



Grower Summary

PO BOF 002a

The National Cut Flower Trials
Centre Programme for 2013 -
2017

Final 2018

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Project number: PO/BOF 002a

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Second Annual Report (2014)
Third Annual Report (2015)
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Date project commenced: 01 January 2013

**Date project completed
(or expected completion date):** 28 February 2018

Grower Summary

Headline

- Fillers such as ammi, anethum, bupleurum and ornamental carrot are in demand and relatively easy to grow, but excessive vigour needs to be kept in check.
- Gomphrena is prolific, with red, pink and white flower spikes, the possibility of once-over cropping and good potential as a filler.
- Asclepias and echinacea cultivars are novel and attractive cut-flowers for the UK, but vase-life (VL) issues need to be addressed.
- Ornamental grasses generate much interest for use in fashionable mixed bouquets (*Panicum elegans* 'Sprinkles' and *P. miliaceum* 'Violaceum' are among the best).
- Scabious shows great promise for cut flower production in the UK, in tunnels and outdoors; modern cultivars have a good range of colours, high yields, good VL and potential for use in mixed bouquets.
- Craspedia is an unusual product with high yields of yellow, globe-shaped flowers on long, strong stems, with potential as fresh or dried flowers and as a filler in bouquets.
- Older cultivars of alstroemeria perform well as a natural-season tunnel crop; with several cultivars in tunnels and outside beds, high yields are obtained over a five-month period.
- Growing in a permanent tunnel or under cold glass, *Aster ericoides* produces two flushes in a year using blackout covers to advance flower initiation.
- As a high-quality crop in tunnels, newer cultivars of ornamental brassicas offer an alternative to the familiar 'Crane' series.
- Box-grown lilies in tunnels grow as well in peat mixed with up to 60% of anaerobic digestate, as they do in plain peat, and also grow well in 100% coir or coir and peat mixes.

Background

The UK had a relatively low *per capita* consumption of cut flowers compared with other

western European countries, but between 1988 and 2016 its imports of cut flowers rose from some £122m to about £750m. This change in consumer spending, combined with the advent of relatively cheap ‘Spanish tunnels’ and environmental demands to cut ‘air miles’, should have provided cut flower growers with opportunities to expand production. That this did not happen is generally ascribed to (1) a lack of ‘know-how’ and (2) a culture of buying in from ‘across the water’. However, Brexit may now provide greater opportunities for UK growers, as has been seen in the short-term advantage created by the changes in the sterling exchange rate against both dollar and euro.

A national cut flower trials centre (CFC) was proposed by industry representatives and subsequently funded by the HDC (now AHDB Horticulture)¹, starting in 2007. Its short-term aim was to provide information on new product development, novel or alternative cut flowers for production outdoors or in tunnels in the UK. The longer-term strategy was to encourage the cut flower industry to develop new products and markets. Funding provided by AHDB Horticulture has since enabled the CFC to enhance its role by taking on a ‘crop association’ role, including developing a voice for the R&D needs of the sector, extending its work beyond new product development to the facilitation of trials on mainstream cut flower crops.

Summary of the project and main conclusions

In practical terms, the CFC collates ***crop information***, investigates ***crop introduction*** (new product development) and trials ***crop improvement***.

Crop information

The CFC’s trial work has been underpinned by reviewing the appropriate scientific literature, technical information and websites. Reports on novel cut flower crops and trials, and on the global statistics and trends of cut flower production, were made available separately in 2015 and at the end of the project.

The CFC has continued to develop its role as an information hub and cohesive voice for the

¹ Initially with part-funding from the Lincolnshire Fenlands LEADER+ programme

UK cut flower industry. There have been regular (and well attended) open days, and a series of study days and study tours. The CFC has been successful in developing assets over and above the core AHDB Horticulture-funded project by facilitating and hosting other AHDB Horticulture-funded herbicide trials, undertaking (with input from industry) trials on alternative growing media, integrating with research on fusarium, carrying out surveys of quality issues in column stocks and flower spotting problems in cut sunflower, and developing a standalone AHDB Horticulture-funded project investigating the hydroponic production of cut flowers.

Crop introduction

The bulk of the CFC's practical work has involved new product development, that is the demonstrations and trialling of cut flowers that are novel to, or alternatives for, UK growers. The term 'novel' has been used in a wide sense, to include crops that are new to cut flower growing, new or unfamiliar to UK cut flower growers, and new cultivars that could reinvigorate crops that are established in UK growing. The crops were included in demonstrations and trials on the basis of information from the new crops report and discussion with growers and the CFC's management group. Once trialled, novel crops may be eliminated if unsuitable, or, if suitable, taken on for further trialling. Over the five years of the project some novel crops have been introduced each year, so, inevitably, progressively more is known about those that have been in the project for longer.

Crops with first trials in 2017

- ***Asclepias curassavica*** and *A. incarnata* cultivars were grown in a tunnel and established well, flowering in their first year. *A. curassavica* 'Apollo Orange' produced prolific, attractive, orange-red flowers on long stems, each plant having a strong leader plus five or six smaller but marketable side-shoots. Flowers of *A. incarnata* 'White' turned brown before reaching the picking stage. 'Apollo Orange' showed obvious potential as a novel commercial cut flower for the UK, subject to getting more data on cultivars, VL (including its poor post-harvest water uptake), hardiness and any issues with its sap.
- ***Echinacea purpurea*** and *E.* 'Yellow Cone' grew well in a tunnel and were free of obvious problems, though the flowers were rather late and sparse, sometimes not unexpected

for a seed-raised perennial in its first year. Echinacea showed obvious potential as a UK crop, subject to trials to assess cultivars, VL, scheduling and tunnel/outside growing.

- **Helipterum** (*Rhodanthe chlorocephala* subsp. *rosea*) cultivars grown in a tunnel produced a large flush of flowers, but its stems were weak and short. Four weeks later they produced a second flush, but with thin stems and small flowers. The stems discounted helipterum as a cut flower crop, unless better cut flower cultivars become available.
- **Lobelia** 'Queen Victoria' and *Lobelia siphilitica*, grown in a tunnel produced few marketable flowers in their first year, but grew and flowered well in their second. 'Queen Victoria' produced attractive, bright red flowers on substantial, long stems, with a good VL (10 days). *L. siphilitica* produced striking, bright blue flowers. Both have potential as UK crops, subject to further trials on cultivars, VL, hardiness, longevity and any issues with its sap.
- **Ranunculus** 'Rococo' is a new series being promoted as a cut flower or garden plant. Planted in a tunnel in autumn 2016 they flowered over April to May 2017. They were productive, but the colour range available was limited, and it is not yet clear whether the stems are long enough for a cut flower (this might be affected by its husbandry). More information is needed before these (or other) cultivars are taken forward.

Crops with trials ongoing in 2017

- **Annual dianthus (pinks)** (cultivars of *Dianthus barbatus*) were once a staple cut flower in the UK, but have been reduced to a small area in the south-west. They were included to allow the testing of new cultivars that might reinvigorate the UK crop. (1) At the start of the project (2013) a new series, 'Breanthus', was trialled in a tunnel. Its large flower heads found favour with the industry and made a case for further trials. Six 'Breanthus' cultivars were transplanted to a tunnel in two batches, with half of each batch pinched two weeks later (pinching reduces stem length and weight in vigorous cultivars). The earlier, non-pinched batch produced the best quality and yield, but left *in situ* they did not overwinter well. 'Breanthus' cultivars showed some issues with premature budding and leaf scorch. (2) 'Green Magma', 'Green Trick' and 'Green Wicky' were grown in a tunnel and their novel, bright green

flower heads were well liked by the industry. By then similar dianthus were being imported from the Netherlands and there was little enthusiasm to grow them in the UK. (3) Plugs of 'Cocktail Pinks' cultivars were tested in a tunnel. It was evident that these were good cultivars for the garden, but too short stemmed for a commercial cut flower. (4) Cultivars of the 'Barberatus' series were grown in a tunnel and outside. They made much vegetative growth, the early flowers had short stems, but their length increased later in the season, especially in the tunnel. As with other trials of annual dianthus, these were generally appreciated by the industry, but at the current time the economics do not stack up for them as a supermarket product because the customer will not pay more than for a standard sweet william. A watching brief needs to be kept for other new series being released.

- **Caryopteris** 'Pagoda' cultivars were grown in a tunnel over two years and grew well in both years with prolific stems and no evident problems. Picking started in mid-September and continued well into October, and the stems were robust and of suitable length and weight. There was interest from the trade – especially for 'Pagoda Lagoon' with its rich blue colour - but it was considered unlikely to attract a large demand under the current economics. Should interest be revived, more data on cultivars, VL and hardiness would be needed.

- **Delphinium** trials concentrated on assessing new series from the Belladonna Group, which have more delicate and elegant flowers than the traditional delphinium. (1) 'Sea Waltz', 'Sky Waltz' and 'Tango Dark Blue' were grown in a tunnel, produced elegant spikes in a wide colour range, with potentially three flushes a year. (2) 'Trick Lilac', 'Trick Pink' and 'Trick Yellow' were grown in a tunnel, producing two good flushes each year. While of good marketable quality, the stems were (as expected) lighter in weight than in the traditional product, and had a good VL (over eight days); an issue with virus-like symptoms remains unresolved. Both series were judged as good products for the UK market, held back only by economics.

- **Eremurus** rhizomes of three cultivars were grown in a tunnel for two years. Flowering in May 2016 was sparse but spectacular (1.2m+ tall stems), and in the following May 2017 the

number of flowers increased appreciably. The cost of planting material is high and needs to be offset by an appropriate return. While probably suitable for the specialist grower, any larger-scale production would be dependent on bulking-up the rhizomes *in situ* in semi-permanent beds. If taken up, further data would be desirable on cultivars, VL and longevity.

Seed-raised **fillers** have seen increased interest from the industry in recent years. Several species were grown, usually by direct-drilling, in tunnels and outside. (1) ***Ammi majus*** and ***A. visnaga*** grew vigorously in tunnels, producing large flower heads suitable for use in the more expensive bouquets, smaller flower heads could be produced using higher planting densities or growing outside to reduce vigour to obtain a cheap filler. They had long VL (17 and 22 days respectively). Grower interest encouraged the trialling of a range of named cultivars, and although this was successful the cultivars were not very dissimilar. Grown in a tunnel they were rather too vigorous, but this has to be balanced against the weather protection afforded by the tunnel. *A. majus* 'Queen of Africa' and 'Snowflake' and *A. visnaga* 'Green Mist' and 'Queen Anne's Lace' were selected for further trialling. (2) ***Anethum graveolens*** (dill) was fast-growing in a tunnel or outside. Its stems wilted after harvest but recovered to give a long VL (10–15 days) accompanied by substantial post-harvest stem elongation that might need to be managed. (3) ***Anthriscus sylvestris*** 'Ravenswing' seed failed to germinate, so plugs were planted and, although growth was weak in the first year, the second year produced a good crop, especially in a tunnel. Anthriscus may be better grown as a perennial. (4) ***Bupleurum rotundiflorum*** 'Griffithii' was slow to establish but eventually produced long, strong stems but with the minimum acceptable VL (five days) (which does not accord with other reports). Nevertheless there has been a revival of grower interest in bupleurum. Seed germination, sequential sowing, season extension and VL would need to be addressed. (5) ***Euphorbia oblongata*** was also slow to germinate, initially producing very short stems, but grown-on in a tunnel produced a good flush of long stems, freely produced into autumn. Euphorbia exude a milky sap, the significance of which should be identified. (6) **Ornamental carrot** (*Daucus carota*) generated much interest from growers despite its yield being relatively low and its flower head size variable. More research would be required to

develop the crop. (7) *Ridolfia segetum* is similar in appearance to anethum; its germination and growth were slow, though secondary stems were produced after cutting the main stem. In all of the trials, fillers provoked considerable interest amongst the industry being judged to have very good potential as UK crops. Bupleurum has been grown commercially for two years, and a wide range of other fillers have been grown in small quantities by specialist growers. The industry is keen to see further demonstrations of ammi and some other fillers – *Atriplex*, *Orlaya* and cereals have been suggested. The common problem of poor germination and slow establishment may require changes to husbandry.

- **Gomphrena** is not well known in the UK, but its lively colours might have appeal as a filler. Nine cultivars were grown in tunnels in two batches and two planting densities. When flowering started the stems were too short for a cut flower, but after three to four weeks much longer stems were produced, and with a good VL (seven days). The following year four of these cultivars were grown in a tunnel, but stems of the 'Globosa' type were too short for cut flowers. Stem length of 'Haageana' cultivars increased through the season, with a high yield (340 marketable stems/m² over a picking period of eight weeks). With prolific, attractive flowers, long stems and good VL, gomphrena generated a lot of interest and it was considered to have good potential as a UK-grown filler. Once-over cropping should be investigated as a means of reducing labour costs, along with the causes of its inconsistent stem length and the properties of other cultivars.

- **Gypsophila** is already a staple filler, but the advent of novel cultivars may offer a number of advantages (including larger, whiter and pink flower heads) over older cultivars, reinvigorating the market. Grown in a tunnel the flower yield was low in the first summer but increased considerably in the second. They were considered to have very good potential as a UK-grown filler.

- Much interest has been shown recently in growing **ornamental grasses** as fillers. Numerous species are available, and a selection was trialled: *Bromus macrostachys*, *B. secalinus*, *Chasmanthium latifolium* (*Uniola latifolia*) (sea oats), *Eragrostis elegans*, *Panicum*

elegans 'Sprinkles', *P. miliaceum* 'Violaceum', *Setaria italica* 'Max', *Setaria pumila glauca*, *Sorghum nigrum* and *Stipa capillata* 'Lace Veil'. In 2016 plug plants and direct-drilled seed were grown in a tunnel and outside. All established well in tunnels, direct-drilled plants flowering slightly later. There was huge variety in flower head form amongst the cultivars, and *Panicum elegans* 'Sprinkles', *P. miliaceum* 'Violaceum' and *Stipa capillata* 'Lace Veil' elicited most positive comments. Those grown outside early failed to thrive, having been severely frosted soon after planting, but the crop would be very suitable for outside production from sequential sowings. In 2017 sequential sowing and transplanting monthly (weeks 21–30) gave picking over a long period (weeks 28–38). Crops from tunnels were taller and more vigorous than those outside, but, with better weather after planting this year, the majority of the latter were also of marketable quality. All plantings of *Bromus secalinus* were affected by powdery mildew. In testing, samples remained in an acceptable condition at vase-day seven, a good VL. There seem to be no reasons why the industry cannot take up the crop on a commercial scale, as a group ornamental grasses have very good prospects as UK crops. Discussions with some packers and growers have indicated that commercial quantities will be planted in 2018.

- The success of **scabious** as a cut flower abroad, and the availability of new cut flower cultivars, led to substantial trials. Plugs of seven 'Scoop' cultivars were transplanted under a tunnel and outside, pinched after three weeks, and grew vigorously, with prolific flowering continuing until the tunnel was de-skinned for winter. Stems long enough to be marketable stems (45cm+) comprised between 15–30% of the total stems in different cultivars. The outside crop also yielded well in spite of adverse weather. In testing, all samples had a good VL, remaining in acceptable condition by vase-day seven. Another trial, a year later, included seven 'Scoop' cultivars and ten other new cultivars. In this case high temperatures in June led to premature budding, and the crop was pinched three and again six weeks after transplanting. In contrast to the previous year, growth was poor and the flower stems, though prolific, were generally short (this was overcome by harvesting to the required stem length and then removing a side-shoot). The new cultivars, with an attractive range of colours, high yields and

good VL, were well received by the industry, have potential for use in mixed bouquets, and are judged to have good prospects as a UK crop. There is scope for further research on the effect of high temperatures on premature budding, the high incidence of short stems and hardness.

- **Solidago** is a well known filler supplied cheaply from imports. Earlier trials produced stems weighing 200–300g and >100cm in length, suitable only for bunch sales, for which there was no demand. To re-examine the prospects for solidago, five new cultivars from the ‘Glory’ series were grown in a tunnel or outside, all producing crops of high-quality stems. While the tunnel-grown stems were too heavy for current requirements, the outdoor-grown stems suited supermarket requirements; these new cultivars have very good prospects as a UK crop. It is understood that some commercial crops have been planted.

- **Trachelium** is not well known in the UK, but is widely grown in the Netherlands and has been trialled in the USA. ‘Corine Purple’ and cultivars of the ‘Lake Michigan’ series were trialled in a tunnel, and while initial growth appeared weak and budding-up occurred early, the stems lengthened as the plants matured, each producing at least one heavy lead stem and a number of marketable side-shoots, and the flower colours were impressive. In a further trial the planting date and effect of pinching ‘Lake Forrest’ and ‘Lake Michigan’ cultivars were investigated. Yields and stem length were satisfactory but showed large varietal differences. Non-pinched plants cropped 10 days earlier than pinched plants. Tests gave a long VL (14–17 days for cultivar averages). The greater number of stems/plant from pinched crops was further investigated with ‘Lake Michigan White’ and ‘Lake Forrest Blue’: pinched plants produced an average of just over 5 stems/plant, while non-pinched plants gave 3.5 stems/plant. Lastly, a novel, green-flowered cultivar, ‘Briba Green’, gave excellent results in trial plots. There appears to be very good potential for growing tracheliums in tunnels commercially in the UK. The UK product appears greener, taller and heavier than imported product. At present the high cost of plants is deterring growers from trying trachelium; further trialling may be needed, for example to understand how the number of marketable stems can be manipulated to increase income.

- **Veronica** 'Spark' cultivars had been trialled in an earlier project and, despite a good colour range, the lightweight stems and small production window made it unlikely to be economic to grow in the UK. Following a revival of interest, cultivars of the new 'Skyler' series were grown in a tunnel. The stems were of higher quality than the earlier trials, flowering was prolific, with straight stems and well coloured spikes. Overwintered, they flowered in two flushes the next year, but second flushes tended to be weaker. The window of production was rather short. Later the same cultivars were trialled outside as well, but outside plots suffered weather damage. 'Skyler' veronica seem to have good potential as a UK crop, subject to trials to extend the cropping period, ensure better quality second-flush stems and measure VL.
- **Woody foliage** can be produced from many hardy shrubs. To demonstrate the possibilities of cut foliage for UK growers, a selection of popular types was planted at the CFC in 2010 and maintained as a long-term crop with minimal maintenance. The plantings included calicarpa, cornus, corylus, cotinus, hedera, hypericum, philadelphus, photinia, quercus, salix, symphoricarpos and viburnum. All established well and marketable stems were cropped from 2012 onwards; hypericum, cotinus, photinia and symphoricarpos were considered particularly impressive. Substantial plantings of hypericum and symphoricarpos have been made and other species have been taken up by local growers. This is a crop with very good prospects for UK growers, and a huge range of species is available.
- **Zinnia** were trialled in an earlier project, when the industry was enthusiastic about their wide range of vibrant colours. But after picking the hollow stems can collapse and bend just below the flower head, making them unusable. In trials with the 'Benary's Giant' and 'Oklahoma' series, the attractive flowers in a wide range of colours and with long stems, were stronger, but VL was five to seven days (just acceptable to good). A number of post-harvest trials were carried out, and overall the results appeared to show that, under some circumstances at least, zinnias are capable of an acceptable, borderline VL. Zinnia have a range of colours that should make their presence in a bouquet of interest to retailers. Apart

from this, zinnia should have good prospects as a UK cut flower, and it is hoped further post-harvest work can be done.

Crops with trials concluded by 2017

- **Basil** can be used as a fragrant filler in mixed bunches and bouquets. Four cultivars were trialled in a tunnel, and, although making strong growth and having attractive foliage and flower spikes, their VL was unacceptable (less than five days). Further cultivars recommended from trials in the USA ('Aromato' and 'Cardinal') were subsequently grown but also produced an attractive product with a poor VL, the stems apparently failing to take up water. If the industry shows further interest in basil, post-harvest treatments could be researched, but this is a specialised crop and has poor prospects as a UK cut flower crop.
- September-flowering **aster** (*Aster ericoides*) is imported as a cheap filler. At the start of this project it was thought the introduction of new, double-flowered cultivars might open a new market. Trials elicited industry interest in these cultivars as a pinched crop flowering in tunnels in September/October. As a short-day (SD) plant, blacking-out for part of the day under long days (LD) would advance floral initiation. Eleven double cultivars were planted in 2012 in a tunnel and outside, overwintered, and the tunnel crop used in 2013 to investigate the use of blackout covers (the outside crops acting as a natural-season 'control'). Blackouts were placed over the plots overnight for 13 hour/day from week 22 (stems 60cm-tall) to week 31 (plants with large buds almost showing colour). The main flower picking period was weeks 32–33, somewhat later and with longer stems than required, indicating the blackout was probably started too late; otherwise quality was superb. A second flush in early-November was too short-stemmed to be marketable. In comparison the controls produced a single flush over weeks 37-43. In 2014 'Cairo', 'Cape Town', 'Cassy' and 'Chicago' were transplanted to a tunnel and the same blackout treatment started in week 25 (stems 50cm-tall) and stopped in week 30; by this time the buds of 'Cairo' and 'Cassy' had started to develop and went on to produce high-quality stems with high yield and no premature budding. But 'Cape Town' and 'Chicago' showed premature bud development resulting in poorer quality and lower yield. Samples of the four cultivars gave a good VL of eight to nine days. The plants were cut back hard and a

second flush grew well in all cultivars, and was approaching a marketable stage when the tunnel was de-skinned for winter (week 43); for comparison the controls' cropped around week 42. Attempting two flushes per year appears to be pushing the crop to its limit in the restricted growing period available in a tunnel, although it would be achievable under glass or perhaps in a fixed tunnel.

- Industry and consumer interest in **ornamental brassica** remains high, despite uncertainties about some aspects of husbandry and which cultivars to grow. Trials in 2015 and 2016 addressed the choice of cultivar for the higher quality tunnel crop, growing newer cultivars alongside the familiar 'Crane' series. In 2015, compared with trial averages, 'Bright Wine' and 'Olga' produced heavier stems, 'Bogdana', 'Crane Queen' and 'Katya' lighter stems, 'Anthonia' larger heads and 'Agathana', 'Crane White', 'Olga' and 'Varvara' smaller heads. With high-quality heads and a long VL of 10 to 17 days, some of the less familiar cultivars showed real promise, generating more interest than the 'Crane' series. One cultivar, 'Kysia', failed to colour-up. A further trial was carried out in 2016. 'Kysia' again failed to colour-up, while the others all produced heads of high quality, but those with dissected leaves (such as 'Crane King', 'Crane Queen' and 'First Lady) failed to equal the marketable yields of others. In contrast to the 2015 results they attained only the minimum guaranteed VL of five days. While there appears to be some resistance by the industry to take up newer cultivars in place of the established cultivars, a larger problem seems to be the inconsistency of the VL obtained. Some preliminary work was carried out with a local grower in 2016. Re-cutting or not re-cutting the stem base when placing the stems in the vase did not appear to have a general effect on VL. Post-cropping conditioner treatment with 'Chrysal CVBN' at a high rate gave a better VL (seven days) than other treatments that gave only the minimum guaranteed VL of five days. There was less leaf yellowing when 'Chrysal Lily and Alstroemeria BVB' had been used as the post-harvest treatment. 'Chrysal CVBN' used at a high rate was beneficial as a bactericide. Further post-harvest studies are clearly needed.

- **Carthamus** has attracted attention in the industry as an unusual, thistle-like filler, and demonstration plots were planted in 2014 and 2015. Cultivars 'Kinko', 'Nemo' and 'Shiro' were

direct-drilled outside and in a tunnel. The plants grew and budded-up quickly. In 2014 plants from week 25 and 27 sowings flowered over weeks 35–37, while those from the week 30 sowing failed to produce marketable stems before the tunnel was de-skinned (week 43). In 2015 sowings in the tunnel over weeks 17–28 reached picking in weeks 29–40, while the week 31 sowing again failed to produce marketable stems before winter. Samples taken for VL testing had a good VL of seven days, though quality was spoiled by bract-tipping. *Carthamus* produces a reliable, sturdy stem and is already being used successfully as a bouquet filler, and no further trials are planned. Bract quality does remain an issue, however.

- **China asters** (annual asters, *Callistephus chinensis*), especially the 'Matsumoto' spray type, have become an important outdoor summer cut flower in the UK. Earlier trials opened up a new market for an alternative, the large-headed, 'bloom'-type of the 'Krallen' series. It showed real potential for commercialisation here, until post-harvest quality became an issue with the development of petal-spotting and flower-tip browning, disorders that have not been remedied. Alternative cultivars are needed. Between 2010 and 2015 trials were conducted with the 'Beautiful Day', 'Benary Princess', 'Harlequin', 'Jewel', 'Lady Coral', 'Matador', 'Meteor' and 'Standby' series, and while many of the cultivars included stem and flower attributes with promise for growing in the UK, none was considered an alternative for 'Krallen'. In 2016 a new spray-type series, 'Julie' was trialled. 'Julie' has a different colour range and a claim for earliness compared with 'Matsumoto'. Used as a source of material for showing to the industry, samples from the trial were well received and as a result it is being trialled on a larger scale by local growers.

- **Cleome** is a sturdy, attractive garden annual with unusual flowers, a possible candidate for wider growing. In 2016 four cultivars were sown into plugs and planted into beds in a tunnel, where establishment was satisfactory. There were no obvious differences in growth or development of the plants grown at two spacings (25 and 65 plants/m²). Transplanted in week 18 or 25 they started flowering in weeks 26 and 30 and continued flowering into October. Cleome was a very prolific crop producing constant flushes of large,

showy and distinctive flowers over a long period. Samples had a good VL of at least seven days, but cleome's spines and aroma could prove difficult in handling and during retail.

- **Cosmos** are well known garden plants, producing masses of bright flowers and feathery foliage. Some cultivars have given good results elsewhere as a cut flower, and they could have potential as a 'short-season filler' in the UK. Over the period 2013–2015 many cultivars were trialled in tunnels and outside, all sharing a number of characteristics. Cosmos were relatively easy to grow, with good germination rates, rapid establishment and vigorous growth – under tunnels sometimes so vigorous as to be unruly. Flower production tended to begin slowly and unevenly, but was soon prolific. Although appearing somewhat wispy and feathery, flowering stems were usually long and surprisingly robust and substantial, especially when grown outside. Drilling sequentially from weeks 17 to 28, picking covered the period 29–41, though the late picks tended to be rather short. Over several tests, VL was unacceptable or only just acceptable with a maximum of five days, and further development work is needed to address ways of improving VL.

- **Craspedia** is a novel cut flower in the UK, with slender, unbranched stems and ball-shaped clusters of yellow flowers. It is useful as a filler and also as a dried flower. In 2016 three cultivars were trialled in a tunnel. Rooted cuttings of 'Paintball Globe' and 'Ellisse' were potted-on and transplanted, and 'Sun Ball' was obtained as seed, sown into plugs and transplanted. 'Paintball Globe' and 'Ellisse' gave large flushes of very strong, tall flowers that were very similar in form. Seed-raised 'Sun Ball' produced weaker plants with smaller flower heads with shorter, kinked stems and fewer stems per unit area. Samples of 'Paintball Globe' and 'Ellisse' were subjected to VL testing and all stems remained in acceptable condition on vase-day seven, a good VL. Craspedia is an unusual product with specific potential and appears relatively easy to grow.

- **Dahlia** are generally considered to have a poor VL, and the 'Karma' series, bred for a longer VL, were grown over the period 2009–2013, primarily for VL testing. Plots of 18 'Karma' cultivars were grown in a tunnel and outside and grew vigorously, especially under protection.

The blooms were striking, but the results of VL tests using various conditioning treatments were disappointing, the flowers failing to reach the minimum guaranteed VL of five days.

- **Annual dianthus (spray carnations)** are a supermarket staple and new cultivars with unusual flower forms have been trialled as they could give UK growers the opportunity to produce a premium product not competing with imports. In 2013 potted cuttings of the 'Floristar' series, 'Solomio' series and 'Star Cherry Tessino' were transplanted under a tunnel and pinched two weeks later. Cropping started in mid-July and continued until the trial was ended in late-October when there were still immature stems present. Among the 'Solomio' cultivars the yield of stems/m² varied from 108 to 197. Overall they produced good quality, strong stems, but there was an issue with bud abortion in some cultivars, especially 'Edo'. 'Star Cherry Tessino' appeared attractive to rabbits. Plants of the 'Floristar' series produced few flowers. From another novel series, 'Tiara Coral Pink' and 'Tiara Lilac' were trialled in 2014. In these cultivars the central bud developed well before the others and needed to be pinched out to preserve the remaining spray, though this is difficult and labour intensive. The overall picking period was weeks 35–37 and the flowers were attractive and appreciated by growers. Stems of 'Tiara Coral Pink' were sampled for testing and had a good VL of an average seven days.

- With their spiky flower-heads and attractive colouration, **eryngium** remain popular. Small plots of seven cultivars were planted in a tunnel and outside in 2011. Marketable flowers were produced from 2012 and stems shown to potential customers evoked keen interest. By 2013 the tunnel-grown plants had become over vigorous and were grubbed out. In the outside plots many plants did not survive the cold winters of 2011/2012 and 2012/2013. By this time the outstanding cultivars were 'Blue Bell' and 'Deep Blue' which appeared to be hardy and that year produced 56 and 113 stems/m², respectively; the other cultivars had plant survival rates between 43 and 69% and produced between 28 ('Marbella') and 88 ('Magical Purple Falls') stems/m². In 2013 necrotic, black spots appeared on the foliage of 'Arabian Dawn' and 'Marbella' and were identified as symptoms of *Alternaria*. VL testing confirmed earlier results, with stems of 'Blue Bell', 'Magical Blue', 'Magical Cloud' and 'Marbella' all having a good VL,

eight to nine days. The stem yields recorded in 2015 showed that 'Arabian Dawn' had more than doubled its annual yield, to 93 stems/m² and that the yield of 'Deep Blue' had fallen slightly (to 94/m²); the yields of the other five cultivars had fallen to between 5 and 33/m². The trial has information on the performance and hardiness of a range of cultivars, and no further trials are planned.

- **Leucanthemum** was included in trials in 2014 to demonstrate a new range of cut flower cultivars, the 'Real' series. Pinched plants of three cultivars were transplanted under a tunnel. 'Real Frilly' budded prematurely and flowered on short stems, 'Real Fancy' and 'Real Fizzy' flowered normally. The plots were mulched and over-wintered but over half the plants died and any flowers produced had short stems. These cultivars appeared unsuitable for growing in a tunnel.
- **Lion's ear** (*Leonotis* species) is a South African plant being introduced to cultivation elsewhere in Europe. *Leonotis leonurus* 'Alba' and 'Staircase', *L. mollis* and 'Wild Dagga' were identified as possible subjects. In 2014 young plants were transplanted under a tunnel and established and grew away quickly. By week 43 'Staircase' was in bud, but gales in late-October flattened the plants before any flowers opened; none of the other *Leonotis* reached a visible bud stage. No further trials were undertaken.
- **Lupin** may be an unlikely choice as a commercial cut flower crop, but research in the USA showed the genus has distinct possibilities as a 'cut'. In 2013 young plants of several 'Gallery' and 'Russell' cultivars were transplanted under a tunnel and outside. Initially growth was weak, but the plants recovered and established well, and flowering started in week 32 and continued over a long period, producing reasonable numbers of stems. Plants of the 'Gallery' series were shorter than the 'Russell' cultivars, but the lengths of both were adequate, while outdoor plants produced much shorter stems than in the tunnel. Left *in situ* to overwinter, many plants failed to survive the winter, but nevertheless the high quality of the remaining stems and the wide range of colours of both series were striking. However, samples tested by

a local packer were reported to have an unacceptable VL (less than five days) and no further trials were planned.

- **Ornamental peppers** proved to be successful novelties in the Association of Specialty Cut Flower Growers (ASCFG) trials, and two cultivars, 'Black Pearl' and 'Masquerade', were trialled in 2014. Plug plants were transplanted under a tunnel: both cultivars were slow-growing but eventually produced large, strong plants. Some fruits were visible on both cultivars by week 36, but they remained more or less static without growing or ripening until the tunnel was de-skinned at the end of the season. No further trials were planned.

- **Physostegia** is another crop seen as a potentially useful cut flower in trials in the USA, and 'Crystal' was trialled in 2014. Plug plants were transplanted to a tunnel. 'Crystal' was rather short-stemmed and late flowering, and in VL testing the stems failed on day two in the vase. *Physostegia* therefore seems unsuitable as cut flowers and no further trials were planned.

- **Rudbeckia** is another well-known garden plant with potential for development as a cut flower. Demonstrations with seed-raised annuals of *Rudbeckia hirta* 'Green Eye' and 'My Joy' had been carried out in a tunnel in 2011. Although the flowers were attractive in themselves, the stems were too vigorous and unruly to be practical for commercial growing. More robust perennial cultivars, *R. laciniata* 'Herbstsonne' and 'Goldquelle', were trialled in 2012–2013, with young plants planted in a tunnel. They showed some market potential, but many of the stems were weak and they were probably unsustainable as cut flowers because they were too vigorous and produced unmanageable stems. See also the section on the similar genus *Echinacea* (also called coneflower); the evidence we have suggests *echinacea* would be the better choice.

- **Sedum** cultivars, *Sedum spectabile* 'Brilliant', 'Herbstfreude' and 'Matrona', were planted as a perennial demonstration in outside beds in 2010. Growth was weak in the first year, but once established growth was vigorous, with impressive stem counts, length and weight, and tests showed their VL was good, at least seven days. In 2011 the trial was

extended by adding four further cultivars. By 2012 the plots had probably generated more attention than any others. No further trials on sedum are planned

- **'Pumpkin-on-a-stick'** (a cultivar of *Solanum aethiopicum*) is an unusual novelty that caught the eye of trial participants in the USA. The plant, with its bright red 'pumpkins', is related to the winter cherry (*Solanum pseudocapsicum*). In 2016 plug plants were transplanted under a tunnel at two planting densities. 'Pumpkin-on-a-stick' was incredibly vigorous and started flowering in July, with fruits seen developing soon after. The lower planting density produced the sturdier stems, but there would probably be a market for both larger and smaller products. The plants have spines on their stems and leaves and removing them would add costs. Further trials are unlikely.

- **Sunflower** became a fashionable cut flower in the early-2000s and its popularity has lasted. Two cultivar trials had an emphasis on new and dwarf cultivars. In 2013 seed of 13 cultivars and numbered lines were sown by hand outdoors and in a tunnel. Despite the dry weather some outside cultivars started to produce marketable stems from week 24 onwards, with the second planting coming into flower around week 32. The majority of the cultivars were 120 to 160cm-tall and large-headed. 'Galilee Miracle' and 'Tavor Lemon' were short (80 to 100cm-tall), though with normal-sized flower heads, while 'Tanya' was short and had smaller flower heads. Growing in the tunnel produced much taller plants than outside, while in most cases flower head diameters were smaller in the tunnel than outside. In 2014 further cultivars and lines were trialled in a tunnel. The main picking periods were weeks 35-37 for week 27 sowing and weeks 39-40 for week 30 sowing. Samples picked for VL testing and had a consistent VL averaging a good seven days.

Crop improvement

- **Alstroemeria: a seasonal tunnel crop?** Commercial cut flower production involves growing contemporary cultivars in a glasshouse. The availability of tunnels suggests the possibility of growing a cheap, seasonal crop of older cultivars (with no royalties attached). A feasibility trial was run over 2014–2017 with twelve older cultivars grown in a tunnel or outside. In the tunnel marketable flowers were produced from week 31 in 2014 and from about week

22 in later years, and each year picking continued until weeks 41–44 (when the tunnels were de-skinned for winter). The plants were vigorous and produced strong stems that some growers considered better than a typical glasshouse crop. The outside crop produced marketable stems (starting week 33 in 2014 and week 26 subsequently) and was less vigorous. With 12 cultivars and tunnel and outside plots the supply of flowers was reasonably constant over a five month period. Yields in the tunnel were more than double those for outside plots, with annual production increasing over the four year period. ‘Nina’ was the highest yielder overall, and ‘Dana’, ‘Flaming Star’, ‘Friendship’ and ‘Tanya’ also yielded well. Samples had a long average VL, twelve days. Growing non-PVR/PBR cultivars in tunnels appeared to have strong potential. Despite lower quality and yields, growing in the open may have a place for smaller scale businesses.

- **Column stocks: improving control of fusarium wilt.** Column stocks are a mainstay of glasshouse cut flower production in the UK. But variety trials in tunnels in 2012 and 2013 stimulated the industry’s interest in the ‘Katz’ series as a late-summer crop that could better the quality of comparable glasshouse-grown plants. Growing stocks in steamed and non-steamed soil demonstrated the benefits of steaming on stem weight and enabled resilient cultivars to be indentified. Increasing concerns about poor establishment and uniformity was found not to be due to any one factor, but to a combination of the poor performance of some cultivars on non-steamed soil and the presence of *Pythium* or *Fusarium*. In 2016 a new demonstration of column stocks showed the cultivars currently available and investigated the effects of steam-sterilisation, and, although the expected results were confirmed, the difference was less marked than previously seen. In 2017, as part of a new project on *Fusarium oxysporum* in horticultural crops an experimental site sufficiently infested with *F. oxysporum* was needed as a site for trials and was set up in the tunnel previously used for stocks trials. The soil was infected with *F. oxysporum* f.sp. *matthioli* culture and one day later the tunnel was planted with plug plants of a range of stock cultivars, together with lisianthus and brassica plots included for checking the host-specificity of the fusarium culture. The first symptoms of *F. oxysporum* infection was seen in three weeks, and the severity of symptoms

and number of marketable stems were recorded when the plants were fully grown. There were large differences in susceptibility/tolerance to fusarium between colours within series, for example, there were high fusarium scores and few marketable stems in 'Anytime White' and the reverse in 'Anytime Rose'. The absence of infection in lisianthus and brassica plots confirmed the culture's host-specificity. The *Matthiola* race of fusarium was spread across the tunnel in concentrations high enough to be pathogenic. The site was rotavated and left in ready for a replicated trial in 2018.

- **Lily: alternatives to peat-based growing media.** The UK's production of lilies from imported bulbs has been very successful and they remain hugely popular with customers. To avoid soil-borne pathogens the bulbs are grown in crates of peat growing medium, and so there is interest in finding alternatives or diluents for peat. Over 2013–2017 alternative media including aerobic digestate (AD), coir, cocopeat, 'Forest Gold' (peat:wood based media), green compost, green waste (GW), wood fibre and mixes - were compared with a typical peat-based lily medium ('peat').

(2013) Bulbs were grown in peat, GW and peat + GW 50:50 mix. Compared with peat, stem length was slightly reduced in peat + GW and more so in GW, but the differences were small and product quality was superb in all three.

(2014) The range of materials was extended to include AD, coir and 'Forest Gold'. Bulbs were planted in peat, coir, 'Forest Gold' and mixes of peat + coir (50:50), peat + AD (80:20 and 60:40) and peat + GW (50:50 v/v). There were no significant differences in stem length or weight. Compared with peat, peat + AD gave better leaf colour; peat + GW delayed picking by a week, produced some stunted stems with chlorotic leaves and slightly reduced the yield of marketable stems. Hence 100% coir or 'Forest Gold' were suitable alternatives, and peat + AD mixes might confer nutritional benefits. But the addition of GW to peat in this trial had some adverse effects; note that, while proprietary materials such as peat, coir and 'Forest Gold' are likely to be of consistent quality, the properties of 'experimental' materials like GW and AD could vary between sources and explain the detrimental effects of GW here.

(2015-1) The previous trial was modified by substituting 'green compost' for 'Forest Gold' and expanding the range of peat + AD mixes (80:20, 60:40 and 40:60). There were insignificant differences in stem length and weight between media, no differences in picking date and no visual differences. In this case the 'green compost' was suitable for growing lilies, as was adding a larger proportion of AD to peat.

(2015-2) Bulbs were grown in AD, coir, peat and the mixes peat + AD (60:40, 40:60 and 20:80) and coir + AD (33:67). Plants grown in 100% AD were stunted, chlorotic and distorted, and those from peat + AD (20:80 v/v) only marginally better; those in AD + coir were of good height but had chlorotic foliage. Plants grown in peat, coir or the weaker mixes of peat + AD (40:60 and 60:40) were normal and marketable. Stems were tallest and heaviest in peat and slightly shorter and lighter in AD mixes. Despite the optimistic results with AD in the previous trials, there are limits to how much AD can be added: using 100% AD (or 80% AD with peat, or 67% AD with coir) had seriously detrimental effects here.

(2016) The emphasis in this trial was assessing peat + wood fibre and peat + cocopeat mixes. The media used were peat, cocopeat and mixes of peat + with wood fibre or cocopeat (90:10, 80:20 and 70:30). Lilies grown in 100% cocopeat had shorter, lighter stems, but otherwise there were no visual differences between treatments and no effect on picking date. These mixes were worthy of further consideration.

(2017) The latest trial returned to AD-based media. Peat and five peat + AD mixes with increasing proportions of AD (details were confidential) were tested with two batches of bulbs. In the earlier batch growth and development were normal with all media and flower quality was superb. Stem lengths and weights were greatest using peat, but the range of averages values was small (142 to 158cm in length and 87 to 105g in weight). In the later batch - which were moved into a glasshouse in the last stages of growth - growth and development were again normal in all treatments though trimmed stem weights were lighter, probably because bulbs were 'forced' in the warmer environment.

The suitability of AD-based media improved over the course of the project, and there seem to

be real prospects for further AD use in lily production, subject to its availability in uniform supplies and specified quality. There are prospects here for up to 60% reduction in peat usage. This does not rule out the use of other alternative materials such as coir- or wood-based materials, which are already being incorporated into growing mixes by some growers. GW materials require further trials as products will be prone to variation between sources. Presently there is industry reluctance to adopt AD into lily media, but this may change if other alternatives (e.g. coir) become less available or less acceptable to the end-customer.

- **Herbicide for outdoor cut flowers.** The loss of key active ingredients (such as oxadiazon, chlorthal-dimethyl and propachlor) continues to be a major concern for cut flower growers. (In the following account, '+' indicates a tank-mix). In 2015 parts of a project to seek alternative herbicide treatments was carried out at the CFC site on four drilled crops. 'Stomp Aqua' (pendimethalin) + 'Gamit 36 CS' (clomazone) (post-drilling, pre-emergence) was safe and effective for use on **drilled china aster**, and could be followed up with post-emergence 'Shark' (carfentrazone-ethyl) if required. In **drilled sweet william** tank-mix 'Stomp Aqua' + 'Goltix 70 CS' (metamitron) provided the best weed control and was the safest option. In **drilled wallflower** 'Butisan S' (metazachlor), 'Gamit 36 CS' and low rate 'Wing-P'(dimethenamid-p + pendimethalin) appeared safe, applied at drilling. Low rate 'Wing-P' + 'Gamit 36 CS' also appeared safe on wallflowers. The active ingredient benfluralin (was safe as a pre-drilling incorporated treatment and could be combined with some of the post-drilling treatments). The **drilled larkspur** trial proved challenging because of phytotoxic effects from the herbicides used.

In 2016 this work was continued as part of the CFC project. For **transplanted china aster** the aim was to follow-up the current recommendation for 'Stomp Aqua' + 'Gamit 36 CS' pre-planting. 'Stomp Aqua' + 'Gamit 36 CS', 'Nirvana' (imazamox + pendimethalin) or 'Wing-P' were applied pre-planting and followed, three weeks post-planting, by 'Butisan S', 'Venzar Flo' (lenacil) + 'Flexidor 500' (isoxaben) or 'Successor' (pethoxamid). There were many weeds on the untreated plots; pre-planting treatments of 'Wing-P' or 'Nirvana' were better in reducing

their numbers, 'Stomp Aqua' + 'Gamit 36 CS' were much less effective. Applied at this stage, however, 'Wing-P' and, especially, 'Nirvana' resulted in stunting of the crop, while 'Stomp Aqua' + 'Gamit 36 CS' resulted in only slight stunting. Of the post-planting treatments, 'Butisan S' was effective, and 'Venzar Flo' + 'Flexidor 500' and 'Successor' less so. Treatment with 'Butisan S' or 'Successor' resulted in slight marginal leaf scorch on young leaves, though this was rapidly outgrown, while there was no scorch with 'Venzar Flo' + 'Flexidor 500'. Overall, the combination of 'Stomp Aqua' + 'Gamit 36 CS' pre-planting, followed by 'Butisan S' three weeks post-planting, was probably the best compromise between weed control and crop safety. On some sites 'Wing-P', either alone or followed by 'Venzar Flo' + 'Flexidor 500', might be an option.

For drilled sweet william the current recommendation is 'Stomp Aqua' + 'Goltix 70 SC' at drilling, followed-up at the 4-true-leaf stage by 'Shark'. A tank-mix of 'Stomp Aqua' + 'Goltix 70 SC' at drilling was followed by either 'Butisan S', 'Butisan S' + 'Shark', 'Springbok' (dimethenamid-p + metazachlor), 'Springbok' + 'Shark', 'Successor', 'Successor' + 'Shark', 'Venzar Flo' + 'Flexidor 500' or 'Venzar Flo' + 'Flexidor 500' + 'Shark'. In addition there was a treatment of 'Goltix 70 SC' at drilling followed by 'Shark'. In the untreated controls weed cover was complete, with the 'Goltix 70 SC' and 'Shark' programme weed cover reached 47%, while for the other programmes (all based on an initial application of 'Stomp Aqua' + 'Goltix 70 SC') weed growth varied widely. The most effective follow-up programme for weed control was 'Venzar Flo' + 'Flexidor 500' + 'Shark' (5% weed cover), followed by 'Springbok', 'Springbok' + 'Shark', or 'Venzar Flo' + 'Flexidor 500' (18–22%) and the remaining programmes resulted in weed cover of 33% or more. In the early stages slight to mild stunting occurred in all treatments except the control, and the four treatments giving good (up to 22%) weed control gave relatively more stunting. The stunting effect, however, was transient, and as a result the recommended herbicide programme would be the one giving the best weed control: 'Stomp Aqua' + 'Goltix 70 SC' at drilling followed by 'Venzar Flo' + 'Flexidor 500' + 'Shark' post-emergence. In addition, the following herbicide applications were made to the dormant crop

in mid-February, prior to spring growth; 'Shark', 'Devrinol' (napropamide) + 'Flexidor 500', 'Venzar Flo' + 'Flexidor 500', 'Butisan S' + 'Flexidor 500' and 'Venzar Flo' + 'Flexidor 500'. Assessed six weeks later, 'Devrinol' + 'Flexidor 500' and 'Butisan S' + 'Flexidor 500' were both crop safe and could be applied if required.

- **Spectral filters for tunnel-grown crops.** In an earlier project spray carnation, spray chrysanthemum, column stocks and godetia were grown in 'Spanish tunnels' under a range of polythene films (spectral filters). One conclusion was that specialist films should not be used unless an advantage could be demonstrated for a specific crop/film combination. In 2013 trials on column stocks and bloom chrysanthemum were conducted at commercial nurseries in conjunction with the present project. **Column stocks** cultivars were grown in tunnels covered with either a standard clear polythene film or 'SteriLite SuperThermic' film (with UV-blocking, light-diffusing and IR-reflecting properties). Random samples were taken from each tunnel at picking and assessed. Average stem lengths were consistently longer under 'SteriLite SuperThermic' film than under standard film, but only by between 1 and 9cm in the different cultivars.

Bloom chrysanthemum were grown in tunnels covered with either a standard film ('Aster TR' with light diffusing, UV-opaque and some thermal properties) or 'SunMaster Smart Blue' (a blue film reducing light intensity in the near- and far-red regions, transmitting UV and reducing light and heat levels). Plants under 'SunMaster Smart Blue' bloomed two weeks later than under 'Aster TR', perhaps because of the former's lower temperatures. Superficially the blooms looked similar, but under 'Aster TR' the stems were thicker and stronger and the petals and leaves slightly lighter in colour compared with those under 'SunMaster Smart Blue', under which the petals and leaves were slightly darker and the leaves thinner. Stem lengths and trimmed stem weights were slightly shorter and lighter under 'SunMaster Smart Blue' film than under 'Aster TR', but these differences amounted to only 2 to 5cm or 2 to 5g. The marketable yield was only 54% under 'SunMaster Smart Blue' film, with one to two usable stems per plant, but 84% under 'Aster TR' with two to three stems/plant. The VL of stems was unaffected by

film type, a long 22 days in both cases. In this case 'SunMaster Smart Blue' film was not suitable for growing this product.

Financial benefits

As this is the final year of the current five-year programme it is useful to now try and assess the financial benefits to the industry over this period as a result of the activities of the CFC. From his other activities within the cut flower industry, the Project Manager is aware that a number of crops have been trialled and grown commercially as a direct result of the CFC trials programme. Examples known to have been grown on a small-scale include the annual dianthus from Hilverda, *Aster ericoides*, carnation 'Solomio', *Dahlia* 'Karma', phlox, seasonal alstroemeria, scented pinks, new cultivars of scabious and solidago, veronica, and zinnia. Others have been grown on a more commercial scale, the main ones being antirrhinum, spot-crops of bupleurum, lisianthus, trachelium and various hardy perennials including hypericum, salix, sedum, symphoricarpos (snowberries) and viburnum. Some of the subjects of the 2017 trials are also likely to be grown on a commercial scale in 2018 including ornamental grasses and gomphrena. The following is an estimate of the area grown and farm-gate value of some of the trialled product already being grown, the hardy perennials being included as a single category.

- Antirrhinum: extra production over the five-year period - approximately 5.0ha with a farm-gate value of £575,000 over this period.
- Lisianthus: extra production over the five-year period - approximately 3.75ha with a farm-gate value over this period of about £427,500 on an 80% yield.
- Hardy perennials: extra production over the five-year period - approximately 15ha. However, because it can take three to five years for these crops to reach maximum yield, it is hard to calculate their exact value over the past five years. However, if a farm-gate value of £50,000 is used, which is based on hypericum with an average yield figure and assume that only half of the 15ha was mature enough to crop over the period, the farm-gate value can be estimated at £1,875,000 over the five year period.
- 'Others' are a category for which it is not easy to give an accurate estimate of area, but when taking into account outdoor bupleurum, trachelium and the various crops planted by the large number of small, artisan flower growers, this could represent between 2 and 5ha

of additional plantings. It is impossible to estimate the value of these crops, but the fact that the specialist subjects grown by the artisan growers commands a premium price, means that the farm-gate value could be in excess of £100,000 per ha.

To enable growers to undertake a basic assessment of the commercial potential of some of the most promising subjects, the following section includes some basic yields, planting density data and plant material costs (in sterling or euro depending upon the source).

- **Alstroemeria:** planting density of 5 plants/m² with an average yield (across all cultivars) over the four years of about 300 stems/m² of planted bed, the plant cost is approximately £3.50 for a 7cm pot and £4.50 for a 9cm pot, plus delivery.
- **Antirrhinum:** planting density around 64 plants/m² of bed, with 80 to 95% of stems being harvested (one stem produced per plant); the plant cost is approximately €46 per 1,000 plus delivery.
- **Hardy perennials, using hypericum as an example:** planting density around 2.4 plants/m² (excluding paths and headlands) and yield of around 20 stems per plant from year three onwards; the plant cost of hardy perennials varies with the subject, the cheapest being sedum at less than €1 per plant, then hypericum at about €1.60 per plant and snowberries at about €2 per plant. The expected life of these crops would be around 10 years before the quality of the product starts to deteriorate.
- **Lisianthus:** planting density between 64 and 80 plants/m² of bed, with 80 to 95% of stems being harvested (one stem produced per plant); the plant cost is approximately €95 per 1,000 (dependent on variety) plus delivery.
- **Scabious:** planting density of 6 to 8 plants/m² with a yield of between 30 and 50 stems per plant; the plant cost is approximately 75 Eurocents each plus delivery. The economics of this crop will be entirely dependent on the stem price achieved (the Dutch auction price ranged from 12 to 30 Eurocents) because harvesting is very labour-intensive.
- **Trachelium:** planting density around 64 plants/m² of bed with at least one lead-stem harvested per plant and with some cultivars in 2016 also producing one or two additional side-shoots; the plant cost is approximately €75 per 1,000 plus delivery. The economics of a pinched crop should also be considered by growers to reduce the cost of plant material.

In addition to the new crops being grown by commercial cut flower growers a wide range of

new products have also been grown on a small scale by a large number of artisan growers. A number of UK mail order companies have also taken on board products such as annual dianthus, dahlia and zinnia.

Action points

- Asclepias, craspedia, echinacea, gomphrena, scabious and a range of ornamental grasses are suitable potential novel ventures for UK cut flower growers.
- *Ammi majus*, *A. visnaga*, anethum, bupleurum and ornamental carrot are economic, direct-drilled 'alternative fillers' for tunnel or outside production; carthamus could be grown in a similar way.
- 'Breanthus' and 'Solomio' carnations are potential new crops for UK growers to investigate, subject to a realistic price per stem.
- Trachelium can be grown successfully under polythene as opposed to glass helping to reduce production costs.
- Older cultivars of alstroemeria can be grown as a natural-season tunnel crop with the advantage of lower plant costs.
- A wide range of hardy foliage including cotinus, hypericum, salix, sedum, symphoricarpos and viburnum perform well under UK conditions and should be considered for outdoor production.
- *Aster ericoides* 'Cairo' and 'Cassy' can be grown using a summer blackout treatment for earlier floral initiation and two flower flushes, improving the economics of production.
- The work on fusarium wilt susceptibility can be used by column stock growers to help plan their future production. The 'Anytime' series of column stocks for example is quicker to crop, has a lower susceptibility to fusarium wilt and seems less prone to heat-induced blindness, compared with other series.
- A range of other growing media mixes beyond straight peat can be used for box-grown lily production. Production in peat + aerobic digestate gives lilies of equal quality, while peat +

wood fibre or peat + cocopeat mixtures are also suitable, but care should be exercised when using anaerobic digestate until a standard specification is available.

- Trial the residual herbicide products suggested for weed control on field-grown cut flowers on a small scale to ascertain efficacy and phytotoxicity risk before widespread use.