A Special Study

Poly Shed Summer Tomato:

Adoption and farmers' innovations

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Glossary

AAS	=	Agricultural Advisory Society
BARI	=	Bangladesh Agricultural Research Institute
BBS	=	Bangladesh Bureau of Statistics
DAE	=	Department of Agricultural Extension
EAL	=	Energypac Agro Ltd
FAO	=	Food and Agriculture Organization
FAS	=	Foreign Agricultural Service
FGD	=	Focus Group Discussion
Fig	=	Figure
GAP	=	Good Agriculture Practice
ha	=	Hectare
IFC	=	International Finance Corporation
Kg	=	Kilogram
NGO	=	Non Government Organization
Nr	=	Number
OP	=	Open Pollinated
PSST	=	Poly shed summer tomato
SDBS	=	Sector Development and Business Service
SEDF	=	South Asia Enterprise Development Facility
STW	=	Shallow Tube well
Tk.	=	Taka
TV	=	Television
USDA	=	United States Department of Agriculture
UVR	=	Ultra Violet Resistant

Executive Summary

Tomato belongs to the family solanaceae and genus *Lycopersicon*. The scientific name of common tomato is *Lycopersicon esculentum*. Tomato is one of the most popular and widely grown vegetables in the world ranking second in importance to potato in many countries. For its outstanding nutritive value it is among the most widely consumed and highly praised vegetables. Global tomato production has increased 291 percent since 1961, reaching 108 million metric tons in 2002. At the same time, overall yield has increased a staggering 64 percent reaching an average of 36 tons per hectare (FAS/ USDA, September 2003). By comparison, Bangladesh grows tomatoes on about 10,000 hectares and produces only about 120,000 metric tons (12 tons per hectare) of fresh tomatoes. Clearly, there is a lot of potential to increase both the total number of hectares devoted to tomato production and the yield per hectare of tomatoes produced in Bangladesh.

Tomato is an annual, warm season crop. Climatic conditions play a major role in its production. Temperature, for example, has profound influence on tomato production. Extremely high temperature, that is, 38^0C generally caused a marked decreased in the pollination of almost all tomato cultivars. Environmental factor such as photosynthetic response (day length), temperature, moisture markedly influence the process of fruit setting, subsequent fruit development and overall yield. A well-drained, fairly light, fertile, loamy soil with a fair moisture holding capacity is ideal for producing a good crop of tomato. Tomato crop prefers a slightly acid soil condition; ranging from P^H 6.0 to 7.0.

Poly-house technology has been in use for intensive tomato production in more than fifty countries around the world. Application of this technology in summer tomato cultivation in Bangladesh is a recent undertaking. The production of summer tomato under poly shed has resulted in higher yields and allows farmers to capitalize on bringing off-season production to market during a period of seasonally scarce supply and high prices. Dissemination of “Poly-House” technology for vegetable/tomato production in Bangladesh could provide immense nutritional and economic benefits to the country. The purpose of the proposed study is to document the extent of these benefits and to show how “poly-house” adoption might be expected to take place in Bangladesh and to measure the degree to which farmers’ have demonstrated their capacity to innovate cost effective applications of the technology; drawing conclusions about the potential scaling-up of sustainable poly-shed technology throughout the country.

Poly shed summer tomato cultivation was first introduced in Bangladesh by the Bangladesh Agricultural Research Institute (BARI) more than a decade ago. In 1995 its regional station at Jessore organized the first demonstration trial on poly shed summer tomato at Bolarampur village of Bagherpara upazila in that Jessore district. Two pioneer farmers, Md. Nur Mohammad Mollah and Md. Mokadas Ali Khan participated in this demonstration. Presently, 72 farmers cultivate summer tomato on 8.5 acres land under poly shed in that area during 2008-9 cropping season. They use several hybrid varieties of tomato.

Bolarampur village is under Bagherpara upazila of Jessore district. The means of household livelihoods of Bolarampur village were assessed through focus group discussion (FGD) at Dadpur Primary School. The highest contribution in household livelihoods in Bolarampur village was found with agriculture (75%) followed in order by daily labor (10%), business and

livestock (5%), fishery and service (2%) and driving including manual (1%). The participants of the FGD were further classified into five categories of crops i.e., rice, fruits, tomato alone, other vegetables and other crops. The highest acreage and contribution in household livelihoods in Bolarampur village was found with rice (33%) followed in order by Fruits (32%), Tomato (21%), other vegetables (13%) and other crops (1%).

BARI tomato 4, an open pollinated heat tolerant variety was first demonstrated in 1995/6 by 2 farmers at Bolarampur village. The number of farmers progressively increased to 34 in 2002/3 with three open pollinated heat tolerant varieties such as BARI tomato 4,5 and 6. Farmers in Bagherpara, Jhekorgacha and sadar upazilas of Jessore district have started cultivation of poly shed summer tomato since 2003/4. The hybrid tomato varieties introduced in these areas are BARI hybrid tomato-3 in 2004/5 followed by BARI hybrid tomato-4 in 2004/5, hybrid Mintoo in 2005/6, Hira-1 in 2006/7 and Hira-2 in 2007/8. Currently hybrid varieties both from BARI and private seed companies are widely cultivated by summer tomato farmers. All demonstrated summer tomato cultivars were found as indeterminate type.

Seeds are line sown in a raised seedbed from May-June. Seed sowing can be started from last week of February in Southwest region of the country. Generally 15-30 day seedlings are used for transplanting though preference is given to younger seedlings in secondary leaf stage of about 15 to 20 days old. Although there is variation in spacing for transplanting, the commonly used spacing is 18 inches between lines and 14 inches between plants.

Polyshed cultivation is an alternative tomato production technology. It involves a bamboo-hoop frame covered with transparent polyethylene film and provides a partially protected environment to give minimum protection in order to get maximum production. The production of summer tomato under poly shed results in higher yield and off-season production, which fetches premium prices in the market. Farmers at Bolarampur and other extension villages in Bagherpara, Jhekorgacha and sadar upazilas of Jessore district were found to follow the BARI recommended/demonstrated design of poly shed with few modifications. Farmers remove the poly shed from the bamboo made frame structure at the end of the monsoon and at the beginning of winter season. Thus, some tomato crop suffers on the bed without poly-shed when monsoon is extended unto October. In general each tomato plant becomes much taller than poly shed by end of September.

Both inorganic and organic fertilizers are used in cultivation of tomato under poly shed. Farmers are used moderate rate of organic fertilizers. The use of inorganic fertilizers, however, is exceedingly high. The use of such high rate of inorganic fertilizers may be dangerous for maintaining soil health in future. Urea, TSP and MOP are used more frequently in approximately same ratio. Farmers are reluctant to apply micronutrients although most of the soils in greater Jessore district are deficient in boron and zinc. Tomato is sensitive to boron and zinc throughout its life cycle.

Diseases were common, including the early blight, late blight, damping off, fusarium wilt, bacterial wilt, root knot (nematode), tomato mosaic etc. Insect pests were more common, including fruit borer, leaf miner, white fly, cutworm and flea beetle. In several cases farmers were found capable identifying plant health problems, but in most cases they were not able to do so. Farmers were typically interested in using chemicals to kill insects and treat disease. Farmers used common as well as some unspecified pesticides, making frequent use of chemicals to control pests and diseases. Due to excessive application of pesticides,

often the wrong ones, a significant portion of farmers' tomato revenue is lost on unwarranted pesticide use.

Rain and tube well water (STW) are common sources of irrigation. Farmers first fill up the furrows between two poly sheds with water. This water is then applied on the raised beds manually by hands. Compared with subsurface water pumped through STW, rainwater is found more effective for healthier growth of the plants. In-field irrigation management was found to be highly effective for summer tomato production. Weed control along with soil mulching on the bed was found to promote higher levels of summer tomato production. The bamboo sticks stuck at the base of the plants are used for staking to keep the plants erect. The plant tie-up practice starts from the day of bamboo stick placement and continues with progress of plant growth. Pruning and pinching is done on regular basis to allow for healthy plant growth. During pruning side branches are cut down and thus no side branches are allowed to grow within one foot of the stem. Unwanted branches are cut off throughout the growing cycle.

Hormone should only be used when the circumstances in the poly shed are not good enough for the pollen to be released from the flower of the tomato plant during summer season. The most common used hormone is tomatone (chlorofenoxyacetil acid) at a dose of 2% per 10 liters of water. Tomatone was found the popular hormone for application on the flower of the summer tomato. Tomatone is applied on the flower with 3-4 days interval from first flowering to end of September. Almost all owners of the summer tomato gardens in Jessore district were found to use tomatone on flowers during hot days from first flowering. BARI is the only supply source of tomatone. According to summer tomato producers' tomatone application was found cost-effective.

Harvesting starts from 90 days after seed sowing in seedbed. Farmers frequently harvest the ripe fruits of tomato from their gardens. Sometimes, even in alternate day, farmers picked the ripe fruits from their gardens. In general, tomato harvesting starts from August and continue into March/April with slower harvesting during November-December.

Farmers have claimed to record an unbelievable amount of harvested yield. It ranged from 145 to 180 tons per hectare based on nine months harvesting period starting from August. The highest claimed tomato yield recorded for Selim Reza (180t/ha) followed by Ayub Hossain (145.36t/ha), Shahin Alam and Jalal Uddin (90.17 t/ha), Mrs. Shamsur Nahar (79.20t/ha) and Abdur Razzaque (75.14t/ha) with an average 110t/ha.

The price of tomato (Taka/Kg) was recorded at Dadpur tomato sale centre as well as from summer tomato growers at 7 villages in Bagherpara and Jhekorgacha upazilas of Jessore district during 2006-7 and 2007-8 tomato-cropping season. The highest estimated average price of tomato was during August (Tk. 69/Kg) followed in order by October (Tk. 55/Kg), September (Tk. 50/Kg), November (Tk. 47/Kg), December (Tk. 29/Kg), January (Tk. 17/Kg), February (Tk. 12/Kg), March (Tk. 9/Kg) and April (Tk. 6/Kg). The average tomato price was found little higher (Tk. 34/Kg) in 2006/7 cropping season than 2007/8 (Tk. 31/Kg) cropping season. However, farmers are expecting higher price than the present price situation. They suggested stopping importing tomato during summer season.

According to the following cost and return analysis based on the recorded data from 6 farmers from 5 different villages in Bagherpara and Jhekorgacha upazilas of Jessore district, the cultivation of poly shed summer tomato was found tremendously profitable. It is however, extremely labor intensive.

In general farmers sown tomato seeds in May-June on seedbed and transplant younger seedling on prepared bed under poly shed. The ripe tomato harvesting starts from later part of August and continues to September/October on regular basis. The harvesting becomes slow at the beginning of the winter season. Thus, regular winter harvesting starts from December and continues unto 1st week of April depending on the temperature.

After intensive media coverage on TV channels, and News papers on the success of poly shed summer tomato cultivation at Bolarampur and Dadpur villages, farmers across the surrounding upazilas of Jessore, Naraial, Magura, Jhenaidah and Satkhira districts became interested in poly shed summer tomato. They discussed with the successful farmers and some of them accordingly started to grow poly shed tomato on their own land with occasional support from skilled farmers from Bolarampur and Dadpur villages. Daily laborers engaged in poly shed tomato cultivation have also become expert in this. In many cases, new farmers have hired them as skilled laborers.

Family relationship was also used to share the knowledge. This is how the technology has been spreading among the motivated farmers of the surrounding upazilas of Jessore, Magura, Jhenaidah and Satkhira districts for the last 3-4 years, and become purely farmer-led. Farmers' skills in cultivation and dissemination the technology to other farmers have been dully recognized by BARI and DAE. Demonstrated farmers are found very much open hearted to share the ideas, skill and knowledge about poly shed summer tomato technology among the interested farmers in different district such as Jessore, Satkhira, Magura, Jhenaidah and Bogra districts.

1 Introduction

Tomato is one of the most popular and widely grown vegetables in the world ranking second in importance to potato in many countries. But as a processing crop it ranks first among the vegetables. It is most highly praised for its outstanding nutritive value and is consumed widely. It is a major source of vitamins and minerals and also rich in medicinal value. It is one of the most popular salad vegetables and is taken with great relish. It is widely employed in cannery and made into soups, conserves, pickles, ketchups, sauces, pure paste, powder, juice etc. Tomato juice has become an exceedingly popular appetizer and beverage. It is used for baking and countless varieties of dishes are prepared. In European countries tomato is popularly known as golden apple or love apple. It is also an excellent source of vitamin C (20.9-22.5 mg per 100 gm) and is commonly referred to as poor man's orange. The cultivated tomato originated in Mexico and the word tomato probably originated from Tomath, the Nahua tongue of Mexico. Tomato belongs to the family solanaceae and genus *Lycopersicon*. The scientific name of common tomato is *Lycopersicon esculentum*.

Global tomato production has increased 291 percent since 1961, reaching 108 million metric tons in 2002, while yield increased 64 percent reaching an average of 36 tons per hectare (FAS/ USDA, September 2003). The top five tomato producing countries of the world are United States, China, Turkey, Italy and India. According to FAO data, global trade of tomatoes and tomato products has increased by 33 percent to $ 4.2 billion from 1991 to 2001. According to BBS (Bangladesh Bureau of Statistics) based on 2004 data, Bangladesh grow tomatoes on about 18,000 hectares and produce only about 120,000 metric tons of fresh tomatoes. Although the figure both in terms of production and area seems very low which needs to be validated, there is lot more potential to increase the area and production of tomato in Bangladesh. Vegetables being grown in the dry winter months between November and February, and only about 30% during the rest of the year.

Tomato is an annual warm season crop and requires relatively long season to produce. The climatic conditions play a major role on the production of tomato. Among the environmental conditions the temperature has profound influence on tomato production. The extremes of summer or winter conditions affect the crop and the varieties should be suitably selected to overcome this problem. Extremely high temperature, that is, 38^0C generally caused a marked decreased in pollen germination of almost all cultivars of tomato. Environmental factor such as light intensity, temperature, moisture markedly influence the process of fruit set of tomato and subsequent fruit development and yield. A well-drained, fairly light fertile loam soil with a fair moisture holding capacity is ideal for growing a good crop of tomato. Tomato prefers a soil reaction ranging from P^H 6.0 to 7.0.

Poly house technology has been used in more than fifty countries all over the world. Application of this technology in summer tomato cultivation in Bangladesh is a recent phenomenon. The production of summer tomato under poly shed has resulted in higher yield, off-season production and higher profit. Dissemination of this technology for vegetable production in Bangladesh could provide an immense benefit to the country as it can reduce the import of summer tomato to a large extent.

2 Purpose

To document adoption and level of farmer innovation with poly shed tomato production for scaling out the sustainable poly shed summer tomato technology throughout the country.

3 Study sites and methodology

3.1 Study sites

The study on poly shed summer tomato: Adoption and farmers' innovations were conducted in Bagherpara, Jhekorgacha and Sadar upazilas of Jessore district in southwest region. The study sites are shown in the map (Fig.1).

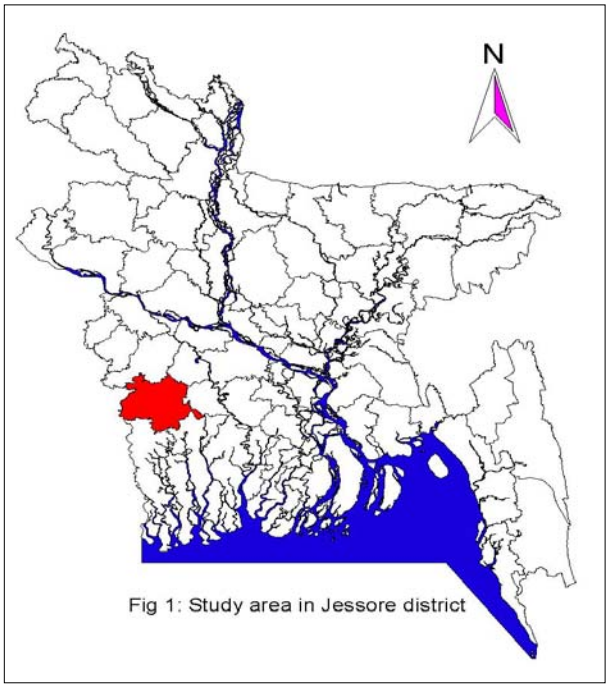


Fig 1: Study area in Jessore district

3.2 Study methodology

Focus group discussion provides wider opportunities to discuss with large number of farmers at the selected site. About 30 summer tomato growers participated in the discussion meeting at Dadpur Primary School in Bagherpara upazila of Jessore district at the beginning of the study. Farmers were asked a set of questions primarily to assess the scales of

FGD sign (left), FGD facilitator (middle) and participants at FGD (Right)

productions and years wise land under poly shed summer tomato cultivation by all farmers together in Dadpur and Bolarampur villages in Bagherpara upazila of Jessore district. They were asked specific impact on household livelihoods of Bolarampur village. In the

discussions special attention was made about the major cultivation practices, yield, price and profitability of poly shed summer tomato cultivation. In addition, the group was encouraged to identify the potential crops for cultivation under poly shed during summer/wet season. They also made tremendous contribution on identification of uptake pathways of poly shed summer tomato from Bolarampur village of Bagherpara upazila. Focus group discussion was also important to validate the information relating to poly shed summer tomato production during interviews with individual farmers and field visits in the selected villages.

Individual interviews were organized with selected summer tomato growers at each study village in Jessore district. In each site farmers were interviewed with a complete set of questionnaire on poly shed summer tomato technology adoption and farmers' innovations.

Field visits: The assigned consultant of SEDF during individual interviews and focus group discussion in each site visited a number of poly shed summer tomato gardens. As the study was conducted during the ripening and harvesting stage of the poly shed summer tomato crop, it gave the assigned consultant an important opportunity to assess and witness the actual performance of poly shed summer tomato production. The field visit was also important to see problems and constraints of poly shed summer tomato that farmers mentioned during the focus group discussion.

Cost and return analysis: To assess and compare the economic details of poly shed summer tomato, the assigned consultant of SEDF made particular cost and return analysis with six farmers at six villages in Jessore district. The cost and return analysis provide particular idea about the pattern of cost and net comes on the basis of cash cost and full cost basis from poly shed summer tomato cultivation.

4 Findings of the study

4.1 Introduction of poly shed summer tomato in Bangladesh

Poly shed summer tomato cultivation was first introduced in Bangladesh by the Bangladesh Agricultural Research Institute (BARI) more than a decade ago. In 1995 its regional station at Jessore organized the first demonstration trial on poly shed summer tomato at Bolarampur village of Bagherpara upazila in that Jessore district. Two pioneer farmers, Md. Nur Mohammad Mollah and Md. Mokadas Ali Khan (also a BARI field staff) participated in this demonstration. Each of these farmers cultivated poly shed summer tomato on 7 decimals land under 5 poly sheds each in which seedlings were transplanted in lines. There were 4 lines on each bed, with two sub-beds under each shed. Presently, 72 farmers cultivate summer tomato on 8.5 acres land under poly shed in that area. They use several hybrid varieties. Each farmer established a poly shed summer tomato production plot.


(Above) Nur Mohammad Mollah a pioneer farmer

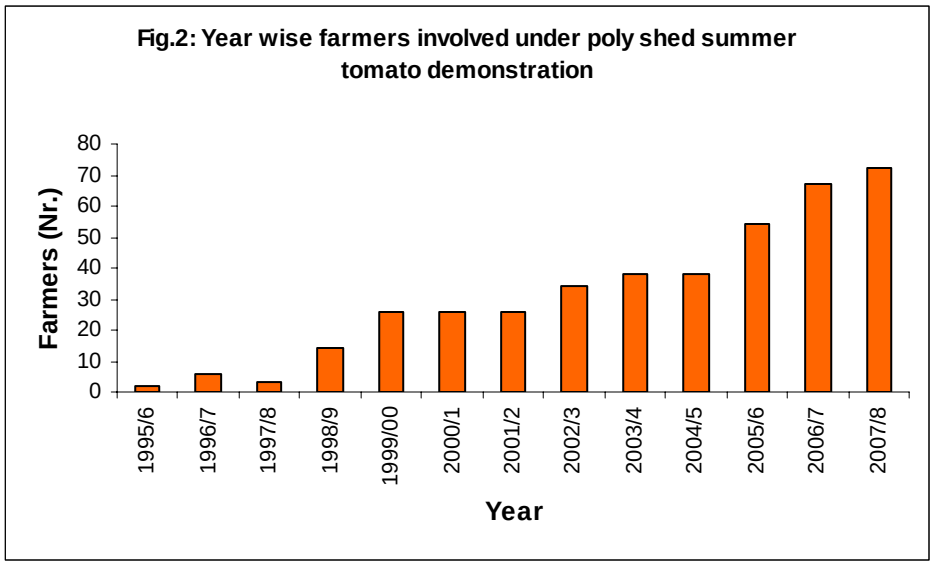
There is a well-established market for summer tomato in Dhaka, Khulna and Jessore these days from Dadpur market, Bagherpara, Jessore. The summer tomato producers at Bolarampur and Dadpur villages established an association for summer tomato producers, named Bolarampur summer tomato farmers cooperative society in 2005. Mr. Nur Mohammad Mollah (president) and Mr. Abdur Razzaque (General Secretary) manage the cooperative society with 53 active members. The society offers services to the member farmers to get quality seeds, seedlings, hormone, and credit either from banks or from its own fund. Progress of poly shed summer tomato production demonstration followed by commercial cultivation in Bolarampur and Dadpur villages from 1995/6 to 2007/8 is presented in the following Table1:

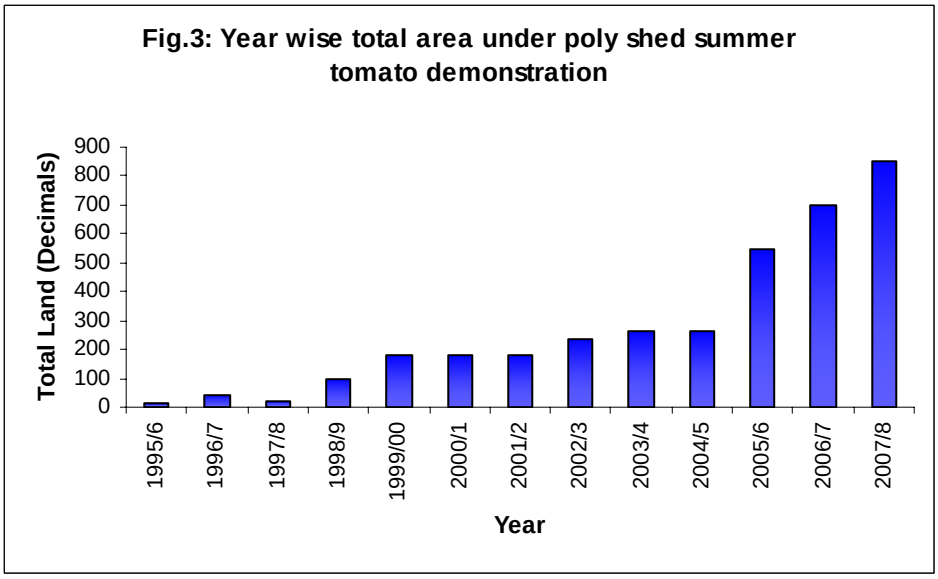
(Above) Abdur Razzaque a lead farmer

Table.1: Cultivation of poly shed summer tomato at Bolarampur and Dadpur villages in Bagherpara upazila of Jessore district from 1995/6 to 2007/8

Year (CY)	Farmers (Nr.)	Plot size (Decimals)	Total land (Decimals)	Variety used	Remarks
1995/6	2	7	14	BARI Tomato-4	Full support demo.
1996/7	6	7	42	BARI Tomato-5	Partly support demo.
1997/8	3	7	21	BARI Tomato-6	Partly support demo.
1998/9	14	7	98	-	Own cost cultivation
1999/00	26	7	182	-	Own cost cultivation
2000/1	26	7	182	-	Own cost cultivation
2001/2	26	7	182	-	Own cost cultivation
2002/3	34	7	238	-	Own cost cultivation
2003/4	38	7	266	BARI Tomato-3 (F_1)	Own cost cultivation
2004/5	38	7	266	BARI Tomato-4 (F_1)	Own cost cultivation
2005/6	54	-	550	Mintoo ((F_1)	Own cost cultivation
2006/7	67	-	700	Hira-1 (F_1)	Own cost cultivation & variable plot size
2007/8	72	-	850	Hira-1 (F_1)	Own cost cultivation & variable plot size

BARI scientists motivated two farmers to demonstrate the poly shed summer tomato technology in 1995/96 and 72 farmers established poly shed summer tomato production on 8.50 acres of land in Bolarampur and Dadpur villages in Bagherpara upazila of Jessore district in 2007/8 cropping season. Number of farmers' involvement and total area under poly shed summer tomato demonstration and commercial production during 1995-96 to 2007-8 are shown in Figures 2 & 3.





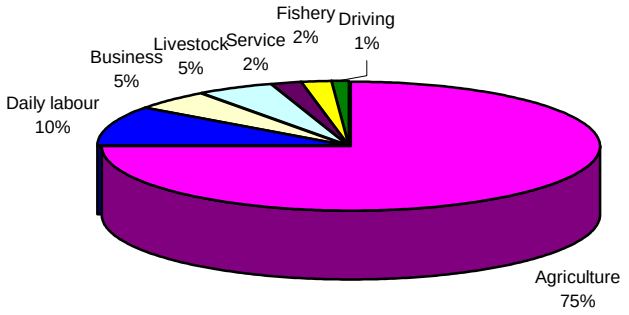
4.2 Means of Livelihoods of Bolarampur Village

Bolarampur village is under Bagherpara upazila of Jessore district. The means of household livelihoods of Bolarampur village were assessed through focus group discussion (FGD) at Dadpur Primary School. Findings of the FGD on means of household livelihoods are described below:

All means of livelihood in Bolarampur village of Bagherpara upazila under Jessore district identified by the participants were classified into seven categories. The participating farmers of the FGD rank seven categories according to their contribution to household livelihood for

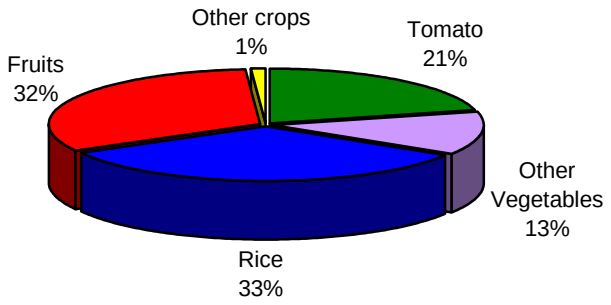
Bolarampur village. The highest contribution in household livelihoods in Bolarampur village was found with agriculture (75%) followed in order by daily labor (10%), business and livestock (5%), fishery and service (2%) and driving including manual (1%) (Fig.4).

Fig. 4: Percent contribution of major means of livelihoods in Bolarampur village, Bagherpara, Jessore



The participants of the FGD were further classified into five categories of crops i.e., rice, fruits, tomato alone, other vegetables and other crops. The participating farmers of the FGD ranked those five categories according to their acreage and contribution. The highest acreage and contribution to household livelihood in Bolarampur village was found in rice (33%) followed in order by Fruits (32%), Tomato (21%), other vegetables (13%) and other crops (1%) (Fig.5).

Fig.5: Percent contribution of crops in Bolarampur village, Bagherpara, Jessore



4.3 Major cultivation practices

4.3.1 Variety use

BARI tomato 4, an open pollinated heat tolerant variety was first started in 1995/6 by 2 farmers at Bolarampur village. In the following season, six more farmers cultivated the variety along with BARI tomato 5, a new variety. BARI tomato-6 was introduced in the summer

Hybrid BARI 3 tomato (Left), Hybrid BARI 4 tomato (middle) and Hybrid Hira-1 tomato (Right)

tomato season of 1997/8. In 1998/99 14 farmers cultivated these three pre-tested open pollinated cultivars and their number progressively increased to 34 in 2002/3. Farmers in Bagherpara, Jhekorgacha and sadar upazilas of Jessore district have started cultivation of poly shed summer tomato. The varieties introduced in these areas are BARI hybrid tomato-3 in 2004/5 followed by BARI hybrid tomato-4 in 2004/5, hybrid Mintoo in 2005/6, Hira-1 in 2006/7 and Hira-2 in 2007/8. Currently hybrid varieties both from BARI and private seed companies (East-West and Supreme Seed) are widely cultivated by summer tomato farmers. All demonstrated summer tomato cultivars were found as indeterminate type.

4.3.2 Seedling production, transplanting and seedling age

Seeds are line sown from May to June. Seeds sowing can be started from last week of February in Southwest region of the country. Seeds need to be dried before sowing. Most farmers use poly shed to cover the seedbed while some use net to protect from insect infestation. Before transplanting seedlings are transferred to a secondary seedbed for hardening. Seedlings are usually uprooted by hand pulling and transplanted on main bed from May to July. Generally 15-30 days seedlings are used for transplanting through preference is given to younger seedlings between 15 and 20 days old. Although there is variation in spacing for transplanting, the commonly used spacing is 18 inches between lines and 14 inches between plants.

(Above) Tomato seedling on seedbed under poly shed

4.3.3 Poly shed technology

Poly shed is an alternative technology to tomato cultivation. It is a bamboo made frame covered with transparent polyethylene film to provide a partially protected environment to get maximum productivity and quality production of tomato during hot/wet seasons in Bangladesh. In recent years, poly shed has been found as an acceptable technology, as it is light in weight, cheap and easy to install. Low cost, locally available materials like bamboo, transparent polyethylene, jute rope etc., have been found quite effective for off-season summer tomato production. Poly shed summer tomato production technology requires fairly large initial investment to install the structure, and production cost is high as well but it is within the reach of medium and large farmers. The production of summer tomato under poly shed has resulted into higher yield and off-season production, which fetched premium prices in the market.

(Above) Poly shed tomato garden

Farmers at Bolarampur and other extension villages in Bagherpara, Jhekorgacha and sadar upazilas of Jessore district were found to follow the BARI recommended/demonstrated design of poly shed with few modifications. There are large variations in width and height measurements of the poly shed. Accordingly, large variation was also found in width and length of beds under each poly shed. The width and depth of furrows between poly shed and beds under each poly shed were found large variation among the farmers in Jessore district. The poly shed is prepared during bed preparation and before seedling transplanting on the prepared beds under each poly shed. Farmers remove the poly cover from the bamboo frame at the end of the monsoon and at the beginning of winter season. Thus, some tomato crop suffers on the bed without poly-shed when monsoon is extended unto October. In general each tomato plant becomes much taller than poly shed by end of September.

(Above) Summer tomato bed & structure without polyethylene

4.3.4 Cost for poly shed

According to the cost and return analysis based on the recorded data from 6 farmers from 5 different villages in Jessore district, the cost of poly shed for summer tomato cultivation was found reasonably high. The average cost of poly-shed materials for summer tomato was estimated about Tk. 3,30,000 per hectare of tomato field. The cost of poly shed of six farmers is provided in following Table 2:

Table. 2: Poly-shed cost for summer tomato cultivation

Farmer	Poly shed cost (Tk./ha)
Abdur Razzaque	4,11,667
Shahin Alam	3,16,160
Mrs. Shamsur Nahar	3,44,303
Selim Reza	3,36,818
Ayub Hossain	2,86,348
Jalal Uddin	2,88,167
Average	**3,30,577**

4.3.5 Measurement of poly shed, bed and furrow

According to BARI design and measurement, 230 cm wide raised bed needs to be prepared for poly shed summer tomato cultivation. A poly-shed structure is to be prepared on two such beds with 30 cm width furrow between two beds. The height of the both sides of the poly shed would be 135 cm (4.5 feet) and the height in the middle of the poly shed would be 180 cm (6 feet). There would be a 50 cm wide irrigation and drainage furrow between two poly sheds. Length of each poly shed would be on the basis of land length and shape. If length of each poly shed is 20 meter, then 170 poly sheds can be prepared on one hectare of land.

(Above) A poly shed with bed, furrow and tomato crop

4.3.6 Fertilizer management

Both inorganic and organic fertilizers are used in cultivation of tomato under poly shed. Among the inorganic fertilizers, the highest quantity used was found with TSP (1937 Kg/ha) followed in order by MOP (1191 Kg/ha), Urea (956 Kg/ha), Gypsum (509 Kg/ha) and Borax (2.25 Kg/ha). On the other hand among the organic fertilizers, the highest quantity used was found with Cowdung/Compost (5130 Kg/ha) followed by Mustard oil cake (273 Kg/ha).

Five respondents were used Urea, TSP, MOP and Gypsum fertilizers. Only one respondent was used Borax and three respondents were used organic fertilizers. None of the respondents used Zinc sulphate in the poly shed summer tomato gardens. Average and range used of inorganic and organic fertilizers are provided in the following Table3:

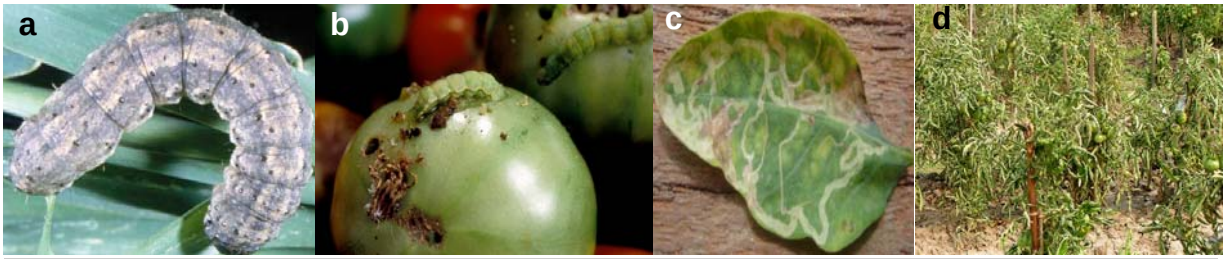
Table. 3: Inorganic and organic fertilizers application in poly shed summer tomato cultivation

Fertilizer	Fertilizer application rate (Kg/ha)		Respondents (Nr.)	
	Average	Range	Total	Applicant
Urea	956	188-1785	5	5
TSP	1937	600-2880	5	5
MOP	1191	300-2378	5	5
Gypsum	509	300-668	5	5
Zinc Sulphate	0	0	5	0
Broax	2.25	0-1.5	5	1
Cowdung / Compost	5130	0-15,000	5	3
MOC	273	0-495	5	3

Farmers used a moderate rate of organic fertilizers. The use of inorganic fertilizers, however, is exceedingly high. The use of high rates of inorganic fertilizers will complicate maintenance of soil health. Urea, TSP and MOP are used more frequently in approximately same ratio. The ideal recommendation for N:P:K is 2.5:1:5. Farmers are reluctant to apply micronutrients although most of the soils in greater Jessore district are deficient in boron and zinc. Tomato is sensitive to boron and zinc deficiencies throughout its life cycle. High rates of phosphate application can aggravate a pre-existing zinc deficiency. Thus, both soil and foliar applications of zinc are recommended for such intensive and long duration crop (about 11 months when cultivated under poly shed).

4.3.7 Pest and diseases

Diseases were common, including early blight, late blight, damping off, fusarium wilt,



(Above) Tomato plant health problems: (a) Cutworm larvae, (b) A larvae of *Helicoverpa armigera,* (c) Leaf minor and (d) Tomato yellow leafcurl

southern blight, bacterial wilt, root knot (nemetode), tomato yellow leaf curling, tomato purple vein, tomato spotted wilt, tomato mosaic, blossom-end rot and soil rot. Insect pests were more common, including fruit borer, leaf miner, white fly, cutworm and flea beetle.

Farmers often used more than one local name for known plant health problems and some of local names had a translatable or literal meaning. In several cases farmers were found capable identifying the plant health problems. Farmers were usually most interested in using chemicals to kill insects and treat diseases. Farmers used common as well as some unauthorized pesticides, making frequent use of chemicals to control the pest and diseases. Indiscriminate use of pesticides at high concentrations and frequent interval was exceedingly common in the five villages surveyed. Farmers often used insecticides before they had properly diagnosed the underlying problem (eg. Leaf minor being considered as disease). Due to excessive application of pesticides, often the wrong ones, a significant portion of farmers' tomato revenue is lost.

(Above) Spraying insecticide

4.3.8 Birds damage and protection

Bird damages the crop during ripening stage of the fruit in the poly shed summer tomato gardens, thus, both yield loss and income reduction are occurred due to bird damage, claimed by the owners of summer tomato gardens in all study sites of Jessore district. To protect the tomato fruits, farmer is placed the net around the poly shed starting from ripening stage of the tomato crop.

A bird eating tomato (Left) and net placed for bird protection (Right)

4.3.9 Post transplanting management practices

Irrigation: Irrigation is an important cultural operation in tomato culture. Water should be provided at optimum level. Excess water leads to water logging conditions while lack of irrigation leads to water stress in plant tissue. Rainwater and subsurface water (STW) are common sources of irrigation. Farmers first fill up the furrows between two poly sheds with water. This water is then applied on the raised beds manually by hand. Subsurface water pumped through STW is found most effective for healthy plants. Farmers irrigate tomato beds on the basis of assessing the soil moisture status of each bed. Excess water drainage was found highly efficient due to introduction of well design drainage system with each and every poly shed summer tomato gardens in Jessore district.


(Above) A well-managed tomato poly shed

Weed control and cultivation of soil: Soil around the plant is cultivated routinely to keep it loose and weed free. Soil is mounded at the base of the plant to keep it stronger.

Stacking: When plants become one foot tall, bamboo stacking is necessary. Five foot long and ½" inch thick bamboo sticks are stuck at the base of the plants. Tie-ups with waste fabric are done to keep the plants upright. The plant tie-up practice starts from the day the bamboo stake is installed and continues for the duration of the crop.


(Above) Bamboo sticks stacking on the bed

Pruning: It is done on regular basis to allow for healthy plant growth. During pruning side braches are cut down and thus no side branches are allowed to grow within one foot of the stem. Unwanted branches are cut during the growing cycle. After harvesting, left over flower parts are also removed. Pruning needs to be done carefully and scientifically.

4.3.10 Hormone use

Hormone should only be used when the circumstances in the poly shed are not good enough for the pollen to be released from the flower of the tomato plant during summer season. The most common used hormone is tomatone (chlorofenoxyacetil acid) at a dose of 2% per 10 liters of water. This quantity of tomatone solution will treat approximately 1000-1500 flower trusses. The best method is to use small hand sprayer and to hold the flower truss in front of the hand palm when applying the hormone solution. Tomatone was found the popular hormone for application on the flower of the summer tomato. Tomatone is applied on the flower with 3-4 days interval from first flowering to end of September. Almost all owners of the


(Above) Spraying hormone on tomato flowers

summer tomato gardens in Jessore district were found to use tomatone on flowers during hot days from first flowering. BARI is the only supply source of tomatone. Application of tomatone on flower of tomato was found beneficial for fruit setting during summer period of the year. According to summer tomato producers' tomatone application was found cost-effective.

4.3.11 Harvesting

Harvesting starts from 90 days after seed sowing in seedbed. Sometimes, on alternate days, farmers pick the ripe fruits from their gardens. Color of the harvested tomato fruits were

Selim Reza at tomato garden (Left), Iqbal Hossain harvesting tomato (Middle) and Harvested tomato (Right)

found very attractive. In general tomato fruits harvesting starts from August and continue until March/April with slower, smaller harvests during November-December. Grading is done after harvesting the fruits. The stage of maturity at which tomato should be harvested depends upon the purpose for which they are used and distance over which they are to be transported. Fruits picked in mature green stage will develop good colour when ripened under favorable condition. Tomatoes for long distance transportation should be picked at mature green stage and ripened after reaching the market. If the market distance is high it is advisable to harvest the tomato at green stage. Most tomatoes picked before they reach the turning stage are selected on the basis of size. However most summer tomato producers used their traditional knowledge about time of tomato harvesting.

4.4 Yield

Farmers have claimed to record an unbelievable amount of harvested yield. It ranged from 145 to 180 tons per hectare based on nine months harvesting period starting from August, covering both the summer and the winter seasons. The highest claimed tomato yield recorded for Selim Reza (180t/ha) followed by Ayub Hossain (145.36t/ha), Shahin Alam and Jalal Uddin (90.17 t/ha), Mrs. Shamsur Nahar (79.20t/ha) and Abdur Razzaque (75.14t/ha)

(a) Selim Reza, (b) Ayub Hossain, (c) Shahin Alam, (d) Shemsur Nahar and (e) A. Razzaque

with an average 110t/ha. Claimed tomato yield of six farmers is provided in the following Table 4:

Table.4: Claimed tomato yield of six farmers

Farmer	Tomato Yield (t/ha)
Abdur Razzaque	75.14
Shahin Alam	90.17
Mrs. Shamsur Nahar	79.20
Selim Reza	180.00
Ayub Hossain	145.36
Jalal Uddin	90.17
Average	**110.01**

4.5 Price of tomato

The price of tomato (Taka/Kg) was recorded at Dadpur tomato sale centre as well as from summer tomato growers at 7 villages in Bagherpara and Jhekorgacha upazilas of Jessore district during 2006-7 and 2007-8 tomato-cropping season. The highest estimated average price of tomato was during August (Tk. 69/Kg) followed in order by October (Tk. 55/Kg), September (Tk. 50/Kg), November (Tk. 47/Kg), December (Tk. 29/Kg), January (Tk. 17/Kg), February (Tk. 12/Kg), March (Tk. 9/Kg) and April (Tk. 6/Kg). The average tomato price was found little higher (Tk. 34/Kg) in 2006/7 cropping season than 2007/8 (Tk. 31/Kg) cropping season. However, farmers are expecting higher price than the present price situation. They suggested stopping importing tomato during summer season. But the expectation of the farmers was found toward higher summer tomato acreage with reasonable and affordable price during discussion with farmers at 7 villages in Jessore district. Monthly price of tomato during 2006/7 and 2007/8 cropping is provided in the following Table.5.

Table.5: Monthly price of tomato during 2006/7 and 2007/8 cropping season

Month	Price (Tk/Kg)		
	2006/7	2007/8	Average
August	72.50	65.50	69
September	48.33	51.67	50
October	63.33	46.67	55
November	50.00	43.33	47
December	30.00	27.50	29
January	17.67	17.00	17
February	11.33	12.00	12
March	7.67	10.00	9
April	6.00	6.00	6
Average	**34.10**	**31.10**	**33.67**

4.6 Profitability

According to the following cost and return analysis based on the recorded data from 6 farmers from 6 different villages in Bagherpara and Jhekorgacha upazilas of Jessore district, the cultivation of poly shed summer tomato was found tremendously profitable. It is however,

extremely labor intensive. The detailed breakdown of cost of six farmers is provided in the annexes A1-6. Net-return of summer tomato production on the basis of full cost and cash cost of six farmers is provided in the following Table 6:

Table.6: Net-return on the basis of full cost and cash cost of six farmers

Farmers	Net return (Tk./ha)	
	Full cost basis	Cash cost basis
Abdur Razzaque	9,72,182	12,86,284
Shahin Alam	13,22,724	17,26,569
Mrs. Shamsur Nahar	10,21,261	13,39,517
Selim Reza	30,31893	37,92,234
Ayub Hossain	29,87,242	38,43,149
Jalal Uddin	15,57,993	19,86,314
Average	**18,15,549**	**23,29,011**

4.7 Labor Use

Average 4108 labor days with range 2250-7658 labor days were engaged for poly shed summer tomato production in a hectare of land. However, the labor used in poly shed summer tomato production per hectare was found very high and unbelievable. Moreover, the estimation of labor used was done on the basis of 6 poly shed summer tomato gardeners claimed.

Table.7: Labor use (Nr./ha) in poly shed summer tomato production

Summer tomato gardeners	Labor Nr./ha
1. Abdur Razzaque	2475
2. Shahin Alam	2723
3. Mrs. Shamsur Nahar	2250
4. Selim Reza	6428
5. Ayub Hossain	7658
6. Jalal Uddin	3113
Average	**4108**
Range	**2250-7658**

4.8 Cultivation period

In general, farmers line sow their tomato seeds in May-June on seedbeds and transplant young seedlings on prepared beds under poly shelter. The ripe tomato harvesting starts from late August and continues to September/October. The harvesting slows in the winter season. Regular winter harvesting starts from December and continues up to the 1st week of April depending on the temperature.

4.9 Shifting from tomato

On the basis of success of summer tomato production under poly shed technology, farmers at Bolarampur village have been introducing several high value cash cropping including seedling production of summer tomato under poly shed. Farmers have been successfully producing various crops including radish, cabbage, spinach, turnip, carrot etc under poly shed during summer and wet seasons at Bolarampur village. Farmers' claimed that they

Radish under poly shed (Left), Spinach under poly shed (Middle) and turnip under poly shed (Right)

harvested much higher yield with quality radish of suitable summer varieties under poly shed than open field. Also, following the example of Thailand, there is scope for producing the full range of Brasica crops (cabbage, cauliflower, etc) Farmers also informed that there are several risks related to these alternative crops under open field during summer and wet season in the country. These risks can be overcome through growing such crops under poly shed during summer and wet seasons. Farmers in the summer tomato villages will introduce radish and several other crops deemed suitable in the future.

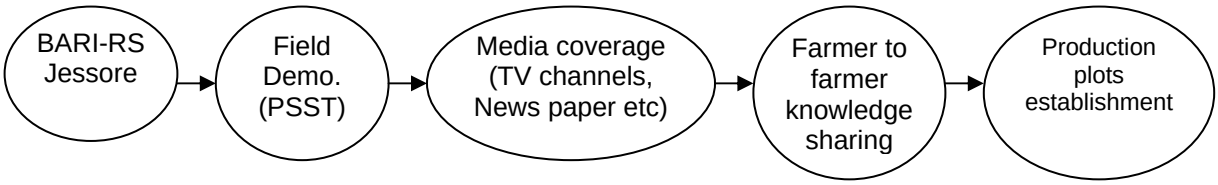
4.10 Farmer-led uptake pathways

After intensive media coverage on TV channels, and News papers on the success of poly shed summer tomato cultivation at Bolarampur and Dadpur villages, farmers across the surrounding upazilas of Jessore, Narial, Magura, Jhenaidah and Satkhira districts became interested in poly shed summer tomato. They discussed with the successful farmers and some of them accordingly started to grow poly shed tomato on their own lands with occasional support from skilled farmers from Bolarampur and Dadpur villages. Daily laborers engaged in poly shed tomato cultivation have also become expert in this. In many cases, new farmers have hired them as skilled laborers.

Family relationship was also used to share the knowledge. This is how the technology has been spreading among the motivated farmers of the surrounding upazilas of Jessore, Magura, Jhenaidah and Satkhira districts for the last 3-4 years, and become purely farmer-led. Farmers' skills in cultivation and dissemination of the technology to other farmers have been dully recognized by BARI and DAE. Demonstration farmers are found very much open hearted to share their ideas, skills, knowledge and experiences with poly shed summer tomato production with farmers from different districts. Accordingly, farmer-led uptake pathways of poly shed summer tomato production are given below:

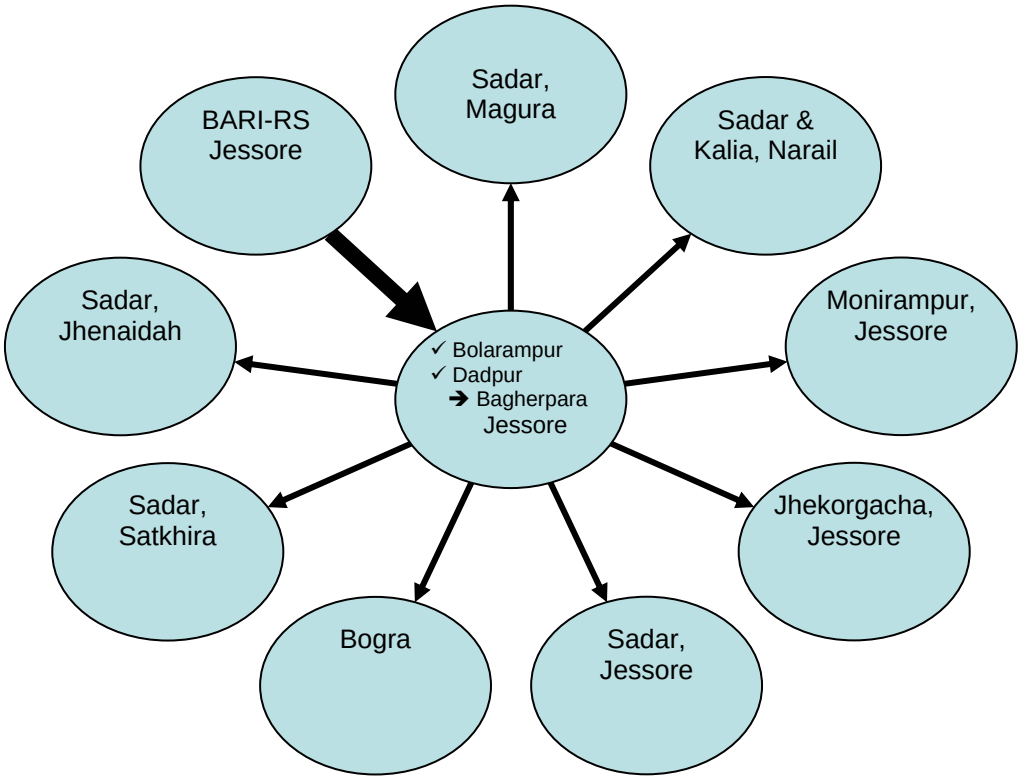
Farmer-led Uptake Pathways:

Poly shed summer tomato (PSST) production



Farmer-led Uptake Pathway Channels:

Poly shed summer tomato production



5. Conclusion

Overall acceptability of poly-shed summer tomato technology was found to be very high in several districts including Jessore district. Considering higher tomato yield per hectare and higher price along with unexpected higher net-return, it is very obvious to note that the farmers are instantly accepting poly-shed summer tomato technology as an outstanding income generating agricultural strategy. Thus, the adaptability of poly-shed summer tomato technology is found to be highly suitable in the district. However, poly-shed summer tomato production technology requires a huge investment along with large labor inputs and thus, production cost is also very high. Consequently, only medium and large farmers can afford the technology due to its high working capital investment. Smaller and more marginal farmers have, so far, been excluded from the equation.

In the process of poly-shed summer tomato technology adoption, farmers have fine-tuned and introduced several practices and techniques as innovative and sustainable for such summer tomato production, harvesting and post harvesting management.

As the comparative yield and fruit quality advantages of tomato hybrids are found significantly higher than offered OP tomato varieties. This is the most important reason why many farmers are shifting from OP varieties to hybrids. As a result, the area under hybrids continues to increase based on farmers' years of experiences with trusted hybrid varieties. Although, at the initial stage there were some reservations about hybrids related to high seeds price and yield. Now, however, the prevailing belief among experienced farmers is that they are doing better with hybrids and that the seed price of hybrid tomato is not a concern among the farmers that use them.

In general farmers were found to follow the BARI recommended design of poly-shed with few modifications on the basis of their practical experience.

According to summer tomato producers, tomatone (chlorofenoxyacetil acid) application was found cost-effective. Thus, almost all owners of the summer tomato gardens in Jessore district are found to use tomatone on flowers during hot days from first flowering to end of September with 3-4 days intervals.

Farmers used moderate rates of organic fertilizers. The use of inorganic fertilizers, however, can be excessive and would be great concern of soil specialists. A high rate of chemical fertilizer application can be economically and financially damaging but is not likely to effect soil health in any real or material way; particularly in Bangladesh where application rates are historically low by international standards. Extremely high rates of phosphate application can, however, aggravate pre-existing zinc deficiencies. Farmers are reluctant to apply micronutrients although most of the soils in greater Jessore district are deficient in boron and zinc. Moreover, tomato is sensitive to boron and zinc throughout its life cycle.

Based on the farmers' experiences, seed sowing can be started from last week of February in Southwest region. But seeds are line sown in seedbeds sometimes under poly-shed from May-June. Farmers prefer to transplant the younger seedling between 15 and 20 days old. The commonly used spacing being 18 inches between lines and 14 inches between plants on bed under poly shed.

There were seven diseases and five insect pests in tomato gardens. Several cases farmers were found capable in identifying the plant health problems and most case not. Farmers used common as well as some unauthorized pesticides, making frequent use of chemicals to control the pest and diseases. Indiscriminate use of both authorized and unauthorized pesticides at very high concentrations and at very frequent intervals was found to be exceedingly common within the study areas. Moreover, excessive and indiscriminate use of pesticides in crop protection has been creating hazards in many ways in the study villages.

In was found in the study that farmer's led rapid spreading of poly-shed summer tomato technology took place in several districts including Jessore. This is due to prime initiative from BARI as farmer's participatory demonstration at Bolarampur and Dadpur villages. Followed by intensive media coverage on TV channels and Newspapers on the success of poly shed summer tomato cultivation at Bolarampur and Dadpur villages, farmers across the surrounding districts became interested in poly-shed summer tomato. They discussed with the successful farmers and some of them accordingly started to grow poly-shed tomato on their own lands with occasional support from the skill farmers from Bolarampur and Dadpur villages. Daily laborers engaged in poly-shed tomato cultivation have also become expert in this. In many cases, new owners of tomato gardens have hired them as skilled laborers. However, almost all poly-shed summer tomato farmers are highly acknowledged the unique contribution of BARI in this respect in Jessore district.

6 Recommendation

Scaling-up: Based on the success and acceptability of poly shed summer tomato cultivation needs to be scaling-up throughout the country based on land suitability. In this regard, farmers' motivation and their practical skills would be the most priority consideration. Practical guidelines need to be prepared on poly shed summer tomato cultivation and for conducting the training to motivate interested farmers. For large-scale dissemination a promotional video needs to be developed for wider distribution through relevant community organizations and service providers. Practical farmers' training needs to be conducted at the cluster of successful poly shed summer tomato gardens. Thus, it would be an opportunity for the trainees to learn about total poly shed tomato production packages in the field. Field demonstration is the most proven strategy for disseminating crop production technologies like poly-shed summer tomato cultivation. Farmer's participatory field demonstration on poly-shed summer tomato cultivation needs to be established for larger-scale dissemination of the technology.

Such labor intensive and high investment technology can be disseminated among the marginal and poor farm families through arranging working capital from interested NGOs and other suitable sources. In this regards group approach can be used for tomato production and marketing.

Good Agriculture Practice (GAP): Application of GAP has tremendous demand in the country to produce human-hazard free quality tomato production throughout the year. The present status of production practice in poly-shed summer tomato is based on the involved farmers' choice and desire and it is currently a "blind leading the blind" approach. In this regard, pathologists, entomologists, soil scientists and horticulturists can play a vital role in the process of introducing GAP for poly shed summer tomato production in collaboration with innovative farmers. A package of GAP for poly shed summer tomato production should be developed through participation and validation of skill and innovative farmers at community level.

Poly shed design: The production of summer tomato under poly shed has resulted in higher yields and off-season production, which fetches premium prices in the market. Involved farmers in Jessore district were found to follow the BARI recommended design of poly shed with few modifications based on their practical experience. A sustainable poly shed design for summer tomato production needs to be developed on a farmer's-demand-driven-basis. Skilled and innovative farmers should be encouraged to participate during the process of developing a standardized poly shed design. Efforts should be given to exploring the availability of UVR resistant poly film. It is available in the world market, albeit at a higher price. UVR film lasts for up to 5 years; whereas the lighter weight, non-UVR films last hardly a season. The higher cost have to be amortized over the longer useful lives of the UVR films and financed with structured borrowing from specialized lenders.

Tomato hybrids: The study indicated that tomato hybrids performed much better than OP varieties. As a result, the area under hybrids continues to increase. Currently hybrid varieties both from BARI and private seed companies are widely cultivated by summer tomato farmers. All demonstrated summer tomato cultivars were found as indeterminate type. However, there is lot of heat tolerant hybrid tomato varieties available for cultivation under poly shed during summer and wet seasons. Those varieties could be demonstrated through involving private seed companies and innovative farmers.

Hormone use: Tomatone (chlorofenoxyacetil acid) was found as the popular hormone for application on flower for the purpose of fruit set during periods of high humidity and heavy rain. BARI is the only supply source of tomotone. Tomatone demand will be high on the basis of increasing acreage of summer tomato cultivation in future. Thus, private companies should be involved in the supply chain. Farmer's knowledge and experience regarding the safe and effective use of tomatone in summer tomato production needs to be better understood through practical training and demonstration at the field.

Harvesting and post harvesting: Study indicated that most summer tomato producers used their traditional knowledge about time of tomato harvesting. The stage of maturity at which tomato should be harvested depends upon the purpose for which they are used and distance they are to be transported. Thus tomato farmers' need more practical training on tomato harvesting strategies and post harvest management practices for short and long distance transportation including export the tomato.

Annexure 1: Cost and return of Poly shed summer tomato

Name of Farmer: Abdur Razzaque **Father's Name:** Late Abdus Samad Mollah **Mob:** 01713902332
Village: Bolorampur **Union:** Doraj hat **Upazila:** Bagherpara **Dist:** Jessore
Crop: Tomato **Variety:** BARI Tomato 3 (F_1) **Sowing:** 9.6.2007
Transplanting: 10.7.2007 **Harvesting:** Starts: 6.9.07-February'08 **Plot Size:** 15 Decimals

SL#	Item	Quantity (Bigha)	Rate (Tk)	Cost-return (Tk/Bigha)	Cost-return (Tk/ha)
A. Cost					
1	**Land Preparation (times)**	3		690.00	**5,164.55**
2	**Labor**	330	100.00	33,000.00	**247,000.00**
3	**Seed/ Seedling (gm)**	55	30.00	1,650.00	**12,350.00**
4	**Fertilizer**				
	a) Urea (kg)	238	8.00	1,904.00	**14,251.15**
	b) TSP/ DAP (kg)	317	24.00	7,608.00	**56,944.73**
	c) MP (kg)	317	22.00	6,974.00	**52,199.33**
	d) Gypsum (kg)	89	5.00	445.00	**3,330.76**
	e) Zinc (kg)				
	f) Borax (kg)				
	g) Cowdung/ Compost (kg)	1320	0.50	660.00	**4,940.00**
	Total fertilizer	**2,281**	**60**	**17,591**	**131,666**
5	**Pesticides:**				
	a) Insecticide	22		11,000.00	**82,333.33**
	b) Fungicide etc	11		5,500.00	**41,166.67**
	Total Pesticide	**33**	**0**	**16,500**	**123,500**
6	**Irrigation**			3,300.00	**24,700.00**
7	**Land rent**			5,500.00	**41,166.67**
8	**Poly shed & net**			55,000.00	**411,666.67**
9	**Hormone (Tomatone)**			4,950.00	**37,050.00**
10	**Interest on working capital**				
	a) Full cost basis		Interest 9%	12,436.29	**93,083.75**
	b) Cash cost basis		Interest 9%	8,971.29	**67,148.75**
A.	**Total Cost:**				
	a) Full cost basis			150,617.29	**1,127,347.59**
	b) Cash cost basis			108,652.29	**813,245.93**
B Gross and Net return:					
	Gross return				
	a) Main product (Kg)	10,018	28.00	280,504.00	**2,099,529.94**
	b) By-product				
	Total Gross return				
	Net return				
	a) Full cost basis			129,886.71	**972,182.34**
	b) Cash cost basis			171,851.71	**1,286,284.01**
C.	**Cost Benefit Ratio**				
	a) Full cost basis				**1.86**
	b) Cash cost basis				**2.58**
D.	**Tomato cost (Tk/Kg)**				
	a) Full cost basis			15.03	
	b) Cash cost basis			10.85	

Note:

1 **1 Bigha = 33 Decimals, 1 Hectare= 247 Decimals,**
A. Cash cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, 6. Poly-shed & net, 7. Hormone, 8. Interest on working capital
B. Full cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, **6. Labour**, **7. Land rent**, 8. Poly-shed & net, 9. Hormone, 10. Interest on working capital

Annexure 2: Cost and return of Poly-shed summer tomato

Name of Farmer: Shahin Alam **Father's Name:** Md. Habibur Mollah **Mob:** 01914847951
Village: Shatkhali **Union:** Basuari **Upazila:** Bagherpara **Dist:** Jessore
Crop: Tomato **Variety:** Hira Tomato 1 (F_1) **Sowing:** 25.6.2007
Transplanting: 11.7.2007 **Harvesting:** Starts: 7.10.07-February'08 **Plot Size:** 5 decimals

SL#	Item	Quantity (Bigha)	Rate (Tk)	Cost-return (Tk/Bigha)	Cost-return (Tk/ha)
A. Cost					
1	**Land Preparation (times)**	3		690.00	**5,164.55**
2	**Labor**	363	100.00	36,300.00	**271,700.00**
3	**Seed/ Seedling (gm)**	33	25.00	825.00	**6,175.00**
4	**Fertilizer**				
	a) Urea (kg)	165	8.00	1,320.00	**9,880.00**
	b) TSP/ DAP (kg)	80	24.00	1,920.00	**14,370.91**
	c) MP (kg)	40	22.00	880.00	**6,586.67**
	d) Gypsum (kg)	80	5.00	400.00	**2,993.94**
	e) Zine Sulphate (kg)				
	f) Other (Borax) (kg)	1.5	100.00	150.00	
	g) Mustard Oil Cake (kg)	66	16.00	1,056.00	**7,904.00**
	Total fertilizer	**433**	**175**	**5,726**	**41,736**
5	**Pesticides:**				
	a) Insecticide			19,800.00	**148,200.00**
	b) Fungicide etc			19,800.00	**148,200.00**
	Total Pesticide	**0**	**0**	**39,600**	**296,400**
6	**Irrigation**			3,300.00	**24,700.00**
7	**Land rent**			13,200.00	**98,800.00**
8	**Poly shed & net**			42,240.00	**316,160.00**
9	**Hormone (Tomatone)**			4,950.00	**37,050.00**
10	**Interest on working capital**				
	a) Full cost basis		Interest 9%	13,214.79	**98,910.70**
	b) Cash cost basis		Interest 9%	8,759.79	**65,565.70**
A.	**Total Cost:**				
	a) Full cost basis			160,045.79	**1,196,795.76**
	b) Cash cost basis			106,090.79	**792,950.76**
B Gross and Net return:					
	Gross return				
	a) Main product (Kg)	12,022	28.00	336,616.00	**2,519,519.76**
	b) By-product				
	Total Gross return				
	Net return				
	a) Full cost basis			176,570.21	**1,322,724.00**
	b) Cash cost basis			230,525.21	**1,726,569.00**
C.	**Cost Benefit Ratio**				
	a) Full cost basis				**2.11**
	b) Cash cost basis				**3.18**
D.	**Tomato cost (Tk/Kg)**				
	a) Full cost basis			13.31	
	b) Cash cost basis			8.82	

Note:

1 **1 Bigha = 33 Decimals, 1 Hectare= 247 Decimals,**

A. Cash cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, 6. Poly-shed & net, 7. Hormone, 8. Interest on working capital

B. Full cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, **6. Labour**, **7. Land rent**, 8. Poly-shed & net, 9. Hormone, 10. Interest on working capital

Annexure 3: Cost and return of Poly-shed summer tomato

Name of Farmer: Mrs. Shamsur Nahar **Husband's Name:** Sheikh Ahmed **Mob:** 01712674903
Village: Godkhali **Union:** Godkhali **Upazila:** Jhekorgacha **Dist:** Jessore
Crop: Tomato **Variety:** BARI Tomato 3 & 4(F_1) **Sowing:** 20 May 06 / 5 June 07 **Plot size:** 33 decimals
Transplanting: 20 June 06 / 5 July 07 **Harvesting:** August/September,06/07-March, 07/08

SL#	Item	Quantity (Bigha)	Rate (Tk)	Cost-return (Tk/Bigha)	Cost-return (Tk/ha)
A. Cost					
1	**Land Preparation (times)**	6		1,000.00	**7,484.85**
2	**Labor**	300	100.00	30,000.00	**224,545.45**
3	**Seed/ Seedling (gm)**	50		1,200.00	**60,000.00**
4	**Fertilizer**				
	a) Urea (kg)	25	12.00	300.00	**2,245.45**
	b) TSP/ DAP (kg)	150	25.00	3,750.00	**28,068.18**
	c) MP (kg)	75	15.00	1,125.00	**8,420.45**
	d) Gypsum (kg)	50	10.00	500.00	**3,742.42**
	e) Zinc (kg)				
	f) Mustard oil cake	50	20.00	1,000.00	**7,484.85**
	g) Cowdung (kg)	2000	0.50	1,000.00	**7,484.85**
	Total fertilizer	**2,350**	**83**	**7,675**	**57,446**
5	**Pesticides:**				
	a) Insecticide			300.00	**2,245.45**
	b) Fungicide etc			3,000.00	**22,454.55**
	Total Pesticide	**0**	**0**	**3,300**	**24,700**
6	**Irrigation**			1,000.00	**7,484.85**
7	**Land rent**			6,000.00	**44,909.09**
8	**Poly shed**				**0.00**
	(a) Polythene			22,000.00	**164,666.67**
	(b) Bamboo	300	70.00	21,000.00	**157,181.82**
	(c) Wire, rope etc			3,000.00	**22,454.55**
	Total Poly shed Cost:	**300**	**70**	**46,000**	**344,303**
9	**Hormone (Tomatone)**			2,200.00	**16,466.67**
10	**Interest on working capital**				
	a) Full cost basis		Interest 12%	8,853.75	**66,268.98**
	b) Cash cost basis		Interest 12%	5,613.75	**42,018.07**
A.	**Total Cost:**				
	a) Full cost basis			107,228.75	**853,609.13**
	b) Cash cost basis			67,988.75	**543,437.01**
B Gross and Net return:					
	Gross return				
	a) Main product (Kg)	10,560	24.00	253,440.00	**1,896,960.00**
	b) By-product				
	Total Gross return				
	Net return				
	a) Full cost basis			146,211.25	**1,043,350.87**
	b) Cash cost basis			185,451.25	**1,353,522.99**
C.	**Cost Benefit Ratio**				
	a) Full cost basis				**2.22**
	b) Cash cost basis				**3.49**
D.	**Tomato cost (Tk/Kg)**				
	a) Full cost basis			10.15	
	b) Cash cost basis			6.44	

Note:

1 **1 Bigha = 33 Decimals, 1 Hectare= 247 Decimals,**

A. Cash cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, 6. Poly-shed, 7. Hormone, 8. Interest on working capital

B. Full cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, **6. Labour**, **7. Land rent**, 8. Poly-shed, 9. Hormone, 10. Interest on working capital

Annexure 4: Cost and return of Poly-shed summer tomato

Name of Farmer: Mr. Selim Reza **Father's Name:** Mr. Korban Morol **Mob:** 01716462882
Village: Mollikpur **Union:** Jhekorgacha **Upazila:** Jhekorgacha **Dist:** Jessore
Crop: Tomato **Variety:** BARI Tomato 3 & 4(F_1) **Sowing:** 17 May 2007
Transplanting: 2 June 07 **Harvesting:** 25 August 07-31 March 08 **Plot Size:** 12 decimals

SL#	Item	Quantity (Bigha)	Rate (Tk)	Cost-return (Tk/Bigha)	Cost-return (Tk/ha)
A. Cost					
1	**Land Preparation (times)**	5	120.00	600.00	**4,490.91**
2	**Labor**	857	100.00	85,700.00	**641,451.52**
3	**Seed/ Seedling (gm)**	100	70.00	7,000.00	**52,393.94**
4	**Fertilizer**				
	a) Urea (kg)	54	6.00	324.00	**2,425.09**
	b) TSP/ DAP (kg)	384	25.00	9,600.00	**71,854.55**
	c) MP (kg)	192	25.00	4,800.00	**35,927.27**
	d) Gypsum (kg)			0.00	**0.00**
	e) Zinc (kg)				
	f) Mustard oil cake			0.00	**0.00**
	g) Cowdung (Mond)	100	5.00	500.00	**3,742.42**
	Total fertilizer	**730**	**61**	**15,224**	**113,949**
5	**Pesticides:**				
	Hormone (Bottle)	60	200.00	12,000.00	**89,818.18**
	a) Insecticide	4	250.00	1,000.00	**7,484.85**
	b) Fungicide etc	6	220.00	1,320.00	**9,880.00**
	Total Pesticide	**70**	**670**	**14,320**	**107,183**
6	**Irrigation**	4	300.00	1,200.00	**8,981.82**
7	**Land rent**	1	5,000.00	5,000.00	**37,424.24**
8	**Poly shed**				**0.00**
	(a) Polythene	70	200.00	14,000.00	**104,787.88**
	(b) Bamboo	300	100.00	30,000.00	**224,545.45**
	(c) Wire, rope etc	10	100.00	1,000.00	**7,484.85**
	Total Poly shed Cost:	**380**	**400**	**45,000**	**336,818**
9	**Hormone (Tomatone) (Bottle)**				**0.00**
10	**Interest on working capital**				
	a) Full cost basis		Interest 12%	20,885.28	**156,323.16**
	b) Cash cost basis		Interest 12%	10,001.28	**74,858.07**
A.	**Total Cost:**				
	a) Full cost basis			194,929.28	**1,459,016.13**
	b) Cash cost basis			93,345.28	**698,675.28**
B Gross and Net return:					
	Gross return				
	a) Main product (Kg)	24,000	25.00	600,000.00	**4,490,909.09**
	b) By-product				
	Total Gross return				
	Net return				
	a) Full cost basis			405,070.72	**3,031,892.96**
	b) Cash cost basis			506,654.72	**3,792,233.81**
C.	**Cost Benefit Ratio**				
	a) Full cost basis				**3.08**
	b) Cash cost basis				**6.43**
D.	**Tomato cost (Tk/Kg)**				
	a) Full cost basis			8.12	
	b) Cash cost basis			3.89	

Note:

1 **1 Bigha = 33 Decimals, 1 Hectare= 247 Decimals,**

A. Cash cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, 6. Poly-shed, 7. Hormone, 8. Interest on working capital

B. Full cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, **6. Labour**, **7. Land rent**, 8. Poly-shed, 9. Hormone, 10. Interest on working capital

Annexure 5: Cost and return of Poly-shed summer tomato

Name of Farmer: Ayub Hossain **Father's Name:** Abu Hanif Biswas **Mob:** 01717726131
Village: Padmapur **Union:** Jhekorgacha **Upazila:** Jhekorgacha **Dist:** Jessore
Crop: Tomato **Variety:** BARI Tomato 3 & 4(F_1) **Sowing:** 29 June 2006
Transplanting: 15 July 06 **Harvesting:** 10 September 06 - March 07 **Plot size:** 21 decimals

SL#	Item	Quantity (Bigha)	Rate (Tk)	Cost-return (Tk/Bigha)	Cost-return (Tk/ha)
A. Cost					
1	**Land Preparation (times)**	6		1,500.00	**11,227.27**
2	**Labor**	1021	100.00	102,100.00	**764,203.03**
3	**Seed/ Seedling (gm)**			0.00	**0.00**
4	**Fertilizer**				
	a) Urea (kg)	75	12.00	900.00	**6,736.36**
	b) TSP/ DAP (kg)	280	25.00	7,000.00	**52,393.94**
	c) MP (kg)	130	15.00	1,950.00	**14,595.45**
	d) Gypsum (kg)	40	6.00	240.00	**1,796.36**
	e) Zinc (kg)				
	f) Mustard oil cake			0.00	**0.00**
	g) Cowdung (kg)			0.00	**0.00**
	Total fertilizer	**525**	**58**	**10,090**	**75,522**
5	**Pesticides:**				
	a) Insecticide			3,929.00	**29,407.97**
	b) Fungicide etc			4,714.00	**35,283.58**
	Total Pesticide	**0**	**0**	**8,643**	**64,692**
6	**Irrigation**			1,100.00	**8,233.33**
7	**Land rent**				**0.00**
8	**Poly shed**				**0.00**
	(a) Polythene			18,857.00	**141,141.79**
	(b) Bamboo	500	30.00	15,000.00	**112,272.73**
	(c) Wire, rope etc	110	40.00	4,400.00	**32,933.33**
	Total Poly shed Cost:	**610**	**70**	**38,257**	**286,348**
9	**Hormone (Tomatone) (Bottle)**	11	100.00	1,100.00	**8,233.33**
10	**Interest on working capital**				
	a) Full cost basis		Interest 12%	19,534.80	**146,215.02**
	b) Cash cost basis		Interest 12%	7,282.80	**54,510.65**
A.	**Total Cost:**				
	a) Full cost basis			182,324.80	**1,364,673.50**
	b) Cash cost basis			67,972.80	**508,766.11**
B Gross and Net return:					
	Gross return				
	a) Main product (Kg)	19,381	30.00	581,430.00	**4,351,915.45**
	b) By-product				
	Total Gross return				
	Net return				
	a) Full cost basis			399,105.20	**2,987,241.95**
	b) Cash cost basis			513,457.20	**3,843,149.35**
C.	**Cost Benefit Ratio**				
	a) Full cost basis				**3.19**
	b) Cash cost basis				**8.55**
D.	**Tomato cost (Tk/Kg)**				
	a) Full cost basis			9.41	
	b) Cash cost basis			3.51	

Note:

1 1 Bigha = 33 Decimals, 1 Hectare= 247 Decimals,

A. Cash cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, 6. Poly-shed, 7. Hormone, 8. Interest on working capital

B. Full cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, **6. Labour**, **7. Land rent**, 8. Poly-shed, 9. Hormone, 10. Interest on working capital

Annexure 6: Cost and return of Poly-shed summer tomato

Name of Farmer: Md. Jalal Uddin **Father's Name:** Late Abdul Mazid Mollah
Village: Dadpur **Union:** Doraj hat **Upazila:** Bagherpara **Dist:** Jessore
Crop: Tomato **Variety:** BARI Tomato 4 (F_1) **Sowing:** 2.6.2007
Transplanting: 4.7.2007 **Harvesting:** Starts: 6.9.07-February'08 **Plot Size:** 12 decimals

SL#	Item	Quantity (Bigha)	Rate (Tk)	Cost-return (Tk/Bigha)	Cost-return (Tk/ha)
A. Cost					
1	**Land Preparation (times)**	3		690.00	**5,164.55**
2	**Labor**	415	100.00	41,500.00	**310,621.21**
3	**Seed/ Seedling (kg)**	30	25.00	750.00	**5,613.64**
4	**Fertilizer**				
	a) Urea (kg)	80	6.00	480.00	**3,592.73**
	b) TSP/ DAP (kg)	80	14.00	1,120.00	**8,383.03**
	c) MP (kg)	40	13.00	520.00	**3,892.12**
	d) Gypsum (kg)	80	3.00	240.00	**1,796.36**
	e) Zine Sulphate (kg)				
	f) Other (Borax) (kg)				
	g) Mustard Oil Cake (kg)	66	16.00	1,056.00	**7,904.00**
	Total fertilizer	**346**	**52**	**3,416**	**25,568**
5	**Pesticides:**				
	a) Insecticide			6,875.00	**51,458.33**
	b) Fungicide etc			6,875.00	**51,458.33**
	Total Pesticide	**0**	**0**	**13,750**	**102,917**
6	**Irrigation**			3,300.00	**24,700.00**
7	**Land rent**			11,000.00	**82,333.33**
8	**Poly shed & net**			38,500.00	**288,166.67**
9	**Hormone (Tomatone)**			4,950.00	**37,050.00**
10	**Interest on working capital**				
	a) Full cost basis		Interest 9%	10,607.04	**79,392.09**
	b) Cash cost basis		Interest 9%	5,882.04	**44,026.18**
A.	**Total Cost:**				
	a) Full cost basis			128,463.04	**961,526.39**
	b) Cash cost basis			71,238.04	**533,205.94**
B Gross and Net return:					
	Gross return				
	a) Main product (Kg)	12,022	28.00	336,616.00	**2,519,519.76**
	b) By-product				
	Total Gross return				
	Net return				
	a) Full cost basis			208,152.96	**1,557,993.37**
	b) Cash cost basis			265,377.96	**1,986,313.82**
C.	**Cost Benefit Ratio**				
	a) Full cost basis				**2.62**
	b) Cash cost basis				**4.73**
D.	**Tomato cost (Tk/Kg)**				
	a) Full cost basis			10.69	
	b) Cash cost basis			5.93	

Note:

1 **1 Bigha = 33 Decimals, 1 Hectare= 247 Decimals,**

A. Cash cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, 6. Poly-shed & net, 7. Hormone, 8. Interest on working capital

B. Full cost basis includes: 1. Land preparation, 2. Seed, 3. Fertilizer, 4. Pesticide, 5. Irrigation, **6. Labour**, **7. Land rent**, 8. Poly-shed & net, 9. Hormone, 10. Interest on working capital