Development of gladioli and lilies for local and export markets

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Introduction

The commercial production of flowers was introduced in Kenya in the late 1960s and early 1970s. The industry has registered tremendous growth and is increasingly gaining importance as a foreign exchange earner due to heavy investment from the private sector and the favourable business atmosphere provided by the public sector (Mutui, 1999).

The total area under cut flower production in Kenya is about 20,000 ha. Flower production contributes 40% of all horticultural production. Kenya is an important cut flower exporter to the flower auction markets in Europe and is one of the largest exporters in the world alongside Israel, Ecuador, Belgium, Denmark, France, Italy, Colombia, Spain, and the USA.

High cost of inputs like plastic sheets, green houses, shade netting, fertigation facilities, soil fumigation, hydroponics, tissue-culture laboratories, soil testing, cold rooms, borehole drilling and maintenance, water reservoirs, labour, housing and welfare have discouraged prospective investment in the production of high value flowers.

However, most potential flower growers will not usually change the choice of crop since low prices in one season do not necessarily imply that this will always happen. Flower growers have learnt to stagger their production to bring the flowers to the market during festivals such as Valentines Day, Easter and Christmas when prices are high.

Among the areas that produce high volumes of cut flowers are Naivasha, Trans-Nzoia, Uasin Gishu, Kericho and Laikipia in Rift Valley Province; Kiambu, Thika, North and South Kinangop, Nyeri, and Murang a in Central Province; Athi River and Embu in Eastern Province and Karen in Nairobi. Most of the flower farms

Gladioli and lilies
in these areas are either large-scale (more than 10 ha) or medium-scale (1-10 ha) except South and North Kinangop which have small-scale (0.1-1 ha) farms while Kiambu and Nairobi have both medium- and small-scale farms. The small- and medium-scale farms contribute 20% of all the flowers produced.

**Small-scale production of cut flowers**

Flowers have for a long time been commercially grown on large-scale farms. That is now changing with small-scale farmers becoming commercial producers of substantial amounts of flowers for export (KARI, 1999). On the average, small-scale growers produce flowers on farms of 0.1 ha. They grow mainly open-field flowers for sale through middlemen who supply them with planting material and information on suitable time of production, marketing and market demands. Often, the information on production is inadequate leading to low quality flowers. Labour is usually provided by family members particularly women and children. Middlemen pay low farm gate prices, at times below the cost of production, making the farmers earnings low (Mutui, 1999). Most small-scale farmers depend on rainfall or farm along rivers for irrigation.

Some of the problems faced by small- and medium-scale growers include low quality seed, poor roads, access to information on market demands, lack of storage facilities, grading sheds, electricity generators, telecommunication facilities including phone/fax and vehicles (Malik and Njenga, 1991).

**Research on small-scale production of flowers**

In 1978, a small-scale floriculture research for development project was initiated at KARI Tigoni with support from UNDP/FAO. The project aimed at introducing varieties from Holland, Israel, Hawaii and West Germany and developing propagation
techniques for carnations and chrysanthemums. The United States Agency for International Development (USAID) continued support for the project through the Mid-American Consortium (MIAC) between 1993 and 1997 and the Agribusiness Development Support Programme (ADSP) between 1998 and 2003. The main focus was on rapid multiplication techniques, introduction and evaluation of varieties, on-farm trials, release of new varieties and postharvest handling. Introduced varieties included those for carnations, roses, orchids, lilies, gladioli, alstroemeria, freesia, lisianthus, gerbera and ornithogalum (Malik and Njenga, 1991).

A countrywide survey conducted by KARI in 1991 in collaboration with the Horticultural Crops Development Authority (HCDA) and the Ministry of Agriculture (MoA) found that the main flowers grown by small- and medium-scale growers included alstroemeria, molucella, delphinium, statice, calla lily, birds of paradise, gypsophilla, anthurium and jatropha. However, due to production and logistical problems, alternative introductions of new flower cultivars was considered with gladioli and lilies having the most potential for production and marketing by smallholders (HCDA, 2000).

**Gladioli**

Gladioli is grown throughout Africa and the Mediterranean region with the greatest concentration in southern Africa. Two species are endemic to Madagascar and 15 grow in countries bordering the Mediterranean. The genus is represented by 180 species. Modern hybrids designated as *Gladiolus g randiflorus* are a complex of at least 11 species. Gladioli grows from a corm which is planted for commercial cut flower, propagated from cormels (daughter corms).
Fig 1-Gladiolus

Gladioli is an important export cut flower (Figure 1). It is grown commercially in Israel, Iran and India. In Africa, Egypt has been growing it for a long time and recently other countries including Zimbabwe have started production. Gladioli is gaining popularity with small-scale farmers in Kenya, especially after KARI introduced new varieties.

Of the 9 varieties introduced into Kenya by KARI, only 6 cultivars; E-106, Pink Majesty, T-200, T-519, T-704 and T-402, were recommended to the growers for multiplication (Table 1).

Table 1. Characteristics of gladioli promoted by KARI

<table>
<thead>
<tr>
<th></th>
<th>Flower colour</th>
<th>Days to flowering</th>
<th>Tolerance to rust and Fusarium corm rot</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-200</td>
<td>White</td>
<td>65</td>
<td>Resistant</td>
</tr>
<tr>
<td>E-106</td>
<td>Red</td>
<td>75</td>
<td>Resistant</td>
</tr>
<tr>
<td>T-519</td>
<td>Pink</td>
<td>75</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Pink Majesty</td>
<td>Pink</td>
<td>75</td>
<td>Susceptible</td>
</tr>
<tr>
<td>T-704</td>
<td>Mauve</td>
<td>75</td>
<td>Highly susceptible</td>
</tr>
<tr>
<td>T-402</td>
<td>Yellow</td>
<td>85</td>
<td>Highly susceptible</td>
</tr>
</tbody>
</table>
The demand for gladioli in the local market has steadily increased. It is, however, important that growers plant at different times of the year in order to avoid flooding the local market and to target specific markets. Late maturing variety T-402 should be planted on 15th of every month and harvested between 10th and 15th of the 4th month while medium maturing varieties E-106, T-519, T-704 and T-315 should be planted on 25th of every month and harvested between 10th and 15th of the 3rd month. Similarly, early maturing varieties T-200 and T-713 should be planted on 5th of every month and harvested between 10th and 15th of the 2nd month.

Between 1992 and 2001, 44 on-farm trials and demonstrations were conducted using recommended varieties in Athi River, Karen, Juja, Thika, Muranga, Embu, Kikuyu, Redhill, Tigoni, Ngecha, Mai Mahiu and Lari (Muthoka, 2002). From these studies, KARI has developed production technologies such as treatment of corms and cormels using recommended fungicides such as Benlate and the use of warm (30° C) water for control of Fusarium corm rot, production of cut flowers using black polyethylene mulch, and high density planting of corms per square metre (70 instead of 50). Other technologies include breaking dormancy using chemicals such as gibberellic acid, weed control by use of herbicides, spacing, fertilisation and seed corm production.

**Suitable production areas**

Gladioli grow well at 18-28°C temperatures with adequate full day light throughout the year. Cool temperatures during the day and lack of full sunshine inhibits flowering. Based on evaluation trials conducted by KARI, several areas in Limuru, Nairobi, Thika, Murang’a and Embu are suitable for gladioli flower production. The crop can also be grown in other areas with similar climate.
Seed multiplication

To maintain varietal purity, the seed fields should be isolated from all other fields of the plant by at least 100 m to prevent seed contamination.

Gladioli corms are propagated from cormels (Figure 2) which are graded into 3 sizes: large [more than one centimetre in diameter]; medium [0.6-1.0 cm] and small [less than 0.6 cm]. Most commercial growers use large cormels for production of corms. Corms from 1.3-2.5 cm are called planting stock and are used for the production of commercial size corms which have a diameter of more than 2.5 cm.

The following cultural practices should be followed when planting flowers.

- Plant-space the seed at 20 x 10 cm
- Apply well-decomposed farmyard manure at 10 kg m⁻² or 60 kg P₂O₅ t ha⁻¹ at planting
- Apply 50 g m⁻² DAP or NPK 17:17:17 at planting
- Topdress with 20 g m\(^{-2}\) of NPK 17:17:17: or NPK 20:10:10 or CAN every 2 weeks
- Foliar feed spray for minor elements after the 4th week from planting at 2-week intervals (before flowering)

The soil should be kept moist for 10-12 days. The seed field should be watered at 2-week intervals. Irrigation must be stopped 2 weeks before lifting the corms. Mulching with black polythene (300-400 gauge) enhances growth and suppresses weeds. (Figure 3)

Wires should be used to support the plants to grow upright (figure 4). The wires should be put in place 2 weeks after planting. The 1st wire support should be 30 cm from the ground while the 2nd should be 60 cm from the ground. Bamboo sticks should then be placed on wires across the bed between the plants.

*Gladioli and lilies*
Diseases and pest control

The main diseases are leaf or brown rust (Figure 5) and Fusarium corm rot while the major pests are thrips, cut worms, aphids, mites, semi-loopers, gladioli fly, and nematodes. These can be avoided by planting certified material and roguing plants affected by Fusarium. Otherwise, apply Furadan granules on planting beds and mix with soil then dip corms in Benlate/Captan solution just before planting. Thereafter, proceed as follows:

<table>
<thead>
<tr>
<th>Week</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 2</td>
<td>Drench soil with Farmuron (herbicide)</td>
</tr>
<tr>
<td>Week 4</td>
<td>Spray Nimrod, Thioflo</td>
</tr>
<tr>
<td>Week 6</td>
<td>Spray Baycor, Bestoc drench, Furadan</td>
</tr>
<tr>
<td>Week 8</td>
<td>Spray Nimrod, Actellic</td>
</tr>
<tr>
<td>Week 10</td>
<td>Spray Baycor, Thioflo</td>
</tr>
<tr>
<td>Week 12</td>
<td>Spray Nimrod, Bestoc drench</td>
</tr>
<tr>
<td>Week 14</td>
<td>Spray Benlate, Actellic</td>
</tr>
</tbody>
</table>

Fig 4-Training gladiolus

8-10 inch clearance between wire and ground

Bamboo sticks
Volunteers are a major problem, so ensure a good crop protection programme is followed to avoid build-up of pests and diseases.

**Harvesting and postharvest handling**

The right stage of cutting flower spikes is as soon as the basal florets start showing colour (Figure 6). For the local market, flowers are cut when the 1st floret is open. The spikes are cut just above 2 pairs of leaves at the base of the plant. As soon as the spikes are cut, they must be put in shade in a bucket containing water and later in cold storage at 4°C in an upright position. For long distance transportation, an earlier harvest stage is recommended.

After harvest, corms and cormels should be treated with fungicide diluted in warm water before being stored. The corms are then chilled for 6 weeks at 2-4°C to break dormancy.
Grading and bunching

Gladioli, like most spike-type flowers, are very sensitive to gravity and will grow away from the ground, particularly in warm temperatures. This can result in permanent deformation of the upper part of the spike and reduction of flower quality. Gladioli should be held upright during all postharvest procedures to avoid this effect.

Quality factors of gladioli include stem straightness and strength, length of the stem (spikes), number of florets, damage, disease damage and maturity. The stems are bunched by colour or variety in groups of 10 and each bunch is wrapped with a rubber band at the base.

The 1st grade florets are more than 100 cm long with more than 15 florets and are the most preferred by florists, followed by the 80-100 cm long (2nd grade) with 10-14 florets and the 70-80 cm long (3rd grade) with 7-9 florets.

The yield is 80-90% saleable spikes of total corms planted (40-45)
Shelf-life

Gladioli respond well to vase solutions containing sugar. The optimum method for applying a sugar pulse is to hold flowers overnight at 21°C in a preservative solution containing 20% sugar. The preferred biocide for pulsing gladioli is 200 ppm 8-Hydroxyquinoline citrate.

Gladioli are very sensitive to fluoride in water (as little as one ppm), therefore tap water should not be used to prepare vase solutions for arrangements where water is fluoridated. Symptoms of fluoride effects are deterioration of the petal margin (bleaching, water soaking, then necrosis), failure of florets to open and develop normally, burning of the floret sheath and marginal leaf scorch.

Packing

Because of their response to gravity, gladioli are traditionally packed in tall glass containers clearly marked for upright stacking. Since the advent of pre-cooling, some shippers pack gladioli in normal flower boxes each containing 300-400 flower stems depending on the grade. After packing the flowers, the boxes are stored at a refrigerated temperature of 2°C before shipment.
Lilies

Lilies have pleasant characteristics such as; scent, petal arrangement, leaf colour and high yield per unit area. They rank 4th in the Dutch flower auction (Malik and Gachukia, 2000).

Lilies are grown for cut flowers that are used during various festivities. In the USA, about 10 million bulbs of *Lilium longiflorum* cultivars are grown as pot plants such that they flower during Easter, hence the name Easter lilies. Easter lilies have white funnel-shaped flowers that face outward. Asiatic and Oriental hybrids have flowers which face outward and have different colours. The Oriental hybrids have longer and strongly fragrant flowers and larger leaves than those of Asiatic hybrids (Figure 7). The Oriental hybrids take longer to flower followed by Easter lilies and Asiatic hybrids (Malik and Njenga, 1999).

The 1st lilies to be introduced by KARI were the 2 varieties of Easter Lily – Osnat (Snow Queen) and Magie Blanche – in October 1994 from Holland through the assistance of United States Agency for International Development/mid-American Consortium (USAID/MIAC). They were evaluated at KARI Tigoni and KARI Thika in the open and under a 50% shade net. The 2

![Fig 7-Oriental hybrid, Delhi](image-url)
varieties produced marketable flowers (more than 60 cm long stems) for both local and export markets under a 50% shade net. The bulbs planted in the open without the shade net produced shorter stems (less than 60 cm).

In 1995, 8 on-farm trials were carried out to determine the optimal light intensity required to achieve the sufficient stem length of lilies. On average, the results indicated that at Tigoni, 50% light intensity net shade produced more 60-70 cm long stems in comparison to Thika which produced the same results at 60% net shade. In 1997, KARI-USAID/MIAC imported Easter lilies (White Fox and Snow Queen) from Holland, Asiatic Hybrid lilies (Romano, Appendon, Brunello, Adelina, Compass, Alaska, Prato, Connecticut King and Menton) and Oriental hybrid lilies (Tiber, Primero, Montana, Olympic Star, Stargazer, Montreal and Siberia). They were evaluated in 21 on-farm trials at Athi River, Karen, Kiambu, Tigoni, Lari, North Kinangop, Njabini, Thika and Muranga (Muthoka, 2002). Snow Queen, Prato, Brunello, Romano and Adelina and, Siberia, Tiber, Montreal, Stargazer, and Primero performed well and are recommended for commercial production.

**Cultural practices**

Lilies are grown from bulbs of diameters ranging between 9 and 22 cm. Bulbs of 12-16 cm are, however, recommended for commercial cut flower production. Smaller bulbs produce few flower buds per stem and have shorter stems. These bulbs are exposed to a cold moist treatment at 2°C for at least 45 days in the case of Easter lilies and 60 days for Asiatic and Oriental hybrids in order to break dormancy. The bulbs must be planted (Figure 8) immediately they are removed from the cold storage. Should the planting be delayed, the bulbs should be stored at 0-2°C for not more than 10 days after which they begin to sprout (Malik and Gachukia, 2000).

*Gladioli and lilies*
Lilies also grow best under 30-80% shade net environments. Some growers place a polythene sheet on the net to increase humidity. This also protects the crop from storms and frosts and catalyses maturity. Lilies grow best in well-drained loam or sandy loam-soils. Heavy loam and clay soils are not suitable.

Lilies are usually grown on raised beds, and water is supplied using drip or mist irrigation. The raised beds (one meter wide and 10-15 cm high) are prepared by mixing 10 kg of well decomposed organic manure and NPK 17:17:17: at 50 g m\(^{-2}\) with the soil. The soil should be disinfected before planting to avoid soil-borne diseases and pests. A spacing of 15 cm between rows and 10 cm between bulbs is recommended giving a planting density of 60 m\(^{-2}\). The bulbs are dipped in Benlate in 30°C water or copper-based fungicide such as Kocide and Nordox cuprivate for 30 min just before planting in slightly moist soils. Beds should be watered thoroughly after planting and the soil kept moist, but not wet until flower harvesting. Topdressing with CAN at 10 g m\(^{-2}\) alternating with potassium nitrate at 10 g m\(^{-2}\) should start after 3 weeks of planting when plants begin to germinate (shoot growth). Topdressing should continue at 2-week intervals until the flowering stage. Foliar feeding with micronutrients is recommended at weekly intervals after the 4th week of planting.

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Diseases and pest control

Botrytis (disease causing fungi) and root rot rot cause economic damage to lilies. In order to control these diseases, chemical application of Rovral and Benlate are recommended for botrytis while Kocide drench and a dip of Benlate are recommended for controlling bulb rot. Aphids are major insect pests of lilies. Aphids can be controlled using contact and systemic pesticides applied at weekly intervals or when the pests are noticed (Malik and Gachukia, 2000).

Multiplication of lilies

Lilium bulbs are multiplied through bulblets, scales or tissue culture micropropagation (Figure 9). Bulblets are formed at the base of the stem during the growing stage together with development of roots and small initial leaves. At the time of lifting mature bulbs, the bulblets are separated from the parent plants, mixed with moist sawdust, kept in cold storage for 45 days (for Asiatic hybrids) and 60 days (for Easter and Oriental hybrids) before transplanting. Scales can also be used for multiplication using the same method. The scales are removed from the 2 outer layers of the bulbs and planted in the soil or in other media for 6 months. The bulblets produced are then stored at 2-4°C for 6-8 weeks after which they are replanted. After 6 months in the field the bulblets will have attained commercial bulb size (Malik and Gachukia, 2000).

Harvesting and postharvest handling

The flowers should be harvested as soon as the 1st flower bud has fully developed colour but has not yet opened. Lilies have a long vase life, especially if pre-treated with STS (silver thiosulphate) complex of silver to reduce the effect of ethylene. Buds will open well when placed in a sugar 8-Hydroxyquinoline citrate preservative solution. Premature yellowing of the foliage,
How to divide Lily Bulbs

Divide into four Bulbs.

Fig 9-Multiplication of lilium bulbs and lily scales

Lily Bulblets.

Scales
which is often a problem with Lilies can be controlled by pre-treatment with a gibberellic acid pulse. Tight-bud stage flowers take some time to open, and petals of open flowers are likely to be damaged during transport. At harvest, the flower stems are placed in a bucket containing water to maintain freshness (Nowark and Rudnick, 1990).

**Grading and bunching**

After harvesting, stems are graded according to the number of flower buds per stem. Depending on varieties, number of flowers will range from 2-8 in hybrids, 2-9 for Asiatics, 1-4 for Orientals. Length and firmness of stems, foliage and flower bud abnormalities will also depend on the variety. The Lily stems are then bunched and during the process, 10 cm of foliage is removed from the bottom of the stem.

Defoliating enhances presentation and also increases the vase-life as less water pollution will occur. After bunching, stems are cut if lilies are to be placed in water. Wrapping, the final stage, is then carried out. The wrap used for lilies should protect both the flower buds and the foliage. If it is not possible to grade and bunch lilies immediately after harvesting, place them in cold storage in clean water; for Asiatic hybrids a pre-treatment agent can be added to the water (Nowark, and Rudnick, 1990).

**Storage**

The optimum storage temperature of cut lilies is 2-3°C and storage time should be as short as possible. The oriental hybrid Stargazer will show brown spots on the outside of the petals if harvested at a greenhouse temperature of 30°C or higher and subsequently refrigerated. In these conditions, it is advisable to store at a slightly higher temperature of at least 4°C.
Commercialisation of gladioli and lilies

In an effort to commercialise lily production, KARI has supported the small-scale growers by importing planting material from Holland and make a follow up at farm level to ensure that farmers are able to grow and manage the crops on their own. By the end of 2002, there were 22 Lilium farmers and more than 25 Gladioli growers supported by KARI.

KARI in collaboration with MOA and other stakeholders work with farmers to ensure that appropriate technology is transferred through publications, field days, on-farm trials, demonstrations, participation in Agricultural Society of Kenya (ASK) shows, seminars, workshops and farm visits. In 2000 KARI-USAID/ADSP encouraged and assisted 19 farmers through farmers groups, as individual farmers and commercial growers to import 36,000 bulbs of lilies from Holland for commercialisation.

Way forward

The demand for lilies and Gladioli in the local market has been rising since 2000. Availability of seed to growers has, however, remained a limiting factor since the material has to be imported. The cost of importation is high due to the airfreight charges. KARI is therefore planning to develop local varieties and propagation methods to enable farmers acquire the bulbs locally. Basic seeds of flowers with market demand could be multiplied and distributed by KARI. The major constraint, however, is the regular provision of information on the varieties in demand in both local and overseas markets to enable the research centres at Tigoni, Embu and Thika to fully support the growers.
In the last 4 years, the international auction markets have received many supplies of lilies from other growers overseas with better advantages in transport and other handling costs than Kenyan producers have. Lilies are bulky and thus occupy a large space, hence increasing the freight cost. Lilies are doing well in the local market but there is often an over supply due to limited local demand which can only absorb about 1000 stems per day. Since payment of royalties increases the cost of locally produced flowers in export market, breeding of local varieties will reduce the costs. Small-scale farmers are not members of recognised flower organisations like the Kenya Flower Council (KFC) and the Fresh Produce Association of Kenya (FPEAK) and others who have laid-down protocols such as usage of chemicals and working conditions to be followed in production and export (see lists in Anon 2003). The associations give farmers a logo of recognition that adds value and acceptability in the export markets. Lilies export value increased to KES 12,183,601 (188%) in the year 2001 from KES 4,229,537 in 2000. The increase is attributed to increase of small variety export to auctions.

Gladioli are pre-dominantly for the local market and there is no data showing the value of this in the export market. Given the limited market absorption capacity of this flower locally, oversupply will always reduce the prices, but staggering the production can reduce the problem.

In order to offer a variety of colours to the market, KARI will breed diversified colours that perform well in the farmers’ fields and on the market. Currently, the standard varieties available to small-scale farmers are heavy, hence high freight cost. The varieties are also old with low demand in the export market. Light and royalty-free varieties demanded in export market will be bred and availed to small-scale farmers. For the local market, farmers should plan well so that they can produce during

Gladioli and lilies
the dry season when prices are high to avoid glut after rains. Postharvest handling techniques should be availed to farmers to reduce losses during marketing.

Geotropism in case of gladioli is a problem and needs a special packaging material. The leaves of lilies are very sensitive to ethylene and micro-bacteria build up and hence appropriate temperature and moisture conditions in transporting facilities should be enforced.

Acknowledgement

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References


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The KARI Technical Note Series was launched to provide an outlet for the enormous amounts of technical work generated by KARI, some of it dating many years back, that has not been published in any of the Institute’s existing publications that include the East African Agricultural and Forestry Journal, the KARI Annual Report, the Highlighter and the KARI Updates. The articles may be on completed or on-going work. The series carries advisory technical information intended to benefit various stakeholders on research findings generated by the Institute. Contribution to the series is limited to KARI staff and collaborators. Manuscripts should be submitted to the Publications Unit, KARI Headquarters, PO Box 57811 00200, City Square, Nairobi.