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Trends in Apple Orchard Management Practices in South Tyrol, Italy

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South Tyrol is situated at 46˚ north latitude and at 11˚ longitude in the center of Europe on the south side of the Alps. As it is protected from the north, it has a Mediterranean climate. Fruit growing is principally focused on apples and pears. The main fruit growing areas are in the Vinschgau Valley, the Etsch Valley and, to a smaller extent, in the Eisack Valley, with a total acreage of 18,000 ha (44,500 acres) in 1998 (Figure 1; also see cover photos, *Compact Fruit Tree* 31(4), October 1998).

South Tyrol produces approximately 800,000 metric tons of apples and 38,000 metric tons of pears. In 1997 a record yield of 910,000 metric tons was achieved. This accounts for more than a third of the Italian and over 10% of the European Community (EC) yield.

The main growing area stretches north from Salurn, the provincial border, which lies at 200 meters (650 ft) above sea-level, as far as Kortsch-Laas in the Vinschgau Valley, which is at an elevation of 1,000 meters (3,200 ft). The whole valley, which is 100 km (60 miles) long and 3-5 km (2-3 miles) wide, and also the adjoining slopes up to an elevation of 1,000 m (3,200 ft) are densely planted.

METEOROLOGICAL DATA

Annual temperatures reach 11.5°C (52.7°F) on an average on the valley floor and at an elevation of 800 m (2,600 ft) in the Vinschgau Valley only 9°C (48°F). The annual precipitation is only 450 mm (18 inches) in the more arid Vinschgau Valley and approximately 800 mm (31 inches) in the Etsch Valley. On the whole, the rainfall is evenly distributed. As spring frosts are common at the bottom of the valley, all orchards are equipped with overhead irrigation for frost control. The Advisory Service has set up a network of electronic weather stations (120), which transmit the most important meteorological data to computerized centers. Around the clock, orchardists have access to the latest weather data via telephone or computer.

These data are also used for the scab warning system. The occurrence of frosts varies considerably from year to year. Very severe frosts occurred in 1997 and the orchardists had to switch on frost irrigation 15-25 times. In 1998, on the other hand, there were only 2-4 frost nights on an average. In autumn, morning frosts are very rare, but on the 27th/28th October 1997 the temperature dropped to -10°C (14°F) and below. Fortunately the harvest, with the exception of Pink Lady, was already over. In South Tyrol the summers are very warm with an average of 97 summer days with temperatures above 25°C (77°F). There are also days with more than 33°C (91.4°F), which may lead to fruit sunburn. The large number of sunshine hours, 1,800-2,000 a

year, as well as the low temperatures during the night in autumn are conducive to good fruit quality, especially coloring.

One of the drawbacks to fruitgrowing in a mountainous region is the frequent recurrence of hailstorms. Every year 10-20% of the total orchard acreage is damaged by hail. In 1998 the damage was particularly severe with 27%.

SOILS

The soils are young, sandy-loamy alluvial soils on the valley floors and brown earth on the hillsides. They are mostly well drained and the average water table is lower than 1 m below the surface. The pH-value varies from 6.5-7, the humus content from 3-5%. Only a small part of the orchards between Nals and Salurn is situated on the typical dolomite sediments which contain magnesium and lime.

OPERATIONS

Small family-owned operations with an average size of 3-4 ha (7.5-10 acres) are typical. As such small economic units often do not provide an adequate family income, secondary occupations are frequent. Of the 8,000 orchardists 39% work full-time on the orchard and 61% part-time. They usually increase their income in the tourist and catering industry (holiday on a farm, wine cellars in farmhouses) and as craftsmen.

TRAINING

Many farmers are very young. Among the young farmers fruit growing is very popular. Why? Fruit growing

- promises a good profit
- is highly mechanized
- leaves enough time for leisure activities
- confers a certain social standing

Great stress is placed on sound professional training. Approximately 70% of the orchardists have special training in agriculture. The South Tyrolean Advisory Service with its more than 6,000 members provides information and the opportunity of further training. Each member has to pay an annual fee.

Trials and experiments on problems related to fruit- and winegrowing are carried out by the Experiment Station Laimburg.

MARKETING

Of the annual production 85% is marketed by 46 cooperatives. The remaining 15% of the crop is delivered by the orchardists to 12 private traders, 3 of which sell their goods by auction according to the Dutch model. Half the annual yield is exported to the various EC countries, especially to Germany.

TYPE OF ORCHARD MANAGEMENT

In 1998 the South Tyrolean growers managed 81.9% of the total acreage according to Integrated Production (IP) guidelines. They were developed and introduced by the Advisory Service about 10 years ago (1988) for the first time in Europe. The trend is increasing, especially since IP is subsidized by the EU. In 1998 the share of apples from organic production amounted to 1.3% of

the total production. Here the trend is also increasing because of the high prices. The remaining acreage, 16.8%, is still managed in the conventional way. The trend is decreasing.

ECONOMIC TRENDS

The orchard acreage has constantly increased in the last years by approximately 170 ha (420 acres) a year. Apples have been planted in completely new areas which had previously been dedicated to husbandry as, for example, the elevated sites along the Etsch Valley.

Especially on warm and sunny slopes fruitgrowing has advanced at the cost of winegrowing. A further expansion is limited by the landscape, the climate and the availability of ground. In proportion to the acreage (Figure 1) production has increased much more (Figure 2).

Contrary to expectations South Tyrol achieved in 1997 a production of 910,000 metric tons, which corresponds to 50 metric tons/ha on average, new plantings included. This increase might be due to several factors:

- higher tree densities (more trees per surface unit)
- smaller trees on M.9 with high initial yields
- varieties with a high and secure yield

In addition, several thinning, training and fertilizing measures aimed at promoting higher yields were introduced. The succession of the various planting systems in the last decades has put its stamp on the South Tyrolean landscape (Table 1).

Up to 1960 tall trees with large canopies (100-200 trees/ha) (40-80 trees/acre) on seedling rootstock were typical. From 1960 onward growers became interested in the hedgerow (Italian palmette), on the semi-vigorous rootstocks M.7, M.4, M.2 and MM.106. They permitted a higher mechanization of plant protection measures, thinning and pruning. Palmettes were not very widely used in the South Tyrol because soon afterwards, at the end of the 1960s, high density plantings with the slender spindle on the dwarfing rootstock M.9 were introduced from Holland. For many orchardists, this was a revolution. It was necessary to convince the growers of the advantages of early yields, better fruit quality, lower costs and easier access to the tree canopies from the ground. From 1975 onward the ice was broken. The triumphal march of the Dutch high density system began. Its basis was the single row on M.9, with a tree spacing of 3.5-4 m x 1-1.5 m (11.4-13 feet x 3.3-4.9 feet), which corresponds to 2,000-2,500 trees/ha (810-1,012 trees/ acres). The tree training aimed at producing well-branched trees 2.5 m (8.2 feet) tall in a Christmas tree shape. It should be possible to perform all the important tree management measures and the harvest from the ground.

In the 1980s, however, some deviations and higher density plantings than the single row system developed:

- the North Holland three-row system with 3,000-5,000 trees/ha (1,215 –2,024 trees/acre)
- the V-System with spacing of 3.5 x 0.7-0.8 m (11.5 feet x 2.3-2.6 feet) and 3,500-4,000 trees/ ha (1,417-1,620 trees/acre)

Both planting systems were not satisfactory. The increased shading led to

- poorer fruit quality (especially coloring)
- considerably higher cost of establishing new plantings
- a greater expenditure of time on tree management and harvesting

The target—higher yields through a larger number of trees per ha—was reached with an increase in production of 3-4% (data from trials at the Experiment Station Laimburg by Dr. Hermann Mantinger). The fruit quality, however, was not improved. At the moment the orchardists in South Tyrol are not interested in the V-system. On the contrary, several V-plantings have been converted back to slender spindles.

The introduction of the super spindle in the late 1980s constituted a great leap toward intensification. It included

- planting densities of 10,000-12,000 trees/ha (4,050-4,860 trees/acre) with tree distances of 2-2.5 m x 0.25-0.4 m (6.5-8.2 feet x 0.82 –1.3 feet)
- canopy diameters of 0.5-1 m (1.6-3.3 feet) at most
- trees with very short lateral branches

The supporters of the super spindle brought forward the following points in its favor:

- early production: 2nd year half of the production capacity, 3rd year full productivity
- hence the opportunity to take advantage of high prices for new varieties
- high yields/ha of 80-120 metric tonnes
- less expenditure of time on pruning and training
- short economic life cycle of the orchard: 7-9 years

The prerequisites to success with super spindle are the total control of shoot growth and fruit set, frost irrigation, hail nets and fertigation. In the early 1990s a number of super spindle orchards were established in Holland, Germany and South Tyrol.

The Experiment Station Laimburg has conducted several trials with super spindle and slender spindle planting systems and the varieties Elstar, Royal Gala and Braeburn on rootstock M.9 (Table 2). After 7 years Dr. Hermann Mantinger came to the following conclusions:

- The cumulative yields/ha were higher for super spindle only with the not very vigorous and not virus-free variety Braeburn; production per hectare for Gala and Elstar was lower for super spindle than for narrow slender spindle.
- In the plot with super spindle, fruit size was smaller on all varieties.
- With Gala, the fruit color remained significantly paler on the super spindle and increased with wider tree spacing (Figure 3).

According to Dr. Hermann Mantinger, these results show that if tree density increases beyond a certain limit the risk of alternate bearing, smaller fruit size and poorer coloring will rise. Furthermore, the yield/ha does not rise beyond a certain threshold.

An economic analysis shows that after taking into account all the determining factors, including production, prices, investment of capital and interest, only with the not very vigorous variety Braeburn were the capital costs covered in the 5th year. With Gala and Elstar the extreme intensification did not bring any advantages.

In conclusion, the higher the density of an orchard, the higher the capital input and therefore the risk of losses. It is also known that an agricultural ecosystem is more sensitive to exterior influences and loses the more intensive the production methods are. In the course of the increasing intensification of the super spindle system we have clearly exceeded the point of maximum profitability. The practically minded South Tyrolean orchardists realized this at once

and stopped the progress of the super spindle. A positive outcome of the scientific and practical intensification trials was the realization that the single rows might be planted somewhat closer together and the number of trees could be increased from 2,500-3,000 to 3,000-5,000 trees/ha (1,012-1215 to 1,215-2,024 trees/acre). These results are included in our latest recommendations regarding planting systems (Table 3).

With the tree numbers and planting systems listed in Table 3, we believe we have found a balance between the following important demands on modern orchard management:

- early, high and regular yields
- good fruit quality
- low costs, little manual work
- consideration for ecological needs

NEW TRENDS

The trees are allowed to grow a little higher, up to a maximum of 3-3.5 m (9.8-11 feet). This has the advantages of higher yields and slower top growth.

On the other hand, the increased tree height impedes tree management and harvesting from the ground. Furthermore, as the experiences in the autumn of 1998 show, higher trees require a stronger support system.

If the prices of different fruit qualities continue to diverge, wider spacing might become interesting to achieve a good fruit color and size with red or bicolor varieties.

REQUIREMENTS FOR YOUNG TREES

It is important for the economic success of an orchard to obtain well-developed trees from the nursery and to train and handle them carefully. We advise our orchardists to plant only well-developed trees. They should have a stem diameter of 11 mm (>5/8") at 10 cm (3.9 inches) above the graft union or 24 cm (9.45 inches) above the ground and they should be well branched (feathered) with at least 5 usable shoots (branches) with a length of at least 30 cm (11.8 inches). Our definition of “usable shoots” is as follows:

- first basic shoots should be 60-80 cm (23.6-31.5 inches) above the ground
- their length and vigor should be equal
- they should be distributed at regular distances around the stem
- the crotch angle should be as wide as possible

TRAINING AND PRUNING

Nowadays a large part of the trees supplied by the nurseries have 10 or more branches. In order to prevent growth of the central leader that is too vigorous and promote the development of fruiting branches we advise:

- bending a central leader of more than 50 cm (19.7 inches) length immediately below the horizontal; as soon as the shoots at the upper side have reached a length of 10 cm (3.9 inches), the central leader must be tied up again
- not touching the central leader if it is shorter than 50 cm (19.7 inches)
- removing feathers that are too vigorous or too close to the ground (below 60 cm from the ground) (23.6 inches)
- cutting back shoots that are too long and bending shoots if the angle is too steep

TRAINING

The slender spindle has been the most widely used tree form in South Tyrol for 25 years. The aim is to obtain a 2.5-3.5 m (8.2-11.5 feet) tall Christmas tree shaped tree with a width of approximately 1-1.5 m (3.2-4.9 feet) at the base. This permits the most efficient interception of sunlight under our conditions and consequently high yields of good quality fruit.

The objectives of tree training have remained the same over the years; however, the ways and means of achieving them have changed due to better tree quality, which means well-feathered, vigorous trees, and new physiological insights into shoot growth and pruning.

The central leader is not headed back at planting. In the early years only excessively vigorous and steep shoots near the central leader are removed. Bend usable steep shoots down and do not prune the laterals. Early yields will assure a slow and harmonious growth.

“Little pruning also in the early years” was a further physiological insight. Pruning at this early stage promotes shoot growth, retards good early crops and the development of the permanent tree shape.

The training during the bearing phase has also changed significantly in recent years. This pruning strategy can be defined as “from short to long.” Its principal objective is to maintain the tree in a physiological balance or to reduce growth if the tree is very vigorous. Contemporaneously this enhances high and regular yields. The following basic rules have to be observed:

- Branches at the base which are too vigorous or too close together as well as vigorous branches at the top must be removed.
- Do not leave more than 2-3 large pruning wounds on a tree per year. They permit a better exposure to sunlight and do not disturb the physiological balance of the tree.
- Never shorten vigorous laterals: remove them or leave them untouched.
- Prune horizontal fruiting branches only if their annual growth is shorter than 20 cm (8 inches). Cut back old and exhausted wood.

VARIETY TRENDS

In the 1980s only 5 varieties shared 90% of total production. This concentration did not meet the demand of the European markets for new varieties. New varieties like Granny Smith, Jonagold or Elstar were planted. The older varieties, Jonathan, Rome Beauty and Gravenstein, declined. This led to a slightly different assortment of varieties in 1990 (Table 4). From 1990 onwards another wave of new, more up-to-date varieties arrived with Gala, Braeburn and Fuji, which is in full swing at the moment (Table 4).

Since 1997 Cripps Pink/Pink Lady has captured our interest. This new variety from Australia exerts a magical attraction for many of our orchardists. The above-mentioned new varieties accounted for a considerable share in the production of 1998. At present much replanting is taking place. It is triggered by the slack demand for and the low prices of the traditional varieties, for example, Golden Delicious and Rome Beauty. This leads to an almost revolutionary upheaval in the assortment of trees offered by the nurseries, as can be seen from the statistics for 1997/98 (Table 5). South Tyrol is following a worldwide trend in this respect.

VIGOR CONTROL

The control of shoot growth has been a central point of interest in the European and South Tyrolean fruit growing industry in the 1990s. Growers and experts realized that only a well-balanced tree gives a good early crop and regular high yields.

In South Tyrolean orchards tree growth is frequently too vigorous (in approximately 30-40%) in spite of all the precautionary measures. In such cases we recommend root pruning.

Many trials and practical experiences have shown that the most effective measure is root cutting which:

- reduces shoot growth (by up to 55%)
- reduces fruit size (this is an advantage only with varieties producing big fruits)
- promotes fruit set in the following year
- reduces bitter pit

Root cutting had no negative effects on russetting of Golden Delicious or on the uptake of nutrients. Prerequisites for root cutting are:

- deep soil, free of stones
- irrigation
- vigorous growth

What is the best time for root cutting? Root cutting should be performed in orchards with vigorous growth, biennial bearing habits and varieties producing large fruits in the year with a heavy crop, although generally in the year with a slight crop. A good time is probably the period before vegetative growth begins. At that time the inhibiting effect on shoot growth and fruit size is strongest. The later in the vegetative period root cutting is carried out, the slighter is its effect.

At what distance and how deep should you cut? The distance from the trunk is more important than the depth. For root cutting with M.9, it should be performed on both sides at a distance of 30 cm (12 inches). The cut should be about 40 cm (16 inches) deep. In the first year the orchardist is advised to work very carefully.

NAA is also used for growth control but is considered an exceptional measure. It often helps to reduce top growth considerably. There are several application techniques. One is painting overly vigorous central leaders (longer than 50 cm) (19.7 inches) from the 2nd to the 4th year. We recommend applying the NAA solution only to the 2- or 3-year-old wood of the central leader in a ring of 5 cm (2 inches) width. The wider the ring, the more active ingredient the wood absorbs. Gala, Braeburn, Red Delicious and Granny Smith react, in decreasing order, rather strongly to the application of NAA. If the central leader is very vigorous we recommend a 2% solution and for weaker shoots 1%.

The ideal time is the end of flowering to the end of May. After the application it should not rain and there should be no irrigation. The disadvantages of this treatment are: The effectiveness is not always consistent, it depends on weather conditions, vigor of the treated shoots and width of the NAA ring. In those places where the paste is applied the central leader may lose stability and is more likely to bend or break.

A second method of reducing growth is the treatment of larger pruning wounds near the tree top with an NAA paste. For fresh wounds use a 1% paste, for old wounds 2%. The date is not important.

A third technique for vigor reduction is spraying in the summer. A lot of knowledge, experience and observation is required for spraying with small doses of NAA (15-25 ml/hl) during the summer. This can reduce the new growth by 16-30% on an average. More dards and spurs have terminal flower buds and therefore flowering is enhanced in the following year. Depending on the vigor of shoot growth we recommend 3-5 treatments at intervals of 10-15 days from June drop onwards. NAA is mixable. A disadvantage is that the treatment leads to a reduction of fruit diameter. Therefore we recommend the use of NAA only for varieties with large fruits like Jonagold, Fuji and Granny Smith.

The fourth method of vigor control is cultural. First of all, orchardists are encouraged to adopt biological measures in order to slow excessive growth, for example, to apply only half the amount of water generally required or to tolerate weeds and grass on the tree strip from mid-summer onwards. They can absorb much excessive potassium and nitrogen.

GROUND COVER MANAGEMENT

In recent years it has become much simpler. As vegetation in the alleyway is tolerated, it is mulched 3-5 times a year. Special attention is paid to the tree strip, which is kept weed-free especially during the early years of an orchard (Table 6).

Trials by the Laimburg Research Station (H. Mantinger) have shown that a ground cover under the trees results in slower shoot growth and lower initial yields. As soon as the trees have reached their full volume and the bearing phase, the vegetation in the tree strip does not have any negative effects on growth and crop.

How is the tree strip managed? In the IP-program, which is observed by approximately 80% of the South Tyrolean producers, only herbicides which are absorbed by the leaves like glyphosate, glyphosinate (Basta) and MCPA-salts are permitted. The only exception is simazine, which may be used in the first 3 years (2 kg/ha) (1.78 lbs/acre). Glyphosate is usually applied also after harvest before the soil freezes. The advantages of this are:

- For a good effect half the dosage is sufficient.
- The effect lasts until mid-May of the following year.
- There is little other work to be done in the period after harvest.

In the course of the vegetative period 1-2 additional herbicide treatments with glyphosate, sometimes mixed with MCPA, will become necessary. From late summer onward we advise tolerating the regrowth under the trees, because it absorbs a surplus of nitrogen and potassium in the soil. This slows down growth and enhances fruit quality, especially red color promotion. In orchards where field mice are a problem, this measure is not advisable. The weed-free strip should not be wider than a third of the alleyway. In many bearing orchards a ground cover of weeds throughout the planting has proved successful. In this case it is indispensable to use a special swing arm mower which can also mow around the trees.

MATURITY AND HARVEST

For each variety and location the maturity stage is carefully monitored with the help of a number of tests. The following parameters are used: sugar level in °Brix, acid content in g/l, starch conversion, penetrometer values in bar/cm^2. Recommendations regarding the ideal picking time are worked out by the technical services of the packing houses and communicated to the growers.

At harvest wooden bins, 110 x 110 x 75 cm (43 x 43 x 30 inch), are still used for the most part, although for 10 years the plastic bin (costs: US$75 apiece) has been gaining steadily so that the wooden bin will soon disappear. For harvesting, the growers use the following equipment: The traditional “Loan” (special kind of tall ladder, typical in South Tyrol, which consists of a single wooden pole with horizontal steps) for higher trees (see cover photo), and a harvesting bag made of heavy cloth. The latter has been substituted largely by the “Tyrolbox” which can be emptied directly into the bin. The bins are lifted by a tractor-mounted forklift onto the trailer. Larger operations also use automatically moving harvesting machines. There is a wide range of different models available at present. Efficient, but rather expensive, is the Dutch Pluk-o-trak machine.

CONCLUSION

South Tyrol offers many advantages for the production of apples, for example, the warm climate, with its cool nights in autumn before harvest which are typical of mountainous regions. They improve the color and the sugar level of the fruits. All interesting varieties in the world, from Gala to Pink Lady, find an ideal habitat. A lot of sunshine as well as sufficient rainfall and water complete the positive picture. The production structure based on small, family-owned farms is also advantageous. It permits intensive care, a high degree of mechanization and inexpensive labor. Research and extension activities are highly specialized and provide information for all the orchardists.

Marketing is based to a great extent on efficient, medium-sized cooperatives which collect, store, pack and sell the fruit. The closeness of the most important markets for South Tyrolean apples, Italy and Germany, is a further advantage.

In the course of an increasing globalization, however, these markets will be hotly contested. Apples from all production areas around the world, even from Australia, South America and South Africa, are coming to Europe. In the last 2 years the prices dropped.

Therefore we consider it a challenge to improve the competitiveness of our operations and our region through know-how, use of new technologies and a constant renewal of our assortment of varieties and planting systems.

Table 1. Development of orchard systems in South Tyrol, Italy.

Until 1960	large, tall, round-shaped trees on seedling rootstocks; 40-80 trees/acre
1960	first Italian Palmetta on M.7, M.106, M.4 rootstocks; 400-500 trees/acre
1970-75	slender spindle on M.9 rootstock; 800-1000 trees/acre
Up to 1990	slender spindle on M.9; 1200-2400 trees/acre

Table 2. Trials at the Laimburg Research Station comparing yield for slender spindle and super spindle systems.

Variety and orchard system	Spacing (m)	trees/ha	Trunk cross-sectional area (cm^2)	Cumulative yield (1991-96)			Average fruit quality		
				kg/tree	t/ha	% increase*	weight (g/fruit)	color (%)	diameter (% >70+ mm)
Elstar									
super spindle	2.5 x 0.33	12,121	12.8	15.4	187	116	180	42.7	92.7
slender spindle narrow	2.8 x 0.80	4,464	32.7	46.3	207	128	177	41.0	94.7
slender spindle wide	3.0 x 1.20	2,777	31.6	57.8	161	100	173	45.5	94.3
Royal Gala									
super spindle	2.5 x 0.30	13,333	6.1	17.3	231	125	163	57.7	72.3
slender spindle narrow	2.8 x 0.70	5,102	16.1	45.8	234	126	176	57.8	80.8
slender spindle wide	3.0 x 1.00	3,333	17	55.4	185	100	171	61.9	78.4
Braeburn									
super spindle	2.5 x 0.30	13,333	8.4	29.7	396	212	188	53.2	79.1
slender spindle narrow	2.8 x 0.60	5,952	10.7	36.8	219	117	186	61.1	78.3
slender spindle wide	3.0 x 0.80	4,166	13.8	44.8	187	100	191	61.5	80.9

*percent increase over lower density slender spindle.

Table 3. Tree densities recommended in South Tyrol, Italy, in 1998/99.

Variety*	Distances	Trees/ha	Trees/acre
Jonagold, Red Delicious Winesap, Granny Smith, Fuji	3.0-3.2 x 1.0-1.2 m 9.8-10.5 x 3.3-3.9 ft	3,333-2,604	1,349-1,056
Gala, Braeburn vf, Golden Delicious, Idared vf	3.0-3.2 x 0.9-1.1 m 9.8-10.5 x 2.9-3.6 ft	3,700-2,860	1,498-1,085
Red Chief (M.9 or M.26)	2.6-2.8 x 0.5-0.6 m 8.5-9.2 x 1.6-2 ft	5,920	2,397

*rootstock M.9.

Table 4. Major apple varieties in South Tyrol, Italy.

Variety	1980 (%)	1990 (%)	1998%
Golden Delicious	51.2	47.3	48.5
Red Delicious	9.0	11.5	10.0
Rome Beauty	21.0	16.6	10.0
Jonathan	12.0	4.4	0.0
Jonagold	0.0	5.2	9.0
Granny Smith	0.0	3.8	7.3
Gala	0.0	0.0	6.0
Elstar	0.0	0.0	2.0
Braeburn	0.0	0.0	1.2
Fuji	0.0	0.0	0.3
Others	6.8	11.2	5.7

Table 5. Share of apple varieties available as grafted trees by nurseries.

Variety	1997 (%)	1998 (%)
Gala	22	42
Braeburn	15	20
Fuji	7	10
Golden Delicious	37	10
Red Delicious	7	8
Others	12	10

Table 6. The influence of weed control on tree growth and yield (Laimburg Research Station, 1996).

	Stem diameter 1990-94	Yield 1990-94	
Treatment	(inch)	lbs./tree	kg/tree
No weed control	3.0	15.6	34.5
Mechanical weed control	3.6	21.0	46.4
Treatment with bark mulch	3.0	16.4	36.1
Herbicide	3.1	20.4	45.0

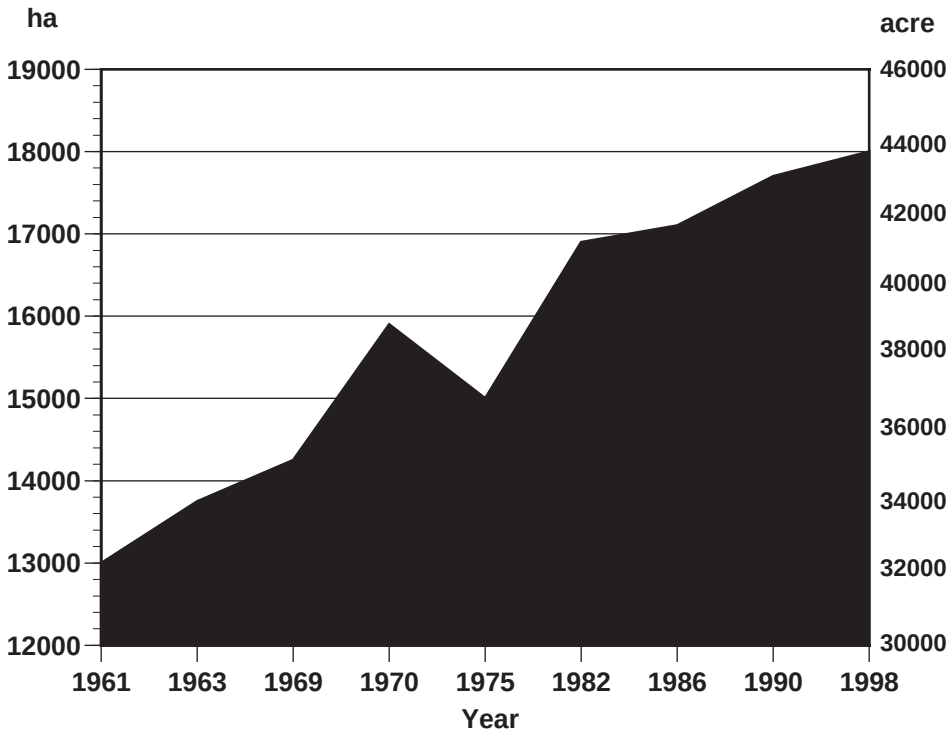

Figure 1. Fruit growing area in South Tyrol, Italy.

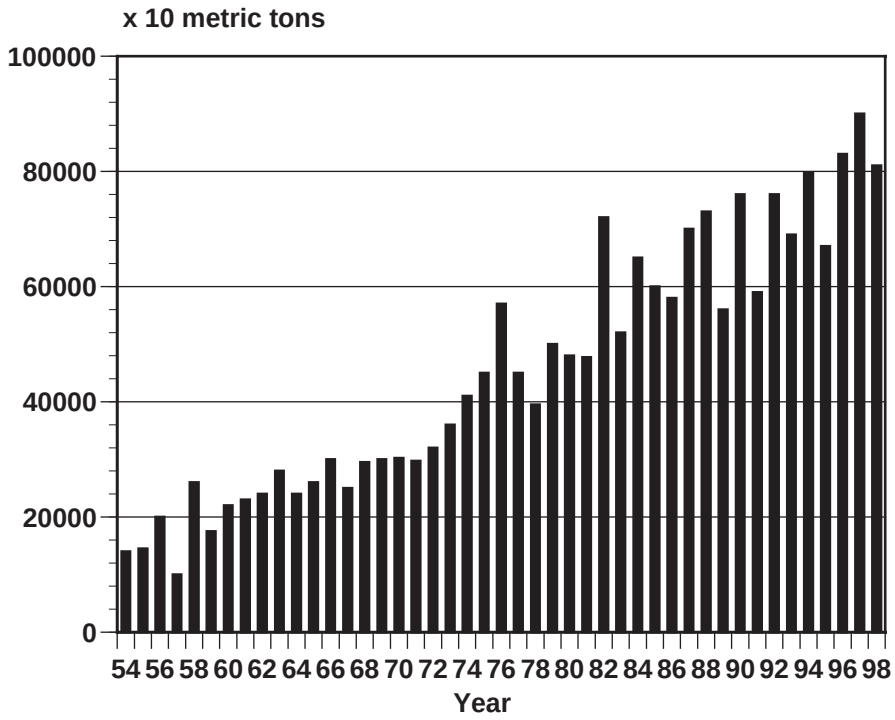

Figure 2. Apple production in South Tyrol, Italy.

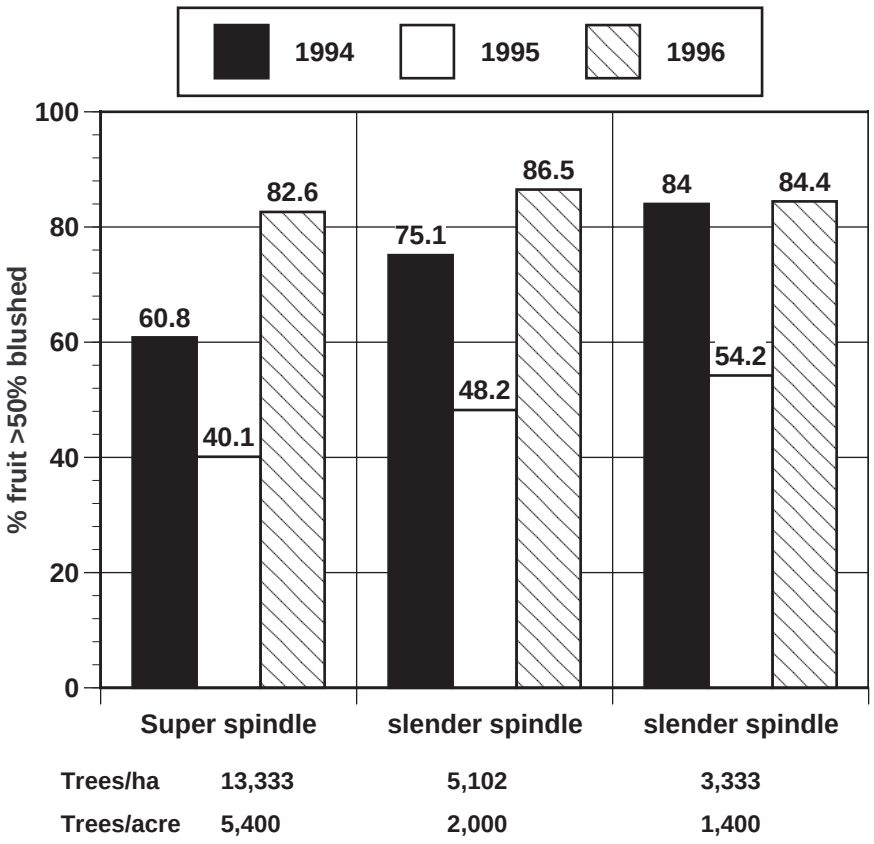

Figure 3. The influence of orchard system on fruit color of Gala (Laimburg Experiment Station).