

Commercial Chrysanthemum Cultivation Under Polyhouse: Construction, Production Technology, Crop Management, Harvesting and Economic Potential of One Acre

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Chrysanthemum is one of the most commercially important ornamental flower crops cultivated in India and throughout the world. It is grown as a cut flower, spray flower, loose flower, pot plant and for applications such as garlands, bouquets, religious functions, floral decorations and landscaping. The crop belongs to the family Asteraceae and is scientifically referred to commercially as *Chrysanthemum* × *grandiflorum* or *Dendranthema grandiflora*, depending on the taxonomic convention used. Its commercial importance is associated with the large diversity of flower colours, forms, sizes, stem characteristics and flowering responses available among cultivars. ICAR-IIHR describes chrysanthemum as a leading commercial flower crop and emphasizes the importance of good agricultural practices, quality planting material, suitable cultivars, environmental management, nutrition, irrigation and pest and disease management for protected production.



Polyhouse cultivation provides an opportunity to regulate the crop environment and produce flowers with improved uniformity and quality. The principal advantage of protected cultivation is not simply protection from rain; rather, it is the ability to manage temperature, relative humidity, irrigation, nutrition, ventilation, light and photoperiod. Chrysanthemum is particularly suitable for this system because flowering is strongly influenced by day length. It is a short-day plant for flowering, and controlled photoperiod manipulation can be used to regulate vegetative growth and flowering time. That chrysanthemum is a facultative short-day plant for flower-bud initiation and an obligate short-day plant for flower-bud development, making photoperiod management one of the most important components of commercial production.

For a one-acre commercial polyhouse, the gross land area is approximately 4,047 m². At the commonly recommended spacing of 15 × 15 cm for spray chrysanthemum, the theoretical plant population is approximately 180,000–182,000 plants. However, the complete polyhouse cannot be planted because pathways, drainage, service areas, fertigation infrastructure and working space are required. Therefore, for a commercial business plan, approximately 150,000–165,000 plants per acre is a practical range, with **160,000 plants per acre** being a useful planning value. A Telangana government Centre of Excellence farmer case reported approximately 160,000 plants per acre, a 90-day crop and 17,000 bunches per acre, demonstrating that this population is commercially achievable under Indian polyhouse conditions.

The crop duration depends on cultivar, planting date, temperature, photoperiod, planting material and management. Under favourable protected conditions, approximately 90–120 days can be used as a commercial planning range. Three crop cycles per year may be

possible in suitable locations when crop scheduling, nursery production, photoperiod management and market timing are properly coordinated. However, three cycles should be treated as a planning possibility rather than a guaranteed biological outcome. Published Indian research has demonstrated significant variation among cultivars, planting dates and growing environments.

Economically, chrysanthemum can provide attractive returns, but profitability is highly dependent on marketable flower yield and selling price. A government farmer case reported ₹10.20 lakh gross revenue and ₹2.20 lakh net return per acre per crop from approximately 17,000 bunches at ₹60 per bunch, with three reported seasons giving ₹6.60 lakh annual net return. This is a historical field-level case and should not be interpreted as a guaranteed present-day return. More recent research has demonstrated that cultivar selection, irrigation, fertigation and nutrient management can substantially influence yield and economic returns.

Introduction

Chrysanthemum is an important ornamental flower crop with considerable commercial value in India. It is cultivated under both open-field and protected conditions and is marketed in several forms, including loose flowers, cut stems, spray flowers, standard flowers and potted plants. Its flowers are available in white, yellow, pink, red, purple, bronze, green and other colours, while the flower forms range from simple and decorative types to pompons, buttons, spiders, disbuds and large exhibition blooms. This diversity gives chrysanthemum an unusually broad market base compared with many other flower crops. Recent ICAR literature emphasizes that chrysanthemum has applications in cut flowers, loose flowers, pot culture, garden decoration and religious use and that year-round production can be approached through cultivar and photoperiod manipulation.

The commercial value of chrysanthemum is closely related to the quality of the harvested product. Buyers generally evaluate stem length, stem strength, number and uniformity of flowers, flower diameter, colour, freshness, pest and disease freedom and post-harvest life. Consequently, the objective of protected cultivation should not simply be maximum biomass. The production system should be designed to produce a high percentage of marketable stems with consistent quality.

Polyhouse cultivation is particularly suitable for chrysanthemum because environmental conditions can be modified more effectively than in open-field cultivation. A polyhouse can reduce direct exposure to heavy rainfall, wind and some environmental stresses while enabling controlled irrigation and fertigation. It also provides an environment in which supplemental lighting or photoperiod manipulation can be used to control flowering. Research comparing spray chrysanthemum under polyhouse and open-field conditions has reported superior performance under polyhouse conditions for several yield and quality characteristics, although the response depended on cultivar and planting date.

The commercial production of chrysanthemum under polyhouse therefore requires an integrated approach. The structure, crop variety, planting density, irrigation, fertigation, photoperiod, pinching, pest management, disease management, harvesting and marketing must all be planned together. A technically strong polyhouse with poor crop management may not be profitable, while a good cultivar and production protocol can perform poorly if the structure does not provide sufficient ventilation or if market timing is ignored.

Importance of Chrysanthemum as a Commercial Flower Crop

Chrysanthemum has become an important component of the Indian floriculture sector because of its multiple market uses. chrysanthemum flowers are widely used for religious ceremonies, garlands and social functions, while cut chrysanthemums are used in bouquets, hotel decoration, weddings, institutional decoration and the ornamental flower trade. Potted chrysanthemum also has a strong market among nurseries, garden centres and urban consumers. The crop can therefore be diversified according to the target market instead of

depending on a single product category. ICAR describes the crop as having commercial opportunities in rooted cuttings, potted plants, loose flowers and cut flowers.

One of the major advantages of chrysanthemum is the possibility of market-oriented production. Since flowering is photoperiod-sensitive, production can be scheduled to some extent by manipulating light and dark periods. This is particularly important in a polyhouse where artificial lighting and blackout or covering systems can be incorporated. The ability to manipulate flowering provides an opportunity to target festival seasons, wedding seasons and periods of reduced supply.

The crop also provides an opportunity for continuous business through planting material production. A commercial farm does not necessarily have to purchase all its planting material for every cycle. With appropriate mother-plant management and disease-free propagation, rooted cuttings can be produced as an additional enterprise. However, the mother-stock area must be maintained separately and carefully monitored for pests, diseases and genetic uniformity.

Objective of One-Acre Polyhouse Chrysanthemum Production

The objective of the proposed one-acre project is to establish a commercially manageable protected-cultivation system capable of producing high-quality spray or cut chrysanthemum flowers with controlled irrigation, fertigation and photoperiod management.

The proposed production system is based on approximately 4,047 m² gross area, with a practical crop population of approximately 160,000 plants. The system uses a naturally ventilated polyhouse rather than a completely climate-controlled greenhouse because naturally ventilated structures generally require lower capital investment and are more appropriate for many Indian production environments.

The project should be designed around four major objectives. The first is to achieve high plant establishment and uniform crop growth. The second is to produce long, strong and commercially acceptable stems. The third is to achieve flowering within the desired market window. The fourth is to obtain a high proportion of marketable flowers and minimize losses due to pests, diseases, physiological disorders and post-harvest deterioration.

Selection of Site for One-Acre Polyhouse

Site selection is the first major decision in a commercial polyhouse project. The land should be relatively level, well drained and free from prolonged waterlogging. The location should have reliable access to good-quality irrigation water, electricity, roads and labour. The farm should also be sufficiently close to the intended market because chrysanthemum is a perishable product and transport conditions can strongly influence the final selling price.

Water quality should be tested before construction. Important parameters include pH, electrical conductivity, bicarbonate, chloride, sodium, calcium, magnesium and other relevant ions. Poor-quality irrigation water can cause salinity, nutrient imbalance and clogging of drip emitters. Soil should also be tested for pH, EC, organic carbon, available nitrogen, phosphorus and potassium and, where required, micronutrients and soil-borne pathogens.

The site should have sufficient space around the polyhouse for water tanks, fertigation equipment, electrical installations, packing, vehicle movement, waste disposal and future expansion. Drainage around the structure is particularly important because water should not accumulate around the foundation during heavy rainfall.

Polyhouse Construction

A one-acre commercial polyhouse should be designed as an engineered structure rather than simply as a plastic-covered field. The major components include the GI frame, columns, arches, ridge structure, gutters where applicable, UV-stabilized covering material, insect-proof net, ventilation openings, doors, side curtains, drainage, irrigation infrastructure and electrical systems.

Naturally ventilated polyhouses are particularly suitable for chrysanthemum in many Indian regions. ICAR-IIHR recommends naturally ventilated polyhouses for cut

chrysanthemum and specifies environmental conditions that include approximately 16–18°C night temperature and 24–28°C day temperature, with relative humidity preferably around 60–70%. Humidity above 95% should be avoided because it promotes soft growth and increases fungal and bacterial disease risk.

The orientation, structure and ventilation arrangement should be finalized according to local wind direction, rainfall, solar radiation and engineering standards. TNAU identifies orientation, greenhouse design, environmental factors, growing structures, fertigation and post-harvest handling as major components of greenhouse production.

The covering film should have adequate UV stabilization and should be selected according to the expected service life and local environmental conditions. Insect-proof netting should be installed at ventilation openings to reduce the entry of thrips, aphids, whiteflies and other insect pests.

A double-door entry system or simple hygiene zone is strongly recommended. Workers should avoid moving directly from infected crops or outside fields into the production area without appropriate sanitation. Tools should be cleaned regularly, and weeds around the structure should be controlled.

Government Cost Norms and Financial Planning for the Structure

Government cost norms provide useful benchmarks for project preparation but should not be confused with actual contractor quotations. The National Horticulture Board has historically listed a cost of approximately ₹33.76 lakh per acre for a tubular polyhouse with drip and fogger systems and a crop-specific cultivation cost of ₹17.04 lakh for rose, liliun and chrysanthemum under its protected-cultivation cost norms, with a project-mode ceiling of ₹60 lakh per acre including specified add-on components under that guideline.

More recent MIDH 2025 guidelines list ₹450/m² as a cost norm for planting material and cultivation of rose, chrysanthemum and liliun grown in polyhouses, with assistance of 50% up to a maximum area of 2,500 m² per beneficiary or on a pro-rata basis for smaller areas, subject to scheme conditions.

Therefore, an investor or farm developer should not calculate the entire one-acre project simply by multiplying one government subsidy figure. The final project budget should separately account for structure, irrigation, fertigation, planting material, crop establishment, working capital, electricity, labour, harvesting, packing and maintenance.

Internal Layout of the One-Acre Polyhouse

The internal layout should be designed for efficient movement of labour, irrigation uniformity and harvesting. Raised beds are preferable to flat beds where drainage is a concern. TNAU protected-cultivation recommendations use approximately 1 m bed width for cut chrysanthemum production.

The final bed length should be adjusted to the structure. Long uninterrupted beds may reduce operational efficiency, so the layout should provide suitable cross paths. Main paths should be sufficiently wide for workers, harvesting crates and maintenance equipment.

Approximately 10–15% of gross area may be reserved as a planning allowance for paths, drainage, entry zones, working areas and infrastructure. This is why a theoretical population calculated over the complete 4,047 m² should not be treated as the actual farm population.

At 15 × 15 cm spacing, the mathematical population is approximately 182,000 plants per acre. After allowing for non-crop areas, approximately 160,000 plants is a practical commercial planning figure.

Suitable Chrysanthemum Types and Varieties

Variety selection is one of the most important factors determining the success of the project. The choice should depend on whether the farm wants spray flowers, standard cut flowers, loose flowers or potted plants.

Spray chrysanthemums produce multiple flower heads on each stem and can be suitable where bunching and bouquet production are targeted. Standard chrysanthemums are normally managed to produce a larger individual flower, making them appropriate for premium cut-flower markets.

Recent Indian research under polyhouse conditions demonstrated significant differences among chrysanthemum cultivars. In an eight-cultivar evaluation, White Marble produced the highest plant height and flower number per plant among the evaluated cultivars, while Yellow Marble produced large flowers and Green Button produced high numbers of primary branches. The study identified Bontempi, Hamilton, Arctic Queen and Champagne Yellow as promising cultivars for commercial protected cultivation.

Older IIHR research also demonstrated that cultivar response varies with planting date and production environment. In a study involving 15 spray chrysanthemum cultivars, polyhouse cultivation generally produced higher yield than open-field cultivation, while Arati showed particularly strong yield performance under the experimental conditions.

Therefore, a commercial farm should not plant the entire acre with an untested cultivar. A small trial of two to four promising varieties should first be evaluated for flower colour, stem length, yield, disease response, market demand and price.

Planting Material

High-quality planting material is essential because the entire production system begins with the genetic and health quality of the cutting. ICAR-IIHR recommends improved varieties or hybrids released by research organizations or planting material from registered nurseries. Planting material should be uniform, vigorous, true to type and free from pests and diseases. Terminal cuttings and tissue-culture plants are commonly used for protected cut-flower production.

IIHR describes the use of 5–7 cm terminal cuttings from healthy mother plants. Basal leaves are removed, the remaining leaf area may be reduced, and the basal portion can be treated with approximately 1,000 ppm IBA for around 30 seconds to improve rooting. The cuttings are then rooted in suitable nursery conditions.

For a commercial population of 160,000 plants, the farm should not purchase exactly 160,000 cuttings. A small additional quantity should be maintained to replace dead or weak plants. A procurement target of approximately 165,000–170,000 healthy rooted cuttings can therefore be used as a practical planning figure.

Nursery Production and Rooting

The nursery should preferably be physically separated from the main production area. This allows better monitoring and prevents the introduction of pests and diseases into the commercial crop.

Rooting media should provide adequate aeration, moisture retention and drainage. Cocopeat, sand, perlite or combinations with suitable nursery substrates can be used depending on local availability and nursery protocol.

The cuttings require high humidity during the initial rooting stage, but excessive water should be avoided. Once adequate roots develop, plants should gradually be hardened before transplanting into production beds. Hardening reduces transplant shock and improves establishment.

The nursery should be monitored for damping-off, fungal infections, thrips and other problems. Weak or diseased plants should be removed rather than transferred to the main crop.

Soil and Growing Medium Preparation

Chrysanthemum requires a well-drained growing medium. TNAU recommends well-drained red loamy soil with a pH of approximately 6–7 for commercial chrysanthemum. In protected cut-flower production, the growing medium may consist of soil combined with organic

matter and cocopeat. A TNAU protected-cultivation technology for cut chrysanthemum used soil, compost and cocopeat in a 1:1:2 ratio under a standardized system.

The exact medium should be based on the existing soil. If the farm has heavy clay soil, adding organic matter and appropriate amendments may improve drainage. If the soil is sandy, additional organic matter may improve moisture and nutrient retention. The bed should not remain saturated. Poor drainage can lead to root disorders, nutrient imbalance and disease development.

Planting Density and Spacing

Plant spacing directly affects canopy development, stem length, flower number, disease incidence and resource competition. For spray chrysanthemum under protected conditions, 15 × 15 cm is a commonly recommended spacing. TNAU's protected cut-chrysanthemum technology also describes 20 × 15 cm spacing for Yellow Regan in its standardized system. For the proposed commercial project, **15 × 15 cm should be used as the primary planning spacing for spray chrysanthemum**, subject to cultivar-specific validation.

At 15 × 15 cm:

One plant occupies:

$$0.15 \times 0.15 = 0.0225 \text{ m}^2.$$

Theoretical population in one acre:

$$4,047 \div 0.0225 \approx 179,867 \text{ plants.}$$

Using 4,050 m² gives approximately 180,000 plants.

The practical number becomes lower after removing pathways, drainage and service space. Therefore, approximately **160,000 plants/acre** is recommended for commercial project planning.

Climate Requirement

Temperature management is critical because both vegetative growth and flowering are sensitive to temperature. ICAR-IIHR recommends approximately 24–28°C during the day and 16–18°C at night for quality cut-flower production under protected cultivation. Relative humidity around 60–70% is desirable, while RH above 95% should be avoided. TNAU gives a broader suitable range of approximately 20–28°C during the day and 15–20°C at night for chrysanthemum. It also identifies the crop as a short-day plant and emphasizes planting and scheduling to coincide flowering with appropriate short-day conditions.

In southern Indian conditions, particularly during hot months, the polyhouse may experience temperatures above the ideal range. Therefore, side ventilation, ridge ventilation, shade management, fogging or misting and irrigation scheduling may be necessary. During rainy periods, humidity becomes the main concern. Excessive humidity reduces transpiration and increases fungal disease pressure. Ventilation should therefore be increased whenever external conditions permit.

Photoperiod Management

Photoperiod is one of the most scientifically important aspects of chrysanthemum production. Chrysanthemum is a short-day flowering plant. ICAR-IARI describes it as a facultative short-day plant for flower-bud initiation and an obligate short-day plant for flower-bud development. The minimum continuous dark period required for flower-bud initiation is reported to be approximately 9.5 hours per day. During vegetative growth, growers can use supplemental lighting to maintain a sufficiently long photoperiod and delay premature flowering. Once the desired vegetative size is achieved, the lighting programme can be modified so that plants receive the required uninterrupted dark period for flower initiation and development.

This technique is particularly useful when production needs to be scheduled for specific market periods. For example, a farm may use long-day management during the initial vegetative stage and then initiate short-day conditions to synchronize flowering. The exact lighting schedule should be determined for each cultivar because cultivars differ in

photoperiod sensitivity. The objective is not simply to provide more light but to control the biological signal responsible for flowering.

Irrigation Management

Drip irrigation is the preferred irrigation method because it delivers water directly to the root zone and is compatible with fertigation. Cut-chrysanthemum technology provides irrigation recommendations based on a controlled soil-moisture system, recommendations indicate that irrigation should be adjusted according to crop stage and growing conditions. A fixed daily irrigation quantity should not be applied throughout the crop. Young plants have relatively small root systems and require less water. As canopy size increases, water demand increases. During flowering, irrigation must remain sufficient but should not create prolonged saturation. Research evaluated different irrigation levels and fertigation regimes and found significant effects on flower yield, water-use efficiency and economic returns. The study found cultivar-specific responses, with Autumn White outperforming Autumn Pink under the tested conditions. This reinforces the principle that irrigation should be based on crop demand rather than a single universal schedule.

Fertigation and Nutrient Management

Fertigation is one of the major advantages of polyhouse production because nutrients can be supplied with irrigation water in small and frequent doses. Assam Agricultural University research compared 50%, 75% and 100% fertigation levels with conventional fertilizer application. In spray chrysanthemum, the 75% fertigation treatment produced the highest values for several measured parameters, including plant height, leaf number, flower diameter, vase life and yield under the experimental conditions.

This does not mean that every commercial farm should automatically apply 75% of a recommended dose. Rather, it demonstrates that efficient fertigation can improve nutrient-use efficiency and that higher fertilizer input does not necessarily produce higher economic returns. Fertigation should be divided according to crop stage. During establishment, nutrient concentration should remain moderate. During vegetative growth, adequate nitrogen is required for canopy and stem development. During bud initiation and flower development, potassium, phosphorus, calcium, magnesium and micronutrients become increasingly important for flower quality and structural strength.

Organic Matter and Basal Fertilization

Organic matter plays an important role in improving soil structure, microbial activity and water-holding capacity. TNAU recommendations for commercial chrysanthemum include approximately 25 tonnes of FYM per hectare along with 125:120:25 kg NPK/ha under its open-field production recommendation. For polyhouse production, the actual nutrient programme should be adjusted according to soil testing and the selected fertigation system. Excess fertilizer should be avoided because high salt concentration can damage roots, reduce water uptake and create physiological disorders. Frequent low-dose fertigation is usually more appropriate than excessive one-time fertilizer application.

Pinching

Pinching is an important cultural operation in spray chrysanthemum because it modifies plant architecture and encourages lateral branching. TNAU recommends the first pinching approximately three weeks after planting and a second pinching approximately five weeks after planting for its cut-chrysanthemum package. The actual timing should depend on the cultivar, plant vigour and production objective. Pinching plants too early may delay establishment, while very late pinching may reduce the desired branching pattern. For commercial spray production, the objective is to produce sufficient lateral branches and uniform flowering stems. The number of pinching operations should therefore be finalized after observing the cultivar response during the initial production cycle.

Disbudding

Disbudding is mainly important for standard chrysanthemum production. In spray chrysanthemums, the lateral flower buds are generally retained because multiple flowers per stem are desired. TNAU specifically recommends that in spray varieties the large apical bud may be removed while lateral buds are retained. In standard varieties, lateral buds are removed and the apical bud is allowed to develop into a large terminal flower. This difference is important because the commercial objective changes according to flower type. Spray production focuses on flower number per stem, whereas standard production focuses on flower size and stem quality.

Staking and Crop Support

High-density chrysanthemum crops can become crowded as plants grow. Strong stems are essential for cut-flower quality. Support nets or horizontal crop-support systems can be installed so that stems remain upright. The support system should be adjustable as the plants grow. A properly supported crop has better canopy organization, improved air movement and easier harvesting. It also reduces stem bending and mechanical damage.

Weed Management and Sanitation

Weeds compete with chrysanthemum for water and nutrients and can also act as hosts for pests and diseases. Because the crop is grown under a protected structure, weeds should be removed manually or through suitable non-chemical approaches wherever possible. The area immediately outside the polyhouse should also be kept clean because weeds can harbour insects. Plant debris should be removed after harvest. Diseased plant material should not be left on the beds or placed in irrigation channels. Sanitation is particularly important in repeated-cycle production because pathogens can survive between crops.

Integrated Pest Management

Important pests of chrysanthemum include thrips, aphids, whiteflies, mites, leaf miners and caterpillars. The first line of protection should be preventive. Insect-proof nets should be maintained properly, planting material should be pest-free, weeds should be controlled and workers should regularly inspect the crop. Yellow and blue sticky traps can be used as monitoring tools. Their primary purpose is early detection and population monitoring, although they may also contribute to suppression. IARI greenhouse research demonstrated that integrated treatments were more effective against important chrysanthemum insect pests than individual interventions in the experimental system. Therefore, chemical pesticides should not be the first and only method of management. Crop scouting, sanitation, biological methods and chemical interventions, when necessary, should be combined within an IPM programme.

Disease Management

Important diseases can include Fusarium wilt, powdery mildew, Botrytis and other leaf or flower diseases. TNAU identifies Fusarium wilt symptoms as yellowing and browning of leaves, progressive death from the base upward, stunting and possible failure to flower. It recommends disease-free planting material, sanitation, crop rotation, monitoring and removal of infected plants as important management practices.

White rust is another serious concern because protected structures can create favourable humidity conditions. Research under greenhouse conditions has reported higher white-rust incidence under approximately 25–27°C with high relative humidity of 85–90%, illustrating why ventilation and humidity management are important. Disease prevention should therefore start before planting rather than after symptoms appear. Clean planting material, clean beds, proper drainage, adequate ventilation and removal of infected plants are fundamental.

Crop Monitoring

A commercial one-acre polyhouse should maintain a crop monitoring register.

The farm manager should record:

Planting date, cultivar, batch number of planting material, number of plants planted, mortality, irrigation, fertilizer application, pest observations, disease observations, pinching date, lighting schedule, flowering date, first harvest, total harvested stems, rejected stems, selling price and final revenue. This information is extremely useful when planning subsequent cycles. For example, if White Star flowers earlier than Yellow Star under a particular lighting schedule, the next crop can be scheduled according to the market window.

Flowering and Crop Duration

Crop duration is not identical for every chrysanthemum cultivar. The Telangana farmer demonstration reported a 90-day crop under polyhouse conditions. However, ICAR-IIHR and research studies demonstrate that cultivar, planting date, temperature and photoperiod influence flowering. In the study of 15 spray cultivars, planting date changed flowering time and flower yield, and polyhouse conditions produced different responses compared with open-field conditions. Therefore, for a business plan, the appropriate range is approximately: **90–120 days per crop cycle.**

A farm can target approximately three cycles per year when nursery preparation, crop duration, sanitation and market timing allow it. The interval between crops should include crop removal and sanitation. If the farm wants continuous production, different sections can be planted at staggered intervals rather than planting the entire acre on one date.

Harvesting

Harvesting should be performed according to the target market. Spray chrysanthemums should be harvested when the flower cluster reaches the required commercial stage and the stems have sufficient strength. Standard chrysanthemums should be harvested when the individual flower reaches the desired development stage. Harvesting during the cooler part of the day is generally preferred because flowers are less exposed to heat stress. The cut stems should immediately be placed in clean water or an appropriate hydration solution. Mechanical damage should be minimized because bruised stems and flowers deteriorate more rapidly.

Grading and Bunching

After harvesting, flowers should be sorted according to stem length, flower size, number of flower heads, colour, freshness and physical damage. A uniform bunch generally obtains a better market response than a mixed-quality bunch. The Telangana government farmer case used bunches containing 10 stems and reported approximately 17,000 bunches per acre under its particular production system. This provides a useful commercial reference, although actual bunch size should be decided according to buyer requirements.

Water and Fertilizer Efficiency

One of the major benefits of protected cultivation is the possibility of improved water and nutrient-use efficiency. Drip irrigation reduces water wastage by delivering water near the root zone. Fertigation allows nutrients to be supplied according to crop demand. Recent IARI research on chrysanthemum specifically examined irrigation and fertigation levels in relation to yield, water-use efficiency and economics, reinforcing the importance of integrating water and nutrient management rather than treating them as separate operations. The objective should therefore be to achieve maximum marketable flower production per unit of water and fertilizer rather than simply maximizing fertilizer application.

Conclusion

Chrysanthemum is one of the most suitable ornamental flower crops for commercial protected cultivation when the production system is designed around cultivar selection, planting density, environmental management, photoperiod control, fertigation, pest management, harvesting and market linkage. Its broad market application as cut flower, spray flower, loose flower and potted plant gives the grower multiple opportunities to diversify

income. Recent ICAR literature confirms that year-round production can be approached through appropriate cultivar and photoperiod management. For a one-acre polyhouse, the theoretical population at 15×15 cm spacing is approximately 180,000 plants. However, after allowing for pathways, drainage, working space and infrastructure, approximately **160,000 plants per acre** is a practical commercial planning value. This population has also been demonstrated in a Telangana government farmer case under polyhouse conditions.

A crop duration of approximately **90–120 days** is appropriate for commercial planning, although the actual duration will depend on cultivar, planting date, temperature and photoperiod. Under favourable conditions, approximately **three cycles per year** may be possible. However, the farm should not build its financial model on three guaranteed cycles until the first production cycle establishes the actual local crop duration. The recommended spacing, irrigation and fertigation practices should be treated as starting points and adjusted according to soil, water quality, cultivar and local climate. ICAR-IIHR recommends approximately $24\text{--}28^\circ\text{C}$ during the day, $16\text{--}18^\circ\text{C}$ at night and 60–70% relative humidity for quality protected cut-flower production, while TNAU recommends appropriate fertigation, pinching and protected-cultivation practices.

The greatest opportunity for improving profitability is not simply increasing plant population. Profitability depends on the interaction between marketable stem production, flower quality, market price, production cost, crop duration and market timing. A high-density crop with poor flower quality may produce less profit than a slightly lower-density crop producing premium stems. Research demonstrates significant differences between cultivars. Therefore, a commercial farm should conduct a cultivar trial before committing the full acre. Recent polyhouse studies have shown substantial differences among cultivars in plant height, branching, flower number, flower size and other quality traits.

Similarly, irrigation and fertigation should be optimized rather than maximized. Recent ICAR-IARI research demonstrated that irrigation and fertigation levels influence yield, water-use efficiency and economic returns, while earlier Assam Agricultural University research showed strong performance under an appropriate fertigation programme. The historical Telangana farmer case provides an important commercial benchmark of approximately 160,000 plants per acre, 17,000 bunches per crop, 90-day crop duration and ₹10.20 lakh gross revenue under its particular price and production conditions. However, flower prices are volatile, and recent market events have demonstrated that excessive supply can sharply reduce prices. Therefore, the project should use conservative, expected and optimistic financial scenarios rather than promising a fixed annual income.

Overall, a properly designed one-acre chrysanthemum polyhouse can become a commercially viable floriculture enterprise when the production system is integrated with high-quality planting material, precise fertigation, controlled photoperiod, effective ventilation, strong IPM, efficient harvesting and reliable market linkage. The recommended business model is approximately 160,000 plants per acre, 15×15 cm spacing, 90–120 days per crop, and up to three crop cycles annually where climatic and market conditions permit. The project should be evaluated using actual local flower prices and the farm's measured production during the first cycle before committing to long-term ROI assumptions.

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