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Bottlenecks in Bottle Gourd Production: Evidence from Western Uttar Pradesh

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Abstract

Bottle gourd is a commercially important vegetable in Western Uttar Pradesh, but growers often face production problems that cannot be resolved through technical recommendations alone. The present study identified and prioritized the major constraints experienced by bottle gourd growers in Hapur and Amroha districts. An ex-post-facto research design with an exploratory component was used. Two blocks were selected from each district, four villages from each block and 12 growers from each village through simple random sampling, giving a total sample of 192 respondents. Data were collected through a structured and pre-tested interview schedule. Seven constraints were ranked using Garrett's ranking technique. Non-availability of fertilizer emerged as the most serious bottleneck with a mean Garrett score of 77.63, followed by high cost of inputs (67.96) and high cost of labour (59.94). Purchase of unauthentic farm inputs ranked fourth (50.03), while low market returns (39.93), weak policy support for inputs and technology (31.93) and distant supply agencies (21.06) occupied the remaining positions. The three leading constraints contributed 58.98% of the cumulative Garrett score, showing a marked concentration of grower concerns around input access and production cost. Strengthening timely fertilizer supply, input-quality assurance, collective procurement, labour-saving services and local input distribution may therefore improve the production environment for bottle gourd growers.

INTRODUCTION

Bottle gourd (*Lagenaria siceraria*) is an important cucurbitaceous vegetable cultivated widely in India for fresh consumption and commercial sale. In the intensively cultivated vegetable belts of Western Uttar Pradesh, the crop is attractive to growers because of its short duration, repeated harvesting and regular market demand. At the same time, the crop requires timely completion of several operations and repeated use of purchased inputs. Delays in the availability of fertilizers, quality seed, crop-protection materials or labour can therefore affect production decisions more quickly than in many long-duration field crops.

The production environment of vegetable growers is shaped not only by technical

recommendations but also by the functioning of input and output markets. A recommended practice can be known and technically feasible, yet difficult to implement when the necessary input is unavailable, unaffordable or of uncertain quality. Similar problems arise when labour becomes costly during peak operations or when market prices fail to compensate for the additional expenditure incurred on improved production practices. Constraint analysis is therefore useful because it shifts attention from what farmers are advised to do toward the practical conditions that determine whether those recommendations can be implemented.

Studies from different vegetable-growing regions of India show that such constraints are multidimensional. Singla and Singh (2016) documented input, financial, technical and marketing problems affecting the use of vegetable production technologies in Punjab. Tiwari and Tiwari (2018) reported high seed cost, shortage of skilled labour and price fluctuation among the important barriers to modern vegetable cultivation. In Uttar Pradesh, Singh et al. (2024) observed that vegetable growers faced a combination of technological, resource, labour and market constraints. Saikia et al. (2024) similarly identified technical, labour, economic and marketing difficulties among commercial vegetable growers in Assam.

More recent research also confirms the continued importance of cost, labour, market and institutional factors. Joshi et al. (2024), while analysing constraints of vegetable growers in Uttarakhand, used Garrett ranking to identify the relative importance of production difficulties. Medhi and Noorain (2025) showed that infrastructure, logistics and market-related weaknesses can substantially reduce returns in vegetable supply chains. In protected vegetable cultivation, Kumar et al. (2026) reported labour shortages, high input costs and market instability as major production and marketing constraints. These findings underline that the relative severity of

constraints is strongly dependent on the crop, location, production system and institutional environment.

Bottle gourd-specific evidence on the relative severity of production constraints is limited for Western Uttar Pradesh. The region has relatively strong road and market connectivity, yet growers may still face localized shortages of farm inputs, rising labour costs, quality uncertainty and weak bargaining power. A simple listing of constraints does not reveal which problems deserve the greatest attention. Ranking them according to growers' own assessment provides a more useful basis for planning extension, input delivery and local support services.

Against this background, the present study was undertaken with the specific objective of identifying and prioritizing the major production constraints faced by bottle gourd growers in Western Uttar Pradesh and interpreting their implications for extension, input delivery and local support systems.

MATERIALS AND METHODS

Research design and study area

The investigation followed an ex-post-facto research design with an exploratory component because the production constraints had already occurred in the respondents' farming situations and were not manipulated by the investigator. The study was conducted in Western Uttar Pradesh. Hapur district represented Meerut division and Amroha district represented Moradabad division. The two districts were selected because bottle gourd cultivation is commercially important in the selected localities and because they provided an appropriate setting for examining production-related constraints under farmer conditions.

Sampling procedure

A multistage sampling procedure was followed. Two blocks were selected from each district on the basis of comparatively greater area and production under bottle gourd cultivation. Joya and Amroha blocks were included from Amroha district, while

Garmukteshwar and Hapur blocks were included from Hapur district. Four villages were selected from each block. Thus, sixteen villages formed the study area. A sampling frame of bottle gourd growers was prepared in each selected village and 12 respondents were chosen through simple random sampling. The final sample therefore comprised 192 growers, with 96 respondents from each district. The sampling structure used in the study is consistent with the field investigation reported in the thesis dataset.

Interview schedule and pre-testing

Primary data were obtained through personal interviews using a structured interview schedule. Before the main survey, the schedule was examined through a pilot exercise and was pre-tested with 30 growers from a non-sampled village. The pre-test was used to identify ambiguous wording, improve the sequence of questions and ensure that the constraint statements were understandable to respondents. Necessary modifications were incorporated before final data collection. The investigator personally contacted the selected respondents and recorded their responses after explaining the purpose of the study. The thesis methodology records the use of a 30-respondent pre-test and personal interview method.

Identification of constraints

Seven major constraints were included in the final ranking exercise: non-availability of fertilizer, high cost of inputs, high cost of labour, purchase of unauthentic farm inputs, low market returns, weak policy support for inputs and technology and distant supply agencies. Respondents ranked these constraints according to their perceived severity in bottle gourd production. The purpose of the ranking was not merely to record whether a problem existed, but to estimate its relative importance compared with the other constraints experienced by the same respondents.

Garrett ranking technique

Garrett's ranking technique was used to transform the ordinal ranks assigned by respondents into scores that could be aggregated across the sample. The method reduces the difficulty that arises when simple ranks are averaged directly and provides a common scoring basis for all respondents (Garrett and Woodworth, 1969). The percent position of each rank was calculated as:

Percent position = 100 (Rij - 0.5) / Nj

where Rij represents the rank assigned to the ith constraint by the jth respondent and Nj represents the total number of constraints ranked by the jth respondent. Each percent position was converted into a Garrett score using the standard conversion table. The scores obtained for a given constraint were summed across all respondents and divided by 192 to obtain the mean Garrett score. Constraints were arranged in descending order of mean score, with the highest score receiving Rank I.

Supplementary descriptive indicators

To describe how strongly the constraint burden was concentrated among the leading problems, a small set of secondary descriptive indicators was calculated from the Garrett totals. These included the difference between the highest and lowest mean Garrett scores, the ratio of the highest to lowest mean score and the share of the cumulative Garrett score represented by the top three and top four constraints. These indicators do not constitute an additional statistical test, they are simple summaries derived only from the seven Garrett-ranked constraints and were used to support interpretation of the ranking pattern.

RESULTS AND DISCUSSION

Overall ranking pattern

The Garrett analysis produced a distinct ordering of the seven constraints (Table 1). Non-availability of fertilizer ranked first with a mean Garrett score of 77.63. High cost of inputs followed with 67.96, while high cost of labour occupied the third position with 59.94. Purchase of unauthentic farm inputs ranked fourth with

a mean score of 50.03. The remaining constraints—low market returns, weak policy support for inputs and technology and distant supply agencies—received mean scores of 39.93, 31.93 and 21.06, respectively. The result demonstrates that growers did not view all constraints as equally serious, immediate production inputs and costs dominated the upper part of the ranking.

Table 1. Garrett ranking of constraints faced by bottle gourd growers (n = 192)

Constraint	Total Garrett score	Mean Garrett score	Rank
Non-availability of fertilizer	14,904	77.63	I
High cost of inputs	13,049	67.96	II
High cost of labour	11,509	59.94	III
Purchase of unauthentic farm inputs	9,606	50.03	IV
Low market returns	7,667	39.93	V
Weak policy support for inputs and technology	6,130	31.93	VI
Distant supply agencies	4,044	21.06	VII

Concentration of the leading bottlenecks

A further look at the ranking shows that the most serious constraints were highly concentrated. The difference between the highest and lowest mean Garrett scores was 56.57 points and the highest score was about 3.69 times the lowest score. The first three constraints alone contributed 58.98% of the cumulative Garrett score across the seven ranked problems, while the first four accounted for 73.34%. This concentration indicates that interventions directed toward a relatively small number of high-priority problems may address a large part of the constraint burden perceived by growers.

Table 2. Descriptive concentration of the Garrett-ranked constraints

Indicator	Value
Number of ranked constraints	7
Highest mean Garrett score	77.63
Lowest mean Garrett score	21.06
Score range (highest - lowest)	56.57
Highest/lowest score ratio	3.69

Top-three share of cumulative Garrett score	58.98%
Top-four share of cumulative Garrett score	73.34%

Non-availability of fertilizer: the dominant access constraint

Non-availability of fertilizer emerged as the most severe constraint, with the highest mean Garrett score of 77.63. The prominence of this problem indicates that timely physical access to fertilizer was a greater concern than several other production and institutional issues. In a vegetable crop with rapid vegetative growth and repeated nutrient demand, delayed fertilizer application can disturb the timing of crop management operations even when the farmer has the willingness and financial capacity to purchase the input. Availability at the required crop stage is therefore a distinct issue from price alone.

The ranking also has implications for the design of local input-delivery systems. A fertilizer shortage during a critical crop stage can force growers to postpone application, substitute products, purchase from distant markets or accept higher transaction costs. These responses may increase production uncertainty. Local forecasting of seasonal demand, better coordination with authorized dealers and advance stocking before peak sowing periods could reduce this bottleneck. Extension agencies can support such measures by communicating expected crop calendars and input requirements to local supply institutions rather than restricting their role to technical advice.

The result is consistent with the wider literature showing that access to production inputs remains a recurring problem in commercial agriculture. Dixit et al. (2025), in a study published in The Bioscan, reported technology-promotion constraints among sugarcane growers in the Lucknow division of Uttar Pradesh, demonstrating that production problems frequently involve the institutional environment surrounding the technology. Although the crop and location differ, the common implication is that dissemination of recommendations must be accompanied by

dependable access to the inputs needed to implement them.

High cost of inputs: the major economic pressure

High cost of inputs received Rank II with a mean Garrett score of 67.96. This result shows that even when farm inputs are available, affordability remains a major production concern. Bottle gourd cultivation involves repeated expenditure on seed, fertilizers, plant-protection materials, irrigation, staking or trellising materials in some situations and other purchased inputs. The cumulative effect of these expenditures can be substantial, particularly when market prices fluctuate or when a grower has limited working capital at the beginning of the season.

Input-cost pressure can influence both the quantity and timing of purchases. Farmers may reduce the use of an expensive input, postpone its application, shift to a cheaper alternative or rely on credit from dealers. Each of these responses can alter production decisions. Singla and Singh (2016) similarly reported financial and input-related constraints in vegetable production, while Tiwari and Tiwari (2018) identified high seed cost among the problems affecting modern vegetable cultivation. Saikia et al. (2024) also observed high cost of quality seed as an important economic constraint among commercial vegetable growers.

From a practical standpoint, collective procurement offers one possible response to high input prices. Farmer Producer Organizations, farmer interest groups or informal purchase groups can aggregate demand and may obtain better prices or reduce transport costs. The usefulness of such arrangements depends on transparency, timely delivery and quality assurance. Small pack sizes of verified inputs can also be important because they reduce the need for growers to commit a large amount of cash at one time. Extension programmes can support growers by providing cost comparisons and demonstrating economically efficient

input-use practices without compromising technical recommendations.

High labour cost and the timing of vegetable operations

High cost of labour ranked third, with a mean Garrett score of 59.94. Labour is a particularly important component of vegetable production because several operations are time-sensitive and cannot always be postponed without affecting crop performance or marketable quality. Sowing, intercultural operations, plant protection, training, harvesting and loading may require labour within a narrow time window. When wage rates rise during peak periods, growers face a direct increase in production cost and may also experience difficulty in completing operations on time. The finding corresponds with reports from other vegetable systems. Tiwari and Tiwari (2018) identified shortage of skilled labour as an important constraint, while Saikia et al. (2024) documented labour-related problems in commercial vegetable production. Kumar et al. (2026) likewise reported labour shortages and production-cost pressures in protected vegetable cultivation in Haryana. These studies support the interpretation that labour is not simply a background cost, its availability and price can become a production bottleneck in its own right.

Possible responses include small-scale labour-saving tools, village-level custom hiring, organized service providers for specialized operations and better scheduling of shared labour resources. Mechanization options need to be appropriate for small plots and should not be assumed to replace labour in every operation. The more realistic objective is to reduce dependence on scarce peak-season labour where feasible and to improve the timeliness of operations that are most sensitive to delay.

Unauthentic farm inputs: a quality-assurance concern

Purchase of unauthentic farm inputs occupied Rank IV with a mean Garrett score of 50.03. This constraint differs from

simple non-availability because it concerns the reliability of what is actually purchased. Doubtful seed, fertilizers or crop-protection products expose farmers to both financial loss and production risk. The farmer pays for an input but may not receive the expected quality, concentration, germination, genetic purity or effectiveness. Such uncertainty can weaken confidence in recommended practices and can also make farmers reluctant to invest in higher-value inputs in subsequent seasons.

The response to this problem requires stronger quality assurance rather than only greater availability. Authorized sale points, visible batch and expiry information, simple verification mechanisms, complaint channels and farmer awareness regarding labels and bills can improve accountability. Extension personnel can also help farmers distinguish between technical failure and product-quality failure, which is important because repeated poor outcomes from unauthentic inputs may otherwise be interpreted as evidence that the recommended technology itself is ineffective.

The importance of quality assurance is closely connected with the broader input-market environment. Where growers purchase frequently from local dealers, trust becomes a major component of technology use. Strengthening dealer accountability and linking local suppliers with formal extension and regulatory systems may therefore be as important as increasing the number of outlets.

Low market returns: the output-side constraint

Low market returns ranked fifth with a mean Garrett score of 39.93. Although this score was lower than those of the leading input and labour constraints, it remains economically important because vegetable crops are perishable and often must be sold soon after harvest. Growers can therefore be exposed to sharp price changes, local gluts, commission charges and weak bargaining power. When the expected sale price is uncertain, farmers may hesitate to

invest in costly production practices even if those practices are technically recommended.

Market-related constraints have been widely documented in vegetable systems. Singh et al. (2024) reported non-remunerative prices and inadequate marketing facilities among problems faced by vegetable growers in Hardoi district of Uttar Pradesh. Medhi and Noorain (2025) found that infrastructure, logistics and price-related problems significantly affected vegetable supply chains in Assam. Kumar et al. (2026) identified price fluctuation and lack of organized marketing arrangements as important constraints under protected vegetable cultivation. Together, these studies indicate that profitability depends on the interaction between production efficiency and the conditions under which produce is sold.

Improvement in market information, aggregation of produce, grading, direct linkage with retailers or institutional buyers and reduction of avoidable transaction costs may improve the grower's position. However, the suitability of any marketing intervention depends on local volume, distance, perishability and the reliability of buyers. Market interventions therefore need to complement rather than replace improvements in production-side input access.

Weak policy support and distant supply agencies

Weak policy support for inputs and technology ranked sixth with a mean Garrett score of 31.93, while distant supply agencies ranked seventh with 21.06. Their lower ranks should not be interpreted as absence of importance. Rather, they were perceived as less immediate than fertilizer shortage, input cost, labour cost and quality uncertainty. These institutional constraints may still shape the environment in which the higher-ranked problems occur.

Distance to a supply agency raises travel time, transport cost and the difficulty of obtaining small quantities of inputs at short notice. The problem becomes more serious

when a crop requires an input unexpectedly, for example following pest incidence or weather-related damage. Decentralized input points, village-level delivery schedules and coordination with producer groups can reduce such transaction costs. At the policy level, the ranking suggests that growers value support that improves the reliability, affordability and accessibility of actual inputs rather than support that exists only as information or a general programme announcement.

Warshini et al. (2025), using Garrett ranking in Makhana cultivation, also demonstrated the usefulness of prioritizing constraints according to farmers' own perceptions before designing support measures. This farmer-centred prioritization is particularly valuable for extension planning because it identifies where limited institutional resources are likely to produce the greatest practical benefit.

Cross-cutting interpretation and intervention priorities

Taken together, the ranking points to three broad dimensions of the production environment. The first is input access, represented by fertilizer non-availability, authenticity of farm inputs and the distance of supply agencies. The second is production cost, dominated by the price of purchased inputs and labour. The third is the market and institutional environment, represented by low market returns and weak policy support. These dimensions are interpretive groupings of the observed constraints rather than separately measured scales, but they help explain how different problems are connected in practice.

The concentration indicators provide an additional planning message. Because the top three constraints represented nearly 59% of the cumulative Garrett score, an intervention strategy that spreads resources equally across all seven problems would not reflect the priorities expressed by respondents. The first line of action should focus on timely fertilizer supply, input affordability and labour-cost management.

Quality assurance of farm inputs should form a second layer because unauthentic products can undermine both investment and confidence. Market and institutional improvements remain important, but their lower Garrett scores indicate that they were not the most immediate concerns in the production season experienced by respondents.

This sequencing does not imply that lower-ranked constraints can be ignored. A distant input outlet may contribute to a fertilizer shortage and weak policy implementation may indirectly influence input availability or market access. The results therefore favour a coordinated response in which extension agencies, input suppliers, farmer organizations and local administrative institutions work on complementary functions. Extension personnel can identify seasonal demand and disseminate verified information, input agencies can improve stocking and quality control, farmer groups can organize collective purchase and service access, and market institutions can improve information and aggregation.

The paper also illustrates why constraint ranking should be treated as more than a descriptive exercise. The Garrett scores convert farmers' relative judgments into an ordered set of priorities. They do not prove causality and they do not measure the monetary loss attributable to each constraint, but they provide a practical basis for deciding which bottlenecks deserve more detailed economic or experimental investigation. Future studies could build on the present ranking by estimating the actual cost of delayed input supply, labour scarcity or poor-quality inputs, or by comparing constraints across farm-size groups and market channels.

CONCLUSIONS

Bottle gourd growers in the selected areas of Western Uttar Pradesh faced a clearly differentiated set of production bottlenecks. Non-availability of fertilizer was the most serious constraint, followed by high input cost and high labour cost. Together, these

three problems accounted for 58.98% of the cumulative Garrett score, showing that grower concerns were concentrated strongly around input access and production expenditure. Purchase of unauthentic farm inputs formed a second major area of concern, while low market returns, weak policy support and distant supply agencies occupied lower positions in the ranking.

The findings suggest that improving bottle gourd production requires more than general technical advice. Priority should be given to timely local fertilizer availability, reliable and authenticated farm inputs, collective or cost-efficient procurement and services that reduce peak-season labour pressure. Market information, producer aggregation and decentralized input distribution can provide additional support. Because the ranking is based on growers' own assessment, the identified priorities offer a practical starting point for extension agencies, local input systems and farmer organizations seeking to improve the production environment of bottle gourd growers in Western Uttar Pradesh.

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ETHICS STATEMENT

The study was a non-clinical agricultural extension survey involving adult farmers. Participation was voluntary and respondents were informed about the purpose of the study before interview. No clinical intervention or collection of sensitive health information was involved.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest related to this manuscript.

SOURCE OF FUNDING

No external funding was received for this study.

AUTHOR CONTRIBUTIONS

Harjeet Singh: investigation, field data collection, data curation, analysis, interpretation and manuscript preparation. L. B. Singh, D. K. Singh, Satya prakash, Manoj Kumar, Shivendra pratap singh, Pramod Tripathi, Harsha and Nikhelesh pal singh: conceptualization, supervision, methodology, interpretation, critical review and editing.

DATA AVAILABILITY

Data supporting the findings of this study are available from the corresponding author upon reasonable request.

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