17.0 THE DANISH PESTICIDES TAX

Introduction

As discussed in the Tier 2 analysis, the Danish National Pesticide Action Plan was introduced in 1986, with the objective of protecting human health and the environment. The aims were to tighten up pesticide approval procedures, to support research in pesticide optimisation, to disseminate information to farmers and to introduce certificates for pesticide users. The goal of the Action Plan was to reduce pesticide consumption by 50% within a period of ten years (i.e., by 1997) and to shift consumption towards less harmful pesticides.

The pesticide action plan consists of the following instruments:

- Advice and research financed through a 3% charge on the wholesale price of all pesticides;
- An improved approval procedure for pesticides before sale, import and use;
- An obligation upon farmers to keep records of the period, quantity and types of pesticides used on each field, though without continuous reporting to any authority;
- Pesticide certification for all professional users (spraying);
- Minimum technical standards on all spraying equipment;
- Banning of pesticide use in and around environmentally sensitive areas and water bodies.

The 1986 Pesticide Action Plan was amended, strengthened and supplemented several times. A sustainable development action plan was introduced in 1991. A pesticide tax was introduced in 1996 aimed at reducing pesticide consumption, and in support of the 1986 target. The Danish Ministry of Environment and Energy concluded a voluntary agreement with local authorities to phase out the public use of pesticides by 2003.

In 1997, the Danish Parliament debated the issue of contamination of ground water and drinking water by pesticides. The Parliament adopted a resolution (D 105) which requested the Government to set up a Committee to assess the consequences of phasing out the use of pesticides in the agricultural industry and to investigate alternatives methods for dealing with those problems currently treated by pesticides. The Bichel Committee was appointed to undertake this task and its report was used to inform a second pesticide action plan that was implemented in the year 2000, with tighter regulations aimed at reducing the frequency of pesticide applications. The Committee looked at agriculture, market gardening, fruit growing and private forestry. The Committee's report did not look at the potential effects on Danish industries which manufacture pesticides of phasing them out. Its wide-ranging report provided some of the information used in this analysis.

From the Tier 2 analysis, there are questions remaining concerning the degree to which the price incentive has altered pesticide use (and if so, how) and the role of this incentive mechanism relative to other measures in the Action Plan. In addition, it was not clear how farmers were being affected by the tax, nor the extent to which this varied across different farm enterprises. Significant impacts in this regard would have been expected to have competitiveness impacts. Also, the issue of pesticide imports was highlighted as a potential issue, but one which was not explored in any great depth.

Farming in Denmark: Structure and Employment

Approximately 62% of Danish land, or 2.7 million hectares, is farmed. An estimated 55% of the area is used for grain production with 35-40% sown with winter cereals. Other crops include grass and feedcrops, beets, potatoes, rape and pulses. Much of the cropped area, as much as 60%, is associated with livestock farming (cattle and pigs).

Approximately 40% of the farmed area is classified as clay soil, and around 60% is classified as having sandy soil. Yields tend to be higher on the former than the latter.

Farming employs around 84,000, or 3.5% of the labour force. An interesting demographic statistic is the average age of farmers, quoted in the Bichel Report as 52 years. The average farm size is 44ha but this includes part-time farmers. The average full-time farm is 74ha.

Trends in Pesticide Use in Denmark Prior to the Tax's Introduction

The use of pesticides in Denmark is measured through:

- The amount of active ingredients used (measured in kg); and
- The treatment frequency. The treatment frequency is a measure of the number of times a farm has been treated with the normal dose (per hectare of cultivated land) in relation to pesticide quantities sold.

Use of both measures is considered wise since the amount of active ingredient used per dose of pesticide varies across products at any given moment in time, and over time as new products come to market.

Trends for the years from 1990 – 1996 are shown in Tables 103 and 104.

Table 103: Treatment frequency, per pesticide types and overall treatment frequency from 1990 to 1996 (Dose per hectare)

	81-85 average	1990	1991	1992	1993	1994	1995	1996	95-96 average
Herbicides	1.27	1.34	1.28	1.28	1.24	1.28	1.72	1.28	1.50
Fungicides	0.81	0.84	0.83	0.71	0.57	0.53	0.58	0.38	0.48
Insecticides	0.45	1.00	0.71	0.61	0.61	0.58	1.04	0.21	0.63
Growth regulators	0.14	0.38	0.09	0.13	0.15	0.12	0.15	0.04	0.10
Total	**2.67**	**3.56**	**2.93**	**2.73**	**2.57**	**2.51**	**3.49**	**1.92**	**2.71**

Source: OECD (1998).

Table 104:Development in sold quantities of active ingredients for agricultural purposes, tonnes

	81-85 average	1990	1991	1992	1993	1994	1995	1996	95-96 average
Herbicides	4636	3128	2867	2824	3632	2685	3281	2915	3098
Fungicides	1779	1396	1426	1333	1033	892	1055	631	843
Insecticides	319	259	146	128	107	95	163	36	99
Growth regulators.	238	867	189	281	331	247	310	87	198
Total	**6972**	**5650**	**4628**	**4566**	**4103**	**3919**	**4809**	**3669**	**4238**

Source: OECD (1998).

Both tables 103 and 104 suggest that in the period to 1994, pesticide usage was declining by both measures. The principal difference in the Tables is that the treatment frequency measure shows an increase in use between 1981-85 and 1990 whilst the quantitative measure shows a decline. There are a number of possible explanations for this, and probably the pattern reflects a combination of these:

- The broad trend in the pesticide industry towards the use of products which are active at lower dose rates (i.e. each treatment requires the use of a lower amount of active ingredient per hectare). This is due to changes in the nature of products. It is one reason why the treatment frequency measure is used since this reflects the extent to which farmers continue to resort to pesticide use even as the average dose per treatment falls as new active ingredients reach the market place;

- The farmers are themselves reducing the use of active ingredient per treatment for a given chemical (so for each treatment, the dose rate may be falling). This may reflect better advice, better management of pesticides, or a more simple derived demand effect associated with changing prices for outputs. This latter point is particularly significant in the context of the changing structure of agricultural support in Europe associated with changes in the Common Agricultural Policy; and

Related to the above, changes in land-use have had implications for pesticide use. There has been a switch from production of barley (mainly spring barley) to wheat since the beginning of the 1970s, accompanied by a fall in the acreage with grass and greenfeed up to the beginning of the 1990s. This increased the need to use pesticides. Working in the same direction is a growing acreage with seed for sowing and industrial use (rape), while a gradual fall in the acreage with root crops for fodder is working in the opposite direction. The trend in the 1990s was affected particularly by the introduction of compulsory set-aside and a falling acreage with industrial seed, which has reduced pesticide consumption. Note that set-aside figures do not affect the treatment frequency figures because they have been calculated without set-aside.

The years 1990 to 1994 show a marked decrease in treatment frequency. The aim of the 1986 Pesticides Action Plan was to reduce use by 25% by 1990, and by a further 25% by 1997. Amongst the Plans objectives, the following achievements can be noted:

- 213 active ingredients were reassessed, of which 105 were banned because no documentation necessary for reassessment was made available or the product was withdrawn, 78 were granted for approval, and 30 were banned or strictly regulated;
- Quantities of active ingredient had fallen by 40% but treatment frequencies had fallen somewhat less. In the reference period (1980-85) treatment frequency was 2.67. In 1997, this figure had fallen to 2.45. However, this reflected in part changes in crop rotations. Since different crops require differing treatment frequencies (see below) changes in crop rotation affect treatment frequency. If treatment frequency had remained the same as in the reference period, the treatment frequency would have been 3.27. Hence, what might otherwise have been a 25% fall in treatment frequency was made less significant by changes in crop rotation (and these have probably been encouraged by changes in agricultural policy and price support levels);
- Attempts have also been made to weight the load of pesticides by toxicity. Chronic and acute toxicity to animals and humans was reduced though carcinogenicity remained largely unchanged.

It seems clear from this that the Pesticides Action Plan may have already been having an effect on the amount of pesticide used and on treatment frequency before the pesticide tax came in. The exact extent to which this effect was due to the Plan itself, or to other factors, such as changes in demand related to evolution in European agricultural policy (changes in the level of price support) is difficult to know. Almost certainly, the changes in the market conditions faced by farmers across Europe have affected demand for agrochemicals. It should be recognised, therefore, that the introduction of a pesticides tax in 1996 took place against a backdrop of recent and ongoing changes in European agricultural policies as well as already established initiatives aimed at reducing pesticides' use in Danish agriculture.

17.1 Incentive effects

Effects of the Tax on Price

As discussed in Tier 2, the current pesticides tax was introduced in 1996 as a percentage of the retail price to stimulate the aims of the 1986 action plan. In 1998 the tax rate was 53.85% of the retail price for insecticides and 33.33% of the retail price for fungicides and herbicides. (Bichel 1998, Main report). Due to difficulties of measurement, the tax is not differentiated according to toxicity or other indicators of the relative health and environmental impacts of the different pesticides (DEPA 2000).

The intention of the pesticide tax is to reduce pesticide consumption through optimisation at farm level, in the context of a regulatory framework, which bans harmful or unwanted pesticides. The pesticides tax is targeted at agriculture, so that only the "old" 3% charge remains for pesticides used in forestry and for control of pests such as mice, rats and rabbits. Table 105 below shows the pesticides tax rates by pesticide as from 1998. The 1998 tax adjustment still applies and evaluation in the year 2000 will determine future levels. Further tax increases or stricter regulation will be imposed if the tax's objectives are not met by year 2002.

Table 105: Development in the Danish pesticides tax rates, 1986-2000

Year	Average Pesticides Tax level % of whole or retail sales price
2000	Implementation of the Pesticide Action Plan II, does not include tax increases
1998	Pesticide tax increase to an average 37% of the retail price, insecticides 54%; fungicides, herbicides and growth regulators 33%; and microbiological agents are taxed 3% of the wholesale price.
1996	Pesticide tax increased to an average 15% of the retail price, insecticides 27%; fungicides, herbicides and growth regulators 15%; and microbiological agents are taxed 3% of the wholesale price.
1986	Pesticide tax introduced; 3% of the wholesale price of all pesticides

Source: Various numbers of Faktuelt, MEM; (Bichel 1998, Main report).

The danger with taxes on products like pesticides is that the incentive is reduced through manufacturers absorbing some of the intended price increase so as to maintain sales. This is not just an effect related to the incidence of the tax as mediated by the elasticity of demand, but also by market structure issues.

The way in which the ad valorem tax is set is therefore of some interest since it suggests an attempt to convert the ad valorem rate into a specific (per unit) tax. In fact, the approach is the same as that which is used for taxes on wine, spirits and tobacco. The producer or importer decides upon a maximum price at which the product will be sold. They then pay the tax which equates to the ad valorem rate levied on this maximum price.

An interesting question arises in this context as to whether these maximum prices have been changed over time to reflect a desire to minimize the impact of the tax on demand. In a competitive market situation, such changes would seem to be unlikely where the demand is relatively price inelastic (as with pesticides). On the other hand, two issues complicate this picture:

Competing products in the field of pesticides may be priced differently. Ad valorem taxes could widen the price differentials such that changes in demand occur (and such switches may involve a switch from a more- to a less-benign product);
Although it is illegal under Danish law for Danish farmers to purchase products in other countries (for their own use), it is thought that some pesticides are purchased from abroad, in Germany and especially in Poland, where pesticides are cheaper.

In such circumstances, it could be that the quoted maximum prices are altered to reflect the perceived change in demand for specific products. We have no evidence that this has or has not occurred.

This pricing system has been used although it is recognized that it is somewhat complicated in administrative terms. The Bichel Committee recommended that investigations were undertaken to see if the design of the tax should shift from being ad valorem to one based on treatment frequency. A working group was established for this purpose and has almost completed its study which suggests that such a switch could generate marginal improvements in the effectiveness of the tax. However, the main pressure for change appears to be coming from producers and importers to abandon this on grounds of the administrative issues it raises.

Effects on Demand

Understanding the degree to which pesticide users have responded to price is notoriously difficult in the case we are considering. Farming can be considered to be like a performance, which changes from year to year in line with variations in rainfall, the weather more generally, and possibly also, market conditions. According to these changes in the conditions under which agriculture is performed, pesticide use will vary from year to year.

If one accepts (and it is generally accepted) that 1995 was a year of stockpiling of pesticides, and that statistical data for 1996 is therefore unreliable, one has only a small number of years of data on which to base one’s evaluation of whether the tax has or has not been effective in reducing demand. The picture, already affected by the exigencies of the weather, is complicated by the fact that:

a) any stockpiling that may have occurred in 1995 may have had an effect beyond 1996; and

b) other policies aimed at reducing pesticide use may have been playing an important, or more likely, a complementary role in reducing pesticide use. Disentangling the effects of ‘the tax’ from those of ‘the tax in conjunction with the other initiatives’ would be extremely difficult without more direct survey work with farmers (and is likely to prove difficult even then).

Lastly, the effects of the policies aimed at reducing pesticide use would also have to account for any derived demand effects associated with changing conditions in agriculture (for example, variations in output prices) and changes in the underlying price of pesticides (due, for example, to changes in the price of input factors).

Generally, despite the difficulties in estimating the changes that have occurred (which are appreciated by the Danish EPA), it is believed that there is evidence of a reduction in the use of pesticides attributable to the tax. Equally, it is accepted that this effect is relatively small and that the tax would have to rise to rather higher levels to have an appreciable (and perhaps, clearly discernible) influence. The aggregated data is shown below.

It is estimated that the current tax rate reduces the overall use of pesticides by 15% to 20% (OECD 1999 April). The state converts the ad valorem tax to a fixed amount applied to the pesticides as calculated on the basis of a yearly price review. This design of the tax setting prevents or reduces price speculation from importers.

Duties on pesticides were increased in 1996 to 15%, for herbicides and fungicides, and 37% for insecticides and soil disinfectants. Spot checks showed that the retail prices of fungicides and herbicides increased by 13% to 14%, respectively, from 1995 to 1996, whereas the prices of insecticides increased by around 48% (OECD 1998 January). According to the Danish Plant Protection Organisation pesticide producers absorbed some of the increases due to the pesticide tax, but the majority of the tax is being passed through to farmers.

In 1996, expenditure on pesticides amounted to 7.7% of the value of crop production in the agricultural sector. These costs have increased since 1994, when they amounted to 6.8% of the value of crop production. It also appears that the prices of some of the plant protection substances that are widely used today have dropped markedly during the course of the past 10 years (OECD 1998 January). According to the Danish Plant Protection Association price drops reflects new products, increased competition, and patents expiring. There is also a view that prices have dropped a little (no figures are available) due to the pesticide tax.

The shift in farm support policies from price support to direct income support (area payments) should have enhanced the effectiveness of a pesticide tax since the share of tax in gross agricultural output becomes relatively more important. If further price reductions are to be implemented in the coming years, the costs of pesticides will become still more important and farmers’ response to the tax is likely to become stronger.

In the Ministry of Environment/EPA a review leading up to the introduction of the tax in 1996, assumed a demand elasticity of -0.5 for pesticide use in general, but it was accepted that there is great uncertainty about this estimate. When the tax was altered in 1996, the expected reduction in consumption was estimated at between 5% and 10%. A joint research project between the Royal Veterinary and Agricultural University (KVL) and the Institute of Local Government Studies (AKF) analysed the regional economic impact of a pesticides tax, implementing KVL's agricultural sector model into AKF's regional model EMIL. The effects of a 100% tax on nitrogen or a 120% tax on pesticides are similar, reducing yield per hectare and reducing output. Pesticide consumption is expected to decline by 40% and agricultural production will decline between 0.5% and 1.5% due to the pesticide tax. (Jensen & Stryg, 1996). The Bichel Sub-committee on Production, Economics and Employment also reviewed the literature on responsiveness of pesticide users to price. They looked at:

a. Damage threshold models
b. Econometric models
c. General equilibrium models and
d. Mathematical programming models

As with other reviews (see ECOTEC 1999), this review uncovered a range of elasticity estimates. It also made clear that the assumptions used in the analysis are crucial in the estimation of farmers' response. Elsewhere, we have argued that the response of farmers to changes in price of pesticides is an extremely complex problem to analyse. Furthermore, the changes which occur through price / exchange rate fluctuations may be quite different to those associated with a tax. Linear programming models suffer from being somewhat constrained in the degree to which they can model shifts to new farming techniques as opposed to optimization within a given approach to farming. Lastly, the report mentioned:

It is difficult to find examples in which the interaction between agriculture and the rest of the economy is analysed in sufficient detail to determine the consequences of phasing out pesticides for agriculture, other sectors and the economy as a whole.

It might have been added that, given the difficulties in modeling the consequences for other sectors in, for example, a General Equilibrium framework, the same could be said of more marginal changes in pesticide use.

Empirical Evidence

The actual effect of a pesticides tax can only be judged over a number of years. Early data is at least suggestive that treatment frequencies are falling. Note that the 1995 and 1996 figures show the effects of stockpiling of pesticides and so neither is completely reliable as a 'pre-tax baseline'. Note also that since Tables 106 and 107 below include years where there were tax increases (1998), it may well be that further stockpiling (relative to the 'without tax increase scenario') occurred in 1997.

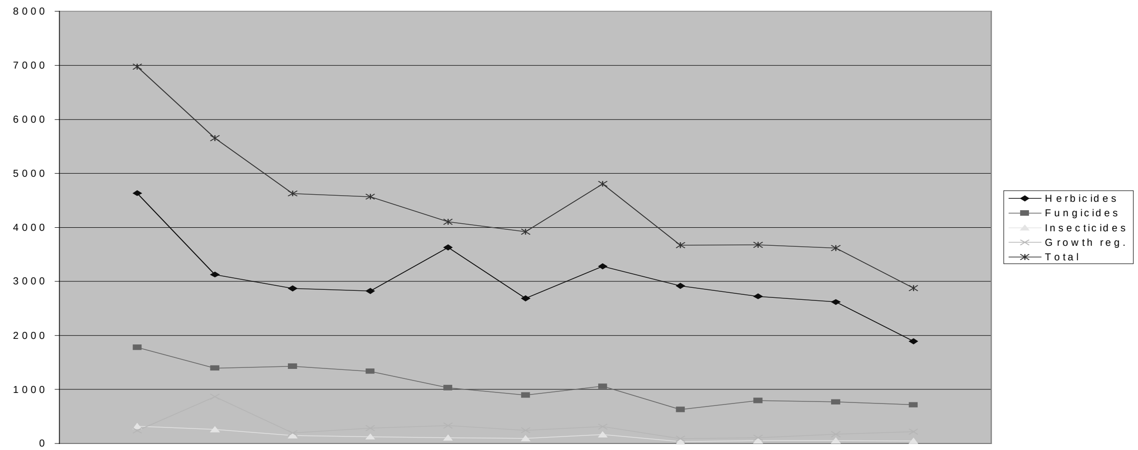
Table 106 (and Figure 18), which deal only with quantitative data, shows that there has been a marked decline in pesticide use as measured in terms of tonnes of active ingredient used. The decrease has been most marked for herbicides, which are the products most used in Danish agriculture (by this measure). This is reflected in the total weight of material used which more or less follows the picture for herbicides. The stockpiling effect referred to above is clearly visible in the figure. Sales of active ingredients obviously reflect (amongst other things) changes in the area of cultivated arable land in rotation and increased use of low-dose products (OECD 1998 January).

Table 106: Development in sold quantities of active ingredients for agricultural purposes, (tonnes)

Pesticides Type	81-85 Average	1990	1991	1992	1993	1994	1995	1996	95-96 Average	Goal 97	1997	1998	1999
Herbicides	4636	3128	2867	2824	3632	2685	3281	2915	3098	2318	2726	2619	1892
Fungicides	1779	1396	1426	1333	1033	892	1055	631	843	890	794	770	715
Insecticides	319	259	146	128	107	95	163	36	99	160	51	55	46
Growth regulators	238	867	189	281	331	247	310	87	198	119	104	175	221
Total	**6972**	**5650**	**4628**	**4566**	**4103**	**3919**	**4809**	**3669**	**4238**	**3487**	**3675**	**3619**	**2874**

Source: OECD (1998), Miljostyrelsen (2000).

Figure 18: Evolution in pesticides use, 1981-85 to 1999 (tonnes)



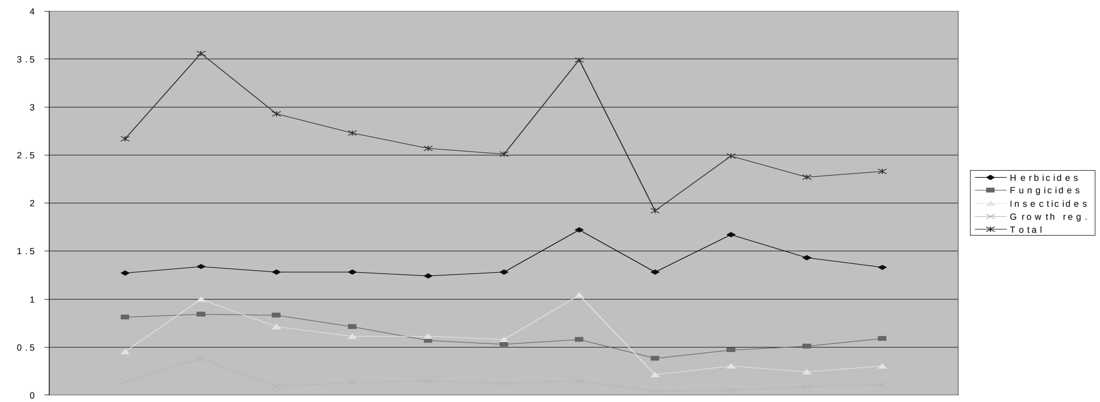
Source: OECD Data on pesticides sales (1998).

Table 107: Treatment frequency distributed over pesticides types and overall treatment frequency from 1990 to 1996 (dose per hectare)

	81-85 Average	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996**	**95-96** Average	**Goal 97**	**1997**	**1998**	**1999**
Herbicides	1.27	1.34	1.28	1.28	1.24	1.28	1.72	1.28	1.50	0.64	1.67 (1.66)	1.43 (1.47)	1.33 (1.37)
Fungicides	0.81	0.84	0.83	0.71	0.57	0.53	0.58	0.38	0.48	0.40	0.47 (0.59)	0.51 (0.58)	0.59 (0.60)
Insecticides	0.45	1.00	0.71	0.61	0.61	0.58	1.04	0.21	0.63	0.23	0.30 (0.32)	0.24 (0.26)	0.30 (0.37)
Growth regulators	0.14	0.38	0.09	0.13	0.15	0.12	0.15	0.04	0.10	0.07	0.05 (0.05)	0.09 (0.09)	0.11 (0.11)
Total	**2.67**	**3.56**	**2.93**	**2.73**	**2.57**	**2.51**	**3.49**	**1.92**	**2.71**	**1.34**	**2.49 (2.63)**	**2.27 (2.40)**	**2.33 (2.45)**

Source: OECD (1998), Miljostyrelsen (2000)
Note: Figures for 1997, 1998, 1999 between brackets are unadjusted for changes in crop rotation

Figure 19: Evolution in treatment frequency, 1981-85 to 1999 (treatment frequency index)



Source: OECD Data on Treatment Frequency (1998).
Key: *The treatment frequency index is calculated by dividing the consumption of active ingredient by the recommended dose per* ha.

It would be very difficult indeed, on the basis of this data, to conclude that the pesticide tax itself was having a major effect on pesticide use in Denmark. The falls in use since 1996 are no more dramatic (perhaps less so) than earlier reductions in use (although the figure is slightly misleading since the first two data points are for 1981-85 and 1990 so these points are not sequential). It is interesting to note that the use of growth regulators appears to be on the increase rather than falling back.

Looking at the treatment frequency data, the only products for which it appears there may have been a reduction in recent years is herbicides. Even this is somewhat questionable since treatment frequencies have been above or close to pre-tax levels.

For fungicides, growth regulators and insecticides, the picture is more complex. For each of these, post-tax treatment frequency appears to be rising, but it is still below pre-tax levels. The stockpiling effect appears particularly marked for insecticides, and this may reflect a higher unit price for insecticides than for other pesticides (so the ad valorem tax would imply a greater increase in outlay for insecticide purchases in absolute terms – stockpiling insecticides would, unit-for-unit, ‘save more money’).

Again, given the fact that the tax was introduced at a time when quantities and treatment frequencies were already falling, it would be difficult to state unequivocally that the pesticide tax has had a major effect on use by either of these measures. It is, as we have noted, difficult to tell with such a short period of data available to us, and when the use of pesticides is conditioned by so many factors which are specific to a crop, and for each crop, change with the climatic conditions in a given year.

The Bichel Committee recommended that targets in respect of the treatment frequency should complement quantitative pesticide goals in order to obtain a more efficient pesticide regulation. This is reflected in the new Pesticide Plan II which includes an aim of reducing treatment frequency from the current figure of 2.5 to below 2.0 by the year 2002 through regulation, advice and research (MEM 1999a,b). Figure 19 above suggests that this would indeed imply further progress, but the fact that this is being considered in the absence of increases in the tax suggests that other measures may be considered more, or equally effective, or that there is a feeling that the tax is taking time to have an impact (the longer-term demand elasticities are much larger). Probably, both are partially true. In 2002 an overall evaluation will determine whether additional measures (quotas and/or tax increases) are necessary to meet the treatment frequency goal of 2.0. As mentioned above, the Ministry of Taxation is already investigating possibilities of treatment frequency taxation instead of the current, administratively more cumbersome, ad valorem pesticide tax.

Environmental Effect

The environmental effects of a pesticide tax do not necessarily flow from considerations concerning quantities of pesticide being used and treatment frequencies. This is only part of the picture.

Pesticides are a heterogeneous group of products. Different pesticides which effectively compete in the market for the control of specific pests affecting specific crops may have quite different application (dose) rates, prices, and effects on different environmental media.

The effects of an ad valorem tax on pesticides are likely to be two-fold:

- Firstly, there will be a general downward pressure on demand – all products will see their price increase; and
- Secondly, there will pressures set up between ‘competing products’ for switching from higher price products to lower price ones. The differentials are magnified by an ad valorem tax.

It is a matter for empirical investigation to understand whether the second effect – the substitution effect as we might call it - would actually act to improve or make worse the environmental effects of pesticide use.

Probably, an answer to this question cannot be given in the absence of what would be extensive and expensive investigations to trace the fates of different products and the degree to which an ad valorem tax has altered the market share of those products deemed to cause (in the specific location) greater environmental damage. However, some have tended to argue that newer, less harmful products might be more expensive. If this were found to be true, it may well be the case that, to the extent that he effect on use is less than conclusive, the tax could have worsened matters rather than improved them.

This is entirely speculative. It should be recalled that the broader policy on pesticides in Denmark has led to the elimination of certain products deemed to be harmful to health and the environment. By 1997 the Danish Environmental Protection Agency had reviewed 213 active ingredients of which 105 were withdrawn from the market by the pesticide industry, 78 were approved and 30 were banned (Bichel 1998, Main report). In 1997 a group of international experts evaluated the Danish approval procedures and found them among the strictest in the world as regards groundwater protection ("Faktuelt" No. 21 of March 23. 1999). This itself will have made the sorts of switch which we are speculating about less likely than might otherwise have been the case.

Pesticides are found in one third of the groundwater tests and in 10% of the tests the pesticide values are above the limit for drinking consumption. (Bichel 1998, Main report). This measure is one of the most readily available statistics concerning the negative effects of pesticide use. Yet these statistics reflect historical use, and the effects of any changes today will not be recorded in groundwater for 20 years and more.

The most noticeable side effects of the use of low -dose products are considered to be damage to plants in boundary and marginal zones, as well as local damage to aquatic plants. It is considered that organisms other than plants and microorganisms are unlikely to be affected. The risk that damage will occur through accident or carelessness on the part of the user is greater where extremely potent substances, such as low-dose products and other products which are active in small quantities, are used (e.g., the pyrethroids). Due to their relatively high solubility in water, sulphonyl-urea-based herbicides can potentially be leached out. In view of the small quantities used the Danish EPA considers it unlikely that the approved usage will pollute groundwater in concentrations above the limit values. (OECD 1998 January)

Generally, it appears difficult to attribute major positive environmental effects to the tax itself. More plausibly, the tax acts to support the general messages contained within the Pesticides Action Plan. The effect of changing relative prices is, however, deserving of some closer investigation (and the data on sales in Denmark appears sufficiently good to allow that given relevant data on prices – used to set the tax – and indicators of environmental risk).

17.2 Revenues and revenue use

Pesticides tax revenues increased from 10 million DKK in 1994 to 302 million DKK in 1998 or from 0.03% of total environmental related taxes in 1994 to 0.53% in 1998 (see Tables 108 and 109 below). The increase in revenues reflects the increase in the level of the initial charge of 3% in 1994 to the average tax rate of 35% in 1998. In 1998 revenue from economic instruments in environmental policy amounted to 18% of total Danish tax revenues. The pesticide tax therefore contributed 0.09% of the total tax revenues.

Table 108: Revenue trend from environmental taxes, 1993-1998 in MDKK (MEUR)

	1994	**1995**	**1996**	**1997**	**1998**
Pesticide tax	10 (1.3)	28 (3.8)	208 (27.9)	240 (32.2)	302 (40.5)
Environmental protection taxes, total	4765 (638.5)	5142 (689.0)	6740 (903.2)	7757 (1039.4)	8911 (1194.8)
Environmental related taxes, total	39612 (5308.0)	44000 (5896.0)	48772 (6535.4)	51820 (6943.9)	57418 (7694.0)
Pesticides as % of total environmental related taxes	**0.03%**	**0.06%**	**0.43%**	**0.46%**	**0.53%**

Source: Eurostat, 1999.

Table 109: Percentage contribution of environmental taxes to total Danish tax revenue, 1998

Source of Revenue	**Share of total tax revenue**
Total tax revenue	100%
Environmental related taxes	18%
Environmental protection taxes	2.7%
Pesticide tax revenue	0.09%

Source: Calculated from MEM, (2000)

In general there is no earmarking of revenue from tax and economic instruments in environmental protection policy (MEM 2000). However, when the pesticide tax, was raised in 1996, two main channels were established for making use of revenues. The first was a reduction on a tax on the value of land (this is an ad valorem tax). This therefore had the effect of reducing production costs in one area whilst providing an incentive to optimize pesticide use through the tax.

The second route for making use of revenue arises partly out of an attempt to ensure no specific sector of agriculture pays much more in tax revenue than the benefit it receives in terms of reduced land taxes. Every year a calculation is performed to establish the net effect of the pesticide tax / reduction in land tax package. Where farmers of a particular types have clearly been 'net losers', an amount of money the difference is transferred into specific funds to be put to uses to be determined by farmers' organizations. Usually, the money is used to support marketing initiatives and research.

Administration of the Tax

The pesticide tax is imposed on domestic manufacturers where the pesticide is sold for use in agriculture, and on importers when the product is sold for use in agriculture. This reduces the costs of control and administration. The number of registered companies at this level is significantly lower than at the retail level. Producers and importers of pesticides must register with the customs authorities (MEM 2000). Importers may import the pesticide free of tax, but the tax is applied as soon as the product is sold for use in Danish agriculture. Exports are exempt from the tax.

There has been, as discussed above, some concern regarding the administrative costs of the scheme for levying the tax. This may be altered if there is a positive decision in favour of a treatment frequency based tax.

17.3 Competitiveness Impacts

The most comprehensive analysis available concerning the effects on agriculture of reducing pesticide use is found in Bichel Committee (1999). Economic impact studies of pesticide reduction in Denmark were undertaken to help understand the effects of pesticide reduction on farm performance. An important conclusion from the study was that it was possible to reduce use of pesticides well below current levels with no net losses to the agricultural economy. Clearly, there may be different effects upon different crops, and these are discussed below, but the fact that there are, potentially, further reductions in use that can be made at little or no net cost to farmers is an important one.

This does not imply that a pesticide tax has no negative impact upon farmers. It does, however, suggest that the tax may be able to play the role of signaling the desirability of reduced use, possibly with (in some cases) win-win outcomes for those who alter growing techniques in line with what is seen as desirable. Having said that, the evidence regarding the outcome from the tax (see above) as currently constituted would not necessarily lead one to turn to a tax as the instrument of first choice.

Insights from the Bichel Committee

The Bichel Committee estimated the economic impact of pesticide regulation by simulating the following four scenarios: 1; a 100% reduction in pesticides consumption, 2; a 80% reduction in pesticide consumption, 3; a 30 to 50% reduction and finally 4; a total conversion to ecological farming neither using pesticides nor importing products treated with pesticides (Bichel Committee 1998 Main Report, Bichel Committee 1999). The study estimates economic impacts on farm level, the impact on the whole Danish economy and the impacts on total agricultural employment (see Table 110 below).

Perhaps the most important conclusion is the one that suggests that optimal pesticide use could reduce today’s consumption by 30% to 50% from current levels without any significant economic impact on farmers nor Danish GDP. Reducing consumption by more than 50% would, it is thought, have negative impacts on the agricultural sector reducing farm incomes significantly and eliminating agricultural exports. These estimates are based on an assumption of bilateral action towards pesticides, not banning the import of pesticide-treated agricultural goods, and a 10 year implementation period.

Table 110: Estimated economic impacts of four different pesticides strategies in percentages reduction or billion DKK (EUR)

Scenario	***Treatment frequency***	***Pesticide consumption***	***Impact***
1. Pesticide ban	0	100% reduction	
Reduction in farm income (farm level)			21-90%
Yearly reduction in GDP			8.3 bn DKK (EUR 1,1 bn)
2. Reduced use of pesticide	0.5	80% reduction	
Reduction in farm income (farm level)			10-25%
Yearly reduction in GDP			3.5 bn DKK (EUR 0.47 bn)
3. Optimised pesticide use	1.4-1.7	30to 50% reduction	
Reduction in farm income (farm level)			
Yearly reduction in GDP			No impact
4. Ecological farming – neither use of pesticide nor imported product with pesticides		No use of pesticide	
Reduction in farm income (farm level)			21-90%
Yearly reduction in GDP			13-30 bn DKK

Source: Ministry of Finance, 1999 (Recalculation of the BICHEL Committee 1992 prices to1998 prices)

Note: EU agricultural subsidies as compared with 1998, product prices, pesticides prices and technological development remain unchanged. Implementation period is ten years. Current treatment frequency is 2.5.

The study lacks economic cost estimations to clean up pesticide pollution in the environment, and any attempt at valuing improvements in health and environmental quality. This is due to insufficient knowledge and availability of data. However, it is estimated that the Danish society saves around DKK 150 million annually (i.e. less than the loss to the agricultural sector) if pesticide purification of drinking water is avoided (Dubgaard 1999).

Although The Danish Farm Organisation (Landboforeningerne) is opposed to the Danish pesticide tax as it is implemented bilaterally, creating unfavourable conditions for Danish farmers compared to competitors in other Members States. This organisation sees the revenue recycling mechanisms (reducing land taxes and dissemination of information and research) as insufficient compensation for farmers. However, the compensation does appear to be adequate in the aggregate. Farmers also fear that politicians will raise the tax simply to increase budget revenues as opposed to seeking to meet the tax’s objectives of protecting human health and the environment. Currently, however, the issue of imports from other countries may be one reason why the tax is unlikely to be raised significantly (see below).

It is worth noting some of the caveats reported in the Bichel Sub-Committee's Report concerning the modeling that was undertaken. It is, in general, very difficult to model the dynamics of technical change that might occur under pressures to reduce pesticide use (such as could be implied by a tax). It may well be that the relatively large losses depicted under pesticide free farming overstate the possibilities and underplay the potential for technical changes to substitute for, or eliminate the need for, pesticides. Hence, the Report's authors state:

It should be noted that the models do not provide the possibility of describing technological changes. Therefore, account is not taken in the analyses of the fact that research and development will make it possible to develop crops and production methods that are better able to compete in pesticide-free farming. On the other hand, the chemical industry is constantly developing more environment-friendly products. There are thus contrary movements in the technological development that are difficult to incorporate in such a concept of analysis. (Bichel Committee 1999)

Crop Specific Analysis

What the above 'aggregate' picture does not do is give is a picture of the extent to which different farm enterprises in Denmark are reliant upon pesticides. Typically, different crops make use of different classes of pesticides with varying intensities. As mentioned earlier, the usage will vary from year-to-year with the climatic conditions of the crop.

In Denmark, the Bichel Committee (1999) reported that full-time farms have a higher consumption than part-time farms. This is to be expected as part-time farmers are, by definition, less dependent upon agriculture for income, and may have different priorities for the farm. As shown in Table 111, full-time arable farms have the largest consumption and also the highest treatment frequency index. That is because arable farmers concentrate mainly on production of cash crops (winter cereals, rape and sugar beet), which have a relatively high consumption of pesticides (see Table 112 below).

Table 111: Pesticides consumption in the main types of farming, treatment frequency index, 1996/97

	Full-time farms			**Part-time farms**		
	Arable farms	**Dairy farms**	**Pig farms**	**Arable farms**	**Dairy farms**	**Pig farms**
Kg active ingredient per ha	2.2	1.2	1.3	1.2	0.8	0.9
Treatment frequency index	3.6	2.4	2.4	2.4	1.4	1.9

Notes: The table is based on the Danish Institute of Agricultural and Fishery Economics' accounts statistics for the 1996/97 operating year, supplemented by information on the composition of the pesticide consumption. The material is based on 607 farms selected from around 2,000 farms on which the statistics are based.

Dairy farms and pig farms have a somewhat lower consumption of pesticides and a lower treatment frequency index. In the case of dairy farms, it is particularly in the production of fodder beet that treatment with pesticides is needed (see Table 112 below), but with the fodder-beet acreage falling and greater concentration on wholecrop, it is estimated that the use of pesticides is diminishing. The lower pesticide consumption at pig farms is due particularly to a low production of root crops (fodder beet and sugar beet for industrial use) and to the fact that pig farmers grow more spring cereals and rape than arable farmers. The said differences in land use must also be seen in relation to the fact that livestock production is concentrated on lighter soils and that the type of soil in itself affects land use.

Table 112 below shows usage of pesticides, in terms of treatment frequency, by key agricultural enterprise. Table 113 shows how total expenditure on pesticides, most of which is on pesticides, relates to the costs of farming the particular crop. Tables 114 and 115 do the same for key crops from the fruit and vegetable sector. Though the treatment frequency for these crops is much higher, they comprise a much smaller proportion of land-use in the agricultural sectors (little more than 0.5% in total).

From Tables 112 and 113, it can be seen that two thirds or more of the treatments applied are of products taxed at the lower rates of tax (fungicides, growth regulators and herbicides). If one takes, as a crude estimate of a 'bad-case' scenario, the assumption that all chemicals are pesticides, and that two-thirds of use is taxed at 33% and one-third at 54% (the rate for insecticides), the overall cost of chemicals would increase by about 40% due to the tax. In this case, and under static conditions, the crop worst affected would be sugar beet, the production costs for which might increase by 4%. Grasses are barely affected, but the typical increase in costs implied by the tax is 1-2% (i.e. 40% of the 4-8% of costs implied by Table 113).

Table 112: Usage of pesticides by enterprise, major field crops, in terms of treatment frequency, in 1994.

	Total	Herbicides	Fungicides	Insecticides	Growth Regulators
Winter Wheat, Clay	3.2	1.2	0.93	0.65	0.4
Winter Wheat, Sand	3.6	1.6	0.93	0.65	0.4
Spring Barley, Clay	2.0	0.79	0.6	0.7	0
Spring Barley, Sand	1.3	0.79	0.4	0.3	0
Rye / Triticale	1.4	1.0	0.3	0.1	0.6
Winter Barley	1.9	1.3	0.6	0	0
Winter Rape	2.47	1.34	0.07	1.05	0
Spring Rape	2.04	0.91	0.03	1.11	0
Peas	3.32	2.1	0.38	0.83	0
Wholecrop	1.0	0.79	0.2	0	0
Sugar Beet	4.3	2.17	0.02	2.1	0
Fodder Beet	4.0	2.17	0.02	1.5	0
Grass	0.08	0.03	0	0.05	0
Seed Grass	1.5	0.81	0.02	0.67	0.1
Potatoes	6.9	1.51	5.15	0.28	0
Maize	1.3	1.0	0	0.3	0
Control of Couch Grass	0.2	0.2	0	0	0

Source: Danish Institute of Agricultural and Fisheries Economics, Economics of Agricultural Enterprises (from Bichel Committee 1999)
Note: Figures do not include dressing products

Table 113: Consumption of Pesticides in Crops, Average, 1994/95 – 1996/97

Crop	Average Consumption In DKK (EUR) per ha	Percentage of costs, total
Wheat	547 (73.3)	6.0
Winter barley	452 (60.6)	5.3
Spring barley	323 (43.3)	4.2
Rape	495 (66.3)	6.7
Sugar beets	1,630 (218.4)	10.4
Potatoes	1,142 (153.0)	6.0
Fodder beet	1,612 (216.0)	8.4
Grass and greenfeed	110 (14.7)	1.6
Rotation grass	27 (3.6)	0.4
Permanent grass	5 (0.7)	0.1

Source: Danish Institute of Agricultural and Fisheries Economics, Economics of Agricultural Enterprises (from Bichel Committee 1999)
Note: The figures concern expenditure on chemicals, most of which are pesticides.

Table 114: Usage of pesticides by enterprise, fruit and vegetable crops, in terms of treatment frequency, in 1994.

Crop	*Treatment Frequency (Dose/Ha)*
Carrots	4-5
Onions	11-12
Cabbage and Red Cabbage	7
Cauliflower and Broccoli	4-5
Peas for Deep Freezing	5-6
Apples	20-25
Pears	16
Dessert and Cooking Cherries	12
Blackcurrants, Redcurrants, Raspberries	15
Strawberries	11

Source: Danish Institute of Agricultural and Fisheries Economics, Economics of Agricultural Enterprises (from Bichel Committee 1999)
Note: Figures do not include dressing products

Table 115: Consumption of chemical and biological agents in market gardening, in thousand DKK per production unit and percentage of total cost 1997/98

	DKK (EUR) 1,000 per production unit		**Percentage of costs, total**	
	Chemicals	**Biological control**	**Chemicals**	**Biological control**
Vegetables under glass	10.4 (1.4)	25.1 (3.4)	0.4	1.0
Pot plants under glass	30.9 (4.1)	13.7 (1.8)	0.8	0.3
Outdoor vegetables	21.6 (2.9)	0.2 (0.03)	2.0	-
Fruit and berries	40.0 (5.4)	0.2 (0.03)	7.2	-
Nurseries	28.4 (3.8)	0.3 (0.04)	1.3	-
All production units	28.5 (3.8)	5.9 (0.8)	1.3	0.3

Source: SJFI (1998)

This would not appear to be a major impact on the potential for growing the crop. Of course, it is an impact, and under static conditions, competitiveness is affected. But if, as the Bichel Committee suggested, farms can substantially reduce pesticide use without significant losses, the suggestion might be that the dynamic adjustment to the tax (which could include switching to cheaper pesticide products) would offset any possible negative consequences from a tax.

Note that overall, the greatest users of pesticides (measured by treatment frequency index) are wheat, beets, peas and potatoes. There is no one-to-one correspondence between use and the percentage of costs absorbed by pesticides since greater use of pesticides may reflect greater value of the crop (see Tables 114 and 115). However, here is some correspondence here between use and the percentage of costs associated with the crop. This suggests that there may be scope for 'optimisation' in the crop rotations being practiced, or more generally, in the use to which land. is being put. Of course, this is another of the medium-term adjustments that could be made in response to a pesticides tax.

More than 5% of fruit and vegetable growing is carried out under organic conditions. However, the non-organic fraction shows much greater intensity of pesticide use measured by treatment frequency than the major field crops. In the case of fruit crops, much of this is probably fungicides.

Even though the treatment frequencies are higher than for the major field crops, the contribution to total costs is not so great. Hence, the effect of a tax on the total cost base would appear to be relatively insignificant for all crops with the exception of fruits and berries (for which the effect may be an increase in costs by 3% or so of total costs). This suggests, once again, the potential to adjust to the tax to maintain competitiveness.

Of course, this somewhat optimistic assessment of the tax's impact on competitiveness has to be conditioned by further investigations into the specific agricultural markets in which Danish producers are engaged. The more keen the competition, the smaller (potentially) are the margins for growers. To the extent that markets for beets, potatoes, and fruits and berries are already threatened by competitors, the scope for further adjustments may be limited. These crops are widely grown in neighbouring countries. The threat from fruit producers in countries such as Poland may be very real. In these conditions, the impact of a tax, though superficially small, may be quite important for marginal producers. Even then, however, it should not be forgotten that any increase in costs under static scenarios will have been offset to some degree by reductions in the land tax paid by all farmers (though see below on the debate about 'winners' and 'losers').

To conclude this sub-section, currently, the tax does not have any major, country-wide impact. The enterprises most affected by the pesticide tax are potatoes, sugar beets, fruit and berry producers and seed producers due to the high spraying frequency and pesticide dependence. These are the areas about which concerns have been raised in respect of competitiveness.

Impact on Danish Pesticides Manufacturers

We understand that the pesticide manufacturing industry is in a slightly odd situation since it appears that the majority of production is exported. To the extent that exports are not subject to the tax, there is no effect on manufacturers in terms of competitiveness per se. There may have been some loss in market size, but this may be compensated by enhanced sales values depending upon the nature of future pesticide use.

Illegal Imports of Pesticides

Illegal cross-border trade is an issue in relation to the pesticide tax. Under current legislation, it is illegal for farmers to buy pesticides outside Denmark. Yet, it is believed that this does occur. The scale of the activity is not known. We have asked a number of representatives for views on this question. No one was able to give a clear answer (as expected since this would require declaration of an activity which is illegal). Given the barely discernable changes from trend concerning pesticide use, it would appear that the activity is relatively marginal.

Imports and parallel imports of pesticides have to be registered at Danish Authorities for VAT reasons and for approval reasons under the Danish Chemical law. With retail tax prices up to 58% illegal cross-border trade or illegal imports of banned pesticides is imaginable. It is generally believed (Farm Unions) that higher taxes increase the potential for cross-border trade and that the Danish bilateral implementation of the tax is harmful and unfair to Danish farmers. Discussions with the Danish EPA indicate that prices in Germany and especially Poland are much lower than in Denmark. Since a year’s consumption of pesticides for some farmers can readily be stored in a family car, this clearly happens. The Ministry of Taxation is concerned that increases in the tax rate would occasion increases in this activity.

Another reason for illegal imports, unrelated to the tax itself (but with environmental consequences) arises from farmers’ concerns that they cannot use the same pesticides as their European Colleagues, especially the Dutch (due to the Danish approval procedure). It has been suggested to us that the presence of banned pesticides in groundwater has been detected, and that this constitutes evidence of such illegal smuggling. This would seem unlikely given the length of time that would be needed to show this.

17.4 Equity Issues and Distributional Concerns

Agricultural Producers

Issues of social equity are generally difficult to discuss where taxes on specific polluting products are concerned. Clearly, the aim is to influence the behaviour of consumers of the product. It is difficult to do that without affecting those consumers.

The pesticide tax is targeted at the agricultural sector, which consumes approximately 80% of all pesticides used in Denmark. It could be argued that the agricultural sector is not the cause of many problems associated with pesticide use and that therefore the tax lacked fairness for these reasons. However, in November 1998 an agreement was reached between the Minister of Environment and Energy and the local authorities to phase out the use of pesticides on all public areas held by local authorities. The agreement covers plant protection products including the use of herbicides on pavements, railways and other non-cultivated areas. The goal is to phase out use by 2003.

It is also the intention of the tax to be relatively fair in terms of giving back to farmers what they pay in tax revenues. This was discussed in the earlier section on revenues. Farmers are therefore compensated in part through the reduced county land tax (an ad valorem tax that was targeted at all farmers) and through payments to sector bodies to fund research and marketing. Some concerns have arisen amongst horticultural producers and the forestry sector that they are the biggest net losers from the pesticide tax / land tax reduction package and this has become the source of some discussions in Denmark. The aim has been to make the payments to farmers' funds reflect the net position of the sector in respect of the pesticide tax and the land tax reduction.

The government review prior to the 1996 introduction of the tax considered distributional impacts. The impacts relate largely to use of revenues to offset County level land taxes, and on the distributional impacts of these land taxes. Smaller agricultural holdings tend to have the highest land values (so benefit most from the reduction in ad valorem land taxes), but the lowest pesticide consumptions. However, the horticultural sector, which has high pesticide use, was estimated to be likely to suffer a significant compensation deficit. Estimates for the forestry sector were dependent on the classification of the land for land tax purposes. It also appears that land prices are relatively higher on small farms than on large farms and land prices are generally higher closer to cities. These groups will benefit (in relative terms) more from the county tax deductions. Reduced property taxes are likely to become capitalised as increased land prices, hence benefiting the current landowners.

One study (Jensen & Stryg 1996) found that the pesticide tax influences regions that are dependent on crop production rather more than livestock farming regions. In the Danish case the pesticide tax would effect the regional economy and farmers of the eastern regions more than others due to the type of farming. The regional impact of the redistribution scheme, on the other hand, is more closely related to land prices than land uses.

Impact on Pesticides Producers

An ad valorem tax on pesticides might be construed as a tax which disadvantages those producing 'higher price pesticides'. Pesticides which are sold at a higher price may be those which are more research-intensive, and which therefore need to command a higher price to recoup research investments over the time until expiry of a patent. Indirectly, this could be seen as a disincentive to more intensive research on pesticides. However, the Danish market for pesticides is very small in global terms. It seems unlikely that agrochemical manufacturers would be affected significantly by such a tax in a country that is a small consumer of pesticides, especially since consumption does not appear to have altered dramatically.

Impact on Consumers of Agricultural Products

As discussed above, the worst-affected crop under a pesticide tax would, assuming no adjustment to the tax, experience an increase in production costs of no more than 4%. More typically, these will be lower, of the order 1% and less of production costs. It would be surprising if such an increase were to be passed through directly to consumers given the international nature of the markets in which Danish products must compete. It would be all the more surprising given that the tax was originally set at a lower level so that the cost increases have occurred over a period of time. To our knowledge, there has been no study looking at this issue in Denmark, but it seems unlikely to have affected prices of food products.

17.5 Impacts on Employment

Given the marginal nature of changes thus far, the (expected) implications for employment would not be expected to be significant. Demand for pesticides (measured in tonnes) has fallen but this reflects, in part, changes unrelated to the pesticides tax per se. Note that since, as we understand the situation, the majority of Danish production of pesticides is exported, the employment impact on domestic industry of any tax-related reduction in demand is also likely to be small.

It is interesting to look at what might be the implications for employment under more severe taxes. The Bichel Committee (1999) estimated the employment impact of four different pesticide scenarios (see Table 116). Banning the use of pesticides in Denmark would reduce the employment in the agricultural sector by 16000 employees. Reducing pesticide consumption by 80% would reduce employment by 8000 employees. The optimisation scenario 3 (approximately 50% reduction in use) would have no or very limited employment effects given a 10 year implementation period. This suggests that given the tax's broad intention to refund revenue to the sector through land tax reductions, the current level of tax would not affect employment significantly.

Table 116: Employment effects of pesticide regulation as estimated by the Bichel Committee

Scenario	Treatment Frequency (dose/ha)	Reduction in farm level income	Employment in agriculture (number)
1. Pesticide ban - a 100% reduction in consumption	0	21-90%	-16,000
2. Reduced use of pesticide – a 80% reduction	0.5	10-25%	-8,000
3. Optimised pesticide use – a 30/50% reduction	1.4-1.7	No impact	?
4. Ecological farming – neither use of pesticide nor imported product with pesticides	Eco-plan	21-90%	Not calculated

Source: Bichel (1999)

Phasing out pesticides in farming would generally affect employment in primary agriculture and the associated industries. The effect would be felt mainly in primary arable farming, where employment would fall by more than 55% in the “100% reduction scenario” (in which pesticides are banned) and by almost 30% in the ”80% reduction scenario” (see Table 117). The fall is primarily a result of lower production, even when allowance has been made for the need for extra manpower for manual weeding of the crops, which means, for example, that manpower consumption in the production of sugar beet would rise despite falling acreage and production.

Table 117: Employment effect, farming and processing, in % change in number of employees per sector, compared to 1992-employment level

	Change, %	
	100% Reduction-scenario (ban)	**80% Reduction Scenario**
Primary agriculture	**-18**	**-10**
Cash crops	-57	-29
Cattle and greenfeed	4	1
Pigs and poultry	6	3
Processing	**-1**	**1**
Abattoirs	3	1
Dairies	1	0
Sugar mills	-71	-7
Total	**-14**	**-7**
Change in number of full-time employees, total	-16.238	-8.058

Source: Jacobsen & Frandsen (1999, from Bichel Committee 1999)
Note: The calculations are based on unchanged total employment, i.e. the manpower released in the agricultural sector would find employment in other sectors.

The fall in sugar beet production is reflected in the sugar mills’ employment, which can be expected to fall by around 70 per cent in the 100% reduction scenario compared with 7 per cent in the 80% reduction scenario. In the livestock sector, on the other hand, production would rise, with a knock-on effect on employment in abattoirs and dairies. In all, it is estimated that employment in agriculture etc. would fall by over 16,000 full-time employees (1992-level) in the 100% reduction scenario (14%) and by over 8,000 full-time employees in the 80% reduction scenario (7%). Most of the reduction would be in primary agriculture.

Besides the above-mentioned job losses, employment would fall in other industries, including those directly associated with agriculture. The demand for nitrogen in artificial fertilisers falls for all crops in the 100% reduction scenario, while the supply of nitrogen in manure rises slightly (mainly because of a bigger pig production). In all, the use of artificial fertilisers is expected to fall by 63% in the 100% reduction scenario, while the total use of nitrogen falls by 41 per cent, primarily due to lower production. It will be seen from the table that the fall in total demand would be accompanied by extensive substitution of manure for artificial fertilisers. A corresponding analyses for the 80% reduction *scenario* shows a somewhat smaller fall in the consumption of artificial fertilisers, especially in cereals, sugar beet and greenfeed. Consumption of artificial fertilisers is expected to fall by 29 per cent, while total fertiliser consumption falls by 19 per cent.

Hence, it can be seen that as pesticide use falls, due to some complementarities in the use of fertilisers and pesticides, the demand for fertilizer would also fall . To the extent that there may be switches in land-use in which livestock production increases, the demand for nutrients would fall. With more being supplied from manure, there would be implications for employment in the manufacture of synthetic fertilisers. As the above discussion suggests, this would be offset slightly by increases in labour deployed on farm as more knowledge and labour intensive processes substitute for chemical inputs (a shift from chemical intensive to knowledge intensive farming).

17.6 Internal Market Effects

It would seem that the Internal Market issue, such as it arises in the context of this tax, relates less to the tax per se, and more to the system of approvals. According to EU legislation and international rules on trade of pesticides may be eliminated only if they have a negative impact on health and the environment. Justifying pesticide elimination by law requires proven environmental, agricultural or climatic conditions, implying that all pesticides have negative and unacceptable impacts to the Danish environment and public health. This is not seen as possible as a basis for bilateral action in Denmark ("Faktuelt" No. 21 of March 23. 1999).

Due to EU rules, forcing agriculture by law to change to organic farming is impossible. Neither is it possible to prohibit imports of vegetables and fruit with pesticide residues. However, a number of legal options to limit pesticide consumption exists, such as exemption of certain areas from spraying, imposing indirect taxation, laying down marketing requirements etc. ("Faktuelt" No. 21 of March 23. 1999)
As from year 2003 the Danish pesticide regulation will have to comply with internal market procedures regarding free trade of pesticide products approved in any Member State. The question then arises as to whether it is possible to keep the present system through exemptions, or whether the EU will adopt the stricter Danish rules after 2003. As mentioned above, farmers may be motivated to smuggle by the bans on the use of certain products in Denmark which are freely used elsewhere.

17.7 Conclusions on the Danish Pesticides Tax

The Danish pesticide tax has been introduced against a backdrop of an ongoing policy to reduce consumption of pesticides. In addition, changes in the level of price support in agriculture have probably contributed to falls in pesticide use in the 1990s.

Against a downward trend in use, the effects of the tax itself (as opposed to the Pesticides Action Plan and ongoing changes in agricultural policy) are difficult to discern. Certainly, there are no grounds to be pessimistic about its impacts, but equally, the tax has not obviously had major positive effects.

Arguably, the tax is still too low to make a difference to farmers' behaviour beyond those which have already occurred. It supports, however, the general shift towards lower pesticide use and conveys a message that pesticides are generally perceived to be undesirable, and that they are the target of minimisation campaigns.

Any claims to environmental effectiveness have also to take on board the potential complexity of the tax's influence on decisions concerning pesticide consumption. An ad valorem tax could, in theory, lead to consumption of less expensive but more damaging chemicals through widening the price differential between the lower and higher price products. For this reason, many countries have considered, or are still doing so, a banded tax on pesticides, and Norway has recently introduced such a tax.

The impacts on competitiveness mirror the effect of the tax in that, to the extent that it is difficult to discern any clear effect of the tax on pesticide use, so it is less than straightforward to discern such effects in agriculture. However, to the extent that there appears to be a consensus that there is considerable scope for reducing pesticide use with no negative impact on the sector, there seems to be good reason to believe that the impacts are not great. This is especially true since the tax revenue was used to reduce the ad valorem land tax being paid by farmers (so this offset production costs to some extent). Some crops may be exceptions to this rule, these being sugar beet, potatoes and fruits and berries (each of which is under considerable competitive pressure).

At its current level, the tax does probably not affect employment significantly. Only with much greater taxes, and consequent reductions in pesticide use, is employment likely to fall significantly. In the meantime, adjustments may even lead to increases in employment as farmers move to more labour- and knowledge-intensive practices in substituting for pesticides.