

# FIFTY YEARS OF STRAWBERRY BREEDING AT THE CENTRE FOR PLANT BREEDING AND REPRODUCTION RESEARCH (CPRO-DLO) IN THE NETHERLANDS

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## Summary

The CPRO-DLO strawberry breeding programme has been very successful and has resulted in the release of 24 cultivars over the past fifty years. The most important cultivars were 'Gorella' and 'Elsanta'. The development of new and better cultivars has made a significant impact on the development of the strawberry culture in Europe. This process still continues and it is likely that in the near future it will be speed up through the usage of new breeding tools such as transformation and molecular markers.

## 1. Introduction

The strawberry breeding programme at the Centre for Plant Breeding and Reproduction Research (CPRO-DLO Wageningen, The Netherlands) was initiated at the former Institute for Horticultural Plant Breeding (IVT) at the end of The Second World War (Kronenberg, 1966). This breeding programme was financed by the Dutch Ministry of Agriculture, because the economical basis for a private breeding programme was insufficient. Therefore, Dutch strawberry growers depended mainly on the breeding programme of CPRO-DLO for high quality cultivars. Since 1996 the Ministry of Agriculture has stopped its financial support for the breeding programme and it is now financed from the proceeds. In the past 50 years nineteen June-bearing cultivars, including two cultivars for early forcing in greenhouses, and five everbearing cultivars have been released (Table 1).

Several of these cultivars have been quite successful and were used in various cultivation systems, in many European countries. Generally, cultivars selected in Wageningen can be grown in the temperate zone roughly between 45° and 60° North latitude. 'Korona' for example is presently becoming increasingly popular in Norway and 'Elsanta' is found in the area of Cesena in North Italy. However, it should be realized that the optimal growing conditions vary for each cultivar and depend on its genetical background and the latitude where it is selected.

## 2. Cultivation methods

It should be noted, that the production of strawberries in the seventies and early eighties resulted mainly from the cultivation of June-bearing cultivars. There was a niche in the market for strawberries in the spring and autumn. The niche in the spring was filled with strawberries from the greenhouse (forcing) and the niche in the autumn was covered partially by growing everbearing cultivars.

New expensive cultivation systems such as the so-called belated culture (outdoors) and the continuous culture ("indoors") evolved, thanks to the very high prices paid for 'Elsanta' in the spring, autumn and at Christmas. This resulted in a nearly year-round production of strawberries in The Netherlands. Traditionally, normal planting involved planting fresh-dug plants in August and harvesting the next year in June. At first the belated culture with cold-stored waiting-bed plants was only possible with the cultivars Gorella and Sivetta, but since the introduction of 'Elsanta', the belated culture became the most important way of producing strawberries in The Netherlands. For the production of cold-stored waiting-bed plants, fresh-dug plants are planted on a waiting bed at 30 x 30 cm in August. These plants are lifted, clustered and stored between -1 °C and -2 °C when they are dormant in December or January. Planting is done in shifts from April to September and the harvest starts 6 to 12 weeks after planting depending on the weather conditions. This cultivation system has significantly extended the production period and has nearly completely replaced the cultivation of everbearing cultivars in The Netherlands.

Another new trend is the 'continuous' culture. In this culture cold-stored waiting-bed plants or A<sup>+</sup>-plants (large frigo plants with a crown diameter >14 mm) are planted in buckets or peatbags in greenhouses or plastic tunnels in July and August and harvested twice, respectively in the fall and in the spring. During the winter the plants are allowed to go dormant for 4 to 6 weeks after which forcing starts again. The buckets or peatbags are placed on drains, which are either placed on posts or hanging on chains from the greenhouse construction, at such a height that the berries can be picked while standing. This results in easy picking and a reduction of the picking costs. Due to this new cultivation system with 'Elsanta', production under glass (or plastic) has increased from about 1,900 tons to 6,566 tons from 1989 to 1994. The average production with this system reached an average of 7 to 8 kg per square meter (2-2.5 kg in autumn, and 5-6 kg in spring) and is still increasing.

## 3. The breeding strategy at CPRO-DLO

### 3.1. The selection scheme

The breeding and selection scheme at CPRO-DLO can be divided into the following steps (Meulenbroek and van de Lindeloof, 1991):

1. Choice of parents
2. Test crosses and large scale crosses
3. Selection of individual plants
4. Selection of clones
5. National cultivar evaluation trials
6. Introduction of new cultivars

Selections which prove to be superior to standard cultivars in the National Cultivar Trials carried out under the supervision of the Research Station for Fruit Growing at Wilhelminadorp or which are so different from the existing cultivars that they can find a 'niche' in the market will be introduced after we have applied for plant breeders' rights. Nuclear stock of a new cultivar is maintained and tested thoroughly against viruses, fungi, bacteria and nematodes by the National Health Service (NAKB). Then super-elite planting material is sold to those nurseries, who are willing to multiply the cultivar under license either in The Netherlands and abroad. Normally it takes 10 to 12 years from the initial cross to the final introduction (Table 1). An exception was the cultivar Elsanta for which only eight years were needed, due to its outstanding fruit traits like firmness and shelf-life, and its high production capacity.

### 3.2. Selection criteria

Most selection traits (skin and flesh firmness, fruit setting, production, shelf-life, etc.) are sensitive to changes in the environment. As the weather in North-West Europe is very variable, it is necessary to evaluate these traits over a number of years in replicated trials. Therefore, the selection in the first two years is concentrated on traits less influenced by environmental factors, like plant habit, length of inflorescence, fruit colour, size and shape. However, even with these traits the weather has to be taken into account when evaluating.

Breeding for disease resistance in general has always been important. Throughout the breeding programme the healthiest genotypes are selected. However, due to rigid government regulations put on the use of chemicals, which are a result of the public awareness of the negative effects of the application of such chemicals in agriculture and horticulture (Anonymous, 1989), the demand for more resistant cultivars is becoming stronger.

In the late nineteen sixties red stele caused by *Phytophthora fragariae* became a very important disease. Several growers had to stop the culture of strawberries on their properties altogether. Therefore, a specific breeding programme was initiated for selection on resistance. Selection was carried out in heavily infested soil. This programme generated many selections with a high degree of resistance. However, none of these selections have been introduced so far, as the fruit quality is still not good enough compared with the present standard cultivar Elsanta. More recently special inoculation and test methods have been developed for selection of genotypes resistant to red stele and other diseases.

### 4. Results

When the breeding programme was initiated the most important cultivars were 'Deutsch Evern', 'Madame Moutôt', 'Madame Lefèvre', 'Oberschlesien' and 'Jucunda'. In those years selection was mainly focussed on attributes crucial for the processing industry like: easy capping, dark red internal and external colour, firm but not too hard or tough fruits and medium fruit size (Wassenaar, 1989). However, soon thereafter, 'Gorella' was introduced as an improvement of 'Madam Moutôt' for the fresh market, because of its larger fruits, better appearance, better taste and higher production. As the processing industry was the main market for which 'Gorella' was not suitable, it was

thought that it would remain a minor cultivar. However, soon after its introduction the importance of the fresh market increased. At that time, 'Gorella' was the only cultivar adapted to a greater part of Europe, with a high production and large fruits and soon it became the leading cultivar from northern Italy to Denmark.

The introduction of the everbearing cultivar Revada in 1960 initiated a whole new cultivation system in The Netherlands. 'Revada' was actually introduced as a curiosity for home gardeners, but soon after introduction it was picked up by professional strawberry growers in the northwestern part of The Netherlands, as it created a possibility to extend the season from July till the first frosts in the fall (Wassenaar, 1967). Therefore, this specific breeding programme for everbearing cultivars was continued. It has resulted so far in the release of the successful cultivars Ostara and Rapella.

In 1981 'Elsanta' was introduced at a time during which strawberry production, in The Netherlands and Belgium decreased. This was caused by the increasing wages for picking labour and the relatively low returns. Owing to its firm flesh and strong skin 'Elsanta' could be picked much faster than other cultivars resulting in a much higher profit for the farmers. It also keeps its quality a few days longer during transport. This was a major improvement compared to the existing cultivars. 'Elsanta' appeared to be a reliable cultivar, highly appreciated by traders, who were willing to pay a higher price for it. These features made it the right cultivar at the right time. It gave the strawberry industry an enormous boost and has caused many farmers to change their cultivation system. The future releases should be 'Elsanta-type' with disease resistance, for a profitable and environmentally safe strawberry production.

## 5. References

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Table 1. Cultivars introduced by CPRO-DLO.

Cultivar	Parentage	Year of cross	Year of introduction	Importance*
<b><u>June-bearing</u></b>				
Juspa	(Jucunda x Sparkle)	1945	1957	-
Oranda	(Deutsch Evern x Temple)	1945	1957	-
Gorella	(Juspa x Md-3763)	1953	1960	+++
Elista	(Jucunda selfed x Md-3763)	1953	1964	-
Tamella	(Gorella x Talisman)	1962	1970	+
Tago	(Gorella x Talisman)	1962	1972	+
Tenira	(Redgauntlet x Gorella)	1963	1973	++
Sivetta	(Redgauntlet x Gorella)	1963	1973	++
Induka	(Puget Beauty x Senga Sengana)	1963	1973	+
Elvira	(Gorella x Vola)	1965	1977	++
Bogota	{{(Climax x Deutsch Evern) x Tago}}	1969	1978	++
Korona	(Tamella x Induka)	1970	1978	++
Elsanta	(Gorella x Holiday)	1973	1981	+++
Valeta	(Sivetta x Holiday)	1974	1983	++
Polka	(Induka x Sivetta)	1975	1987	+ / ++
Avanta	{{(Induka x Sivetta) x (Karina x P.d. Romagna)}}	1977	1990	-
Lambada	{{(Sivetta x Holiday) x (Karina x Primella)}}	1980	1994	?
<b><u>early forcing</u></b>				
Karina	{{(Gorella x D.Evern) x Valentine}}	1966	1976	-
Karola	{{(Gorella x Midway) x Karina}}	1972	1983	+
<b><u>everbearing</u></b>				
Repita	(Ada Herzberg x Climax)	1954	1960	-
Revada	(Climax x Ada Herzberg)	1954	1960	+
Rabunda	(Redgauntlet x Repita)	1962	1969	-
Ostara	(Redgauntlet x Macherauchs Dauerente)	1962	1969	++
Rapella	(Tioga x Rabunda)	1971	1983	++

\* '+++' = very important and '-' = unimportant