



**PROTECTED CULTIVATION OF TOMATO  
FOR  
ASSURED LIVELIHOOD**

**DISSERTATION SUBMITTED TO  
ORISSA UNIVERSITY OF AGRICULTURE AND TECHNOLOGY  
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS  
FOR AWARD OF THE DEGREE OF  
MASTER OF BUSINESS ADMINISTRATION  
AGRIBUSINESS MANAGEMENT**

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**CERTIFICATE-II**

This is certify that the dissertation entitled “**PROTECTED CULTIVATION OF TOMATO FOR ASSURED LIVELIHOOD**” submitted in partial fulfilment of the requirement for the degree of **Master of Business Administration in Agribusiness Management** to Orissa University of Agriculture and Technology (OUAT), Bhubaneswar is record of project work done by **Miss. Binapani Kundu** during the period of her study in this University under my guidance and supervision. This dissertation has not been previously formed on the basis for award of any Degree/Diploma or other similar titles. The assistance and help received as well as source of information availed during the course of investigation have duly acknowledged.

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## **DECLARATION**

I do here by declare that dissertation entitled “PROTECTED CULTIVATION OF TOMATO FOR ASSURED LIVELIHOOD” being submitted by me in partial fulfilment of the requirement for the degree of Master of Business Administration in Agribusiness Management of Orissa University of Agriculture Technology (OUAT), Bhubaneswar under the guidance of Dr. Naresh Babu, DRWA. I further declare that the contents of the report are authentic and have not been published or presented earlier.

Date:

(Binapani Kundu)

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## **Abstract**

Adoption of greenhouse technology can improve yield and productivity of tomato crop in off season cultivation. A field experiment was conducted to study the "Protected cultivation of tomato (*Lycopersicon esculentum* L.) for assured livelihood " at Directorate of Research on Women in Agriculture, Bhubaneswar during 2013-14. The experiment was laid out in Randomized Block Design with factorial concept comprised of three environments namely glass house, poly house and net house and five varieties namely Avinash, Naveen, Hybrid FA-574, R-144 and DT-7 of tomato. The results indicate a remarkable significant difference on all the vegetative growth and yield parameters. The maximum plant length, number of leaves, number of branches and leaf area 3.01m, 24.53, 1.75 and 448.37 cm<sup>2</sup>, respectively were found in glass house conditions as compared to minimum in net house condition. Among different varieties of tomato maximum plant length (3.26 m), number of leaves (29.96), number of branches (1.73) and leaf area (449.71 cm<sup>2</sup>) were recorded in variety Avinash against the minimum plant height (2.43 m), number of leaves (20.40), number of branches (1.44) and leaf area (405.76 cm<sup>2</sup>) in variety R-144. Number of fruits per plant (19.17) weight of fruits per plant (3.98 kg) and average fruit length (3.52 cm) were recorded maximum in glass house. Among different cultivars the maximum number of fruits per plant (20.44) and highest fruit weight (137.98 g) was obtained in cultivar Avinash. The significantly higher yield was recorded in cultivar Avinash (11.05 kg/ square meter) followed by Naveen (928 kg per square meter).

**Key words:** Polyhouse, net house, tomato, cultivars, green house technology,

Productivity.

# **CHAPTER –I**

## **1.1 Organisation overview**

The Working Group on Agricultural Research and Education, constituted by the Planning Commission for the formulation of the Eighth Five Year Plan (1992-97), recommended the establishment of a National Research Centre for Women in Agriculture (NRCWA). Accordingly, the Indian Council of Agricultural Research established the NRCWA in April 1996, at Bhubaneswar that has since then been upgraded to the Directorate of Research on Women in Agriculture (DRWA) in the year 2008. Keeping in view the role of women in integration of farm and household activities, AICRP on Home Science started in the VI Five Year Plan (1980 – 85), was merged with NRCWA in 2007. Since its inception, DRWA has been in the forefront undertaking research on issues affecting women and the opportunities in agriculture. It has focused on participatory action research in different technology based theme areas involving rural women to test suitability of technologies for women and suggest for their refinement. The Directorate is also working to catalyze and facilitate R & D institutions to bring in farm women perspectives in their programmes.

Women have traditionally been playing very important role in all sections of agriculture and the need of the hour is to strengthen their participation by empowering them with women friendly technologies that help in increasing the production and also reduce drudgery for those who carry out the farming operations

Sustainable agricultural development is very important for farmers. Sustainability cannot be achieved without the partnership between men and women. They are like to wheels of a cart and together only they can move towards progress. The country has achieved much progress in agricultural and the growth can be further accelerated only by harnessing all resources including the human resource, fifty percent of which is women.

The Directorate of Research on Women in Agriculture is mandated to address the gender issues through technology refinement, farming system development, extension approach and capacity building of stakeholders in a gender perspective through basic, applied and strategic research, for gender equity is basic to achieving food and nutritional security.

# **INTRODUCTION**

# INTRODUCTION

## 1.2 IMPORTANCE OF INDIAN AGRICULTURE

Agriculture in India has a significant history. Today, India ranks second worldwide in farm output. Agriculture and allied sectors like forestry and fisheries accounted for 16.6% of the GDP in 2009, about 50% of the total workforce. The economic contribution of agriculture to India's GDP is steadily declining with the country's broad-based economic growth. Still, agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of India.

Agriculture continues play a dominant role in the growth of Indian economy. It represents the largest sector producing around 13.9 percent of the GDP (economic survey of India 2011-2012) is the largest employer providing more than 60% of the jobs and the prime arbiter of living standard for 70% of India's population living in the rural area . These factors together with a strong determination to achieve self-sufficiency in food grains production have ensured a high priority for agriculture sector in the successive development plans of the country.

## 1.3 ROLE AND CONTRIBUTION OF AGRICULTURE IN INDIAN ECONOMY

Agriculture is the backbone of the **Indian economy**. Despite major emphasis on industrial development during the last four decades, agriculture continues to occupy a place of pride in our economy. The **importance of agriculture** can be brought out from the following facts:

### **Share in national income:**

Although the share of agriculture in the total national income has been gradually decreasing on account of the development of the secondary and tertiary sectors, it still contributed about 18 % of nation income in 2006-07.(in 1950-51, it was 59%)

### **Source of employment:**

In India, agriculture is the main source of employment. Even in 2004-05, more than 56% of the total labour force of India is engaged in agriculture and depend on it for their livelihood

(1950-51: 69.5%). It becomes evident from this fact that other sectors of the economy could not generate enough employment for the growing population.

### **Provision of food grains:**

In a developing country like India where a very large proportion of income is spent on food and the population is increasing rapidly, the demand for food grains has been increasing at a fast rate. Agriculture in India has played an important role in meeting almost the entire food needs of the people. The production of food grains in India has increased from 51 million tonnes in 1950-51 to 208.3 million tonnes in 2005-06, i.e. by a little more than 4 times since 1950-51. This has enabled the country to overcome the problems of food grain shortages. The country is almost self-sufficient in food grains and it no longer depends on import of food grains.

### **Supply of raw materials to industrial sector:**

Agriculture plays an important role in industrial development. Many industries like cotton industry, jute industries, sugar industries, food processing industries, etc. depends on agriculture for their raw material requirements. Moreover, workers engaged in various industries depend on agriculture for their food requirement.

### **Market for industrial product:**

Agriculture provides markets for a large number of industrial products. Since about two thirds of India lives in rural areas, there is a large rural purchasing power which has created a large demand for all types of industrial products. Green revolution has considerably increased the purchasing power of the large farmers substantially in the recent years. Thus for the demand for various products like soaps, detergents, clothes, cycles, scooters, radios, television, torches, lead batteries, etc. has witnessed a marked increase. Likewise, the demand for a variety of agricultural inputs like chemical fertilizer, tractors, pump-sets, pesticides etc. has increased sharply. This has stimulated the development of industries producing these inputs.

**Earner of foreign exchange:**

Agriculture plays an important role in Indian economy as an earner of foreign exchange through exports of agricultural commodities like tea, cotton, coffee, jute, fruits, vegetables, spices, tobacco, sugar, oil, cashew kernels, etc. in the past, export of agricultural products accounted for about 70% of the export earnings of the country. However, with economic development and consequent diversification of our exports, the share of agriculture in total exports has come down to about 10% in 2005-06. All these exports bring valuable foreign exchange to pay for the increased imports of machinery and raw materials required in the non- agricultural sector.

**Significance for trade and transport:**

Agriculture helps in the development of tertiary (or service) sector. For example various means of transport like roadways and railways get bulk of their business from the movement of agricultural commodities and raw materials. A significant part of internal trade constitutes mainly of agricultural products.

**Source of revenue for the government:**

Through the direct contribution of agricultural taxes to the central and state governments is not significant, they get a significant part of their total revenue in terms of land revenue, irrigation charges, taxes imposed on the commodities purchased by the cultivators etc. central government also earns revenue from export duties on agricultural production. Freight charges imposed by Indian Railways for carrying agricultural product generate huge revenue to the central exchequer

On over all view, India has always been benefited by agriculture. Though the future of India is industrialization, the contribution of agriculture would always prove to be vital for making India a powerful and stable economy in the future.

## **1.4 IMPORTANCE OF PROTECTED CULTIVATION**

Vegetable production in our country is significantly influenced by the seasonality and weather conditions. Extends of abundance and deficiency in production and availability cause considerable fluctuations in the prices and quality of vegetables. Vegetable production, at present, is also characterized by a strong dependence on chemical plant protection with its all inherent environment and health hazards, both for growers and the consumers. Striking a balance between all-season availability of high quality vegetables with minimum environment impact, and still to remain economically competitive in this time of globalization, is a major challenge for the modern technology of crop production. The crop productivity is influenced by the genetic characteristics of the cultivar and the management practices including nutrients, water and microclimate. Under open field cultivation, while the other factors could be taken care of, it is not possible to effect control on the microclimate around the plant. The main purpose of protected cultivation is to create a favourable microclimate for the sustained growth of plant so as to realize its maximum potential even in the adverse climatic conditions. Greenhouses, rain shelters, plastic tunnels, mulches, insect-proof net houses, shade nets, etc. are used as protective structures and means depending on the requirements and cost-effectiveness. Besides modifying microclimate, these protective structures provide protection against wind, rain and insects.

Protected cultivation offers several advantages to produce vegetables of high quality and yields-particularly during the off-season when prices are higher, thus using the land and other resources more efficiently. This becomes relevant to vegetable growers in India who have land holding smaller than one hectare. They would be interested in a technology which helps them to produce more crops each year from their land, particularly during off-season when prices are higher. Other advantages of greenhouse cultivation include timely harvest as per market demand; higher yield due to better management, optimum use of land and increase in harvesting period and raising quality seedlings and plant propagation.

Important consideration needs to be given while going for greenhouse cultivation is the selection of crop which can give more produce over a longer harvesting period under sub-normal conditions of light and carbon dioxide and high humidity prevalent in the greenhouses, if they are not monitored properly. Besides, the choice of crops to be raised in a greenhouse is made on the basis of the physical size of the structure and the economics of crop production. As a result, high value horticultural crops have been more popular for

cultivation in greenhouses. Besides, the crop should be preferred by a large mass. Another consideration for the viability of greenhouse technology is the higher return per unit area per day. However, growing vegetables under protected conditions requires high input cost and good management practices, which have direct bearing on the economic viability of the production system. Even if the protective structures are cost effective, proper planning, management and attention to details are needed to achieve maximum benefits. Growing vegetables under location-specific suitable protective structures may accrue substantial profits even to the small growers.

Tomato (*Lycopersicon esculentum* Mill.) is one of the most popular, cash earning and versatile vegetable crops for small farmers of India. It is also most important and remunerative vegetable crop in India. A rich source of mineral, vitamins and organic acids.

Uttar Pradesh, Maharashtra, Karnataka, Bihar and Odisha, are major tomato-growing states in India.

Tomato, a warm-season vegetable, is grown extensively in cool season. The optimum temperature required for its cultivation is 15°-27°C. At high and low temperatures, there is low germination of seeds, poor plant growth, flower drop, poor fruit set and ripening. At high temperatures, generally the quality of fruits is poor and there is high incidence of sun-scald. Under extreme high and low temperature conditions, the yield and quality of fruits is reduced. Mild winter condition in northern plains is ideal for seed germination, plant growth, fruit set, fruit development and ripening. Excessive rain adversely affects its fruit set causing flower drop.

A rich Main constraint of its cultivation round the year in plains of North-West India including Rajasthan where weathers condition during winter and summer season is extremes. The tomato fruits are thus available for a short period (mid April to mid June). It is a challenge to the vegetable production technology and utilization of natural resources to produce vegetables several times more to meet the needs of the expected vegetable requirement of 150 millions tones by 2020. In these circumstances green house production offers great scope. There are several factors i.e., suitable varieties, nutrition management, training and pruning, water management, plant protection etc. are responsible for production and productivity of the vegetables. Among them screening of suitable variety for off season, production under protected condition is most important factor. Therefore, the present investigation entitled "Performance of Six Exotic tomato Varieties under protected conditions

in relation to growth, yield and quality” was initiated with the objectives of raising off season crop with good quality produce under low cost naturally ventilated poly house.

## **1.5 Government schemes for protected Cultivation of Vegetables**

Various government and non government national level organisations like National Horticulture Mission, National Horticulture Board, RKVY State Departments, NGOs are providing subsidies to the growers for encouraging protected cultivation of vegetables for boosting production as well as income of the farming. The study was carried out with the following objectives:

## **1.6 OBJECTIVES**

- To increase the production
- To get the production in off season
- To earn higher income

### **To increase the production**

Through protected cultivation the farmers/growers can increase the production. In open cultivation a farmer/grower can cultivate only 3-4months but in protective cultivation a farmers can cultivate 7-8 months. In open cultivation the crop loss is more due to insect pest attack where as in protected cultivation the wastage is very less.

### **To get the production in off season:**

In protected cultivation the temperature can be controlled. Therefore, farmers can able to produce vegetables in off season and can sell them at higher price in the market.

### **Higher Income**

As the farmer can produce vegetables in off season, so the farmer can sell the product in higher price to the retail stores such as Reliance Fresh, Udyan fresh, Vegekart and big hotels. To avoid wastage of the produce, the farmers can produce product according to the demand of these retail stores. And also the farmer can charge higher rate because it is not a seasonal product.

# **CHAPTER- II**

## **REVIEW LITRATURE**

## 2.1 Review Literature

Tomato (*Lycopersicon esculentum* Mill.) is the first important vegetable crop grown under different protected conditions throughout the world. In greenhouse this crop is grown for longer duration and the indeterminate varieties/hybrids are used for protected cultivation. In India the information about cultivation of tomato crop under greenhouse cultivation for production of high quality and quantity produce is very limited. However, the available information is presented hereunder ( Shukla *et al.*, 2014).

Experiment was conducted to grow the nursery of tomato, chilli and capsicum in plastic greenhouse from January 23 to February 18, 1991 (More and Gill, 1991). Essentially during this period the temperatures in northern India are very low for growing nursery of these crops and even germination may be a problem particularly of chilli and capsicum seeds.. Data were recorded on seedling height 26 day after sowing. The height of seedlings of tomato cv. Pusa Ruby was 23.2 cm within a short span of 26 days (More and Gill, 1991). These results are more encouraging. If one compares the raising of tomato seedlings in the month of January-February outside, it may take 60 days or more with low percentage of germination. This shows that there is a great prospect for raising tomato nursery in winter months in northern India under plastic greenhouse.

The investigations were carried out in the computer controlled greenhouses to study the effect of heat stress on four different varieties of tomato for yield and other physiological parameters (Kanthaswamy *et al.*, 2002). The effect of high, mild stress on photosynthesis, night respiration and anther dehiscence, fruit set, fruit production, release of pollen grains were examined in tomato differing in high temperature sensitivity. Plants were grown under three temperature regimes (i) 29/23°C (or) 27/23°C (optimal temperature), (ii) 33/27°C (high temperature) and (iii) 33/26°C day/ night temperatures relieved at 28.22°C for 5 days before anthesis, then returned to 33/27°C (relieving treatment). Espero was the only cultivar with fruit set under the relieving treatment (RT). Longer the relief, higher the per cent of fruit set. Longer periods of relief also increased the number of pollen grains released and the per cent fruit set. Germination of pollen grains was also lowered in higher temperature grown plants. The number of pollen grains produced, photosynthesis and night respiration did not limit fruit set under high and mild heat stress. This suggested that cultivar differences in pollen release and germination under heat stress are the most important factors determining their ability to set fruit.

Study on effect of shade on growth and yield of tomato genotypes was undertaken at the orchard of Horticultural College and Research Institute, Coimbatore during 1997 in two seasons viz., summer and rainy to find out the effect of shade on growth and yield (Thangam et al., 2002). The experiments were laid out in FRBD with 20 treatments, which included six varieties and 14 hybrids of tomato in two replications. Black HDPE agro shade net (50% shade) was used as shading material on the erected structures. Simultaneously, open field planting was taken up for comparison. Similar cultural practices were followed in both the cases. The plants grown under shade exhibited better growth in terms of plant height and dry matter production compared to those in open field. During the summer season, Naveen was the tallest (307.0 cm) under shade and in open field (88.45 cm). During rainy season, the maximum plant height was recorded by S-72 (325.5 cm) under shade and Naveen (83.13 cm) in open field. The stem girth and number of primary branches were higher in open field compared to shade during both the seasons in most of the genotypes. In general, earlier flowering and fruiting were noticed in open field in both the seasons. However, the yield under shade was lower when compared to open field. Avinash-2 recorded the highest yield of 968.4 g and 1512.2 g per plant under shade during summer and rainy respectively and the same hybrid recorded the maximum yield under open field in both the seasons. Therefore, further experiments are needed to study the effect of lesser shading (30, 25, 20 and 15%) to intercept sunlight, and reduce the temperature especially during summer for optimum photosynthesis and fruit set.

Tomato hybrid Naveen yield 11.05 kg/m<sup>2</sup> and 3.98 kg/plant whereas Pusa Hybrid yields 9.86 kg/m<sup>2</sup> and 3.55 kg/plant (Chandra *et al.*, 2000). Studies on standardization of agro-techniques for locally available tomato hybrids were carried out under low-cost greenhouse during 1999-2000 (Khan et al., 2000) at UAS, GKVK, Dharwad. Among the nine hybrids and high yielding varieties studies under low-cost greenhouse in different seasons, Sun 7611 (90.12 t/ha), NS-1237 (88.72 t/ha) and Naveen (87.28 t/ha) were found to be on par and significantly superior over all the other hybrids/varieties evaluated in respect of yield, quality of fruits and least incidence of pests and diseases.

A experiment was conducted to evaluate the performance of exotic and indigenous tomato varieties/hybrids under high-tech greenhouse conditions in Indo Israel Project, IARI, New Delhi. Out of the five varieties/hybrids of big size tomato evaluated, variety R-144 (from Israel) produced significantly higher fruit yield (2185.18 q/ha), maximum TSS in fruits (5.0%), maximum number of fruits per truss (5-6 fruits) with an average fruit weight of 130

g/fruit as compared to all other tomato varieties, grown for more than 10 months duration in climate control greenhouse (Singh *et al.*, 2002). Variety R-144 had longest shelf life (12 days) and had minimum incidence of the most economical physiological disorder blossom-end rot (1.0 %) as compared to all other exotic and indigenous varieties of tomato. Hybrid FA-574 produced biggest sized fruits with an average fruit weight of 145 grams per fruit, but produced significantly lower fruit yield (1722.22 q/ha) as compared to variety R-144. Variety DT-7 (IARI) had recorded as highly susceptible to blossom end rot, minimum shelf life (6.0 days) with lowest fruit yield (833.33 q/ha) in climate control greenhouse under Delhi conditions with all the production technology as is being followed in Israel.

Based on three years trials at farmer's fields, Pathania *et al.*, 2002 observed that capsicum (ratoon and 1 year crop), tomato, French bean and cucumber were the most promising crops that given 2 - 10 times higher yield under protection during summer season in hilly regions of North-Western Himalaya. Different vegetable based sequences, viz, capsicum (ratoon crop) followed by cucumber cucumber-vegetable nursery and tomato-cucumber-vegetable nursery, have been found to be remunerative for efficient and throughout the year utilization of protective structure in mid hills of North-western Himalaya. A strategy for protected cultivation of potential summer vegetables for different agro-ecological situations in North-Western Himalaya is formulated under this situation.

Among the various spacing and pruning levels tried to accommodate maximum plant population per unit area, providing spacing of 60 x 45 cm and allowing two main branches for fruiting resulted in getting the highest yield of 94.12 t/ha in Sun-7611, 92.51 t/ha in NS-1237 and 90.85 t/ha in Naveen under low cost greenhouse (Khan *et al.*, 2000). Further, studies on fertigation with regard to sources and constraint levels of fertilizer with Sun-7611 revealed that application of 120 per cent of the recommended level of water soluble fertilizers gave maximum of 122.56 t/ha followed by application of 140% of the recommended level of normal fertilizers (120.53 t/ha) as compared to control with application of recommended level of normal fertilizers (92.89 t/ha). Thus the studies have indicated that indeterminate hybrids such as Sun-7611, NS-1237 and Naveen along with spacing/plant density of 60 x 45 cm, pruning (two branches/plant, supporting with plastic tape and providing 120 per cent of the recommended levels of water soluble fertilizers through fertigation gave highest fruit yield (122.56 t/ha). It is also observed that quality fruits can be obtained from a low cost greenhouse during a period of five to six months. It may be concluded from this study

that two crops/year with highest yield of 245 t/ha/year can be obtain during off-season for fetch maximum returns.

Prabhakaran *et al.*, 2000 were conducted field experiment at IIHR, Bangalore to utilize the greenhouse space more efficiently in order to make it a viable proposition to grow vegetables in greenhouses. Two tomato hybrids, one with indeterminate growth habit (SH-7611) and the other with semi-determinate growth habit (Arka Abhijith), were planted as sole crops and also together in paired row on the planting bed of one meter width. Three spacing (20,30 and 40 cm) and two pruning levels (one and two stems per plant) were also tried to intensify the use of greenhouse space. Growth and yield parameters were recorded to evaluate the advantage of paired planting of tomato hybrids of different plant growth habits. In the present studies, planting of both indeterminate and semi-indeterminate hybrids together in a paired row has shown a yield advantage of 11 per cent over indeterminate hybrid. The spread of the harvesting period was also longer in the paired planting system. Observations revealed that closer spacing of 20 cm between the plants recorded the maximum yield of 275 t/ha. Maintaining two stems per plants resulted in 12 per cent increase in fruit yield. The above system of two tier planting of tomato hybrids with different growth habits, planted at close spacing of 20 cm between plants and maintaining two stems per plant was improved productivity of tomato under the horizontal and vertical space dimensions of greenhouse. Application of NAA and GA on tomato grown in unstabilized plastic covered greenhouse increased tomato yield by 12-16 % over to control (Nimje *et al.*, 1990).

A specific climatic requirement does not permit successful cultivation of tomato during December to March in North Indian plains. Keeping in view the above facts an investigation was conducted at Indian Agricultural Research Institute, New Delhi to evaluate the performance of tomato varieties under plastic greenhouse during off-season (Munshi *et al.*, 2000). Six varieties of tomato, namely, Pusa Early Dwarf, Rishi, Matri, Pusa Ruby, KT-4 and Pusa Gaurav were grown under polyhouse as well as under open field conditions. All the varieties performed significantly better under polyhouse as compared to open field condition. Yield per hectare varied from 110.7 to 488.0 q/ha and 15.6 to 75.0 q/ha under polyhouse and open field conditions respectively. On the basis of results obtained it is concluded that Rishi and Pusa Gaurav are most promising varieties under polyhouse cultivation as they recorded significantly higher yield of 488.0 q/ha and 411.0 q/ha, respectively. The investigation further reflects the possibilities of successful growing of tomatoes under polyhouse during January to April under Delhi conditions.

An experiment was conducted to evaluate the response of micro irrigation and fertigation on tomato and capsicum under control condition. Observations revealed that yield of tomato and capsicum could be significantly enhanced through drip irrigation method in polyhouse conditions (Singh, Chandra and Srivastava, 2010).

**CHAPTER- III**  
**MATERIALS AND METHODS**

## **Materials and Methods**

A field experiment entitled “Protected cultivation of tomato (*Lycopersicon esculentum* L.) for assured livelihood ” was conducted at Directorate of Research on Women in Agriculture during 2013-14. The details of experiment techniques, materials used and methods/techniques adopted during the course of investigation are described in this chapter.

### **3.1 Experimental site and location**

Based on sound principals of experimentation, investigations were made to study the “Protected cultivation of tomato for assured livelihood” under the agro climatic condition of Bhubaneswar. The climatic and edaphic conditions under which the present investigations were carried out and the details of techniques adopted and materials employed are described below:

### **3.2 Location and climatic condition**

The field experiment was conducted at Directorate of Research on Women in Agriculture, Bhubaneswar during 2013-14. Geographically Bhubaneswar is located at 20° 15' N latitude and 85° 52' E longitude about 120 cm above sea level. The climate of Bhubaneswar is subtropical high humidity, medium to high rainfall . The normal rainfall is 1451 mm of which 75- 80% is received from June to September. The mean annual temperature of Bhubaneswar is 29<sup>0</sup> C with mean annual maximum of 32<sup>0</sup> mean annual minimum of 32<sup>0</sup>.

## Experimental Details

The treatments for the experiment comprised of fifteen treatment combinations consisting of three design of protected structure, and five cultivar. The details of plan of work are given as follows:

### A. Details of treatments with their notations

	Treatments	Notatio
(a)	<b>Design of protected structure</b>	
	1. Agro shade net house 50% shed	S1
	2. Poly house	S2
	3. Glass house	S3
	<b>Cultivars</b>	
	1. Avinash	V1
	2. Naveen	V2
	3. Hybrid FA-574	V3
	4. R-144	V4
	5. DT-7	V5
	(@ 5:3:6 NPK solution applied twice in a week)	

### B. Treatment Combinations:

S. No.	Treatment combination of protected structure and varieties	Symbol
1.	Agro shade net house 50% shed + Avinash	S <sub>1</sub> V <sub>1</sub>
2.	Agro shade net house 50% shed + Naveen	S <sub>1</sub> V <sub>2</sub>
3.	Agro shade net house 50% shed + Hybrid FA-574	S <sub>1</sub> V <sub>3</sub>
4.	Agro shade net house 50% shed + R-144	S <sub>1</sub> V <sub>4</sub>
5.	Agro shade net house 50% shed + DT-7	S <sub>1</sub> V <sub>5</sub>
6.	Polyhouse + Avinash	S <sub>2</sub> V <sub>1</sub>
7.	Polyhouse + Naveen	S <sub>2</sub> V <sub>2</sub>
8.	Polyhouse + Hybrid FA-574	S <sub>2</sub> V <sub>3</sub>
9.	Polyhouse + R-144	S <sub>2</sub> V <sub>4</sub>
10.	Polyhouse + DT-7	S <sub>2</sub> V <sub>5</sub>
11.	Glass house + Avinash	S <sub>3</sub> V <sub>1</sub>
12.	Glass house + Naveen	S <sub>3</sub> V <sub>2</sub>

<b>13.</b>	Glass house + Hybrid FA-574	S <sub>3</sub> V <sub>3</sub>
<b>14.</b>	Glass house + R-144	S <sub>3</sub> V <sub>4</sub>
<b>15.</b>	Glass house + DT-7	S <sub>3</sub> V <sub>5</sub>

### 3.3 Experimental details:

- (i) Crop - Tomato
- (ii) Variety - Avinash, Naveen, Hybrid FA-574,  
R-144, DT-7
- (iii) Season - Kharif season
- (iv) Replication - Three
- (v) No. of treatments - 15
- (vi) Experimental design - RBD
- (vii) Spacing - 60X60 cm

### 3.4 Raising of the nursery:

For greenhouse cultivation, of tomato, the seedlings were raised on soil-less media in plastic pro trays having cells of 1.5" in size. A mixture of coco-peat, vermiculite and per litre @ 3:1:1 was used as a media for raising seedlings. One seed was sown in each cell. Regular watering and plant protection measures were adopted. Nutrients were applied in the form of N: P: K (1:1:1) @ 140 ppm once a week through the fine sprinkler to maintain the uniformity in application of nutrients. The seedlings were ready for transplanting within 20-25 days in winter season and within 20 days in summer season.

### **Bed preparation:**

The raised beds were prepared about 60 cm above the ground level for the experimental purpose. Beds of 1m x 3m size were prepared. Basal dose of FYM @ 250 quintals per hectare was applied and thoroughly mixed in the soil one week before transplanting.

### **Fertilizer application:**

Crop was fertilized with nitrogen, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O as per treatment. In case of conventional method of fertilizer application, half dose of nitrogen and full dose of phosphorus and potassium were applied before transplanting. Remaining ½ dose of nitrogen was applied in two split doses i.e. at 30 DAT and 60 DAT, in conventional method of fertilizer application, nitrogen was applied as urea, phosphorus as diammonium phosphate and potassium as muriate of potash, in this method, as a basal dose of 653.82 g urea, 1479.13 g di-ammonium phosphate and 2268 g muriate of potash was applied in 126 sq. meter area. Remaining half dose of nitrogen was applied through urea as a top dressing with 616.30 g at 30 DAT and 616.30 g at 60 DAT at two different stages of crop. Similarly, in case of fertigation, same dose of nitrogen, phosphorus and potassium was applied through irrigation water in the ratio of 5:3:6 at twice in a week with the following concentrations @ 3 litre water m<sup>-2</sup> area.

- Nitrogen - 0.300 g N/3 litre water/m<sup>2</sup>
- Phosphorus - 0.180 g P<sub>2</sub>O<sub>5</sub>/3 litre water/m<sup>2</sup>
- Potassium - 0.360 g K<sub>2</sub>O/3 litre water/m<sup>2</sup>

In case of fertigation method nitrogen, phosphorus and potassium were applied in liquid form along with irrigation water as NPK mixture (19:19:19), urea and muriate of potash in 30 split doses as 112 g, 32.35 g and 37.33 g, respectively. The total quantity of used NPK mixture, urea and muriate of potash in fertigation method was about 3360 g, 970.5 g and 1119.9 g, respectively in remaining 126 sq. meter area.

### **Transplanting:**

Three weeks old seedlings at 2-3 true leaf stage were transplanted at 60cm x 60cm, Transplanting was done in the evening and watering was done thereafter.

### **Intercultural operations:**

First hoeing and weeding was done after 20 days of transplanting and second was after 20 days of first weeding in all the treatments to keep plots weed free.

### **Plant protection measures:**

To protect the crop from the attack of insect and pests like aphids, whiteflies and thrips, imidacloprid (0.04%) or dimethoate (0.05%) were sprayed at ten days intervals as a precautionary measure after transplanting. Besides, to protect the crop from fungal disease as *Fusarium* root rot, a fungicide mancozeb @ 2.0 gram/litre of water was sprayed at weekly intervals during the entire experimental period.

### **Harvesting:**

Fruits were harvested when they were more or less cylindrical and well filled and subsequent harvesting was done three times a week.

### **Observations recorded:**

The following observations were recorded

1. Plant height ( cm)
2. Number of leaves
3. Number of primary branches
4. Flower initiation ( Days)
5. Fruit setting ( days)
6. Fruit size
  - Fruit width (cm)
  - Fruit length (cm)
7. Fruit weight ( gm)
8. Number of fruits/ plant
9. Yield per plant
10. Total Soluble Solids (TSS)
11. Net returns (Rs. ha<sup>-1</sup>)
12. B:C ratio

**CHAPTER-IV**  
**RESULT AND DISCUSSION**

## RESULTS AND DISCUSSION

### 4.1 Vegetative Growth Characteristics:

It is evident from the data that various types of structures and cultivars had significant effect on vegetative growth parameters of tomato like, number of branches, number of pickings, average length of vine (m), average number of leaves and leaf area (cm<sup>2</sup>). As far as winter season was concerned various structures had significant influence on number of branches, number of pickings, average length of plant, average number of leaves and area of leaves. The maximum number of branches per vine (1.75), number of pickings (3.93), average length of plant (3.25 m), average number of leaves per plant (26.93) and leaf area (451.17 cm<sup>2</sup>) were measured in glass house followed by poly house. The present results are supported by the findings of Arora *et al.* (2006) and Singh *et al.* (2002) in greenhouse grown tomato; Ban *et al.* (2006) and Maynard and Scott (1998) in melons; Kwon and Chang (1996) in chillies. These results are in accordance with the findings of Al-Jaloud *et al.* (1999), Al-Harbi *et al.* (1996), Ramirez *et al.* (1988) and Choudhari and More (2002) in gynococious cucumber hybrids.

### 4.2 Flowering Characteristics:

Data clearly showed that effect of cultivars and different type of structures along with their interaction effects had significantly influenced the various flowering characteristics as days to first flowering. Among the various protected structures, the least number of days to first flowering was recorded in glass house (37.60) followed by poly house (38.68) and Among the various cultivars, least number of days required for first flower initiation was recorded in cultivar Avinash (41.80) followed by Naveen (43.42). The findings of the present investigation are in close conformity with the findings of Gulam ud din *et al.* (2006) and Guo *et al.* (2010) in cucumber, Kwon and Chang (1996) in chillies and Brahma, Phookan, Kachari and Hazarika (2012) in capsicum.

### **4.3 Yield and Yield Attributing Characteristics:**

Among the various yields attributing characters number of fruits per plant, weight of fruits per plant, average fruit length, average fruit girth, average fruit weight, yields per square meter and yield per hectare were recorded in the present investigation.

Yield attributes such as number of fruits per plant (19.17) weight of fruits per plant (3.58 kg) and average fruit length (4.52 cm) were recorded maximum in glass house. Among different cultivars the maximum number of fruits per plant (20.44) and highest fruit weight (137.98 g) was obtained in cultivar Avinash The significantly higher yield was recorded in cultivar Avinash (11.05 kg/ square meter) followed by Naveen (928 kg per square meter). The similar findings of increase in average fruit weight and number of fruits per plant was reported by Mantur and Patil (2008) and Bahadur and Singh (2005) in tomato and Singh and Asrey (2005) in tomato and sweet pepper.

It is concluded that the main factors responsible for the increase in fruit yield per unit area were due to greater crop biomass. These results indicated that maximum yields are function of greater number of plants per unit area. The present findings are in accordance with the results of Papadopoulos and Pararajasingham (1997) and Sezen *et al.* (2010) and Champugain *et al.* (2004). Similarly, the early and total yield enhanced in pepper grown under glass house (Dasgum and Abak, 2003).

### **4.4 Physiological Parameters:**

It is evident from the data that various types of structures and cultivars had significant effect on physiological parameter like photosynthetic rate ( $\mu\text{m CO}_2/\text{m}^2/\text{s}$ ), transpiration rate ( $\mu\text{m H}_2\text{O}/\text{m}^2/\text{s}$ ) and chlorophyll content (mg/g fresh weight) of tomato under different type of structures.

As far as winter season concerned, effect of structure has a significant influence on photosynthetic rate ( $\mu\text{m CO}_2/\text{m}^2/\text{s}$ ), transpiration rate ( $\mu\text{m H}_2\text{O}/\text{m}^2/\text{s}$ ) and chlorophyll content (mg/g of fresh weight). The maximum photosynthetic rate ( $12.83 \mu\text{m CO}_2/\text{m}^2/\text{s}$ ) and chlorophyll content (1.30 mg/g) was found in glass house. Whereas, minimum transpiration rate ( $1.01 \mu\text{m H}_2\text{O}/\text{m}^2/\text{s}$ ) was found in glass house. The photosynthetic rate, transpiration rate and chlorophyll content are dependent on different factors such as  $\text{CO}_2$  concentration, temperature, light intensity, humidity, air temperature etc. Carbon makes up about 40 per cent

of the dry matter, weight of higher plant; therefore CO<sub>2</sub> concentration enrichment increased photosynthesis and plant productivity significantly. Increased CO<sub>2</sub> concentration in glass house (300-1000ppm) has been reported to increase photosynthesis and decreased stomatal conductance in most of the crop plant resulting in reduced transpiration rate per unit area of leaf and overall increase in water use efficiency (Dwivedi and Dwivedi, 2005). Reduced transpiration will alter the microclimate particularly, the selective humidity in immediate environment of plant which will have implication for other living organism sharing the same ecosystem with the plant.

#### **4.5 Fruit Quality Characteristics:**

The data presented in table 4.6 revealed that the various cultivars had resulted in significant increase in vitamin C content (mg/100g), Fibre content (%), Calcium content (mg/100g), Phosphorus content (mg/100g), Iron content (mg/100g). Among different cultivars maximum vitamin C (6.37 mg/100g) and minimum fibre content (0.78 %) were found in cultivar Avinash. This might be due to genetic expression in the tomato cultivar. The solanaceous is known to control by different genetic environment and hormonal factors. Fruit quality is also determined by the gene expression of a particular variety under favourable climatic condition in greenhouse (Manzano *et al.*, 2008). As discussed in section 5.4, auxin induced pistillate flower formation through its stimulation of ethylene production, therefore, number of female flower were measured and it has been reported that the ethylene has higher genetic expression in case of gynocious line that's why the improved of Avinash and Naveen variety under glass house (Guo *et al.*, 2010).

The economics of tomato production reflected that the net returns were significantly affected by different types of structures. It is clear from the data that maximum net returns and B: C ratio can be obtained by the poly house structure with 35821 ` per 500 square metre and 2.18, respectively. Where as in case of cultivar the maximum net return and B: C ratio was found with Avinash (40145` per 500 sq m) and B:C ratio (2.25).

**CHAPTER-V**  
**SUMMARY AND CONCLUSION**

## 5.1 SUMMARY

A field experiment entitled “Protected cultivation of tomato (*Lycopersicon esculentum* L.) for assured livelihood” was conducted at Directorate of Research on Women in Agriculture Bhubaneswar during 2013-14. The investigations were planned to meet the need of the following objectives:

- To increase the production
- To get the production in off season
- To earn higher income

The experiments were carried out in kharief season in a Randomized Block Design under the normal intensity factors of a production in the agroclimatic condition prevailing at Bhubaneswar. Results of the investigation provided information of paramount significance both from the view point of academic as well as practical significance which are summarized as follows:

1. The maximum number of branches per plant (9.75), number of pickings (3.93), average length of vine (3.25 m), average number of leaves per vine (26.93) and leaf area (451.17 cm<sup>2</sup>) were measured in glass house followed by poly house.
2. Among the various protected structures, the least number of days to first flowering was recorded in glass house (37.60) followed by poly house (38.68) and Among the various cultivars, least number of days required for first flower initiation was recorded in cultivar Avinash (41.80) followed by Naveen (43.42).
3. Number of fruits per plant (19.17) weight of fruits per plant (3.98 kg) and average fruit length (3.52 cm) were recorded maximum in glass house. Among different cultivars the maximum number of fruits per plant (20.44) and highest fruit weight (137.98 g) was obtained in cultivar Avinash. The significantly higher yield was recorded in cultivar Avinash (11.05 kg/ square meter) followed by Naveen (9.28 kg per square meter).
4. Maximum net return and B: C ratio was found with Avinash (40145` per 500 sq m) and B:C ratio (2.25).
5. Out of the three structure applied, polyhouse proved most effective and increased fruit set and improved physico chemical traits of fruits followed by green net shade. Polyhouse and green net shade proved beneficial in improving the quality of fruits.
6. Pulp content, TSS and ascorbic acid accumulation were also improved favourably by protected structure.

## 5.2 CONCLUSION

Based on the above findings, it could be concluded that tomato should be grown during *khariif* season out of the three protected structures *viz.* glass house, poly house and net house, the poly house (naturally ventilated) was found to be statistically better to obtain the maximum B:C ratio (2.18) and net returns (35821 ` per 500 sq m).

The cultivar Avinash was found superior to obtained the good quality of fruits and it was also produced the higher net returns (40145` per 500 sq m) and B:C ratio (2.25).

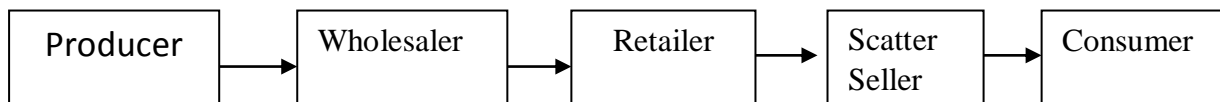
Protected cultivation is most suitable technology for cultivation of tomato for year around production to get maximum benefit. This technology generates more profit and suitable for women as it is less drudgery prone activity. By this method farmers can cultivate high value vegetables particularly during lean period when open field cultivation is difficult. We can also cultivate foreign vegetables by this method and get these vegetables in our country at lower price. It may be concluded that protected cultivation technology suitable for higher production and improve economic status of the farmers.

### 5.3 Problems faced by the farmers in marketing and suggestions

As we are very well know that our farmers are not getting proper amount for their produces due to involvement of more number of middlemen in the distribution channel and the lacking of proper marketing.

#### Current flow of product from farmer to consumer

Normally the farmers sell their products to the wholesaler then they sell it to various retailers then it goes to scatter seller then finally to consumer. Due to this long process the prices of the product increase step by step simultaneously the wastage of the products is more and the final consumer gets the product in a very higher price. But the producer/farmer doesn't get his actual benefit of his product.



Secondly, the retail shops like Reliance Fresh and Udayn Fresh Mother Dairy purchase the products from the farmers directly as per their demand and then they sell it to the consumer. Involvement of middle man in this channel is less and wastage of products is also less. Post harvest activities like cleaning, shorting, grading and packaging of vegetables according to their variety, shape, size and weight are done by them to reduce the losses.



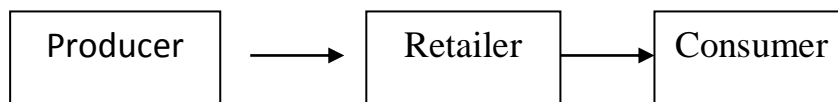
Presently Vegekart a new system has been introduced by the Directorate of Horticulture Department, Govt. of Orissa for smooth functioning of market channel. In this system there is no more middle. The procurement officer of the directorate procures vegetables from the growers/farmers. Post harvest operations like cleaning, shorting, grading and packaging of vegetables according to their variety, shape, size and weight are performed by them. Here people get good product in a very good manner.

## New Business Idea

The farmers should be contacted to the retail shops, big hotels and restaurants in well advance for selling their produces. So that farmers can receive order from the retail shops, big hotels, restaurants and other marketing agencies and produce according to their demand and sell to them. In this channel farmer assures their products for marketing without difficulty.

When he received the demand, quantity and time for distribution accordingly to that he will produce the product. So that he can avoid over production and he will able to deliver his product at right time in right quantity.

It will be better if the product can reach at the door step of the consumer or nearer to the consumer because now day's people can pay high price for the product but they can't afford the time due to their busy schedule. So there should be a proper marketing channel, where the middleman involvement is also very less by which the grower can get proper amount for his product and the customer can get good quality product.



It is really a very good channel from every angle that is from farmers, retailer and the consumer. Here the farmer produces according to the order received from the retailer so that farmers produce as per demand. And it is known to him that how much he has to produce and when to produce that means the time and the quantity is predetermined. And the retailer can add some more value to the product by shorting, grading and packaging according to their variety, shape, size and quantity. And after that he can sell it to the consumer.

## 5.4 PHOTOS



**Tomato Under protected cultivation**



**Polly House**



**Green House**

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