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The Economics of Pesticides in Danish Agriculture

by

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1. Introduction

Danish agriculture has changed in the post-war period from being a labour-intensive sector to being a high-technology one. The high technology includes both machinery and chemistry in the form of, for example, pesticides. This change has caused a rise in productivity considerably greater than that seen in urban industries. But in the last couple of decades a growing number of people have come to see pesticides as a problem both for consumers and for the environment. This is the reason why a profound investigation of the effects of a change to completely or partially pesticide-free production was carried out in 1998-1999.

The investigation was initiated by the Danish parliament, and was highly interdisciplinary. Four groups of experts (agronomists, economists, biologists and jurists) and a considerable number of scientists carried out the work. This paper provides a summary of the economic methods used and the results obtained.[1]

Costs in relation to production were calculated in a three-stage procedure. In the first stage, agronomists summarized the experimental results for crops of different sorts; they tried to quantify the fall in productivity related to a ban on pesticides for all important types of crops.

The second step comprised the calculations at farm level, carried out by the microeconomists

[1]Niels Kærgård was chairman of the economic expert group, Søren E. Frandsen and Alex Dubgaard were members of the group, Aage Walter Jørgensen was secretary for the group, and Jens Erik Ørum and Lars-Bo Jacobsen were experts working for the group. Søren E. Frandsen and Lars-Bo Jacobsen worked mainly on the macroeconomic problems, Jens Erik Ørum on the farm economic problems and

in close cooperation with the agronomists. These calculations were made on the basis that any differences in changes in productivity for various crops which were brought about by a pesticide ban would bring about a change in the distribution and rotation of crops. For some crops pesticides are relatively unimportant, while for others they are almost essential, and if pesticides were forbidden then a substitution between the various types of crop would take place. The new optimal allocations between the various crops were found by using a linear programming model with restrictions laid down by the agronomists.

The third step was a calculation of the macroeconomic effects for the agricultural sector in Denmark and for the Danish economy. For these calculations, an applied general equilibrium model of the Danish economy was used.

The benefits of a pesticide ban are mainly to be expected in the health of the population and in biodiversity. However, the results from the biologists were not so precise that a calculation of the value of the benefits was possible. Only the effects related to drinking water have been quantified. Consequently, the arguments for a ban must be found in the precautionary principle, and the implementation of this principle is a debatable area.

Section 2 of the paper describes the Danish agricultural sector; section 3 discusses the agronomical foundation of the economic models; section 4 presents the results on farm level; and section 5 presents the macroeconomic results. The paper ends with some conclusions and policy recommendations.

2. Background

In the past, agriculture was very important in Denmark, but now only about 4 per cent of the labour force work in the sector. About 4 per cent of the gross national product is produced in the sector, but nevertheless it is still responsible for about 25 per cent of Danish exports.

The sector has changed rapidly in the decades since the Second World War. The number of farms has fallen from 208,100 in 1946 to 57,644 in 1998, which means that the average farm has grown from 15.3 ha to 45.8 ha. This calculation, however, includes a considerable number of small-scale part-time farmers. The farms operated on a full-time work basis are on average 78,4 ha in size. Not only has the number of farms decreased rapidly, but the remaining farms have become highly specialized. In 1968, 74.5% of all farms had both cows and pigs. Today this figure have fallen to 12%.

62.5% of the land area of Denmark is cultivated farmland. The types of crops grown in Denmark are shown in table 1. The main crops are wheat, barley and grass, but some of the products grown in smaller quantities (potatoes, sugar-beet and seed) are very profitable.

The labour force employed in the agricultural sector has fallen in size from more than 500,000 persons in 1945 to about 80,000 in 1995.

Alex Dubgaard on evaluation of the benefits.

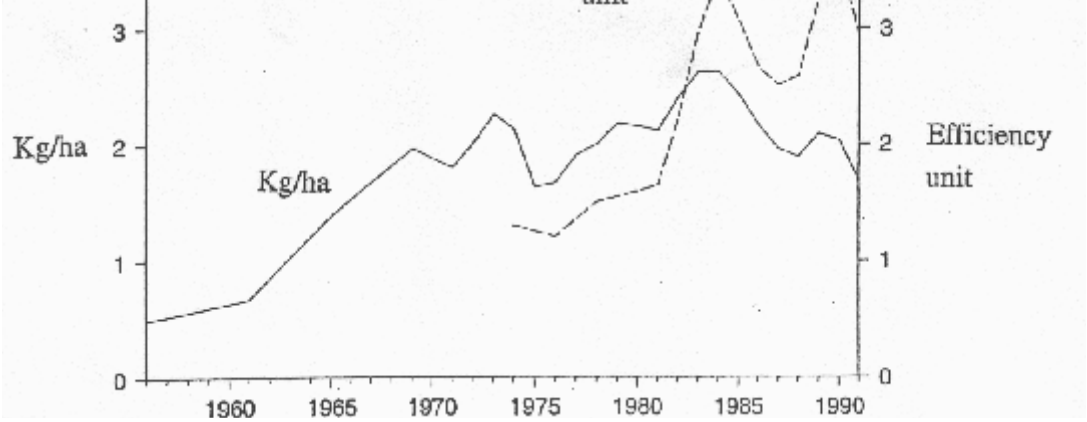


Table 1: Areas under cultivation with various types of crops, '000 ha, 1998

Wheat	673
Rye	103
Winter barley	162
Spring barley	498
Mixed grain	58
Rape seed	116
Pulses	106
Roughage (mainly grass)	608
Potatoes	36
Sugar-beet	66
Seed for sowing	85
Horticultural products	21
Set-aside	141
Total cultivated area	2672
Total area	4306

Source: Agriculture in Denmark (1999)

Agricultural development, especially during the period 1960-1985, resulted in a considerable growth in the use of fertilizers and pesticides. Fig. 1. shows the increase in the use of pesticides.

The difference in the two curves is caused by a change to new, more concentrated pesticides.

The use of pesticides in Denmark is moderate compared to that in other countries (see fig. 2), but such international comparisons are questionable, because the figures are highly dependent on the type of crops grown. For example, agriculture in Belgium and the Netherlands is characterised by a large market garden sector.

Fig. 1.: Use of pesticides in Danish Agriculture

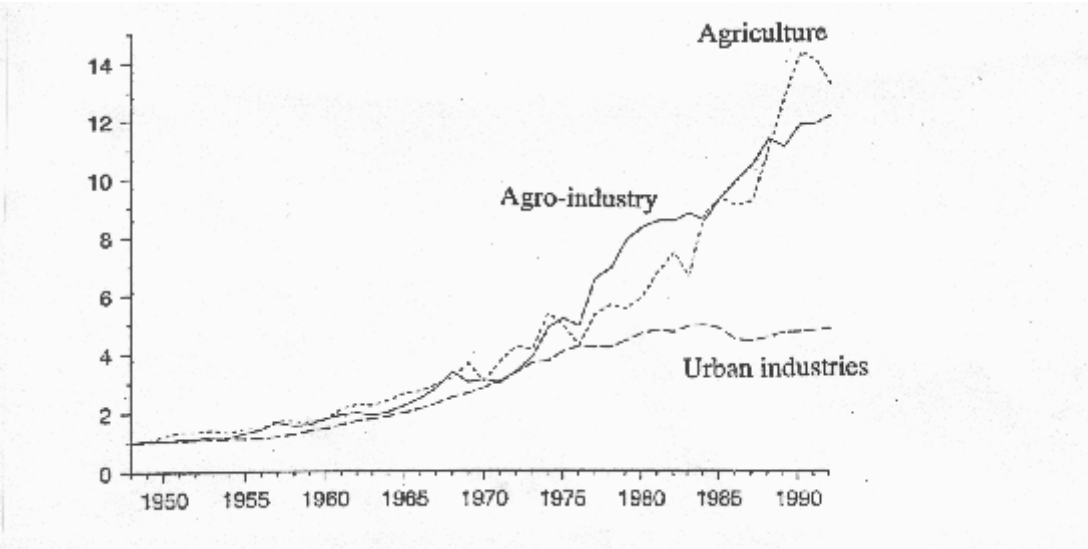
Source: Economic Council (1993), p. 85

Fig. 2.: Use of pesticides, kg/ha, 1996

Source: Bichel committee (1999), p. 32

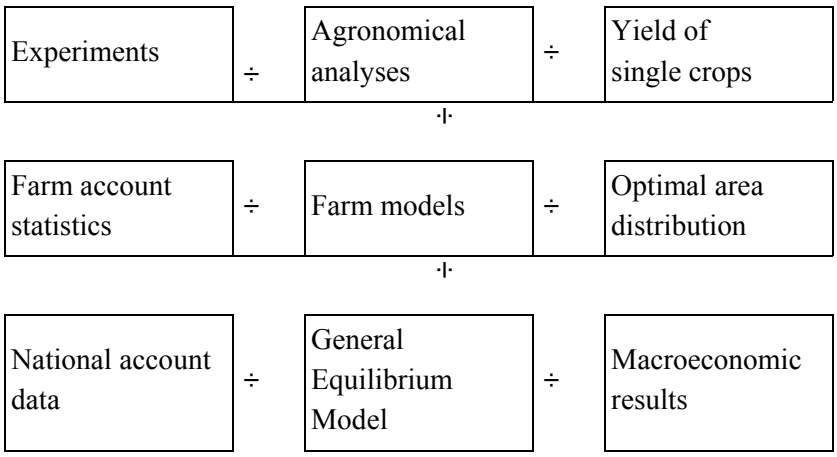
The change from small family farms to bigger, more capital-intensive farms, and the increased use of fertilizer and pesticides, have had positive effects on productivity. Work force productivity has grown considerably faster in agriculture than in the urban sector since 1945 (see fig. 3).

Fig. 3.: Labour productivity, 1948=1



Source: Economic Council (1993), p. 82

Fig. 4.: The structure of the investigation



Since the 1980s, the environmental effects of the use of fertilizer and pesticides have been given further attention in Danish debate. A number of political initiatives have been taken, but with mixed results. This was the reason that the Danish parliament decided in 1998 to start a thorough investigation of the effects of a change to completely or partially pesticide-free production.

3. The structure and basis of the investigation

The analysis of costs was divided into three steps (see fig. 4). The first step was based on agronomic experiments. By means of field experiments, agronomists were able to determine how much the yield would fall if pesticides were phased out. Such experiments show the effects for individual crops; the reductions in yield are shown in table 2.

Table 2: Loss in yield from eliminating use of pesticides, per cent

Seed for sowing	50
Potatoes	42
Wheat	28
Winter barley	22
Peas	21
Spring barley	18
Sugar beets	14
Rye	12
Winter rape seed	7
Grass	3

Sources: Bichel committee, (1999), p. 68

These results were used in economic models in the next two steps. From many points of view, it would of course be logical to use one big economic model. But if both detailed results for

remarkable, too, that the drinking water, which has played a major role in the public debate in Denmark, is totally insignificant for pesticide intake.

Even if there are risks and even if the precautionary principle is used, it is difficult to find strong arguments for very drastic domestic restrictions on pesticides. A rational decision needs to be “proportional”. The proportionality principle indicates that it will be irrational to seek full safety in one area if other even greater risks still exist.

Table 6: Danish consumers' intake of pesticides, distribution of sources, per cent.

	Danish products	Imported products
Fruit and vegetables	30	54
Cereal products	11	2
Animal products	<1	<1
Fish products	<1	<1
Drinking water	<1	<1
Total	42	58

Source: Bichel-committee (1999b), p. 109

7. Conclusion

A full investigation of the use of pesticides in Danish agriculture seems to indicate that a ban on the use of pesticides would be very costly, but that a considerable reduction in the use of pesticides is possible with only very small costs.

The damage resulting from pesticide use is not so great and obvious for either public health or biodiversity that a costly ban seems rational. The precautionary principle and the small costs involved are, however, strong arguments for a considerable reduction.

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