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# Economic Analysis of Tomato Cultivation under Polyhouse

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## ABSTRACT

Economic analysis of tomato cultivation under conventional and polyhouse for area of 1000 $m^2$ is estimated and results are analyzed to access its feasibility and profitability. Different parameters of economic analysis like Net Present Value (NPV), Benefit cost Ratio, and payback period is estimated to access the economic feasibility of tomato cultivation under conventional and polyhouse. The Net present value, Benefit cost ratio and Payback period for tomato cultivation under conventional cultivation is Rs 107120.0, 1.98 and 12 months respectively however, under polyhouse, it is Rs 786036.2, 2.40 and 7 months respectively. It is found that, despite the higher productivity under polyhouse condition, the BC ratio is not encouraging because of higher cost of cultivation including expenditure on material cost, labour cost, and cost of other input materials.

**Keywords** Tomato, Polyhouse, Net present value, Benefit cost ratio, Payback period.

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## INTRODUCTION

Protected cultivation is an emerging technology for raising vegetables, flowers, and others high valued as well as perishable crops. In modern agriculture, protected structures held an extreme potential for more production with higher productivity. Quantity and quality of produce is also much better than open field produces. In protected structures, production of vegetables and flowers are higher than open field conditions and productivity is also higher. Gross and net returns were higher in these structures as compared to open conditions (Singh *et al*. 2016). The initial cost of protected structures is higher, but it is compensated in 3-5 years with the good production of crops. Off-season vegetable cultivation and nurseries are grown under protected structures to get higher profit from it. Financial support or subsidy is also provided by the Govt. agency to spread this technology all over India (50% of the total cost through Mission for Integrated Development of Horticulture (MIDH). Resources are efficiently used in these structures because modern methods/techniques are used. Protected cultivation has so much of advantages but there is some constraint also in these structures. Many of production constraints like a short life of poly sheet and severe and incidentally infestation of insect-pest and nematodes and of marketing constraints like lack of minimum support price, high price fluctuations and lack of market information are the major constraint. Initial high cost and non-availability of various materials are also the major constraints in the adoption of polyhouse technology (Sreedhara *et al*. 2013).

Tomato (*Lycopersicon esculentum*) belongs to the genus *Lycopersicon* under Solanaceae family, is rich source of vitamins A, C, potassium, minerals and fibers. India ranks second in the area as well as production of tomato next to China. Globally, the share of China and India in tomato production accounts 27.8 and 11.2 %, respectively (Kumar *et al.* 2016). The total area under tomato cultivation in India is 789.15 thousand ha, with total production 19759.32 thousand MT, and productivity is 25.03 MT/ha (Horticultural Statistics at a Glance 2018). Jharkhand is in 16$^{th}$ position in terms of tomato production in India. The total area under tomato cultivation is 20.11 thousand ha, which is 2.55% of total area under tomato cultivation of India and the total production of tomato is 265.26 thousand MT, which is 1.34% of total tomato production in India and productivity is 13.19 MT per ha (Horticultural Statistics at a Glance 2018). Kumar *et al.* (2016) reported that the cost of cultivation of tomato under poly houses was higher by Rs. 206816.90/acre as compared to open field conditions. At the same time, the net returns under poly houses were higher by Rs 51097.54/acre. Farmers realized 53.71 % higher yield of tomato under poly house as compared to open field conditions. The gross returns over variable cost and net return were also higher by 106.94 %, 160.70 % and 48.70 %, respectively in case of poly house as compared to open field conditions.

Numbers of studies are reported for economic analysis of vegetable cultivation under conventional and polyhouse cultivation. But none of them are analyzed the economics of cultivation in details. They have just calculated the B-C ratio and payback period whereas in this study in-depth analysis of economics of tomato cultivation are done and presented herewith. Different parameters of economic analysis like Net Present Value (NPV), Benefit cost ratio, and payback period is estimated to access the economic feasibility of tomato cultivation under conventional and polyhouse cultivation.

## MATERIALS AND METHODS

Economics analysis of tomato cultivation under conventional and polyhouse for area of 1000 m$^2$ is calculated and results are analyzed to access its feasibility and profitability. Primary data required for calculating expenditure and price realization for tomato cultivation are collected from AICRP on Plastic Engineering in Agriculture Structure and Environment Management (PEASEM) and Precision Farming Development Center (PFDC), Department of Agricultural Engineering, BAU, Ranchi. Secondary data required for calculating economics of tomato cultivation under conventional and polyhouse are collected through published information from books, journals, articles, internet source.

### Conventional cultivation

*Cost of cultivation*

The annual recurring cost for tomato cultivation which includes cost of land preparation, planting material, fertilizers, irrigation, spraying and labor are Rs 48119. Details of recurring cost are already published in Kumar *et al.* (2020).

*Production and income*

The yield is highest (25t/ha) during winter season (Nov to Feb) and lowest (12 t/ha) during monsoon season (July to Oct) due to high mortality rate and weed infestation. The high temperature and intense solar radiation resulted in lesser marketable yield (18t/ha) during summer season (March to June). The total annual income generated from selling of tomato is Rs 95060 (Kumar *et al*. 2020).

### Polyhouse cultivation

*Cost of cultivation*

The estimated cost of fabrication of polyhouse is Rs 935000 for 1000 m$^2$ area. The economical life of polyhouse structure and cladding material is 20 years, 3 years respectively. The annual cost of plastic mulch is estimated as Rs 6000 (Table 1).

**Table 1.** Estimated capital cost and means of finance.

| Sl. No. | Items | Rate (Rs m$^2$) | Amount (Rs) | Life (Years) | Annual cost (Rs) |
|---|---|---|---|---|---|
| 1 | Polyhouse structure | 800 | 800000 | 20 | 40000 |
| 2 | Cladding material | 135 | 135000 | 3 | 45000 |
| 3 | Mulching cost | 6 | 6000 | - | 6000 |
| | | Total | | | 91000 |

**Table 2**. Annual breakup of recurring cost.

| Sl. No. | Item/Year | Amount (Rs.) |
|---|---|---|
| 1 | Soil sterilization | 10000 |
| 2 | Land preparation cost | 1000 |
| 3 | Planting material cost | 9300 |
| 4 | Fertigation cost | 6351 |
| 5 | Irrigation cost | 7000 |
| 6 | Spraying cost | 800 |
| 7 | Labor cost | 19513 |
| | Total recurring cost | 53964 |

Land preparation is considered to be done using tractor with rotovator. The charges for soil sterilization and land preparation are Rs 10000 and Rs 1000 respectively (Table 2).

Planting material cost which includes the cost of tray, low tunnel, vermicompost, cocopit and seed are estimated and presented in the Table 2. The cost of tray, low tunnel, vermicompost, cocopit, and seed are Rs 3500, Rs 3000, Rs 960, Rs 640, and Rs. 1200 (Table 2). The total cost of planting material is Rs 9300.

Water soluble fertilizers like Urea, DAP and MOP are selected for fertilization using drip irrigation system. N and K were given through fertigation whereas P was given as basal dose at the time of transplanting. The recommended dosage of fertilizers (RDF) for tomato under polyhouse is taken as 350:120:390 kg NPK/ha. Cost of fertilizers are estimated as per the rates given by ATIC, BAU, Ranchi and presented in Table 2. The cost or Urea, DAP and MOP are Rs 449, 702, 5200, respectively.

The cost of irrigation is estimated for cropping period from June to February and total number of irrigations provided is 56 times. The duration of irrigation is considered as 1 hour/day/time and unit rate of irrigation is taken as Rs 125 per hour. The annual cost of irrigation is Rs 7000 for tomato cultivation using drip irrigation.

**Table 3**. Production of tomato in different seasons and income generated from tomato cultivation.

| Sl. No. | Particular | Amount (Rs)/ Quantity (kg) |
|---|---|---|
| 1 | Plant population @6 plant/$m^2$ | 6000 plants |
| 2 | Total production in kg @ 180 t/ha | 18000 kg |
| 3 | Less: Loss of produce (2%) | 360 kg |
| 4 | Produce available for sale (kg) | 17640 kg |
| 5 | Income from sale of produce @ Rs 20/kg | Rs. 352800 |

The cost of spraying of different insecticides are estimated and found that total cost of insecticides used for tomato cultivation is Rs. 800.

The annual recurring cost for tomato cultivation which includes cost of planting material, fertilizers, irrigation, spraying and labor are Rs 42964. The details of recurring cost are presented in Table 2.

*Production and income*

The production of tomato is estimated as 18000 kg from 1000 $m^2$ polyhouse. The average selling price of tomato is considered as Rs. 20/kg respectively. The total annual income generated from selling of tomato is Rs. 352800 (Table 3).

*Economic analysis*

The economic analysis for tomato cultivation under open field and polyhouse are calculated using Net Present Value (NPV), Benefit cost ratio and payback period and is estimated as per the methodology suggested by (Devika *et al.* 2017).

*Net present value (NPV)*

Net present value is the difference between the present value of cash inflows and the present value of cash outflows over a period of time. A positive net present value indicates that the projected earnings generated by a project exceed the anticipated costs. It is assumed that an investment with a positive NPV will be profitable, and an investment with a negative NPV will result in a net loss, which dictates that only investments with positive NPV values should be considered (www.investopedia.com). A discount factor of 15% was used to discount the net cash inflow representing the opportunity cost of capital with the following formula.

$$NPV = \sum_{i=1}^{t} \frac{Bi}{(1+r)\,t} - \sum_{i=1}^{t} \frac{C\,i}{(1+r)\,t}$$

**Benefit cost ratio**

The benefit-cost ratio of an investment is ratio of the discounted value of all cash inflows to the discounted value of all cash outflows during the life of the project and computed as

Benefit cost ratio =

$$NPV = \sum_{i=1}^{t} \frac{Bi}{(1+r)\,t} \setminus \sum_{i=1}^{t} \frac{C\,i}{(1+r)\,t}$$

Where,
$B_i$ = Gross benefit per year, $r$ = Rate of interest, $C_i$ = Cost per year, $t$ = Time, $i$ = Number of years.

*Payback period*

Since the cash flow is not constant from year to year, the payback period was determined by calculating the cumulative average proceeds in successive years until the total return is equal to the original outlays.

Payback period = Cost of investment/Annual net cash flow

## RESULTS AND DISCUSSION

**Conventional cultivation**

The annual recurring cost of tomato cultivation is Rs 48119 and the annual income from sale of produce is Rs 95060, hence the annual net benefit is Rs 46941. The Net present value, Benefit cost ratio and Payback period for tomato cultivation under conventional cultivation is Rs 107120, 1.98 and 1.03 years respectively (Kumar *et al*. 2020).

**Polyhouse cultivation**

Economic analysis of tomato cultivation under polyhouse is estimated for 6 years of tomato cultivation. Different parameters of economic analysis (Net present worth, Benefit cost ratio and Payback period) has been estimated and presented in Table 4. The annual fixed cost is Rs 91000 for fabrication of polyhouse and cost of mulching. The annual recurring cost for tomato cultivation under polyhouse is Rs 53964 and the annual income from sale of produce is Rs 352800, hence the annual net benefit is Rs 207836. Considering the discount rate of 15%, discounted cost and discounted benefit has been computed as per the procedure suggested by Devika *et al.* (2017). The Net present value, Benefit cost ratio and Payback period for tomato cultivation under polyhouse is Rs 786036, 2.4 and 7 months, respectively. Findings of economic parameters are completely in-line with the similar study conducted by Singh et al. (2015) at PFDC, ICAR-CISH, Lucknow who reported that tomato fruit yield under polyhouse condition may reach 170 to 180 t/ha (17 to 18 kg/sqm or 5.7 to 6.0 kg/plant). They also reported the BC ratio of 2.37 for tomato cultivation under polyhouse which is very close to the result of this study. Similar results of economic study of Tomato cultivation is also reported in model

**Table 4.** Net present value, benefit cost ratio and payback period for polyhouse cultivation.

| Sl. No. | Particulars | Year First | Second | Third | Forth | Fifth | Sixth |
|---|---|---|---|---|---|---|---|
| 1 | Capital cost | 91000 | 91000 | 91000 | 91000 | 91000 | 91000 |
| 2 | Recurring cost | 53964 | 53964 | 53964 | 53964 | 53964 | 53964 |
| 3 | Total cost(1+2) | 144964 | 144964 | 144964 | 144964 | 144964 | 144964 |
| 4 | Total income | 352800 | 352800 | 352800 | 352800 | 352800 | 352800 |
| 5 | Net benefit (4-3) | 207836 | 207836 | 207836 | 207836 | 207836 | 207836 |
| 6 | Discount factor @ 15% | 0.869 | 0.756 | 0.657 | 0.571 | 0.497 | 0.432 |
| 7 | Discounted cost (3X6) | 125974 | 109593 | 95241 | 82774 | 72047 | 62624 |
| 8 | Total Discounted Cost | | | 548253 | | | |
| 9 | Discounted benefit (4X6) | 306583 | 266717 | 231790 | 201449 | 175342 | 152410 |
| 10 | Total discounted benefit | | | 1334290 | | | |
| 11 | NPV @15% | | | 786036 | | | |
| 12 | BC ratio | | | 2.4 | | | |
| 13 | Payback period | | | 7 months (less than 1 year) | | | |

**Table 5.** Comparative economics of tomato cultivation.

| Sl. No. | Particulars | Conventional | Drip irrigation | Drip with mulch | Polyhouse |
|---|---|---|---|---|---|
| Annual recurring cost | | | | | |
| 1 | Depreciation on fixed cost | 0 (0.0) | 3571 (5.7) | 15571 (22.4) | 91000 (62.8) |
| 2 | Soil sterilization | 0 (0.0) | 0 (0.0) | 0 (0.0) | 10000 (6.9) |
| 3 | Land preparation cost | 560 (1.2) | 560 (0.9) | 560 (0.8) | 1000 (0.7) |
| 4 | Planting material cost | 14900 (31.0) | 14900 (23.7) | 14900 (21.4) | 9300 (6.4) |
| 5 | Fertilizer cost | 2774 (5.8) | 6855 (10.9) | 6855 (9.9) | 6351 (4.4) |
| 6 | Irrigation cost | 2750 (5.7) | 14000 (22.3) | 9750 (14.0) | 7000 (4.8) |
| 7 | Spraying cost | 1200 (2.5) | 1200 (1.9) | 1200 (1.7) | 800 (0.6) |
| 8 | Labor cost | 25935 (53.9) | 21736 (34.6) | 20748 (29.8) | 19513 (13.5) |
| | Total recurring cost | 48119 | 62822 | 69584 | 144964 |
| Return structure | | | | | |
| 1 | Total annual yield(kg) | 5390 | 8820 | 13720 | 17640 |
| 2 | Gross return (Rs) | 95060 | 156800 | 235200 | 352800 |
| 3 | Net return (Rs) | 46941 | 93978 | 165616 | 207836 |
| 4 | NPV @15% | 107120 | 214457 | 365982 | 786036 |
| 5 | BC ratio | 1.98 | 2.50 | 3.14 | 2.40 |
| 6 | PB period (months) | 12 | 8 | 5 | 7 |

Note- Figures in parentheses indicate their percentages to total cost.

bankable project on protected cultivation in Haryana (2012) published by Department of Horticulture, Government of Haryana. In this report, they have estimated a BC ratio of 1.26 for tomato cultivation under naturally ventilated polyhouse

**Comparative economics of tomato cultivation under conventional, drip irrigation, drip irrigation with plastic mulch and polyhouse.**

The returns from tomato cultivation under conventional, drip irrigation, drip irrigation with plastic mulch and polyhouse is given in Table 5 showed that, the BC ratio and payback period for all four conditions is 1.98, 2.50, 3.14, 2.40 and 12, 8, 5 and 7 months respectively. It is clear that the highest B:C ratio is found for drip irrigation with plastic mulch because in this case fixed and operating cost is less in comparison to polyhouse. In case of drip irrigation and polyhouse three crops can be taken but under polyhouse only one crop can be taken from June to February.

Findings are in agreement with the study of Nagalakshmi *et al.* (2001) who concluded that the capsicum crops grown in the naturally ventilated poly house had 4 times more yield and yield components compared to those grown in the open field and Sreedhara *et al*. (2013) who reported the labor cost, expenditure on material cost, total cost of cultivation, was higher under protected structure, hence despite the higher productivity under greenhouse condition, the BC ratio is not encouraging. Short life of UV stabilized polyethylene sheet is major production constraint in case of polyhouse as weather conditions changes abruptly. Infestation of nematodes and white-fly, high cost of water soluble fertilizers and hybrid seeds was one of the major bottlenecks in production under polyhouse. High weather fluctuations, fear of failure of technology, lack of knowledge about latest package of practices and weed infestation negatively affects the production under polyhouse.

## CONCLUSION

In the present study a systematic approach has been tried to calculate the economics for cultivation of tomato under conventional and polyhouse, but economics of cost of cultivation will vary from region to region. The important economic parameters such as NPV, BC ratio and pay-back period are calculated to access the economics. Here the cost of water and fertilizer use efficiency is not considered in calculat-

ing the economics.

From the economic analysis of present study, it can be concluded that tomato cultivation under polyhouse is far beneficial than under conventional method of cultivation. The Net present value, Benefit cost ratio and Payback period for tomato cultivation under conventional cultivation is Rs 107120, 1.98 and 12 months respectively however, under polyhouse, it is Rs 786036, 2.40 and 7 months respectively.

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