Resource use efficiency in carnation production under polyhouse conditions in Himachal Pradesh, India

Abstract: Floral expressions often capture the depth of emotions and sentiments that surpass the capabilities of verbal communication. The practice of flower farming within polyhouse conditions has emerged as a burgeoning segment within the agricultural domain, offering substantial revenue opportunities. This is particularly relevant in terrains characterized by hilly topographies, such as Himachal Pradesh, where agricultural land is scarce, with an average of 0.12 hectares of cultivable land and 0.02 hectares of irrigated land per capita. Such limitations necessitate an agricultural paradigm focused on maximizing returns per unit of area, labor, and capital investment. The research undertook an analytical journey in the Bilaspur district of Himachal Pradesh to scrutinize the efficiency of resource utilization in the cultivation of carnations under polyhouse conditions. Engaging a cohort of 60 polyhouse-utilizing farmers, selected through proportional allocation across two blocks of the district, the study unveiled that the utilization efficiencies, as measured by the marginal value product (MVP) to price ratios, were highest for manure (5.78), followed by pesticides (3.55), and labor (2.04), each exceeding the unity threshold. This indicates that augmenting the input of these resources could potentially amplify returns.

Keywords Cobb-Douglas production function, resource use efficiency, carnation, polyhouse

JEL codes C01, Q12

Introduction

In the contemporary agricultural landscape, the advent of protected agriculture stands out as a prime solution for the optimal use of land and resources amidst the shrinking size of land holdings and the fluctuating patterns of weather and climate. This innovative approach promises to enhance the efficiency of utilizing scarce resources like land, water, and energy. It has proven particularly advantageous for small and marginal farmers, providing them a viable means to sustain and improve their livelihoods through small-scale farming and limited investment. Moreover, protected cultivation paves the way for self-employment opportunities for young people and the rural populace, enabling the cultivation of exotic vegetables and flowers throughout the year. Notably, India positions itself as the second-largest flower producer globally, following China. The fiscal year 2017-18 saw an estimated production of 1962 thousand tons of loose flowers and 823 thousand tons of cut flowers. India's ambition to be recognized as a dependable source of floriculture globally has led to significant exports, reaching 19726.57 MT of floricultural products valued at Rs.571.38 crores/81.94 million USD in the fiscal year 2018-19 (APEDA, 2019). The Himachal Pradesh government has initiated a strategic plan worth 150 crores to foster floriculture, offering various incentives under the

'Himachal Pushp Kranti Yojna' to encourage farmers to invest in this lucrative cash crop. Consequently, a study was undertaken to assess the resource productivity and efficiency of carnation cultivation in Himachal Pradesh, identifying key challenges such as substantial investments, skilled labor shortages, and inadequate cold storage facilities for greenhouse rose cultivation (Kumar and Ravichandran, 2017). Similar research by Kumari et al. (2018) in south Gujarat pinpointed pest and disease outbreaks and the high costs associated with polyhouse construction as significant obstacles for Gerbera cultivators. Another study in Solan district emphasized the necessity for ongoing technical training for polyhouse farmers to enhance their proficiency with protected cultivation technologies, given the capital-intensive nature of such practices (Chahal et al., 2020).

The efficiency in resource utilization is crucial for the advancement of modern agriculture. By facilitating the optimal use of resources, minimizing expenses, and enhancing sustainability, these efficiency metrics play a vital role in ensuring the agricultural sector's sustainability and economic success. Interpreting resource use efficiency aids farmers in maximizing the utilization of their assets, including land, water, and fertilizers, thereby increasing crop yields, profitability, and environmental sustainability. The principle of resource use efficiency has been the subject of extensive research, maintaining its relevance in the field of Agricultural Production Economics. Bhendi and Kalirajan (2007) highlighted the potential of improved farmer education and extension services to enhance efficiency, subsequently boosting productivity and agricultural output. Patil et al. (2010) advocated for the provision of technological knowledge, efficient management strategies, and robust input support systems to escalate flower cultivation on a grand scale. In marigold cultivation, Kolambkar et al. (2014) discovered that the most significant return on investment came from working capital, followed by fertilizers, pesticides, and manure, with ratios exceeding one, indicating that increased resource investment would yield higher returns. The capability of farmers to employ these resources effectively is directly proportional to their potential income and savings. This study endeavors to explore the economic benefits of carnation cultivation under polyhouse conditions in Bilaspur district, Himachal Pradesh, by examining resource allocation and efficiency through production function analysis.

Data and methodology

The study specifically chose the Bilaspur district in Himachal Pradesh for its analysis. Employing a two-stage random sampling method, from the district's four community development blocks, Jhandutta and Bilaspur Sadar were selected through a random process. Among these, polyhouse operators engaged in the cultivation of carnations were identified for participation. The collection of primary data concerning various facets of commercial flower cultivation was achieved via face-to-face interviews, utilizing a well-organized questionnaire.

In assessing the productivity and efficiency of resource use in the cultivation of carnations, the study adopted the Cobb-Douglas production function approach, as outlined by Yeware et al., (2009). This method served as the framework for evaluating the factors influencing the productivity and resource utilization efficiency in carnation production.

$$Y = aX_1^{b_1}X_2^{b2}X_3^{b_3}X_4^{b_4}X_5^{b_5}X_6^{b6}$$

Where,

Y = Number of carnation sticks (number of sticks / ha)

X1= Labour (number of man-days/ ha)

X2= Expenditure on initial capital (Rs. /ha)

X3= Expenditure on Planting material (Rs. /ha)

X4= Expenditure on Manure (Rs. /ha)

X5= Expenditure on Fertigation (Rs. /ha)

X6= Expenditure on Pesticides (Rs. /ha)

The efficiency of resource use in production of carnation was determined by the ratio of Marginal Value Product (MVP) to Marginal Factor Cost (MFC) of variable inputs based on the estimated regression coefficients. The coefficients from Cobb-Douglas production are used in the resource use efficiency measurement. So, efficiency of the resources was calculated by using formula:

r = MVP/MFC

Where,

r = Efficiency ratio

MVP = Marginal value product of a variable input,

MFC = Marginal factor cost (Price per unit of input)

The value of MVP was estimated using the regression coefficient of each input and the price of the output.

MVP= MPP x_i × Py(Unit price of output)

$$MPP_{x_i} = b_i \times \left(Y/\bar{x}_i\right)$$

Where; b_i= Estimated regression coefficient of input X_i

Y= Geometric mean value of output

$\bar{x}_i$= Geometric mean value of input being considered

The prevailing market price of input was used as the Marginal Factor Cost (MFC).

MFC= Px_i

Where,

Px_i= Unit price of input xi.

The decision rule for the efficiency analysis was as:

r=1; Efficient use of a resource

r>1; Underutilization of a resource

r<1; Overutilization of a resource

Result and discussion

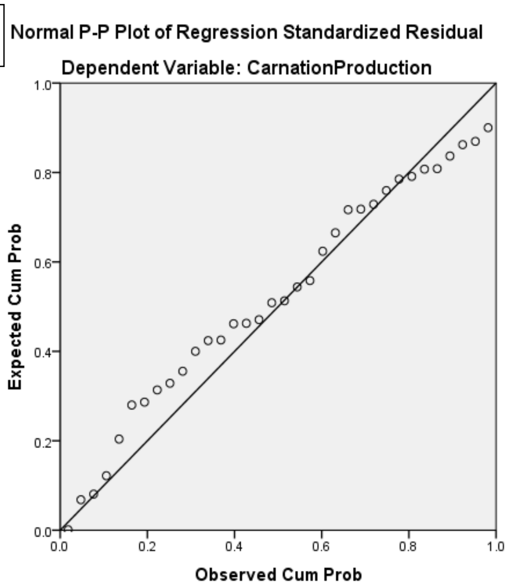
The findings derived from the Cobb-Douglas production function are summarized in Table 1. The coefficient of multiple determination, valued at 0.87, signifies that 87 percent of the variance in carnation production output under polyhouse conditions can be explained by the combined influence of six resources. The elasticity coefficients for labor (X1), manure (X4), and pesticides (X6) were found to be 0.929, 0.465, and 0.416, respectively. This implies that a one percent increase in labor man-days (X1), spending on manure (X4), and spending on pesticides (X6) would respectively lead to an increase in gross income by 0.929 percent, 0.465 percent, and 0.416 percent. The regression coefficients for labor, manure, and working capital were positive and demonstrated high significance at the 1 percent probability level. Meanwhile, the elasticity coefficient for the initial cost (X2) stood at 0.052, which, although positive, was found to be statistically insignificant. The elasticity coefficients for planting material (X3) and fertigation (X5) were negative, at -0.583 and -0.2 respectively, indicating that a one percent increase in the number of planting materials and spending on fertigation would lead to a decrease in gross income by 0.583 percent and 0.2 percent, correspondingly.

Table 1. Estimated coefficients of Cobb-Douglas production function for carnation production

Explanatory variables	Coefficient	Standard error	t-value
R^2	0.878		
Constant	5.6	4.86	1.15
Labour (X_1)	0.929*	0.19	4.67
Initial Capital (X_2)	0.052	0.06	0.75
Planting material (X_3)	-0.583	0.26	-2.22
Manure (X_4)	0.465*	0.11	3.96
Fertigation (X_5)	-0.200	0.12	-1.55
Pesticides (X_6)	0.416*	0.06	6.58

* indicate significance of value at P=0.

Fig .1



Efficiency in the utilization of resources was calculated by analyzing the elasticity of individual inputs derived from the Cobb-Douglas production function. Table 2 presents the marginal value product (MVP), marginal factor cost, and the ratio of MVP to marginal factor cost for each resource involved in the production of carnations under polyhouse conditions. The findings indicated that manure utilization in carnation cultivation yielded the highest MVP to price ratio (5.78), followed by pesticides (3.55) and labor (2.04), all surpassing the unity mark. This suggests that incremental usage of these resources is likely to result in enhanced returns. The analysis highlighted potential avenues for profit maximization through increased resource application. Conversely, the MVP to price ratios for initial capital fell below unity, whereas those for planting material and fertigation were negative. This implies that farmers could optimize their profits by reducing the use of planting material and minimizing expenditures on initial costs and fertigation.

Table 2. Estimated results on resource use efficiency of carnation production

Independent variable	Geometric mean of inputs	Coefficient	MVP (Rs.)	MFC	r	Level of resource use
Labour (X_1) (Man days)	7172.350	0.929	2.046	1.000	2.046	Under utilization
Initial Capital (X_2) (Rs.)	1981760.000	0.052	0.145	1.000	0.145	Excess utilization
Planting material (X_3) (number)	2177787.000	-0.583	-0.148	1.000	-0.148	Excess utilization
Manure (X_4) (Rs.)	444333.000	0.465	5.786	1.000	5.786	Under utilization
Fertigation (X_5) (Rs.)	704658.000	-0.200	-1.569	1.000	-1.569	Excess utilization
Pesticides (X_6) (Rs.)	647158.000	0.416	3.554	1.000	3.554	Under utilization

Conclusion and policy implications

The cultivation of carnations under polyhouse conditions is gaining traction, attributed to its myriad benefits. Polyhouses provide a protective environment against harsh weather and pests, while still permitting essential sunlight and ventilation for plant development. Optimal temperatures for carnation growth within polyhouses range from 18°C to 24°C during daytime and 12°C to 16°C at night, conditions readily met in Himachal Pradesh. Additionally, maintaining humidity levels between 80% to 85% is crucial. Carnations necessitate consistent fertilization and watering, with a balanced NPK (Nitrogen, Phosphorus, and Potassium) fertilizer applied biweekly. Drip irrigation is favored for its efficiency in delivering water and nutrients directly to the plant roots. It's established that successful carnation farming under polyhouse conditions in Himachal Pradesh demands diligent planning, oversight, and management, which can lead to substantial yields of high-quality flowers. The coefficient of multiple determination R2 stood at 0.87, elucidating that the chosen model variables accounted for 87 percent of the variance in carnation production outcomes. It was noted that manure utilization led to the highest MVP to price ratio, surpassed by pesticides and labor, indicating that increased investment in these resources could potentially enhance returns.

Flower farming under polyhouse conditions in Himachal Pradesh presents a significant opportunity to boost agricultural income, generate employment, and enhance export prospects. Nonetheless, to capitalize on this potential, several policy measures must be considered. Encouraging farmers to embrace polyhouse flower cultivation through financial aids such as subsidies, loans, and grants is vital. The government might also explore tax benefits for investments in polyhouse infrastructure. Transferring technology is crucial for elevating productivity and efficiency in flower farming; establishing centers for technology transfer and providing farmer training on modern cultivation techniques, irrigation systems, pest control, and post-harvest handling could be beneficial. Moreover, to spur demand for Indian flowers both domestically and internationally, governmental marketing efforts, the creation of flower auctions, and support for exporters are imperative. Infrastructure improvements, including roads, electricity, and water supply, are essential for thriving flower cultivation. Governmental investment in infrastructure in floriculture areas is needed. Research and development investment is key to advancing cultivation methods, breeding new flower varieties, and boosting yields. Establishing research centers dedicated to flower cultivation under polyhouse conditions can support these initiatives, especially as we rely on importing planting materials from other states.

In summary, enhancing flower cultivation under polyhouse conditions in Himachal Pradesh requires a comprehensive strategy encompassing financial incentives, technology dissemination, marketing support, infrastructure upgrades, and research and development. Implementing these policies can create an encouraging environment for farmers to venture into polyhouse flower cultivation, thus positioning Himachal flowers more competitively in the global market.

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