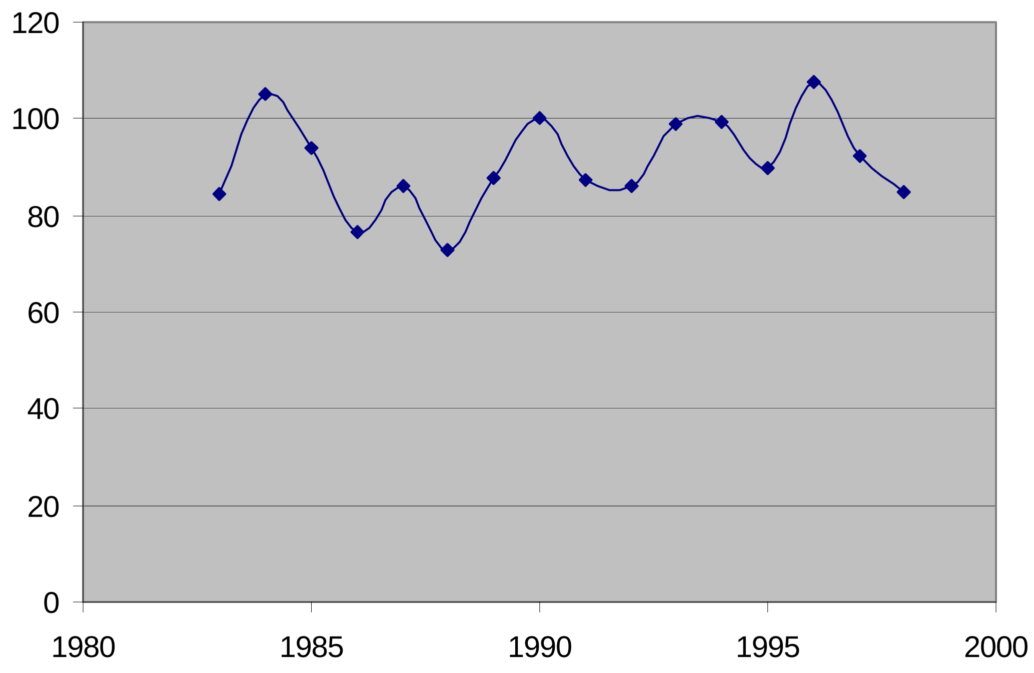


Fig. 2.14: Producer price: animals (for slaughter and export)

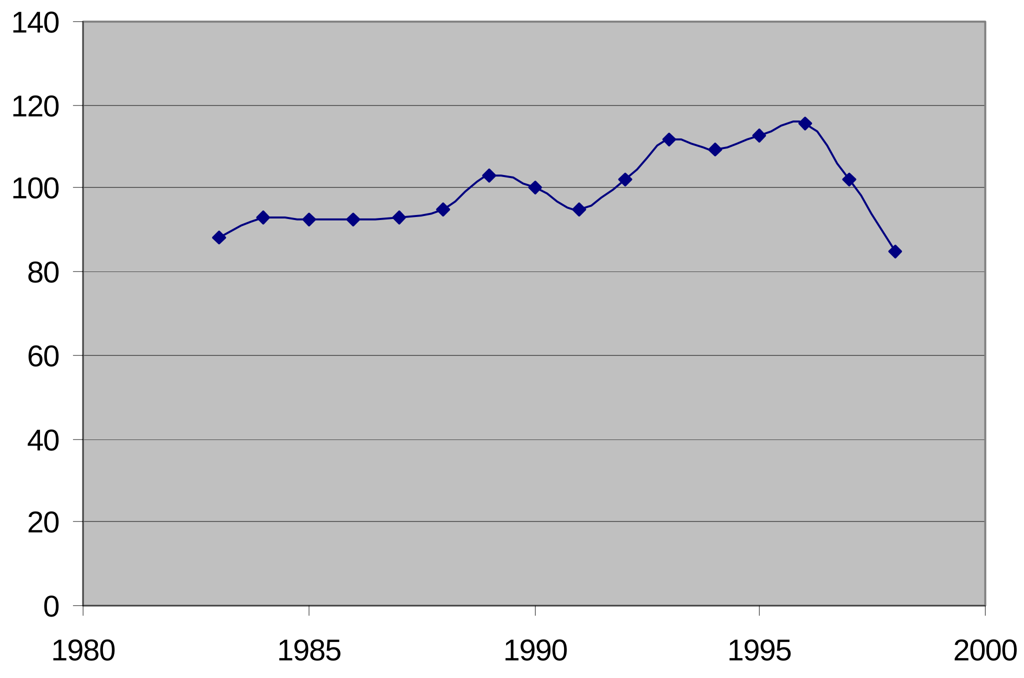


Fig. 2.15: Producer price for milk

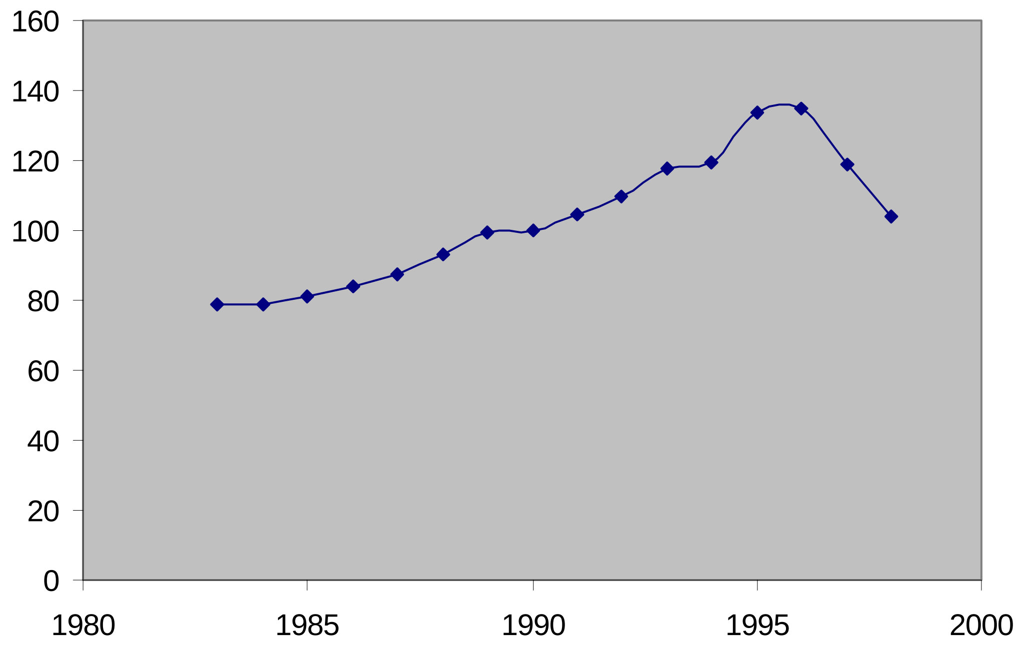
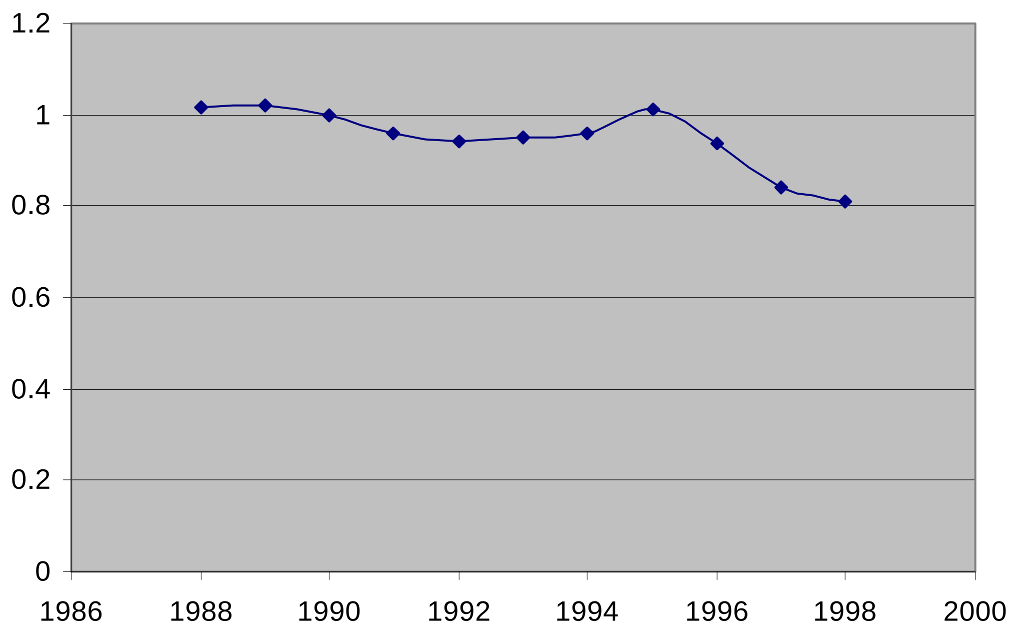


Fig. 2.16: Ratio of the index of producer prices to the index of purchase prices (where 1995=100)



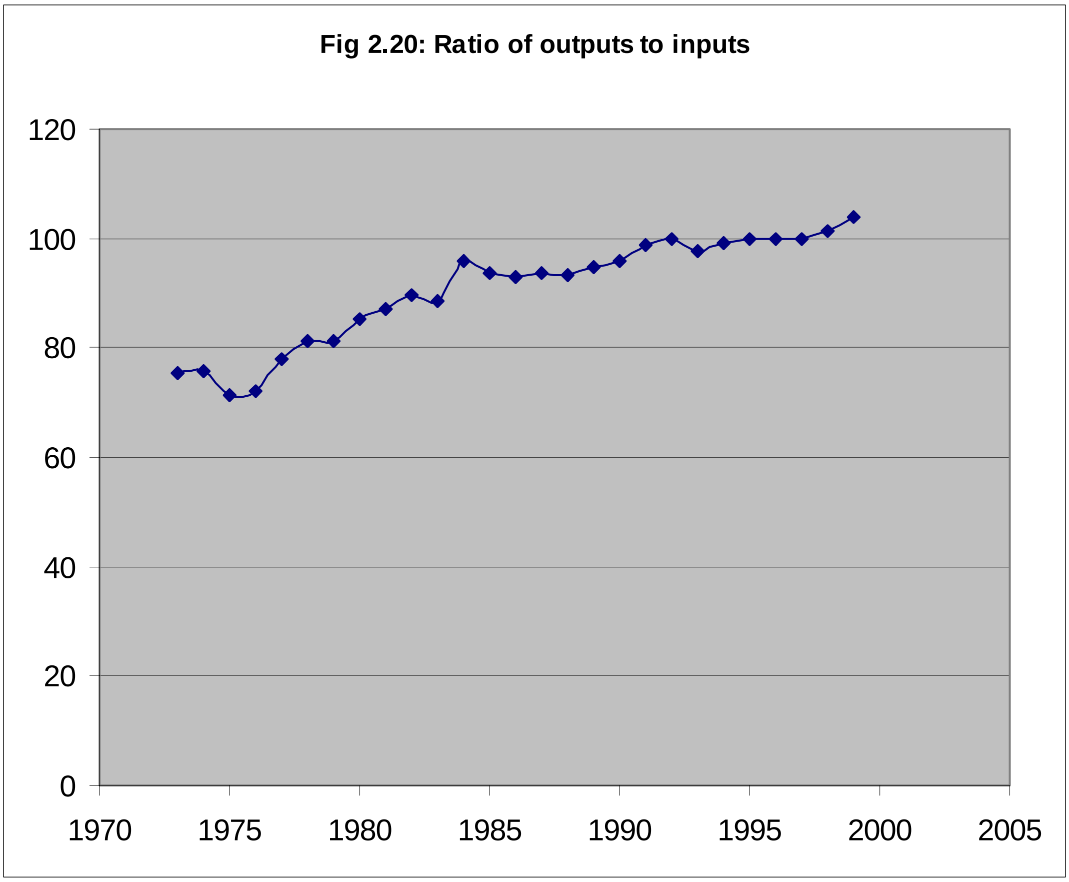


Fig 2.20: Ratio of outputs to inputs
120
100
80
60
40
20
0
1970
1975
1980
1985
1990
1995
2000
2005