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# Status and impact of protected cultivation of horticultural crops in Maharashtra

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## ABSTRACT

**Protected cultivation of high value crops has taken pivotal role for increasing higher productivity and increasing income of the farmers. This study was undertaken to analyse the status and impact of protected cultivation of horticultural crops in the Pune and Nasik districts of Maharashtra during 2018-19. The cumulative area covered under protected cultivation by National Horticulture Mission in Maharashtra is about 4478 ha, of which 61% is under shade net house and 37% is under naturally ventilated polyhouse. Farm business analysis shows that among four crops grown under polyhouse, carnation was the best option for farmers getting maximum net income of ₹2.22 lakhs per year for 1000 sq.m area. Similarly, among four crops grown under shade net house, capsicum was found to be the best option for realizing maximum net income of ₹1.03 lakhs per eight months for 1000 sq.m area. Fractional logit model shows that the age of household, farm size, household income and access to subsidy were the significant factors for the proportion of total farmland allocated to protected cultivation. Higher initial investment, high cost of planting materials, incidence of pests and diseases, poor price received etc., were the most important constraints in adoption of protected cultivation. Thus, it is suggested that the government support in the form of capital subsidy needs to be strengthened further to enhance adoption rate and also high value crops such as anthurium and orchid which provide high income to the farmers need to be focused on.**

**Key words**: Impact of protected cultivation, economics of protected cultivation, fractional logit regression.

## INTRODUCTION

Protected cultivation is a capital intensive technique, wherein the microclimate surrounding the plant body is controlled to clinch a higher net return compared to its traditional cultivation (Spehia, 13; Prabhakar *et al.*, 8; Punera *et al.*, 10; Kumar *et al.*, 5). Protected cultivation involves the use of innovative structures (greenhouses, net houses, tunnels) to provide a controlled environment to crops and assists them in protecting from adverse climatic conditions. Apart from this, protected cultivation ensures higher returns due to higher yield with better quality. Furthermore, it ensures efficient utilization of inputs such as fertilizers, pesticides, and water when compared to the open field conditions (Sanwal *et al.*, 12; Martínez-Blanco *et al.*, 6; Van Lenteren,14; Yang *et al.*,15). Since off-season production can be made under protected cultivation, therefore it gives an opportunity to fetch higher prices (Kallo and Singh, 4; Sabir and Singh, 11). The Government of India has initiated a number of schemes such as National Horticulture Mission (NHM), National Horticulture Board (NHB), Rashtriya Krishi Vikas Yojana (RKVY) and Horticulture Mission for North East and Himalayan States (HMNEH) for the promotion and development of protected cultivation. The major scheme is NHM, which offers a 50% subsidy for setting up of protected cultivation structures and also provides 50% subsidy for purchase of planting materials and cultivation of vegetables and flowers under polyhouse/shade net house. With these interventions, the area achieved under protected cultivation by NHM in India was 14136 ha during 2005-06 to 2017-18 (Prakash *et al.*, 9). Under number of schemes such as NHM, NHB and RKVY are being implemented by the Government of Maharashtra for providing financial assistance to the farmers to enhance the adoption level of protected cultivation technology. This has led to the emergence of as a major producer of horticultural crops in the state. Pune and Nasik districts of Maharashtra, shares nearly 1/5$^{th}$ of total area under protected cultivation. Pune district has been identified as an Agri Export Zone (AEZ) for floriculture and the State Agricultural Marketing Board (SAMB) has established horticulture training center at Talegaon-Dabhade. At this centre, training is provided to the farmers regarding green/poly house management, with special focus on floriculture. Besides, numerous public and private nurseries were established which meet the requirement of planting materials both for protected and open field conditions. A number of research centers and adequate extension service agencies are providing all help and support to the

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farmers and also conducting research in various areas pertaining to these crops. All these policy will have an impact on the feasibility of the protected cultivation technology and ultimately improving farm income. With this backdrop, this research study was conducted in Pune and Nasik districts of Maharashtra with the objectives: (i) to study the present status of protected cultivation in Maharashtra; (ii) to estimate the crop-wise costs and returns under protected and open field conditions; (iii) to analyse the proportion of the total farmland allocated to the protected cultivation; and (iv) to identify constraints in adoption of protected cultivation.

## MATERIALS AND METHODS

The study was conducted in Pune and Nasik districts of Maharashtra, which accounts for 18% of the total area under protected cultivation in Maharashtra. A multi stage sampling technique was used for collecting primary data pertaining to the year 2018-19. Four blocks viz., Maval, Haveli, Nasik and Malegaon were selected purposively based on large area under protected cultivation. In subsequent stratification, three villages from each block were selected purposively. A total of twelve villages comprising 116 protected cultivation farmers from four blocks were surveyed. Further, for the purpose of comparison, 80 farmers following open method of cultivation were also selected randomly from the same villages. Thus, a total of 196 farmers were interviewed consisting of 116 protected and 80 open field cultivators. These farmers were interviewed to collect information on socio-economic characteristics, type of structure and its establishment costs, cost of cultivation, productivity, income and constraints.

Farm business analysis was done to estimate the costs and returns of different crops under protected and open field conditions. The costs were categorized into fixed and variable costs. Fixed costs included land rent, interest on fixed capital, the amortized cost of crop establishment and depreciation. Variable costs included interest on working capital, planting materials, fertilizers, organic manures, labour, irrigation charges, plant protection chemicals, and packaging and transportation. The gross returns were computed by multiplying the total production of flowers and vegetables with respective prices received. The net returns were calculated by subtracting the gross returns from annual total costs and the equation can be expressed as

$$\pi = TR_i - TC_i \qquad (1)$$

Where π is net revenue; TRi is total revenue and TCi is the total cost

The fractional logit model was employed to estimate the proportion of the total farmland allocated to the protected cultivation. The dependent variable is a fractional value that ranges from zero to one, with a 1×k vector of explanatory variables. The solution for these variables can be addressed with a nonlinear function satisfying 0 ≤ g (.) ≤ 1, where g (.) is a non-linear model. The conditional mean of the dependent variable is denoted as,

$$E(Y/X) = g(X\beta) \qquad (2)$$

Where, g is the function satisfying 0 <g (.) <1 condition, β is a k×1 vector and × is a set of independent variables. The log-likelihood function for the fractional model is specified as

$$lnL = \sum_{i=1}^{N} Y_i \log[g(X_i\beta)] + (1 - Y_i)\log[1 - g(X_i\beta)] \qquad (3)$$

Where N is the number of protected cultivation farmers, $Y_i$ is the dependent variable. Based on the above equation, the parameters can be estimated in the same manner as in the binary logistic regression model by maximizing the log-likelihood function. The explanatory variables used in the regression are summarized in Table 1.

## RESULTS AND DISCUSSION

There are various schemes for promotion and development of protected cultivation both at central and state level. The major scheme is NHM, which offers 50% subsidy for setting up of protected cultivation structures and also provides 50% subsidy for purchase of planting materials and cultivation of vegetables and flowers under polyhouse/shade net house. In India, the area covered under protected cultivation promoted by NHM from 2005-06 to 2017-18 was 14136 ha. During the same period, the area brought under protected cultivation in Maharashtra was about 4478 ha (Table 2), of which the share of shade net house is 61% followed by naturally ventilated polyhouse (37%), plastic tunnel (1.9%) and green house structure (0.9%).

Socioeconomic characteristics of farmers practicing protected cultivation and open field cultivation in Maharashtra were presented in Table 3. Majority of the farmers were between 30 to 45 years of age, which was 71.7% and 70% in case of protected and open field cultivation, respectively. A considerable difference in the educational qualification between the two groups of farmers was witnessed. It was observed that majority of the farmers practicing protected cultivation had intermediate education (41.7%), followed by graduates and above (26.7%) and high school education (28.3%). Whereas, about 45% of the farmers doing open field farming had either higher school education or less than that. About 38% of the farmers had an experience of 5 to 10 years, followed by 2 to 5 years (35%) and very few (17%) had farming experience of more than 10 years in

**Table 1.** Definition of variables used in the fractional logit regression model.

| S. No. | Unit of measurement | Expected sign |
|---|---|---|
| Dependent variable | Proportion of farmland allocated to protected cultivation | |
| Age | Age of the head of the household (years) | + |
| Education | Number of years of formal education by the farmer | + |
| Farm size | Size of the land owned by household (ha) | ± |
| Household size | Number of people in the household | ± |
| Ln_Income | Average household annual income (₹) | + |
| Loan | 1 if the farmer has access to credit; 0 otherwise | + |
| Subsidy | 1 if the farmers has access to subsidy; 0 otherwise | + |
| Distance to market | Distance of the farm to the market (km) | - |
| Extension contact | 1 if the farmer has access to advice from extension workers; 0 otherwise | + |
| Protected farming experience | Experience in protected farming (years) | + |

**Table 2.** Area achieved under protected cultivation by NHM in Maharashtra.

| Particulars | Total area (ha) | % share |
|---|---|---|
| Green house structure (fan & pad system) | 41 | 0.25 |
| Naturally ventilated polyhouse | 1639 | 10.23 |
| Shade net house | 2747 | 17.14 |
| Plastic tunnel | 51 | 0.32 |
| Sub total# | 4478 | 27.94 |
| Anti-bird / anti-hail nets | 219 | 1.37 |
| Planting material of high-value vegetables grown in poly house | 341 | 2.13 |
| Planting material for flowers for poly house/ shade net | 623 | 3.89 |
| Plastic mulching | 10364 | 64.68 |
| Sub total | 11547 | 72.06 |
| Total | 16025 | 100 |

Source: National horticultural mission (2005-06 to 2017-18); Note: # indicates up to plastic tunnel can be called as protected cultivation.

protected cultivation as it is relatively new technology for India. While under open field cultivation, almost all the farmers had farming experience of more than 10 years. Majority of the farmers (87%) had 1 protected cultivation structure and the remaining had 2 protected cultivation structure. Majority of the population surveyed under open field condition is engaged in agriculture (97.5%). While in case of protected cultivation about 92% of the farmers were engaged as farming by profession, followed by businessmen/service providers (5.83%), LIC agents (1.67%), and very few had government service (0.83%). In case of the area under protected cultivation, most of the farmers (53.3%) had less than 1000 m$^2$, followed by 1000 to 2000 m$^2$ (28.3%).

Table 4 shows that the total establishment cost under polyhouse condition was higher in the case of a rose about ₹16.15 lakhs followed by gerbera (₹13.79 lakhs), carnation (₹12.99 lakhs) and capsicum (₹10.05 lakhs) for polyhouse size of 1000 m$^2$. The most important component of the establishment cost was polyhouse structure which was highest for capsicum accounts for 84% of the total establishment cost, followed by rose (80%), gerbera (72%) and carnation (66%). Whereas, the crop establishment was high for carnation (₹3.12 lakhs) having 24% share to the total establishment cost followed by gerbera (₹2.60 lakhs), rose (₹1.4 lakhs) and capsicum (₹0.32 lakhs) having 19, 9 and 3% share to the total establishment cost, respectively. The subsidy amount to the total establishment cost was ₹7.18 lakhs, ₹5.97 lakhs, ₹5.75 lakhs and ₹4.76 lakhs for rose, carnation, gerbera and capsicum, respectively.

The cost of cultivation of different crops under different polyhouse sizes were analysed and presented in the Table 5. The total cost of cultivation

**Table 3.** Classification of farmers based on socioeconomic characteristics (N=196).

| Particulars | Classification | Polyhouse in % (N=96) | Shade net house in % (N=20) | % to total (N=116) | Open field in % (N=80) |
|---|---|---|---|---|---|
| Age (years) | Less than 30 | 11.5 | 0.0 | 9.2 | 15.0 |
| | 30-45 | 70.8 | 80.0 | 71.7 | 70.0 |
| | More than 45 | 17.7 | 20.0 | 19.2 | 15.0 |
| Education | Illiterate | 0.0 | 0.0 | 0.0 | 10.0 |
| | Primary | 0.0 | 0.0 | 0.8 | 30.0 |
| | High school | 29.2 | 30.0 | 30.8 | 45.0 |
| | Intermediate | 40.6 | 50.0 | 41.7 | 15.0 |
| | Graduate and Above | 30.2 | 20.0 | 26.7 | 0.0 |
| Farming Experience (years) | Less than 2 | 6.52 | 10.0 | 9.2 | 0.0 |
| | 2 to 5 | 25 | 80.0 | 35.8 | 0.0 |
| | 5 to 10 | 45.8 | 0.0 | 37.5 | 0.0 |
| | More than 10 | 22.9 | 0.0 | 17.5 | 100 |
| Number of polyhouse owned | Up to 1 | 85.4 | 90.0 | 86.7 | - |
| | 2 | 14.6 | 10.0 | 13.3 | - |
| Occupation | Farmer | 93.7 | 80.0 | 91.67 | 97.5 |
| | Business/service | 6.3 | 5.0 | 5.83 | 2.5 |
| | Government | 0.0 | 5.0 | 0.83 | 0.0 |
| | LIC agent | 0.0 | 10.0 | 1.67 | 0.0 |
| Area under protected cultivation ($m^2$) | Less than 1000 | 52.08 | 70.0 | 53.3 | - |
| | 1000 to 2000 | 33.33 | 10.0 | 27.2 | - |
| | 2000 to 3000 | 1.0 | 0.0 | 0.8 | - |
| | 3000 to 4000 | 13.54 | 20.0 | 15.8 | - |

**Table 4.** Crop-wise establishment cost under different polyhouse sizes.

| Crop | Poly house size ($m^2$) | Polyhouse structure (₹) | Irrigation system (₹) | Crop establishment (₹) | Total establishment cost (₹) | Subsidy (₹) | Establishment cost minus subsidy (₹) |
|---|---|---|---|---|---|---|---|
| Rose | 1000 | 1296507 | 173000 | 145898 | 1615405 | 718500 | 896905 |
| | 2000 | 2103291 | 264000 | 290716 | 2658007 | 1192000 | 1466007 |
| | 3000 | 2972546 | 344000 | 433830 | 3750376 | 1619000 | 2131376 |
| | 4000 | 3797220 | 414000 | 579522 | 4790741 | 2092000 | 2698741 |
| Carnation | 1000 | 861507 | 125000 | 312836 | 1299343 | 597500 | 701843 |
| Gerbera | 1000 | 996507 | 122500 | 260470 | 1379477 | 575500 | 803977 |
| | 2000 | 1803291 | 213500 | 519146 | 2535937 | 1106000 | 1429937 |
| | 4000 | 3497220 | 359000 | 1026933 | 4883152 | 2120000 | 2763152 |
| Capsicum | 1000 | 846507 | 126400 | 32750 | 1005657 | 476500 | 529157 |
| | 2000 | 1653291 | 217400 | 65500 | 1936191 | 908000 | 1028191 |
| | 4000 | 3247219 | 367000 | 131500 | 3745720 | 1724000 | 2021720 |

of carnation under polyhouse worked out to ₹4.60 lakhs, followed by gerbera (₹4.59 lakhs), rose (₹4.49 lakhs) and capsicum (₹3.14 lakhs) for the polyhouse size of 1000m$^2$. This may be due to fact that carnation and gerbera have high planting materials cost leading to increase an overall cost of cultivation. Among four crops under study, carnation was the best option for getting maximum income from polyhouse as it showed net income of ₹2.22 lakhs in area of 1000m$^2$. This was followed by rose (₹1.64 lakhs), gerbera (₹1.63 lakhs) and capsicum (₹1.04 lakhs). The benefit cost ratio is found to be highest in carnation (1.48), followed by rose (1.37), gerbera (1.36) and capsicum (1.33) for the polyhouse size of 1000m$^2$. The benefit cost ratio was greater than unity indicating that the cultivation of crops under protected cultivation is profitable.

The establishment cost of different crops under shade net house is depicted in Table 6. The total establishment cost without subsidy ranges between ₹5.71 lakhs to ₹5.81 lakhs for the shade net house size of 1000m$^2$. Among the total cost of establishment, installment of shade net house structure comprises of nearly 75% of the cost, whereas irrigation system and equipment's accounts for around 22% of the cost of establishment. It could be seen that, land development cost in case of cucumber was about 4.28%, which is less than 4% in the case of the other three crops.

The cost of cultivation of different crops under shade net house is displayed in Table 7. Total cost was maximum in case of capsicum (₹2.90 lakhs), followed by tomato (₹2.72 lakhs), Cucumber (₹1.15 lakhs), and Marigold (₹1.08 lakhs) for the shade net house size of 1000m$^2$. It is clear that, about 80% of the total cost is composed of total variable cost, and the remaining 20% comprises of total fixed cost for all the four crops. Among four crops under study, capsicum was the best option for getting maximum income from shade net house as it showed net income

**Table 5.** Crop-wise net income under different polyhouse sizes.

| | Cost of cultivation | | | | Income | | |
|---|---|---|---|---|---|---|---|
| Crop | Polyhouse size (m$^2$) | Fixed costs (₹) | Variable costs (₹) | Total cost (₹) | Total income (₹) | Net income (₹) | Benefit cost ratio |
| Rose | 1000 | 205666 | 243809 | 449475 | 613888 | 164413 | 1.37 |
| | 2000 | 354828 | 340446 | 695275 | 1175785 | 480511 | 1.69 |
| | 3000 | 516183 | 434334 | 950517 | 1799671 | 849154 | 1.89 |
| | 4000 | 683143 | 607810 | 1290953 | 2399562 | 1108609 | 1.86 |
| Carnation | 1000 | 230272 | 230613 | 460885 | 683205 | 222321 | 1.48 |
| Gerbera | 1000 | 226234 | 233287 | 459521 | 623441 | 163920 | 1.36 |
| | 2000 | 407870 | 359039 | 766909 | 1260242 | 493333 | 1.64 |
| | 4000 | 783488 | 597791 | 1381280 | 2449233 | 1067953 | 1.77 |
| Capsicum | 1000 | 136634 | 177969 | 314603 | 419025 | 104422 | 1.33 |
| | 2000 | 268247 | 355938 | 624185 | 849375 | 225190 | 1.36 |
| | 4000 | 521995 | 699548 | 1221543 | 1728000 | 506457 | 1.41 |

**Table 6.** Crop-wise establishment cost under shade net house.

| Crop | Shade net house size (m$^2$) | Shade net house structure (₹) | Irrigation system (₹) | Crop establishment (₹) | Total establishment cost (₹) | Subsidy (₹) | Establishment cost minus subsidy (₹) |
|---|---|---|---|---|---|---|---|
| Capsicum | 1000 | 431611 | 123500 | 24850 | 579961 | 274500 | 305461 |
| Tomato | 1000 | 431611 | 124250 | 16000 | 571861 | 274500 | 297361 |
| | 2000 | 588140 | 215500 | 36000 | 839640 | 398000 | 441640 |
| Cucumber | 1000 | 431611 | 129000 | 21200 | 581811 | 274500 | 307311 |
| | 4000 | 1069979 | 367000 | 67600 | 1504579 | 710989 | 793590 |
| Marigold | 1000 | 431611 | 123000 | 18700 | 573311 | 274500 | 298811 |
| | 4000 | 1069979 | 359500 | 74800 | 1504279 | 710989 | 793290 |

of ₹1.03 lakhs for the size of 1000m$^2$, followed by marigold ₹1.02 lakhs. Also benefit cost ratio was found to be highest in capsicum (1.36) followed by marigold (1.35), cucumber (1.17). The benefit cost ratio for tomato is slightly more than one, therefore, the production of tomato in a shade net house was not found to be economically feasible.

The crop-wise productivity under protected and open field condition was analyzed and the results are presented in the Table 8. It is observed that the crop productivity inside the polyhouse/shade net house increases by a minimum of 76% (marigold) to a maximum of 136% (capsicum) as compared to that in open method of cultivation. On an average, the productivity obtained under protected cultivation was 2.13 times more when compared to open method of cultivation. Jethi *et al.*, (3); Negi *et al.*, (7); Sphehia, (13) also confirmed that the protected cultivation of vegetables leads to higher yields ranges between 40% to 955% when compared to open method of cultivation.

Marginal effects from the multiple fractional logit regression models are depicted in Table 9. Results of the fractional logit regression model show that one-year increases in a farmer's age, the proportion of land allocated to protected cultivation increases by 0.32. On the contrary, a one ha increases in farm size the proportion of land allocated to protected cultivation decreases by 9%. Further, a one percent increase in household income increases the proportion of land allocated to protected cultivation by 8%. The estimated marginal effects of dummy variable show that with the provisions of subsidy the proportion of land allocated to protected cultivation increases by 3%.

The protected cultivator's expressed a number of constraints which needs the attention of the policymakers and implementing agencies. The high initial investment in the construction of polyhouse, high cost of planting materials and incidence of pests and diseases were the most important constraints in adoption of protected cultivation (Table 10). The polyhouse cultivation requires a high initial investment. To promote protected cultivation, the government of India has launched a number of program/scheme. However, its access is limited to a few farmers (Chatterjee *et al*., 2; Bhatnagar,1). Long-distance to the market is another challenge as a result the farmers had to incur higher expenditure on transportation of produce. It was observed during the survey that almost all the farmers had reported non-availability of crop insurance scheme for flowers and vegetables. Insurance of risky and high-value crop is utmost required and can be achieved by the inclusion of such crops in the ongoing scheme "Pradhan Mantri Fasal Bima Yojana" (PMFBY).

The polyhouse cultivator's of flowers and vegetables expressed the need for training and skill development on various aspects of cultivation. The most important was agronomic practices of cultivation of various flowers and vegetables under polyhouse cultivation (Table 11). Control of pests and diseases were other aspects which once attack the polyhouse is very difficult to control unless the right kind of dose of pesticide is applied. Cultivation of flowers and nursery raising were another challenge for which farmers felt

**Table 8.** Crop productivity under protected and open field condition (₹/acre).

| Crop | Protected | Open cultivation | Increase (%) |
|---|---|---|---|
| Rose (No in lakhs)$^{\$}$ | 7.99 | 3.48 | 129.6 |
| Capsicum(tons)$^{\#}$ | 14.8 | 6.25 | 136.8 |
| Tomato (tons)$^{\#}$ | 27.7 | 13.1 | 111.5 |
| Marigold (tons)$^{\#}$ | 18.0 | 4.8 | 76.5 |

Note: $- one year growing period of rose considered for open field and protected cultivation as well; #- four month growing period of capsicum and tomato considered for protected and open field cultivation as well.

**Table 7.** Crop-wise net income under shade net house.

| Crop | Cost of cultivation | | | | Income | | |
|---|---|---|---|---|---|---|---|
| | Shade net size (m$^2$) | Fixed costs (₹) | Variable costs (₹) | Total cost (₹) | Total income (₹) | Net income (₹) | Benefit cost ratio |
| Capsicum | 1000 | 58240.9 | 232155 | 290396 | 394250 | 103854 | 1.36 |
| Tomato | 1000 | 54516 | 218136 | 272651 | 283500 | 10849 | 1.04 |
| | 2000 | 105183 | 376640 | 481823 | 501260 | 19437 | 1.04 |
| Cucumber | 1000 | 22940 | 92983 | 115923 | 135135 | 19212 | 1.17 |
| | 4000 | 62648 | 238676 | 301325 | 383877 | 82552 | 1.27 |
| Marigold | 1000 | 21966 | 86681 | 108647 | 147000 | 38353 | 1.35 |
| | 4000 | 79239 | 342817 | 422056 | 525000 | 102944 | 1.24 |

**Table 9.** Estimated coefficients and marginal effects of fractional logit regression model.

| Variables | Estimates of the fractional logit model | | Marginal effects | |
|---|---|---|---|---|
| | Coefficients | Z | (dy/dx) | Z |
| Age (years) | 0.0228** | 2.16 | 0.0032** | 2.17 |
| Education (years) | 0.0288 | 0.73 | 0.0040 | 0.73 |
| Farm size (ha) | -0.6520*** | -4.43 | -0.0924*** | -4.37 |
| Household size (No) | -0.0376 | -0.97 | -0.0053 | -0.97 |
| Ln_Income (₹) | 0.5936*** | 4.56 | 0.0841*** | 4.48 |
| Loan (1=yes, 0=otherwise) | 0.0873 | 0.50 | 0.0123 | 0.50 |
| Subsidy (1=yes, 0=otherwise) | 0.2127* | 1.79 | 0.0301* | 1.76 |
| Distance from market (km) | 0.0008 | 0.35 | 0.0001 | 0.35 |
| Extension contact (1=yes, 0=otherwise) | -0.1445 | -1.22 | -0.0204 | -1.24 |
| Experience in protected farming (years) | 0.0160 | 0.93 | 0.0022 | 0.92 |
| Constant | -10.239*** | -6.32 | | |
| Wald $chi^2(11)$ | 180.80 | | | |
| Pseudo $R^2$ | 0.0743 | | | |
| Prob > $chi^2$ | 0.001 | | | |
| Observations | 116 | | | |

Note: ***p<0.01, **p<0.05, *p<0.1

the need for training. Repair and maintenance of the structure is another skillful task which needs training. Application of fertilizer through drip is also a skillful task and requires an understanding of the right dose and quantity of fertilizer to be applied.

Shade net house cultivators expressed a number of constraints like a high initial investment, low price for the produce, difficulty in getting subsidy and high cost of transportation (Table 12). Long-distance to the market is another constraint as a result a few farmers in the study area were forced to sell the produce to the local aggregators. The small amount of product which is harvested every day is aggregated by the transporter who collects from each of the polyhouses. The small volume and distant market adds to the marketing cost. Many of the farmers also indicated that high cost of plant protection chemicals, low price for the produce, lack of adequate and timely disbursement of loans, the incidence of pests and diseases, difficulty in getting credit and no insurance for crops etc., were the major constraints in adoption of shade net house.

**Table 10.** Constraints in adoption of polyhouse farmers.

| Particulars | Mean Garrett's score | Rank |
|---|---|---|
| High initial investment in the construction of polyhouse | 93.67 | 1 |
| High cost of planting material | 87.00 | 2 |
| High incidence of insect pest or diseases | 83.42 | 3 |
| Long-distance to the market | 77.00 | 4 |
| High cost of transportation | 75.00 | 5 |
| High cost of plant protection chemicals | 73.65 | 6 |
| Poor price received | 68.00 | 7 |
| Lack of adequate and timely disbursement of loans | 67.12 | 8 |
| Non-availability of skilled labour | 58.23 | 9 |
| No insurance for crops | 53.43 | 10 |

**Table 11.** Training needs of polyhouse cultivators.

| Particulars | Mean Garrett's score | Rank |
|---|---|---|
| Agronomic practices | 84.12 | 1 |
| Control of pest and diseases | 82.32 | 2 |
| Flower cultivation | 75.00 | 3 |
| Nursery raising | 67.00 | 4 |
| Vegetable cultivation | 62.30 | 5 |
| Repair and maintenance structure | 50.40 | 6 |
| Fertigation unit | 48.00 | 7 |
| Packaging | 45.30 | 8 |
| Trainings on export aspects | 42.50 | 9 |

**Table 12.** Constraints faced by shade net house farmers.

| Particulars | Mean Garrett's score | Rank |
|---|---|---|
| High initial investment in the construction of net house | 90.10 | 1 |
| Poor price received | 86.23 | 2 |
| Difficulty in getting a subsidy | 83.33 | 3 |
| High cost of transportation | 80.00 | 4 |
| Lack of local technical expertise | 78.65 | 5 |
| Long-distance to the market | 75.76 | 6 |
| Lack of adequate and timely disbursement of loans | 73.23 | 7 |
| High incidence of insect pest or diseases | 71.13 | 8 |
| Difficulty in getting credit | 69.00 | 9 |
| No insurance for crops | 58.20 | 10 |
| High cost of plant protection chemicals | 53.54 | 11 |

**Table 13.** Training needs of shade net house farmers.

| Particulars | Mean Garrett's score | Rank |
|---|---|---|
| Agronomic practices | 81.00 | 1 |
| Vegetable cultivation | 78.33 | 2 |
| Training in marketing and exports | 73.67 | 3 |
| Control of pest and diseases | 67.00 | 4 |
| Nursery raising | 62.33 | 5 |
| Flower cultivation | 50.20 | 6 |
| Repair and maintenance structure | 46.10 | 7 |
| Fertigation unit | 43.00 | 8 |

The shade net house cultivation being the capital and knowledge-intensive the farmers expressed the need for training in number of aspects to improve their skill and knowledge. The major areas are agronomic practices, vegetable cultivation, marketing, control of pests and diseases, nursery raising, flowers cultivation, repairs and maintenance of the structures and fertigation unit (Table 13).

The results shows that the area covered under protected cultivation by NHM in India was 14136 ha, while the area brought under protected cultivation by Maharashtra was about 4478 ha, of which the share of shade net house is 61% followed by naturally ventilated polyhouse (37%), Plastic tunnel (1.13%) and green house structures (0.9%). The establishment cost of protected cultivation was very high, but offers higher returns. Protected cultivation of vegetables and flowers leads to higher yields ranging from 76% to 137% as compared to open method of cultivation. The benefit cost ratio was found to be more than one for all crops except tomato under shade net house, therefore the production of tomato in a shade net house was not found to be economically feasible even with subsidy. The fractional logit regression model showed that the age of household, farm size, household income and access to subsidy were found to be significant factors influencing allocation of share of total farmland to protected cultivation. The high initial investment, high cost of planting materials and incidence of pests and diseases were the most important constraints in adoption of polyhouse cultivation. While, the shade net house cultivators expressed high initial investment, low price for the produce, difficulty in getting subsidy and high cost of transportation were the important constraints. Thus, it is suggested that the government support in the form of capital subsidy need to be strengthened further to enhance rate of adoption of protected cultivation and high value crops.

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