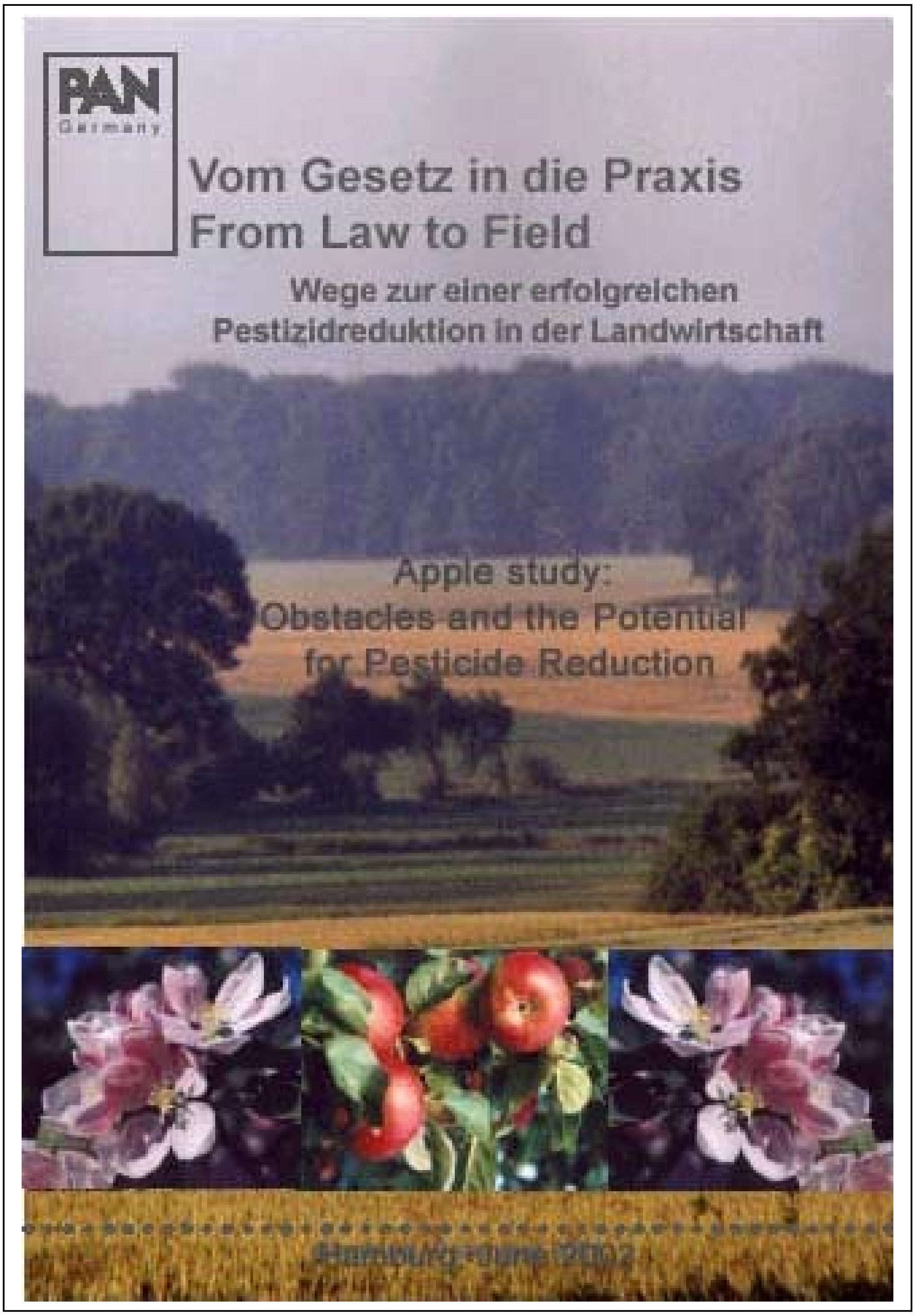

Pesticide Action Network Germany

Pesticide Action Network (PAN)

Founded in 1982, the Pesticide Action Network is an international coalition of over 400 citizen groups in more than 60 countries working to oppose the misuse of pesticides and to promote sustainable agriculture and ecologically sound pest management.
PAN Germany was established in 1984 as part of this global network and has continually been involved in initiatives to reduce the use of hazardous pesticides and to promote sustainable pest management systems on national, European and global level.

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1. Introduction –The Current Situation in Apple Production

The 5th Environmemntal Action Programe launched by the Council of the E.U. in 1993 set the objective of a substantial decrease in the use of pesticides by the year 2000. The objective was not realised. Apple production is still one of the agricultural areas where large quantities of pesticides are applied in frequent sprayings at every stage of growth. Apples are still as contaminated as ever with pesticide residues. The objective of this part of the study “From Law to Field: Pesticide Use Reduction in Agriculture – From Pesticide Residue Analysis to Action” is to use the example of apple production to show wherein lie the obstacles to a meaningful reduction in pesticide use. Three current agricultural systems will be considered with a view to comparing the use of pesticides in each case. It will become apparent that the greatest obstacles, and thus the greatest potential for reduction, lie less in improvements to the system of apple production, more in matters external to agricultural practice. Additionally a few major factors and some easily adoptable minimum requirements for good agricultural practice in apple production will be outlined. The following observations are based primarily on examples taken from apple production in Germany, particularly in Sections 2-4.

2. Pest control problems in apple production

In pome fruit (apples, pears) there are numerous organisms which cause damageand financial loss. The main pests in pome fruit growing are listed below:

Table 1: Major pests in fruit production
Fungus Apple/pear scab,apple mildew, storage moulds (nectria, gloeosporium, fusarium, botrytis), fruit canker (nectria galligena)
Insect pests Red spider(metatetranycus), rust mite(family phytophdae), apple leaf-curling midge (dasynaura mali), apple capsid (plesiocauris rugicollis), common green capsid (lygocoris pabulinus), apple leaf miner (stigmella malella), green apple aphid, woolly aphid (eriosoma lanigerum), pear leaf sucker (psylla mali), owlett moth (family nocturdi), apple blossom weevil (anthonomous pomorum), sawfly (genus hoplocampa), dock aphid (aphis ramicis), dockleaf wasp, types of moth

Source: G.Palm, 1989

Worldwide the most prevalent and dangerous apple disease is scab fungus (Gross-Spangenberg, Weltzien,1993). It is only in warm dry climates such as the apple-growing area of Spain, Lerida, that mildew is more prevalent (Landell Mills,1996). In two of the European apple-growing areas studied interviews with farmers confirmed that among pesticides the fungicides were

the ones with the most impact on profitability in apple production (Landell Mills,1996).
The level of infection by scab is in general determined by the area where the fruit is grown, the weather during the growing season, the previous year's level of infection, and the susceptibility of the apple variety. In areas where scab is prevalent, or in years when there are prolonged periods of rain and relatively high humidity, even farms in the integrated system find it necessary to spray 15 – 20 times with different fungicides in the course of one season. In years where weather conditions are more favourable, or areas where the siting of the orchards is better suited to apple growing, it would be possible to achieve the same result with 8 sprayings. Even in the organic system measures have to be taken to control outbreaks of scab, in this case by the use of sprays containing sulphur and copper. Here also weather conditions may make it necessary to repeat treatments frequently.
The case of scab infection alone makes it clear that apple production is an area where pesticide use is at its most intensive. In 1992 pome and stone fruit growers in the E.U. used on average 24.3 kg per hectare. By contrast, grain farmers used only 1.9 kg per hectare. Only vegetables, vines and tobacco were more heavily treated with pesticides (Landell Mills,1996).

3. Methods of apple production described

3.1 Historical overview of developments in Germany

Fruit production in Germany has only been established as an agricultural business since 1945. Previously fruit production was only a minor branch of agriculture, which concentrated mainly on field crops and livestock. Apples, pears, plums and cherries grew in orchards on tall robust trees, and their cultivation lent itself well to being combined with other types of farming. In dairy country the combination of orchard and pasture for rearing calves allowed for intensive use of the land. On arable farms the trees were typically underplanted with field crops. As farmers began to specialise in fruit growing as their only branch of business there was a progressive movement towards planting smaller trees and increasingly grafting onto dwarf rootstock. At first tall trees were used almost exclusively as robust seedling rootstock, but little by little the spindelbush form on dwarf M9 rootstock took over. At the same time the number of trees per hectare rose from 100 to 150, then to 3,000 and in one extreme case to 6.000 (Baab,1998). A complex packet of measures ensures that the trees produce the optimal crop of ripe fruit. "Optimal" here does not merely describe the amount harvested in one year, but the size and colour of the fruit and the setting of blossom and fruit in the following year. The tall trees which had earlier been common usually produced huge quantites of fruit every other year and recuperated in the following season. Such alternation is not acceptable in today's profit-based fruit-growing business. Care is taken by pruning, intensive application of fertilizers, thinning of both flowers and newly-set fruit to ensure that the plants develop only the amount of fruit of market quality (size, colour) that they can bring to optimal maturity – without threatening the following year's potential production by fruiting too heavily. The fruit that remains on the trees is protected from pests and fungus infections by intensive chemical treatments

(and in between times even partly with organic ones) so that as much as possible remains for the harvest.
Plant protection for fruit trees began at an early date. Wencel (o.J.) reports in the 1930s : “Pest control is one of the most important activities in the care of the orchard. Without routine spraying success is quite impossible.” Pruning aside, in the1930s a whole range of what were very poisonous preparations became available for spraying by the fruit farmer (for example, copper arsenic and lime, and nicotine-soap mixture). In due course a regular pattern of spraying was established (See Table 2).). Spraying was targeted primarily at pests and diseases in their various stages of development once these had been exactly determined.

Table 2: Directions for drawing up a spraying timetable for intensive apple production after Friedrich (1977)

Spray no.	Description	Suggested subtances and directions	Target organism
1	First shoots from bud formation to mouse-ear stage	Parathionmethyl + copper	Aphid eggs Leaf sucker Frost geometer Red spider mites Apple blossom weevil Caterpillars Scale insects
2	1. Pre-blossom (mouse-ear stage)	In case of insect infestation – Parathionmethyl again organic fungicides	Surviving pests Scab
3	2. Pre-blossom (to balloon stage)	Organic fungicides or sulphur sprays, where danger of scab infection being present - Benomyl	Scab-Ascospores Creeping mites
4	Short pre-blossom stage (only for mildew prone varieties).	Dinocap Triforine Chinomethionate Net sulphur	Mildew
5	Blossom	Benomyl Triforine No sprays harmful to bees	Scab Apple mildew
6	1. Post-blossom (after petals fall)	Captan Chinomethionate Thiuram + insecticide (e.g. Dimethionate, Carbaryl)	Scab Applemildew Sawfly Aphids Other insects Red spider

Table 2 continued

Spray no.	Description	Suggested subtances and directions	Target organism
7	2. Post-blossom (codling moth spray from the end of May – mid-June. Look out for the emergence date)	Fungicide + Carbaryl Dimethoat Lindane Parathionmethyl	Apple weevil Sawfly Fruit tortrix Scab mildew
8	Further spraying according to the level of attack.	Fungicides every 8-10 days for mildew prone varieties	Apple mildew Scab Look out for breeding apple weevils
9	Storage spray Late scab spray	Captan + insecticide where required (e.g. Parathionmethyl)	Scab and other infections that reduce fruit storage life
10	Special spray (from walnut size)	Calcium chloride 6-10 times	Baldwin spot in prone varieties
11	Special spray	Urea about 4-6 times	Promotes assimilation rate

Friedrich (1977) makes the point in the legend to the above table that ”one should not try to set out a universally valid calendar for spraying, since any timetable has to take into account the location and the exact state of infestation if it is to be appropriate to the plants as well as economically viable”.
Today we recognise in principle three different systems of fruit production: conventional, integrated and organic. In the most important fruit-growing area of North Germany, the Lower Elbe, the integrated system accounts for 80%, organic around 3% and conventional the remaining 17% of fruit produced (Hauschildt,1998).
In the following section the three systems are defined and their individual objectives, histories, ethos, and permitted use of pesticides described.

3.2 The conventional system of fruit growing

Conventional farming embraces the methods that have evolved through the historical process described above and is at present the established system for apple production. On the whole conventional methods are scarcely worth taking into consideration, as by far the greater number of farms in German fruit-growing areas are now working on the integrated system (for the proportion of land see above). Organic fruit farming is at present practised over a very small area but is on the increase, whereas conventional methods seem old-fashioned. Conventional fruit farmers are in any case moving towards integrated methods without fully complying with the conditions and self-regulation incurred. Their products cannot therefore be marketed as “integrated”.

3.2.1 Objectives

The conventional system has no set aims for the reduction of pesticide use, in so far as reduction offers no economic advantage.

3.2.2 Definitions

There is no precise definition for the conventional system. This study uses conventional to describe practices that conform to legal requirements, such as the Pesticide Act and the E.U. Guidelines 91/414, but do not impose any further limitations on pesticide use. The reference to the use of pesticides in agriculture in the Pesticide Act (PflSchG) is as follows: ”Pesticides should only be used in accordance with good agricultural practice. Good agricultural practice includes taking into account the principles of integrated pest control.” These words seem to indicate that the introduction of integrated methods is already legally binding. The formulation, however, is so vague - “includes…taking into account…” – that in a legal sense it could not be binding and non-compliance would meet with no sanctions. Only in 1998 did The Federal Ministry for Food, Agriculture and Forestry formulate and publish its ground rules for good agricultural practice in the use of pesticides in accordance with the Pesticide Act. There it was made quite clear that good agricultural practice reflected the status quo. The use of pesticides was sanctioned if:
Their use was scientifically proven safe
Practical experiment had proved their use appropriate, suitable and necessary
They were recommended by the advisory services
They were known to expert users
There was a further prognosis: “In the long term the standard for good agricultural practice in the use of pesticides will alter to a greater or lesser extent to conform to the present day conditions for integrated pesticide use.”(BML,1998)

Thus “good agricultural practice” only reflects the average, and accordance with the rules signifies no more that conformity to legal requirements. The term “good agricultural practice” might be taken to mean a standard appreciably higher than normal, but that is not the case. A more suitable term would be “current agricultural practice”.

3.2.3 Limitations on use – Reductions

The choice of pesticides available for use in conventional apple growing is governed by licence from the Federal Biological Research Centre for Agriculture and Forestry and set out in the Pesticide Register Part 2 (Vegetables, fruit, and ornamental plants). (Table 3)
The choice can be amended by special provisions related to contract growing or exceptional natural conditions. On the Lower Elbe, for example, a special area was set up by application to the Plant Protection Office as pesticides could not be used there in accordance with the “good agricultural practice” (comp. Section 4.2.2). The minimum distance from watercourses could not be observed because of the many ditches that drain the orchards. In the special area the regulation distances were reduced by one tenth, and

simultaneously the number of pesticides and treatments that could be applied was also reduced. The following were not allowed (Tiemann, 2001). Bitertanol, Cyprodinil, Diuron, Ethephon, Fenarimol, Flusilazol, Glyphosate, Potash-saponin, Lezithin, Mancozeb, MPCA, Mineral oil, Myclobutanil, Pyrethrum, Rapeseed oil, Streptomycine, Thiophanat-methyl, Triadimenol.

Table 3: Active ingredients in pesticide preparations authorised for use in conventional stone fruit production (Tiemann 2001)

Fungicides	Insecticides/ Acaricides	Herbicides	Other
1. Benomyl	1. Amitraz	1. Amitrole	*1. Pheromone*
2. Bitertanol	2. Codling moth granulosis virus	2. Diuron	2. Codlemone
3. Captan	3. Bacillus thuringiensis	3. Glufosinat	*3. Rodenticides*
4. Cyprodinil	4. Clofentizin	4. Glyphosate	4. Chlorphacinon
5. Dichlofluanid	5. Cyfluthrin	5. Glyphosate-trimesium	5. Zinc phosphide
6. Dithianon	6. beta-Cyfluthrin	6. MPCA	6. Difenacoum
7. Fenarimol	7. Diflubenzuron	7. Mecoprop-p	7. Sulfuramid
8. Fluquinconazole	8. Dimethoate	8. Propyzamide	8. *Bactericides*
9. Kresoxim methyl	9. Ethiofencarb	9. Simazine	9. Streptomycinea
10. Copper hydroxide	10. Fenazaquin		*10. Growth regulators*
11. Copper oxichloride	11. Fenoxycarb		11. Urea
12. Lezithin	12. Fenpyroximate		12. Ammonium thio sulphate
13. Mancozeb	13. Imidacloprid		13. Ethephon
14. Metiram	14. Potash-soap		
15. Myclobutanol	15. Mineral oils		
16. Penconazole	16. Neem		
17. Propineb	17. Oxydemetonmethyl		
18. Pyremethanil	18. Parathion-methyl		
19. Sulphur	19. Phosphamidon		
20. Tolylfluanid	20. Piperonylbutoxide		
21. Triadimenol	21. Pirimicarb		
	22. Pyrethrins		
	23. Rapeseed oil		
	24. Scale bug granulosis virus		
	25. Sulphur		
	26. Tebufenozide		
	27. Tebufenpyrad		

[a.] Licence runs to 15.03.01 (BBA,2001)

3.2.4 Documentation

The recommendation in good agricultural practice is that in principle all plant protection measures that have been applied should be documented (BML,1998). The recommendation is in no way binding on the growers.

3.2.5 Monitoring

There is no monitoring of pesticide use in conventional farming. It is only at the level of the product itself in the context of the official inspection of foodstuffs that there is a spot check on pesticide residues.

3.3 The integrated system of fruit growing

Fruit growing has played a leading role in the development of integrated methods of pest control. Diercks (1986) cites as a motive the increasing awareness, at the end of the 1950s, of the economic and ecological implications of forced, over-intensive pest control. Diercks counts among the “ecological side effects”of chemical pest control the phenomenon of resistance, accumulating pest disasters and ever-increasing costs (pesticide syndrome). Schulz (1993) detects a further motive in a growing interest among consumers in foodstuffs with the minimum amount of chemical residues. Since the 1970s the main focus for research and development in the area of integrated fruit production has been in Baden-Württemberg, Switzerland and northern Italy. Switzerland was the first to produce labelling for integrated fruit growing in 1986 (Schulz, 1993); since 1988 there have been guidelines for integrated produce in South Tirol; in the same year outline guidance for integrated production was worked out in Germany. The different German fruit-growing areas, such as the Lower Elbe, Rhineland-Pfalz and Baden-Württemberg, each developed their own guidelines and labelling (Tiemann, Grossgebauer,1998).

In October 1994 The International Organisation for Biological Controls (IOBC /WPRS) and The International Society for Horticultural Science (IHCS) jointly published a list of general principles, minimum standards and guidelines for integrated pome fruit production in Europe. A central concern in integrated pest control is the economic injury level. For apples it can be expressed as a rate of infestation by the most destructive pests at each stage of development throughout the year. The stages, for example, are from winter rest to first shoots; from mouse-ear stage to green buds; from hazelnut size to walnut size; and so on. Times of year are: e.g. from the beginning to the end of August, November to December. (Examples of infestation rates in apples:- green aphid:- 10-15 colonies per 100 bushels of leaves: saw-fly:- 3%-5% of fallen blossoms or fruits). If the rates are exceeded pest control becomes essential. The rates can only be seen as guidelines as they are influenced by various factors (fruit prices, the size of the crop, the weather, the presence of natural predators) (Tiemann, 2001). Similarly for fungus control – in integrated apple orchards spraying is not prophylactic but only undertaken (for example against scab) when weather conditions make infection likely. In integrated fruit-growing regions such as “the old country” (Lower Elbe) growers benefit from a scab forecasting service. Dates for scab infection calculated by recording leaf humidity and the use of thermohydrographs are broadcast and appropriate treatments recommended.

3.3.1 Objectives

It is the aim of integrated system to produce fruit of the highest quality in flavour and appearance by methods least harmful to the environment (Schulz, 1993).

The Federal Committee on Fruit and Vegetables has a specialist group on fruit (an alliance of fruit-growing associations, representing their members’ professional and economic interests). Its president, Gerhard Kneib, has stated that after organic fruit production the second most environmentally friendly system is the integrated. Integrated fruit production is based more soundly on scientific knowledge and takes greater account of economic principles (Kneib, 1998).

3.3.2 Definitions

The Plant Protection Act 15.09.86 defined integrated pest control as “a combination of strategies by which the use of chemical pesticides is kept to a minimum while all biological, bio-technical, crop production, and technical procedures necessary for the cultivation and production of fruit are fully implemented”. Diercks (1986) quotes the following definition used internationally: ”Integrated pest control is a strategy by which all methods, economic, biological, organic and toxicological, are evaluated in terms of the economic injury level. The conscious exploitation of natural means of control is at the forefront of this strategy.”
The above is the working definition of the Westpaläarktische Section (WPRS) of the International Organisation for Biological Controls (IOBC) in conjunction with a definition issued by the Food and Agriculture Organisation (FAO). The IOBC definition of integrated fruit production is: “The economically viable production of high quality fruit by ecologically safe methods with no undesirable side effects and requiring the minimum application of agro-chemicals, for the better protection of human health and the environment” (IOBC/WRPS, 1994).

3.3.3 Limitations on use – Reductions

Integrated fruit production leaves growers with a limited choice of pesticides. As well as an effective control of pests, diseases and weeds, the selected treatments have to conform to the IOBC/WRPS guidelines and pose as little threat as possible to humans, cattle and the environment. The list of approved pesticdes differs from state to state, with the German guidelines offering probably the strictest limitations, leading to distortions through competition (Schulz, 1993). Germany’s list of approved pesticides was drawn up by a committee of experts under the auspices of the specialist group on fruit growing in the Federal Committee on Fruit and Vegetables. (Table 4)

Table 4: Active ingredients in pesticides authorised for use in integrated pome fruit production (Tiemann, 2001)

Fungicides	Insecticides	Acaricides	Herbicides	Other
1. Benomyl	1. Codling moth granulosis virus	1. Amitrole	1. Mecoprop-p	*1. Pheromone*
2. Bitertanol	2. Bacillus thuringiensisi	2. Diuron	2. Propyzamide	2. Codlemone
3. Captan	3. Clofentizin	3. Glufosinat		*3. Rodenticides*
4. Cyprodinil	4. Diflubenzuron	4. Glyphosate		*4.* Chlorphacinon
5. Dichlofluanid	5. Fenoxycarb	5. MPCA		5. Zinc phosphide
6. Dithianon	6. Fenpyroximate			*6. Bactericides*
7. Fenarimol	7. Imidacloprid			7. Streptomycine[a]
8. Kresoxim methyl	8. Potash-saponin			*8. Growth regulators*
9. copper hydroxide	9. Mineral oils			9. Amidthin[b]
10. Copper-oxichloride	10. Neem			10. Etephon
11. Mancozeb	11. Parathion-methyl			
12. Metiram	12. Phosphamidon			
13. Myclobutanol	13. Piperonylbutoxide			
14. Penconazole	14. Pirimicarb			
15. Pyremethanil	15. Pyrethrins			
16. Sulphur	16. Rapeseed oil			
17. Triadimenol	17. Scale bug granulosis virus			
	18. Sulphur			
	19. Tebufenozide			
	20. Tebufenpyrad			

[a.] Licence suspended until 15.03.01 (BBA, 2001)
[b.] currently not licenced

3.3.4 Documentation

A prerequisite for establishing a value for the economic injury level is the observation of pest behaviour which must be recorded by the grower in his business report if he is to be recognised as an integrated producer (Hauschildt,1998). The guidelines for controlled integrated fruit growing also require a full account of all the pesticide treatments that have been applied. A diary must be kept, detailing all applications, with the following rubrics:
date / time, site / variety, water in litres per hectare, quantity in kg or litres per hectare and per 1 metre crown height, type of irrigation, air temperature, wind speed, wind direction (Tiemann, 2001).

3.3.5 Monitoring

Every grower's records have to be inspected, and extra checks made on the ground (at least 20%).They are carried out in only a few areas (Schulz,1993). In the administrative region of the Lower Elbe from 2001 the records can be consulted at the Plant Protection Office responsible (Tiemann, 2001).

3.4 The organic system of fruit growing

Organic fruit growers aim to produce food in accordance with the laws of nature. Organic farmiing began back in the 1920s with Rudolf Steiner's biodynamic agriculture. In the 1950s organic-biological agriculture was developed by Müller. !n 1962 the Association of Fruit, Vegetable and Field Crops (ANOG) was founded by Leo Fürst, whose first concern was to specialise in fruit and vegetable production (AGÖL,1996).

3.4.1 Objectives

The objectives of organic farming are:

- to produce high quality wholesome food with the lowest possible content of pollutant substances.
- At the same time to conserve the living nature of soil, air and water
- To preserve the natural diversity of plants and animals and where possible to re-instate those that are lost
- To avoid general pollution of the environment

The aim of organic farming is to cultivate plants in such a way as to ensure that attacks by pests or disease have little or no effect on their commercial value. The use of artificial treatments must only be as a last resort.

3.4.2 Definitions

Since 1988 the various agricultural associations have come together in The Association for Organic Agriculture (AGÖL) and accepted a set of common guidelines. The first time minimum standards for organic farming were set out for use within the E.U. was in 1991. Council Regulation (EEC) 2092/91/ defined organic farming and laid down rules applicable to the output of all organic crops in the European Community. The AGÖL guidelines on organic farming are in some ways more stringent that those of the E.U. (Schulz,1993). The two large agricultural associations, Bioland and Demeter, who between them own 60% of the businesses and 45% of agricultural land, withdrew from AGÖL in April 2001 (Ökologie und Landbau, 2001).

3.4.3 Limitations on use – Reductions

No use of “synthetic-chemical pesticides” is permitted for the prevention or treatment of fungus, virus or other diseases nor for weed eradication (AGÖL,1996). The range of treatments available is reduced to a relatively small number of anorganic and plant-based pesticides and a series of biological measures for control and growth regulation (Table 5).
One of the problems with organic fruit growing is the use of copper as a fungicide, as it is absorbed into the soil with a long-lasting detrimental effect on the environment. Current research shows it would be impossible to give up the use of copper without a considerable loss of crops. As an interim measure the German Association for Organic Agriculture limits the use of copper preparations to 3kg pure copper per hectare per year (Geier et al., 2001). The E.U. Regulation of 15/03/2002 allows quantities per year well above that level.

Table 5: Active ingredients in pesticides authorised for use in organic pome fruit production – E.U. Regulation (Tiemann 2001, Advisory Service 2000)

Fungicides	Insecticides/acaricides	Herbicides	Other
1. Copper hydroxide 2. Copper oxychloride 3. Sulphur 4. Lime sulphur	1. Codling moth granulosis virus 2. bacillus thuringiensis 3. mineral oils 4. Neem 5. Piperonylbutoxide 6. Pyrethrins 7. Rapeseed oil 8. Scale bug granulosis virus		*Pheromone* 1. Codlemone *Growth regulators* 1. Algae extracts 2. Alginic acids 3. Betonit 4. Powdered grit 5. Horsetail extract 6. sulphuric acid clay *Predators* 1. Trichogramma-parisitic wasps

3.4.4 Documentation

Each grower is obliged to keep a record of all the major agricultural activities, such as use of fertilizer, pesticides, sowing, fruit variety, crop, harvesting and so on. The record and all papers such as invoices for purchases and sales must be produced on demand for inspection by representatives of the controlling body (ANOG,1997).

3.4.5 Monitoring

Officials or an officially recognised private inspection service carries out yearly inspections of farms and farm records in accordance with article 9 of the EEC regulation 2092/91, wherever production follows the EU rules (Schulz,1993).

4. The contribution to date of the integrated and organic systems to the targeted reduction in pesticide use

In the following section an attempt is made to evaluate the contributions made by integrated and organic apple growing to the reduction of pesticide use. Separate consideration will be given to:-

- The quantity of pesticide
- The frequency of application
- The number of different preparations

Comparison of the available data is not without its problems, for the reasons listed:

- The data have been collected in regions with different climate conditions. Temperature, precipitation, humidity, and other extremes of climate affect the incidence of pests and disease-carrying organisms and accordingly there are many variations in the quantity of pesticides and the frequency ofapplications.

- Different farming methods using a range of treatments with different characteristics lead to variation in the quantities of pesticides used and the frequency of applications.

4.1 Reductions in the quantity of pesticides

There is a close connection between the quantity of the selected pesticide and the frequency of its use (comp. Section 5.2), but the two must be described and discussed separately in the first instance. The data for the quantities applied must be interpreted with care for the reasons below:
The proportion of chemicals in different preparations varies considerably according to the chemical concerned. Data for quantities are normally given in terms of the chemical content, and so a reduction in strength could lead to a reduction in the quantity applied (this aspect is discussed more fully in Sections 4.1.1 and 4.1.2).
As with the problems of scab infection discussed above, the quantity of pesticide applied from year to year can vary considerably with the weather conditions or other factors, making the detection of trends in the quantity of pesticide used extremely difficult.
According to Klingauf (1986), the current president of the Federal Biological Research Centre for Agriculture and Forestry, pesticides were applied at a rate of 27 kg per hectare per year in the apple orchards of the Rhineland in 1983.
There are no current market figures available for the quantities of pesticides used in apple production in Germany. The authorities, fruit research institutes and producers, who were the obvious sources of information, were either unable or unwilling to provide answers in this matter. In order to evaluate the effect of conversion to integrated or organic systems on the quantities of pesticide recourse was made to two studies: the first commissioned by the European Union (Landell Mills.1996), the second by the Environmental Office of the Free Hansestadt Hamburg (Geier et al., 2001).
The European Commission’s study examined three European apple-growing regions - Lerida in Spain, Provence/Languedoc/Rhone-Alps in France and Trentino in Italy, with reference to the quantities and types of pesticides in use in 1994. At that time the North Italian region of Trentino was fully integrated (int), whereas the Northern Spanish and French regions were still working on the conventional (conv.) system (Landell Mills, 1996). Geier et al., (2001) examined both integrated and organic apple farms in Hamburg in 1997 and collected data on the intensity of pesticide use.
From these two sources the following quantities of pesticides per hectare were derived (excluding growth regulators):

- Lerida (conv.): 27.0 kg active ingredients
- Provence/Languedoc/Rhone-Alps (conv.):39.9 kg active ingredients
- Trentino (int.): 33.5 kg active ingredients
- Hamburg (int.): 19.9 kg active ingredients

The data for the integrated farms in Hamburg are derived from a calculation of the proportion of active ingredients in the recorded quantities of commercial preparations applied at the rate of 33.2 kg per hectare. Comparative figures for active ingredients in pesticides used on organic fruit farms are not available. However in Section 4.1.1 comparisons are made with reference to the use of fungicides.

4.1.1 Fungicides

In all the areas studied fungicides were the major type of pesticide in use and are thus the deciding factor in the assessment of quantity. The figures from both Landell Mills (1996) and Geier et al. (2001) provide the following quantities of active ingredients in fungicides per hectare:

- Lerida (conv.): 11.5 kg active ingredients
- Provence/Languedoc/Rhone-Alps (conv.):32.57 kg active ingredients
- Trentino (int.): 27.56 kg active ingredients
- Hamburg (int.): 18.25 kg active ingredients

The least heavy application of fungicides was in the conventional fruit-farming area of Lerida. It would appear that the climatic conditions are the main influence in this area. Although scab is a major fungus infection in all areas its incidence in the drier areas of Lerida in Spain is less than in the more humid regions of Northern Italy or the Lower Elbe. According to the Spanish growers scab is a much less common problem than mildew. The rate of scab infection in Lerida can be taken to explain the low quantities of fungicide in use, and thus the low quantities of pesticide in use overall.

The choice of preparation also affects the information on quantities of fungicide. In Provence/Languedoc/Rhone-Alps contact fungicides were mainly used. They require a relatively high rate of application –for example: Sulphur(1-2 kg per hectare), Captan (0.6 kg per hectare), Mancozeb and Metiram (normally 1 kg per hectare). In Trentino, Italy, and Lerida, Spain, wider use was made of systemic fungicides which require comparitively less per application. Among others Myclobutanol (0.375 kg per hectare) and Flusilazole (0.0625 kg per hectare) were in use (BBA,1997,Tiemann, 2001). Since sulphur is one of the main ingredients it is worth looking at the comparitive amounts of sulphur preparations applied on average per hectare.

- Lerida (conv.): 2.44 kg sulphur
- Provence/Languedoc/Rhone-Alps (conv.):19.24 kg sulphur
- Trentino (int.): 4.77 kg sulphur
- Hamburg (int.): 3.58 kg sulphur

The effect of replacing “classic” components such as sulphur with modern sytemic fungicides does admittedly lead to a reduction in the amount needed to control attacks. It is not however desirable to widen the use of systemic fungicides as their long-lasting effectiveness may lead in the end to a build up of resistant strains (Landell Mills, 1996). Preparations such as Flusilazole have already been reported as having such an effect in some regions (Palm,1989). In the organic system it is to be expected that fungicides will be used in greater quantities than in either the conventional or integrated system. The only permitted treatments, copper hydroxide, copper oxichloride and sulphur have to be applied in greater quantities than the organic fungicides that are increasingly used in conventional and integrated farms. The data collected by Geier et al. (2001) in Hamburg on the quantities applied per hectare support this assumption. In the integrated farms in the study the amount of fungicide used per hectare was on average18.25 kg; in the organic farms, depending on the apple variety, the average was between 26.98kg and

32.10 kg. The quantities in organic farms would be even higher if the fruit-growers had not been able to optimise the use of their copper and sulphur sprays and thus reduce the quantity applied per hectare. The amount of copper in preparations for use on organic farms is restricted to 3 kg pure copper per year per hectare (Geier et al., 2001). In Hamburg the amount of pure copper in the preparations used on organic farms was between 1.63 kg and 2.8 kg. Integrated farms in the same area were using 4.47 kg/ha, though not every one of the seven integrated farms in the study was using copper preparations. To take only those farms where copper preparations were being used copper is being applied at the rate of 5.22 kg/ha. Individual organic farms were applying copper at the rate of 3.05 kg/ha and 4.89 kg/ha. The average use of copper was within the limits set for organic farms, but in individual cases the limits were exceeded. The quantity of copper used in the integrated farms was in any case higher than in the organic ones.

4.1.2 Insecticides and acaricides

The reduction in quantity that replacement by modern substances can effect does not only apply to fungicides. Insecticides and acaricides similarly are used in reduced quantities and the differences in the effectiveness of the dose are much more marked. If we compare pyrethrins with sulphur they amount to factor 6000 (Landell Mills,1996) (sulphur not only combats fungus but has a prophylactic effect on red spider mite, BBA, 1996). The adoption of new substances has thus led to a reduction in the quantities of pesticides used in both conventional and integrated fruit-growing. In contrast to conventional farming, the integrated system exhibits the opposite tendency in certain individual cases. On the one hand modern pesticides such as the fungicides lead to a reduction of the quantities in use, on the other hand integrated farms do not use any of the pyrethrins because of their harmful effect on predatory mites (phytoselids). In Trentino, Northern Italy, mineral oils are commonly used, requiring comparatively higher quantities (Landell Mills,1996). For the three areas in the comparative study (Landell Mills,1996) with the additional data supplied by the work of Geier et al. (2001) in Hamburg
the following quantities for active ingredients in insecticide/acaricide applications per hectare can be deduced:

- Lerida (conv.): 6.28 kg active ingredients in insecticide/acaricides
- Provence/Languedoc/Rhone-Alps (conv.):4.37 kg active ingredients in insecticide/acaricides
- Trentino (int.): 1.83 kg active ingredients in insecticide/acaricides
- Hamburg (int.):0.62 kg active ingredients in insecticide/acaricides

There is a noticeable contrast between the more carefully targeted applications in the integrated system (insecticides/acaricides only applied at an agreed degree of infestation) and the quantities used in the conventional system. The distinction is only relative, however, (as in the case of the integrated farms of Trentino) if the use of mineral oil preparations is taken into account. They are used primarily to control red spider mites and scale insects and require high quantities per hectare (see Section 4.1.1 in this context). The average use of mineral oils per hectare is as follows:

- Lerida (conv.): 8.10 kg mineral oils
- Provence/Languedoc/Rhone-Alps (conv.):0.85 kg mineral oils

- Trentino (int.): 3.31 kg mineral oils
- Hamburg (int.):0.00 kg mineral oils

The organic farms in Hamburg which featured in the study made by Geier et al. (2001), used 2.06 kg –2.09 kg of the permitted treatments for insect infestation. The figures refer to commercial preparations and not to the proportion of active ingredients and are not comparable to the above data for conventional and integrated farms. At the level of active substances there are no figures for the quantities applied on organic farms to control insect and mite infestations. The 0.62 kg of active ingredients in insecticides/acaricides quoted above for integrated farms corresponds to 3.3 kg in terms of commercial preparations. There is also no comparison to be made between the range of treatments used in organic farms and that in integrated farms, as they are put together on an entirely different basis. On organic farms natural products such as quassia, neem, pyrethrum and virus preparations are used[1], while integrated farms use exclusively synthetic-chemical products.

4.1.3 Herbicides

The quantities of herbicides per hectare calculated on the basis of their chemical content, are as follows:

- Lerida (conv.): 1.3 kg herbicide active ingredients
- Provence/Languedoc/Rhone-Alps (conv.):2.06 kg herbicide active ingredients
- Trentino (int.): 0.81 kg herbicide active ingredients
- Hamburg (int.): 2.00 kg herbicide active ingredients

There is very little difference in the quantities of herbicide applied in conventional and integrated farms. The region in Southern France shows the largest quantity of herbicides. Enquiries revealed that some of the farms in the study still treated the whole area of the farm whereas in Spain that was very seldom the case and in Italy never. In Lerida only 22% of the farms applied herbicides to some sections of their fields; in Trentino on the integrated farms a mere 4% did so (Landell Mills,1996). There are no specific figures for the use of herbicides on the integrated farms in Hamburg. Where herbicides are concerned organic farmers can show a clear reduction as these treatments are not allowed and never used. Weeds are cleared by mechanical means only.

4.2 Reduction in spraying frequency

The quantities of spray used and the frequency of spraying are closely linked. Klingauf (1986) reports that in the Rhineland in 1983 the average number of sprayings in apple orchards was 27. It would seem that the integrated system has led to a better targeted use of spray and thus to a reduction in frequency throughout the season. The reduction in insecticides is more obvious than the reduction in fungicides. Diercks (1986) reports that in Western Switzerland the introduction of integrated methods in apple growing probably led to a average reduction from 7 to 4 sprayings with insecticides and from 13 to 10.7

[1] In the study by Geier et al., (2000) the measure ment of 2.06 – 2.09 did not take into account a number of preparations which may at the least have some insecticidal properties. They include:e.g. sulphur/lime mixture, cocnut oil/soap applied at the rate of 0 – 9.8 kg/ha (drawn from the ready-made preparations).

fungicide treatments against scab and mildew. Hauschildt (1998), in a study of 214 farm reports from the Lower Elbe, finds that in 1997 the number of applications of insecticides and acaricides may have fallen to an average of 3, in contrast to the previous average of 5 before the introduction of integrated methods.

The average frequency of fungicide spraying on conventional and integrated farms (drawn from those farms that use them) as it appears in the studies of Geier et al. (2001) and Landell Mills (1996) is as follows:

- Lerida (conv.): 9.9 sprayings
- Provence/Languedoc/Rhone-Alps (conv.): 15.5 sprayings
- Trentino (int.): 22.7 sprayings
- Hamburg (int.): 24.0 sprayings

The average figures for the frequency of application of fungicides reflect chiefly the climate conditions in the different areas and the resultant level of fungus infection. Hence the low frequency in Northern Spain. In Trentino and more especially in Hamburg the weather conditions (high humidity and heavy rainfall) are more favourable to fungus infections. The other influence on the frequency of spraying is in the choice of treatment. Those preparations that are designed to control infection by maintaining a constant state of protection for the plants have to be applied more frequently than the systemic pesticides which continue to be effective in new growth.

The organic farms in the Hamburg region, in contrast to the integrated farms, sprayed against fungus infections between 22 and 26 times (Geier et al., 2001). The treatments were exclusively sulphur- and copper-based and needed to be used regularly to provide the necessary protection. The different procedure in fact results in frequencies very little less than in integrated farms.

Figures for the frequency of spraying with insecticides/acaricides appear below:

- Lerida (conv.): 11.4 sprayings
- Provence/Languedoc/Rhone-Alps (conv.): 14.2 sprayings
- Trentino (int.): 4.3 sprayings
- Hamburg (int.): 4.0 sprayings

In this case the integrated farms are clearly distinguished from the conventional ones by the low frequency of their application of insecticides. The more frequent use of insecticides and acaricides in Northern Spain and Southern France cannot be explained, as was the case with fungicides, by heavy infections caused by the climate. Landell Mills (1996) established that infestation by aphids is reduced by the adoption of integrated methods. Even in the conventional farms of Lerida it was normal practice only to spray certain targeted areas.

The participating farms in the Hamburg area sprayed in accordance with the density of their planting – on average 1.7 times (in the extensive orchards of the variety Boskoop on mostly robust rootstock) or 3.2 times (in the intensive orchards of the variety Elstar on dwarfed rootstock). Only those treatments allowed for pest control on organic farms were used (virus preparations, Spruzit, neem, and quassia). The frequency of spraying was thus at a similar rate to that on the integrated farms, although on the organic farms the treatments tended to be more specific (e.g. virus preparations) than in the integrated ones.

For herbicides the following frequencies for spraying were recorded in the four studies:

- Lerida (conv.): 6.4 sprayings
- Provence/Languedoc/Rhone-Alps (conv.): 5.3 sprayings
- Trentino (int.): 2.5 sprayings
- Hamburg (int.): 2.0 sprayings

In herbicide use also integrated farms score better than conventional ones. There was little mechanical weed control in either Northern Italy (integrated) or in Northern Spain or Southern France (conventional) (Landell Mills, 1996). As already remarked in the discussion on comparative quantities the organic system does not allow any use of herbicides and weeds are controlled by mechanical means.

The following principles form a basis for a clear distinction between conventional and integrated methods in the frequency of their use of pesticides:

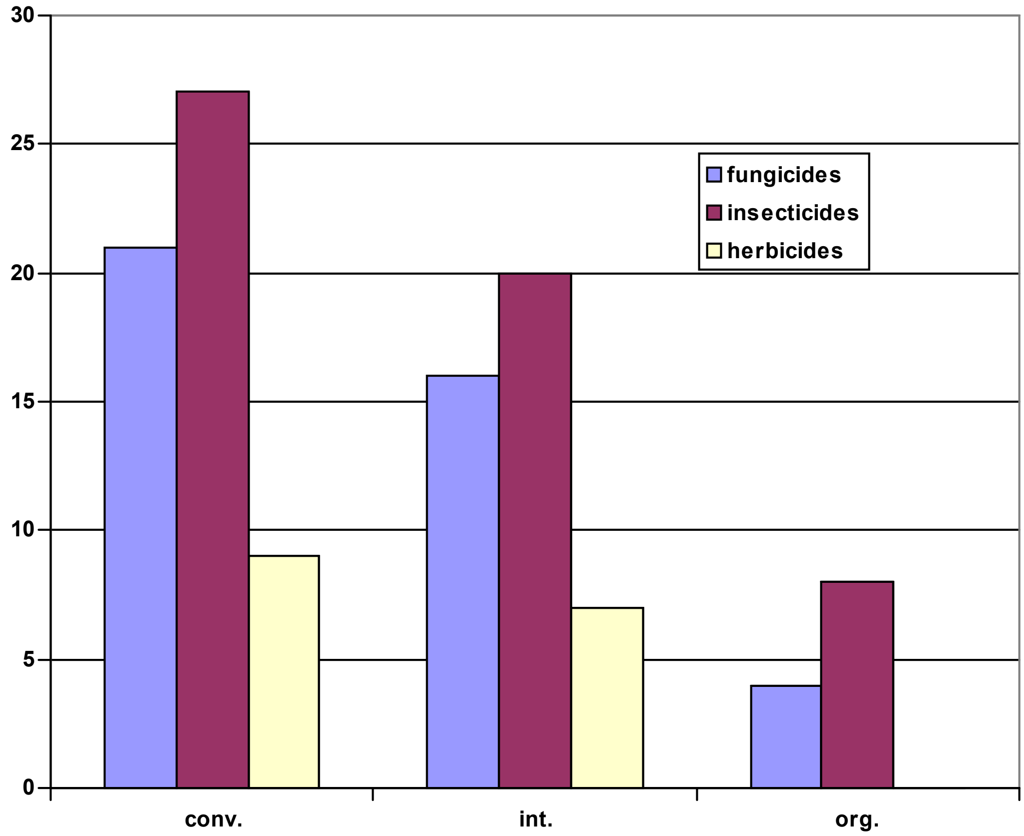
- Regular spraying of pesticides according to a strict timetable, as was formerly the practice, has now no place in either conventional or integrated fruit farms. The rule is now to spray when necessary. To take as an example fungus infections and the corresponding use of fungicides: these are only applied when weather conditions are such that farmers know from experience that an outbreak is likely and spray accordingly. In all the larger fruit growing areas farmers have access to a warning service. In Germany at least the general trend is towards integrated fruit production methods and the consequent reduction in the use of pesticides is something with which the integrated system can be credited. In Provence, one of the two areas of conventional farming in Landell Mills' study (1996), it was still a regular practice for an appreciable number of farmers to spray against codling moth according to a strict timetable. In Northern Spain, however, where the farming was on equally conventional lines, growers used the official warning system and delayed spraying until necessary.
- Integrated farms, in Germany at least, are now the major fruit producers (for figures on the "old country" (Lower Elbe) see Section 3.1). Today integrated methods are standard in fruit production and the conventional system plays a minor role. In theory a contrary tendency could emerge with the use of newer, highly specific pesticide treatments. One example is the codling moth (cydia pomonella) granulosis virus, a preparation that only attacks the grubs. This preparation only targets one organism and it could be assumed that all other pests would have to be dealt with by separate treatments, thus increasing the number and quantity of pesticides in use. Geier et al. (2001) noted that in the Hamburg area the highly specific, ecologically safe codling moth granulosis virus was used exclusively by organic growers. If it is true that specific pesticide treatments lead to a higher number of applications, the increase would be shown only in organic farms. The records of frequency of insecticide spraying, however, reveal that on organic farms the average rate of spraying against insects and red spider mite is less than on integrated ones. There should also be some examination of the extent to which non-specific treatments lead to further pesticide use by virtue of destroying useful insects and organisms, thereby favouring the mass reproduction of certain pests. One example of this process occurs with the use of pyrethroids which are used to control predatory mites (phytoselids) but

consequently increase the danger of mass reproduction of the red spider mite (tetranchidae). Pyrethroids are therefore not used in integrated production (see Landell Mills,1996: also Section 4.1.2). Whether or not the above observation has general validity cannot be decided in this study. Further research will be required. Different pests and fungus infections would have to be studied to find out how previous practices had been modified by the introduction of integrated or organic systems and what influence they had had on the reduction of pesticide use. The essential prerequisites for clarification on this subject would be:

- At producer level, the secrecy over pesticide coverage in fruit farms should be lifted and the data from reports to the BBA made public.
- At farm level, the documentation of all data referring to pesticide use should be made obligatory and
- These data should be made available within the profession

4.3 Reduction in the number of different pesticides used

First of all we should look at the multiplicity of chemicals which are coming into use on individual holdings (Diagram 1).



Diamgram 1: Numbers of permitted pesticides in conventional, integrated and organic apple production

While integrated and to a greater extent conventional pome fruit growing still requires a large number of different pesticides, in organic cultivation the range is severely limited. The integrated fruit-growing system relies on the availability of a certain number of different preparations, if only to avoid the appearance of resistant strains. The organic system has to cope with very few different preparations, and with a limited range of treatments, particularly in the case of fungicides, has to compensate by using them in greater quantities (see 4.1.1).

4.4 Summary

In contrast to conventional apple production the integrated system is distinguished by a more carefully targeted approach to the control of pests and fungus disease. Controls over infection have been established in conjunction with the withdrawal of prophylactic applications of pesticides. Consequently there has been a reduction in the quantity of pesticides used, at least in the case of insecticides and acaricides. The data for fungicides do not reveal any definite trend. The climatic conditions in the regions studied are so very different from each other that the influence of the production system is obscured. There is also no clear tendency in the use of herbicides.
As far as frequency of treatments is concerned the integrated system has led to a clear reduction in insecticide and acaricide spraying. With fungicides the opposite is the case. Here again difficult climatic conditions in the regions studied make the incidence of fungus infection much greater.
The number of treatments in use is only very slighly lower in integrated apple production.
To summarise – the integrated system cannot be seen as a first step towards pesticide-free apple production. It has led to an optimal use of pesticides, motivated in the first instance by economic considerations (for reasons of cost only essential spraying is allowed). A secondary well-founded concern is the development of resistant strains, occurring very quickly, especially with fungus disease, if the same treatment is repeated too often. There do not seem to be any other basic strategies for solving or avoiding problems with pests and diseases. The potential for reducing pesticide use by integrated methods seems for the present to have reached its limit.
A further question is raised if the number of different pesticides in use is to be reduced. The more frequent application of a smaller range of treatments risks the emergence of resistant strains. As well as the direct benefits of reducing pesticide use there is the indirect consequence of converting to the integrated system. The controls and evaluation process required of integrated farmers with regard to the need for pesticides should act as a kind of training. They can move on from this system to convert to organic methods. Organic methods do lead to a real reduction in the number of pesticides. The quantity of pesticides in use against insects is also less than in the integrated system. On the other hand fungicides are applied in greater quantities. The active ingredients of the fungicides in use require heavier quantities and more frequent sprayings than those used in integrated farms. Even so the organic frequency of application is not much higher and in the case of insecticides much lower. The most obvious reduction in terms of quantity, frequency and numbers of preparations comes with organic weed control where herbicides are not used at all and weeds are removed by mechanical means.
Organic fruit production methods are quite distinct from those of integrated apple growing. The integrated growers do not differ in principle from

conventional growers, but are making gradual changes, while organic agricultural methods are part of an entirely new concept. The health of plants is maintained as a priority, the onset of disease or pest infestation held at bay, and optimal conditions created for natural predators. One strategy is to leave ground fallow for several years between clearing old trees and planting new ones, another to improve soil quality by the addition of compost, the planting of flower strips and allowing green vegetation in the tree lines after the growing season. In the integrated farms such practices are recommended but in fact rarely carried out. The provision of nesting boxes (in the hope that birds will have a beneficial effect in reducing the insect population) has proved very popular here, but the outcome is uncertain. Hatching young on intensively farmed ground has proved difficult. It seems that spraying with insecticides deprives the parent birds of their basic food at the very moment when it is essential for feeding their offspring (G.Hoffmann, verb. comm.).
Organic apple-growing will not benefit from a reduction in the matter of spraying or non-spraying or the introduction of new treatments. Organic systems only allow treatments that have a relatively weaker effect than those used in conventional and integrated farming. Organic fruit growers are constantly challenged to find other basic methods of controlling pests and diseases. Their starting point must always be the growing conditions and health of the plants. Integrated growers, like conventional ones, are much more concerned with the different treatments, their effectiveness and availability. So for example, for most growers, if there is an outbreak of woolly aphid (eriosoma lanigerum), the focus is on the choice of a suitable treatment; the organic apple-grower is restricted to questioning his practice overall. He has to check whether fertiliser has been applied too heavily, or the pruning has been too harsh, two strategies which increase the fruit-bearing capacity of the trees but also lay them open to attack by woolly aphid. He also has to ask why the trees in that orchard have not been colonised by the chalcid wasp (a natural predator on woolly aphid). Apple production in the organic system must be viewed as a problem (no possibility of a follow-on crop, high incidence of pests and disease) where efforts to limit pesticide use (particularly of fungicides) are quickly exhausted.
Integrated fruit production does offer a more positive image than conventional methods: from a situation where apple production in particular was known for the massive use of pesticides it has succeeded in leading the movement for reduction. It would be false to give the impression that organic production in its basic concept does not offer better possibilities for reduction. The analysis of pesticide use in the three systems of the comparative study makes it quite clear that further initiatives in pesticide reduction must go beyond current practices. The example of efforts to control fungus diseases such as scab shows how the problem cannot be satisfactorily solved by pesticide technology if the ultimate aim is to reduce the use of fungicides.
Success seems more probable from a different starting point, as is explained in the following section.

5. Obstacles to reduction – Potential for reduction

Against the background of facts presented above the question remains: how is the major reduction in pesticide use required by the 5th Environmental Action Programme of the E.U. to be achieved?
Chemical pest control has to produce pesticides of a guaranteed quality (they must be effective) and a guaranteed selection of treatments (while the various pests must be eradicated there must be no build-up of resistance). Within these limits lies the potential for the reduction of chemical plant protection. The obstacles to reducing the use of pesticides are not so much in the systems of agriculture as in the overall conditions affecting the growing and marketing of apples. Only by removing these obstacles can a further reduction in pesticide use be achieved. They can be considered under the following three headings:

- Production
- Trade
- Consumption

5.1 The potential for reduction at production level

The greatest use of pesticides is in conventional apple production. The requirement to follow "good agricultural practice" describes the status quo. If there is to be the desirable reduction in pesticides used as plant protection (in the narrower sense)"good agricultural practice" will have to be more accurately measured. Table 6 shows the minimum conditions PAN-Germany would impose as good agricultural practice in apple production. They go beyond the status quo and are relatively easy to implement.

Table 6: Key elements in good agricultural practice and their application to apple production

Key Elements in good agricultural practice	Application to apple production
1. Soil structure	Avoid stagnant wet land, (favourable to fruit tree canker)
2. Crop rotation not an option	Allow land to lie fallow for several years before replanting
3. Irrigation	No overhead spraying as favourable to scab
4. Choice of variety	Preference to resistant strains (acclimatised and resistant varieties)
5. Control of harmful fungi	No close planting of rows, choice of variety (see above), shredding and mulching to aid decomposition of fallen leaves, no pesticides harmful to soil based organisms, pruning as control of mildew and canker
6. Wild life refuges	Hedge planting, nesting space for insects and birds, ditches in preference to drainage pipes, grassing down between trees from midsummer

Table 6 continued

Key Elements in good agricultural practice	Application to apple production
7. Provision of nutrients	Appropriate fertilisation after soil analysis, preference to organic fertiliser, grassing down between tree rows to conserve nutrients
8. Weed control (clearing between tree rows)	No use of herbicides, mechanical weed control, targeted grassing down of tree rows in summer
9. Use of pesticides	No prophylactic treatments, no substances harmful to useful predators or soil-basedf fauna, (nor resistance-building substances such as pyrethroids), no anti-biotics, use of scab warning system, treatment only after regular infestation controls (lures, scarers), where possible partial treatment of area, dispersion strategies.
10. Chemical-free treatments	Pruning (to control mildew and canker),mechanical clearing between trees, biological pest control (codling moth/scale bug granulosis virus, bacillus thurigiensis preparations)
11. Agricultural practice	No planting of dwarf rootstock to the exclusion of more resistant varieties, choice of rootstock to suit variety grown
12. Use of resources	Preference to regional marketing as energy-saving
13. Documentation	Documentation on all plant protection measures

In areas where integrated farming methods are not yet established, the adoption of these strategies would lead to a reduction in pesticide use.
A further reduction (not including fungicides) would be achieved by conversion to organic farming.

5.2 The potential for reduction at marketing level

5.2.1 Prices to growers

The move towards intensive apple production has had a considerable effect on prices to growers, and these in turn have led to an almost unbelievable degree to a greater level of intensification. Even organic growers have become involved. The modern version of apple farming for profit was briefly described in Section 3. Now that such importance is attached to the quantities of fruit produced no grower can afford to let pest infestation reduce his carefully calculated harvest. The situation differs fundamentally from production in the domestic orchard, where a few worm-eaten apples are of no consequence in an otherwise abundant harvest. In profit-driven fruit farms however, all the fruit left on the trees after thinning must be harvested in order to achieve an acceptable return on investment. Yet more: when chemical treatments are replaced by mechanical means, e.g. shoots affected by mildew are cut out, the sensitive balance between the new shoots and the setting of blossom is disturbed. The balance has to be maintained by a combination of chemical and mechanical intervention to ensure the output is as required.

With prices as they are today it is scarcely conceivable that anything will alter the compulsion to continue on these lines. Only a rise in prices would create a climate in which producers would be prepared to face greater losses by using less pesticides and accepting variations in their level of output.

5.2.2 Marketing structures

Today fruit is marketed all over Europe and even world-wide. One feature of this super-regional marketing is the use of long transport lorries with high-energy consumption. Transport costs make a negligible contribution to the overall expense, but have a highly negative effect on the ecological balance. The lorries' emissions of large amounts of CO_2 contribute to the greenhouse effect.

The structures required for inter-regional marketing cannot take into account regional characteristics. On the inter-regional level the concern is production and marketing of fruit in an increasingly diminishing number of varieties. On the supermarket shelves there are seldom more than a dozen. As late as 1941 the trade lists of the Agricultural Department contained 190. European trade has exacted its tribute. It is not in the interests of the trade to handle dozens of different varieties. It is much easier to deal with a small selection that is recognised all over Europe than to buy and sell all kinds of regional ones. The scene was set for a reduction from the previous large choice to around ten which could be marketed across the whole of Europe from Germany to Italy. The wholesale fruit trade is the deciding influence in the producers' choice of varieties. If the trade does not accept certain ones they will not be planted, whatever their resistance to pests they may be. It is even the case in organic fruit production that in recent years there has been a shift towards growing the varieties favoured by conventional and integrated farmers with the consequent increase in problems related to their susceptibility to fungus disease. The trend has only recently shown signs of going into reverse.

The limited range of varieties is in itself an obstacle to pesticide reduction. Over centuries of fruit growing in the different regions of Europe thousands of apple varieties have developed. More than a few are ideally suited to the climate and soil conditions of their native area and in some cases exhibit an observable resistance to local pests. As an example the variety Prinzenapfel, which is grown all over Northern Germany, can be cited as highly resistant to scab. It is not a characteristic that has been bred into the variety but a tolerance that has developed over time. Infection by scab remains a possibility, but only happens in extreme attacks, which is not the case with the averagely sensitive, or particularly with the susceptible varieties that are part of the trade selection, (e.g. Golden Delicious, Elstar). Friedrich had already identified Golden Delicious as scab prone in 1977, a conclusion he reached from his own experience in Northern Germany. In Italy,however, it was rated as reasonably scab-resistant. These ratings have recently been subject to revision due to conditions favourable to scab and fungus strains that have overcome the variety's natural resistance. The original rating was made in comparison to the much more susceptible group of varieties Red Delicious or Morgenduft. Landell Mills' (1996) research showed that farmers in Trentino put resistance to disease, and to a lesser extent, to pests, as an important criterion in their choice of variety. They did not however consider local varieties, and in the final analysis it was economic good sense (market demand and long storage quality) that was the deciding factor for the growers of Northern Italy.

In recent years more scab resistant varieties have been developed, but it remains to be seen whether these will survive long in the very different climates of Germany's fruit-growing areas (e.g., the "old country", or Lake Constance), let alone those in the rest of Europe. A good sign is that even organic farmers have reported good results with some varieties (e.g. the Czech variety Topaz in the "old country").

The marketing structure outlined above stands in the way of increased planting of the new resistant varieties, much as it did in the case of the old locally adapted ones. The creation of local marketing structures and trade based on local varieties would open the door to planting less susceptible ones and thereby reducing the frequent use of pesticides (see the case study "Finkenwerder Herbstprinz" in Section 5.4).

5.2.3 Quality norms

The quality norms for dessert apples set by the E.U. (official paper no. L126 of 17.05.97) prohibit the sale of apples which have more than 1cm^2 skin blemish (e.g. scab patches). Frequent spraying with fungicide is hardly avoidable if fruit is to be kept within this norm. Its relaxation would be an important step towards reducing the frequency of fungicide spraying, second only to making way for less susceptible varieties. There would be no danger to the consumer as scab patches pose no threat to human health and are only a cosmetic problem. So far it is only fruit produced by organic methods that does not entirely conform to this dubious ideal of beauty, since only a limited number of treatments are allowed in the system. Organic farming is constantly under attack from integrated growers, as a quotation from Tiemann (1989) shows: "We wish to dissociate ourselves entirely from the so-called 'biological' tendency: it makes impossible the production of any fruit meeting the present norms of taste and appearance."

5.3 Potential for reduction at consumer level

In order to realise the potential for further reduction it is essential to conduct an awareness campaign at consumer level. Consumers must agree to accept fruit that does not conform to the current image of the typical commercial product. Some suitable strategies must be sought to persuade consumers that apples do not lose quality or affect health unfavourably if the size, shape, colour and skin condition are not standard. Scab patches, equally, must be shown not to have the adverse effect on health that is commonly feared. It would not be impossible to bring to consumers' notice the wide range of taste and consistency among apple varieties, in contrast to the almost universal flavour (primarily sweet) and the over-rated dominance of 'crispness' in commercial apples. Then there would be a bigger market for varieties with

flavours different from the familiar ideal, with a sharp,acid taste, or nutty, spicy with a hint of roses or berry fruit. Crispness could be replaced by a light, soft or foamy consistency. In this way the ground would be prepared for the marketing of new, disease-resistant strains or even the older more robust varieties.
Purchasing fruit directly from organic growers, for example in the local markets, would help to increase the demand for more disease-resistant apples and encourage other farmers to convert. Consumers may, however, be discouraged by the higher prices of organic fruit in comparison to integrated or conventional produce. Here again an awareness campaign is called for; organic apples are not cheaper to produce - the work involved is greater, the output lower and the risk of losing the crop higher. Given that expenditure on food now represents a constantly shrinking section in the cost of living index, it should be possible to convince consumers that the higher prices of environmentally sound and healthy foodstuffs is money well deserved by the producers.

5.4 Case Study "Finkenwerder Herbstprinz"

5.4.1 Objectives of the initiative

In Hamburg in recent years there has been a marketing initiative to make a certain local apple, the Finkenwerder Herbstprinz , better known to the public. It had been almost completely excluded from the market by the commercial growers and traders, and it was hoped to increase opportunities for sales. There were three different objectives in the campaign:

- Maintenance of genetic diversity
- Reduction of pesticide use
- Regionalisation of marketing

Maintenance of genetic diversity

The Finkenwerder Prinz is a left-over sample of the diverse regional varieties of the Lower Elbe. The story of its discovery is quite dramatic. As with many of the old varieties the Herbstprinz was not the result of a breeding programme but emerged as a chance seedling. The mother tree must have been growing since about 1860 on Finkenwerder in the lüneburger section and about the turn of the century was discovered on a neighbour's plot by the young apple grower Carsten Benitt. Benitt recognised the apple's qualities (excellent flavour, versatile, good keeper, robust growth) and propagated it, planting a large number of trees. From that time onwards it was constantly under cultivation in the Lower Elbe region which In the 1950s and 1960s was the most extensive fruit-growing area of Germany. Then in the 1970s and 80s it fell from favour. The fruit-grower and retailer, Eckart Brandt, an expert on and collector of old varieties, gives two reasons for its decline: firstly, the greater intensification of trade relations in the European Common Market/European Union led to a narrowing of the range of apple varieties and the sidelining of those known and widely grown only in local regions. Secondly, orchards were converted to dwarf trees on the M9 rootstock, which led to the Finkenwerder Prinz producing over-large apples. Although normally it had kept well without refrigeration the larger fruits quickly fell to pieces in the storage sheds.

Reduction of pesticide use

The propagation of the Finkenwerder Prinz has particular relevance to the objective of reducing pesticide use. It had proved very well-suited to the climate and soil conditions of the region and had a especially high resistance to scab infections. Unlike the most commonly grown dessert apples of today, e.g. Elstar, the Finkenwerder trees produced large numbers of dessert fruit without any treatment whatsoever against scab. They were also highly resistant to fruit tree canker, a fungus disease to which trees on the heavy marshy soils of the Lower Elbe are particularly prone. The Finkenwerder Prinz, as described above, was not a variety which had been bred to resist certain diseases but a chance seedling that had proved itself resistant under the harsh conditions of self selection in the local habitat. It does not follow, of course, that a variety like the Finkenwerder Prinz would do well in an area with a pronounced continental climate, since there a higher susceptibility to a disease like mildew could not be ruled out. In such a area another proven local variety would have to be sought out.

Regionalisation of marketing

In this connection the Finkenwerder initiative assumes great importance: here a variety is being propagated which is traditionally grown in the Lower Elbe region. The object of the action is to create a stronger demand for this locally produced fruit with a view to resuming the planting of the Herbstprinz on a larger scale. A prerequisite of the action was that substantial Finkenwerder Herbstprinzen orchards are still to be found in the area around Hamburg (the output is estimated at about 100 tonnes per year). Furthermore many people in Hamburg still know the Herbstprinz and value it highly.

5.4.2 Account of the initiative

Brandt went to the trouble of launching a drive for preservation because of the difficulties the organic fruit farmers found in selling their crop of Finkenwerder Herbstprinz as dessert apples. Several articles in the local papers and a media campaign “Save the Finkenwerder Herbstprinz” led to a short improvement in sales in the region. Such campaigns should not be repeated too often and the idea was born of an annual event to be held on a fixed date and linked to a half-forgotten tradition.

The day of action

The first day of action was held in the autumn of the year 2000 and was designed to become a regular event in the future. The purpose was to celebrate the first harvesting of the regional speciality, allied to the old tradition of transporting the harvest by boat from the island of Finkenwerder to the centre of Hamburg. The residents of Hamburg would then be reminded regularly every year of the existence of this variety of apple. 20 cases of apples were symbolically loaded onto three historic cutters from Finkenwerder Island, the home of the Finkenwerder Prinz. The media and local officials accompanied the load as it sailed along the Elbe and into the port of

Hamburg, just as would have happened at the beginning of the 20th century. In the harbour the precious cargo was handed over to the Hamburg city councillors, and from there transported into the Inner City on a historic tractor. There a little market was set up around the Finkenwerder Prinz. Freshly picked Finkenwerder Prinz apples, Finkenwerder liqueurs and brandy, even young trees of the variety were on sale and a local juice firm had apple juice for tasting and purchase.

Success of the Action

The “Action Day” was rated a success not only because of the sales of fruit (in spite of poor weather more than one and a half tonnes were sold). More importantly the citizens of Hamburg were reminded of the existence of the Finkenwerder Prinz. The Action had a positive long term outcome in the sense that the increased demand for the fruit led to organic farmers replanting the variety in their orchards – a big success for a fruit that had lost sales to such an extent that it was being used mostly for pulping and juice.
In many ways the Action to promote the Finkenwerder Prinz provides an example which could well be followed in other fruit-growing areas. If similar marketing initiatives were to be taken in other regions, the result would be a replacement of the varieties grown at present by the local ones still in existence. They would be well suited to local conditions and much more resistant to disease and pests. Such a development would lead to a reduction in pesticide use for apple production.

6. Summary and prospects

Apple production in Europe is still typically a area of intensive use of pesticides, regardless of the important statement issued by the E.U. in 1993 aimed at a meaningful reduction by the year 2000. Great numbers of different pesticides against fungus, insects, mites, and weeds are sprayed at frequent intervals according to the season. In the different climatic conditions of Europe’s fruit growing regions either fungus or insect/mite pests make it essential to apply pesticides in quantity.
In Germany the movement from conventional apple growing to the integrated system has been almost universal and has led to a reduction in the use of pesticides. Even integrated production characteristically makes intensive use of pesticides, though modern treatments require lower quantities. The range of different preparations is an indication of the extent to which their use is unavoidable in this kind of system. A further reduction in the use of pesticides in integrated production cannot be counted upon.
The organic system claims a much more extensive reduction in the use of insecticides and in particular of herbicides (fully banned) than the integrated. Since all synthetic chemical pesticides are excluded the number of different treatments for pest control is significantly smaller than in either conventional or integrated farms. In cases of fungus infection the restrictions mean that sulphur or copper preparations have to be used, both of which have to be applied in large quantities. Copper especially is problematic for its pollutant effects. Its use in organic farms is restricted and is used over less widely than

in integrated production. A full ban on copper would lead to unacceptable losses in the fruit varieties at present being cultivated.

The example of fungus infection makes it clear that further reductions in the use of pesticides cannot be achieved simply by the growers improving their methods; the potential for reduction lies outside the farms. In this context the excessively high standard for the skin quality of fruit can be cited – a standard that cannot be achieved without intensive use of pesticides. Another major problem is the reduction, enforced by the fruit trade, in the marketing of local varieties of apple which do well in a given region and require less pesticides for their cultivation.

Consumers could be targeted by publicity to accept that organically grown apples cannot be produced at the same low prices as integrated or conventional apples. They could use their puchasing power to increase the demand for organic fruit and thus persuade more farmers to convert to the organic system. Conversion to organic methods is not enough in itself. They have to develop further to make the use of such substances as copper unnecessary. Here again well-informed consumers could make a contribution by demanding disease-resistant varieties which would then be more widely grown. The local marketing initiative of the Finkenwerder Prinz provides an encouraging example of promotion of an apple which is relatively tolerant of scab, well suited to the conditons of its region (“Altes Land”) and requires little fungicide treatrment.

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