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Development of integrated flowerbulb production

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Abstract

Motivation and objectives of new research projects on the integrated production of flowerbulbs are presented. On 3 locations, 9 different bulbfarming prototypes will be developed and tested, with increasing substitution of pesticides to achieve short- and long-term policy goals. The 5 prototypes on 2 locations in the major bulb-production regions on sandy soils have bulb-crops only, while 4 prototypes on a location on heavier soils combine bulb and vegetable crops.

Keywords: integrated flowerbulb production, economic evaluation, soil fumigation, tulip, crocus, narcissus, lily, hyacinth, dahlia

Introduction

The international image of the Netherlands is still dominated by the traditional landscape of the Western part of Holland, lying a few metres below sea-level behind dunes and dykes and characterized by windmills, wooden shoes and tulips, which is still the major bulb crop (Table 1).

Table 1. Bulb production in the Netherlands in 1988.

Crops	Area (ha)
tulip	7 100
gladiolus	2 200
lily	2 000
narcissus	1 600
hyacinth	1 000
iris	900
others	1 500
total	16 300

Not only do flowers colour the international image, they represent as well a substantial source of income to thousands of people involved in the production and trade of flowerbulbs and corms that are produced on 3 691 farms. The national production value amounted to NGL 1 200 million in 1988. In addition, the colourful fields during spring are an important tourist attraction.

Since flowers are luxury products, the flowerbulb sector has always been market-oriented. Consumers want flowers of good appearance that can be enjoyed in a vase or in the garden for a long time. So the main objective of the sector is maintenance, or rather expansion, of its share of the international market by producing a wide variety of quality products in large quantities.

Fifty years ago flowerbulb production still was unstable with relatively high production costs. Pests and diseases could easily destroy a crop and with it a huge investment. From 1950 on, better production methods, including the use of pesticides and fertilizers, improved stability. At the same time production costs increased substantially, mainly due to an increase in the price of labour. Consequently, production was intensified and mechanized to reduce labour costs, but with increasing dependence on pesticides. At farm level this resulted in capital-intensive production systems with high yields per hectare meeting high quality standards. Although it brought high profits, it was accompanied by high environmental costs, because of high emissions of pesticides and fertilizers. Around 10% of the use of pesticides in the Netherlands (21 000 t a.i. yr^{-1}) is used in the production of flowerbulbs. This implies a 12 times higher input of pesticides than the overall average input per hectare (10 kg ha^{-1}).

Table 2. The use of pesticides in flowerbulb production.

Type of use	Amount of pesticide $t\ yr^{-1}$	Amount of pesticide $kg\ ha^{-1}$
soil fumigation	1 100	64
soil fungicides	200	14
fungicides/insecticides	500	33
bulb desinfectants	100	6
herbicides	100	6
total	2 000	123

Besides pesticides, large quantities of fertilizers are also being used to obtain the highest possible yields without considering emissions. On top of this, almost without taking into account the amount of nutrients applied with it, organic manure is used to improve the organic-matter content of the soil, to prevent wind erosion and to seal the surface after soil fumigation. As a result, this manure cannot be incorporated into the soil, causing relatively high emissions of ammonia.

Bulb production has gradually shifted or expanded from small, specialized farms on sandy soils to regions with, for bulb crops, less-favourable soil types and to farms with arable or vegetable crops. This type of farming has in general less phytopathological problems because of the wider rotations, but not all bulb crops can be grown on these heavier soil types. Therefore in grassland regions with predominantly dairy farming, sand from lower soil layers has been put on top of the original heavy soils, to improve growth and harvest conditions for flowerbulbs and corms. This means a strong disturbance of the ecosystem of this area with respect to water management and nutrient cycles.

Objectives

Dutch flowerbulb production should remain internationally competitive by providing quality products, produced in an environmentally acceptable way, to meet the growing environmental concern of consumers. At farm level, production systems should become available that provide a reasonable income to the entrepreneurs and durably conserve the biosphere.

To make farmers adopt such production systems, the government has launched long-term policy plans comprising the following elements:

- the use of environmentally hazardous pesticides will be prohibited;
- in the year 2000 the volume of pesticides used has to be reduced by 60% and emissions by 90%;
- emission of ammonia has to be reduced by 70%;
- in 1995 the maximum allowed quantity of nitrogen in the soil at the end of the growing season will be 70 kg ha^{-1}
- in 2000 the maximum P_2O_5 application may not exceed the uptake of the crop.

Farming strategies

At present bulb-farming practices are market-oriented, which has led to high inputs. In most sectors of agriculture an ecosystem-oriented vision is developing, in many aspects opposite to the world-market-oriented vision. It considers agriculture as the management of agro-ecosystems to provide sufficient and sustainable (food) production and is based on responsibility for the biosphere (Vereijken, 1992). In this vision, pesticides are unwanted and should be substituted by an appropriate set of preventive measures. However, ecosystem-oriented flowerbulb production is difficult to achieve. Notably the farm size of the specialized bulb producers is too small to adopt a diversified and sound rotation without losing income, because at the moment only the most profitable crops are grown. The lack of broadly resistant varieties and the lack of experience in growing bulbs without relying on pesticides also makes the ecosystem-oriented production strategy not feasible on short-term. On the long-term, however, when a market is developed with consumers willing to cover the gap between higher production costs and lower yields, extensive bulb-cropping systems based on organic manure and without most pesticides might be developed on grassland farms or ecological arable farms.

The economic benefit of lowering the pesticide inputs in bulb production is marginal. Compared with 19 kg a.i. ha^{-1} in arable farming 120 kg a.i. ha^{-1} in bulb production is a very high dosage. However, 340 kg a.i. ha^{-1} on a hyacinth crop represents only 4% of the total production costs, while 10-15 kg a.i. ha^{-1} on winter wheat represents between 26% and 43% of the total costs. Moreover, the economic risks in bulb production are many times higher than in arable farming, which explains why growers rely heavily on 'chemical insurance'. Nevertheless, on a short-term integrated production systems can be developed with much lower inputs of pesticides and losses of minerals. It demands the development of prototype systems based on a consistent set of materials and methods.

Materials and methods

The dependency on pesticides caused by narrow production schemes can be reduced by a combination of wider crop-rotation schemes and green manure crops to cover the soil between harvest and planting. These additional crops are needed to prevent wind erosion (e.g. grasses), to reduce soil pathogens (e.g. *Tagetes* species) (Winoto Suatmadi, 1969) or to restore soil fertility. Another way to reduce the dependency on pesticides is using varieties, which are less susceptible to pests and diseases, and more hygienic measures like the use of pathogen-free planting material (e.g. from tissue culture). Finally, all kinds of measures have to be taken to reduce emissions to the environment, such as better application techniques, reduced dosages, row or furrow treatments and substituting chemical bulb desinfection by hot-water or hot-air treatments and soil fumigation by soil inundation. The losses of minerals can be minimized by accurate dosage based on available reserves of nutrients and specific needs of the crop. In the case of nitrogen, split-dosage methods can be applied based on repeated monitoring of soil and crop reserves. The use of organic manure, which can cause high emissions of nutrients, will also be reduced. Compost, with a much lower risk of emission of nutrients, will be used as an alternative source of organic matter.

Currently, three experimental farms have just started to develop and evaluate prototype integrated bulb-production systems. On sandy soils in the original bulb production regions, two farms have been started to produce bulbs according to integrated principles. One of these farms is located at Sint-Maartensbrug, 40 km north of Amsterdam. Here tulip, narcissus, lily and crocus are grown under two different systems: a so-called 'applicable' system and an 'advanced' system. In the applicable system, all available cultivation methods and techniques will be applied to reach the objectives of integrated farming on the short term. The advanced system is aimed at the policy goals set for the year 2000. New components that are not yet fully developed will be tested here. As a consequence, the risks involved in this system will be higher than those for the applicable system.

The farm at Sint-Maartenbrug is divided into four main fields with one crop per field (Figure 1). Each field is divided into two parts, one for each system, and in each system, two different varieties are being tested. The rotation scheme is especially aimed at prevention of soil pathogens. Tulips are grown after lilies that clear the field late in the season. Then, because of the lower temperatures, virus transmission by nematodes is reduced and diseases like *Rhizoctonia* will be prevented from infesting the new crop. After the harvest of the tulips, the field will be inundated for six weeks. Narcissus, which is less susceptible to soil pathogens like *Pythium* species, is planted after inundation; it is followed by crocus, an early lifted crop. In the 9 months thereafter, *Tagetes patula* will be grown to control free-living nematodes,

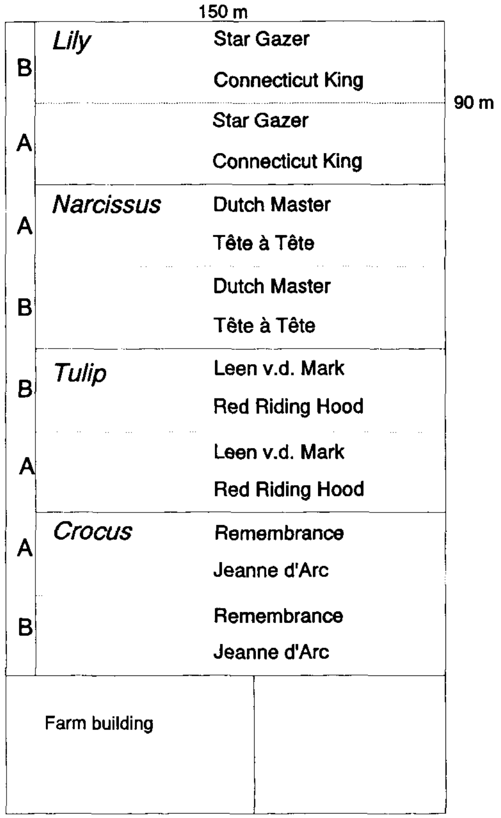

Fig. 1. Layout of the experimental farm at Sint-Maartensbrug in 1991, aimed at the development of bulb production systems for the short- and long-term ('A' = applicable and 'B' = advanced).

like *Pratylenchus penetrans*, before a new rotation of lilies is started. On this farm, emissions and emission routes will be monitored intensively to obtain parameters for emission models. These models are used to test whether the objecxtives of the Multy-Year Crop Protection Plan can be met.

At Hillegom, the second experimental farm on sandy soils, an 'applicable' and an 'advanced' prototype system will be developed and tested with tulips, narcissus, hyacinths and dahlias. The objectives of these systems are the same as for the farm in Sint-Maartensbrug. A third prototype system, a socalled 'futuristic' system, has objectives that go even further. In this system, which will start in 1992, pesticides will be substituted almost completely. Only when extremely high crop losses or high quality losses are foreseen will it be permitted to use pesticides. Apart from a different crop rotation, one of the methods to achieve this is by a strict separation of the production of planting material and saleable bulbs. In normal production schemes, bulbs are sorted after harvest and the largest bulbs are sold to produce flowers. The smaller bulbs become the planting material for the next year. From a phytopathological point of view this situation can lead to infestations of different kinds of diseases which make it necessary to desinfect the planting material. By using (almost) disease-free planting material, grown under controlled conditions from disease-free tissue-culture material, the outdoor crop will start off comparatively clean, which reduces the need to use pesticides.

The last farm to be described here is located at Zwaagdijk, on a relatively heavy soil type where four prototypes with rotations including bulb, vegetable and arable crops are being investigated. These prototypes are:

- *intensive vegetable growing:* cauliflower every second year alternated with potato, carrot and onion;
- *intensive vegetable growing with bulb crops:* cauliflower (2 ×), carrot, potato, tulip and iris;
- *less intensive (vegetable growing:* cauliflower (2 ×), carrot, potato, tulip and grass;
- less intensive vegetable growing with arable crops: cauliflower, winter wheat, carrot, grass (1 ×), tulip and potato.

Initial results

Because the first farms in Zwaagdijk and Sint-Maartensbrug were started in 1990 and the farm in Hillegom in 1991, there are no presentable results, yet. The first year has been used as as bridge between the old rotation and the planned rotation for the experiments, and to overcome organizational problems involved in starting a new farm.

Perspectives

Although it is premature to discuss at present possibilities to introduce and expand an integrated bulb production strategy of which the development started only recently, it becomes clear that there are only few alternatives. The two systems that are being developed and tested on both farms, the applicable and the advanced system, are designed to provide knowledge to cover the period up to the year 2000. By then, bulb production has to be changed dramatically to meet the objectives set by the government. It is possible that only the futuristic system can meet these production standards. This will demand an enormous effort by research and extension services, as well as farmers themselves.

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