

ORGANIC FRUIT GROWING

Annual report 2002

LBI organic fruit
growing research

including plans for 2003

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1 General

1.1 Organic fruit growing in 2002

To put our work into context we will first outline some important developments in the organic fruit sector.

Hectarage and production in 2002

Not a single new farm embarked on conversion in 2002. The organic production incentive scheme (4425 euro/ha for 5 years) did not provide sufficient incentives at a time when sales and the choice of varieties are uncertain and the range of available crop protection products is inadequate. Nine of the ten farms currently under conversion received full EKO status this year. This makes a total of around 35 fruit farms with around 300 ha of organic large fruit. In addition there are also around 45 ha of organic small fruits and fruits of the forest in the Netherlands.

The 2002 harvest consisted of around 3,000 tonnes of apples (1,300 tonnes Elstar, 630 tonnes Jonagold and 210 tonnes Santana as the three main apple varieties), and 350 tonnes of pears. In addition there are still many organic farms which include some fruit. The overall hectarage is thus comparable to that reported in the previous year. The stagnation in further expansion in organic fruit growing can be seen throughout Europe. The reasons are the same too: uncertainty in cultivation, stagnation in approvals of crop protection agents and an uncertain and demanding market.

Sales

The 2002 organic apple harvest was around 140% of the 2001 figure. Apart from apples in the Albert Heijn supermarkets, there is still little interest from supermarkets in Dutch organic fruit. However, interest in imported organic fruit is increasing. Farmers' markets, box schemes and the health food market are stable. The market is growing steadily. There is increasing pressure on the market from cheap foreign fruit.

There was strong resistance among fruit growers to the general 'unsprayed' slogan for organic products, since this does not do justice to organic fruit growing. The health food and supermarket trade impose increasingly high quality requirements on organic fruit, which is good for the sector, as long as prices rise accordingly. The growers' association Prisma appointed a chain manager on 1 October 2002 to coordinate the scaling-up operation and to increase professionalism in marketing.

Innovation in the range with Vf-resistant apple varieties

The first young plantings of Santana in the orchards are now five years old. This is proving to be a tasty apple variety with reasonable storage qualities. It is susceptible to powdery mildew, but not particularly susceptible to aphids and not prone to biennialism. However some scab has already been observed on a number of farms. These qualities make it one of the better varieties for organic production, but it cannot be grown without spraying and is not suitable for extended storage. Topaz has also been grown for two years on a number of organic farms.

A new development this year is the availability of organically raised plant material of the early apple variety Collina. This is a cross developed by organic fruit grower Mart Vandewall from Priscilla and Elstar: it is scab resistant, has good flavour and firmness, and is ripe at the end of July or the beginning of August. This summer apple precedes Alkmene in the season and could make a proportion of the imports of Gala from Southern Europe superfluous. Around 8000 trees have now been planted on a number of organic fruit farms.

The Organic Fruit Growing Study Group on resistant varieties comprising growers, researchers and consultants, supports the development of resistant varieties. The PPO (Institute for Applied Plant Research) and Inova are now working on the next generation of apple varieties with field resistance and are profiling apple variety 'P' and the pear variety Concorde.

Approval of control agents

There is a separate committee working on the problems surrounding approvals of crop protection products. Approval of lime sulphur in the Netherlands foundered on the problem of insufficient data. For 2002 and

2003 powdered sulphur is the only product available to combat scab. Approval of a pheromone which disrupts mating in tortrix moths is proceeding slowly. Where a trial exemption was obtained, this product proved highly effective.

1.2 Characteristics of the 2002 season

2002 was preceded by a wet autumn and consequently a considerable amount of rot in stored fruit and canker in the orchard. A mild winter with exceptionally early flowering (mid-April in apple), followed by bad weather, poor setting and considerable and lengthy early drop. Serious apple scab infections occurred in mid and late April.

After mid-May the weather grew warm and dry. There were two heat waves in mid-June and at the end of July - causing a good deal of sunscald on the apple skins - and local hail storms. At the end of June and the beginning of July there was a great deal of rain. September and October were exceptionally pleasant, dry and warm for picking. The apples ripened relatively early. It was a relatively bad year for rosy apple aphid and mealy plum aphid, there was a lot of woolly aphid and only late parasitisation by the parasitic wasp, a lot of canker and moderate to heavy scabbing.

It was a good year for pears, cherries, plums and berries. Apple production was ultimately disappointing. The skin was fairly smooth, but there was a lot of sunscald and russetting in stalk cavities. The apples were relatively sweet, and many had poor storage qualities due to the large size, low calcium content and lack of firmness.

1.3 Research by the LBI

The LBI primarily selects projects involving close cooperation with organic fruit growers. The role of the growers is to provide their orchard as a practical context for the research, to help the researchers develop a relevant experimental design, to carry out some of the practical activities and to assist in the evaluation of the results. In addition, the LBI selects fundamental research projects that focus on innovative issues relevant to organic agriculture. In fruit cultivation, our main emphasis is still on apple and pear, focusing specifically on growth regulation and fruit bearing, soil care, scab and canker, fruit quality and sales. The institute is currently investing across the board in research in new areas of product quality and socio-economic research in agriculture. The institute works closely with Prisma, PPO Fruit, DLV and *Biofruitadvies*.

Fruit growing research at the LBI was carried out in 2001 by Joke Bloksma (senior researcher), PieterJans Jansonius (researcher), and Marleen Zanen (junior researcher) in collaboration with the fruit growers Henri Albers, Harrie van de Elzen, Jaap Flikweert, Robin Kars, Kees Konijn, Piet Korstanje, Hans Levels, Gerard van Noord, Harald Oltheten, Olmenhorst, Harmen Peters, Paul van de Poel, William Pouw, Louis Ruissen, Wim Stoker, Wil Sturkenboom and Dirk van Ziel. The research was also supported by many unseen staff at the LBI (in administration, acquisition, IT, statistics, lay-out, soil research, flavour research, picture developing methods, publication sales, etc.).

Funding comes from the national and provincial governments, the fruit-growing industry, Triodos Bank, Rabobank, Software Stiftung (D), sponsors of the Louis Bolk Institute, the ter Linde Orchard, *Biologica* and private donations.

2 Soil management

2.1 General

Our objectives in soil management research combine a number of issues: soil fertility, production, fruit quality, regulation of growth, prevention of night frost damage, leaf decomposition (scab) and practical feasibility. This will result in different regimes of weed control, fertilisation, foliar feeding and watering for each plot. The evaluation criteria remain particularly difficult to assess.

2.2 Evaluation of leaf analysis in organic fruit growing

Leaf analysis in fruit growing is still a good way of evaluating the uptake of nutrients in a tree with normal vigour. After each year in which we have seen leaf analyses of organic orchards we have noticed that a number of values deviate from what we are accustomed to finding in conventional orchards: nitrogen is generally lower, magnesium and manganese are often lower, phosphorus is actually always higher. Low nitrogen levels can be explained by the policy of applying nitrogen only sparingly (because of the fruit quality or the scarcity of manure in organic agriculture). Low levels of manganese and magnesium are often a sign of poor leaf quality due to aggressive crop protection products. This last problem is undesirable for both production and quality.

There is a long-running debate about whether target values for organic orchards should be the same as for conventional growing. Well-founded research to answer this question for all (new) varieties is sadly not feasible. This year consultants and researchers exchanged practical experiences and the LBI hopes (with reservations) to work with the target values shown below. Deviations from the norm are based on the following considerations: for nitrogen, the balance between large quantities of nitrogen (strong buds, resistance to night frost) and little nitrogen (less greasy skin, less scab, fewer aphids, less spider mite, less fruit rot, etc.) will under organic conditions, tend to lead to a lower optimum level than in conventional growing because there are practically no crop protection agents for correction. We determine optimum levels slightly differently for each variety (see table).

In conventional growing it is customary to administer large quantities of trace elements as foliar feed as an 'insurance premium'. Organic production only permits of foliar feeding with trace elements if there is a real shortage. We therefore maintain a slightly lower minimum level at the expense of certainty. In the organic market a green ground colour is less fashionable than in the conventional market. This means we do not have to set high target values for manganese.

We are aiming for higher potassium levels than before (official advice, 1994, Information and Knowledge Centre (IKC)/DLV) because of the increasing importance of flavour and decreasing concern about bitter pit with current storage techniques and the current range of varieties.

Provisional target values for leaf analyses end July to mid-August for mature organic planting on weak rootstock and with normal vigour and fruit bearing

Variety	N	P	K	Mg	Ca	B	Fe	Mn	Zn	Cu
	% ds	% ds	% ds	% ds	% ds	ppm	ppm	ppm	ppm	ppm
Elstar	2.25-2.50	0.20-0.30	1.35-2.00	0.22-0.35	>1.20	25-50	60-400	40-200	30-80	8-20
Santana	2.10-2.40	0.20-0.30	1.50-2.00	0.22-0.35	>1.20	25-50	60-400	40-200	30-80	8-20
Jonagold	2.15-2.50	0.17-0.30	1.35-1.75	0.22-0.35	>1.20	25-50	60-400	40-200	30-80	8-20
Conference	2.20-2.40	0.17-0.30	1.35-2.00	0.30-0.45	>1.20	25-50	60-400	40-200	30-80	8-20

2.3 Impact of sulphur stress

We take into account that a proportion of the poor leaf arrangement which fruit growers observe relates to stress from sulphur and not to fertiliser issues. For reference we compared a row with a normal powdered sulphur regime (approx. 60 kg/ha after flowering) and a row with reduced use of sulphur (approx. 27 kg/ha after flowering). Leaf arrangement and colour were comparable.

Despite only small differences in leaf quality, we note that the fruit quality is better in the reduced sulphur treatment. This was a non-replicated study, so there are still real reservations about the conclusion.

Differences in leaf quality and fruit quality affected by greater or lesser use of sulphur

Sulphur use	Leaf analyses August						Fruit at harvest		
	% N	% P	% K	% Mg	% Ca	ppm Mn	firmness	brix	acidity
Target value →	2.25-2.50	0.20-0.30	1.35-2.00	0.22-0.35	>1.20	40-200	>7	>12	9-10
Reduced	1.72	0.40	1.95	0.19	1.54	22	7.8 b	12.3	9.9
Normal	1.85	0.41	2.01	0.17	1.65	14	7.3 a	11.9	8.7

Based on mature Elstar on poor soil at the ter Linde Orchard 2002; leaf sample (100 leaves) and fruit sample (25 fruit) in non-replicated plots. Various letters after the averages indicate a 95% certain difference.

2.4 Fertilisation

While basic fertilisation in the winter has long been used as the basis for organic fruit growing, much attention has been paid in recent years to other fertilisation strategies. The reason for this change is dissatisfaction in organic fruit farming with the level of production, particularly the risk of weak buds, and the expectation that production can be increased by using a different fertiliser regime (perhaps with higher levels, different timing or quick-acting fertilisers).

The point of departure for the LBI is still that manure is a rare commodity in organic agriculture and should be used sparingly. The requirement to apply only fertiliser originating from organic agriculture will be increasingly stringent in the future.

Other important issues concern the side effects of a higher level of fertilisation, particularly on the susceptibility of the tree to pests and diseases and the effect on fruit quality. It is pointless to increase gross production only to have that increase eaten away by pests and diseases. A number of trials are currently being conducted on increasing production capacity by applying larger amounts of fertiliser and applying them at different times.

Level of fertilisation

A multi-year trial has been set up in 4 replications on a farm with poor soil to determine whether different doses of poultry manure granules can be used to achieve an optimum level with little risk of night frost damage, reasonable production and good fruit quality (see also 2001 annual report). The quantities of fertiliser have been altered slightly from 2001 because the fertiliser proved to contain less nitrogen than originally assumed.

Results of late summer fertilisation trial with Elstar, ter Linde Orchard, 2002:

	From 2000 Late summer Fertilisation	% N leaf	% K leaf	growth rate	mg N fruit	mg K fruit	mg Ca fruit	firmness fruit	brix fruit	acidity fruit
	Date →	8-02	8-02	8-02	9-02	9-02	9-02	9-02	9-02	9-02
	Target →	2.25-2.5	1.35-2.0	5	<50	high	>5	>7	>12	9-10
1	0	1.8	2.1	5.9	30	114	3.3	8.2 b	13.3	9.6
2	44 kgN/ha	1.9	1.9	6.1	33	121	3.2	7.8 ab	12.9	9.5
3	88 kgN/ha	1.9	1.9	6.5	34	118	2.7	7.6 a	12.7	9.4
4	132 kgN/ha	2.0	1.7	6.8	36	116	2.3	7.4 a	13.1	9.2

This year again extra fertiliser led to higher N-levels in bud and leaf and to lower K-levels. There were no night frosts. The usual target value for nitrogen in the leaf was not achieved in this plot, not even with 132 kgN over 2 years. The nitrogen content in fruit was not too high at any point. Further fertiliser is undesirable for the calcium content in fruit, and for firmness, sugar and acidity, but in this plot it was never below the target value for good flavour.

Timing of fertilisation with poultry manure

A multi-year experiment was laid out in 2001 on the same plot of Elstar as the above trial in 4 replications with 5 different application times for fertilisation with 132 kg N/ha in the form of poultry manure granules. The object is to track developments in productivity and fruit quality for several years and anticipate the restrictions which HACCP will place on this type of animal manuring (not in the last three months before harvest). The treatments chosen are: 1. unfertilised, 2. Jan/Feb., (as in Germany), 3. Mar/Apr., (as normal in the Netherlands), 4. mid-June (HACCP), 5. beginning of August (advice from Jan Peeters, not under HACCP) and 6. immediately after harvest.

The initial conclusions are:

1. trees fertilised late summer/autumn have a higher nitrogen content in the bud the following spring.
2. fertilising just before winter leads to increased growth of weeds in the next season.

Type of manure

Commercial fertilisers are easy to apply, but there are concerns about the quality of the fertiliser and the impact on soil, tree and fruit quality. On one farm a multi-year trial in an Elstar plot began in 2001 to compare different levels of poultry manure and Maltaflor with composted bio-dynamic cow manure. (For further information see under fruit quality).

2.5 Ground cover

Prospects offered by a permanent undergrowth of white clover at the tree strip

Past experience and specialist literature have shown that a planted tree strip has many advantages for soil structure, soil life, and the accumulation of organic matter. Anywhere where competition from tree strip cover is desirable, or can be compensated by water, ground cover at the tree strip offers good prospects for the organic system. Even in a conventional orchard undergrowth can offer an attractive alternative in a number of situations to the use of herbicides and other methods of retarding growth.

We distinguish two different undergrowth (ground cover) strategies: periodic late summer undergrowth (already published as LF62) or permanent undergrowth, for which white clover offers the best prospects in the Dutch climate (recent publication LF70).

The strategy of white clover undergrowth can be chosen if there is sufficient vigour to aim for a grass clover mowing regime in due course. This applies to vigorous situations, often on heavy soil, with good natural moisture or moisture provided by a sprinkler system. Under these conditions white clover will make the transition over two or three years from a bare tree strip to a mown tree strip.

Undergrowth has a number of advantages over a bare tree strip: better soil structure, increased soil life, better build-up of humus, faster drying of the soil in spring, less phytophthora fruit rot, more options for growth retardation (with the associated reduction in pests and diseases) and cover for natural predators.

There are also disadvantages to undergrowth for which partial solutions have been found: greater risk of mice, collar rot and sprouting adventitious roots, particularly after the invasion of grasses (cut short going into winter); risk of night frost in the spring (tolerable: max. 0-0.5°C low) and risk of too much competition (water to compensate).

White clover has specific advantages over other types of ground cover: good weed suppression, extra nitrogen fixation (we estimate the saving in fertiliser at around 40-80 kg N/ha orchard in a good clover year), extra calcium uptake (beneficial for fruit quality). The growth retardation is moderate and falls somewhere between the strong retardation associated with spontaneous weeds and no retardation in the case of a bare tree strip.

In addition to providing an attractive alternative for weed control, ground cover also makes it easier to apply the strategy of 'controlled drought stress' for retarding growth. After all, the ground cover plants transpire and so the soil dries out more rapidly after rain. In this strategy, the moisture content of the soil is measured and extra watering can be carried out as necessary. Even moisture levels up to and including June, and then a

gradual drying out in July to ensure stable cessation of shoot growth are extremely important in growth regulation.

Where growth inhibition is too strong, intermediate strategies can be adopted in which the tree strip is only partially covered in clover. For example, only the narrow strip between the trees, or only the strip alongside the aisle or only around the tree post. The first two options require at least equally complicated practical maintenance, the last is relatively simple.

An undergrowth of white clover is not ideal for all orchards. Clover transpires water and it requires light. It is suitable if the clover is allowed to give way to grass in a number of years, after which a full-scale mowing regime is introduced. This applies to vigorous situations, to heavy soil where mechanical soil cultivation is difficult, and where there is good natural moisture or a sprinkler system. It also applies to situations where some light reaches the soil: in young plots, where the trees are high (pears), under open trees (apple cultivar *Alkmene*) and where planting is not too dense.

In the first year when the clover has yet to establish a sward, the competition for nutrients is relatively fierce and from the third year onwards, with increasing invasion of grasses, competition for water also increases. Nitrogen is only released after the first year when old clover roots and leaves decompose. Our advice is to sow from around the third year and always to ensure that water can be provided.

The art of a well-covered clover undergrowth lies in a fluent start: good availability of phosphorus, potash and lime, pH over 5, a relatively clean tree strip without too many perennial weeds, a fine soil structure, warmth and moisture during germination, invasion of grasses after sowing and sprinkling during dry periods. The ideal time to sow is from the end of April to mid-May with a second opportunity at the end of August, when there is a greater risk of slug damage. Sowing in an existing orchard is done manually or with a fertiliser spreader or herbicide granule broadcaster. Around 1.5 to 2.5 grams seed per m² (= seed costs €100.- to 200.- per ha. tree strip).

Important variety characteristics of white clover for undergrowth are rapid germination, weed suppression, frost hardiness, persistence after mowing (relevant in the case of large-leaved clover varieties) and a high prussic acid content to cut down slug damage. Modern clover varieties are much more persistent than the older ones. Nowadays there are even clovers which are too competitive, which invade the tree strip and push back the grass from the aisle. White meadow clover (e.g. cultivar *Gwenda*) is less competitive with trees, but also less persistent than larger leaved white clover (e.g. cultivar *Alice*). Water provision and the vigour of the trees determine the optimum choice of variety.

Following successful germination practically only white clover will grow in the first year. In the course of the second year spontaneous weeds and grass varieties take up more and more space. The management of the clover undergrowth comes down to the art of controlling the invasion of grasses. For this purpose close cutting is important, as are not applying too much nitrogen, ensuring sufficient light reaches the soil and a good soil structure. Sooner or later tall weed varieties will grow up through the clover. These must be removed by hand or cut back to a height of 10 to 20 cm.

The key to white clover undergrowth is to 'do it properly or not at all'. It is difficult for an organic grower - without herbicides - to restore undergrowth which has been invaded by grasses to bare earth. Undergrowth is definitely not the answer for fruit growers who have any difficulty with mechanical weeding. The management of ground cover requires at least as much mechanisation as the bare tree strip.

3 Regulating growth and crop

3.1 General

We assume that significant improvement can still be achieved in average production levels and in fruit quality on organic fruit farms by means of good crop and growth regulation. Organic cultivation, however, differs in a

number of respects from conventional growing, and research is directed towards finding appropriate adaptations for organic practice.

Differences relating to crop regulation are the lower nutrient level, stress in the crop due to applications of sulphur, and less effective disease and pest control. This means that there must be enough leeway for later fruit thinning for quality. Differences relating to growth regulation are mainly in the slow release of fertilisers, and the lack of fertigation to prevent adverse effects of root pruning, and the fact that synthetic growth retarding agents do not have approval.

3.2 Steps to counter biennialism in Elstar

Fruit thinning remains a major concern with Elstar in particular. The aim is to create a good balance from the first year of production between fruit bearing and bud formation, and thereafter to continually monitor this balance. Despite all our attention to this, we can still end up in a biennial cycle, for example as a result of severe night frost. What steps can we take to get out of this cycle?

In 2002 a trial was set up at three orchards combining various measures: thinning or not thinning with two or three applications of lime sulphur, adapted pruning, 3 levels of fruit bearing (30, 40, 50 tonne/ha) and early or late manual thinning. This trial should demonstrate the relative significance of the various measures. The trial at the van Noord orchard was lost due to extremely poor setting. The other trials have achieved the set production targets. Flowering will be evaluated in the spring of 2003.

In a trial in 2000 using organic agents and methods on Elstar the PPO determined that a one-off thinning with 3% lime sulphur around full bloom is insufficient to prevent an alternate bearing year. The only treatments which produced sufficient flowers in 2001 were combinations of lime sulphur and hand thinning in which the number of fruit at four weeks after full bloom was reduced to 100 (tree of 1m diameter and 2.25m tall). A limited extra 'spur'-pruning did reduce the number of thinning hours, but it did not lead to an increase in flower buds. (Maas et al, PPO report 2002-20).

3.3 Fruiting spur pruning in Elstar

Both the PPO trial referred to above and earlier work by the LBI have shown that extra pruning of excessive fruiting spurs is a relatively efficient way to reduce the effort involved in thinning. Until now, however, it has not led to better flower bud formation in the following year. This may be due to the method of pruning. The trials referred to here have always focused on removing mixed buds and perhaps too little on sparing the wood on which flower buds can form. For good flower initiation the ratio of mixed buds to strong leaf buds is probably extremely important. There is a tendency to remove all one-year-old wood from heavily flowering trees to retain only the short spurs with strong flower buds. This makes a difference to thinning hours but has an adverse effect on the ratio of leaf buds to flower buds.

To obtain better insight into the effect of different pruning methods three pruning treatments were used in the above trials in Korstanje:

- a.) standard pruning without much attention to extra removal of fruiting spurs,
- b.) removal of an extra large amount of fruiting spurs,
- c.) removal of extra fruiting spurs but sparing smooth one-year-old shoots.

These pruning treatments were replicated again on a less vigorous plot with the addition of a fourth treatment, similar to c) but with extra cutting to stimulate growth of more one-year-old shoots for production on the end buds of these shoots. The production of the trees has been estimated and the blossom will be evaluated in the spring of 2003.

3.4 Effect of thinning times, fertilisation and bearing

Experimental design of ter Linde Orchard trial 2000-2003

In 2000 a multi-year trial was set up at the ter Linde Orchard to investigate the relationship between different combinations of fruit-bearing levels, fertilisation levels and thinning strategy for level and regularity of production and fruit quality in Elstar (planted in 1992). Can a higher level of fertilisation facilitate higher and more

stable production, or permit of a later thinning without sacrificing the increase in production to a poorer fruit quality or increasing pressure from pests and diseases? We are using a combination of 18 treatments in 10 replications, see the 2000 and 2001 annual reports for further background and preliminary results. The trial will run until the end of blossoming in 2003.

Side effects of higher levels of fertilisation

An important issue in this research is whether any positive effects of a higher level of fertilisation offset the negative effects. The difference between the two levels of fertilisation is now very clearly visible in a far darker and larger leaf and more shoot growth at the higher level. In 2002 we were also able to identify a number of disadvantages. Rosy apple aphid was much more inclined to spread out on the terminal shoot. In a harvest analysis we identified more scab, earwig and woodlouse damage. We could not determine any difference in tortrix moth and fungal damage due to sooty blotch.

It is striking that the differences we found seem to be related to the increased shoot growth and not necessarily to higher nitrogen levels. The long proliferous terminal shoots increase the risk of a spread of rosy apple aphid and scab and possibly also provide an attractive climate for earwigs and woodlice. It is not possible to determine whether the higher N% in the leaf also plays a role in this. It could be that with a good combination of fertilisation and growth retarding measures, we could reap the benefits of a higher level of fertilisation without having to accept the disadvantages.

Damage from pests and diseases at high and low N-levels, Elstar 2002.

fertiliser level ⁻	% N leaf	# clusters with rosy apple aphid	# shoots with rosy apple aphid	% fruits with				
				early scab	late scab	tortrix moth	earwig or woodlouse	Sooty blotch
date →	8-02	6-02	6-02	9-02	9-02	9-02	9-02	9-02
target →	2.25-2.50	0	0	0	0	0	0	0
low	2.1	4.0 a	0.9 a	1.0 a	8 a	7.5 a	4 a	2.3 a
high	2.3	3.4 a	3.1 b	3.3 b	32 b	9.0 a	7 b	2.1 a

Various letters in the same columns indicate that the averages differ from each other with 95% certainty.

Fruit quality at high and low N-levels, Elstar 2002.

fertiliser level ⁻	%N leaf	starch chart	firmness	brix	acidity	fruit Mg N	fruit mg Ca
date→	8-02	9-02	9-02	9-02	9-02	9-02	9-02
target→	2.25-2.50	2-3	>7	>12	9-10	<50	>5
low	2.1	4.6	7.2 b	13.5	9.1	31	3.5
high	2.3	5.3	6.7 a	13.8	9.7	51	3.2

Ripening was delayed by the high nitrogen dose and associated higher acid content. Despite the late ripening the firmness was still lower, the calcium content lower and the nitrogen content higher. All three factors produce a clear deterioration in quality. On the other hand, the sugar and acidity were higher in this case, but both these values fall within the target band.

The acceptability of the adverse effects of a higher level of fertilisation described here will ultimately depend on the positive effects in stability and level of production. However, it should be noted that the determining factor is not only the highest net production, but also whether the product can continue to meet the high quality requirements.

3.5 Demonstration trials on thinning times and bearing capacity

Assessing the optimum fruit bearing capacity is a fraught issue, particularly in varieties which are prone to biennialism. Getting it wrong can lead to dramatic biennial cycles and leave the trees out of balance for years. In organic farming it is even more important than in conventional growing to ensure a good balance between growth and bearing in the tree. Trees which are in balance have the greatest resistance to pests and diseases,

produce the best fruit quality, and the highest production averaged over the years. Our experience is that, at farms under conversion to organic growing, the bearing capacity initially decreases severely, and recovers somewhat thereafter, but never returns to the conventional level. Uncertainty about optimum bearing capacity is particularly great in the case of young trees.

In principle the organic farms have as much production potential as conventional farms. What can be achieved in each situation (= bearing capacity) depends on many factors: climate and available light, tree type and age. And for organic growing there are additional contributory factors such as the nutrient levels (nitrogen), spraying with agents which reduce leaf quality, mechanical weeding, time of thinning, etc. To improve the involvement of fruit growers and consultants in the assessment and evaluation of optimum bearing capacity the optimum capacity for a particular plot is jointly assessed on a number of farms and checked afterwards.

Demonstration trials on Elstar apples, 2001-2002

Three different bearing levels were achieved by manual thinning. Depending on the farm and its prevailing concerns, a number of variations were selected for the layout of the trials. The level of bearing was evaluated afterwards based on fruit size, fruit quality and growth regulation in 2001 and the flowering rate in 2002.

Demonstration trials with 3 bearing levels in Elstar (10 to 15 trees per treatment) at 3 different farms

Farm	age of tree 2001	soil	Organic or u.c. ¹⁾	extra treatment	Thinning date	2001 estimated optimum # fruit/tree	2002 corrected optimum # fruit/tree
Daamen	5	sandy clay	u.c.	2 thinning times	13 June, 12 July	77, <u>90</u> , 120	50
Konijn	2	clay	u.c. ²⁾		5 June	25, 35, <u>45</u>	27
Pouw	2	clay	Organic	extra fertiliser at highest bearing level	12-25 June	27, 36, <u>45</u>	<25

¹⁾ = organic or under conversion to organic (u.c.) ²⁾ treated organically from planting.

When the trees were in bloom in 2002 it transpired that the prior estimate of the optimum bearing capacity was quite a long way out. Manual fruit thinning in July is very labour-intensive and still too late to prevent an alternate bearing year (this was also confirmed in recent research on thinning by the PPO). Extra fertiliser or earlier thinning did not improve the susceptibility to biennialism in these two examples. On all the farms a larger crop meant a sacrifice in taste, firmness, sugar content and acidity.

Leaving too heavy a crop on the tree is not recommended as a method of curbing growth on over-vigorous plots. On such plots an excessively large crop cannot retard growth sufficiently, while it reduces fruit quality and can easily lead to biennialism. This only aggravates the problem. Growth must be retarded by other means.

A more detailed report on these trials has been distributed to interested parties.

Demonstration trials with Elstar apples, 2002-2003

On a farm where different bearing levels were maintained in 2002 fruit analyses again showed that greater bearing (capacity) leads to lower sugar content and acidity, but no difference in firmness. All values fell within the target band. Blossom thinning with lime sulphur in any case did not lead to higher calcium levels in the fruit. We will have to wait until 2003 to assess the effect on flower bud formation.

Can the number of pips be used to predict alternate bearing years?

Another unanswered question is whether the bearing capacity can be predicted on the basis of the number of pips/ha and whether the limit value in organic plots is different to that in conventional plots (hypothesis of consultant M.Kers of the DLV). He estimates that in a mature conventional plot of Elstar the maximum number of pips per hectare must be between 1.5 and 2 million to prevent the onset of biennialism. In the plots we monitored, an alternate bearing year occurred even when there were far fewer pips, even at 0.75 million

pips/ha in June. Clearly there were other limiting factors or there were a great deal more pips at the time of floral initiation. We also investigated the effect of the number of pips on fruit quality, see §5.7

Demonstration trials on Santana apples, 2002-2003

With Santana it is possible to influence vigour, fruit size, firmness and flavour by regulating fruiting. A larger crop per tree leads to higher production per hectare up to a certain optimum level which varies from farm to farm. We already know from other research that Santana with a heavy crop is far less prone to biennialism than Elstar. However if the crop is too heavy it has a limiting effect on flavour, fruit size, leaf arrangement and vigour.

Four fruit farmers, in collaboration with their advisors, maintained various bearing levels in 2002 and the fruit quality was evaluated within the framework of the Classy Apple project. If there is too little fruit the fruits are too large and the growth too vigorous. With too much fruit, the fruits lose flavour and firmness. It is striking how much bearing affects the sugar to acid ratio. The fruits are proportionally less acid when there is a larger crop. For this fairly acid variety, which is not particularly prone to biennialism, it is thus possible to aim for relatively high production as long as the firmness is carefully monitored. The flower bud formation is still to be evaluated at flowering in 2003.

4 Canker

4.1 Administering calcium hydroxide through the sprinkler irrigation system

In the autumn of 2001 a research project was again carried out on 2 fruit farms and funded by the Horticulture Commodity Board (*Productschap Tuinbouw*). This trial again demonstrated the efficacy of sprinkling with 5 a 7 times 100 kg/ha calcium hydroxide. Canker damage was even reduced on bourse scars. The efficacy of 74% was below target (80%). One treatment was missed in response to a shortage of water.

Administering the agent via the sprinklers may be regarded as a good alternative to spraying in terms of effectiveness. Furthermore this method can also be used under very wet weather conditions when it is not possible to drive around with the sprayer.

The obstacle to wider application of this technique remains the serious risk of clogging because the product does not remain in suspension long enough. After two years of trials on a farm we have to admit that we were unable to solve these problems at that location. We conclude that this application makes very specific demands on the construction of the sprinkler installation.

The nub of the problem lies with the product (calcium hydroxide) itself. All the difficulties stem from the fact that the agent does not really dissolve, and the suspension formed very rapidly settles out. The most obvious solution would be a good formulation of calcium hydroxide. However, this holds little commercial interest for the crop protection industry. Calcium hydroxide is a cheap bulk product, the market is small and a formulation cannot be protected. Seen in this light, it is more desirable to try to continue to work with the pure calcium hydroxide product. It must then be prevented from settling out by optimising the sprinkler installation or by adding environmentally approved additives. Further research into the prospects for such additives is therefore desirable.

We still know very little about the side effects of this use of calcium hydroxide. PPO Fruit has determined that leaves treated with calcium hydroxide decompose more slowly than untreated leaves. It was not demonstrated that this has adverse effects on pressure from scab in the following spring (de Jong et al., 2001)

We have as yet very little data indeed on the effects on insect life in the orchard. In the orchards where frequent use has been made of calcium hydroxide for a few years, no positive or negative effects have been noticed. Observations in this research on rosy apple aphid did not identify any significant difference.

Calcium hydroxide has been approved for preventive use against canker in the Netherlands (RUB list), but the approval procedure under the organic production in Europe scheme has not yet been completed. Despite its effectiveness, sprinkling with calcium hydroxide cannot as yet be generally recommended for practical application.

4.2 Strategies for canker prevention in organic fruit tree cultivation

This year the LBI, partly in collaboration with the PPO Fruit Research Station, began research into canker in fruit tree cultivation. The research was financed in full by the Horticulture Commodity Board. It consists of two projects:

1. An inventory of the incidence of canker in organically grown trees.
2. Research into the prevention of canker by spraying with calcium hydroxide during leaf drop.

Two further projects which would have been included on measures to promote ripening and a handbook of preventive measures were not accepted by the funding body.

The research was carried out on the apple variety Topaz. This was selected because it is a susceptible variety and also seems to offer prospects for organic farming and is consequently being widely planted at present. The inventory has now been completed. The report will be published early in 2003. The results of the second project will not be available until the end of 2003.

5 Fruit quality

Fruit quality is an important aspect of organic fruit production. Now that supermarkets have entered the market as new players, higher requirements are set for fruit quality than was the case for sales to farmers' markets, fruit box schemes and health food shops. Expansion of the market is the only way that all the converting fruit growers will be able to find an outlet and the supermarkets offer great potential here. Using organic growing methods it may not be possible to meet the high standards for external quality. However, the more expensive organic apple will have to have excellent internal quality with a clear accompanying message to the consumer about what organic means.

LBI is currently running two projects on apple quality: 'Classy Apples' (*Appels van Stand*), 2001-2004, together with partners in the chain to reduce the quality gap between supply and demand and 'Parameters for Fruit Quality', 2001-2003, addressing more fundamental issues about suitable quality parameters for organic production. Progress reports on the Classy Apples Project are published twice yearly on the LBI website.

5.1 Monitoring cultivation of Elstar and Santana

In 2001 all the apples from the 1st, 2nd and 3rd pickings of representative trees in eleven Elstar plots were collected separately and, after central storage, evaluated for internal and external quality. This monitoring carried out in 2001 provided the factual material for the debate on current and potential quality, price formation and points for consideration in advice for 2002. For each farm a picture was formed of the quantity of saleable apples remaining at three levels of stringency in the sorting. In 2001 in Elstar class 2 the main losses were due to: fruit rot (10%), scab (6%), mechanical damage (3%), tortrix moth and earwigs together (3.5%). When sorting into class, colour is also taken into account, and the losses are far greater. For each farm we calculated what the consequences are for the yield per kg cultivated product at these three levels. For class 2 it is 0.90 to 1.10 euro/kg, but with more stringent quality standards this could drop to 0.70 to 0.80 euro.

Flavour was generally good, the firmness after storage frequently left something to be desired.

The same procedure was followed with the 2002 harvest: there are currently Elstar from 12 farms and Santana from 5 farms in the store. By including Santana in this monitoring exercise we can offer material to the Organic Fruit Growing Study Group (*Biofruitteelt-studiegroep*) about new scab-resistant varieties.

5.2 Shop monitor

We now note that consumers certainly do not always find the desired quality in the shops, even though the fruit grower delivers a perfect apple. The quality of apples in the shops will also be evaluated in the coming season in the Classy Apples Project.

5.3 Chain discussions

We distinguish various different market segments: supermarkets, health food shops, farmers' markets, house to house sales, exports, etc. The plan was to have each participating combination of growers and sellers (including retail) formulate their own quality criteria, and to adjust them at regular intervals during chain discussions between growers and traders. The trader gains experience in presenting a profile in the market and the grower gains experience in optimising cultivation techniques. By this means we hope to introduce a new culture of discussion about quality, which should help to bridge the quality gap. Points for consideration raised by growers or traders include: size, colour, soundness (flawlessness), the Dutch product, regional sales, flavour, flavour profiles, EurepGap, vitality, biodynamic quality and use of grower websites. We note that, a year and a half into the Classy Apples Project, fruit quality is now firmly on the agenda in the chain.

5.4 Optimum picking time for Santana

Santana is a relatively new variety, and further investigation is required into optimising cultivation and storage. In any case the variety has shown itself to be fairly acid if picked too early. Initial experience with Santana at the PPO indicated that we need to find an optimum between picking early (less brown flesh, greater firmness, less greasy skin, longer shelf-life) and later picking (more kilos of apples, better bloom, less acidity, more sweetness, better aroma). Two fruit growers, in conjunction with DLV carried out start date determinations under the Organic Fruit-Growing Programme and picked the apples at three different times. The apples were stored and the fruit quality and flavour were evaluated in the Classy Apples Project. The apples only developed their full flavour when picked some time after the point of physiological ripeness. By consequence, when placing emphasis on good flavour, the storability will decrease. After storage the apples showed a dramatic decrease in flavour and an increase in core flush between 5 and 9 days on display.

5.5 Sprinkling to combat sunscald

The emphasis placed by the trade on red fruit, and thus on good light exposure during cultivation, also has a drawback in the form of an increased risk of sunscald. DLV this season stressed the importance of sprinkling during hot periods with climate stress. As a rule of thumb they suggest: sprinkle if the temperature exceeds 25 degrees and the relative atmospheric humidity drops below 50%. The availability of clean water (specifically: Ec <1.5 mS/cm; Fe <18 mg/l) is a prerequisite for this facility. The 2002 season saw three distinct sunscald periods: mid-June, end of July and mid-August. A fruit grower used a sprinkling system in his orchard and also left a number of sprinkler nozzles closed to measure the benefits against the labour involved.

Sprinkling dates in the van Albers orchard, mature Jonagold.

period	date of sunscald risk 2002	duration	quantity of water
1	17 and 18 June	no sprinkling (prior to this trial)	--
2 trial	28 July	2 x one half-hour at 11 and 15 hours	3 mm/ hour
	29 July	14.30 – 19.00 hours	3 mm/ hour
	30 July	11.30 – 17.00 hours	3 mm/ hour
3	17 August	10.45 – 16.45 hours (after the trial)	3 mm/ hour

Fruits with fresh sunscald damage, evaluated on 14 August in a total of 2016 fruits exposed to sunlight.

sprinkler number	sprinkling on/off	# fruits/tree in the sun	# fruits/tree with new sunscald damage	% fruits with sunscald damage	95% certainty ¹⁾
2,5,7,8	on	17.8	0.34	1.64 %	a
3,4,6,9	off	19.5	1.72	8.04 %	b

¹⁾ = different letters after the averages indicate that the averages differ from each other with 95% certainty based on a one way analysis of variance. There is still considerable variance due to other factors; the declared variance due to sprinkling is 21%.

Conclusion:

By sprinkling under these specific conditions an average of 1.38 fruits per tree was protected from sunscald. Per hectare sprinkling on these three days yielded around €621 per ha. (Assuming: 3000 trees/ha, 6 fruits/kg, price €1.10 or €0.20 for industrial use). The profit may even be higher, since the atmospheric humidity around the closed nozzles in this trial will of course also have increased with as yet unknown effects on the reducing sunscald damage.

5.6 Fruit rot

Fruit rot in the orchard and during storage is a major cause of loss and so leads to an increase in cost price. Elstar monitoring in 2001-2002 showed that the % loss through rot per farm varied from 2 to 21%. With the proviso that many research questions remain unanswered, possible preventive measures may be:

1. reduction of the infection pressure (hygiene in the orchard and the harvest and storage barrels; spraying with permitted control agents? warm water or calcium chloride treatment after harvest? antagonists?),
2. less damage to the skin (measures to control pests, diseases and russetting),
3. increasing the fruit's natural resistance by means of cultivation measures: dry, warm situation, good lighting, regular provision of moisture, sufficient calcium uptake, limited nitrogen uptake and picking at the right time.

Rot resistance test

The Louis Bolk Institute is attempting to develop a test for the evaluation of the natural resistance of the fruit, in which the apple can demonstrate how well or poorly a fruit rot fungus can spread in the flesh of the fruit. We make small lesions in the skin, inoculate them with *Botrytis* spores and note whether or not rot develops, and measure the size of the affected area after standardised storage (20°C and 99% r.h.). This demonstrates, for example that apples with a high nitrogen content have more and larger areas of rot than apples with a lower nitrogen content (see under fertilisation).

Prospects offered by calcium chloride (CaCl₂) before or after harvest

A pilot experiment was carried out on a farm to look into the prospects of spraying with CaCl₂ before the harvest or rinsing with CaCl₂ after harvest to reduce fruit rot.

Questions relating to these applications are: 1. what is the optimum dose between efficacy and skin damage, 2. does application after harvest reduce the adverse side effects of CaCl₂ in the orchard and 3. what are the possible side effects on fruit quality. The fruit grower, by way of a trial, had a stainless steel band at the end of the sorting line for the rinse treatment with recirculation, an EC meter and filter.

Neither treatment led to a reduction in fruit rot, but rather to an increase. The soundest apples were the untreated ones! It is possible that the extra infection was due to recirculated rinsing water and/or inadequate checks on the correct concentration of CaCl₂ during the rinsing process. Another possibility is that the skin quality (wax layer) is damaged by the use of CaCl₂ and is thus more susceptible to fruit rot. However, no signs of this were visible to the naked eye. None of the treatments led to a difference in ground colour, blush, white mould or flavour.

It is not clear from the results (table A) whether the CaCl₂ spraying in the orchard (with a relatively low dose compared with normal conventional practice) did or did not lead to higher calcium levels. According to the measurements after the harvest it did, but not according to the measurements after storage. This shows the limitation of the trial design in this pilot project: no replications and hence no significant conclusions. However 2x shows a tendency to a lower Brix content in the case of spraying in the orchard. This ties in with the familiar idea that CaCl₂ in the orchard is a stress factor for the functioning of the foliage. Post-harvest rinsing with CaCl₂ on the other hand clearly produced a higher calcium content and firmness.

Table A: Fruit quality after spraying with calcium chloride in the orchard and/or rinsing after harvesting,

Stoker Orchard, 2001

pre-harvest 28 kg/ha ¹⁾ CaCl ₂	post-harvest rinsing 2,7% CaCl ₂	firmness in kg/cm ²	acidity in g/l	brix	Ca ²⁾ in mg/100 g fresh	% sound fruit	% rotten fruit
Immediately after picking, 21 Sept. 2001							
no		6.2 a	8.1	12.7	3.6		
yes		6.3 a	8.3	12.4	4.7		
After storage, 21 March 2002 ³⁾							
no	No	3.7 b	5.6	13.6	6.1	85 a	15 a
no	Yes	4.0 c	5.9	14.1	9.6	75 ab	19 ab
yes	No	3.6 b	5.7	13.4	6.1	80 a	20 ab
yes	Yes	4.0 c	5.9	13.0	9.4	70 b	28 b
1) between mid-June and mid-Sept.: 5, 5, 5, 5, 8 = 28 kg/ha in a mature orchard on M9. 2) analyses of Brix, acidity and calcium carried out on a mixed sample of 25 fruits the skins of which were scrubbed clean prior to analysis. The calcium measurements after storage were carried out using a different method and are not comparable to those prior to harvest. 3) Following Ultra Low Oxygen (ULO) and mechanical cell storage, 3,174 fruits (75-85 mm and sound at harvest) were evaluated for soundness and decay. Different letters after the averages indicate that the averages differ from each other with 95% certainty							

LBI will not pursue this line of investigation for the time being. It would only be worthwhile to continue if there were some prospect of approval of this post-harvest treatment, a better method for decontaminating rinse water, a measuring method for a constant concentration of CaCl₂ and a facility to produce microscope images of any damage to the skin.

Prospects offered by hot water treatment

In the Classy Apples Project we focused on the possibilities of hot water treatment directly after harvest. This method reduces gloeosporium rot in particular and has little effect on other types of rot. There are model farms in Northern Germany which have invested EUR 50,000 to make the water tank of an existing grading machine double as a warm water immersion tank. This method could still be improved. The current set-up requires a lot of extra work in the busy picking season to immerse the apples after harvesting. The range in temperature between effective treatment and skin damage is small and varies from variety to variety and possibly also depends on skin quality. An error in setting the temperature leads to serious damage. For producers it is an expensive and labour-intensive treatment. Further information is available at the LBI workshop 2002 and at the 'Heißwasserseminar' in Jork. PPO Fruit and fruiterers Fruitmasters are currently researching the optimum combination of water temperature and duration for Elstar.

5.7 Apple blossom weevil, pips and fruit quality

In 1999 we investigated the effect of the number of pips on the quality of Boskoop. We found there was a clear improvement in quality (larger size, greater firmness, acid, sugar and calcium content) with more pips (see 1999 annual report). This was in line with the literature.

In 2002 this exercise was repeated with Elstar and added in the issue of the quality of apple blossom weevil apples. When blossom is attacked by apple blossom weevil this usually leads to the loss of the flower (the flowers fail to open), but it can sometimes lead to the setting of a fruit without pollination. This grows out to the characteristic broad, flat apple blossom weevil apple without pips.

Effect of number of pips and apple blossom weevil on the fruit quality of Elstar

# pips/ fruit	weight	dia- meter	firm- ness	dry matter	sugar	acidity	N	P	K	Mg	Ca
0 +K	150	7.3	6.8	17.4	14.2	8.5	40	17	146	5.6	4.6
0	150	7.1	6.9	16.7	14.4	9.0	40	16	149	5.6	4.6
1	163	7.3	6.9	16.7	14.0	8.1	41	16	149	5.7	4.1
2	168	7.3	6.3	16.6	13.9	8.0	42	16	151	5.2	3.6
3	173	7.3	6.4	16.6	13.7	7.9	41	16	151	5.2	3.5
5-6	184	7.6	6.1	16.3	13.6	7.6	39	16	149	5.1	4.0
7-9	185	7.6	6.1	16.4	13.4	7.6	38	16	147	5.3	5.0

Based on Elstar at the ter Linde orchard, 25 apples per sample in a single replication.

0+K = fruits with 0 pips and with apple blossom weevil; 0 = fruits with 0 pips but without apple blossom weevil.

Weight in grams, diameter in cm, firmness in kg/cm², dry matter in %, sugar in Brix, acidity in g/l, minerals in mg/100 grams fresh weight.

This study shows that in Elstar apples too, more pips mean a larger size and a smaller dry matter content. However, the firmness, sugar and acid contents are reduced when there are more pips and the calcium content reaches a low at the level of 2-3 pips. This means that the quality of this Elstar is absolutely no better with more pips. That is good news, since in this variety in particular, with its susceptibility to biennialism, should not have too many pips at the end of May if it is to form good flower buds. This conclusion is given with some reservations, since we only looked at a single batch of Elstar in this study.

Apple blossom weevil apples are comparable to ordinary apples with no pips in terms of firmness and sugar and calcium content. They differ by having a higher dry matter and phosphorus content and a lower acid content, and hence probably a less fresh taste.

5.8 Search for relevant parameters for 'vitality'

Consumers in the health food channel are concerned that their food should be 'delicious', 'natural' and 'safe', but they also set store by its 'vitality'. An organic product was expected to have greater vitality than the conventional product, but there was much confusion as to the meaning of vitality and how it could be measured.

International association for 'Organic Food, Quality and Health' (FQH)

The purpose of the group of researchers and traders brought together under the FQH banner is to develop a new concept of quality based on life processes and to select and further develop relevant methods of measurement. The results of the research must help growers to produce products of great 'vital quality' and help consumers to recognise such products. The first part of the research was carried out on apples in 2000-2001; and subsequently on carrots, while a second project is underway on apples (2001 – 2003). For further information on the 'vital quality' concept see the previous annual report and associated publications (FQH-01, LF63).

The impact of fertilisation and biodynamic preparations on the quality of Elstar, 2001-2003

At the ter Linde orchard 24 lots each of 150 Elstar apples were grown specially for this project. For two growing seasons strictly identical thinning was carried out, and variation was introduced into the level of fertilisation with fast-acting fertiliser (chicken manure pellets and Maltaflor: 0, 40, 80, 120, 160 kg N/ha/year), composted biodynamic cow manure (100 kg N/ha/year), in 2 replications with and 2 replications without biodynamic preparations. A large amount of data were collected on the soil, phyllotaxis, growth, pests and diseases, etc. Various quality aspects of all these apple samples were measured by various laboratories in the Netherlands and abroad. Both the usual quality characteristics and experimental, more holistic characteristics were determined: size, colour, firmness, flavour, mineral contents, biophotons, electrochemical characteristics, copper crystallisation pictures, capillary dynamolyses, etc. The data have not yet been elaborated.

6 The future of organic fruit growing

The expansion of organic agriculture has resulted in interest from growers and traders who entered the organic field for economic reasons. These entrepreneurs bring with them a high level of specialisation and expertise and their concerns are different from those of their more idealistic, all-round predecessors: cost price reduction, more security in cultivation, strict monitoring of standards, etc.

We should guard against this one-sided emphasis on cost price reduction making organic fruit growing identical to its conventional counterpart. Thought must be given to the entire cultivation system, the selection of varieties, organic origin of the parent material, use of control agents, marketing strategies and advisory services, and we need to reconsider motivation and standards and how we deal with risks, variety ownership and land ownership.

6.1 Marketing strategies

In 2003 we want to describe the various marketing styles (or trading circles). The object is to provide an inspirational image to traders and fruit growers to consciously opt for a certain trading style and then consistently develop it in profiling and communication about apple quality. 'Consistency' is important because the current mixture of styles sometimes fails to do full justice to any one aspect. Market differentiation is important because it makes it possible to involve more consumers and more products, thus allowing for more expansion than if all attention was devoted to a single type of marketing.

6.2 Does cooperation between fruit growing and livestock farming deliver added value?

In times gone by it was not unusual to see a combination of livestock and fruit in the standard tree orchard. Now we see specialised, unmixed, separate livestock and fruit farms. Does the combination of the two still deliver an added value which is attractive now and for the future? For example, added value in efficient use of minerals, soil fertility, animal health, fruit tree health or landscape values. This topic has been researched by staff of the Louis Bolk Institute and the Institute for Applied Plant Research in Fruit (PPO/WUR) and explored from three angles for both conventional and organic production:

1. the mixed or partner farm with both livestock and fruit;
2. fruit trees used to embellish livestock farms;
3. Poultry or other livestock in fruit orchards to control pests or to keep the ground cover short.

The results are published in publication LF69.

Pasturing of livestock in the orchard

The classic standard tree orchard with young cattle or sheep is only economically viable these days if additional money comes in for purposes other than production. The orchard provides food and shelter for the livestock while the animals provide manure, keep the vegetation down and clear up the leaves.

The dual-purpose use of livestock in the somewhat more intensive orchard has been tried in many places and has led to many disappointments. Usually it foundered on the crop protection agents required for fruit growing, local soil compaction by the livestock, and the amount of labour involved in looking after livestock or poultry in an orchard. Where a solution can be found to these problems, the combination can offer prospects. In the case of chickens, it is important to remember that there are significant differences in levels of activity between different types: layers (12 months) are more active than meat-producing chickens (3 months) and chickens reared outdoors are more active than those reared indoors. Fast-growing broilers are not suitable.

Poultry and fruit seem the easiest to combine, particularly where the emphasis is on EITHER the poultry OR the fruit - not on both at the same time. We know of one holding in the Netherlands, which is going to investigate the feasibility of keeping turkeys in the orchard as a dual-purpose cultivation system.

Mixed or partner farms

The concept of 'partner farms' centres on the exchange of products between specialist holdings. Obviously the livestock farm can deliver manure to the fruit farm. In future organic fruit farms will not only be able but will need to make increasing use of manure from organic livestock farms.

It is less clear what the fruit farm can offer the livestock farm in return.

Extracting grass clover from the orchard is very time-consuming, and in fact it is better to leave it in the orchard where it can contribute to soil fertility.

In a number of countries foliage from fruit trees or coppice wood is traditionally fed to sick animals. The gathering of the foliage is laborious and the health benefits are not yet clearly demonstrated. Fruit tree or coppice foliage is very attractive as food, especially for goats, and the harvesting of the foliage can sometimes be practicable. Finally, growing green manure or livestock fodder crops for a year or so between grubbing up and re-planting of fruit trees is good for soil fertility and economically feasible.

Fruit trees to embellish the livestock farm

Fruit trees enrich the entire livestock farm and certainly improve free range management of livestock. However, many apple and pear varieties have to be sprayed to produce dessert fruit and are susceptible to soil compaction. There are fruit trees which are not susceptible to these problems, but nor do they show any significant profit. These include hazel, cooking pears, elder and plum, and these types of trees are suitable for embellishment of the farm.

Poultry or sheep to control pests and diseases in the orchard

Based on the life cycle of the insect pest, one could argue that a number of pests which affect fruit growing could be suppressed by letting poultry range free in the orchard at certain times of the year. It would be worthwhile to carry out further research into the practical implications and the effects on pests of such a system.

We anticipate a substantial impact on the codling moth (*Carpocapsa laspeyresia*), apple-, pear-, berry- sawfly (*Hoplocampa spp*, *Nematus ribesii*), apple blossom weevil (*Anthonomus pomorum*), strawberry blossom weevil (*A. rubi*) and pear midge (*Contarinia pyrivora*). Any evaluation of chickens used to control pests must certainly also consider the effect on spiders, earwigs and other useful insects.

Sheep help in the removal of leaves and fungi, which overwinter on leaves. They are used for this purpose in New Zealand and the United States, but we have not found any research to support the efficacy of the method. There is an example in arboriculture in which a small group of bantam chicks effectively control vine weevil (*Otiorhynchus sulcatus*) and annual meadowgrass.

Recommendations for further research

- The effectiveness of chickens in controlling fruit pests such as codling moth, apple-, pear-, berry- sawfly, apple blossom weevil, strawberry blossom weevil and pear midge.
- Side effects of keeping poultry in the orchard on natural predators, soil compaction and homogenous manuring.

If the above themes offer suitable prospects, then research into the practical side of keeping poultry: what the birds want, their behaviour, number per surface area, time of year, supplementary feed, grazing regimes, shelter and housing, tolerance of crop protection measures, etc.

6.3 The concept of 'naturalness' for the development of standards

Consumer research showed that the concept of 'naturalness' could be used to improve the profile of organic agriculture. As a follow up to the 2001 survey of consumer perceptions of 'naturalness' in organic production methods, in 2002 the 3 levels of 'naturalness' were distinguished and elaborated for cultivation and standardisation. The example of aphids in apple growing was raised. The first level of 'naturalness' concerns the substitution of synthetic chemical control agents with agents of 'natural' origin or bought-in natural predators. The second level concerns the reinforcement of natural regulatory processes in the orchard such as attracting natu-

ral predators with flowers, ground cover, nesting boxes, etc. The third level seeks to respect and support the 'natural' intrinsic nature of the apple tree, for example by growth regulation suited to the soil type, type of tree and time of year. This was reported at the symposium on Naturalness in Driebergen and at the *BD-Obstbau-Tagung* (biodynamic fruit growing conference) in Switzerland (publ.no. LF71). The Louis Bolk Institute is convinced of the need to work on all three levels simultaneously to facilitate sustainable organic fruit farming. For further information see under publications.

7 Exchange of knowledge

7.1 In the Netherlands

We organised a workshop on fruit quality for the Prisma organic fruit growers' cooperative. Pieterjans and Joke of the LBI both act as advisors to Prisma. We presented LBI research findings on excursions and open days.

7.2 International: EUGROF en EUFRIN

The LBI participated in and provided speakers for a number of international conferences in 2002, including Weinsberg (D), Dornach (CH), Frick (CH) and Jork (D). The LBI is an active member of an international working group of researchers who work intensively with organic fruit growers and are involved in the further development of organic fruit growing. A list of research and participants can be found on the website www.FIBL.ch and shortly at www.EUGROF.com. There is also a group of European researchers who carry out research on organic cultivation at experimental stations and universities (EUFRIN). This year a global network was set up for researchers in organic fruit farming under the auspices of the ISHS which hopes to organise a world congress in 2004.

7.3 International Research Group on Biodynamic Fruit Growing

This group was set up in 2001 to promote the exchange and development of specific biodynamic aspects in fruit cultivation (secretariat in Dornach). The research group made a working visit to two farms in the Netherlands in August 2002. Discussion techniques were practised to improve exchange of information. The content of the conference in Dornach was prepared and the tasks of the research group defined during group meetings and farm visits. At the end of November the biennial meeting (*BD-Obstbau Tagung*) was held in Dornach (CH) on the theme of dealing with pests and diseases in fruit cultivation. Three people from the LBI and two biodynamic fruit growers from the Netherlands were present. Joke gave a paper on what can be learned from aphids (see LF71).

7.4 Study trip to New Zealand

Pieterjans and Joke visited New Zealand in February within the framework of the Classy Apples Project. The main issues for discussion were: Are there much more suitable areas in the world than the Netherlands for the cultivation of organic apples? How do the New Zealanders go about quality management and can we learn from them? Does the southern hemisphere offer competition or a welcome complement to Dutch apples? Conversion to organic fruit growing is proceeding at a rapid pace in New Zealand. The first farm converted in 1996 and in 2002 already 10% of apples are grown organically. Strong points in production opportunities there are: plenty of light, leading to high production per hectare, low land prices, low labour costs and market-oriented farmers. Here too, we encountered many problems with scab, fireblight, codling and tortrix moths and woolly aphids which have to be controlled using environmentally-friendly control agents. Organic pear growing is practically impossible due to *Pseudomonas* (Pear blossom blight), fireblight and pear sawfly. Permitted control agents include: sulphur, lime sulphur, copper, baking powder, pyrethrum, mineral oil, *Bacillus thuringiensis*, pheromones, codling moth virus, soap and stone dust. Thus New Zealand is not a country in which organic apples can be produced with fewer crop protection agents than in the Netherlands. Hawkes Bay, with the greatest concentration of apple growing, has good logistics, good private information provision from the

trade and research available to guide the growers. New Zealand growers pay much more for advisory services than Dutch growers. It became clear to us that if traders and growers in the Netherlands decided to devote more funds and attention to guidance it would also be possible to achieve a better quality of apple. Interesting research is currently being carried out in the areas of scab control and flower thinning. The fruit is grown almost entirely for export to Europe and the USA. The US imposes high quality requirements in the form of large size, colour and zero tolerance of live insects (protection), but also pays one and a half times as much as the European market thanks to the favourable dollar exchange rate. New Zealand organic apples suffer strong competition from Argentina (particularly in 2002 after the crisis), Chile and South Africa. Southern hemisphere apples seem to us a welcome supplement to northern hemisphere apples to supply the Dutch market with good quality all year round. A PowerPoint presentation with photographs and facts has been compiled on organic fruit growing and its market in New Zealand.

7.5 Working group on organic fruit growing

The objective of the working group is to identify problems in the development of organic fruit growing and if possible develop initiatives to solve them. The working group has the status of a programme advisory committee for research on organic fruit growing and is much consulted for advice on priorities and problems. The Louis Bolk Institute provides the secretariat.

Research questions

Problems for the further development of organic fruit growing include: the available range of varieties including robust varieties, and effective measures to deal with pests and diseases where the varieties are not sufficiently robust to do so. In apples the main problems are: scab, canker, rosy apple aphid, tortrix moths, diseases due to rain splashes, fruit rot, apple blossom weevil and apple sawfly. In pears they are scab, canker, *Pseudomonas*, tortrix moths and possibly black rot in future. In both apples and pears the labour costs and organisation of labour for growth and bearing regulation without thinning and growth retarding agents are a problem. With small fruit and soft fruit there are less urgent problems with cultivation; in this case the logistics of marketing pose a problem when scaling up. Problems affecting organic raising of fruit trees are: canker, rosy apple aphid, gall midge and sufficient vigour for a well-formed tree.

7.6 Publications

Fruit growing research file

Six new titles in the fruit growing series were published in 2002. The policy of including both research results and lectures in the publications remains unchanged. In 2003 a new binder (binder 6) will be created. Members of the Prisma cooperative automatically receive copies of the publications.

Other publications 2002

Anoniem, 2002: Wat heet 'natuurlijk?' brochure van het LBI.

Appels van Stand: herkenningskaart soorten vruchtrot, biologie, preventieve maatregelen. LBI.

Bloksma, J., 2002: Parameters for apple quality and an outline for a new quality concept. Proceedings 10th Intern. Conference on org. fruit growing and viticulture. Febr. 2002 Weinsberg, p. 98-105.

Bloksma, J., 2002: Parameters for apple quality and an outline for a new quality concept. ÖkoObstbau Nov. 2002.

Bloksma, J. en P.J. Jansonius, 2002: Undergrowth of late summer sowings at the tree strip. Proceedings 10th Intern. Conference on org. fruit growing and viticulture. Febr. 2002 Weinsberg, p. 185-186.

Bloksma, J., P.J. Jansonius, M. Zanen, 2002: Classy Appleproject to reduce the quality gap between supply and demand of organic apples. Proceedings 10th Intern. Conference on org. fruit growing and viticulture. Febr. 2002 Weinsberg, p. 185-186.

Jansonius, P., 2002: Kalk werkt goed tegen kanker, maar is lastig toe te dienen. *Fruitteelt* 92, 47, p.10-11.

Strien, W. van, 2002: Natuurlijkheid maakt biologische landbouw blijvend anders. *Ethiek en Beleid* 02/2, p.6-13.

Verhoog, H., M. Matze, E. Lammerts van Bueren, and T. Baars, 2002: Hoe 'natuurlijk' is de biologische landbouw? LBI publ. LD09.

7.7 Publications LBI Fruit Growing binders

LO3	All available publications in binder 1 up to 6 (1990-2003) excl. porto	€ 100.00
	All publications in binder 5 (1999-2002) excl. porto	€ 35.00
LO4	Subscription on current year incl. porto	€ 30.00
	<i>If the title is repeated in foreign language in between brackets, you will find a summary in that language</i>	↓excl.porto
1990, tweede jaargang, map 1:		
LF2	Bloksma, J., 1990: De bewaarkwaliteit van appels ; verslag van een vergelijkend onderzoek naar de bewaarkwaliteit van biologisch geteelde Rode Boskoop op 8 verschillende bedrijven in 1989 (<i>Lagerqualität von biologisch gezüchteten 'Roter Boskoop'-Äpfeln bei 8 verschiedenen Betrieben in 1989; Preservationquality of organic grown 'Red Boskoop' apples of 8 different orchards in 1989</i>). LBI (46p)	€ 3.59
LF6	Bloksma, J., 1990: Kaliumprofiel bij 5 verschillende fruittelers, LBI (4p)	€ 1.14
LF9	Bloksma, J. en M. van Brakel, 1990: De zelfontbindingstest als mogelijke kwaliteitsbepaling bij appels. (<i>Der selbstzerstörungstest bei Äpfeln; the selfdecompositiontest of apples</i>). LBI (12p)	€ 3.40
LV7	Baars, T., 1990: Het bosecosysteem als beeld voor het bedrijfsorganisme in de biologisch dynamische landbouw, LBI & Ver. v.BD-landbouw. (32p)	€ 5.68
1991, derde jaargang, map 2:		
LF12	Bloksma, J. en M. Vandewall, 1991: Morellen , tak-en bloesemsterfte bij zure kers – 3 (5p)	€ 1.14
LF13	Bloksma, J. en T. Wijnen, 1991: Minimaliseren van zwavelbespuitingen , LBI (4p)	€ 1.14
LF14	Wijnen, T. en J. Bloksma, 1991: Minerale en plantaardige olie tegen groene appelwants en bladluizen , LBI (5p)	€ 1.14
LF15	Wijnen, T. en J. Bloksma, 1991: De invloed van oorwormen op de luizenaantasting in appelbomen. (<i>The effect of earwigs on aphid in apple trees. Observations in the orchard of Korstanje in Holland 1986-1991.</i>). LBI (30p)	€ 4.54
LF16	Bloksma, J. en H. van Noort, 1991: Valeriaan-preparaat ter stimulering van nieuwe bloemknopvorming na nachtvorstschade bij aardbeien, tussentijds verslag, LBI (4p)	€ 1.14
LF17	Bloksma, J., 1991: Aantekeningen over luizen (<i>Remarks on Aphid on apple and plum; Aufzeichnungen über Blattläusebefall von Apfel- und Pflaumenbäumen</i>). LBI (56p)	€ 6.80
LF18	Bloksma, J., 1991: Jaarverslag 1991 onderzoek fruitteelt LBI met plannen voor 1992, LBI (16p)	€ 3.40
1992, vierde jaargang, map 2:		
LF19	Bloksma, J. en G. Brouwer, 1992: Studiereis biologische Fruitteelt; Venlo-Keulen-Herford-Das Alte Land, 31 juli tot en met 2 augustus 1992. (28p)	€ 6.80
LF20	Wijnen, T. en J. Bloksma, 1992: Waarnemingen van de vroege fruitmot (<i>Pammene rhediella</i>) en bestrijding door <i>Bacillus thuringiensis</i> en Neem-extract. (<i>Observations of the fruitlet mining tortrix moth and control by Bacillus thuringiensis and Neem-extract</i>). LBI (14p)	€ 3.40
LF21	Wijnen, T. en J. Bloksma, 1992: Het voorkomen van oorwormvervuiling van appels door aanbieden van schuilplaatsen. (<i>Less earwig excrements by hanging up hiding-place sacks; Weniger Ohrwurmverschmutzung durch Aufhängen von Schlupfsäckchen</i>). LBI (4p)	€ 2.26
LF22	Bloksma, J., 1992: Telling van schurftconidiosporen tussen de knopschubben bij biologische fruitbedrijven. LBI (4p)	€ 2.26
LF24	Bloksma, J., 1992: Jaarverslag 1992 Fruitteeltonderzoek LBI (18p)	€ 3.40
1993, vijfde jaargang, map 2:		
LF25	Bloksma, J., 1993: Zwavel als schurftbestrijdingsmiddel . (<i>Evaluation of the use of sulfur for scab control in organic fruit production</i>). LBI (70p)	€ 6.80

LF27	Bloksma, J., 1993: Evaluatie van 4 behandelingen van uitgesneden kankerwonden bij appelbomen. (<i>Vergleich von 4 Behandlungen von Wunden an Apfelbäumen nach dem Ausschneiden des Obstbaumkrebses, Nectria galligena</i>). LBI (8p)	€ 2.26
LF28	Wijnen, T. en J. Bloksma, 1993: Bestrijding van vruchtbladroller met <i>Bacillus thuringiensis</i> . (<i>Bekämpfung des Apfelschalenwicklers Adoxophyes orana mit Bacillus thuringiensis; Management of summer fruit tortrix moth Adoxophyes orana with Bacillus thuringiensis</i>). LBI (8p)	€ 2.26
LF30	Bloksma, J., 1993: Jaarverslag 1993 Fruitteeltonderzoek LBI (15p)	€ 3.40
	1994, zesde jaargang, map 3:	
LF31	Wijnen, T., J. Bloksma, G. Brouwer en Q. Lawant, 1994: Bestrijding van de appelzaagwesp met het plantaardige middel Quassia (<i>Management of the applesawfly, Hoplocampa testudinea with the plantextract Quassia</i>) (<i>Bekämpfung der Aepfelsägewespe mit dem Pflanzlichen Präparat Quassia</i>). LBI (40p)	€ 6.80
LF32	Bloksma, J. 1994: Bedrijfsportret van het Bd-fruitbedrijf van Piet en Heleen Korstanje . LBI (70p)	€ 6.80
LF34	Bloksma, J. 1994: Bodemveranderingen na omschakeling van gangbare naar biologische fruitteelt en het effect van verschillende compostsoorten en verschillende toepassingstijdstippen. (<i>Veränderungen im Boden nach Umstellung von Konventionellem auf biologischen Obstbau und dem Effekt verschiedener Kompostarten und verschiedener Anwendungszeitpunkte</i>). LBI (25p)	€ 4.54
LF35	Bloksma, J. 1994: Jaarverslag 1994 Fruitteeltonderzoek LBI (<i>Annual report research organic fruitgrowing</i>). LBI (13p)	€ 3.40
	1995, zevende jaargang, map 3:	
LD3	Lammerts van Bueren E. en J. Beekman-de Jonge, 1995: Biologisch-dynamische Spuitpreparaten in ontwikkeling. LBI + Ver.v.BD-landbouw.	€ 11.34
LF37	Bloksma, J., 1995: Biologische fruitteelt in Noord-Amerika , reisverslag 1995 (<i>Organic and bio-dynamic fruitgrowing in the North of America, report of a journey in 1995</i>). LBI (48p)	€ 6.80
LF38	Bloksma J., 1995: Jaarverslag 1995 Fruitteeltonderzoek LBI. (<i>Annual report research organic fruitgrowing</i>). LBI (24p)	€ 3.40
	1996, achtste jaargang, map 3:	
LF39	Bloksma, J., 1996: Mogelijkheden voor de bodemverzorging in de fruitteelt vanuit biologische gezichtspunten . Literatuur-overzicht. A4-formaat LBI (155p)	€ 11.34
LF40	Bloksma, J., 1996: Knelpunten in de ontwikkeling van de biologische fruitteelt ; wensen voor ondersteuning door middel van onderzoek, voorlichting, overheid en bedrijfsleven. LBI	€ 3.40
LF42	Bloksma J., 1996: Jaarverslag 1996 Fruitteeltonderzoek LBI. (<i>Annual report research organic fruitgrowing 1996</i>). LBI (24p)	€ 3.40
	1997, negende jaargang, map 4:	
LF43	Bloksma, J. en P.J. Jansonius, 1997: Jaarverslag 1997 (<i>Annual report 1997 Research organic fruitgrowing</i>). LBI (24p)	€ 4.54
	1998, tiende jaargang, map 4:	
LF45	Bloksma, J. en P.J. Jansonius, 1998: Toekomstvisies voor de biologische fruitteelt,-1 . LBI (22p)	€ 4.54
LF46	Jansonius, P.J, 1998: Drachtregulatie in de biologische fruitteelt, deel 1 . LBI (21p)	€ 3.40
LF47	Brouwer, G., J. Bloksma en P.J. Jansonius, 1998: Natuur in en rond de boomgaard . DLV-LBI. Brochure met foto's. LBI	€ 10.00
LF48	Bloksma, J. en P.J. Jansonius, 1999: Nutriëntenbalans in de biologische fruitteelt . LBI (12p).	€ 2.26
LF49	Bloksma, J. en P.J. Jansonius, 1998: Jaarverslag 1998 biologische fruitteelt met plannen voor 1999 . LBI (30p)	€ 4.54
LF50	Bloksma, J. en P.J. Jansonius, 1998: Annual report 1998 organic fruit growing research including plans for 1999 . Translated edition of LF49. LBI (26p)	€ 4.54

	1999, elfde jaargang, map 4:	
LF51	Jansonius, P.J., 1999: Biologisch uitgangsmateriaal voor de fruitteelt, situatie 1999 - mogelijkheden en knelpunten. (<i>Organic nursery stock for fruit cultivation</i>). LBI (30p)	€ 4.54
LF52	Bloksma, J., P.J. en H. Albers, 1999: Bedrijfsbegeleidend onderzoek in Boomgaard Bokhoven 1996-1998, thema verbetering van kalium- en stikstofopname. (<i>Farmer participatory research in Orchard Bokhoven 1996-1998 to improve uptake of potassium and nitrogen.</i>). LBI (23p)	€ 3.40
LF54	Bloksma, J., J. de Schipper, H. Veijer, R. v.d. Maas en M. op 't Hof, 1999: Verschillen in bodemvruchtbaarheid tussen een gangbaar en een biologisch verzorgd perceel met appel op Proeftuin Wilhelminadorp. (<i>Soil quality differences between a conventional and an organic apple production system at the Trial Garden 'Wilhelminadorp'</i>). LBI (17p)	€ 2.26
	2000, twaalfde jaargang, map 5:	
LF55	Bloksma, J. en P.J. Jansonius, 2000: Jaarverslag biologische fruitteelt 1999 met plannen voor 2000. LBI (20p)	€ 4.54
LF56	Bloksma, J. en P.J. Jansonius, 2000: Annual report 1999 organic fruit growing research including plans for 2000. Translated edition of LF55. LBI (16p)	€ 4.54
LF57	Bloksma, J. en P.J. Jansonius, 2000: Bladreeksen als beeld van de twijggroei; methode, voorbeelden en interpretatie. Gewijzigde herdruk van LF41. LBI (32p)	€ 6.80
LF58	Bloksma, J. en P.J. Jansonius, 2000: Leaf series as an image of shoot growth; Method, examples and interpretation; Revised and English edition of the Dutch LF41. LBI (32p)	€ 6.80
	2001, dertiende jaargang, map 5	
LF59	Bloksma, J. en P.J. Jansonius, 2001: Jaarverslag biologische fruitteelt 2000 met plannen voor 2001. LBI (20p)	€ 4.54
LF60	Bloksma, J. en P.J. Jansonius, 2001: Annual report 2000 organic fruit growing research including plans for 2001. Translated edition of LF59. LBI (16p)	€ 4.54
LF61	Bloksma, J. en P.J. Jansonius, 2001: Bloemdunnen met kalkzwavel; drachtregulatie in de biologische fruitteelt, deel 2. (<i>Flower thinning by lime sulfur, part 2 in crop regulation for organic fruit growing</i>). LBI (12p)	€ 4.54
LF62	Bloksma, J. en P.J. Jansonius, 2001: Ondergroei op de boomstrook, deel 1: nazomerondergroei. (<i>Undergrowth at the tree strip, part 1: late summer sowings</i>). LBI (16p)	€ 4.54
LF63	Bloksma, J., 2001: Hoe beoordeel je appelkwaliteit? Achtergrond bij de lezing op de studiedag 15 maart 2001 en samenvatting voor fruittelers van LBI publ. FQH01. <i>How to judge about apple quality?</i> Only in Dutch, and see for English publication FQH01. LBI (12p)	€ 6.00
LF64	Bloksma, J., P.J. Jansonius, M. Zanen (LBI) en G. Brouwer (DLV team Fruitteelt), 2001: Informatie en literatuur voor de biologische fruitteelt, (<i>Information and literature for organic fruit growing</i>), 4e gewijzigde druk van LF53. LBI-DLV (14p)	€ 6.00
LF65	Teeffelen, W. en J. Bloksma, 2001: Omgaan met onzekerheid in de biologische fruitteelt (<i>Management of uncertainty by organic fruit growers</i>). LBI en Accon (20p)	€ 6.00
	2002, veertiende jaargang, map 5	
LF66	Bloksma, J., P.J. Jansonius en M. Zanen, 2002: Jaarverslag biologische fruitteelt 2001 met plannen voor 2002. LBI (22p)	€ 6.00
LF67	Bloksma, J., P.J. Jansonius en M. Zanen, 2002: Annual report 2001 organic fruit growing research including plans for 2002. Translated edition of LF66. LBI (20p)	€ 6.00
LF68	Bloksma, J., P.J. Jansonius, 2002: Blattreihen als Abbild des Triebwachstums; Methode, Beispiele und Interpretation. Deutsche Bearbeitung 2002 von LF57. LBI (30p)	€ 6.80
LF57		
LF69	Bloksma, J., U. Prins, J. de Wit, M. Bestman, H. Helsen (PPO), 2002: Geeft samenwerking tussen fruitteelt en veehouderij meerwaarde? (<i>Does coöperator between fruit growing and livestock farming deliver added value?</i>). LBI (16p)	€ 4.00
LF70	Bloksma, J. en P.J. Jansonius, 2002: Ondergroei op de boomstrook deel 2: Perspectief van	€ 6.00

permanente ondergroei met witte klaver. (*Undergrowth at the tree strip part 2: prospects offered by a permanent undergrowth of white clover at the tree strip*). LBI (21p)

- LF71 Bloksma, J., 2002: **Wat heb ik van de luizen geleerd? Was habe ich von den Lusen gelernt?** (*What did aphids taught me?*) Lezing Bd-Obstbau Tagung Dornach 1-12-2002. Twee talig. LBI (10p) €3.50
- 2003, vijftiende jaargang, map 6
- LF72 Bloksma, J., P.J. Jansonius en M. Zanen, 2003: **Jaarverslag biologische fruitteelt 2002 met plannen voor 2003.** LBI (22p) €6.00
- LF73 Bloksma, J., P.J. Jansonius en M. Zanen, 2003: **Annual report 2002 organic fruit growing research including plans for 2003.** Translated edition of LF72. LBI (20p) €6.00