Rose cut flower cultivation is gaining popularity among the farmers in different areas of Punjab and is increasingly seen as a lucrative enterprise. In the last few years, various factors have increased cut flower consumption and the need for high-quality flowers, including increased education level of the general public, high return on investments, rapid economic growth rate, improved living standards, use of electronic media, increased desire to live and work in an environment-friendly atmosphere, and increased hotel and restaurant business.

A wide range of favorable climatic conditions in Pakistan allow many different species of cut flowers to be grown, which can improve the economic status of the growers. As roses are typically grown in rural and peri-urban areas, rose production has the added advantage of generating employment in this economically weak section of our society. However, there is still a big gap between demand and supply, which indicates that local consumption and demand is not yet satisfied (Riaz et al., 2007). For export-quality cut rose flower production, there is a need to optimize the growing conditions and standardize production techniques, which are essential for plant growth and development under local climatic and edaphic conditions.

In the past, flowers were grown only for social functions or to prepare products such as rose water, rose jam, or perfume (Byczynski, 1997); but now, cut flower production can be a potential enterprise for farmers wishing to diverge from traditional agriculture to non-traditional, high-value floricultural crops. There are an increasing number of florists’ shops, who are selling cut flowers in different forms like bouquets, garlands, bracelets, etc. However, this industry is in its infancy stage in the country, mainly due to lack of infrastructure and facilities, skilled manpower, professional training, modern production and handling techniques, and elite planting material (Kurd et al., 1999). Similar bottlenecks have been reported in other provinces of the country, which are also

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**Summary.** Present status and future prospects of cut rose (Rosa × hybrida) flower production and postharvest management in Punjab, Pakistan, were investigated. Cut roses were the leading flower crop in the area under study, but production systems and practices were outdated and primitive, resulting in cut stems that were not acceptable in international markets. The majority of growers (65%) had only basic education (grade 10 or less) and 57% had small landholdings (<1 ha); therefore, they did not have modern production techniques and resources for high-quality cut rose production. Moreover, lack of production and postharvest facilities, ignorance of both public and private resources, and poor production and postharvest practices were prevalent. Growers’ training regarding production and postharvest management would be required to lift the quality standards of this industry up to the international level. However, a positive trend was observed in cut rose businesses as more than half of growers (52%) entered into the business during last 5 years. In addition, 30% of growers were in business over 10 years, indicating that cut rose production can provide a sustained income for producers. This analysis of the cut rose industry in Punjab can serve as a model for other countries whose cut flowers industries are at a similar stage of development.

The rose is one of the leading cut flowers in the global floriculture trade and is used at almost every event in both local and international markets. The major rose-producing countries of the world include The Netherlands, Colombia, Kenya, Israel, Italy, United States, and Japan. Considering only the Dutch flower auctions, 3243 million cut rose stems were marketed in 2007 and 3415 million stems were marketed during 2008 at a value of $10 billion (Evans, 2009).

Rose has always been the favorite flower in Pakistan and has a special place in our culture as there is hardly any event where roses are not displayed. Rose production has great potential in Pakistan because it has an agricultural economy with diverse climatic conditions. According to a survey, cut roses are already being grown on ≈526 ha in the province of Punjab (Khan, 2005).
impeding the development of cut flower production in those areas (Kurd et al., 2001). Other reasons limiting the growth of the cut flower industry in Pakistan are the lack of progressive growers, cold chain facilities, and government interest. However, during last few years, the government has begun several initiatives to increase the export of floriculture products. Agriculture in Punjab was previously dominated by traditional wheat (Triticum spp.)–rice (Oryza sativa) cropping pattern, which is now gradually being modified by incorporation of floricultural crops in traditional cropping patterns. The main reason for this change is that floriculture crops not only provide more return than traditional crops but also regular source of income and employment generation.

Considering the socioeconomic value of cut rose flowers, this study was conducted to develop a profile of growers’ practices, analyze the trends in the area, study the infrastructural facilities available for rose cultivation, and identify the problems faced by the rose growers. In addition, this study determined the present status of the cut rose industry and the major bottlenecks in its development in the province, which will serve as a model for other countries.

Materials and methods
The study was conducted at various rose growing areas in the province of Punjab, Pakistan. A list of growers was prepared by visiting flower farms and flower markets. Complete biographical data of the growers along with their business information were recorded. In total, contact information was found for 67 growers, of which 40 growers were randomly selected. They were interviewed using a detailed questionnaire. Interview questions were prepared in English and then translated into Urdu for the convenience of the respondents. Each interview lasted 30 to 40 min.

A profile of each cut rose flower grower was prepared in which biographical data, educational level, business experience, and area under rose cultivation were recorded. Growers were asked about cultivar selection, pruning time, premium quality production period, cultivation mode, and sources of modern information/technologies to determine the level of cultivation practices being used. In addition, growers were surveyed regarding problems they faced in rose cut flower production related to soil and nutrient management, salinity, climatic conditions, and postharvest handling techniques to understand major technical constraints impeding production and quality, which might reduce profitability. Postharvest handling problems were identified by inquiring about harvesting stage, use of preservatives, cold storage facilities at farm level, packaging materials, and transportation modes. Growers were also asked about marketing, including how they manage production for special occasions, destination markets, and exporting.

A pilot survey of the project area was conducted before starting the actual data collection. The survey instrument was pre-tested with 10 growers who subsequently completed the final survey after their suggestions were incorporated.

Numerical data were analyzed by analysis of variance using PROC GLM and correlation using PROC CORR in SAS (SAS 9.1; SAS Institute, Cary, NC), where appropriate. Statistical difference of various indices was tested at 5% level of probability.

Table 1. Forty growers randomly selected in Punjab, Pakistan, and interviewed using a detailed questionnaire regarding rose production: Data stratification on the basis of education and age of the owner, the number of years the business has been in operation, and the farm size.

<table>
<thead>
<tr>
<th>Farms</th>
<th>Mean (1–4 scale)*</th>
<th>Median (ha)*</th>
<th>Farm size</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Farm size</td>
<td></td>
<td>&lt;1 ha</td>
<td>1–2 ha</td>
<td>2–4 ha</td>
</tr>
<tr>
<td>Age (yr)</td>
<td>Mean (1–4 scale)*</td>
<td>Median (ha)*</td>
<td>&lt;1</td>
<td>1–2</td>
<td>2–4</td>
</tr>
<tr>
<td>Up to 30</td>
<td>14</td>
<td>35.0</td>
<td>1</td>
<td>64</td>
<td>21</td>
</tr>
<tr>
<td>31–40</td>
<td>12</td>
<td>30.0</td>
<td>1.4</td>
<td>&lt;1</td>
<td>67</td>
</tr>
<tr>
<td>41–50</td>
<td>8</td>
<td>20.0</td>
<td>1.9</td>
<td>1–2</td>
<td>25</td>
</tr>
<tr>
<td>50 and above</td>
<td>6</td>
<td>15.0</td>
<td>1.3</td>
<td>&lt;1</td>
<td>66</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Illiterate</td>
<td>5</td>
<td>12.5</td>
<td>1.2</td>
<td>&lt;1</td>
<td>80</td>
</tr>
<tr>
<td>Middle (less than grade 10)</td>
<td>12</td>
<td>30.0</td>
<td>1.2</td>
<td>&lt;1</td>
<td>83</td>
</tr>
<tr>
<td>Matric (grade 10)</td>
<td>9</td>
<td>22.5</td>
<td>1.7</td>
<td>1–2</td>
<td>44</td>
</tr>
<tr>
<td>Faculty of Arts (grade 12)</td>
<td>6</td>
<td>15.0</td>
<td>1.8</td>
<td>1–2</td>
<td>33</td>
</tr>
<tr>
<td>Graduate</td>
<td>5</td>
<td>12.5</td>
<td>2.6</td>
<td>1–2</td>
<td>20</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>3</td>
<td>7.5</td>
<td>1.3</td>
<td>&lt;1</td>
<td>66</td>
</tr>
<tr>
<td>Business duration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;1</td>
<td>5</td>
<td>12.5</td>
<td>1.0</td>
<td>&lt;1</td>
<td>100</td>
</tr>
<tr>
<td>1–5</td>
<td>16</td>
<td>40.0</td>
<td>1.3</td>
<td>&lt;1</td>
<td>75</td>
</tr>
<tr>
<td>5–10</td>
<td>7</td>
<td>17.5</td>
<td>2.2</td>
<td>1–2</td>
<td>14</td>
</tr>
<tr>
<td>&gt;10</td>
<td>12</td>
<td>30.0</td>
<td>2.1</td>
<td>1–2</td>
<td>42</td>
</tr>
</tbody>
</table>

*1 = <1 ha, 2 = 1–2 ha, 3 = 2–4 ha, 4 = >4 ha (1 ha = 2.4711 acres).
enhance their business as compared with experienced ones.

Regarding area under rose cut flower cultivation, 57.5% of the growers were growing roses on less than 1 ha of land, whereas 32.5% were producing roses on 1–2 ha of land followed by 5% on 2–4 ha and greater than 4 ha of land each (Table 1, Fig. 1B). Thus, most of the growers had a small area under cut rose production. Probable reasons for this include overall small...
landholdings, lack of initial high capital needed for expansion, lack of infrastructure, perishability of the product, and risk of marketing (Ahmad et al., 2006, 2008). Of the variables surveyed, educational level and business experience of the growers were positively correlated ($r^2 = 0.3902, P = 0.0128$ and $r^2 = 0.4515, P = 0.0034$, respectively) with rose production area such that increasing education and longer business experience resulted in larger farms. For example, 80% or more of the farmers who were illiterate or left before completing grade 10 had farms of less than 1 ha, while 80% of those who graduated college had farms more than 1 ha in size (Table 1). The postgraduate owners mostly had farms less than 1 ha because many were part-time producers rather than full-time growers. One hundred percent of farmers who had been in business for less than a year had 1 ha or smaller farms, while 58% of those in business for 10 or more years had more than 1 ha in production.

All the growers surveyed reported that they were not solely dependent on roses but were also growing other floricultural crops, including gladiolus (Gladiolus hybrids), statice (Limonium spp.), and tuberose (Polianthes tuberosa). It is commercially important for growers to diversify their crops according to the market demand and to reduce the risk of crop failure from natural calamities.

Regarding number of cultivars grown, 42.5% of producers were growing five or more rose cultivars per acre (0.4 ha) followed by three cultivars by 22.5% of producers, four cultivars by 17.5% of producers, two cultivars by 12.5% of producers, and one cultivar by 5% of producers. In the leading African cut rose–producing countries like Colombia and Ecuador, cultivars are also generally renewed every 5–6 years (Mercurio, 2007). Not surprisingly, the established farms kept their plants in production longer than new farms, mostly due to being in business longer and also due to having more production experience that allowed them to better maintain plants in a productive condition (Table 2).

Of the 40 growers surveyed, 65% obtained the best-quality flowers during January to March, 25.5% during October to December, and 32.5% during both time periods together (October to March) (data not presented). No quality flowers were produced during April to September. Climatic conditions in Punjab are most conducive for rose growth from October to March with mild temperatures of 15–25 °C during day and 5–15 °C at night, 60–80% relative humidity, and limited cloud cover resulting in high light. During summer months, April to September, higher temperatures do not favor production of good-quality flowers and cut stems have short stems and small flower diameters.

The majority of respondents (97.5%) were growing roses in open fields, whereas only 2.5% were using greenhouses. Few growers in Pakistan have sufficient capital to afford the construction of greenhouses and the high cost of energy required to operate them. Since most growers have small landholdings, it is unlikely that they can save sufficient capital to construct a greenhouse without support by governmental or other agencies. However, 14–33% of the experienced growers who were in business more than 5 years were using greenhouses, indicating that they were successful enough to afford the greenhouses (Table 2). As smaller businesses develop and become larger, they may also be able to build greenhouses. The use of high tunnels may be a lower-case alternative to greenhouses.

The growers were asked if they produced roses for special occasions or not. Of the total 40 respondents, 60% produced flowers for special occasions, while the rest 40% did not produce flowers for special occasions. The majority of the farmers who were illiterate or had less than a 10th grade education did not produce their flowers for special occasions, while 100% of farmers with a 10th grade or higher education took advantage of the higher prices received for flowers used for special occasions to maximize their profitability (Table 3). Only 66% of postgraduate farmers sold flowers for special occasions, but many were part-time producers not able to take advantage of special occasions.

Regarding pruning time, 57.5% of respondents pruned roses during

<table>
<thead>
<tr>
<th>Business duration (yr)</th>
<th>Time plants were kept in production</th>
<th>Production environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1–2</td>
<td>3–4</td>
</tr>
<tr>
<td>&lt;1</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>1–5</td>
<td>0</td>
<td>15</td>
</tr>
<tr>
<td>5–10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>&gt;10</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
December to January, while 42.5% pruned during May to June. During December to January, the climate does not support rapid growth due to low temperatures. Roses pruned at this time of year produce vigorous shoots that produce high-quality flowers in the following spring. On the other hand, during summer, due to high temperatures (above 40 °C) in study area, poor-quality, unmarketable flowers are produced. If such flowers are marketed, they sell for low prices, which are not economically profitable. Consequently, growers prune their roses during May to June to reduce their harvest labor cost and prepare the plants to produce more and higher quality flowers later in the year.

**Information Sources.** Of the growers surveyed, 75% of respondents obtained information on the latest technologies through seminars and lectures, while 12.5% relied on books, 7.5% on agricultural magazines, and only 5% on Internet (Fig. 1D). The results stress that access to the growers to the latest communication technologies should be improved. Growers thought that agricultural universities should provide technical training (57.5%), whereas 12.5% responded that research institutions should provide training to the growers and 30% suggested that both research institutions and agricultural universities should help the growers. The survey also revealed that growers had no financial or technical assistance from any public or private organizations for coping with their problems (data not presented).

Regarding specific training required by the growers, 52.5% reported that they need training in postharvest handling, while 47.5% reported that they need training in soil and nutrition management. The need for training and assistance is apparent as all of the growers reported that they resolved 100% of problems on their own without assistance from the government or the private organizations (data not presented).

**Cultivation Problems.** Of those surveyed, 35% of growers blamed environmental conditions and soil salinity for impeding plant growth, while 27.5%, 10%, 10%, and 7.5% reported that postharvest handling, nutrition, salinity, and soil/growing media, respectively, were the major problems in rose cultivation (Fig. 1E). The results suggested that climatic and edaphic factors restrict commercial rose growth and productivity in the study area. These problems may be overcome by using best management practices as well as greenhouse production with proper media and well-balanced nutritional programs containing all required macro- and micronutrients.

Regarding postharvest problems, 60% of respondents reported lack of cold storage facilities as a major hurdle, while 22.5% and 17.5% indicated that shorter vase life and improper non-refrigerated transportation, respectively, were the major problems (Fig. 1F). Thus, the lack of infrastructure is a major problem.

**Harvest and Postharvest Management Practices.** Regarding harvest stage, 60% of respondents reported that they harvested flowers at partially open bud stage, whereas 40% harvested flowers at tight bud stage. Harvest stage depends on where the flowers will be marketed. Flowers are harvested at partially open bud stage when marketed in nearby local markets and at tight bud stage when transported to distant markets. As majority of the growers were harvesting flowers at partially open bud stage, most flowers were sold in the nearby local markets. All the growers who were illiterate or had less than a 10th grade education harvested their flowers when they were partially open, while the more educated growers harvested them when they were tighter indicating that they were more knowledgeable about proper harvest standards (Table 3).

Regarding postharvest handling, 92.5% of respondents placed their flowers in water, while 7.5% used ice for this purpose. No one reported using any floral preservatives (data not presented). For packaging materials, 60% of growers used wooden crates, while the rest 40% used spent cardboard boxes without ventilation holes and layers of dry grass in-between (data not presented). Sixty percent of growers use ice for storage of cut roses, while 40% marketed flowers without storage (data not presented). Except for the part-time postgraduate growers, the more educated growers used ice, indicating that they had a comparatively better understanding of the perishability of their produce and had better packaging and storage conditions (used ice) for their product than other growers (Table 3). The roses were being transported by rail (40%), both rail and non-refrigerated trucks (30%), non-refrigerated trucks (27.5%), and carts and bicycles (2.5%) (Fig. 1G). All the transport facilities required by the growers, 67% reported

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**Table 3.** Forty growers randomly selected in Punjab, Pakistan, and interviewed using a detailed questionnaire regarding rose production: The effect of education level on production of cut roses for special occasions, reason why flowers are predominantly marketed locally, harvest of buds either tight or partially open, and either no storage of cut stems or storage using ice.

<table>
<thead>
<tr>
<th>Education</th>
<th>Production for special occasions</th>
<th>Reasons for marketing only locally</th>
<th>Harvest stage of buds</th>
<th>Storage method</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Yes</td>
<td>No</td>
<td>Non-cooperation of government</td>
<td>Ignorance of exports</td>
</tr>
<tr>
<td>Illiterate</td>
<td>20</td>
<td>80</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Middle (less than grade 10)</td>
<td>8</td>
<td>92</td>
<td>8</td>
<td>50</td>
</tr>
<tr>
<td>Matric (grade 10)</td>
<td>100</td>
<td>0</td>
<td>89</td>
<td>11</td>
</tr>
<tr>
<td>Faculty of Arts (grade 12)</td>
<td>100</td>
<td>0</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Graduate</td>
<td>100</td>
<td>0</td>
<td>40</td>
<td>40</td>
</tr>
<tr>
<td>Postgraduate</td>
<td>67</td>
<td>33</td>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>
were non-refrigerated, whereas refrigeration is a prerequisite to preserve quality of flowers during transporta-
tion (Mercurio, 2007). These results revealed a deficiency in the proper in-
frastructural facilities required to pre-
serve the quality of this highly perishable commodity. During October to No-
Vember and February to March, good-
quality flowers were produced by
growers, but due to unavailability of
proper postharvest facilities, more
than one-third of the product was
wasted, reducing net return and prof-
itability (Ahmad and Khan, 2009).

Marketing. All the growers in-
terviewed marketed their flowers in
local (Pakistan) markets and no one
reported that they exported their
flowers (data not presented). Producers
indicated that they were only selling
locally because of non-cooperation of
government organizations (45%), igno-
rance of international standards (30%),
and poor-quality production (25%)
(Fig. 1H). The growers with limited
or no education felt that their product
quality was too low to allow export-
ing, whereas more educated growers
felt that the lack of support from the
government prevented them from
exporting (Table 3). Regarding where
the producers market their flowers,
22.5% reported that they sold their
flowers in Lahore, 7.5% in Islamabad,
2.5% in Karachi, whereas 67.5% were
marketing their roses in all the afore-
mentioned markets (data not presented).

Discussion
Rose is the leading cut flower
crop in Pakistan and is grown on an
area of ~526 ha in Punjab, which is
highest for any flower crop in the
province (Khan, 2005). Majority of
rose growers in Punjab have small
landholdings of less than 1 ha with
larger farms run by educated (except
postgraduates, who run part-time busi-
ness) and experienced growers. New
entrants in this business were more
educated than older ones and were
interested in training on production
and postharvest handling techniques
to improve their business. Almost half
of the producers started growing
roses in the last 5 years and is a posi-
tive sign for development of rose
industry as a non-traditional high-
value crop to incorporate into tra-
tional wheat–rice or wheat–cotton
cropping pattern in the province.
Ex-
perienced growers were maintaining
plants in production for a longer pe-
riod as compared with newer pro-
ducers. So far, growers were selecting
cultivars on the basis of flower color
(preference is given to red color as it
has high market demand in local mar-
kets) (Ahmad et al., 2008).

Because of high temperatures
during summer months, good-quality
flowers were only produced from Oc-
tober to March as there is limited com-
mercial greenhouse production so far in
the country to control environmental
conditions. The unavailability of cap-
greenhouse construction and the
shortage and high cost of electricity
prevented growers from building many
greenhouses.

Currently, there are no programs
to train growers on modern cultiva-
tion and postharvest handling tech-
niques or to provide elite cultivars
that could maximize yield of good-
quality cut roses. Respondents of the
survey stressed that concerned agri-
cultural institutes and government
organizations should train them.

Regarding postharvest handling
facilities, growers had little idea on
how to protect their perishable prod-
uct after harvest; thus, more than one-
third of the production was wasted
(Ahmad and Khan, 2009). The major-
ity of growers were using primitive
modes of storage, packaging, and trans-
portation, such as placing stems on bare
soil after harvest, dipping flower buds
in stagnant dirty water, packaging in
wooden boxes, and transporting on
bikes and carts out of water and under
direct sunlight (Ahmad et al., 2008).

However, most growers do not have
the financial resources to implement
high-quality handling techniques due
to lack of capital facilities, human re-
source development, and poor infra-
structure, resulting in the lack of a
cool chain system for preserving cut
rose quality. Consequently, producers
rely on traditional agro-based tech-
niques for production of cut rose
flowers (Ahmad, 2009).

Conclusion
In summary, cut rose production is a
potential enterprise that can be
expanded by adopting modern tech-
niques and innovations and facilitating
growers’ community through training,
planting elite cultivars, infrastructural
facilities, interest-free loans, and assis-
tance in marketing of their product at
reasonable prices. Growers were using
outdated production practices that pre-
vent the production of high-quality
product demanded by the international
markets. Moreover, public and private
sector negligence has resulted in less-
than-optimum growth of this sector;
however, its potential has now been
realized and initiatives are being taken
by various organizations for boosting
this industry in the country (Qasim
et al., 2006). It is likely that similar
recommendations would apply to other
countries that have cut flowers industries
at a similar stage of development.

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