STRAWBERRY

1. INTRODUCTION

Strawberry (*Fragaria vesca*) is an important fruit crop of India and its commercial production is possible in temperate and sub-tropical areas of the country.

2. OBJECTIVE

The main objective of this report is to present a bankable one-acre model for high quality commercial cultivation of the crop.

3. BACKGROUND

3.1 Area & Production

Strawberry is cultivated in Himachal Pradesh, Uttar Pradesh, Maharashtra, West Bengal, Delhi, Haryana, Punjab and Rajasthan. Sub-tropical areas in Jammu have also the potential to grow the crop under irrigated condition.

Estimates of area and production of the crop are not available.

3.2 Economic Importance

Strawberry is rich in Vitamin C and iron. Some varieties viz. Olympus, Hood & Shuksan having high flavour and bright red colour are suitable for ice-cream making. Other varieties like Midway, Midland, Cardinal, Hood, Redchief and Beauty are ideal for processing.

4. MARKET ANALYSIS AND STRATEGY

4.1 Export/Import Trends

India exports strawberry mainly to Austria, Bangladesh, Germany, Jordan & U.S.A.

The trend in export of strawberry from India during the period 1999-2000 to 2001-02 is given in ***Graph 1*** and country-wise exports during 2000-02 in ***Table-1***.

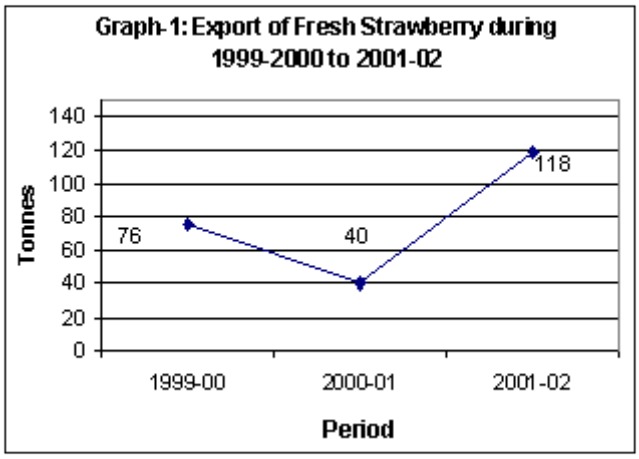

Table-1 : Country-wise export of fresh strawberries from India during 2001-02.

Country	**Quantity (Tonnes)**	**Value (Rs. in lakhs)**
Austria	4.82	6.65
Bangladesh	110.50	4.88
Germany	0.01	0.005
Jordan	0.25	0.39
U.S.A.	1.96	0.81
Total	**117.55**	**12.74**

Source : APEDA, New Delhi

4.2 Analysis and Future Strategy

Strawberry has advantages of easy propogation, early maturity and high yield with 5-9% sugar. To boost its production there is a need to develop infra-structure facilities for transport of produce to primary markets as the fruit is highly perishable. Processing facilities in the major producing states have to be made for value addition.

5. PRODUCTION TECHNOLOGY

5.1 Agro-climatic requirements

Strawberry grows well under temperate climate. Some cultivars can be grown in sub-tropical climate. Daylight period of 12 hrs. or less and moderate temperature are important for flower-bud formation. Each cultivar has a different day length and temperature requirement.

Sandy loam to loamy soil with pH 5.7-6.5 is ideal for cultivation.

5.2 Varieties Cultivated

Important strawberry varieties cultivated in India are Chandler, Tioga, Torrey, Selva, Belrubi, Fern and Pajaro. Other varieties include Premier, Red cost, Local Jeolikot, Dilpasand, Bangalore, Florida 90, Katrain Sweet, Pusa Early Dwarf & Blakemore.

5.3 Land Preparation

The soil is ploughed during summer with a soil turning plough which is followed by repeated ploughing to make soil friable, remove weeds and stubbles. Soil fumigation with a mixture of methyl

bromide and chloropicrin helps to increase root system, reduce fertilizer requirement and control the weeds.

5.4 Planting

5.4.1 Planting Material

Strawberry is commercially propagated by runner plants. For large scale propagation of virus free plants, tissue culture is widely used.

5.4.2 Planting Season

The ideal time of planting runners or crowns in hilly areas is September-October. If the planting is done too early, plants lack vigour and result in low yield and quality of fruits. If planted very late, runners develop in March and crops are light.

Runners are uprooted from nursery, made into bundles and planted in the field. These can be kept in cold storage before transplanting.

The soil should be frequently irrigated to reduce water stress in the leaf. Defoliation suppresses the plant growth, delays fruiting and reduces yield & quality.

5.4.3 Spacing

Planting distance varies according to variety & type of land. A spacing of 30 cm. x 60 cm. is usually followed. In the model scheme, a spacing of 30 cm. x 30 cm. with a population of 22,000 plants per acre has been considered which was commonly observed in areas covered during a field study.

5.5 Nutrition

A fertilizer dose of 25-50 tonnes farmyard manure, 75-100 kg. N, 40-120 kg. P_2O_5, 40-80 kg. K_2O/ha. may be applied according to soil type and variety planted.

5.6 Irrigation

Strawberry being a shallow-rooted plant requires more frequent but less amount of water in each irrigation. Excessive irrigation results in growth of leaves and stolons at the expense of fruits & flowers and also increases the incidence of Botrytis rot.

Irrigation is applied in furrows between the rows. Trickle and sprinkler irrigation systems are becoming popular nowadays. In case of trickle irrigation, 30% water and energy are saved.

5.7 Training

Four different types of training systems viz. matted row, spaced row, hill and plastic mulch are used to train the strawberry plants. Usually matted row system is followed in India.

5.8 Intercultural Operations

The field is kept weed free during the first season by harrowing & ploughing, applying herbicides or plastic sheet. Inter-cultural practices are continued till the straw mulch is applied.

5.9 Growth regulators

Application of GA_3 (50 ppm.) sprayed four days after flowering and maleic hydrazide (0.1-0.3%) sprayed after flowering increases the yield by 31-41%. Morphactin (@ 50 ppm.) improves the fruit size.

5.10 Plant Protection Measures

5.10.1 Insect Pests

White grubs, cutworms and hairy caterpillars attack the crop. Areas where strawberries are to be planted should be free from white grubs and cutworms. Application of endosulfan (0.05%) or malathion (0.05%) on appearance of caterpillars has been found to be effective in most cases.

5.10.2 Diseases

Main diseases reported are leaf spot and grey mould. Application of carbendazim / thiophanate methyl has been found to be effective in most cases.

5.10.3 Disorders

Albinism (lack of fruit colour during ripening) is a physiological disorder in strawberry. It is probably caused by certain climatic conditions and extremes in nutrition. Fruits remain irregularly pink or even totally white and sometimes swollen. They have acid taste and become less firm. Albino fruits are often damaged during harvesting and are susceptible to Botrytis infection and decay during storage.

5.11 Harvesting and Yield

Strawberries are generally harvested when half to three fourths of skin develops colour. Depending on the weather conditions, picking is usually done on every second or third day usually in the morning hours. Strawberries are harvested in small trays or baskets. They should be kept in a shady place to avoid damage due to excessive heat in the open field.

Plants start bearing in second year. An average yield of 45-100 q./ha. is obtained from a strawberry orchard. However, an average yield of 175-300 q./ha. may be taken from a well managed orchard.

6. POST HARVEST MANAGEMENT

6.1 Grading

Fruits are graded on the basis of their weight, size and colour.

6.2 Storage

Fruits can be stored in cold storage at 32^0C upto 10 days. For distant marketing, strawberries should be pre-cooled at 4^0C within 2 hrs. of harvesting and kept at the same temperature. After pre-cooling, they are shipped in refrigerated vans.

6.3 Packing

Packing is done according to the grades for long distance markets. Fruits of good quality are packed in perforated cardboard cartons with paper cuttings as cushioning material. Fruits of lower grades are packed in baskets.

6.4 Transportation

Road transport by trucks/lorries is the most convenient mode of transport due to easy approach from orchards to the market.

6.5 Marketing

Majority of the growers sell their produce either through trade agents at village level or commission agents at the market.

7. TECHNOLOGY SOURCES

Major sources for technology:

(i) Dr. Yashwant Singh Parmar University of Horticulture & Forestry, Solan, Nauni-173230, Himachal Pradesh.

(ii) Directorate of Horticulture, Shivajinagar, Pune, Maharashtra-560003.

8. ECONOMICS OF A ONE ACRE MODEL

8.1 High quality commercial cultivation of crop by using high quality planting material and drip irrigation leads to multiple benefits viz.

- Synchronized growth, flowering and harvesting;
- Reduction in variation of off-type and non-fruit plants;
- Improved fruit quality;

Costs & Returns

8.2 A one acre plantation of the crop is a viable proposition. Project cost of the model, along with the basis for costing are exhibited in ***Annexures I & II***. A summary of the project cost is given in the table below.

Cost Components of a One Acre Model Strawberry Plantation

(Amount in Rs.)

Sl. No.	Component	Proposed Expenditure
1.	**Cultivation Expenses**	
	(i) Cost of planting material	200000
	(ii) Fertilizers & Pestsicides	11000
	(iii) Mulching	12400
	(iv) Cost of Labour	14400
	(v) Others, if any, (Power)	3600
	Sub Total	**241000**
2.	**Irrigation**	
	(i) Tube-well/submersible pump	50000
	(ii) Cost of Pipeline	-
	(iii) Others, if any	-
	Sub Total	**50000**
3.	**Cost of Drip (Turboline) with Fertigation**	**40000**
4.	**Infrastructure**	
	(i) Store & Pump House	20000
	(ii) Labour room	10000
	(iii) Agriculture Equipments & Implements	5000
	(iii) Others, if any, please specify	-
	Sub Total	**35000**
5.	**Land Development**	
	(i) Soil leveling	4000
	(ii) Digging	-
	(iii) Fencing	29600
	(iv) Others, if any, please specify	-
	Sub Total	**33600**
	Grand Total	**4,00,000**

N.B: Cost of land, if newly purchased, can be included in the project. This will be limited to 10% of the total project cost.

8.3 The major components of the model are:

· Land Development: (Rs. 4.0 thousand): This is the labour cost of shaping and dressing the land site.

· Fencing (Rs. 29.6 thousand): It is necessary to safeguard the orchard by a barbed wire fencing.

· Irrigation Infra-structure (Rs. 50.0 thousand)**:** For effective working with drip irrigation system, it is necessary to install a tube-well with diesel/electric pumpset and submersible motor. This is post cost of tube-well for one acre.

· Drip Irrigation (Rs. 40.0 thousand): This is average cost of one acre drip system for the crop inclusive of the cost of fertigation equipment. The actual cost will vary depending on location, plant population and plot geometry.

· Implements & Equipment (Rs. 5.0 thousand): For investment on improved manually/power operated essential implements and equipment.

· Building Infrastructure (Rs. 30.0 thousand): A one acre orchard would require minimally a labour shed and a store-cum - pump house and a labour shed.

· Cost of Cultivation (Rs.2.41 lakhs): Land preparation and planting operations and cultural practices will involve 206 days of manual labour, the cost of which will come to Rs.14.40 thousand. The cost of planting material works out to Rs.2.00 lakhs for 25000 plants @ Rs.8 per plant.

8.4 Labour cost has been put at an average of Rs.70 per man-day. The actual cost will vary from location to location depending upon minimum wage levels or prevailing wage levels for skilled and unskilled labour.

8.5 Recurring Production Cost: Recurring production costs are exhibited in ***Annexure III***. The main components are planting material, land preparation, inputs application (FYM, fertilizers, micro-nutrients liming material, plant protection chemicals etc.), power and labour on application of inputs, inter-cultural and other farm operations.

8.6 Returns from the Project: The strawberry is short duration crop. The crop planted in September-October starts going yield in May-June. It continues to give yield upto 3rd year thereafter it needs re-planted. Average yield of strawberry is 8 tonnes/acre with good management. The average sale rate is Rs.40,000 per tonne. Thus gross return works out to Rs.3.20 lakhs per acre/annum. ***(Vide Annexure-III).***

Project Financing

8.7 Balance Sheet: The projected balance sheet of the model is given at **Annexure IV**. There would be three sources of financing the project as below:

Source	**Rs. Thousand**
Farmer's share (50%)	200.00
Capital subsidy (20%)	80.00
Term loan (30%)	120.00
Total	**400.00**

8.8 Profit & Loss Account: The cash flow statement may be seen in ***Annexure V***. ***Annexure VI*** projects the profit and loss account of the model. Annual gross profit works out to around Rs.184.70 per acre.

8.9 Repayment of Term Loan: The term loan will be repaid in eleven equated 6 monthly installments of Rs.10.91 thousand with a moratorium of 12 months. The rate of interest would have to be negotiated with the financing bank. It has been put at 12% in the model (vide ***Annexures VII & VII A)***.

8.10 ***Annexure VIII*** gives depreciation calculations.

Project Viability:

8.11 IRR/BCR: The viability of the project is assessed in ***Annexure IX.*** The IRR works out to 45.07 and the BCR to 1.1.

8.12 The Debt Service coverage ratio calculations are presented in ***Annexure X***. The average DSCR works out to 8.0.

8.13 Payback Period: On the basis of costs and returns of the model, the pay back period is estimated at 2.31 years (***vide Annexure XI***).

8.14 Break-even Point**:** The break even point will be reached in the third year. At this point fixed cost would work out to 51.3% of gross sales (***vide Annexure XII)***.

Introduction

Skip to Introduction

Leaf Scorch is the most common leaf disease in matted row systems in North Carolina but rarely occurs in annual production systems. The pathogen can survive and cause disease at a wide range of temperatures, and has been reported to cause disease year-round on perennial crops. Replanting frequently is recommended in these systems since the disease usually is not severe the first or second year after planting. Because of this, leaf scorch is not a major problem in annual systems.

Symptoms and Signs

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Leaf scorch symptoms are very similar to the early stages of common (*Mycosphaerella*) leaf spot, with irregular dark purple spots being scattered over the upper leaf surface. As the spots enlarge, they begin to look like drops of tar, and are actually the accumulations of black fruiting bodies (acervuli) of the fungus. The centers of the spots remain purple (in Mycosphaerella leaf spot they are white) and there is no well-defined lesion border. In heavy infections, these regions coalesce and the tissue between the lesions often takes on a purplish to bright red color that is dependent on cultivar, temperature, or other factors. The leaves eventually turn brown, dry up, and curl at the margins giving the leaf a scorched appearance. Examination of the acervuli and conidial morphology can help to distinguish between leaf spot and leaf scorch at this advanced stage of disease. On the upper leaf surfaces of leaf scorch lesions, the acervuli are dark with glistening spore masses and dark apothecia. Petiole lesions are elongate, sunken, with a purplish to brown color and can kill the leaf by girdling the petiole. Runners, fruit stalks, fruit and caps can also become infected. Plants may become weakened and the number and vigor of crowns reduced. Infection predisposes the plants to winter and drought stress. In severe infestations, flowers and fruit may die. Overall, there can be a serious reduction in yield in matted row systems. It has not been observed as a yield-reducing problem in annual production systems.

Figure SS-1: Leaf scorch lesions on strawberry leaves from a plug production facility. Note the upward curling of leaf margins.

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Disease Cycle

Skip to Disease Cycle

In annual production systems, the disease can come on transplants or tips and build up in the plug production phase in the early fall in the field. However, the pathogen does not cause damage the following spring. In the matted row system, the population can build up to damaging levels. Spores are produced in the spring and midsummer on lower leaf surfaces of dead leaves infected in the previous year, and are spread by wind and splashing rain. Disease increase is favored by leaf wetness during warm weather (68-86°F), and is likely to become more significant on older plantings of susceptible varieties. One ascospore generation (the starting sproes) and several overlapping generations of conidia (spores) are produced every year. Apothecia, a small mushroom-like structure, generally form on infected leaves in the fall and forcibly discharge ascospores, which are wind dispersed, in the springtime. Acervuli are found throughout the season in lesions or on residue of the foliage. Under dry conditions the acervuli can go into dormancy, but once moist conditions return, they again become active and exude conidia in a sticky mass. The conidia are disseminated to new infection sites where they directly penetrate and grow intercellularly.

Management

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In matted row or perennial strawberry systems, select a planting site with good air drainage and sun exposure. Cultivars resistant to leaf scorch may be available and need to be evaluated for specific horticultural characteristics. Plant new transplants frequently, and allow adequate spacing between

them to increase airflow. Control weeds. Avoid amendment with supplemental nitrogen in spring, as this may enhance disease. Keep moisture levels down and avoid long wetness periods by monitoring irrigation schedules; if possible, use drip irrigation rather than overhead. Remove foliage and crop residues after picking or at renovation to remove inoculum and delay disease increase in late summer and fall. Fungicide treatments are effective during the flowering period, and during late summer and fall.

In annual plasticulture production systems, the disease has not been observed to cause economic damage in fruiting fields and generally does not require action. Although symptoms may be on plants at the time of planting or soon after, the levels of disease are typically low and do not persist into the spring. In plug production facilities, high disease levels may affect the look of the plants and this decreased aesthetic value may impact sales. See our *Strawberry IPM Guide* at for current recommendations.

Pathogen

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Leaf Scorch (*Diplocarpon earlianum* (Ellis and Everh.) F. A. Wolf teleomorph; *Marssonina fragariae* (Lib.) Kleb.)

Diplocarpon earlianum is a fungus that causes leaf scorch, one of the most common leaf diseases of strawberry. This ascomycete produces disk-shaped, dark brown to black apothecia (0.25-1 mm) on advanced-stage lesions on strawberry leaves and leaf residues (Heidenreich and Turechek). Mature apothecia contain asci interspersed with unbranched capitate paraphyses. Asci (55-90 x 15-20 µm) are oblong-cylindrical, short-stalked, and contain 8 spores each. Ascospores (18-28 x 4-6 µm) are hyaline, two-celled, and slightly constricted at the septum (Sutton, 1998).

The anamorph of *D. earlianum, Marssonina fragariae*, produces conidia in dark brown to black acervuli (100-200 µm) on infected leaves (Figure P-1). The conidia (18-30 x 5-7 µm) are hyaline, two-celled, and constricted at the septum (Figure P-2). The distal cell of the conidium is often larger and curved (Sutton, 1998). The host range of *D. earlianum* and it's anamorpic stage is limited to species and cultivars of *Fragaria*.

Figure P-1: Disk shaped acervuli of the pathogen formed on plug plant leaves.

Matt Bertone

Figure P-2: Hyaline, two-celled, conidia of the anamorph state of D. earlianum. Note the larger, curved distal cell of each conidium.

Frank J. Louws

Diagnostic Procedures

Skip to Diagnostic Procedures

Symptoms of leaf scorch may be confused with those of powdery mildew caused by *Podosphaera aphanis*. As with leaf scorch, powdery mildew infection causes the upward curling of the strawberry leaf edges and the development of purple spots on leaves that are variable in size, from specks to larger spots. *D. earlianum* can be distinguished from *P. aphanis* by the presence of black acervuli with glistening spore masses and the absence of mycelium growing on the abaxial leaf surface.

Symptoms of leaf scorch caused by *D. earlianum* are indistinguishable from those caused by another fungus, *Marssonina canadensis*. Conidia of *M. canadensis* measure 31-44 x 5-8 µm (Sutton, 1998).

If fruiting structures of the pathogen are not present on affected plants, individual leaves or leaflets may be incubated in a moist chamber for 24-48 hours to induce sporulation.

References

Skip to References

Heidenreich, C., and Turechek, B. *Strawberry Leaf Scorch*. Cornell University Extension.

Sutton, J. C. 1998. Leaf Scorch. Pp. 19-20 in: Compendium of Strawberry Diseases, 2nd edition, Maas, J. L. (ed.). APS Press. St. Paul, MN.