Bulbous Flower Production Systems: State of the Art

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Abstract

The Dutch flower bulb industry is highly dynamic. From 1990 to 2003 the number of enterprises was reduced by 33%, farm size increased by 50%. The increase of scale reduced production costs per unit, of which costs of labor are the most important. The demand for environmental protection and improved working conditions also affects the production systems. System Innovation research programs were designed to stimulate new developments. In this context radical changes took place in the bulbous flower production systems, which resulted in cleaner (both environmentally and in working conditions), as well as in more efficient bulb flower production. The use of energy per unit was strongly reduced. Intensive cooperation and exchange between various stakeholders in the industry, research and extension, has contributed to a large extent to these rapid developments.

This paper describes the underlying system component developments and future expectations.

THE DUTCH FLOWER BULB INDUSTRY

In the Dutch flower bulb industry, three main types of primary producers can be distinguished: a) bulb growers, b) growers of both flower bulbs in the field and bulbous flowers in the greenhouse and c) ornamental crop growers who include bulbous flower production in their greenhouse cropping system. The numbers of enterprises of the former two types are approximately equal, but cropped area of type-a is almost twice as big as type-b (Wildschut, 2004, unpublished data). The number of type-c enterprises is substantial, but not exactly known.

Apart from primary producers, of which most are members of horticultural organizations, the industry consists of various stakeholders such as suppliers of inputs, machineries, automated systems, etc., of exporters and trading companies and of privatised research and extension services.

DEVELOPMENTS IN THE INDUSTRY

Since 1990, some drastic changes took place: the total flower bulb production area increased by 50% (from 16,000 ha to 24,000 ha), whereas the number of flower bulb producers decreased by 33% (CBS, 2004). Hence, the average farm size more than doubled. Particularly the lily, special bulbs (which includes *Zantedeschia*) and tulip area increased (105%, 59% and 51%, respectively). For some crops, however, the total area was reduced (iris and gladiolus with 26% and 37%, respectively).

The total production of bulbous flowers increased as well, e.g. the total number of forced tulips increased from 650 million in 1990 to 1,250 million in 2003 (an 87% increase), of which 78% is produced on the 35% larger farms (CBS, 2004).

This increase of scale holds for all three main types of primary producers. Differences are that type-b enterprises, growers of both flower bulbs and bulbous flowers, tend to specialize on fewer crops (and in addition force a higher percentage of their bulbs at the farm), whereas type-a and type-c enterprises tend to increase production variety.

The main factor underlying the increase of scale is the reduction in production costs per unit, of which the costs of labor are highest. An average crop budget analysis for the forcing of tulips shows the costs of labor to account for almost 45%, directly followed by the costs of bulbs (almost 40%). Costs of greenhouse construction and machinery are around 10%, whereas costs for energy (electricity for cold storage, machinery, etc. and natural gas for greenhouse heating) account for 4-5% (data from Van Rijssel and Snoek, 2003). Costs for fertilizers and pesticides account for 2-3% only. Production scale and type of forcing system strongly reduce the costs of labor per unit.

SYSTEM INNOVATIONS

Another factor affecting bulb and bulbous flower production systems is the demand of the society to protect the environment, e.g. to reduce the use of fossil fuels and emissions of CO_2, nutrients and pesticides, as well as to improve working conditions.

The government of the Netherlands, through the Ministry of Agriculture, stimulates the development of technical and/or organizational innovations which realize both environmental protection and improved working conditions, while maintaining or improving production profitability. Such innovations are defined as Systems Innovations and are subject to various research programs.

In the context of the developments mentioned above, radical changes took place in the bulbous flower production systems, which resulted in cleaner (both environmentally and in working conditions), as well as in more efficient bulb flower production. The use of energy per unit was strongly reduced. In addition, in some systems the emission of pesticides and nutrients is reduced to near zero. Intensive cooperation and exchange between various stakeholders in the industry, research and extension, has contributed to a large extent to these rapid developments, which are summarized in Table 1.

SYSTEM AND COMPONENT DEVELOPMENTS

Underlying system and component developments are:

- An increased efficiency of the greenhouse area use through improved internal logistics such as automated transport of containers or tablets. Earlier, bulbs were forced in topsoil or in boxes with potting soil on fixed tables and the effective greenhouse area was around 65%. The introduction of mobile systems allowed filling the greenhouse up to above 90%, while planting and harvesting is done in a separate working place. Thus, energy use per unit is reduced.
- The most outstanding development is bulb forcing on water, which is rightfully considered as a perfect example of a System Innovation as defined above. Forcing in water allows for a 1.5-2°C lower greenhouse temperature, avoids soil- and bulb-treatment with pesticides and allows for a more efficient use of space in the cold storage rooms. In this system, the cold treatment can be done with dry bulbs in pallet boxes, whereas the use of boxes with potting soil requires much more space.
  Energy use, the use and emission of pesticides, the degradation of natural peat areas and production costs are reduced.
- A most promising type of forcing on water is the ebb/flow system. It allows for the recycling of water and nutrients, combined with UV-disinfection of the water. It also improves the control of the water temperature, EC and pH. In addition, the quality of the product is better than for normal forcing on water, and it offers the possibility to integrate other ornamental crops in the greenhouse production system.
- A reduced greenhouse production cycle, e.g. for tulips from ± 50 days in topsoil cultivation, through 25-30 days in trays to 25-15 days in water. Multi-storey pre-forcing (allowing some sprouting in the rooting room) reduces the greenhouse production cycle even further. Again, energy use per unit is reduced, whereas investments are used more efficiently.
- Through the separation of cold storage and rooting in different sections of the farm, the efficiency of the use of installations, space and energy is increased.
- Improved working conditions through cleaner circumstances by avoiding the use of potting soil and a reduced weight of trays (4 kg/tray in the ebb/flow system against 20 kg/box if potting soil is used).

- An increased flexibility regarding planting period of bulbs. Forcing on top soil or in boxes with potting soil requires all bulbs to be planted at the beginning of the season. For forcing on water, bulbs are planted only a short time (less than 3 weeks) before the greenhouse cycle starts, after which rooting has to start immediately in order to avoid damage from injures caused by the pin trays. The trays used in the ebb/flow system do not injure the bulbs, and therefore it is not imperative to start the rooting period immediately, thus allowing more flexibility in planting period.
- An increased use of computerized systems for optimum timing of operations, temperature integration, fertigation and internal logistics.
- Increased mechanization/robotization of the production cycle, e.g. planting machines, flower-processing lines and bunch binding machines. The increase of scale makes such investments easier.
- An increased application of energy saving measures such as improved isolation of the heating system and the greenhouse. Various potential energy saving measures exist. The extension service uses a list of more than 80 alternatives to save energy in the greenhouse or other units of the farm. Most popular measures are registration/monitoring, isolation including the use of energy screens, and improved and more frequent maintenance of installations (Wildschut, 2004b, unpublished data).

Some of these developments are taking place especially, or exclusively, in tulip production, e.g. in the last 5-6 years the number of tulips forced on water increased from 0% to 50%. Other flower bulbs (hyacinths, iris, and maybe lily) probably will follow.

FUTURE EXPECTATIONS

Based on the current trends expected future developments are:

- Further increase of the effective greenhouse area from 90% up to 180% and above (Multi-Storey Cropping), which improves energy-efficiency of the greenhouse.
- On the farm possibly a further separation in different sections based on the different flower bulb treatments, growth stages, light requirements, etc. However, on some aspects such a differentiation might develop between farms/enterprizes as well.
- Increased and improved robotics and mechatronics, including image processing and vision systems, which improves internal logistics, quality control and production planning and reduces the costs of labor.
- The application of the principle of using the greenhouse as a net source of energy (storing the summer excess heat in aquifers and make it available in the winter through the use of heat pumps).

Literature Cited

CBS 2004. http://statline.cbs.nl
Van Rijssel, E. and Snoek, A.J. 2003. Kostprijs en energieverbruik bij tulpenbroei.

Tables

Table 1. Summary of bulb forcing system and component developments and realized improvements.

Systems and components	Realized improvements					
	Capital efficiency	Cost of labor	Labor conditions and flexibility	Reduced use of energy/ CO_2 emission	Reduced nutrient use/ emission	Reduced pesticide use
Water forcing*	X	X	X	X		X
Ebb/flow*	X	X	X	X	X	X
Greenhouse area (up to > 90%)	X			X		
Greenhouse cycle reduction	X			X		
Differentiation cooling, rooting and sprouting	X			X		
Computers, mechanization, robots and mobile systems	X	X	X	X		

* In addition, these systems avoid the degradation of natural peat areas