UNDERSTANDING ECONOMICS OF RAIN SHELTER METHOD OF TOMATO CULTIVATION

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Abstract: While it is a common approach for many horticultural crops, rain shelter cultivation has not been applied extensively to tomatoes. However, Assam's small- and marginal-farm owners are starting to use the Rain Shelter (RS) technology. Although it requires a large initial investment, the Rain Shelter technique is increasingly seen as more sustainable than conventional farming methods because it blocks the influence of rain during the months when crops are at their peak and because the temperatures inside these structures are typically lower than in open fields. The cost-benefit analysis of the traditional Open Field approach (OF) and the Rain Shelter (RS) method for tomato farming in Assam is presented in the current study. In order to gain a better understanding of the diversity in costs associated with various components in the site; this study was conducted in the Golaghat district in the state of Assam.

It was discovered that the comparable component, with only slight differences, exhibited cost dynamics at both methods. This posed a challenge when calculating the cost of cultivation to calculate the benefit-cost ratio using the same methodology. The approaches present different elements to comprehend the costs associated with Rain Shelter, a component of Protected Agriculture (PA) and the conventional Open Field approach employing cost concept. The district's farmer's field served as the experiment's location. Cost concept was used to analyse the results and compare the cost of cultivation and B: C ratio. The findings showed that while the Rain Shelter (RS) approach is more expensive than the standard method of Open Field (OF), the profitability of RF is much higher than the OF method of tomato cultivation.

Keywords: *Assam, Open Field, Rain-shelter, horticultural crops, Golaghat, PA, approach, method, tomato, study.*

Introduction: The tomato, (*Solanum lycopersicum*), is a member of the Solanaceae family and is one of the most widely grown, significant, and profitable vegetables in India. In 2018, tomatoes were grown in Assam on 18.28 thousand hectares of land and produced 396.024 thousand MT

(*Agricultural Statistics at a Glance, 2019*) . It increased to 432.40 thousand MT in 2024 ((*Production: Horticulture Crops: Vegetables: Tomato: Assam*). In recent times, Assam has witnessed notable progress and prosperity in the field of tomato cultivation, both in area and production. And this reflects the growing importance of tomato in the region's agriculture.

Tomatoes grow best in well-drained, sandy or red loam soils that have a pH range of 6.0 to 7.0 and are high in organic matter. Temperatures between 21 and 24°C are ideal for tomato cultivation. Frost and temperatures above 32 °C can have a negative impact on plants (*Indian Council of Agricultural Research*). These climatic conditions are prevalent in Assam. Assam can grow a number of tomato varieties, including Pusa Ruhini, Pusa Hybrid 8, Arka Vikas. Arka Saurabh, Pusa Uphar, Pusa Hybrid 2, Sioux, Pusa Rohini, Pusa Sadabahar, Pusa Hybrid 4. Arka Ashish, Arka Meghali, Arka Ahuti etc (*Indian Council of Agricultural Research*). Assam ranks 15th in terms of tomato production and counts more than 2% share in the country *(National Horticulture Board, 2019).*

The amount of land available for agriculture is running out daily. The increasing population's need for food will require more productive and intensive agricultural methods. A crop's productivity is affected by the microclimate surrounding it in addition to its genetic makeup. Production is typically completed in the winter, but demand cannot be met throughout the rest of the season.

In Assam, a farmer cannot grow vegetables during periods of high rainfall,high temperature, humidity, rainfall, strong winds, and high incidence of diseases. Therefore, the production of tomato during this unfavourable condition is limited. In order to maximize yield and conserve resources, protected cultivation is a cropping technique in which the microenvironment surrounding the plant body can be partially or fully controlled according to the needs of the plant during its growing period.One of the most useful approaches to accomplish the goals of protected agriculture is the Rain Shelter technique, which modifies the natural environment using good environmental principles to produce more produce per unit area and maximize plant growth and yield while using less inputs (Das et al., 2016). Thus, farmers in Assam have renewed hope that they will be able to grow vegetables during the rainy season with the use of inexpensive polyhouses and readily available bamboos. This method helps farmers to protect the plants from environmental extremes and they will be able to satisfy market demand with this. The farmers will also realize a higher price in the off season (*Off-Season Tomato Cultivation in Barpeta District*, n.d.)

Furthermore, in order to maintain environmental health while increasing farm output and profit, new sustainable technology must be incorporated with old (*Farming Innovations Feed the World and Protect the Planet _ World Economic Forum*, n.d.)

Globally, a great deal of research has been done on different horticultural crops using strategies based on Protected Agriculture (PA). However, there hasn't been much research done on tomatoes in a comparable manner. While some researches have addressed some elements of PA in tomatoes, a thorough analysis that reveals the cost-benefit of a PA-based approach in tomatoes remains an interesting topic. One such technique that aids farmers in increasing the household income reducing the ill effects of climate change for crop production is Rain Shelter technique. It also reduces the cost of cultivation in the long run.

As temperatures in Rain Shelter are typically lower, if managed properly, yields and productivity can potentially be higher than open-field production (Heckman et al., 2015). The findings of root rot incidence, crop yield, quality, soil water content, plant nutrition uptake, water productivity, and economic benefit demonstrated that deficit irrigation plus rain-shelter cultivation was superior than deficit irrigation plus un rain-shelter cultivation (Zang et al., 2024).The result was in consonance with the findings of(Mu et al., 2023) and (Zhang et al., 2023).Rain shelters intercept rainfall and act as wind and insect barriers. Daytime temperatures rise above ambient, benefiting warm-season crops like tomatoes (Kratky, 2006).These technologies offer numerous advantages such as saves water, increases crop production, environment friendly, food can be grown round the year, and provides jobs for residents (Rajiv & Kumari, 2023).Vegetable nursery raised in a polytunnel structure has several advantages, including simple management, early nursery, and protection from biotic and abiotic challenges. Growing food off-season allows for a higher price to be obtained for it. Progressive farmers with little holdings are most suited for inexpensive covered structures. (Kalita et al., 2023)

In order to show the cost-effectiveness of the new technique when compared to the current method of tomato cultivation by providing a cost-benefit analysis, the current study aims to implement a Protected Agriculture (PA) based technique for tomato cultivation in the districts of Golaghat in the State of Assam. It was done using Rain Shelter, a Protected Agriculture- based technique, to grow tomatoes on farmer's fields.

Materials and methods: The study was conducted in Bebejia Likson village, Marangi block of Golaghat district in the state of Assam (26.47° North latitude and 93.86 East longitudes) for the

agricultural year 2021-22. The plot of the cultivation belonged to one farmer named as Mr. Dibyajyoti Gogoi. To establish a consistent understanding of the costs associated with the entire operation throughout the crop cycle in both methods, one experimental Rain Shelter (RS) plot covering an area of 100 square meters (sqm) was employed. In addition, the same plot was used for Open Field (OF) method in the same farmer's another plot in the same village. For ease of comprehension of the farmers, the production cost and cost-benefit calculations were performed for a 0.33-acre area in Assam known as one Bigha (1333 sqm) in both scenarios.The order of the actions involved in the cultivation process was used to categorize the entire operation. A field register was used to record the costs associated with each activity for both RS and OF. The tomato variety used in the experiment was **Anup** produced by Syngenta India Private Limited**.**

The standard cost concept, which includes costs A1, A2, B1, B2, C1, C2, and C3, was used to determine the economics of tomato cultivation in the research area under both RS and OF conditions. The following norms served as the basis for the cost item calculations (Sarma et al., 2024).

Cost A1: The producer's real out-of-pocket and in-kind production expenses. The cost of item A1 includes the following elements.

A. The wages paid to the hired human labour.
B. The wages paid to the permanentlabour.
C. The wages paid to the contract labour.
D. The wages paid to the hired animal labour.
E. The imputed (estimated) value of wages of hired animal labour and fees paid for rented farm equipment
F. The prevailing actual rate for inorganic fertilizer and organic manures in the market.
G. The imputed (estimated) value of organic manure from own generation.
H. Imputed (estimated) value of using owned farm machinery in the agricultural operation.
I. The prevailing actual rate of seed in the market.
J. The imputed (estimated) value of using seed from own generation.
K. The prevailing actual market price of agrochemicals like pesticides, fungicides, herbicides, growth hormones, micro nutrients etc.
L. The cost involved for utilizing irrigation facility.
M. Govt regulated expenses like money paid for land revenue, cess and various taxes

levied.

N. Value of depreciation on own buildings,farm tools, machinery,

O. Cost of installation of irrigation facility in the farm.

P. Cost of installation of the rain shelter structure.

Q. Interest accrued on using the working capital for farm operation.

R. Other miscellaneous costs involved in the farm .Cost A2 = Cost A1 + Rent for the land that was rented Cost B1: A1 plus interest on the fixed capital (not including land) plus the rental value of owned land Cost B1: A1 or A2 plus interest on the amount of owned capital used in the company (not including land value) Cost B2 = Cost B1 + Land revenue - less rental value of owned land + Rent paid for rented land Cost C1 = Cost B1 + Family labour's estimated worth Cost B2 + Imputed value of family labour = Cost C2. Cost C3 is equal to Cost C2 plus 10% of Cost C2.

Cost A2= Cost A1+ The amount of rent paid on account of acquiring the land on lease purpose.

Cost B 1= Cost A 1+ The amount of interest paid that is accrued on the own fixed capital which does not include value of rent for using the own land that belongs to the farmer.

Cost B 1=Cost A 1 or Cost A 2 +The amount of interest paid that is accrued on the owned capital utilized in the farm operation which does not include the value of the own land that belongs to the farmer.

Cost B2= Cost B1 + The value of rent of the owned land that belongs to the farmer -The amount of revenue paid for the land + Rent paid for leased in land

Cost C1= Cost B1 + The imputed (estimated) value of utilizing family labour in the farm operation.

Cost C2= Cost B2 + The imputed (estimated) value of utilizing family labour in the farm operation.

Cost C3= Cost C2 + 10 percent of Cost C2

Table no 1: The sample farmers' economics of growing tomatoes (Rs./ha) based on the cost concept under Rain Shelter and Open Field conditions

Items of the cost	**Amount in Rs.**	
	Rain Shelter	**Open Field**
Cost A 1		

The wages paid to the hired human labour	21900 (12.41)	25100 (17.44)
Expenditures incurred on account of using the farm machinery and implements	3680 (2.09)	5900 (4.10)
Expenditures incurred on account of tomato seeds	1150 (.65)	1200 (.83)
Cost of inorganic fertilizers	24500 (13.88)	23900 (16.61)
Cost of organic manures	6000 (3.40)	6200 (4.31)
Cost of plant protection items like pesticides, fungicides, herbicides, hormones, micronutrients etc	4000 (2.27)	8000 5.56)
Cost incurred on account of applying irrigation	5000 (2.83)	8575 (5.96)
Polyhouse structure for rain shelter	50000 (28.33)	0
Cost of over head shed infrastructures in the nursery to raise seedlings	1150 (.65)	1290 (.90)
Land preparation and other cultivation practices in the nursery	1220 (.69)	1255 (.87)
Maintenance and repairing cost	2975 (1.69)	3290 (2.29)
Total working capital	121575 (68.89)	84710 (58.86)
Interest on working capital	7295 (4.13)	5083 (3.53)
Depreciation	900 (.51)	618 (.43)
Expenses incurred on account of payment made for land revenue	1050 (.59)	1080 (.75)
Miscellaneous expenditures	10780 (6.11)	12500 (8.68)
Total of Cost A 1	141600	103991
Expenditures incurred for taking the land on lease	0	0
Total of Cost A 2	141600	96835

The amount of interest paid that is accrued on own fixed capital which does not include value of rent for using the own land that belongs to the farmer.	1812 (1.03)	1286 (.89)
Total of cost B 1	143412	105277
The value of rent of the owned land that belongs to the farmer (the actual value to be paid for the purpose using the farmer's own land)	9050 (5.13)	10250 (7.12)
Total of cost B 2	152462	115527
Imputed value of using family labour	24025	28400

Total of Cost C 1	167436	133676
Imputed value of using family labour	24025 (13.61)	28400 (19.73)
Total of Cost C 2	176487	143930
10 % of Cost C 2	17649	14393
Total of Cost C 3	194135	158319
Tomato yield (Q/Hac)	45120	38750
Price (Rs/Kg)	16	12
Gross return in Rs.	721920	465000
Net return over Cost C 2 in Rs.	545434	321073
B : C ratio	**4.09**	**3.23**

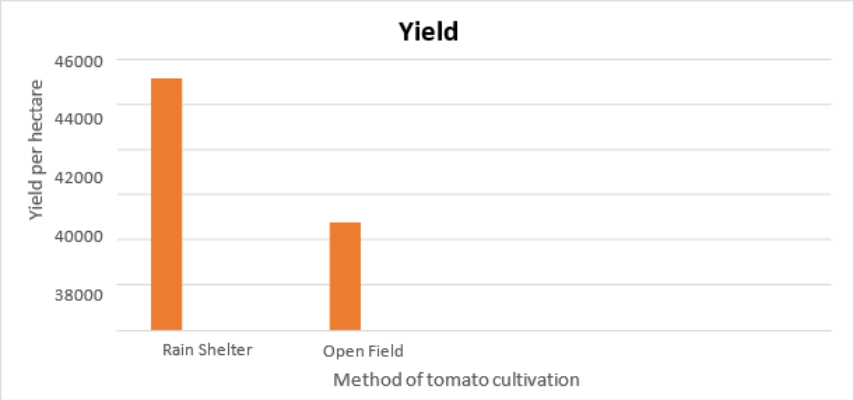

Fig 1: The tomato yield comparison per hectare under Rain Shelter and Open Filed methods of cultivation

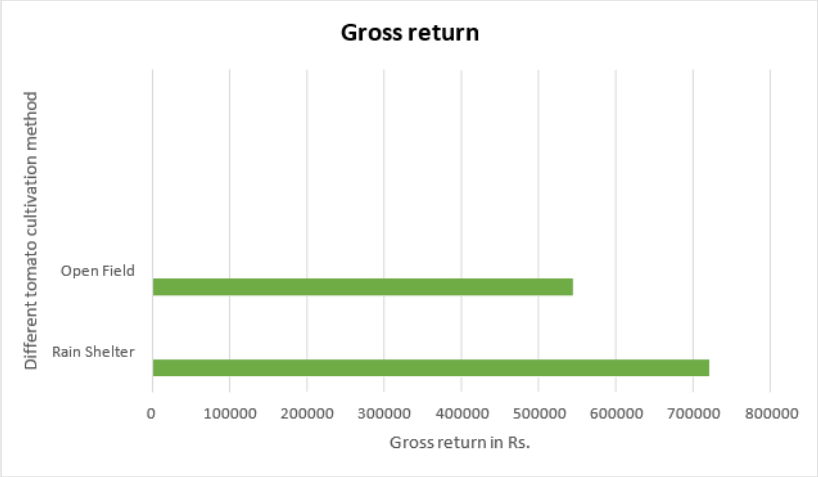

Fig 2: Comparison of gross return per hectare o tomato farming under Rain Shelter and Open Field methods of cultivation

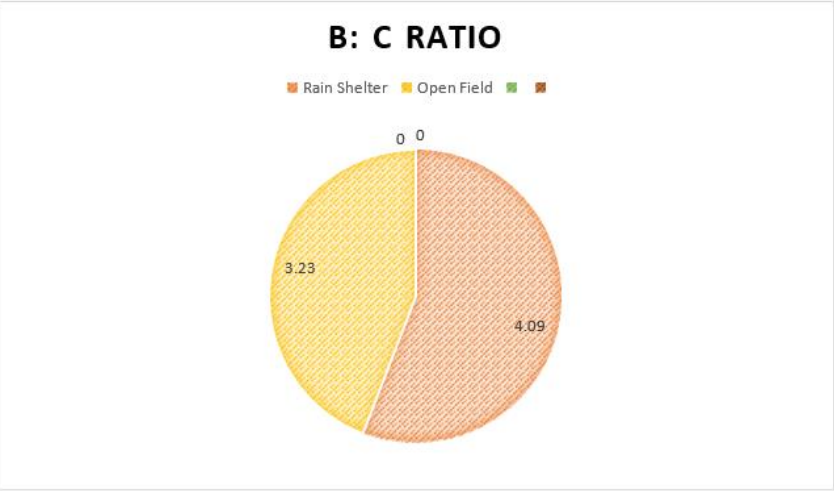

Fig 3: Comparison of B: C ratio of tomato farming under Rain Shelter and Open Field method of cultivation

Results and discussion: The financial aspect or cost-return analysis of growing tomatoes per hectare under two different methods Rain Shelter (RS) and Open Field (OF) techniques are shown in table 1. The table shows that the total working capital to cost C2 in the RS method is 68.89 percent, which is much higher than the OF technique. This difference was mainly seen due to the polyhouse structure required in RS method. Other major contributors of the cost were hired human labour (12.41 and 17.44 percent), inorganic fertilizers (13.88 and 16.61 percent) and imputed value family labour (13.61 and 19.73 percent) in both the farming methods respectively. The market price of tomatoes varied significantly with the methods of cultivation. From the table, we can see that the price realization under RS method were quite high as Rs. 16 per kg while the farmers cultivating tomatoes under open field condition got a fairly low price as Rs. 12 per kg. The reason of high sale difference is that the tomatoes cultivated under RS method can be sold in the market when the demand for tomato is high and supply is insufficient, i.e. in off season. The study found that tomato cultivation in Rain Shelter method ismore profitable than the Open Field farming, with a benefit-cost ratio of 4.09 in the protected farming as against 3.23 in the traditional method. The gross returns were Rs. 7,21, 920 and Rs. 4, 65, 000 and net return over cost were Rs. 5, 45, 434 and Rs. 3, 21, 073 in RS and OF method respectively. Although the initial investment in Rain Shelter method is a bit high but the high profitability of tomato cultivation in this method mitigates the cost and offer good pay-off benefit the farmers to enhance the income in the long run.

Conclusion and Recommendation: This new method of producing tomatoes under rainfed conditions in Rain Shelter method was found to be economically profitable, environmentally sound, and suitable for human life under farmer circumstances in the plain tomato production area of Golaghat district, Assam, India. It was also found to be better at producing fresh tomatoes with high quality and yield during the rainy season. A partial budget analysis was also conducted. As a result, the holders of the stack and responsible bodies work hard to develop this technology and establish connections between the various players in the tomato production value chain in order to guarantee a sustainable supply and enhance farmers' livelihoods. The Golaghat area is suitable for the production of vegetables, more specifically tomatoes.

Photographs:

Fig: Some of the pictures related to the Rain Shelter tomato cultivation plot by the researcher

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