Intermediate Vocational Course
First Year (Theory Paper-II)

Mulberry Farm Maintenance
for the Course of Sericulture

State Institute of Vocational Education
Directorate of Intermediate Education
Govt. of Andhra Pradesh,
HYDERBAD

and

Board of Intermediate Education
Govt. of Andhra Pradesh,
HYDERBAD
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AUTHORS

K. SATYANARAYANA
M.Sc. (Seri) PGDS
Junior Lecturer in Sericulture
G.J.C. (B) Dharmavaram

P. VENGANNA
M.Sc. PGDS
Junior Lecturer in Sericulture
G.J.C. Nandikotkur, Kurnool

EDITOR

Dr. P. SRINIVAS
M.Sc., B.Ed., Ph.D., PGDCMP,
CYP-PGDYDW
Junior Lecturer in Zoology (Sericulture)
Govt. Pingle Junior College for Girls
Waddepally, Hanamkonda-506 370.
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Farm Maintenance

1.1 Introduction

Indian farmers are confined to small scale (2-3 acres) agriculture. Most of the farmers are confined to traditional methods only. This is continuously reducing the crop yield. Further management practices are developed for individual crops and recommendations are made for individual crops, without considering residual effects. This approach has failed to utilize the resources efficiently. One should not forget that land is a unit but not a crop and management practices should be for all crops that are to be grown on the particular land. Thus adoption of scientific, technical methods improves farm products. The farm of a farmer includes the cultivable land, livestock, implements etc. The farm products depend on rainfall or irrigated water, soil structure, utilization of fertilizers, cropping pattern, besides farm management. Farming systems represent an appropriate combination of farm enterprises. These enterprises are interrelated. The end products and wastes of one enterprise are used as inputs in others and thus generate profits to the farmer. The complete crop product, techniques and other methods followed to produce are called farm system. In agriculture farm types and systems are different. The farm enterprises interact with environment without dislocating the ecological and socioeconomic balance.

Farm management deals with the organization and operation of a farm with the objective of maximizing profits from the farm on a contributing basis. It is necessary to adjust farm organization from year to year. Thus it is the science which deals with the analysis of the farming resources, alternatives, choices and opportunities within the framework of resource restrictions and social and personal constraints of the farming business. This information is integrated and synthesized to increase profitability of the farming business and to raise the standard of living of the farming people.

1.2 Systems of Farming

Farming system represents proper combination of farm enterprises viz., cropping system, livestock, poultry, fisheries, forestry and the means
available to the farmer to raise them for increasing profitability. Cropping system is an important part of a farming system. It represents cropping patterns used on a farm and their interaction with farm resources, other farm enterprises and available technology which determine their make up. But the goal in farming is not to make a profit on some single enterprise or from a part of the farm land, but to use land, labour and capital resources in such a way that they make the greatest contribution to the total profits from the entire farm. Farm management helps to identify uneconomical practices and most limiting factors. Farmer as businessman should know (i) how to produce more (ii) how to reduce the cost of production (iii) how to secure high prices for his products to get more returns by utilizing the resources viz., land, labour, capital, managerial ability. Normally the bigger the farm, the greater are the advantages it will have, as on such a farm, capital and labour are most efficiently used and overhead expenses are kept low.

1.2.1 Different Types of Farms

The farms are classified on the basis of income and enterprise.

a) Specialized Farm

The income is generated from only one institution to a range of 50 per cent or more.

b) Simple or Diversified farm

In this type one farm can not produce 50 per cent income.

c) Mixed Farm

It is a farming on a particular farm which includes crop production, raising livestock, poultry, fisheries, bee keeping etc.

d) Ranching

There is no cultivation practice and no crop yield. But naturally grown grass it is utilized to rear cattle.
e) **Dry farming**

In this crops are grown entirely under rainfed conditions. It is cultivation of crops in areas where rainfall is less than 750mm per annum. There is no irrigation in this farming. Crop failures are more frequent. Prolonged dry spells during crop period are most common. Mulberry is utilized under rainfed conditions.

1.2.2 **Farm Systems**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>System</th>
<th>Management</th>
<th>Cultivation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Co-operative Farm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>a.</td>
<td>Good cooperative farm</td>
<td>Individual</td>
<td>Individual</td>
</tr>
<tr>
<td>b.</td>
<td>Co-operative working together</td>
<td>Individual</td>
<td>Together</td>
</tr>
<tr>
<td>c.</td>
<td>Co-operative rented farm</td>
<td>Together</td>
<td>Individual</td>
</tr>
<tr>
<td>d.</td>
<td>Co-operative collective farm</td>
<td>Together</td>
<td>Together</td>
</tr>
<tr>
<td>2.</td>
<td>Collective Farm</td>
<td>Society/State</td>
<td>Society/State</td>
</tr>
<tr>
<td>3.</td>
<td>State Farm</td>
<td>State</td>
<td>Management with salary</td>
</tr>
<tr>
<td>4.</td>
<td>Villager Farm</td>
<td>Individual / Manager</td>
<td>Own</td>
</tr>
<tr>
<td>5.</td>
<td>Capitalist Farm</td>
<td>Own</td>
<td>Own</td>
</tr>
</tbody>
</table>

These are classified basing on management.

Mulberry is grown in rainfed and irrigated farms. In rainfed or dry farming the mulberry leaf production and finally cocoon production depends upon rain. Due to insufficient rain the soil lacks water. Further mulberry cultivation is not encouraging because rainfall is confined to June - October only. However mulberry is cultivated like other crop utilized irrigation. Further the varieties are perennial and drought resistant. The rainfed mulberry cultivation in South India contributes 2/3 parts. Instead of large scale mulberry farming it is better to adopt one hectare farm for better crop yield by adopting good managerial methods. The mulberry leaf production increases enormously in irrigated condition. Not only this there are too
many high yielding hybrid varieties. Good irrigation, manures, intercultivation, pruning methods can yield 15000-35000 kg mulberry leaf per hectare.

1.3 Labour Management

Farm work is of a different type than factory work. The nature of work depends upon the season. There cannot be fixed hours. There is no guaranteed work all the year round to every one. Unlike urban industries, there is no standardization and specialization of work. The labour of farm consists of farmer's own labour, his family labour and hired labour. The Indian farmer is himself a farm manager and a labourer. Further his family members are also engaged on his own farm, where wages are not paid. This free labour is called as labour income of the farmer. The hired labour may be permanent, temporary, casual labour and contract labour. The permanent labour are generally equal to the number of bullock pairs on the farm. The women permanent labour stay on the farm and the farmer can employ them wherever needed. Further these are given preference over the casual labourers who are engaged on daily wages for various seasonal operations. Sometimes seasonal operations like weeding, harvesting, land development work like digging of pits or channels, construction of bunds etc., are carried out by engaging contract labour. Contract labour work fast to earn more wages and farmer has to see only standard and quality of work, doesn't need any supervision. Certain agricultural practices like sowing, transplanting, harvesting have shortage of labour and wages also go up considerably. During unseason plenty of labour are available. At such times, works like bunding, farm development, roads, drain are to be taken up.

1.3.1 Characters of Indian Labour

1. There is no work throughout the year.

2. Generally work is available for only 140-190 days per year. This is still less in case of family labour.

3. Wage problems arise because of low production in the farm.
4 Lack of workmanship labour association and thus labour life is at low level.

1.3.2 Classification of Labour

It is of two types basing on wages.

1 Free labour

It includes farmer, his family members who work without wages. This is also an income to the farmer and doesn't require any supervision.

2 Wage labour

In this permanent, temporary, casual and contract labour are included. Some of these labour are familiar with farm techniques and some doesn't require it.

1.3.3 Wages

The wages are of three types. The wages are based on time, place, capital share. According to "Wage Regulation and Minimum Wages Act, 1948" the labour wages are to be decided on the basis of physical status of labour, concentration in the work, utilization of implements, type of implements, natural conditions i.e., cold, rain, temperature, the technical knowledge of the labour.

1.3.4 Labour Efficiency

Labour efficiency is the amount of productive work done on the farm per labour. It may be measured in many ways. In India, since the labour is not always fully engaged, the labour efficiency is judged on the basis of manwork units required for different kinds of operations. The labour efficiency largely depends on the labour himself i.e., healthy, capacity to work, experience, skill and interest. Other factors like tools, equipment and implements handled by him, health of bullocks, season, size of fields, fertility and general condition of the field also effect the efficiency of labour.
1.3.5 Measures in Labour Management

1. Farm efficiency can be improved by fulfilling the needs of labour. Employer should take care of proper wage payments, health supervision, children protection.

2. Prepare a calendar dependency on season, crop to engage labour. Labour are engaged depending on the cultivation practice. The employer should think properly before implementing.

3. Family members are engaged when there is no work. Labour are not kept idle. If there is no work in the farm, they are engaged in other way to repair implements, to clean the farm house, to look after farm animals.

4. During rainy days waged labour are engaged only when required.

5. Selection of crop, cropping methods, utilization of farm animals reduces the labour.

6. Manager must be efficient to utilize the labour in a proper way.

7. Usage of efficient implements and machinery and proper attention to their repairs and servicing is also important.

8. Daily working hours are adjusted as per season i.e., in summer season, start the work very early, while in winter it may be started late.

9. Specialized labourers are employed from such communities who are known for their expertise and efficient work.

10. Beside this efficiency of labour depends on proper farm management, supervision, training to labour, to provide all facilities, selection of good implements, incentive wages, to keep on certain standards to each and every farm work, regular payment of wages, to finish the work in proper time.
The qualities of farm manager also add to the efficiency of labour. The qualities such as personal knowledge of the work, his personal influence and tact, appreciation of labourers’ work, not having frequent changes in work, firm but sympathetic or considerable attitude towards the labourers help in getting better output from the labourers. One should remember that a labourer is not a machine but a human being and proper human approach is necessary. A farm manager should remember that a highly paid efficient labourer is cheaper for hard or intelligent work, while a low paid inefficient labourer is in fact costly for such items of work.

1.4 Farm Records

These records are necessary to manage the farm well. It helps the manager to know whether the farm is giving profits or not. These records show certain important facts such as yield of different crops and livestock, the dates of various farm operations, labour details, increase or decrease in capital, annual receipts and expenses from which profits or losses for the different activities and the farm as a whole for the year can be worked out. It will help to locate the weak points in farming practices, and show ways of strengthening them. The farmer can plan the future programme on the facts that have been recorded. He can also work out the cost of cultivation of major crops and think about amendments.

1.4.1 Advantages of Registers

1. It is a base for identification of needs and to implement.
2. To improve the efficiency of farmer.
3. Basis for management, loaning.
4. Acts as a compass for management.
5. Scope for research.
6. Basis to take proper decision.
7. Useful for benefit of farm.
1.4.2 Problems in Maintenance of Registers

1. Small scale farm maintenance.

2. Maintenance becomes a problem because farmer is a labour, manager, owner.

3. Illiteracy is a problem for maintenance. Lack of awareness on business.

4. Complicated agriculture industry.

5. Records are not simple to suit to our country.

6. Fear about taxes.

7. Lack of awareness on registers.

1.4.3 Different Farm Records

Mulberry farm maintenance, silkworm rearing has got much importance in sericulture. The quality of cocoons depends on mulberry leaf quality. The cocoon crop is totally depends upon mulberry crop. Thus mulberry crop is grown with sufficient irrigation, manuring pruning methods, intercultivation, pest management, besides good management skills. The following registers help the farmer to get good crop registers.

It is to find out the yield of leaves in a unit area. The performance of each plot/variety with several treatments can be assessed. The deficiencies observed can be made up by application of suitable dose of manure or fertilizer.

1.4.3.2 Work Register

It is useful in utilization of labour (both men and women) in the maintenance of mulberry garden and several cultural operations. The efficiency of labour can be assessed based on man days utilized for each cultural operation. The work turned out on each day and the work attended to for each plot could be assessed.
1.4.3.3 Nominal Roll

It is for labour strength and also to assess the attendance of each labour. His punctuality and attendance can be checked. The attendance and the work allotted to him is marked by the supervisor every day. The wage earned by each worker is worked out depending on the number of days he worked. It also helps to assess labour performance.

1.4.3.4 Inventory

It is to record information about the implements used, stock of fertilizers and disinfectants and cost of production of mulberry leaves. Stock of fertilizers can be used for timely application. This record also has information on the dosage of manure applied and irrigation provided to a particular plot. The total quantity of mulberry leaves produced and the cost involved on the several inputs have to be worked out and the cost per kilogram of leaves calculated as follows.

\[
\text{Expenditure on inputs} \div \text{Amount of mulberry leaves harvest} = \text{cost per kg of mulberry leaves produced}
\]

1.4.3.5 Meteorological Record

Temperature and rainfall have a great impact on the productivity of mulberry leaves. The daily record of maximum and minimum temperatures and rainfall should be recorded as a ready-reckoner.

**SUMMARY**

- Traditional agriculture farming reduces crop yield.
- Adoption of scientific, technical methods improve farm products.
- Farm management deals with the organization and operation of a farm with the objective of maximizing profits from the farm on a contributory basis.
Farming system represents proper combination of farm enterprises viz., cropping system, livestock, poultry, fisheries, forestry and the means available to the farmer to raise them for increasing profitability.

Farm management helps to identify uneconomical practices and most limiting factors.

The big farm has great advantages.

Farms are classified on the basis of income and enterprise. They are five types.

Farm systems are classified basing on management.

The labour of farm consists of farmer's own labour, his family labour and hired labour.

The permanent labour are generally equal to the number of bullock pairs on the farm.

Labour are classified into free and wage labour.

The wages are three types based on time, place, capital share.

Labour efficiency is the amount of productive work done on the farm per labour.

There are many managerial skills to improve the efficiency of labour.

The quality of farm manager also adds to the efficiency of labour.

One should remember that a labourer is not a machine but a human being and proper human approach is necessary.

Farm records help the manager to know whether the farm is giving profits or not.
There are many advantages of farm records but problems encounter in maintenance.

There are five farm records in mulberry farm which help to improve the efficiency. They are plot, work, nominal roll, inventory and meteorological records.

QUESTIONS

I. Short Questions

1. Mention different types of farms.

2. Mention farm systems.

3. Define labour management.

4. What are the classes in labour?

5. Why farm records are essential to a farmer?

6. Mention different farm records.

7. What is free labour and hired labour?

8. Differentiate permanent and contract labour.

9. What are the characters of Indian labour?

10. How do you improve labour efficiency?

II. Essay Questions

1. Write about labour management in mulberry farm.

2. Write about mulberry farm records.

3. Write about the measures in labour management.
4. Write short notes on
   a) Farm systems  b) Types of farms  c) Farm record uses

5. Write short notes on
   a) Labour wages  b) Problems in maintenance of records

6. Write short notes on
   a) Labour management  b) Classification of Labour  
   c) Labour efficiency
Estimation of Leaf Yield

2.1 Introduction

The quality of mulberry leaf is the backbone of silkworm rearing. It can be considered as a plan for silkworm rearing. The quantity of brushing is determined by annual harvesting of mulberry leaves depending on the area of the mulberry garden, labour force, rearing room and rearing implements. The quantity of mulberry leaves required to rear the larvae differs in the spring and autumn rearing. In spring, the weight of mulberry leaves required for rearing is less compared to summer-autumn rearing. Besides adjusting the quantity of mulberry leaves supplied according to the conditions prevailing outside, the quantity is also changed depending upon the quality of mulberry leaves. For example, if the mulberry leaves are immature and soft, their quantity per feed is decreased to some extent and if hard, the number of feed as well as the quantity per feed increases. If the contents of the mulberry leaves are less and hampers the growth of the silkworm, the suitability or unsuitability of mulberry leaves fed to silkworm larvae greatly affects the rearing. The quantity of mulberry leaf and quantity supplied for rearing are important aspects in sericulture.

The quality of mulberry leaf supports good growth and development of silkworm larvae. Good quality leaves are obtained from mulberry garden grown by adopting optimum agronomic practices like application of manures and fertilizers, timely irrigation, intercultivation, plant protection measures etc. The commencement of rearing should be so timed that bulk of the harvest is made and utilized at the correct stage of leaf maturity which also ensures higher leaf yield. Insufficient quantity of feed does not permit full growth of larvae and survival ability which are important from the point of view of overall cocoon yield and returns. On the other hand, overfeeding is harmful in rearing. Good silkworm rearing emphasizes proper regulation of quantity of leaf to suit different larval instars and the right quantity of feeding. The assessment of these two parameters i.e. quality and quantity are of prime importance in sericulture.
2.2 Methods of Estimation

Leaf estimation is compulsory before brushing of silkworm eggs. One cannot assume the number of DFL’s to be brushed basing on simply observation of field. Once the leaf is estimated it would be easy for sericulturist to calculate the number of layings. If rearing is started without leaf estimation it becomes a problem in late age rearing leading to crop loss. The leaf is estimated 10-12 days prior to brushing of silkworm eggs.

It is a prerequisite to specify plot for assessment of leaf yield. The cultivation system and crop pattern recommended for that system is to be known. The assessment is to be done for all the crops in a year. The sampling for leaf yield estimation is done according to standard principles which are in practice.

I. Expected No. of plants in the mulberry plot

This is to know the expected plant number in the plot.

a. Expected no. of plants in the plot

\[ = \text{standard no. of plants per acre} \times \text{plot size} \]

b. Standard no. of plants/acre

\[ = \frac{43560 \text{ sq.ft.}}{\text{Plant spacing sq. ft.}} = \text{Expected number} \]

Example: In 2'x2' system cultivation

\[ = \frac{43560}{2'x2'} = 10890 \]
10890 plants are there in one acre

When the selected plot area is 0.8 acre

The no. of plants = 10890 X 0.8 = 8712 plants

Thus in selected plot the expected plants are 8712.

II. Plant density in selected plot

Observe fail pit percentage, based on actual count of plants in an expected 200 plants unit area.

\[ \text{ fail pit percentage} = \left( \frac{\text{actual no of plants}}{\text{expected no. (200)}} \right) \times 100 \]

If the number is 150 instead of 200

\[ = \left( \frac{150}{200} \right) \times 100 = 75\% \]

III. Actual No. of Plants in the plot

It is estimated when the plot area is 0.8 acre.

\[ = \frac{\text{expected no. of plants} \times \text{plant density}}{100} \]

IV. Leaf yield/plant
This is estimated depending on the system of cultivation. In shoot system harvest, the leaf yield is assessed based on observation of three plants. These three plants are actually pruned and leaves are separated.

Then leaf yield is estimated as

\[
\text{Leaf yield per plant} = \frac{\text{weight of leaf alone (kg)}}{\text{no. of plants harvested}}
\]

When the total leaf weight is 0.390 kg in three plants

\[
\text{The single plant leaf production} = \frac{0.390}{3} = 0.130 \text{ kg}
\]

Therefore the estimated leaf yield for the entire plot is calculated using actual No. of plants and leaf yield per plant. It is as follows.

\[
\text{Leaf yield in entire plot} = \text{actual No. of plants x leaf yield}
\]

\[
= 6534 \times 0.130 \text{ kg} = 849.42 \text{ kg}
\]

= 850 kg leaf.

In leaf harvest system the leaf yield per plant is estimated as leaf harvest from three plants as detailed above.

Therefore the leaf yield per entire plant and entire plot is calculated as in earlier case.

V. Expected increase in leaf yield
Generally the leaf yield increases than expected by the time the field is utilized for silkworm rearing. Assessment of leaves during brushing period is done for nearly 10-12 days and from brushing to peak utilization it is done nearly for 20 days. Therefore nearly 30 days expected growth and increase in leaf yield should be considered in estimating the leaf yield at the peak period. If the leaf yield assessment is done on the 30\textsuperscript{th} or 35\textsuperscript{th} day of pruning or the last harvest, it is expected to double in another equal period. The peak leaf yield is therefore assessed by doubling the estimated leaf yield on the 30\textsuperscript{th} or 35\textsuperscript{th} day of pruning or the last harvest, it is expected to double in another equal period. The peak leaf yield is therefore assessed by doubling the estimated leaf yield on the 30\textsuperscript{th} or 35\textsuperscript{th} day of growth.

\[
\text{Leaf yield} \times \text{actual No. of plants} \times 2
\]

\[= 0.130 \times 6534 \times 2 = 1700\text{kg leaf per 0.98 acre area of field.}\]

\textbf{2.2.1 Model problem-I}

Venkaiah has cultivated 1.2 acre mulberry where 3’x3’ spacing is adopted. The actual number of plants are only 130. What would be the leaf yield? When the leaf weight of three plants is 0.400kg.

\[
\frac{\text{Standard number of plants per acre}}{\text{plant spacing}}
\]
\[
\frac{43560 \text{ sq. ft.}}{3 \times 3} = 4840 \text{ plants/acre}
\]

Venkaiah plot area is 1.2 acre

:. No. of plants = 4840 X 1.2 = 5808 plants

In 1.2 acre area 58.8 plants are expected

Failed pits per cent based on actual count of plants in an expected 200 plants unit area.

\[
\frac{130 \times 100}{200} = 65\% \text{ plant density percentage}
\]

Actual no. of plants in 1.2 acre area are therefore

\[
\text{Leaf yield per plant} = \frac{\text{weight of leaf (kg)}}{\text{no. of plants harvested}}
\]
leaf yield per entire plot - actual no. of plants x leaf yield

\[ = 3775 \times 0.133 = 5.207 \text{ kg.} \]

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Particulars</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Expected increase of leaf yield = leaf yield x actual no. of plants x 2</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Cultivation System</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Rainfed/Irrigated</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Season</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Date of last leaf harvest</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Date of assessment</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Crop age on assessing day (days)</td>
<td></td>
</tr>
<tr>
<td>7.</td>
<td>Area of mulberry plot</td>
<td></td>
</tr>
<tr>
<td>8.</td>
<td>Standard No. of plants present</td>
<td>3560 sq.ft.</td>
</tr>
<tr>
<td>9.</td>
<td>Fail pit percentage</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>Actual no. of plants present</td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>Average leaf yield per plant</td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>Estimated leaf yield in the plot on assessment day (Kg)</td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>Predicted leaf yield in the plot on peak growth stage</td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>It is necessary to note the information, crop-wise or season-wise separately</td>
<td></td>
</tr>
<tr>
<td></td>
<td>in the following sheet;</td>
<td></td>
</tr>
<tr>
<td>15.</td>
<td>Observation Sheet</td>
<td></td>
</tr>
</tbody>
</table>
SUMMARY

- The quality and quantity of mulberry leaf is essential in sericulture.

- The suitability or unsuitability of mulberry leaves fed to silkworm larvae greatly affects the rearing.

- The quality of leaf supports growth and development of silkworm larvae and finally has a greater impact on quality and quantity of cocoons produced.
Leaf estimation is compulsory before brushing of silkworm eggs.

Rearing without leaf estimation causes lot of problems during rearing especially in the late age leading to crop failure.

Leaf is to be estimated 10-12 days before brushing.

The plot area, plant spacing, actual no.of plants based an count, leaf yield per plant are essential to calculate the leaf yield per given acres of area.

Basing on leaf yield the no.of dfl’s are estimated for silkworm rearing

QUESTIONS

I. Short Questions

1. When do you do leaf estimation ?

2. How leaf estimation is essential in sericulture ?

3. What is the principle to find out leaf yield/plant ?

4. What are the chief contents of observation sheet while leaf estimation?

II. Essay Questions


2. Estimate leaf yield on the following values

   plot size 0.6 acres; spacing 3’x3’ : actual plants 135:

   Weight of leaf in 3 plants 0.410kg.

3. Estimate leaf yield on the following values plot size 1 acre:

   spacing 2’x2’ actual plants 165
3 Economics

3.1 Introduction

Economics gives an idea of the margins of profits and loss related to entrepreneurship. Every crop has its own economics. One has to know economics of any farm before establishing the farm. It has different angles which reflect on the net returns. Sometimes it may lead to loss if one has no idea about expenditure, cost of production, mainly input expenditure and cash returns. It indicates the difference between investment and profits. Generally profits indicate the success of the farm. The economic status decides the fate of farm. One can be sure of getting good profits unless he is sure of managing different activities in the farm or business. Any farmer is of the view to select a crop, that generates more profits than the investment. Every businessman and farmer or any entrepreneur thinks to find an approach to earn more within a short period. He wants to invest less in the farm of physical labour, time, money etc., and tries to generate more. It requires efficient management of human resources, natural resources. An efficient entrepreneur identifies unnecessary activities which hamper the functioning of farm. Further he views every aspect with a positive approach. However there is difference in management for small and big commercial crops.

Each and every aspect of cultivation has its own effect on the crop yield. The cultivator should possess proper knowledge of each and every activity of farm so as to get good results. The following are some of the aspects in relation to mulberry cultivation. They are nurseries, mulberry cultivation under rainfed and irrigated method.

3.2 Nurseries

In one hectare nursery two lakh or more saplings can be produced. The expected loss would be 20 percent. The cost of production details are as follows.
Table 3.1
Expenditure for Land Preparation
(2.5 lakh saplings)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Work Details</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Two time ploughing (Tractor) 5 hrs. work @ Rs.100 per hour</td>
<td>500-00</td>
</tr>
<tr>
<td>2.</td>
<td>Ploughing with bullocks – 6 pairs @ Rs.50 per pair – two times</td>
<td>600-00</td>
</tr>
<tr>
<td>3.</td>
<td>Levelling, picking of weeds 10 man days</td>
<td>200-00</td>
</tr>
<tr>
<td>4.</td>
<td>Preparation of plots, channels – 30 man days @ Rs.20 per man</td>
<td>600-00</td>
</tr>
<tr>
<td>5.</td>
<td>Cow dung 20 kg. per plot – 1092 plots 22 cart loads - @ Rs.150 per load</td>
<td>3300-00</td>
</tr>
<tr>
<td>6.</td>
<td>Application of cow dung, mixing 10 man days @ 20 per man</td>
<td>200-00</td>
</tr>
</tbody>
</table>
### Table 3.2
**Expenditure for Plants, Planting**
*(2.5 lakh saplings)*

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Work Details</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Expenditure for plants, Rs.300 per tonne (25000 cuttings/tonne) 10 tonnes</td>
<td>3000-00</td>
</tr>
<tr>
<td>2.</td>
<td>Transport 3-4 lorries @ Rs.200 per lorry</td>
<td>800-00</td>
</tr>
<tr>
<td>3.</td>
<td>Cutting preparation 2500 cuttings/one man day – total man days @ Rs.20 per day</td>
<td>2000-00</td>
</tr>
<tr>
<td>4.</td>
<td>B H C 100 kg. @ Rs.5 per kg.</td>
<td>500-00</td>
</tr>
<tr>
<td>5.</td>
<td>Planting – 10 plots/one man day – 10 MD @ Rs.20 per man day</td>
<td>2200-00</td>
</tr>
<tr>
<td>6.</td>
<td>Weeding – 100 MD - @ Rs.20 per MD</td>
<td>2000-00</td>
</tr>
<tr>
<td>7.</td>
<td>Irrigation 5 times per day – 3 MD – 25 times Irrigation @ Rs.20 per MD</td>
<td>1500-00</td>
</tr>
<tr>
<td>8.</td>
<td>Complex Fertiliser 15 kg. @ Rs.800 per kg.</td>
<td>2000-00</td>
</tr>
<tr>
<td>9.</td>
<td>Fertiliser application 6 MD</td>
<td>120-00</td>
</tr>
<tr>
<td>10.</td>
<td>Uprooting of saplings 100 MD</td>
<td>2000-00</td>
</tr>
<tr>
<td>11.</td>
<td>Other expenditure</td>
<td>500-00</td>
</tr>
<tr>
<td></td>
<td><strong>Total :</strong></td>
<td><strong>16620-00</strong></td>
</tr>
</tbody>
</table>
Table 3.3
Expenditure for Garden Implements

These implements can be used for five years. Thus the expenditure per year would be 2125/5 = Rs. 425 only.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Work Details</th>
<th>Number</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Crow bars @ Rs.100 per one</td>
<td>5</td>
<td>500-00</td>
</tr>
<tr>
<td>2.</td>
<td>Pick axe @ Rs.40 per one</td>
<td>5</td>
<td>200-00</td>
</tr>
<tr>
<td>3.</td>
<td>Axe @ Rs.35 per one</td>
<td>1</td>
<td>35-00</td>
</tr>
<tr>
<td>4.</td>
<td>Iron pans @ Rs.20 per one</td>
<td>10</td>
<td>200-00</td>
</tr>
<tr>
<td>5.</td>
<td>Spades @ 30 per one</td>
<td>4</td>
<td>120-00</td>
</tr>
<tr>
<td>6.</td>
<td>Bill hook @ Rs.30 per one</td>
<td>4</td>
<td>120-00</td>
</tr>
<tr>
<td>7.</td>
<td>Water Cans @ Rs.50 per one</td>
<td>5</td>
<td>250-00</td>
</tr>
<tr>
<td>8.</td>
<td>Weeding sickles @ Rs.10 per one</td>
<td>10</td>
<td>100-00</td>
</tr>
<tr>
<td>9.</td>
<td>Land preparation expenditure</td>
<td>1</td>
<td>400-00</td>
</tr>
<tr>
<td>10.</td>
<td>Others, sharpening of implements</td>
<td>1</td>
<td>200-00</td>
</tr>
</tbody>
</table>

Table 3.4
Expenditure for Mulberry Nursery

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Work Details</th>
<th>Number</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Plots 8’x4’ size / acre</td>
<td>1735</td>
<td>1735-00</td>
</tr>
<tr>
<td>2.</td>
<td>195 cuttings per one plot</td>
<td>200</td>
<td>200-00</td>
</tr>
<tr>
<td>3.</td>
<td>Total Cuttings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Good cuttings 80% - eliminate dead cuttings (2.5 lakh saplings)</td>
<td>270660</td>
<td>54132-00</td>
</tr>
<tr>
<td>5.</td>
<td>Land preparation expenditure</td>
<td>5220</td>
<td>5220-00</td>
</tr>
<tr>
<td>6.</td>
<td>Plants, Planting cost</td>
<td>16620</td>
<td>16620-00</td>
</tr>
<tr>
<td>7.</td>
<td>Implements cost</td>
<td>2125</td>
<td>2125-00</td>
</tr>
<tr>
<td>8.</td>
<td>Total cost</td>
<td>23965</td>
<td>23965-00</td>
</tr>
<tr>
<td>9.</td>
<td>Cost of production per one sapling</td>
<td>10</td>
<td>0-11</td>
</tr>
<tr>
<td>10.</td>
<td>Total income (by the sale of 270660 saplings)</td>
<td>54132</td>
<td>54132-00</td>
</tr>
<tr>
<td>11.</td>
<td>Net income for six months – one hectare or one acre mulberry</td>
<td>10000</td>
<td>10000-00</td>
</tr>
</tbody>
</table>
Farm Implements

Every farmer should have the necessary farm implements, equipments. These are to be maintained properly. The following are the equipments for any cultivation method.

### Table 3.5
Farm Implements

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Equipment / Name of the Implement</th>
<th>Required Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mould broat plough</td>
<td>1</td>
</tr>
<tr>
<td>2.</td>
<td>Disc harrow</td>
<td>1</td>
</tr>
<tr>
<td>3.</td>
<td>Country plough</td>
<td>4</td>
</tr>
<tr>
<td>4.</td>
<td>Spades</td>
<td>10</td>
</tr>
<tr>
<td>5.</td>
<td>Pick axe</td>
<td>6</td>
</tr>
<tr>
<td>6.</td>
<td>Weeding implements</td>
<td>25</td>
</tr>
<tr>
<td>7.</td>
<td>Pruning knives</td>
<td>25</td>
</tr>
<tr>
<td>8.</td>
<td>Axe</td>
<td>2</td>
</tr>
<tr>
<td>9.</td>
<td>Bill hook</td>
<td>2</td>
</tr>
<tr>
<td>10.</td>
<td>Sprayer (10 ltr.)</td>
<td>1</td>
</tr>
</tbody>
</table>
3.3. Rainfed Cultivation

The following is the economics of rained mulberry farm which is quite different from irrigated. The cost of leaf production is comparatively high than irrigated field.

Table 3.6
Cost of Initial Establishment of One Acre of Rainfed Mulberry

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Work Details</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td><strong>Land Preparation</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Two deep ploughings by mould-board ploughs – 16 pairs of bullocks at Rs.60</td>
<td>960-00</td>
</tr>
<tr>
<td>2.</td>
<td>Two light ploughings by country plough 8 pairs of bullocks at Rs.60</td>
<td>480-00</td>
</tr>
<tr>
<td>3.</td>
<td>Digging pits, application of FYM – 15 men at Rs.60 – 120 MD</td>
<td>7200-00</td>
</tr>
<tr>
<td>II.</td>
<td><strong>Planting material and Planting</strong></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Two cartloads of cuttings at Rs.150</td>
<td>300-00</td>
</tr>
<tr>
<td>5.</td>
<td>Preparation of cuttings and planting – 6 men at Rs.60 for 6 days</td>
<td>360-00</td>
</tr>
<tr>
<td>III.</td>
<td><strong>Manures and Fertilisers</strong></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>4 tonnes of FYM at Rs.150</td>
<td>600-00</td>
</tr>
<tr>
<td>7.</td>
<td>Fertiliser cost</td>
<td>350-00</td>
</tr>
<tr>
<td>8.</td>
<td>Intercultivation and weeding – 12 per weeding at Rs.60 (twice)</td>
<td>1440-00</td>
</tr>
<tr>
<td>IV.</td>
<td><strong>Irrigation</strong></td>
<td></td>
</tr>
<tr>
<td>V.</td>
<td><strong>Miscellaneous requirements</strong></td>
<td>750-00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong>:</td>
<td>12440-00</td>
</tr>
</tbody>
</table>
The economic life of the plantation is over 15 years. Thus this amount is distributed over 15 years. Therefore the amount of annual cost to be added to cultivation expenses is Rs.830.00.

One year expenditure = 12440.00/15 years = 829 say Rs.830.00.

After plantation the crop is established within nine months thus one silkworm nearing can be planned during first year. The economics of cost of leaf production is as follows.

Table 3.7
Annual Cost of Maintenance after Initial Establishment
Hence cost of one Kg mulberry leaf is 0.91 paise. This cost is considerably reduced in the next raising as the time passes.

3.4. Irrigated cultivation

The maintenance of irrigated mulberry crop is as follows.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Work Description</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td><strong>Land Preparation</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Two deep ploughings by mould-board ploughs – 16 pairs of bullocks at Rs.60</td>
<td>960-00</td>
</tr>
<tr>
<td>2.</td>
<td>Two light ploughings by country plough 8 pairs of bullocks at Rs.60</td>
<td>480-00</td>
</tr>
<tr>
<td>3.</td>
<td>Farming ridges and furrows 12 men at Rs.60</td>
<td>720-00</td>
</tr>
<tr>
<td>II.</td>
<td><strong>Planting material and Planting</strong></td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Four cartloads of cuttings at Rs.150</td>
<td>600-00</td>
</tr>
<tr>
<td>5.</td>
<td>Preparation of cuttings and planting – 30 men at Rs.60 for 6 days</td>
<td>1800-00</td>
</tr>
<tr>
<td>III.</td>
<td><strong>Manures and Fertilisers</strong></td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>10 tonnes of FYM at Rs.150</td>
<td>1500-00</td>
</tr>
<tr>
<td>7.</td>
<td>Fertiliser Cost</td>
<td>400-00</td>
</tr>
<tr>
<td>8.</td>
<td>Application of FYM – 6 men at Rs.60 and Fertiliser -2 men at Rs.60</td>
<td>480-00</td>
</tr>
<tr>
<td>9.</td>
<td>Intercultivation and weeding-12 men per weeding at Rs.60 (twice)</td>
<td>1440-00</td>
</tr>
<tr>
<td>IV.</td>
<td><strong>Irrigation</strong></td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td>10 irrigations during first 6 months at Rs.100 per irrigation</td>
<td>1000-00</td>
</tr>
<tr>
<td>11.</td>
<td>2 men at Rs.60 per irrigation / 10 irrigations</td>
<td>1200-00</td>
</tr>
<tr>
<td>12.</td>
<td>Miscellaneous</td>
<td>800-00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td>11380-00</td>
</tr>
</tbody>
</table>
The economic life of mulberry plantation is 15 years. Thus this amount is distributed over 15 years.

Thus one year expenditure = $\frac{11380}{15} = Rs.758$.

Table 3.9
Annual Cost of Maintenance after Initial Establishment
(Irrigated Mulberry)
Generally the leaf production is 25000-30000 Kg. Thus an average of 27500 Kg. leaf is produced.

Therefore cost of leaf production per kg. = \( \frac{14698}{27500} = 0.53 \) paise.

3.5. Economics of One Acre Mulberry

The economics of mulberry plantation in rainfed and irrigated cultivation per one acre are already detailed above which shows a slight variation. The leaf production is high in irrigated than rainfed.

* Condition :

All these values listed in Tables are not standard changes according.

**SUMMARY**

- Economics gives an idea about margins of profits and loss related to entrepreneurship.
- It indicates the difference between investment and profits.
- It requires efficient management of human resource and natural resources.
- Each and every aspect of cultivation has its own effect on the production which directly or indirectly influences the cost of production.
- The economics of mulberry nursery of 2.5 lakh saplings is Rs.10000 net income for six months/one hectare.
Rainfed mulberry cultivation in one acre the cost of leaf production is 0.91 paise.

Irrigated mulberry cultivation in one acre the cost of leaf production is 0.53 paise.

QUESTIONS

I. Short Questions

1. On what basis you assess the economics of a farm?

2. When do you say that economics of mulberry farm is good?

3. Mention some farm implements.

4. What is the expenditure incurred for establishing mulberry farm?

5. How does economic details help the farmer?

II. Essay Questions

1. Write about income-expenditure details of rainfed mulberry garden.

2. Write about economics of nurseries.

3. Write about economics of irrigated mulberry.
Secondary Food Plants and Diet

4.1 Introduction

Silkworms *Bombyx* are monophagous and eat only mulberry leaves. The contents of mulberry leaf slightly are largely matches with other leaves. This is in relation to nutrients especially amino acid pool and water content which makes the insect palatable. But in nature these insects likes to select and eat only mulberry. At certain circumstances like other animals it also trends to eat other food plants which are considered as secondary food plants. The insect completely can’t depend on these plants to fulfill its appetite. But these plants are of substitute nature and good choice to the growing worm so as to have a continuous growth till the availability of its original food plant.

Silkworms after its domestication are fed with selected mulberry leaf to get good crop results. These worms are fed 4 to 5 times a day to meet their energy demands and to have good growth. At certain times non-availability of mulberry leaf the rearer is forced to feed the worms with secondary food plants or artificial diet. Therefore it is necessary to have proper knowledge about secondary food plants and also artificial diet preparation. However continuous feeding secondary food plants is not advisable.

4.2 Secondary Food Plants

4.2.1 Moraceae

Among Moraceae *Cudrania triloba* leaves are preferred as substitute plant, but when used larval length is prolonged and results in small cocoon formation.

Same is the case with *Cudrania javanensis* and the cocoon size is smaller than with *C. triloba*.
Maclura aurantiaca is considered as effective as Cudrania sp.

Ficus pumila and F. mipponica can also be used for all instar but results in small cocoons.

4.2.2 Ulmaceae

Ulmus pumila, U. parvifolia can be used for all instar although the larval life span is prolonged and small cocoons are obtained.

4.2.3 Compositae

Lactuca sativa, L. lanceolata, L. debilis leaves can be used for rearing though larval life is prolonged, poor growth and small cocoons were obtained.

4.2.4 Campanulaceae

Adenophora sp. leaves are successfully used for rearing though poor growth and small cocoons were obtained.

4.3 Artificial Diet

Application of artificial diet for silkworms nutrition dates from 1960. The diet used at that time contained 50% or more of dried, pulverized mulberry leaves. The silkworms reared on other diets resulted in retarded larval growth and development, small cocoons, small number of eggs in a laying. After many attempts a diet containing mulberry leaf powder (10%) together with starch, sucrose, raw soybean powder, a salt mixture and cellulose was prepared and was known to sustain larval growth. Later diet containing crude soybean oil (sterol) was proved as a better choice.
At present there are only small differences in the rate of growth and development of larvae reared on mulberry leaves and artificial diets. Artificial diets without any mulberry leaf powder are usually called semi synthetic diets and can be considered as meridic diets.

Based on information on the dietetics of the silkworm, three different semi-synthetic (meridic) diets have been formulated. They are;

a. Starter (for I instar larvae)

b. Grower (for II to IV instar larvae)

c. Producer (for V instar larvae)

On the other hand molding materials such as starch, agar, glue are included in the diet to improve its capacity for water retention. Further hardness of diet influences the dietary efficiency greatly. Cellulose powder, water content were found to improve dietary efficiency.

While using artificial diet one must be sure of protecting the diet from decomposition for which an antiseptic and or antibiotic is usually added to the diet.
### Composition of Diet

The composition of artificial diets containing mulberry leaf and without mulberry leaf are presented in the tables.

#### Table 4.1 Composition of Diet with Mulberry Leaf Powder

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Ingredients</th>
<th>Diet for I-IV instar (g)</th>
<th>Diet for V instar (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mulberry Leaf Powder</td>
<td>25.0</td>
<td>25.0</td>
</tr>
<tr>
<td>2.</td>
<td>Soybean Oil</td>
<td>1.5</td>
<td>3.0</td>
</tr>
<tr>
<td>3.</td>
<td>Defatted Soybean Meal</td>
<td>36.0</td>
<td>45.0</td>
</tr>
<tr>
<td>4.</td>
<td>Cholesterol</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>5.</td>
<td>Citric Acid</td>
<td><strong>4.0</strong></td>
<td>4.0</td>
</tr>
<tr>
<td>6.</td>
<td>Ascorbic Acid</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>7.</td>
<td>Sorbic Acid</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>8.</td>
<td>Agar</td>
<td>7.5</td>
<td>5.0</td>
</tr>
<tr>
<td>9.</td>
<td>Salt Mixture</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>10.</td>
<td>Glucose</td>
<td>8.0</td>
<td>10.0</td>
</tr>
<tr>
<td>11.</td>
<td>Potato Starch</td>
<td>7.5</td>
<td>15.0</td>
</tr>
<tr>
<td>12.</td>
<td>Cellulose Powder</td>
<td>20.8</td>
<td>--</td>
</tr>
<tr>
<td>13.</td>
<td>Vitamin-B Mixture</td>
<td>Added</td>
<td>Added</td>
</tr>
<tr>
<td>14.</td>
<td>Antiseptic</td>
<td>Added</td>
<td>Added</td>
</tr>
<tr>
<td></td>
<td><strong>Total:</strong></td>
<td><strong>115.7</strong></td>
<td><strong>112.4</strong></td>
</tr>
<tr>
<td>15.</td>
<td>Water</td>
<td>300ml</td>
<td>220ml</td>
</tr>
</tbody>
</table>
### Table 4.2
Composition of Semi Synthetic Diet without Mulberry leaf powder

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Ingredients</th>
<th>Dry Diet (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Starter</td>
<td>Grower</td>
</tr>
<tr>
<td>1.</td>
<td>Potato Starch</td>
<td>10.0</td>
</tr>
<tr>
<td>2.</td>
<td>Sucrose</td>
<td>10.0</td>
</tr>
<tr>
<td>3.</td>
<td>Glucose</td>
<td>--</td>
</tr>
<tr>
<td>4.</td>
<td>Soybean Meal, Defatted</td>
<td>30.0</td>
</tr>
<tr>
<td>5.</td>
<td>Soybean Oil Refined</td>
<td>3.0</td>
</tr>
<tr>
<td>6.</td>
<td>β-Sitosterol</td>
<td>0.5</td>
</tr>
<tr>
<td>7.</td>
<td>Salt Mixture</td>
<td>3.5</td>
</tr>
<tr>
<td>8.</td>
<td>K_2HP0_4</td>
<td>1.0</td>
</tr>
<tr>
<td>9.</td>
<td>Ascorbic Acid</td>
<td>2.0</td>
</tr>
<tr>
<td>10.</td>
<td>Cellulose Powder</td>
<td>34.0</td>
</tr>
<tr>
<td>11.</td>
<td>Agar</td>
<td>15.0</td>
</tr>
<tr>
<td>12.</td>
<td>Citric Acid</td>
<td>0.5</td>
</tr>
<tr>
<td>13.</td>
<td>Sorbic Acid</td>
<td>0.2</td>
</tr>
<tr>
<td>14.</td>
<td>Morin</td>
<td>0.2</td>
</tr>
</tbody>
</table>

**Total :** 109.9 119.8 105.2

15. Vitamin-B Mixture Added  Added  Added

16. Antiseptic Added  Added  Added

17. Distilled Water 300ml  300ml  260ml
4.5 Preparation of Diet

The diet is prepared in small quantity. The components of the diet are ground and mixed thoroughly. This mixture is transferred into a container having water containing vitamins and antiseptic. The container is closed with a lid and heated to approximately 97°C on a water bath for 15-20min. The diet forms a gel on cooling. This diet can be kept in fridge for a few days. While feeding it is cut into slices and fed to larvae once a day or every other day.

SUMMARY

- Feeding on secondary food plants are not encouraging.
- Family moraceae, ulmaceae, compositae, campanulaceae includes a few secondary food plants.
Artificial diet contains 50% of mulberry leaf powder.

Starter, grower, producer are the three different semi-synthetic (meridic) diets.

Diet with soybean oil proved to be better.

Care is taken to avoid decomposition of diet.

QUESTIONS

I. Short questions

1. What do you mean by secondary food plant.

2. Mention some secondary food plants.

3. Mention names of family that includes secondary food plants.

4. What is semi synthetic diet/meridic.

5. Mention different semi-synthetic diets.

6. Mention some ingredients of artificial diet.

7. Why antiseptic/antibiotics are added to artificial diet.

II. Essay questions

1. Write an essay on secondary food plants.

2. Write about artificial diet.

3. Write short notes on
   a. Preparation of diet
   b. Semi synthetic diets
5

Mulberry Diseases

5.1 Introduction

Mulberry plant is not an exception to diseases. The mulberry being a perennial crop the pathogens seem to rapidly develop and quickly spread to cover extensive areas. Certain alternate and collateral hosts (weeds) play some role in perpetuation of some of the pathogens. Disease is an abnormal condition that results due to some micro or macro organism which causes disturbance in physiology. This leads to hamper the growth and development sometimes drying of complete plant if not attended in time. There are various types of diseases of mulberry. The plant gets affected in roots, stems and leaves and the area of attack varies depending on the type of disease. They show lot of diversity in disease symptoms. The mulberry diseases are caused by bacteria, viruses, fungi, parasitic nematodes. Among them about half a dozen diseases are economically important which affect the growth of mulberry and cause considerable damage to the plant and loss in leaf yield. However, these pathogens do not pose any serious threat to mulberry cultivation in general. Their incidence, however, varies with seasonal factors, mulberry varieties and cultivation practices. Because these varieties are not resistant against different types of diseases. Biochemical studies have revealed that diseased leaves are poorer in proteins, moisture content and sugars. Thus such leaves when feed to silkworms, yield very poor quality cocoons. Therefore the sericulture farmer should know about the common diseases and their control measures. Some of the important diseases of mulberry are discussed here.
5.2 **Bacterial Diseases**

There are not many diseases reported from mulberry.

5.2.1 **Leaf Blight**

It is caused by *Pseudomonas mori*.

**Symptoms:**

Numerous, small, irregular, water-soaked patches appear on the lower surface of leaf margins. These spot grow bigger and change to brown colour. Then leaves become curled and rotten. The affected patches fall of prematurely and appear like torn in wet weather. But in dry weather remain dry on the intact leaf. The veins and veinlets, petioles are also infected. Black longitudinal lesions are also seen on the back of the young shoots.

![Fig. 5.1 Mulberry Leaf affected by leaf blight](image)

**Disease Cycle:**

Soil is the primary source of infection. Secondary infection takes place through irrigation, cultivation processes, mechanical injuries and biological agents. It multiplies by binary fission. The disease occurs during rainy season. Under favourable condition it infects the new plants. The loss is 5-10 per cent.
Control:

The diseased plants should be rooted out and burnt. The soil should be exposed to sun. Close spacing plantations are avoided. Foliar spray at 0.1 per cent concentration of streptovitcin or streptocyclin are used. Further fungicides like captatol or mancozeb at 0.2 per cent concentration can also be used.

5.3 Viral Disease

There are a few viral diseases which cause damage to the silk production.

5.3.1 Mosaic disease

It is caused by viruses transmitted by grafting or insect vectors.

Symptoms:

The green part around the veins are lost and mosaic, dark and green patches appear on the leaves. Then the leaves show inward curling especially leaf margin and tip with chlorotic lesions on the leaf surface. This results in a reduction in plant height and leaf size, sometimes these are reduced to half size than healthy ones. The leaves loss nutrient value and physical features.

Disease Cycle:

It spreads primarily through infected plants. Once the virus is inside the susceptible host tissue, it becomes systemic. The incubation period varies from 7-25 days. Depending on the climate and host pathogen relationship the disease symptoms may be expressed or masked. This disease is common during rainy season.

Control:

Uprooting and burning of diseased plants. Removing old plants before planting, washing the hands and tools with a disinfectant to prevent the transmission. It is also advised to select only virus free plant material for grafts and cuttings.
5.3.2 Dwarf disease

It is caused by mycoplasma like organism of mycoplasmatales order, transmitted by grafting outwards. Internodes become shortened with many lateral branches giving an appearance of witches broom. Other symptoms are chlorosis, stunted plant growth.

**Disease Cycle:**

Transmission is by leaf hopper vector and by grafting and primary source is infected plant. The incubation period is 13 days at 29°C or 55 days at 18°C. The pathogen proliferates in phloem sieve tubes and moves into the phloem tissue leading to phloem necrosis in root system.

**Control:**

Uproot the diseased plant and burn. Insect vector is controlled with malathion diluted with water or DDVP at 0.1 per cent is advisable and safe period for use of leaves is 7 days.

5.4 Fungal disease

This is the predominant section which affects mulberry causing lot of damage to stem, root and leaves. There are many fungal diseases of which 5-6 are economically important.

5.4.1 Leaf Spot

It is caused by *Cercospora moricola* (C) a fungal pathogen.

**Symptoms:**

The diseased leaves have a number of circular or irregular brownish spots of varying sizes. These spots become enlarged and lead to ‘shoot holes’. Severely affected leaves become yellowish and fall prematurely. Diseased leaves are not suitable for feeding silkworm. The leaf yield is reduced to 10-30 per cent.
**Disease Cycle:**

The disease spreads by rain. The fungus produces a compact mass of interwoven cushion-like hyphae. Which produces conidiophores. These once again turn to produce 3-7 celled conidia. Conidia are hyaline, tapering at one end and 70 x 3mm size. These conidia are capable of producing new hyphae from any cell. It takes about 10-12 days after inoculation of conidia to produce a spot and another 3-4 days for forming conidia.

**Control:**

Disease can be controlled by fungicide carbendazim of 500-625 gr per hectare dissolving in same quantity of water and sprayed. These leaves can be used for feeding silkworm after a period of 8 days. The physical and cultural methods include uprooting of weeds which are alternate hosts to fungus and picking, burning of diseased leaves.

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**Fig. 5.2a Disease Cycle of Leaf Spot**

a) Affected Mulberry leaf  
b) T.S. of infected leaf  
c) Conidia  
d) Germinating conidia on the leaf surface  
1 Conidiophores with conidia  
2 Upper epidermis  
3 Palisade tissue  
4 Spongy tissue  
5 Lower epidermis
5.4.2 Powdery mildew

The causative organism is *Phyllactinia corylea* (Pers) a common and dangerous fungus.

**Symptoms:**

It is most common in the rainy or post rainy season and more prevalent in hilly areas. It spreads very rapidly through wind. The disease results in a net leaf yield loss of about 40 per cent. The protein content of harvested leaves in diseased plants is reduced to 30 per cent.

Initially white powdery patches appear on the lower surface of the leaf. These patches cover the entire leaf surface at a later stage and turn black to brown in colour. Affected leaves dry, leathery and fall off.

**Disease Cycle:**

This ectoparasite absorbs nutrients by sending haustoria into the epidermal cells through the stomata. The pathogen reproduces by both sexual and a sexual methods. A sexual reproduction takes place by conidia.
Conidia are hyaline, unicellular and club shaped measuring 70x20μm. Conidia are formed terminally on septate conidiophores. The liberated conidia disperse through wind current and finally spread the disease. The mycelium is unbranched hyaline and forms a mycelial mast sticking to the leaf surface.

Sexual reproduction is by formation of fruiting bodies known as **cleistothecia**. These are covered with numerous colourless needle shaped appendages. These are 5-50 asci inside the **cleistothecium** which on maturity liberated during favourable conditions. Each ascus has two ascospores which germinate to produce hyphae, spreading the disease.

*Fig. 5.3 a* Mulberry leaf affected by mildew

*Fig. 5.3 b* Conidia of *Phyllactinia corylea*
Control:

Spraying of dianoecap 0.2 per cent which is prepared by mixing 400-500ml of chemical in 200-300lit. of water per one acre mulberry garden. These leaves can be used for silkworm rearing after 10 days of spray. Care is taken while spraying to drench the leaf completely. Dusting of sulphur powder; spraying of dithane/sulphur suspension or lime-sulphur mixture on the lower surface of leaf is advisable. Plucking and burning of leaves.
Mildew resistant varieties like MR1 and MR2 are selected for plantation. It is better to adopt wide spacing during initial plantation, training as a high bush and regular weeding to reduce humidity.

5.4.3 Leaf Rust

In our country \textit{Cerotelium fici} is the fungal pathogen causing the disease affecting only leaf.

Symptoms:

It is the dangerous leaf disease affecting mostly the nature leaves, the food of late age silkworms. Leading to leaf loss of 10-30 per cent. The pathogen produces numerous pin head size circular to oval brownish to black eruptive lesions on the lower surface of the leaf. In advanced stage the leaves become yellow and fall off prematurely.

![Fig. 5.4 a Disease cycle of Cerotelium fici](image)

a) Mulberry leaf infected by leaf rust  

b) T.S. of infected leaf  

c) Liberated Uredospores  

d) Germinating Uredospore  

1. Upperepidermis  
2. Palisade tissue  
3. Spongy tissue  
4. Lower epidermis  
5. Uredospore
**Disease Cycle:**

It is a microcyclic fungi exists primarily as mycelium, uredium and uredospore.  Uredospores are oval to round, uninucleate produced singly on uredospores and uredia. These germinate to form hyphae which enter the leaf through stomoda. The hyphae grow intercellularly in the host tissue, extending haustoria into the host cells to collect nutrients. Uredospores are spread through water droplets and wind. This disease is common during winter. The disease severity increases with the age of leaf.

**Control:**

Timely utilization of leaves without delaying the leaf harvest during winter season. Wide spacing in plantation is another way to reduce the disease incidence. Spraying of fungicides like dinocap and carbendazim at 0.2 per cent concentration is also helpful and the safe period to use the leaf is 7 days. Diseased leaves, shoots are cut and burnt.
5.4.4 Root rot

There are two types i.e. white and violet root rot.

5.4.4 A) White root rot:

It is caused by the pathogen *Rosellinia necatrix* (B).

**Symptoms:**

The diseased mulberry plants become weak, feeble growth of leaf buds, withering of leaves, weak growth of plant and the plant dies very soon. The stump region of the affected plants are covered with whitish-gray mycelial mat.

**Disease Cycle:**

Thus fungus reproduces asexually by forming chlamydospores, sclerotia and conidia. Under favourable conditions it reproduces sexually by asci and ascospores inside perithecium. Each asci has eight ascospores. The hyphae emerging from different spores infect the primary roots and later spreads to the whole shoot system causing white root-rot. The sclerotia and sexual spores remain as resting spores in the soil, dried root and stump parts in unfavourable conditions and perpetuate the disease in favourable condition causing plant death.

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**Fig. 5.5 Disease cycle of White root-rot**

- a) Mycelia on the root surface
- b) Mycelium
- c) Chlamydospores
- d) Interoven mycelia with conidia
- e) Perithecium
- f) Enlarged ascus with ascospores
- g) Ascospores
5.4.4 B) Violet root-rot:

It is caused by *Helicobasidium mompa* (N).

**Symptoms:**

Withering of leaves and collapse of plants during rainy season. The epidermal tissue of roots are covered with violet coloured mycelial mat. As the disease advances the rooting spreads to the xylem tissue also.

**Disease Cycle:**

The hyphae are purplish, septate, terminating with fructification bodies called basidia. Each basidia has four basidiospores at the top. Basidiospores rapidly germinate in wet soils and rain drops and the hyphae enter the new root system and spread disease. The germinating spore becomes the nutritive hyphae. Under unfavourable conditions the mycelia form the sclerotia or the hardened masses of hyphae. They remain for a long time on the dead root tissue and germinate under suitable conditions. This pathogen can also live in many other host plants and perpetuate indefinitely.

**Control:**

The root-rot diseases bring about the rotting of roots. These are dangerous and killer diseases of mulberry. The affected plants suddenly winter and dry.

The diseased plants are immediately uprooted, remaining stumps and root portions collected and burnt. A meter deep pit is dug around the diseased plant and soil excavated should be piled up away from the field to prevent disease spread. The soil around should be ploughed, leveled and disinfected with chloropicrin. Small vertical holes of 3-4 feet deep are made and chloropicrin @ 1/2 kg per 108 sq. ft. should be put in and holes are closed with soil. The field is sprinkled with water. The chloropicrin fumigates in the soil. Disinfection by mixing calcium cyanamide with soil uniformly at @ 75.2gr/36 sq. ft. area. The new saplings before planting may be treated by washing in 20 per cent lime water or one per cent copper sulphate solution for an hour then washed in water.
5.2 Mulberry Farm Maintenance

Fig. 5.6 Disease cycle of Violet root-rot

a) Mycelia on the root surface
b) Intercellular mycelium with basidia and basidiospores
c) Young basidia    d) Matured basidia with basidiospores
e) Basidiospores    f) Basidiospores germination

5.4.5 Twig Blight

It is caused by *Fusarium pallidoroseum* (Cooke). Other species like *F. lateritium; F.mori; F. oxysporum; F. roseum* also cause this disease.

Symptoms:

In the initial stage leaves show marginal blackening or burning and at a later stage complete burning and defoliation. The affected twigs become feeble and fragile with irregular black longitudinal patches (lesions) on the stem surface. Further these lesions resulting in the splitting and drying of twigs. Buds become rotten.
Disease Cycle:

It produces both micro and macro conidia. The micro-conidia are small, elliptical or curved and unicellular. Macro-conidia are linear, curved, pointed at both ends, thin-walled and septate. Chlamydospores are spherical and thick walled are after formed within the host tissue. All those spores germinate in water to form germ tube. Chlamydospores can survive in adverse climatic conditions for a long period. This disease can exist throughout the year and causes 5-6 per cent loss.

Control:

Fungicides like captafol or mancozeb may be used both as a foliar spray at 0.2 per cent and soil drenching with 0.5 per cent.

5.4.6 Stem Disease or Stem canker or collar-rot

It is commonly called canker caused by *Botryodiplodia theobromae*. 
Symptoms:

Greenish-black lesions appear on the stem in initial stage which change to dark-black, hard carbonaceous structures.

Control:

To prevent cuttings from being infected with stem canker fungus, they are soaked in 10ppm solution of Bavistin for 12 hours, washed with water before planting. Affected stem should not be used for the preparation of cuttings because they do not sprout.

5.5. Parasitic Diseases

The nematodes have a wide range of host plants and cause economic damage to many crops including mulberry.

5.5.1 Root-knot nematode

It is caused by *Meloidogyne incognita* (knotoid and white) nematode.

Symptoms:

This disease is more prevalent in summer following rains. The degree of infestation is up to 80% in various states. This parasite causes alteration in plant physiology. The affected plant shows stunted growth, marginal necrosis and yellowing of leaves. The underground symptoms are formation of characteristic knots or galls on the roots. Small knot indicate single infection and large one multiple infections. The parasite damage xylem and phloem tissues resulting in disruption of water and food conduction.
Fig. 5.8 Disease cycle of Meloidogyne incognita

a. Eggs within gelatinous matrix  b. Second stage infective larva
c. Larva with hemispherical posterior and terminate spike
d. Female completed moults
e. Typical female f. Mature egg laying female

Disease Cycle:

It has three stages in life cycle i.e. egg, larva and adult. The second stage female larva found in soil enter the root through the hole made by stylet and settle in subepidermal layer. It feeds on parenchymatous tissue. It also stimulates the cells to undergo repeated division leading to enlargement. Thus forming cancerous knot/gall on the roots. Female larvae undergo four moults to become adult. Each female lays 200-322 ellipsoid eggs covered with gelatinous material. Eggs hatch larvae and are liberated into soil under favourable conditions. It take 30-40 days to complete life cycle. It can repeat life cycle 2-3 times in its life span. The soil temperature 15-30°C and moisture 40-60 per cent encourage parasite growth. The nematode infestation is more in irrigated mulberry farming. The leaf loss is 10-12 per cent.
Control:

It can be controlled by deep ploughing or digging of infested garden during summer to expose nematode eggs and larvae to direct sun. Further mulching, application of green manures, compost, oil cakes (neem) to control the infestation. Application of nematicides like Aldicarb or carbofuran at the rate of 30kg/ha/yr in four equal splits along with fertilizer is good to control the worm. The leaves can be used after 45-50 days of application. Soil fumigants like methyl bromide, D-D mixture and DBCP are also effective to control soil nematode population.
5.6 Nutrient Deficiencies and Control

5.6.1 Nitrogen

Symptoms:

Retarded development of roots, reduction in size of the branches. Slow and weak growth of plant with less branching/vigour. Stunted appearance of the plant indicate deficiency of soil nitrogen. Young leaves show chlorosis. Stem is slender and yellowish green with stunted root growth.

The nitrogen is an important nutrient for plants and accounts for about 1-4 per cent of the dry weight of the plant. It also forms a biological constituent of all proteins, enzymes, chlorophyll, vitamins, hormones and nucleic acids. It is essential to increase the content of water in plant tissue and decreases the percentage of calcium in them. The critical level in the soil below which deficiency symptoms occur for mulberry is 18 lb/acre when the nitrogen is in the form of nitrate and 65 lb/acre when it is in the form of ammonia.

5.6.2 Potassium

Symptoms:

Stem and root systems become weak and slender. The young leaves become small, show marginal scorching and later become coarse, non-juicy, necrotic when they mature. The deficiency causes intra-veinal chlorosis, retards photosynthesis and production of new tissues. The plant may not show good growth even if other elements are available in the soil.

This element is highly mobile do not form any structural component of the plant, but exists in free state as a cation. It activates many enzymes, regulation of the stomodeal closure mechanism, photosynthesis, cell hydration, synthesis of carbohydrates and protein and catalyzing nitrate reduction. Its role is important to promote thick outer walls in the epidermal cells and tissues which resist collapse. In West Bengal the common mulberry disease is controlled by using potassium though exact cause is still unknown.
The leaves show rusty brown patches and are deficient in potash, protein and sugar contents. The diseased leaves are poisonous to silkworms and cause flacherie disease.

5.6.3 Phosphorus

**Symptoms:**

The deficient plants show intra-veinal chlorosis of older leaves. The chlorosis spreads throughout the leaf and this is followed by marginal necrosis and defoliation. The stem will be slender without fresh growth and the root system becomes stunted. The decoloration of the stem and leaves to reddish or purplish colour.

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**Deficiency Symptoms**

<table>
<thead>
<tr>
<th>Old leaves</th>
<th>New leaves</th>
<th>Old and New leaves</th>
<th>Terminal buds</th>
</tr>
</thead>
<tbody>
<tr>
<td>N, P, K, Mg, Mo</td>
<td>S, Fe, Mn, Cu</td>
<td>Zn</td>
<td>Ca, B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dead spots</th>
<th>No dead spots</th>
<th>Green veins</th>
<th>Yellow veins</th>
</tr>
</thead>
<tbody>
<tr>
<td>K, Mo</td>
<td>N, P, Mg</td>
<td>Fe, Mn</td>
<td>S, Cu</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Green Veins</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mg</td>
<td>N</td>
</tr>
</tbody>
</table>
This element is a component of nucleic acid, protein and phospholipids and necessary for metabolic activity. It strengthens the stem and prevents the lodging of the plant. It influences plant vigour, crop quality, resistance against diseases. The minimum level of phosphorous required for mulberry growth is 50-65lb/acre.

5.6.4 Calcium

Symptoms:

It causes defoliation of young leaves with necrosis along the veins and later stages leads to abscission of the leaves. The leaves become pale. The plant show stunted growth with woody stem with yellowish tips. The roots become stubby and dry.

Calcium is an important element of all plant cell membranes and concerned with its permeability. This element controls all division and formation of cell wall, by its presence in the middle lamella. It promotes the activities of soil bacteria to form nitrates from organic nitrogen and to fix atmospheric nitrogen. It also promotes good root system. It reduces the harmful action of iron and manganese to the plant roots. Plants grow in calcium enriched soil, when subjected to moisture stress, lose their water slower than those grown in ordinary soil. Thus calcium is an efficient element for plant.

5.6.5 Sulphur

Symptoms:

It results in slight chlorosis of leaves with subsequent abscission, abnormally long and woody stem and roots finally leading to arrest of growth.

Sulphur is necessary for the synthesis of some amino acids, coenzymes and vitamins and also formation of chlorophyll. When sulphur is oxidized to sulphates, soil becomes acidic and growth and survival of some bacteria and fungi in the soil are discouraged.
5.6.6 Zinc

**Symptoms:**

Young leaves show intervenial and yellowish spots on leaves. Irregularly shaped leaves, short internodal distance giving a bushy appearance to the plant.

It regulates the activities of the enzymes involved in the formation of IAA the natural growth hormone. It is necessary for synthesis of protein, nucleic acid and carbohydrates. It regulates stem elongation and cell enlargement.

In addition to the above said, many other trace elements may also be necessary for the healthy growth of mulberry plants. These minerals support good vegetative growth of quality and quantity of leaves and building resistance to diseases and pests. A close and methodical observation, timely supply of required mineral elements and proper cultural practices prevent the occurrence of deficiency diseases and boost the quality and quantity of leaf produced by the crop which can be utilized to feed silkworms to get good quantity and quality of cocoons.

**5.6.6.1 Control Measures**

**Nitrogen:**

Application of nitrogenous fertilizers like urea, ammonium nitrate, potassium nitrate or calcium nitrate at appropriate doses is recommended for correction.

**Potassium:**

Application of potassium fertilizer is useful in curing the element deficiency.
Phosphorus:

This deficiency can be cured by phosphorus fertilizers like triple phosphate or superphosphate.

All these are corrected by sufficient supply of NPK to the soil at a proper time.

Calcium:

Liming the fields with requisite amount of lime corrects the deficiency. Application of calcium nitrate also serves the purpose.

Sulphur:

Application of gypsum or ammonium sulphate at appropriate dose is recommended for correction. Factampose (15%) or Zinc sulphate (15%) can also be used.

Zinc:

Application of zinc sulphate at appropriate dose for correction of this element is recommended. Further soluble zinc salt or zinc chelates or zinc sulphates can also be used.

SUMMARY

- Disease is an abnormal condition that appears due to an organism causing disturbance in physiology.
- Disease to mulberry plant causes leaf loss, leaf quality, plant death.
- Bacteria, virus, fungi, parasitic nematodes cause diseases.
- The disease causing organism incidence varies with seasonal factors, mulberry varieties and cultivation practices.
• Leaf blight (bacterial disease) shows small, numerous, irregular water-soaked patches on the ventral leaf surface.

• Mosaic viral disease shows loss of green part around the veins and mosaic, dark green patches appear on leaves.

• Dwarf diseases cause yellow, wrinkles and curling outward of leaves. Internodes are shortened with many lateral branches.

• Fungal diseases are common in mulberry.

• Powdery mildew appears as white powdery patches on the lower surface of the leaf.

• Leaf rust affects mostly mature leaves causing 10-30% loss.

• Root rot causes rotting of root and sudden withering of leaves forming white or violet mycelial mat on the root.

• Twig blight causes marginal blackening or burning of leaf.

• Stem disease form cankers on the stem.

• Nematodes form knots or galls in the root.

• Plant growth depends on the nutrient availability in soil.

• The deficiency symptoms appear clearly in crops with larger leaves.

• The region of appearance of deficiency symptoms depends on mobility of nutrient in the plant.

• Mulberry shows deficiency symptoms due to the non-availability of different mineral elements.

• Nitrogen shows chlorosis and stunted growth of stem corrected nitrogen fertilizers.
- Potassium causes stem and root weakness, causes marginal necrosis and leaf becomes coarse, non-juicy and necrotic. Corrected by potassium fertilizers.

- Phosphorus causes intra-veinal chlorosis of older leaves. Decolorization of stem and leaves also occur. Its deficiency is corrected by phosphorus fertilizers.

- Calcium deficiency causes defoliation of young leaves with necrosis along the veins, can be cured with calcium nitrate.

- Sulphur cause slight chlorosis of leaves and corrected with gypsum.

- Zinc shows intraveinal and yellowish spots on leaves and deficiency is corrected by zinc sulphate.

**QUESTIONS**

I. **Short questions**

1. What are the causative organisms of mulberry diseases?

2. Mention some mulberry diseases.

3. Mention some fungal diseases.

4. What are the characters of dwarf disease?

5. What are the symptoms of leaf spot?

6. What are symptoms of leaf blight?

7. What are causes for mildew disease?

8. What do you mean by root knot?

9. What is the causative organism of root rot?
10. What is stem canker?

11. What are causes for twig blight?

12. What is the damage caused by nematode?

13. What are causes for leaf rust?

14. What are the symptoms of twig blight?

15. What are the causes for stem canker?

16. Which leaves show deficiency symptoms?

17. Mention some plant nutrients.

18. What are the control measures of nitrogen deficiency?

19. What are the control measures of phosphorus deficiency?

20. What are the character of Zn deficiency?

21. What are symptoms of copper deficiency?

22. What are symptoms of potash deficiency?

23. What are the symptoms of sulphur deficiency?

II. Essay Questions

1. Describe leaf spot disease with diagrams.

2. Detail root knot disease with diagrams.

3. What is white root rot? Explain?

4. What is mosaic disease? Explain?
5 Explain about leaf blight disease.
6 Describe powdery mildew disease.
7 Write short notes on:
   a) Stem canker       b) Leaf rust       c) Leaf spot
8 Write short notes on:
   a) Mosaic disease    b) Root knot         c) Dwarf
9 Detail about deficiency symptoms of plant nutrients.
6

Mulberry Pests

6.1 Introduction

The mulberry being a perennial tree is green throughout the year. There are larger number of insects and non-insects depend on mulberry for food and shelter. These organisms definitely cause harm to the plant which in turn reflects on the quality of cocoons produced. These organisms may also carry certain micro organisms which are transmitted into silkworm through mulberry. However the ultimate loss is on cocoon production. In total, over 210 types of insects are feeding on mulberry in different parts of the globe. The degree of damage caused by these insects varies depending on the type of these insects. The damage to the mulberry is during larval and adult stages of insect. Such insects are called pests. Because of the polyphagous nature pest is able to survive in unfavourable growth period also. Further mulberry is periodically pruned and the leaves are harvested for feeding silkworm, the pest attack on mulberry is less and seasonal. Some of these insects eat leaves and check the growth of the mulberry plants, or these insects live as a parasite on shoots. In the case of later the shoots weaken and the yield reduces drastically. Some of the important insect pests are described to know the nature, life cycle, control methods.

6.2 Lepidopteran Pests

6.2.1 Diacrita oblique (Walker)

It is commonly known as “Bihar hairy caterpillar” or Black header caterpillar. It is a polyphagous pest causes highest damage to mulberry plant besides castor, groundnut and jute. The caterpillars are voracious leaf eaters and skeletonize them. The fourth instar larvae onwards the damage becomes more as they devour the leaf very fast and defoliate the plant leaving only veins. The rearer hardship during silkworm rearing come to an end. The incidence is frequent from November to January. The life cycle is completed in 48 days with a larval duration of 30 days. Thus these pest causes serious loss to rearer.
6.2.1.1 Life Cycle

About 1000-1200 eggs green in color with a metallic shining colour are laid by female moth in small groups on the lower surface of the leaves. The eggs incubate in 5-7 days.

The larvae measuring 0.2cms in length, hatched out are dull white in colour with prominent black head. The body is completely covered with small hairs. These gregarious larvae cluster together on a single leaf. Except the size the first two larval stages are similar.

Fig. 6.1 Diacrisia obliqua larva

The third instar larvae is yellowish black in colour. These early stage larvae devour leaf chlorophyll leaving only veins which appear like dead leaf. The larvae start dispersing after third stage. The fourth instar larva head is black further the anterior and posterior parts of the ody are black and the middle part is yellowish brown in colour. A visible dorsomedian stark extending from head to anal segment is present. Each segment has 12 tubercles provided with number of hairs. The hairs are of three types i.e., white, yellowish brown and black. The larvae attains full size after six moults and measures 4.5 to 5cm long and continues for 5-7 days.

The pupa is inside a thin silken cocoon formed by the interwoven shed hairs of the larvae. The pupation occurs in soil and lasts for 12-14 days. The pupa is dark brown in colour measuring 2 cm long.
The emerged months are light brown in colour with wings having scattered black spots. The abdomen is brick red with rows of black dots on lateral and mid dorsal sides. The moths are nocturnal.

6.2.1.2 Control

a. Collection and destruction of egg masses and gregarious young instar caterpillars. Early stage larvae are identified by dried leaves in the field.

b. Deep ploughing and flood irrigation is useful in killing the pupae which pupate in soil.

c. In biological control – Apanteles obliqua is found to parasite the larvae by laying the eggs on the body. The parasites puncture the host body to come out for pupation, thus killing the host (pest of mulberry).

d. Spraying of 0.2 per cent DDVP or Dimethoate on mulberry plants and leaves are used for rearing after 17 days.

6.3 Jassids

These are small green insects commonly called as leaf hoppers. Its scientific name is Empusa flavescens. These pests attack during October-May and suck plant sap from the veins on the underside of the leaf. While feeding, a virus is introduced by the hoppers into the leaf which cause ‘hopper burn’. These spots are triangular brown at the tip and end of each vein indicating hopper bite. The affected leaf rolls and becomes scorched these spots slowly spread complete leaf. During this stage the main vein will be green. The tender leaves are damaged first and later lower leaves causing much damage to crop.
6.3.1 Life cycle

Adult female lays pale yellow color and elongated in shape, on the lower surface of the leaves below the epidermis. The eggs hatch in 4-9 days. The newly hatched nymph resembles adult but wingless. It is pale green in colour. This nymph starts eating the leaf and grow slowly on the same leaf. It moult 4 times and becomes adult. The adult is pale green and measures 2-4mm in length, with tapering posterior end. The adult and nymphs moves sideways. These pests jump to reach other leaves or plants. Pupation takes place on the leaf itself.

6.3.2 Control

a. Light traps to trap adults.

b. Sprinkler irrigation

c. Spraying of DDVP at 0.05% (safe period after 3 days) or Dimethoate at 0.1% (safe period after 10 days) to control the pest.
6.4 Mealy bug

Maconellicoccus hirsutus is a common mealy bug on mulberry. These insects are vectors of the virus disease. Tukra disease of mulberry considered to be caused by a virus for which mealy bug is the vector. The plant affected by this tukra show curling of leaves at the growing point, thickening and shortening of the internodal region and resetting of the leaves at the apical end.

6.4.1 Life cycle

Each adult female lays 350-500 eggs in a loose cottony terminal ovissac during a week’s time. The eggs are elongated and orange colored. Depending on the climatic condition the eggs hatch in about 5-10 days. The newly hatched crawlers are orange in color. The body is covered by white powdery secretions giving the name mealy bug. The females have three while males have four nymphal instars which are passed in about 25 and 26 days respectively. The adult reproduce parthenogenetically. They don’t feed but mate and die in 2-3 days.

These occur in summer months. The leaf yield is tremendously reduced and are depleted in nutritive values. The leaves are wrinkled and dark green in color.

Fig. 6.3 a Infected Plant (Tukra)
6.4.2 Control

a. Affected shoots are removed and burnt.

b. Spraying of 0.01 parathion, safe period is after 13 days.

c. Soil application of phosphate at the rate of 4 kg per hectare after pruning. Safe period is 45 days after first application.

d. Biological control by introducing predator like Cyptolaemus montrouzieri (Mils).

6.5 Scale insects

These are red and black in colour. Generally when these insects are in small numbers, the damage caused is negligible. Since these are fast breeders thus cause much damage to the plant. When the attack is severe the branches dry and leaves turn yellow and finally plant dies. The common Indian scale insects are Saissetia nigra (black scale) and Aonidella aurantii (red scale).
The black scale insects occur on the stem and branches. They suck the cell sap and kill the plant. The surface of the attacked stems are covered all over with scales. The lenticles are completely hidden thus respirative rate of the plant cells are considerably lowered. Yellowish or mottled appearance of the leaf blade can also be noticed.

The red scale attacks the twigs, branches, stems. It does not attack older plant. In heavy attack the leaves become yellow finally the whole plant dries up and die.

6.5.1 Life Cycle

Adult female lays 300-600 eggs which are minute, white, elongated. The eggs change color to reddish brown with age. The female shields the eggs which hatch in 6 days. The hatched nymphs, within few hours crawl and select the place of feeding on the stem. It secretes a fibrous waxy material which hardens to form the scale. The female moults three times while the male twice, during which appendages are lost. Thus makes the insect sedentary. These reproduces pathogenetically.

Fig. 6.4 Mulberry scale insect

a. Male scale b. Female scale
c. Dorsal view of female adult d. Ventral view of female adult
6.5.2 Control

a. Cutting and burning of attacked branches.

b. Diesel oil and soap emulsion (1:3) swabbing on the stem to dislodge the scale insects.

c. Lime-sulphur swabbing on stem.

d. Spraying of 0.05 per cent malathion, safe period 10 days.

e. Release of predator coccinellid – Chilocorus kuwaneae.

f. Spreading of parasitic fungus Attarctium indicum is also helpful.

6.6 Thrips (Thysanoptera)

Five different species cause damage to mulberry. The attack is frequent during the summer season (Feb-June). The common Indian species is Pseudodendrothrips mori. These insects affect the leaves. The epidermal tissue is injured. Early maturity, depletion of moisture, reduction in crude protein and total sugars are met with the affected leaves. Leaves become unsuitable for healthy silkworm rearing. Leaves show streaks in the early stages of attack, which become yellowish brown on maturity.

6.6.1 Life Cycle

Females (0.9 mm) are larger than males. Adult males are brownish yellow, female is dark brown in color. Female lays 30-50 bean shaped yellow colored eggs on the ventral side of the leaf. Within 6 – 8 days nymphs hatch which are pale yellow colored. The nymphs moult four time in 15 – 18 days to form adult with fringed wings.
6.6.2 Control

a. Sprinkler irrigation

b. Spraying of 0.02 per cent DDVP twice at weekly intervals to kill nymphal and adult stages and leaf is used after 7 days.

6.7 Mites

These are characterized by four pairs of legs in the adult stage. Two species Tetranychus equitorius and T. telarius are found in India. Theses mites suck plant sap inducing white specks at the place of feeding. The increased feeding produce large patch. Presence of spider mite on the mulberry appears silky. In severe infestation the leaves lose their green healthy color, appear rusty and finally dry and fall.

6.7.1 Life cycle

The adult (newly emerged) are light pinkish in color and later attains reddish color with pale-yellowish legs. The female insect lays 45-140 eggs on the ventral side of the leaves as well as among webs. The eggs are smooth, spherical, translucent, incubate in 5 days. The hatched larvae are
light amber colored which changes into light greenish with dark lateral specks and finally turn to dark green. The larvae are attached to the leaf and completes its period in two days. The larva changes into nymph in four days which finally molt into adult. Total duration of life cycle is about 10 days.

Fig. 6.6 Female adult mite

6.7.2 Control

a Sprinkler irrigation.

b Spraying of Zolone or Thiodon 0.05 per cent. The safe period is after 9 days.
6.8 Beetles

6.8.1 Stem girdler beetle

The insect Sthenias gresator is a common pest in India. This nocturnal insect girdles the young or green stem, the bark and wood are nearly cut around the main stem leaving a clear girdle. The upper portion of the girdle gradually wilts and dry.

6.8.1.2 Life Cycle

The adult insect is stout built with strong mouth parts especially mandibles. The female beetle deposits eggs underneath the bark of the girdled branch at night. The eggs hatch in about 8 days. The hatched grub tunnels into the wilting branches and feeds. The grub changes into pre-pupa and pupa inside the tunnel. The life cycle is completed in 7-8 months duration.

Fig. 6.7 Stem girdler

a. Affected stem  b. Egg  c & d. Grubs
e. Pupa  f. Adult
6.8.1.3 Control

a. Affected branches are cut and burnt.

b. Swabbing of base of branch with 0.1%, BHC (safe period -11 days) or 0.1% malathion emulsion (safe period -11 days).

6.8.2 Powder pest beetle

Sinoxylon pubens shows characteristic presence of the white powdery substance extruded from the stem holes. The affected stem is killed gradually due to tunneling by the insect. These pests are identified easily. This pest is controlled as said above.

6.8.2 Myllocerus species (Weevils)

There are four species identified in India. The adult and grubs damage the plants. The adults feed on leaves and buds while grubs depend on underground parts (roots). Adult feeding results in irregular serrated margins on foliage. These insects complete 3-5 generations in a year. Thus in severe attack the plants wilt and dry.

Fig. 6.8 Weevil Adult

6.8.3.1 Control

a. Digging of soil up to a depth of 7-8 cm to destruct eggs, grubs and pupae.

b. Spraying of 0.01 per cent quinalphos (safe period - 7 days) or 0.02% methyl parathion (safe period - 10 days) or malathion (safe period - 8 days).
6.9. **Grasshopper**

The Neorthacris acuticeps nilgriensis nymphs and adults voraciously feed and reduce leaf yield considerably.

6.9.1 **Life cycle**

Adult wingless grass hopper is green in color. Female adult lays 6-8 egg pod each having 11-18 eggs. These egg pods are deposited in the loose soil at a depth of 2-3 cm which hatch in 28-31 days. The nymph passes six moults to become adult. The early nymphs are light brown while late instars are green in color. It completes the life cycle in 5-6 months.

6.9.2 **Control**

a Exposure of egg masses by deep ploughing.

b Spraying of 0.5% BHC. Safe period is after 10 days.

![Wingless grasshopper (Adult)](image)
SUMMARY

- Large number of insects and non-insects depend on mulberry for food and shelter which definitely cause damage reflecting on the low quality and quantity of cocoon production.

- Such insects which cause damage are called pests.

- The damage to the mulberry is during larval and adult stages of insect pest.

- Bihar hairy caterpillar devour the leaf very fast and defoliate the plant leaving only veins.

- These larvae cluster together on a single leaf. The final larvae has white, yellowish brown and black hair.

- Leaf hoppers cause hopper burn by which leaf rolls and becomes scorched.

- Mealy bugs cause tukra disease which is characteristics of curling of leaves at the growing point, thickening and shortening of the internodal region and resetting of the leaves at the apical end.

- The newly hatched bugs are covered with white powdery secretions giving the name mealy bug.

- When the scale insect attack is severe the branches dry and leaves turn yellow and finally plant dies. The scale insect suck the cell sap and kill the plant. The lenticles are completely covered by scales.

- Thrips affect leaves which are unsuitable for rearing.

- Mites suck plant sap and leaves turn to rusty color and finally dry and fall off.

- Stem girdle beetle girdles the branches or shoots with its powerful mandibles thus the branches wilt and dry.
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- Power pest beelte shows white powdery substance extruding stem/shoot holes.
- Myllocerus species damage foliar and root parts.
- Wingless grasshopper feeds on leaf and reduce leaf yield.
- Affected stem/branches are separated and burnt.
- Spraying of pesticides at required doses and utilizing the leaf after safe period can control the pest.
- Deep digging and ploughing to expose insect life stages to direct sun.
- Flood irrigation to drive away the pupae.
- Sprinkler irrigation to kill nymphs and adults.

**QUESTIONS**

I. **Short Questions**

1. Define pest.
2. What is hopper burn?
3. What is tukra disease?
4. What is causative organism of hopper burn?
5. What damage is caused by stem girdler?
6. Name some mulberry pests.
7. What is the causative organism of shoot holes?
8. How do you control scale insects?
9. What is the damage caused by Bihar hairy caterpillar?

10. What is the damage caused by mites?

11. How do you control thrips?

12. What is the causative organism of tukra?


14. How do you control stem girdler?

15. What are the symptoms of damage caused by weevil?

II. Essay Questions

1. Detail about Bihar hairy caterpillar?

2. Detail about life cycle of scale insects?

3. Jassids are serious pests - comment.

4. Describe about thrips.

5. Describe about mealy bug.

6. Write short notes on
   a) Mites   b) Grass hopper   c) Tukra

7. Write short notes on
   a) Powder pest beetle   b) Weevils   c) Mealy bugs

8. Write short notes on
   a) Thrips   b) Hopper burn   c) Scale insects.
7

Uses of Mulberry

7.1 Introduction

Mulberry cultivation is the main and initial aspect of sericulture. It is closely associated with other aspects as they directly depend upon mulberry. Thus all these are closely associated and are interdependent. And one need to have a clear idea and an approach to utilize all the benefits of any farming. Because all biological material are natural and can be recycled easily which can generate profits and add to net return of farm income. Further such utilization will not cause any disturbance to the nature. Therefore the most important factor of the planning will be the adoption of new technology to get more profits. A proper planning with an integrated approach definitely gives good results. Mulberry cultivation has additional advantages besides lead production. Every part of it can be generated into a product to get good cash returns. Like other aspects of sericulture and crops, mulberry cultivation also leaves some by-products at every level which are better utilized in many ways. One can surely get employment where he is involved to collect the product and sale. Mulberry leaf, stem, branches, roots, bark, fruits, wood are having medicinal, ornamental and other values which are detailed in this chapter.

7.2 Medicinal uses

Mulberry the sole food of silkworm is said to have many medicinal values and is made use of in treating febrile diseases and even diabetes. It contains different chemicals of medicinal value in leaf, fruit, stem and root portions.

7.2.1. Leaf

1. Mulberry leaf juice has a special quality of moisturizing nature for the skin which keeps the skin smooth and healthy.

2. The leaf juice prevents throat infections, irritation and inflammations of throat.
3 Leaves are used for preparing a decoction known as mulberry tea. It can be mixed with roots, stem to prepare a broth which is effective in lowering the blood pressure, blood sugar.

4 Leaves are also used as cattle feed. Rabbits have a great liking for mulberry leaves and grow well when fed on them. The body weight and growth is more when fed with mulberry. The mountain sheep fed with these leaves increase their milk yield, and milk is tastier, more concentrated.

7.2.2. Fruits

1 Mulberry fruit juice is commonly used for preventing high fever as Febrifuge during endemic malaria, except when the patent is suffering from diarrhoea.

2 Fruit juice is used to prevent diarrhoea and cold but should be prevented when patient has amoebiasis.

3 Fruit juice has capacity of reducing high fever. It is used to provide excessive strength for withstanding the effect of high fever.

4 Mulberry fruit can be used as a vitamin supplement as it contains carotene, thiamin, nicotinic acid, riboflavin and ascorbic acid.
5. Fruit is principally used in the preparation of syrup which possesses refrigerant and laxative properties and also used as laxative for infants. Juice may be used as drink in febrile diseases.

6. Oral juice administration checks thirst, cools the blood.

7. Fruit is used for sore throat, dyspepsia and melancholia.

8. The organic acids of fruits induce appetite and helps in digestion also.

9. Fruit is used prepare juice and jams which are rich in nutrients.

10. In Europe, a wine is prepared by the fermentation of fruits because of high source of vitamin C.

7.2.3 Stem/shoot

1. The stem contains the steroid sapogenine. Aqueous extract of the stem is active against Gram-positive bacteria and yeast.

2. The bark is used as purgative and vermifuge. A substance which are effective in improving hair growth in higher animals. In experiments using some of these substances on angora rabbits and Coliadale sheep, the fur growth improved to 111-115 units in rabbits and to 101-117 units in sheep against 100 units in normal animals.

3. The extract of shoot has certain polysaccharides including pectin, glucose and forms a viscous material which is used for making the skin and hair soft.

4. The shoots have latex producing capacity, has the property of healing the wounds and injuries.

5. The roots of black mulberry Morus nigra has a special effect on the pancreas and glycojenolysis. The root juice is good for diabetic patients as decoction which reduces the blood suga.
6 Root possesses cathartic, antihelminthic and astringent properties.

7 The medicine prepared from the root called Glucosidase can be used to reduce high blood pressure.

8 An alkaloid deoxyjirimycin (DNJ) is extracted from the roots of black mulberry and found to inhibit the enzyme glycosidase and considered to be a potential drug against AIDS.

7.3 Ornamental uses

Mulberry wood has a specific fibre, latex and cellulose content, hence used to manufacture cricket bats and stumps, tennis rackets and hockey sticks. The phloem of mulberry shoots can give cotton fibres and used as supplementary cotton. Artificial leather can also be produced by preparation of this enzyme and can be used for desizing in textile industry. In Europe and China paper is also being manufactured utilizing the bark of immature and mature stem of mulberry. Shade-dried young twigs are used to prepare boxes. Mulberry wood can be used as timber for buildings. We can see huge mulberry trees all along the Himalayas being used as timber. Because of its specific character of shining, smoothness, right molding, turnery quality of wood, can also be used for making door furniture materials.

7.4 Other uses

The over-mature leaves and leaf stalk are good source of carbohydrates and proteins can effectively be used in biomass production. The leaf waste and leaf parts like stalks left behind in the tray during silkworm rearing are collected to feed sheep / goat rearing.

Mulberry planted as a shade tree along roadsides, railway embankments and hedges of farm. The leaves of these are used for silkworm rearing. Like all trees it can be used as fuel. Dried twigs, pruned branches, dead trees etc. are used as firewood. These can be used directly or indirectly after converting them to charcoal. The shoots can be conveniently used as fencing material to make thick mats. These branches can also be used for fresh cutting preparation for plantation.
Mulberry fruits are expected in the middle of May-June. These are white to whitish pink, purple to dark purple in color. People in North India grow these mulberry trees only for fruits. Morus macrocarpa fruits grow up to 8 cms long. These fruits are used in juice and jam preparation. This tree is familiar to public as the fruits of Jamun tree. In China, providing mulberry leaf juice is the most common hospitality in the villages for a visitor. Japanese have already isolated a hormone called Moranolone which contains five carbon atoms and one nitrogen atom. Its use as medicine is yet to be confirmed. In Greece it is fermented to derive intoxicating beverage. The fruit has special taste and attracts women who are on their family way. This is due to vitaminic which gives a sour taste and makes them chew the fruit repeatedly.

**SUMMARY**

- Mulberry can be used in different ways because of its uses besides feeding silkworm to get silk.

- Different plant parts of mulberry are used for mankind in medicine, sports, ornaments etc.

- It can be used as leaf, leaf juice as a medicine to cure various human diseases/disorders besides to generate biomass and as a fodder for cattle, rabbit, sheep/goats to yield more milk and meat for human consumption.

- The fruits can be used as fruits, jams, juices etc. for endemic malaria, diarrhea, high fever, as a laxative, cool drink, sore throat, dyspepsia, melancholia, to induce appetite, to prepare wine, as a source of vitamin C, coloring agent.

- The mulberry stem or shoots bark is used for improving hair, growth, to make cream for skin and hair softening to heal wounds and injuries.

- The root juice are good for diabetic patients, high blood pressure, antihelminthic, astringent and for AIDS.

- Wood is used for sports material, timber for building, furniture, artificial fibre/leather, as a desizing material, firewood, coal.
Uses Mulberry

- Shoots are used for fencing, mat preparation, cutting preparation.

- Bark or peeled bark is used to prepare quality handmade paper, ropes, nets.

QUESTIONS

I. Short questions

1. Name some parts of mulberry of medicinal use.
2. What are the uses of mulberry fruit?
3. What are the uses of mulberry stem?
4. What are the uses of mulberry roots?
5. What are the uses of mulberry leaf?

II. Essay questions

1. Detail medicinal uses of mulberry plant.
2. Describe ornamental and other uses of mulberry.
8

Seri Biotechnology

8.1 Introduction

The term Biotechnology indicates is the product of interaction between science and technology. The discovery of biotechnology dates back to 1920 when Chaim Weizmann converted starch into butanol and acetone; the latter was an essential component of explosives during World War-I. During World War II Alexander Fleming (1929) produced penicillin from cultures of *Penicillium notatum*. And third rediscovery of biotechnology is about recombinant DNA technology.

This branch of science can be defined as “the application of biological organisms systems or processes to manufacturing and service industries” (British Biotechnologists).

It is “the controlled use of biological agents, such as micro-organisms or cellular components, for beneficial use” (US National Science Foundation).

At present biotechnology has a wide scope in tissue, organ culture, gene technology, hybridoma and monoclonal antibodies, medicines, protein/enzyme engineering, metabolic engineering, agriculture, industrial microbiology, environment, intellectual property rights.

Biotech centres in India are Indian Agricultural Research Institute (IARI), New Delhi; National Dairy Research Institute (NDRI), Karnal; Indian Veterinary Research Institute (IVRI), Izatnagar; Later nine Distributed Information Centres (DICs), 14 user centres were established in the area of bioinformatics. They are IISc, Bangalore; MKU, Madurai; Bose Institute, Calcutta; JNU, New Delhi; Poona University, Pune; IARI, New Delhi; CCMB, Hyderabad; NII, New delhi; IMTECH, Chandigarh.
8.2 Tissue and Organ Culture

Tissue and organ culture is a process to grow cells, tissues, organs in an artificial medium. It is conducted in vitro process. In this method a plant part is taken and introduced into glass equipment in aseptic condition into a suitable nutrient medium after sterilization. Every tissue, organ or any plant part requires a proper medium. These mediums are specific to different species depending on the requirements of nutrients. Many propagating mediums passes inorganic salts, vitamins, sucrose, auxins, gibberellins, cytokinins, food stuffs growth regulators in different quantities. These are mixed as per the plant requirements. This culturing has nutrient medium, aseptic condition, air circulation phases.

8.2.1 Tissue Culture in Mulberry

8.2.1.1. Nutrient medium

It is called basic medium having sugar, inorganic substances, vitamins. When plant material is kept on this medium an undifferentiated cell mass callus develops. The auxins present in medium induces root system and cytokinins induce stem system. These materials are dissolved in distilled water to mix them in medium. Coconut milk, fruit juices east are mixed with medium for vitamins and hormones. Otherwise commercial products available in the market can also be used. The Ph must be 5.8. The medium is made semisolid by adding 1% agar. The method described by Murash and Skoog are followed to prepare the medium.

8.2.1.2 Aseptic condition

The nutrient medium is favourable for various microorganism to undergo proliferation thus aseptic condition is necessary. The medium is transferred into glass equipment and kept in autoclave of 120°C temperature, 30 pounds pressure for 15 min. then plugged with sterilized cotton. The tissue or plant organs are surface sterilized by 0.5 percent sodium hypochloride or mercury chloride. The medium is kept in inoculation chamber and plant material is introduced into the medium.
8.2.1.3 Aeration

It can be done by keeping the tissue on the surface of semi solid nutrient medium.

8.2.2 Process of culturing

The basic medium is prepared with sucrose, inorganic substances, vitamins. The NAA, NBA are added to get Auxins and Kinetin for cytokinin. To make it semi solid medium one percent agar is added and made aseptic. Plant parts are surface sterilized to introduce into nutrient medium and kept in an air conditioned chamber. Callus develops in four weeks which will be transferred into a plastic pot. A separate medium is prepared for this purpose. The pot is kept at 20 – 25°C for two more weeks and later can be transplanted in shade and in the field.

8.2.2.1 Importance of Tissue Culture

a) Large number of plants produced in a short period.

b) Any plant part can be developed into a plant.

c) Pest resistant varieties can be produced by taking plant tissues material from virus-infested plant.

d) Disease resistant hybrids can also be produced.

e) Seed fertility can be known by reducing democracy.

8.3 Plant Biotechnology

This branch of science is aimed to conduct cell culture, tissue culture for mutant selection in relation to crop improvement. Further production of secondary metabolites i.e. alkaloids, glucosides (steroids and phenolics), terpenoids and a variety of flavors, perfumes, agrochemicals are also produced. The yield of these chemicals in cell culture is though generally lower than in whole plants, it can be substantially increased by manipulating physiological and biochemical conditions.
Other techniques like micropropagation, synthetic seeds, production of virus-free plants, maintenance of male sterile parents for hybrids, propagation of hybrid plants, overcoming crossing barriers, endosperm culture, nucellus culture, production of haploids and to use in plant breeding programmes isolation of protoplast and culturing regeneration of plants. Gene transfer methods, transgenic plant propagation for crop improvement, molecular farming, targeting of foreign proteins into mitochondria, molecular mapping of plant genomes, isolation and purification of different enzymes for medical and clinical food industry, industrial uses.

Protein engineering, metabolic engineering for over production of metabolites and for use of microbes in industry and agriculture are the aspects of plant biotechnology practices in the present days with an aim to develop various industries for mankind.

8.3 Silkworm biotechnology

Central silk board (CSB) established a Seribiotech Research Laboratory (SBRL) at Bangalore as an R & D component of NSP during 1993. The objectives of SBRL are

- To conduct research in frontier areas of modern biology and to seek potential applications of this work to improve silk productivity.
- To interact with the other institutions doing basic and applied research in sericulture and other allied areas.
- To disseminate technology developed to the targets through the other R & D constituents of CSB.

The lab has been assigned analysis of genome of diapausing and non-diapausing silkwarms for the purpose of molecular tags and to generate DNA profile of various silkwarms strains, germplasm screening, to evaluate genetic distance and to use in marker based gene cloning etc. The molecular marking is a tool for breeders to practice "DNA Marker Assisted Breeding" to efficiently incorporate the genes of interest such as for larval maturity period, disease resistance, cocoon weight, cocoon shell weight for developing new strains. DNA markers can be conveniently used for genetic
fingerprinting, population and pedigree analysis, to screen the existing germplasm.

Chinese scientists have mapped the genome (genetic make-up) of silkworm *Bombyx mori*. Silkworm is the first lepidopteran to have its genome mapped. These scientists identified five key genes relating to gender control, growth and immunity. They also found 1874 genes associated with the silk gland. Silkworm has an estimated 18510 genes. These findings are of great advance to sericulture practicing countries to have novel strains in the near future.

**SUMMARY**

- Biotechnology has a wide scope for the development of science, engineering technology.
- Biotech centres are established in certain potential parts of India.
- Plant biotechnology is aimed towards crop improvement.
- Chinese Scientists have mapped the genome of *Bombyx* and found 1874 genes associated with the silk gland.
QUESTIONS

I. Short questions.

1. Define Biotechnology.
2. Mention some biotech centres.
3. Expand IARI, NDRI, IVRI.
5. Mention any two techniques of biotech.
6. What is the main function of SBRL?
7. Which country mapped the genome of Bombyx?
8. How many genes are present in Silkworm?
9. Define tissue culture.
10. Define medium.

II. Essay Questions.

1. Write organ and tissue culture.
2. Write about plant biotech.
3. Write about seri biotech.