Entrepreneurial Technical Information Packages

Rashmi Singh
J.P. Sharma
M.S. Nain

Division of Agricultural Extension
ICAR-Indian Agricultural Research Institute
New Delhi-110012
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Rashmi Singh
Jagdish Prasad Sharma
Manjeet Singh Nain

Division of Agricultural Extension
ICAR-Indian Agricultural Research Institute
New Delhi - 110 012
There is need to commercialise and diversify Indian agriculture in such a way that one can generate more income per unit of area and time and create agro-based employment opportunities. Entrepreneurship is considered as an effective strategy and a milestone in multi-lateral development of countries. Entrepreneurship Development in agriculture is an important way out to bring a transformation in rural areas. Developing agriculture based enterprises and making farmers entrepreneurial is needed urgently to pave the way for evergreen revolution.

Over the years, IARI researchers have developed many technologies which need commercialization and uptake by farmers on a large scale. Division of Agricultural Extension of Indian Agricultural Research Institute have motivated, trained and facilitated establishment of small agri-based ventures by farmers, youth and farm women. But, there is dearth of adequate technical information in this respect among potential farm entrepreneurs. How these technologies can be converted into commercial ventures, how much profit they can fetch, how much investment is needed, can it be done on leased land; are some of the questions which normally plague the farmers interested in taking up such agricultural technology based ventures. Entrepreneurs have special needs in understanding the potential technologies for enterprises. Appropriate Entrepreneurial Technical Information Packages (ETIPs) are not readily available to farmers for adoption. There is need to develop and validate Entrepreneurial Technical Information Packages (ETIPs) of selected IARI technologies which farmers can adopt.

An initiative in this direction was done under IARI research project “Enhancing Entrepreneurship among Youth” during 2009-2014 where an effort was made to develop appropriate Entrepreneurial Technical Information Packages (ETIPs) of selected IARI technologies which can be adopted by farm youth, farmers and farm women to start their own profit making ventures and earn better from the same
land. The six validated ETIPs presented in this book are discussed technically, economically as well as giving several entrepreneurial ideas for their up-scaling. Mushroom cultivation, Vermicomposting, Bee Keeping, Baby Corn Cultivation, Tomato Seed Production and *Parthenocarpic* Cucumber production in Protected Structures are the six ETIPs included.

I congratulate the project researchers and authors for bringing out this book for the benefit of potential agri-entrepreneurs. I am sure that the technical information along with economic details will suffice the information needs of would be entrepreneurs and would be helpful to Krishi Vigyan Kendra trainers also.

(Ravinder Kaur)
Preamble

Large population in India is still dependent on agriculture for their livelihood. Agripreneurship is emerging as solution to many economic problems like poverty, unemployment, migration towards urban areas and rural youth’s disenchantment with agriculture. Developing agri-enterprises and making farmers entrepreneurial is needed urgently to pave the way for evergreen revolution. There is a great need to make farmers entrepreneurial and this is an achievable proposition since the characteristics of entrepreneurs are not inherited but can be developed through systematic motivational training and capacity building of farmers. Entrepreneurial opportunities and special government provisions are helping agri-enterprises to be developed.

However, most of the farmers and rural youth who are desirous of starting their own agri-enterprises face lack of information about the exact procedures to adopt and how much to invest. Several studies have highlighted the need for developing information packages for would be entrepreneurs wherein they get the information regarding technical methods but also about the economic feasibility and profits to be expected. For farmers to become entrepreneurs they need all type of information before its establishment and also they need to be innovative and forward-looking. They need to manage their businesses as long-term ventures with a view to making them sustainable. They need to be able to identify opportunities and seize them. Information is very important for any successful starting and running of enterprises. The core areas in which an entrepreneur seeks information before its establishment are not only the technical details but also the project economics. Researchers usually give in detail the methodology, precautions to be taken as well as diseases, pests and overall management but what a potential entrepreneur needs besides these details is that how much he will be investing and when he will start making profits.

Appropriate Entrepreneurial Technical Information Packages (ETIPs) are not readily available to farmers for adoption. Due to this gap, many farmers are not able to reap benefits of good technologies developed by research institutes. IARI Perspective Plan Vision 2025 underlined the importance of ‘Rural Entrepreneurship Development’ for transforming rural areas. It envisages “to promote implementable farm innovations into commercial ventures with full participation of the local people”. It details the expected outcome of generating a manual for conversion of farm innovations into commercial enterprises.
Thus, in 2009 an action research project entitled “Enhancing Entrepreneurship among Rural Youth” was taken up which aimed at developing such Entrepreneurial Technical Information Packages based on selected IARI implementable technologies which farmers can adopt and earn better from the same land. An attempt has been made to develop such packages and six technologies are being published here as holistic ETIPs which discuss detailed production technologies, market possibilities and economic returns expected along with the investment needed. The technical analysis concerns the projects inputs (supplies) and outputs (production). It is extremely important, and the project framework must be defined clearly enough to permit the technical analysis to be thorough and precise. Economic and Financial analysis gives a potential agripreneur with a preparedness to go ahead and make some effective decisions resulting in success. Six agricultural technologies including Protected Cucumber Cultivation, Tomato Seed Production, Baby corn cultivation, Mushroom cultivation, Vermi-composting, and Bee-keeping were selected and ETIPs developed for these technologies, tested and refined with actual practitioners’ participation as well as experts’ validation.

We are thankful to the guidance and timely opinions provided regarding subject matter in their respective disciplines by Drs; R.K. Sharma (Plant Pathology), R.K. Sharma (Entomology), R.K. Palta (Agronomy), V.K. Yadav (DMR), A.K. Singh (DMR), B.S. Tomar (SPU), Sudipta Basu (SST), Balraj Singh (CPCT) and R.K. Thakur (AICRIP-Honey Bee). A heartfelt gratitude is hereby acknowledged for many practitioners interviewed to get the field level data for this compilation.

We believe that this will be useful for the potential entrepreneurs who wish to start their own ventures for income generation and economic growth. These ETIPs would also be helping the extension functionaries and trainers of KVKs in spreading the spirit of entrepreneurship nationwide.

Rashmi Singh, J.P. Sharma & M.S.Nain
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About the Authors

**Dr. Rashmi Singh**, is Principal Scientist at Indian Agricultural Research Institute, New Delhi having an experience of 24 years. She is an accredited Entrepreneurial Motivation Trainer and has been part of EDP unit at the Division of Agricultural Extension of IARI since the pioneering efforts were taken in 1995 for Entrepreneurship Development in Agriculture at the Institute. She has conducted research studies on Enhancing Entrepreneurship among Rural Youth and her doctoral work is on Women Entrepreneurship Process. She has been teaching PG course on Entrepreneurship development and conducted many training courses on the topic whereby a cadre of master trainers all over the country have been developed. She has also been recognized as an International Expert on Women Entrepreneurship by Asian Productivity Organization, Japan. She has completed a NABARD funded project as Principal Investigator on developing seed producer entrepreneurs. She has to her credit 110 publications out of which 30 research papers are in peer reviewed national and international journals, besides authoring 3 trainers manuals and PG teaching Manual on Entrepreneurship.

**Dr. J.P. Sharma**, Joint Director (Extension), IARI, New Delhi has a vast experience of 28 years conducting strategic research, guiding, teaching post graduate students, conducting national/international training programmes and carrying out agricultural extension activities in the farmers’ field. He has to his credit researches on highly relevant topics like assessment, refinement of agricultural technologies, peri-urban agriculture and entrepreneurship development. He is an accredited Entrepreneurial Motivation Trainer and has been founder team member of EDP unit at the Division of Agricultural Extension of IARI. He has published more than 300 papers in reputed journals, magazines and newspapers, published 30 books, bulletins and is editor of journals of repute like Journal of Community Mobilization for Sustainable Development. He is member of various professional committees and has been invited as expert by various organizations. He is Founder President, Society for Community Mobilization for Sustainable Development and Secretary, International Federation for Women in Agriculture. He has received more than 60 national and international awards/recognition for contributing towards upliftment of the farming community.

**Dr. Manjeet Singh Nain**, Senior Scientist, Agril. Extension, IARI, New Delhi has 17 years of professional experience in teaching, research and extension. He started his professional career from KVK of Cold desert of Ladakh and worked for 12 years at Sher e Kashmir University of agricultural Sciences and Technology of Jammu in the capacity of Assistant Professor and Associate Professor (Agril. Extension). He has published more than 100 papers including 50 research papers, 25 book chapters, two books technical papers and popular articles for farmers. His area of research includes; agricultural communication, diffusion of innovation, participatory methods, entrepreneurship development and training methodologies. He is recipient of Young Scientist award of society of Extension Education, Mobilization fellow in addition to other appreciations and Fellow of Indian Society of Extension education and member of editorial board of three professional journals.
Mushroom Production Enterprise

Mushroom production has tremendous potential as an income generating activity. Mushroom is important not only from nutritional and medicinal point of view but for export also. It requires little space or land and hence it is of great importance for landless and marginal land holders. It grows independent of sunlight, feed on organic matter and does not require fertile soil. In addition to floor, air space is also utilized resulting in higher productivity. Mushroom cultivation can provide additional income to farmers who wish to take up this activity especially in their lean season. The greatest advantage of this venture is the fact that mushrooms have capacity to convert nutritionally valueless substance like wheat or paddy straw in the nutritious delicacies. It also enables recycling of agro wastes like dung and chicken manure which otherwise are posing pollution problems.

Mushroom is a fungal body having no chlorophyll and, it is a parasitic plant. It depends upon other living or dead plants to obtain food. Mushroom is an excellent source of protein, vitamins, minerals, folic acid and is a good source of iron for anemic patients. Mushroom contains 19 to 35 per cent protein which is higher than most of vegetables and cereals. Its protein quality is as good as animal protein. Moreover, lysine and tryptophan protein which are absent in vegetables and cereals can be obtained through mushrooms.

Mushrooms are of different types:

a) Button Mushroom
b) Dhingri (Oyster) Mushroom
c) Paddy Straw Mushroom

Materials Required

1. Cereal Straw Fresh golden yellow paddy straw free from moulds and properly stored in a dry place not exposed to rain.
2. Plastic Sheet of 400 gauge thickness
3. Wooden Mould of 45x30x15 cms size each having no top or bottom but having a separate wooden cover 44x29 cms dimension.
4. **Hand Chopper** or Chaff cutter for cutting the straw.
5. **Drum for boiling straw** (minimum two).
6. **Jute rope, coconut rope or plastic ropes**
7. **Gunny bags**
8. **Spawn or mushroom culture** which may be obtained from the Office of the Assistant Pathologist, Mushroom Development Center for each block or registered sellers.
9. **Sprayer**
10. **Straw Storage Shed -10X8m size**

**Technical Details**

This section provides information regarding ‘Technical and Financial involvements’, including plant protection, compost production, preparation of growing culture (compost), harvesting, storage, processing, packaging, marketing linkages in order to increase employment opportunities and generating income.

1. **Production process**
   
   i) **Spawn (mushroom seeds):** Spawns are readily available in the markets. If desired, the same can be produced and sold commercially. Separate training may be attended to get mastery in spawn production.

   ii) **Compost preparation:** There are several mixtures for compost formation and anyone that suits the entrepreneur can be chosen. Agricultural by products like cereal straw (wheat, barley, paddy, oat and rice), maize stalks, hay, sugarcane bagasse or any other cellulose wastes can be used for compost preparation. Wheat straw is used, should be freshly harvested, shining yellow in colour and should not have been exposed to rains. The straw should be in about 5-8cm long pieces, otherwise heap prepared by long straw would be less
compact which may lead to improper fermentation. Conversely, too short straw makes heap too compact to allow enough oxygen to enter the centre of the heap leading to anaerobic fermentation. Wheat straw or any materials provide cellulose, hemicellulose and lignin, which are utilized by the mushroom mycelium as the carbon source. These materials also provide physical structure to the substrate needed to ensure proper aeration during composting for the buildup of microflora, which is essential for the fermentation. Rice and barley straw are very soft, degrade very quickly during composting and also absorb more water as compared to wheat straw. While using these substrates, care should, therefore, be taken on the quantity of water to be used, schedule of turnings and adjustment to the rate and type of supplements. Since the by products used in composting do not have adequate nitrogen and other components required for the fermentation process, compounding mixture is supplemented with the nitrogen and carbohydrates, to start this process. In synthetic compost straw is supplemented with nitrogen nutrients, organic and inorganic matter. In organic compost, horse dung is added. The compost can be prepared by long or short composting method. Only those who have pasteurizing facility can employ short method. In long method 7-8 turns at regular intervals are required for a period of 28 days. Good compost is dark-brown, ammonia free, little greasiness and having 65-70% moisture.

iii) **Spawning (mixing compost with spawns):** Spawning is mixing of spawn in compost for optimum and timely yields. Optimum dose for spawn ranges between 0.5 and 0.75% of fresh weight of compost. A bottle of spawns is good enough for 35 kg of compost spread over 0.75 sq.mt. area (about 2 trays). Lower spawn rates result in slow spread of mycelium and chances for diseases and competitors may increase. Higher rates may increase cost of spawning and very high rate of spawn sometimes results in unusual heating of compost. The optimum temperature for growth of *A. bisporus* is 23°C. Relative humidity in growing room should range from 85-90% during spawn-run.
For mixing spawn with compost any of the three procedures can be followed:

a) **Layer spawning**: Compost is divided into equal layers and spawns spread in each layer. Result is spawning in different layers.

b) **Surface spawning**: 3 to 5 cms of compost is remixed, spawns spread and covered with compost.

c) **Through Spawning**: Spawns are mixed with compost and pressed. Trays are then arranged in tiers in the cropping room and covered with newspapers. 2% formalin is sprinkled over them. Desired room temperature is around 23°C with 85-90% humidity.

iv) **Casing**: Spawned compost is covered with sterilized hay, chalk powder etc.

v) **Cropping**: Besides temperature and humidity mentioned above, proper room ventilation should be ensured. Mushrooms prop up in 30-35 days. Usually 3 to 4 days after opening the bags, mushroom primordia begin to form. Mature mushrooms become ready for harvesting in another 2 to 3 days. These fungal fruit bodies appear in flushes and harvested when buttons are tightly closed. In a cropping cycle of 8-10 weeks an average yield of 10 kg mushroom/sq meter is feasible. An average biological efficiency (fresh weight of mushrooms harvested divided by air-dry substrate weight x 100) can range between 80 to 150% and sometimes even more. A knife should not be used to harvest the mushrooms, they are grasped by the stalk and gently twisted and pulled. The mushrooms remain fresh up to 3 to 6 days in a refrigerator/cool place. Cropped mushrooms can be packed for marketing.

**Cropping Room**

- An ideal house/room would be an R.C.C. building, installed with proper insulation and provisions for heating and cooling the rooms. However, an indigenous low cost house has been recommended using locally available materials.
materials like bamboo, thatch and mud plaster. Walls of split bamboo plastered evenly with a mixture of mud and cow dung may be made.

- In order to provide a crude insulation system, a second wall is made all around the house keeping about 15cms space between the first wall and the second. Mud plastering should be done on the outside of the outside wall. The air space in between the two walls will act as an insulator, since air is a bad conductor of heat. An even better insulation could be provided if the space between the walls is filled with well dried thatch. The floor of the house should preferably be of cement but where it is not possible, a well-beaten and plastered mud floor will suffice. However, more care will have to be taken in case of a mud floor. The roof should be made of thick thatch layers or preferably asbestos sheets. A false ceiling is essential to avoid contamination of unwanted materials from the thatch roof. Besides the front door, ventilators should also be provided from both the upper and lower sides of the front and rear side of the room for proper exchange of air inside the room. The house/room should be installed /framed with horizontal and vertical bamboo poles.
required for hanging the block after the incubation period. The vertical poles can also be arranged in a 3 (three)-tier system as the incubation shelves. Poles should be preferably 60 cms away from the walls and in between each row of three tiers, a minimum space of 1 m should be maintained. A cropping room of 3.0 x 2.5 x 2.0 m will accommodate about 35 to 40 cubes.

![Image of mushroom blocks]

This method saves space and can be organized in a small area available, thus being more economical for small entrepreneurs.

Variety of mushrooms are produced using polybags hung vertically as depicted in pictures

Diseases and Pests

A number of diseases and pests may attack the mushroom crop if left uncared.

a) Disease

1. **Green mould** (*Trichoderma viridae*): It is the most common disease in oyster mushroom where green coloured patches are observed on cubes.

   **Control:** Dip a cotton swab in formalin solution (4%) and scrapped off the affected area. If the fungus attacks more than half of the cube then the entire cube should be discarded. Care should be taken that the contaminated cube is burnt or buried in a place far from the cropping room to avoid re-infection.

b) Insects

1. **Flies:** Scarid flies, Phorid flies, Cecid flies are found to be attracted to mushroom and odour of spawn. They lay eggs on the straw or mushroom, and the larva emerging from them damage the crop. Larva feed on the mycelium, mushroom and penetrate inside the fruiting bodies making it unfit for consumption.
Control: To check entry of adult flies during the cropping period, screen the doors, windows or ventilators, if any with 30 mesh nylon or wire net. Use fly-trap or repellent in mushroom house.

2. Mites: These are very thin, small crawling arthropods that appear on the mushroom body. They are not damaging, but annoy the grower when present in large numbers.
   Control: Maintain a hygienic condition of the house as well as its surroundings.

3. Slugs, Snails: These pests chew up portion of the mushroom which may later get infected with bacteria and affect the quality of the crop.
   Control: Remove the pests from the cubes and kill them. Maintain hygienic conditions.

Other Pests

1. Rodents: The attack by rodents is found mostly in low cost mushroom house (mud house). They eat the grain spawn and make holes inside the cubes.
   Control: Use rat poison bait in the mushroom house. Burrow of rats should be close down with glass pieces and plaster.

2. Ink caps (Coprinus spp.): It is a weed of mushroom that develop on the cubes before cropping begins. They subsequently disintegrate into a black sliming mass at maturity.
   Control: Physical removal of Coprinus from the cube is the only control measure recommended.

Precautions

“Prevention is better than cure” is the fundamental motto of mushroom growing since it is a very delicate crop and curative measures are often difficult.

It is difficult to control the fungal diseases of mushroom with chemicals, as mushroom itself is a fungus and the chemicals used against the disease may affect the mushroom itself. Thus, infinite care has to be exercised from the very start to discourage the entry of any foreign “germs” or contamination.

The very first requirement in mushroom growing is sanitation and hygienic conditions. Most of the problems in mushroom growing arise due to improper hygiene. Following care need to be taken for profitable Mushroom Production:

1. The room where mushrooms are to be grown should be thoroughly washed and then whitewashed with lime. The floor should also be limed.
2. The surrounding of the house should be devoid of stagnant drains, shrubs and other weeds as these harbour harmful diseases and insect pests.

3. At the entry of every room, there should be a trough filled with 2% formalin solution, wherein the shoes or feet must be dipped before entering the room.

4. The workers should be clean and preferably wear clean overalls.

5. No trash or surplus straw etc., should be left around the house.

6. In case of contamination, the contaminated block should be removed to a spot well away from the house and buried in a pit or burnt.

7. At the end of every cropping process, the room should be washed again white-washed and fumigated with formalin.

8. The plastic sheets should be washed thoroughly and then soaked in 2% formalin as a final wash and then dried out, after every lot is removed.

9. Any fallen bits of straw or mushroom should not be left on the floor of the room. Cleaning and cutting off of the base of the mushroom stalk should be done outside the growing room and properly disposed off.

10. Broken pieces of the mushroom stalk, during harvesting, should not be left on the blocks. If the stalk breaks, it should be removed entirely from the bed.

11. Clean straw is important for mushroom growing. While preparing the block, care should be taken that it is properly compressed. The more the compression, the better will be the spawn running.

12. Excessive moisture at any stage of growth is harmful. The environment should be damp but not wet. For this, a sprayer with a very fine nozzle is advisable to avoid large droplets. Excessive moisture will invite unwanted contaminants, which will be a hindrance, and in many cases will be serious competitors to the mushroom spawn.

13. While raising the temperature of the room, on requirement, care should be taken that there is no sudden rise in temperature. The temperature should be raised gradually till it attains the required level.

14. At the time of placing the block for spawn running do not place them on top of each other, otherwise this will generate excess heat. Place the blocks side by side in single layers only.

15. The block should not be left unopened in the plastic for more than 24 hours after the spawn has completely impregnated the straw.

16. There should be gentle exchange of air in the room with fresh air. Wind current cause drying and formation of malformed mushroom.
# Project Details of 8000 Kg Per Annum Production Target

## 1. Plant & Machinery

<table>
<thead>
<tr>
<th>S. no.</th>
<th>Item</th>
<th>Qty</th>
<th>Rate (Rs.)</th>
<th>Value (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Tray or wooden cases</td>
<td>450</td>
<td>150.00</td>
<td>67,500.00</td>
</tr>
<tr>
<td>2.</td>
<td>Sprayers with pump</td>
<td>3</td>
<td>1,750.00</td>
<td>5,250.00</td>
</tr>
<tr>
<td>3.</td>
<td>Mistomatic automatic humidifier or cooler</td>
<td>1</td>
<td>4,500.00</td>
<td>4,500.00</td>
</tr>
<tr>
<td>4.</td>
<td>Room heater/blower</td>
<td>3</td>
<td>2,000.00</td>
<td>6,000.00</td>
</tr>
<tr>
<td>5.</td>
<td>Other equipment (thermometers, fans etc.)</td>
<td>-</td>
<td>-</td>
<td>4,000.00</td>
</tr>
<tr>
<td>6.</td>
<td>Misc. tools</td>
<td></td>
<td></td>
<td>2,750.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>90,000.00</strong></td>
</tr>
</tbody>
</table>

## 2. Utilities (per annum)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>Amount (in Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Power (5 kw x 6 hrs x 200 days x Rs.3.50/-)</td>
<td>21,000.00</td>
</tr>
<tr>
<td>2.</td>
<td>Water</td>
<td>4,000.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25,000.00</strong></td>
</tr>
</tbody>
</table>

## 3. Raw material requirement (including consumable/month)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Items Annual</th>
<th>Quantity</th>
<th>Rate (Rs.)</th>
<th>Value (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Compost including casing soil</td>
<td>3000 kg</td>
<td>Rs.10/kg</td>
<td>30,000.00</td>
</tr>
<tr>
<td>2.</td>
<td>Spawn</td>
<td>400 trays (or 800 bottles)</td>
<td>Rs.16/tray (Rs.8/bottle)</td>
<td>6,400.00</td>
</tr>
<tr>
<td>3.</td>
<td>Chemicals (Formaline, pesticide, insecticide etc.)</td>
<td>L.S</td>
<td></td>
<td>4,000.00</td>
</tr>
<tr>
<td>4.</td>
<td>Packing material</td>
<td>L.S</td>
<td></td>
<td>2,000.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>42,400.00</strong></td>
</tr>
</tbody>
</table>

## 4. Manpower requirement

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Category</th>
<th>Nos.</th>
<th>Salary/person/month (Rs.)</th>
<th>Total monthly Salary (in Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Skilled</td>
<td>01</td>
<td>7,500.00</td>
<td>7,500.00</td>
</tr>
<tr>
<td>2.</td>
<td>Unskilled (20 days/month)</td>
<td>01</td>
<td>4000.00</td>
<td>4,000.00</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>11,500</strong></td>
</tr>
</tbody>
</table>
5. Working capital (at full capacity utilization)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Items</th>
<th>Period</th>
<th>Amount (in Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Raw material</td>
<td>15 days produce</td>
<td>21,200.00</td>
</tr>
<tr>
<td>2</td>
<td>Recurring expenses (power + wages)</td>
<td>1 month</td>
<td>18,000.00</td>
</tr>
<tr>
<td>3</td>
<td>Other misc. expenses</td>
<td></td>
<td>2,800.00</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>42,000.00</td>
</tr>
</tbody>
</table>

6. Cost of project

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item</th>
<th>Total cost (in Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Building (1000 sq.ft)</td>
<td>Self/on rent</td>
</tr>
<tr>
<td>2</td>
<td>Plant &amp; machinery (including installation)</td>
<td>90,000.00</td>
</tr>
<tr>
<td>3</td>
<td>Furniture &amp; fixture (including office equipment)</td>
<td>7,000.00</td>
</tr>
<tr>
<td>4</td>
<td>Preliminary &amp; preoperative expenses</td>
<td>3,000.00</td>
</tr>
<tr>
<td>5</td>
<td>Insurance, interest during implementation, contingencies including cost escalation, etc.</td>
<td>10,000.00</td>
</tr>
<tr>
<td>6</td>
<td>Working capital</td>
<td>30,000.00</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>1,40,000.00</td>
</tr>
</tbody>
</table>

7. Project Economics

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item</th>
<th>Total cost (in Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A.</td>
<td>Sales realization: Mushroom 8000 kg x Rs.50/kg. and compost (mushroom bed) [Rs.400000 + Rs.80000 p.a.]</td>
<td>4,80,000</td>
</tr>
<tr>
<td>B.</td>
<td>Cost of production</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Raw material (Rs.42400/produce x 3 produce including packing materials)</td>
<td>1,27,200.00</td>
</tr>
<tr>
<td>2.</td>
<td>Utilities (power, fuel, water etc.)</td>
<td>25,000.00</td>
</tr>
<tr>
<td>3.</td>
<td>Salary and wages (Rs.11500 x 12 months)</td>
<td>138,000.00</td>
</tr>
<tr>
<td>4.</td>
<td>Rent (Rs.2000 x 12 months)</td>
<td>24,000.00</td>
</tr>
<tr>
<td>5.</td>
<td>Transportation/freight</td>
<td>5,000.00</td>
</tr>
<tr>
<td>6.</td>
<td>Conveyance &amp; Traveling</td>
<td>5,000.00</td>
</tr>
<tr>
<td>7.</td>
<td>Administrative overheads (Telephone, postage, stationery etc.)</td>
<td>5,000.00</td>
</tr>
<tr>
<td>S. No.</td>
<td>Item</td>
<td>Total cost (in Rs.)</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td></td>
<td>Selling expenses (including advertising, distribution cost, commissions &amp; rebates)</td>
<td>10,000.00</td>
</tr>
<tr>
<td>9</td>
<td>Insurance &amp; misc.</td>
<td>4,500.00</td>
</tr>
<tr>
<td>10</td>
<td>Repair &amp; maintenance</td>
<td>5,000.00</td>
</tr>
<tr>
<td>11</td>
<td>Interest</td>
<td>8,300.00</td>
</tr>
<tr>
<td>12</td>
<td>Sustenance for applicant</td>
<td>30,000.00</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>3,87,000.00</td>
</tr>
<tr>
<td>C</td>
<td>Gross profit</td>
<td>93,000.00</td>
</tr>
<tr>
<td>D</td>
<td>Depreciation/@ 10% of fixed assets cost and amortisation of expenses</td>
<td>11,000.00</td>
</tr>
<tr>
<td>E</td>
<td>Net Profit (D-E)</td>
<td>82,000.00</td>
</tr>
</tbody>
</table>

**Entrepreneurial Ideas for Upscaling Mushroom Enterprise**

Author have visited a mushroom unit in Yogyakarta, Indonesia where a couple entrepreneur were proud owners of a unit of mushroom production and they have taken their unit to the next level of business where they established a specialty cuisine restaurant famous only for serving mushroom based dishes. Potential entrepreneurs can also learn from this innovative idea which has enough scope in Indian conditions as well, specially in peri urban areas.

Mushroom cultivator-entrepreneurs in Yogyakarta, Indonesia - owners of a special cuisine restaurant (mushroom based)
Vermi-composting Enterprise

There is a growing realisation that vermi-composting provides the nutrients and growth enhancing hormones necessary for plant growth. The fruits, flowers vegetables and other plants grown using vermi-compost are reported to have better keeping quality. A growing number of individuals and institutions are taking interest in the production of compost utilising earthworm activity. As the wastes are pulverised as they pass through the worm, the surface area of the material increases which in turn helps as base for nutrients.

Vermicompost, apart from supplying nutrients and growth enhancing hormones to plants, improves the soil structure leading to increase in water and nutrient holding capacities of soil. Chemical fertilizer in moderate doses can go along with vermicomposting. The cost of production of compost works out to about Rs. 1.5 per kg, and is quite profitable to sell the compost even at Rs. 2.50 per kg. Other organic manures like neem cake, groundnut cake, etc., are also available in market at same rates. Suburbs of cities and villages around urban centres can be ideal locations for practice of vermi-composting on a large scale, from the view point of availability of raw material and marketing of the produce. As use of the compost is said to have ameliorative effect on product from fruit, flower and vegetable crops, vermi-composting units may be located in areas with concentration of fruit, vegetable and floriculture units.

Vermicomposting unit in village Joye ki Madhaiya near Pilakhua (U.P.)
**Preparation of vermi-compost:** Earthworms live in the soil and feed on decaying organic material. 5-10% of the organic matter is digested by the cells and rest undigested material moves through the alimentary canal of the earthworm, a thin layer of oil is deposited on the castings. This layer erodes over a period of 2 months. Although the plant nutrients are immediately available, they are slowly released to last longer. The process in the alimentary canal of the earthworm transforms organic waste to natural fertilizer. The chemical changes that organic wastes undergo include deodorizing and neutralizing. The worm castings also contain bacteria, so the process is continued in the soil, and microbiological activity is promoted. *Vermicomposting* is the process of turning organic debris into worm castings. The worm castings are very important to the fertility of the soil. The castings contain high amounts of nitrogen, potassium, phosphorus, calcium, and magnesium. Castings contain 5 times the available nitrogen, 7 times the available potash, and 1½ times more calcium than found in good topsoil.

The process of composting crop residues and agri wastes using earthworms comprise spreading the agricultural wastes and cow dung in gradually built up shallow layers. The pits are kept shallow to avoid heat built-up that could kill earthworms. To enable earthworms to transform the material relatively faster a temperature of around 30°C is maintained. The final product generated by this process is called vermicompost which essentially consist of the casts made by earthworms eating the raw organic materials. One earthworm reaching reproductive age of about six weeks lays one egg capsule (containing 7 embryos) every 7-10 days. Three to seven worms emerge out of each capsule. Thus, the multiplication of worms under optimum growth conditions is very fast. The worm live for about 2 years. Fully grown worms could be separated and dried in an oven to make 'worm meal' which is a rich source of protein (70%) for use in animal feed. Vermicompost is ready for harvest when it contains few-to-no scraps of uneaten food or bedding.

For commercial production, the beds can be prepared with 15m length, 1.5 width and 0.6 height spread equally below and above the ground. While the length of the beds can be made as per convenience, the width and height cannot be increased as an increased width affects the ease of operation and an increased height on conversion rate due to heat built up. Cow dung and farm waste can be placed in layers @ 350 worms per m³ of bed volume that weighs nearly one Kg. The beds are maintained at about 40-50% moisture content and a temperature of 20-30°C by sprinkling water over the beds.

**Land**

About 0.5-1 acre of land will be needed to set up a vermi-culture production centre. The centre will have at least 8-10 sheds each of about 180-200 sq.ft. It
should also have a bore well/pump set or watering arrangement and other equipment as described in the scheme economics. If the unit has to be established on leased land, the land can be taken on lease for at least 10-15 years. Even sub marginal land also will serve the purpose.

**Buildings**

In a commercial large scale unit, considerable amount may have to be spent on buildings to house the office, store the raw material and finished product, provide minimum accommodation to the Manager and workers. The cost of the buildings along with the electrification of these buildings and the vermi-sheds may be included under this item.

**Seed Stock**

This is an important item requiring considerable investment. Though the worms multiply fast to give the required numbers within a period of 6 months to a year, it may not be wise to wait till such a time having invested on the infrastructure heavily. Thus, worms @ 350 worms per m³ of bed space should be adequate to start with and to build up the required population in about two cycles or three without unduly affecting the estimated production.

**Fencing and Roads/Paths**

The site area needs development for construction of structures roads and pathways for easy movement of hand-drawn trolleys/wheel barrows for conveying the raw material and the finished products to and from the vermi-sheds. The entire area has to be fenced to prevent trespass by animals and other undesired activity. These could be estimated based on the length of the periphery of the farm and the length and type of roads/paths required. The costs on fencing and construction of roads should be kept low as these investments are essential for a production unit, yet would not lead to increase in production.
Water Supply System

As the beds have always to be kept moist with about 50% moisture content, there is need to plan for a water source, lifting mechanism and a system of conveying and applying the water to the vermi-beds. Drippers with round the clock flow arrangement would be quite handy for continuous supply and saving on water. Such water supply/application system requiring considerable initial investments, however, reduces the operational costs of manual watering and proves economical in the long run. The cost of these items depends on the capacity of the unit and the type of water supply chosen.

Machinery

Farm machinery and implements are required for cutting (shredding) the raw material in small pieces, conveying shredded raw material to the vermi-sheds, loading, unloading, collection of compost, loosening of beds for aeration, shifting of the compost before packing and for air drying of the compost, automatic packing and stitching for efficient running of the unit. Costs of providing necessary implements and the machinery have to be included in the project cost.

Transport

For any vermi-composting unit transport arrangement is a must. If the source of raw material is away from the production unit, an off-site transport becomes major item of investment. A large sized unit with about 1000 tonnes per annum capacity may require at least one 3-tonne capacity mini-truck. With small units particularly with the availability of raw material near the site, expending on transport facility may become in fructuous. On-site transport facilities like manually drawn trolleys to convey raw material and finished products between the storage point and the vermi-compost sheds could also be included in the project cost.

Furniture

A reasonable amount could also be considered for furnishing the office-cum-stores including the storage racks and other office equipment. These arrangements enhance the efficiency of operations.
Operational Costs

In order to operate the unit, expenditure on some items have to be incurred on recurring basis. These items include salaries of the staff, wages to the labourers, cost of raw material, fuel cost on transport of raw materials and finished goods, packing material cost, repairs and maintenance, power, insurance, etc. The number of office personnel and labourers have to be decided breaking each activity into a number of sub-activities and for each sub-activity estimating the work involved and the capacity of the labour to finish the work in a given time. The number of persons should be so chosen to keep them engaged throughout by providing enough persons at various work points like stores, vermi-beds and equipping them with adequate number of implements to avoid undue waiting.

Project Profile

Vermi-composting could be taken up on any scale starting from 10 tonnes per annum (tpa) to 1000 tpa and above. As the production is proportional to the vermi-bed space, it is advantageous to start with less capacities and later it can be expanded after gaining production experience and developing assured market for the product.

A bed volume of 330 m³ spread over sixteen beds - 15 m long, 1.5 m wide and 0.3 m high is estimated to produce vermi-compost of 200 tpa over 5 cycles/crops of 75 days each annually. These beds may be housed in 8 open sheds of 15 m x 5.4 m.

The construction cost of sheds, cost of machinery and tools, operational cost/production cost of compost are set out. As can be seen, the investment cost is Rs.2,77,000/-, operational cost Rs.3,68,000. Operational cost of two cycles amounting to Rs.1,47,200 is capitalised. Production of 60% in the first year and 90% in the subsequent years is assumed. Benefits include the income from sale of vermi-compost @ Rs.2500 per tonne and worm @ Rs.50/- per kg. The net income from the 2nd year onwards would be about Rs.1,36,000 annually. The financial analysis of the project suggests that the activity is financially viable. Economics have been worked out without the subsidy component. With the subsidy its viability will be much better.
Project Details of 200 Ton Per Annum (TPA) Production Target

Estimate for construction of temporary shed for setting up 200 TPA vermi-compost unit (Size 8 m x 15m x 5.4 m)

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Particulars</th>
<th>Quantity</th>
<th>Rate (Rs.)</th>
<th>Amount (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wooden ballies (3 m long)</td>
<td>472</td>
<td>25</td>
<td>7800</td>
</tr>
<tr>
<td>2</td>
<td>Wooden ballies (3.6 m long)</td>
<td>48</td>
<td>30</td>
<td>1440</td>
</tr>
<tr>
<td>3</td>
<td>Bamboos (3 m long)</td>
<td>800</td>
<td>15</td>
<td>12000</td>
</tr>
<tr>
<td>4</td>
<td>Bamboos (6 m long)</td>
<td>240</td>
<td>20</td>
<td>4800</td>
</tr>
<tr>
<td>5</td>
<td>Bamboo mats for covering the roof</td>
<td>720</td>
<td>25</td>
<td>18000</td>
</tr>
<tr>
<td>6</td>
<td>Coir rope 6 mm dia</td>
<td>200 kg</td>
<td>15</td>
<td>3000</td>
</tr>
<tr>
<td>7</td>
<td>Binding wire for tying bamboos &amp; mats</td>
<td>100 kg</td>
<td>25</td>
<td>2500</td>
</tr>
<tr>
<td>8</td>
<td>Labour charges for erection of sheds</td>
<td>LS</td>
<td></td>
<td>20000</td>
</tr>
<tr>
<td>9</td>
<td>Miscellaneous</td>
<td></td>
<td></td>
<td>2460</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>72000</strong></td>
</tr>
</tbody>
</table>

Implements and machinery

*Total operational cost for one cycle of 75 days*

Bed volume 330 m³ Recovery percent: 30%

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>Unit</th>
<th>Rate</th>
<th>Amount (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Agricultural waste @ 320 kg per m³</td>
<td>105.6 ton</td>
<td>100</td>
<td>10560</td>
</tr>
<tr>
<td>2</td>
<td>Cow dung @ 80 kg/m³</td>
<td>26.4 ton</td>
<td>150</td>
<td>3960</td>
</tr>
<tr>
<td>3</td>
<td>Worms @ 350/m³ 500 worms per kg</td>
<td>231 kg</td>
<td>50</td>
<td>11550</td>
</tr>
<tr>
<td>4</td>
<td>Formation of vermi bed with agro-waste, cow dung and worms</td>
<td>330 m³</td>
<td>46</td>
<td>15180</td>
</tr>
<tr>
<td>5</td>
<td>Harvesting, sieving, packing, etc., including cost of bags</td>
<td>40 ton</td>
<td>0.45</td>
<td>18000</td>
</tr>
<tr>
<td>6</td>
<td>Electrical charges for pump, machinery, lighting etc.</td>
<td>-</td>
<td>-</td>
<td>4800</td>
</tr>
<tr>
<td>7</td>
<td>Repair and maintenance</td>
<td>-</td>
<td>-</td>
<td>7950</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>72000</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Cost for 5 cycles</strong></td>
<td></td>
<td></td>
<td>360000</td>
</tr>
<tr>
<td></td>
<td><strong>Rent on lease @Rs 8000/year</strong></td>
<td></td>
<td></td>
<td>8000</td>
</tr>
<tr>
<td></td>
<td><strong>Total Operating Cost</strong></td>
<td></td>
<td></td>
<td><strong>3,68,000</strong></td>
</tr>
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</table>
## Cost and Benefits

<table>
<thead>
<tr>
<th>Sl. N.</th>
<th>Item</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Costs</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) <strong>Investment costs</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Open sheds with bamboo mat roofing over bamboo frame work supported by wooden <em>ballies</em></td>
<td>72000 -</td>
</tr>
<tr>
<td></td>
<td>ii) Machinery and tools</td>
<td>80000 -</td>
</tr>
<tr>
<td></td>
<td>iii) Office-cum-store</td>
<td>60000 -</td>
</tr>
<tr>
<td></td>
<td>iv) Water source</td>
<td>60000</td>
</tr>
<tr>
<td></td>
<td>v) 2 tanks</td>
<td>5000</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>277000</strong></td>
</tr>
<tr>
<td></td>
<td>b) <strong>Operational cost</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>For 5 cycles in a year @ Rs. 72,000 per cycle of 75 days</td>
<td>360000 360000</td>
</tr>
<tr>
<td></td>
<td>Lease rent</td>
<td>8000 8000</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>368000 368000</strong></td>
</tr>
<tr>
<td>2</td>
<td><strong>Benefits</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Sale of vermi-compost of 200 tons @ Rs.2500/- per ton (60% in first year and 90% from 2nd year onwards)</td>
<td>300000 450000</td>
</tr>
<tr>
<td></td>
<td>b) Sale of worms @ 5 kg per ton of compost and Rs. 50 per kg</td>
<td>- 45000</td>
</tr>
<tr>
<td></td>
<td>c) Consultancy &amp; ext. services</td>
<td>- Free</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>300000 504000</strong></td>
</tr>
</tbody>
</table>

* Net Benefit: 79200* 136000

*Operational cost for two cycles is capitalized in the first year*

## Financial Analysis (in lakhs rupees)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars</th>
<th>Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Costs</td>
<td>1st  2nd year onward</td>
</tr>
<tr>
<td>A</td>
<td>Capital Cost</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Buildings</td>
<td>1.32 -</td>
</tr>
<tr>
<td></td>
<td>ii) Machinery / tools</td>
<td>0.8 -</td>
</tr>
<tr>
<td></td>
<td>iii) Water supply system</td>
<td>0.6 -</td>
</tr>
<tr>
<td></td>
<td>iv) Tanks</td>
<td>0.05 -</td>
</tr>
<tr>
<td>B</td>
<td>Operational cost</td>
<td>3.68  3.68</td>
</tr>
<tr>
<td></td>
<td><strong>Total Cost</strong></td>
<td>6.45  3.68</td>
</tr>
<tr>
<td>S. No.</td>
<td>Particulars</td>
<td>Years</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>2</td>
<td>Benefits</td>
<td></td>
</tr>
<tr>
<td></td>
<td>i) Sale of vermi-compost</td>
<td>3.00</td>
</tr>
<tr>
<td></td>
<td>ii) Sale of worms</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>iii) Consultancy and extension services</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><strong>Total benefit</strong></td>
<td><strong>3.000</strong></td>
</tr>
<tr>
<td>3</td>
<td>Net benefit</td>
<td>0.792</td>
</tr>
</tbody>
</table>

**Unit as an Extension Centre**

The unit is expected to provide extension services to the nearby villages through supply of cultural material of the desired species, and train farmers and farm entrepreneurs is setting up their own small units for use in their farms. The technical graduate who will establish such an unit under the scheme for agri-clinics will train more people, demonstrate practically the production methodology on the unit that will be set up by him and also supply the pure culture with quality worms. He may also try to explore marketing for small units that will be promoted by him at reasonable cost. The following benefits can be assumed under extension services for the unit, which have not been included in analysis of economics:

- Sale of culture material
- Consultancy for setting up new units @Rs. 1,000/- per unit and say 10 units per year comes to Rs. 10,000/-.
• It is advised that the same unit will also construct models of simple, alternate methods of compost making to serve as demonstration to the local farmers. One of the simple method comprise of construction two tanks of size 10x6x3 feet at a suitable location. In addition any other simpler low cost methods also may be installed to consultation with research institutions/Universities and give wide publicity to popularise the sustainable practices for wider adoption.

Precautions during the process

The following precautions should be taken during vermi-composting:

• The African species of earthworms, *Eisenia fetida* and *Eudrilus eugeniae* are ideal for the preparation of vermi-compost. Most Indian species are not suitable for the purpose.

• Only plant-based materials such as grass, leaves or vegetable peelings should be utilized for preparing vermi-compost.

• Materials of animal origin such as eggshells, meat, bone, chicken droppings, etc are not suitable for preparing vermi-compost.

• *Gliricidia* lopping and tobacco leaves are not suitable for rearing earthworms.

• The earthworms should be protected against birds, termites, ants and rats.

• Adequate moisture should be maintained during the process. Either stagnant water or lack of moisture could kill the earthworms.

• After completion of the process, the vermi-compost should be removed from the bed at regular intervals and replaced by fresh waste materials.

Use of Vermi-compost

• Vermi-compost can be used for all crops: agricultural, horticultural, ornamental and vegetables at any stage of the crop.

• For general field crops: Around 2–3 tonnes per hactare vermi-compost is used by mixing with seed at the time of sowing or by row application when the seedlings are 12–15 cm in height. Normal irrigation is followed.

• For fruit trees: The amount of vermi-compost ranges from 5 to 10 kg per tree depending on the age of the plant. For efficient application, a ring (15–18 cm deep) is made around the plant. A thin layer of dry cow dung and bone meal is spread along with 2–5 kg of vermi-compost and water is sprayed on the surface after covering with soil.
• For vegetables: For raising seedlings to be transplanted, vermi-compost at the rate of one tonne per hectare is applied in the nursery bed. This results in healthy and vigorous seedlings. But for transplants, vermi-compost at the rate of 400–500 g per plant is applied initially at the time of planting and again at 45 days after planting (before irrigation).

• For flowers: Vermi-compost is applied at 750–1000 kg per hectare

• For vegetable and flower crops vermi-compost is applied around the base of the plant. It is then covered with soil and watered regularly.
Bee Keeping for Enhanced Profits

Bee keeping is an agro based enterprise, which farmers can take up for additional income generation. Though, collection of honey from the forests has been in existence for a long time, but honey bee keeping has emerged as an income generation activity even for those who don’t have much land for farming. Also, in modern times due to health concerns, there is a growing market potential for honey and its products which has highlighted bee keeping emerging as a viable enterprise. Honey and wax are the two economically important products of bee keeping. Honey bees convert nectar of flowers into honey and store them in the combs of the hive. Honeybee is one of the important pollination agents of flowers.

Indian honey has a good export market and preferred by Indian consumers because of its medicinal properties. With the use of modern collection, storage, beekeeping equipment, honey processing plants and bottling technologies the potential export market can be captured. Beekeeping could be a great decision for a person who wishes to launch his own enterprises without huge start up costs and limited space.

Why Beekeeping?

- It is an income generation activity resulting in profits for farmers.
- Bee keeping requires less time, money and infrastructure investments.
- Honey and beeswax can be produced from an area of little agricultural value.
- Bee keeping does not compete for resources with any other agricultural enterprise.
- Bee keeping has positive ecological consequences. Bees play an important role in the pollination of many flowering plants, thus increasing the yield of certain crops such as sunflower and various fruits. Under traditional method of honey hunting many wild colonies of bees are destroyed. This can be prevented by raising bees in boxes and producing honey at home.
- Honey is a delicious and highly nutritious food.
- Bee keeping can be initiated by individuals or groups.
- The market potential for honey and wax is high.
Bee Keeping in India

Honey and bee keeping have a long history in India. Honey was the first sweet food tasted by the ancient Indians inhabiting rock shelters and forests. They hunted bee hives for this gift of god. India has some of the oldest records of bee keeping in the form of paintings by prehistoric man in the rock shelters. With the development of civilization, honey acquired a unique status in the lives of the ancient Indians. They regarded honey as a magical substance and was given credit for maintaining health, vigour, fertility of not only humans but also of cattle and plants.

In India bee keeping has been mainly forest based. Several natural plant species provide nectar and pollen to honey bees. Thus, the raw material for production of honey is available free from nature.

Tribal populations and forest dwellers in several parts of India have honey collection from wild honey bee nests as their traditional profession. The methods of collection of honey and beeswax from these nests have changed only slightly over the millennia. The major regions for production of this honey are the forests and farms along the sub-Himalayan tracts and adjacent foothills, tropical forest and cultivated vegetation in Rajasthan, Uttar Pradesh, Madhya Pradesh, Maharashtra and Eastern Ghats in Orissa and Andhra Pradesh.

With the development of apiculture (bee keeping) using the indigenous bee (Apis cerana), use of the European bee (Apis mellifera) also gained popularity in Jammu & Kashmir, Punjab, Himachal Pradesh, Haryana, Uttar Pradesh, Bihar and West Bengal. Wild honey bee colonies of the giant honey bee and the oriental hive bee have also been exploited for collection of honey.
Bee hives neither demand additional land space nor do they compete with agriculture or animal husbandry for any input. The beekeeper needs only to spare a few hours in a week to look after his bee colonies. Beekeeping is therefore ideally suited to him as a part-time occupation. Beekeeping constitutes a resource of sustainable income generation to the rural and tribal farmers. It provides them valuable nutrition in the form of honey, protein rich pollen and brood. Bee products also constitute important ingredients of folk and traditional medicine.

**Resources and Potential**

The raw materials for the beekeeping industry are mainly pollen and nectar that come from flowering plants. Both the natural and cultivated vegetation in India constitute an immense potential for development of beekeeping. About 500 flowering plant species, both wild and cultivated, are useful as major or minor sources of nectar and pollen. There are at least four species of true honey bees and three species of the stingless bees. Several sub-species and races of these are known to exist. In recent years the exotic honey bee has been introduced. Together these represent a wide variety of bee fauna that can be utilized for the development of honey industry in the country. There are several types of indigenous and traditional hives including logs, clay pots, wall niches, baskets and boxes of different sizes and shapes. In modern beekeeping, the combs are built on wooden frames that are moveable.

**Different Species of Honey Bees**

There are four well known species of true honey bees in the world:

1. Rock bee, *Apis dorsata*
2. Little bee, *Apis florea*
3. Asian bee, *Apis cerana*
4. European bee, *Apis mellifera*

Out of these four bees species, *Apis dorsata* and *Apis florea* are wild and are open nesting and cannot be domesticated in modern hives. Each colony of *A. dorsata* yields 30-40 kg of honey per year whereas *A. florea* yields only about 500g per colony. *A. cerana* and *A. mellifera* are domesticated in modern hives and are cavity nesting i.e. live in enclosures. The wild bees construct single comb whereas hive bees construct multiple parallel combs. The body size as well as the comb cell size of these bee species varies to a great extent.

Among the two domestic bee species, each has many subspecies in different parts of the world e.g. *A. cerana* has three subspecies in India like *A. cerana* in
Himachal Pradesh and Jammu Kashmir (North India), \textit{A.cerana} indica in Kerala, Tamilnadu and Karnataka (South India) and \textit{A.cerana} Himalaya in Nagaland, Manipur, Mizoram, Assam and Meghalaya (Eastern Parts of India). In addition to above three subspecies, \textit{A.cerana japonica} has been identified from Japan. Honey yield of \textit{A.cerana} per colony per year is 3-5kg.

\textit{A.mellifera} has many subspecies which can be placed under three groups:

1. Eastern subspecies: \textit{Apis mellifera remipes} (in Iran), \textit{A.mellifera syriaca} (in Syria, Israel and Lebanon) These subspecies are not suitable for modern beekeeping

2. European subspecies: \textit{A.mellifera mellifera} (Dark Dutch or German bee), \textit{A.mellifera carnica} (Carniolan bee; in Southern Austria), \textit{A.mellifera ligustica} (Italian bee; Italy), \textit{A.mellifera caucasica} (Caucasian Bee; USSR)

3. African subspecies: \textit{A.mellifera intermissa} (Tellian bee; Morocco and Lybia), \textit{A.mellifera lamarckii} (Egyptian bee; restricted to the Nile Valley), \textit{A.mellifera capensis} (Cape bee; the only bee which can rear queen from eggs laid by workers), \textit{A.mellifera adansonii} (African bee; also known as killer bee)

**How to differentiate a sub species from species?**

Species: Species are reproductively isolated from each other and these cannot interbreed.

Sub species: Subspecies are geographically isolated and can interbreed. In addition to honey bees of genus \textit{Apis}, stingless honey bees also provide honey; these are: \textit{Melipona sp.}, \textit{Trigona sp}. These bees are also domesticated, but produce little amount of honey (250g per colony).

In India, all the four bee species are found. \textit{A.mellifera} is an exotic bee which was introduced in India for the first time successfully in 1962 at Nagrota Bagwan, Himachal Pradesh. Honey yield from this species from stationary beekeeping varies from 10-15 kg/colony but through migration yield increases to 45-60 kg/colony. One bee keeper in Himachal has extended as much as 110kg honey from a single colony of \textit{A.mellifera} which is indicative of its potential.

**Other species found in different parts of the world:** In addition to the four true honey bee species, more species have been found in some parts of the World.

- \textit{A.laboriosa} (from Nepal) resembles \textit{A.dorsata}.
- \textit{A.koschevnikovi} (from Malaysia) resembles \textit{A.cerana}.
- \textit{A.andreniformis} (from China) resembles \textit{A.florea}.
- \textit{A.nuluensis} (Malaysia, Indonesia) resembles \textit{A.cerana}.
- \textit{Nigrocincta} (Indonesia) resembles \textit{A.cerana}.
Differences between two hive bees: It is important to know differences among the two hive bee species, *A. cerana* and *A. mellifera* which are enlisted below:

<table>
<thead>
<tr>
<th><strong>A. cerana</strong></th>
<th><strong>A. mellifera</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tongue length varies from 4.39 to 5.53 mm.</td>
<td>Tongue length varies from 5.4 to 7.2 mm.</td>
</tr>
<tr>
<td>They make 21-25 workers cells per 10 linear cm comb.</td>
<td>They make 17-19 workers cells per 10 linear cm comb.</td>
</tr>
<tr>
<td>Average honey yield is 3-5 kg/colony.</td>
<td>Average honey yield is 10-15 kg/colony.</td>
</tr>
<tr>
<td>Prone to swarming, absconding, robbing and development of laying workers.</td>
<td>Good honey gatherer, swarms less and gentle in temperament.</td>
</tr>
</tbody>
</table>

**Understanding the Bees**

The bee colony consists of the live bees, including the brood but not including the structure they live in. The hive is the bee colony plus the structure around them: the wooden boxes owned by beekeepers, a hollow tree, or any other structure they might find. Sometimes a colony will not have a hive, for example a swarm of bees that is searching for a place to live. In practice, many beekeepers use the terms colony and hive interchangeably.

The queen is the heart of the colony and is usually the mother of all the other bees in the colony. Her abdomen is slightly cone-shaped and enlarges greatly when she is actively laying eggs. The workers are sterile females, numbering up to 60,000 per colony. They are true to their name — tending the larvae, feeding the queen, cleaning the hive, grooming each other, constructing beeswax comb, guarding the hive, foraging for nectar and pollen, making honey, and keeping the hive warm or cool as needed. Drones are the hopelessly lazy male bees. They do nothing but eat and wait for afternoons with hopes of meeting a young queen bee. A drone can be recognized by his enormous black eyes which cover most of the head. His thorax and abdomen are stockier than those of a worker bee. Both his eyes and his powerful flight muscles are key to his success on a mating flight.

Each bee starts as an egg, which is incubated in its hexagonal, wax cell for three days. It hatches to become a tiny, white, worm-shaped larva. The larva eats food placed in its cell by the workers, and grows very rapidly for about six days. By the time the larva is fully grown it has filled its wax cell. The workers then cover the cell with wax. Soon the larva becomes a pupa, which is the transitional stage between larva and adult. As the pupa matures wings, legs, eyes, antennae, hair and all the other adult bee organs develop. At the end of the pupal stage, the bee chews an opening in the cell cap and crawls out. It is now an adult bee.
The development periods for the three types of bee are shown below in Table 1. These numbers are very useful for a beekeeper to memorize. With them we can make a lot of sense out of what we see in the hive.

Table 1. Approximate development times (in days)

<table>
<thead>
<tr>
<th></th>
<th>Egg</th>
<th>Larva</th>
<th>Pupa</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Queen</td>
<td>3</td>
<td>5 ½</td>
<td>7 ½</td>
<td>16</td>
</tr>
<tr>
<td>Worker</td>
<td>3</td>
<td>6</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>Drone</td>
<td>3</td>
<td>6 ½</td>
<td>14 ½</td>
<td>24</td>
</tr>
</tbody>
</table>

We can understand more about the honey bee colony by learning details of the lives of the individual bees. An outline of the lives of a queen, worker and drone follows:

**Queen Bee**

The queen begins her adult life when she emerges from her peanut-shaped queen cell. If you see the cell just after her emergence, you may see the circular hole she cut for herself at the bottom. The worker bees destroy the empty queen cell soon after the queen has emerged. For this reason, queen cells are seen only in a hive when queens are reared, or just afterward. As a young virgin, the queen will appear relatively small. She is able to walk quickly across the comb because her ovaries have not yet enlarged. She may be difficult for the beekeeper to find because she is not much larger than the worker bees. A few days into her adult life, she takes flight in search of a drone congregation area. This is a location that can be near the hive, but is often quite a distance about 50 feet above the ground where hundreds of drones are circling. Her mating flight will be during the afternoon, usually on a warm sunny day. The queen mates with many drones in rapid succession, and then returns to her hive. If the queen was unsuccessful in finding enough drones for mating she may try another mating flight within the following days. The sperms so obtained will be sufficient to fertilize her several hundred thousand eggs during her two or three years.

When the queen is ready to lay an egg, she first inspects the inside of a beeswax cell. If the cell is empty and clean, she then turns around and inserts her abdomen. The queen is able to control the sex of the egg she lays. If the egg is to be female, she releases a bit of sperm from her spermatheca as the egg passes through her reproductive tract. Fertilized eggs are female and will develop into workers or queens. If, however, the egg is to be male (drone) the queen withholds sperm as the egg passes. Unfertilized eggs develop into drones. The queen’s ability to control the sex of her offspring is one of her most valuable traits. In this way drones may be produced only for the mating season. As spring
progresses, the young, mated queen in a healthy hive devotes herself entirely to the task of laying eggs. If the workers bring an abundance of nectar and pollen home, the queen is fed accordingly. In May and June she lays 1000 to 2000 eggs daily if she’s aided by a strong colony. That’s by almost continuous activity day and night. Most of her eggs develop into the workers that run the whole hive. When foraging slows in midsummer, the queen is fed less and her egg production tapers off. Her ovaries shrink and she becomes slightly smaller. The last eggs will be laid in October. For the queen, winter is a time only for waiting in the middle of the cluster. The ball of worker bees surrounds and warms her. In February she is fed more and stimulated to lay a few eggs.

With springtime’s abundant forage and increasing worker bee population, the queen bee is fed more and more by the workers. Most of this food is royal jelly, the glandular secretion which is generated by the worker bees. Royal jelly is also fed to larvae as they develop into queens. The queen returns to her role as an “egg-laying machine”. This second year, however, she will do more than lay eggs in worker and drone cells. In April, May or June she will find a few wax queen cups which have been constructed by the worker bees.

When the eggs in queen cells hatch, the workers feed the new young larvae royal jelly. This liquid is thick enough to be suspended inside the cells. The workers add wax to the cells, extending them downward. Since they are created in anticipation of the swarming process, they are often called swarm cells.

The colony typically rears more queens than it will actually need for the swarming process, so there is a rivalry among these new queens. The colony is now on the verge of swarming, a dramatic process in which one honey bee colony becomes two or more colonies. Just as her queen daughters are ready to emerge from their cells, the original queen leaves the hive with a cloud of worker and drone bees. They quickly settle in a cluster somewhere near the hive, often on a branch.

The most mature new queens in the hive chew open the bottoms of their cells. The worker bees may prevent their exit by holding them inside until their mother has left, and then release one from her cell. The first queen out then hunts for the other queen cells and kills the queens in them by stinging through the cell wall. As the survivor, she has become the new queen. She inherits the original nest from her mother and reigns over the bees which have remained in the hive. A populous colony may generate a second and even a third swarm shortly after the first prime swarm departs. These are called after swarms. Each after swarm leaves with one of the new virgin queens, which must mate after her colony finds a permanent nest site. Older queens lay fewer eggs and relatively more drone eggs. Eventually the worker bees begin to feed royal jelly to some
of the young female larvae, initiating queen cells. These are supersedure cells. One of these daughter queens is allowed to emerge, mate and begin laying eggs. Often the original, mother queen remains in the hive during this process, but she is fed less and less by the workers. Gradually she is starved and dies. This process is called supersedure. If you see two queens in a hive, you might be witnessing supersedure in progress.

**Worker Bee**

The young adult worker chews her way out of her brood cell and joins her many nest mates. One can often observe emerging workers when examining a frame of nearly mature capped worker brood. Within a few hours of her emergence, the young worker can be identified by her slightly whitish hair and awkward movements. She is unable to fly or sting for the first day of her adult life. She feeds herself on honey and pollen to strengthen herself. By the second day she starts to help the colony with the first of a series of tasks: cleaning cells. Several days later her brood food glands have developed and she is able to secrete food for young larvae. This worker is now a nurse bee. A few days later she is old enough to secrete wax from a set of eight glands under her abdomen. If the colony needs new comb, she may participate by pulling newly secreted wax scales from her abdomen and molding them into hexagonal cells. Other workers that are one to several weeks old will fill colony needs by guarding the hive entrance (guard bees), ripening honey, circulating air through the hive by fanning their wings, and attending the queen. Some specialize as “undertaker bees”, removing dead nest mates by dropping them outside of the hive. Individual bees generally perform one or a few tasks at any given time but switch as per age and the needs of the colony change.

At the age of two or three weeks, a worker first ventures outdoors for a play flight for memorizing landmarks, the direction of the sun and the appearance of her hive. Once she discovers a patch of blooming flowers, she specializes in that type of flower. Specialization is part of the efficient nature of the colony. Some worker bees specialize on water or propolis collection. The spring and summer life of a worker bee is concerned much with brood rearing and foraging. A worker bee will fly many miles daily and her wing margins eventually become badly tattered. Workers rarely live longer than two months during this time. Their job in winter will be to cluster, consume honey, and generate heat. The winter bees live from four to six months for this wintering process to be successful. For this reason a beekeeper should nurture as many well-fed bees into fall as possible. A good beekeeper should be aware of the worker bee tasks, their relationship to the ages of the bees and their function in the colony.
Drone Bee

The drone bee leads a simple and melancholy life. It usually begins in late spring time or early summer, when the queen is most inclined to lay male eggs in drone cells. When the drone emerges from his cell as a young adult he feeds himself on honey and pollen. Within a few days he is ready to fly. His first flights may be primarily play flights. Eventually he begins to fly to a drone congregation area. He fills up on honey before each flight in order to be airborne for as long as possible. These flights continue on sunny afternoons for as long as he is able. A small number of the drones in a colony, about 1%, actually succeed in mating with a queen. Those that do so die immediately afterward.

Those drones that survive until fall are evicted from the hive as they would be nothing but honey consumers in winter. Since the drones are unable to rear brood, clean the hive, secrete wax, sting, forage or perform other useful tasks, they would be only a liability during winter and early spring. Drones have no stingers, so they are useless for colony defense. Watch the hive entrance on a warm day after the first cold October nights. Drones are dragged struggling from the hive by the workers. If one breaks free the workers capture him again and force him out, perhaps stinging him in the process. Finally, the exhausted drones are left to die outside.

Understanding the Hive

The bees need a place to live. Beekeepers need to be able to open and examine it without destroying the carefully constructed comb. Consequently, we use hives with removable frames. The equipment is made to standard dimensions so that hive parts are interchangeable, even if they are bought from different companies or different manufacturers.

Hive Parts

One or two deep boxes, or brood boxes, sit on a bottom board. This is usually where the queen is active. Smaller boxes, supers, rest on top of the deep boxes. All of these boxes are called hive bodies. Some beekeepers use deep boxes as honey supers. However, a deep box with 9 or 10 frames of honey can weigh over 20 Kilograms. A super is more manageable. At harvest time, most beekeepers don’t want to carry this much at once. On top, an inner cover and outer cover shelter and insulate the whole hive. A brick or small cement block should be placed on the outer cover in windy locations. The outer surfaces of the hive should be painted with exterior house paint. Inner surfaces, the inner cover and the frames should never be painted. Some beekeepers treat the hive bodies, bottom board and outer cover with wood
preservatives instead of paint. Be careful not to use a wood preservative containing toxic substances. Generally hives are painted hives white but, any light colour will do. A multicoloured apiary is striking in appearance, and the different colours help the bees to identify their own hives but avoid dark colours. Consequently, drift among hives will be reduced.

The hive should be elevated a few inches above the ground. This helps with hive ventilation, reduces problems with weeds and grass growing in front of the hive entrances, and prevents wooden bottom boards from rotting. Use a very stable and level hive stand. Hive inspections, divisions, honey harvesting and all other manipulations became easy. All of the hive parts described above can be made from plastic also. At first it might seem that plastic is best because it cannot be damaged by rot, wax moths or mice. However wood has several important advantages. Most important, wood absorbs the odour of the bees. This hive odour is important to the bees, because they must recognize their own home this way. The plastic is a poor insulator compared to wood. In winter, condensation will develop on the inner plastic walls. All in all, the bees do better with wooden

A week after their combs were capped, well fed larvae have started pupating into fully formed nymphs. Twelve days after the beginning of this rest, a young bee is born.

Establishing and Maintenance of Bee Colonies
hive bodies, frames and inner covers. The outer cover can be plastic, or wood covered with metal sheeting.

**Location for the bee hives**

The best site for bee hives would be one which is accessible to the beekeeper, where the bees will thrive, and where they will not bother people or animals. Choose a spot which gets considerable sun, especially in the morning. It’s good to place the hive so that the entrance faces south or east. The sunlight stimulates bee activity, especially early in the morning. The location should be sheltered from the wind by trees, bushes or buildings. Bees need blooming flowers to make honey, so think about the plants which grow within two to three kilometers. Bees may fly up to five kilometers from the hive in search for flowering plants. The ideal rural location is one that is near a mixture of wooded and open weedy areas or orchards. Areas that include mostly grass land or tobacco are not helpful for the bees.

Towns and cities can also be good for honey production. The diversity of trees and gardens make for excellent honey production. If the hives are located in a backyard or any spot near your neighbours, a tall fence or row of bushes around your yard is must. The bees will fly above this barrier when they leave the hive, and continue to fly at that height.

Once colonies have attained full strength, the bees collect surplus honey from honey flow sources which should be available in abundance and secrete copious amount of nectar.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Common name</th>
<th>Botanical name</th>
<th>Source of nectar or pollen</th>
<th>Flowering period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Summer honey flow species</strong></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Toon</td>
<td><em>Toonaciliata</em></td>
<td>N+P</td>
<td>April-May</td>
</tr>
<tr>
<td>2.</td>
<td>Safeda</td>
<td><em>Eucalyptus sp.</em></td>
<td>N+P</td>
<td>March-May</td>
</tr>
<tr>
<td>3.</td>
<td>Robinia</td>
<td><em>Robinia pseudoacacia</em></td>
<td>N+P</td>
<td>April</td>
</tr>
<tr>
<td>4.</td>
<td>Bottle brush</td>
<td><em>Callistemon sp.</em></td>
<td>N+P</td>
<td>April-May</td>
</tr>
<tr>
<td>5.</td>
<td>Thistle</td>
<td><em>Cnicus sp.</em></td>
<td>N</td>
<td>May-June</td>
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<tr>
<td><strong>Monsoon honey flow species:</strong></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>1.</td>
<td>Khair</td>
<td><em>Acacia catechu</em></td>
<td>N</td>
<td>June-July</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Autumn honey flow species:</strong></td>
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</tbody>
</table>

Other sources of honey flow in other parts of Himachal and India are buckwheat, berseem, soapnut, jamun, sunflower, shisham, rubber, litchi, citrus, sarson, pigeon pea, terminalia etc.

*In areas with dense plantations*
Acquiring and establishing the bee colony

There are four ways to get a colony of bee hives. You can (1) get established hives from a beekeeper nearby, (2) get small hives made by dividing a beekeeper’s stronger hive (splits or divides), (3) purchase packages of bees from a commercial package bee producer, or (4) catch swarms. Each method has its advantages and disadvantages. An established hive may be purchased any time of year, but it’s not a good idea to move a hive in winter. The move disrupts the bees when they are trying to maintain their winter cluster. An established hive is easiest to move in early spring when the bee colony is smallest and its stored honey is depleted. Splits should be made only in the spring (April through June) when they will have time to grow in preparation for winter. Packages are shipped in April and May. Swarms are most frequent in spring and early summer. Package bees and swarms also need the whole summer to get ready for the coming winter.

Getting ready to work with the bees

As a part of the bees’ world, the beekeeper must learn how to disrupt the hive as little as possible. In this way the hive will function well and be less likely to sting. Vision and the sense of smell are most important. The bees see colours, but not exactly the same colours we see. They see a spectrum of colours from orange to violet and then to the next “colour” which is ultraviolet. Bees can’t see red, so red object looks black to them. Many flowers have ultraviolet patterns invisible to us. In general, bee-pollinated flowers are not red. Bees are inclined to sting dark objects because many natural predators are dark: bears, skunks, etc. So the beekeeper wears white or light colours. And remember that red counts as black for bees. Bees are also sensitive to rapid movements. Beekeepers, especially beginners, should move slowly when the hive is opened.

Like many insects, bees have a very acute sense of smell. They need this ability for several reasons —to discover flowers, to detect the pheromones of the other bees in their colony, and to detect enemies near their hive. And the bees will smell you too especially if you carry a strong scent from soap, perfume, or other scent. It might smell nice to your human friends, but the bees interpret it as a foreign odour and an invitation to sting. Before working with bees, try to make yourself as odour-free as possible. Additionally breathing or blowing into the hive while working it will excite the bees. Bees do hear, but sounds are much less important to bees than they are to people. Beekeepers may talk as they work the hives, without any apparent effects on the bees. Bees associate fuzzy clothing with their predators, which are also pretty fuzzy. Beekeepers should avoid textured clothing in favor of smooth cotton or synthetic fabrics. A white nylon windbreaker that is too smooth for the bees to get their stingers into is one example. It’s good in cool
weather but too warm during the summer. Suede leather would be about the worst possible clothing to wear because it looks, smells and feels like an animal. Vibration of the hive or the ground nearby is important to the bees. If you bump the hive or run a lawnmower nearby, the bees will be alerted and be more likely to sting. If tractors, mowers or weed eaters must be near the bees, the operator should wear a veil and full bee suit. Avoid opening the hive just after the bees have sensed vibrations and exhaust odours of machines near the hive.

Bees are very sensitive to the weather, and they apparently have their own internal barometers. When the barometric pressure drops, the bees sense that bad weather is on the way. They all come home from foraging, and they definitely don’t want anyone opening the hive at that time. Windy, cool or rainy weather also makes the bees grouchy. A hive with many bees is always more likely to sting, because it has more worker bees on guard duty. A hive without a queen is always more inclined to sting. Stings will always be a part of beekeeping but there are ways to greatly reduce the number of stings you get. The trick is to imagine what the bees are sensing based on how bees understand the world around them (above). With experience you will be able to anticipate the behavior of your bees.

The worker bee has a barbed stinger with a small venom sac attached. When you are stung, the barbs prevent the bee from removing her stinger from your skin. The bee breaks away from her stinger and dies soon afterward. But the stinger continues to inject venom even though the bee is gone. This is why you should remove the small, white venom sac left by a sting. Scrape it off with a hive tool, knife blade or fingernail.

The stinger releases a scent which can stimulate other bees to sting. This is called a sting pheromone. If you receive many stings you may notice it—a banana smell from the stingers. By removing the venom sac you will eliminate the source of the pheromone. It’s a good idea to remove the stingers in your gloves and clothing also. The queen has an un-barbed stinger which she uses only against rival queens. The drone has no stinger. If one experiences any of the following symptoms after stings, be aware that you may have a serious reaction to stings: light headedness, a flushed face, wheezing. These symptoms indicate a systemic (whole-body) reaction to the sting, and possibly an allergy. You should consult your doctor. In contrast, a swelling only near the spot you are stung is usually not so serious.

Examining the Hive

Opening the Hive

In addition to your bee veil and gloves, you will always need your hive tool, smoker, matches, and extra smoker fuel. Place a handful of smoker fuel inside
your smoker and light it. Stand to the right or left side of the hive, not in front of the hive where you would block bee flight. Puff a little smoke into the hive entrance. The bees at the entrance will move inside. Now remove the outer cover and gently pry the inner cover off slowly with the hive tool. Puff just a little smoke in at the top. Most of the bees will run down between the frames and start buzzing.

Remove the inner cover. Soon the bees will come back up. Use smoke only to keep the bees from getting irritable. Over-smoking the hive is stressful to the bees. Standing at the side of the hive, use the hive tool as a lever to push the three or four frames nearest to you away from the side. Then push the nearest frame a little bit back toward you. The most important rules to follow when examining your hive are to work in a way that is safe to you and anyone nearby, to avoid hurting the queen, and to disturb the bees as little as possible. Hold the frame so that direct sunlight is over your shoulder and down into the cells. Queen will almost always be on a frame in the brood nest, looking for an empty cell where she can lay an egg. A white mark on her back will make the queen much easier to. Drones will be abundant in late spring and early summer. They are distinguished by their very large eyes. On a nice afternoon many drones will be seen coming and going at the hive entrance.

**Closing the Hive**

When you are done with your hive inspection, return the frames to the hive in their original order. This keeps the arrangement of honey, pollen and brood that the bees prefer. Extinguish the smoker carefully. Depending on the weather and time of year, you should see bee flight. Bees returning with pollen loads on their legs are always a good sign. It tells you that the bees are rearing brood, and that pollen bearing flowers are available. Bees waddling in with large balls of pollen indicate that pollen is abundant. At other times they will carry very small loads, indicating that pollen has been hard to find. Estimate the number of bees returning in a 10-second interval. During a honey flow in late spring, 50 or more bees may return to a vigorous hive in 10 seconds. Look for tiny bits of white wax added to the edges of the dark, older comb. This is a good indicator of colony health. It is commonly seen when the bees are on a honey flow. It may be observed also when the bees are feeding on sugar syrup from a feeder. If the bees are on a honey flow, check to see whether they have enough storage space (frames with many empty cells). Frames with most cells full of brood, honey and pollen tell you it’s time to add an extra hive body or super so that the colony can expand and store food.

As always, compare your observations with what you saw the previous times you examined that particular hive. Beginners and experienced beekeepers often
keep a notebook to follow the trends and compare one year to the next. The brood nest and adult bee population should be increasing from February to June, and declining gradually from July to November. If the supers are filling with honey, make a rough prediction about when the next super will be needed. For example, if the bees are filling five frames a week, another 10-41 frame super may be needed every two weeks. Of course, the honey flow can accelerate or slow down according to the weather and what’s blooming nearby.

**Feeding bees with sugar syrup**

Bees are often fed sugar syrup as a substitute for nectar. They concentrate it into a thicker syrup, and add enzymes as they do to nectar. But we can’t really call it honey because it’s made from artificial feed. Syrup is made from common table sugar and water. Mix it up 50:50 sugar to hot water. The best method is to feed the bees at the top of the hive. Some beekeepers feed the easiest way. They leave a large container of syrup open near the hives. The bees find it quickly, especially during a dearth, and consume it in no time. This is called open feeding and there are several reasons not to do it, especially if you have more than one hive.

**Feeding pollen supplements or substitutes**

Beekeepers are often advised to feed solid cakes or powdered food containing protein-rich materials such as soy flour or yeast. This is to supplement the pollen they normally eat. The cakes are placed inside the hive where the bees eat them quickly. Pollen supplements can be useful in spring if an extended rainy period interferes with foraging.

**Water for Bees**

In May and June the bees need to find water to cool the hive. Forager bees will collect water from streams, lakes, puddles, dripping air conditioners, swimming pools and wherever they can. The bee returns to the hive and deposits a water droplet inside an empty cell. Other bees are busy fanning their wings to circulate the air through the hive. The hive is cooled by the evaporation of water. It can be helpful to give them a water source if a good one is not already nearby.

Swarming is a natural division of colony in which some bees (may be half or more) leave the colony along with old queen and this swarm settles generally in the nearby area of the colony. It occurs when queen has reached her peak of brood rearing activity can also occur during summer or fall, depending upon floral conditions of the area. This generally occurs during the period before honey flow.
What causes swarming?

Swarming occurs due to:
- Overcrowding and lack of ventilation.
- Presence of old queen.
- Sudden honey flow.
- Lack of space for egg laying and honey storage.

Problems due to swarming:
- Loss of working force due to division of the colony.
- The morale of colony is not favourable for honey collection. The bees direct their efforts towards building queen cells and searching for new home sites.

Colonies show great variations in respect of swarming. Some colonies do not swarm even after becoming quite populous yet many swarm without any apparent reason indicating genetic variation to the instinct of swarming.

Indication of Swarming

The colonies start raising large number of queen cells usually along the lower edges of combs. However, few emergency queen cells are also raised in the event of queen failure i.e. supersedure. Many bees do not go to field creating additional crowding, resulting in clustering of bees outside the hive.

Time of swarming: Time to issue swarms by the colonies is from 10 AM to 2 PM on sunny days. If weather is not favourable, swarms may be issued even earlier in the morning or late in the evening.

Catching and hiving a swarm: A settled swarm can easily be caught using swarm catching basket. This basket is placed above the bee cluster and the cluster is gently pushed upwards so that the bees start ascending into the basket. Once the queen has entered, the whole swarm will follow the queen. The swarm in this basket can be taken to the apiary for hiving. To make the swarm settle properly, a hive is prepared by giving one frame each of capped brood, pollen and honey and provided with extra as per strength of the swarm. The swarm from the swarm catching basket is then shaken on the top bars of such a prepared hive and immediately covered with burlap cloth, inner cover and top cover. Sugar syrup is also fed to such a newly settled down (1 part sugar dissolved in 1 part of water).

How to prevent and control swarming? Depending on the internal and external factors, one colony may issue one to several swarms resulting in loss of population of the parent colony. To prevent swarming do as given below:

Avoid overcrowding by adding empty combs for egg laying. Sealed brood can be shifted to second hive body.
Remove the queen cells at regular interval as soon as these are made. Delay in queen cell removal is not much effective.

Provide shade and ventilation to the colonies.

Swarming can be prevented by removing old queen (which otherwise provides the supersedure impulse) followed by introduction of a young laying queen. Requeening the colonies annually is also a good practice.

Another well-known method of swarm control is “Demaree plan of swarm control” which is described below:

1. Examine the brood of the colony and remove all the queen cells.
2. Remove the brood chamber from the bottom board. Place another hive body containing one comb of unsealed brood on this bottom board and also put the queen in this part. Fill the remaining hive with empty combs.
3. Place queen excluder on this hive body and keep the removed brood chamber along with remaining brood and bees over it.
4. Again inspect the top hive body after 10 days and remove all queen cells. In this way swarming can be checked.
5. Swarming instinct of the colonies can also be overcome by temporarily dividing the colony and then re-uniting them just before honey flow.

**Summer, Monsoon and Autumn Season Management**

**Summer management:** Under summer management, information on indication of honey flow, method of supering, honey extraction and management for dearth period has been provided. What is honey flow? It is the period when honey bees gather and store surplus honey in the hive after attaining peak population in the colony. Honey flow is indicated by: Whitening of honey cells of the comb due to deposition of fresh wax, Appearance of large quantities of burr and brace combs (freshly prepared pieces of combs), Increase in weight of the colonies due to incoming nectar (a colony kept on a stage balance in an apiary indicates the sudden increase in weight: such a colony is also known as balance colony), During this period colonies should be quite populous but without swarming instinct and should gather maximum honey instead of only concentrating on brood rearing. Colony morale should be high for honey collection.

**Supering**

With the first indication of honey flow, provide supers to the colonies. But before putting supers, examine the colonies for disease: check whether queen
is present or not and whether laying satisfactorily because after the honey flow
starts the bee keeper becomes too busy in putting and taking off the supers.
Place queen excluders between brood chamber and super so as to prevent laying
in the super by the queen. Keep swarming under check by avoiding congestion
in the brood chamber. Provide empty combs at all the times until end of honey
flow. The space can be provided by removing sealed brood to super chamber.
Supers should contain drawn combs. If these are not available, provide frames
with comb foundation sheets. In that case, also place at least one or two drawn
combs with the comb foundation sheets to attract bees for raising the combs
on foundations. Supers can be of half or full depth. But full depth supers are
more practical since frames can be exchanged among different chambers. When
first super is full and there is a need to put the second one, it should be added
between brood chamber and first super.

If there is shortage of drawn combs and raising of new combs is likely to
lower honey production, the fully sealed and two third sealed honey frames
can be taken out for honey extraction and empty combs can be returned for
re-use. A strong colony can collect 4.5 to 10kg of unripe honey in a single
day during good honey flow. Therefore, keep the supers ready for meeting
colony demand. It is better to supply at least one super ahead of needs of the
colony.

**Winter Management and Migratory Beekeeping**

**Winter management:** After preparing the colonies in fall for wintering,
protection should be provided to the colonies from winter by:

- Reducing the hive entrance.
- Plugging all cracks and crevices in the hive.
- Protecting the colonies from direct chilly winds.
- Storage and protection of combs: protect the spare combs from attack of wax
  moth by fumigating in hive stacks frequently till spring when these drawn
  combs will be needed by the colonies again.

**Wintering:** Honey bees use honey as source of energy for generating heat
and to maintain hive temperature of 32-35°C for wintering, if insulation to hive
is provided, it will help in reduction of store consumption and saving energy of
bees. The type of insulation depends upon the climatic zones.

**Packing of hive:** Only good colonies with young bees in large number and
enough food stores should be packed.
For packing colonies straw, sawdust, wood shavings, been stalks or dry leaves, chopped rice or wheat straw can be used. Packing material should be dry since moisture will make it poor insulator. Packing can be given in the brood chamber beyond dummy board, as well as between inner and top cover. Strong colonies with young bees and good food stores, with proper packing need no care during winter and are opened only in spring.

**Migratory beekeeping**

Commercial beekeepers of Himachal Pradesh migrate their colonies to flora rich belt areas in the foot hills where winter is not very harsh. This helps the beekeepers in getting increased honey production at a time when colonies require sugar feeding for over wintering in the harsh winters of hills.

**Migration:** Honey bees can be migrated from one place to another as they can withstand long journey if properly prepared.

**Preparing colonies for Migration**

Provide proper ventilation by using entrance screens and even top screen in place of inner cover during hot weather. Close all cracks or openings in the hive. Nail all movable parts of the hive properly or tie with migratory belts. Before packing the colonies, remove frames of honey which are more than half sealed since honey combs can not bear much jolts. However, the colonies should have sufficient food during the journey. Close the entrance in the evening when all bees have returned. Colonies should be moved during night. For deciding migrating site, the beekeepers should have a detailed knowledge of honey flow sources and density of bee colonies in the surrounding area. Avoid areas which already have lot of bee colonies.

Migration can involve shifting of one truck load of bees up to 200 km or even more. If journey can not be undertaken in one night during hot periods then the truck should be parked in the shade during day, entrances opened and providing water. Journey can be started in the evening after closing hive entrance. On arrival at the destination, colonies are unloaded and placed at the desired site. Then the entrance screens are removed. Check the colonies after 1 or 2 days for any damage to combs and working of queens.

**Pests, Diseases and Other Problems of Honeybees**

**Colony Collapse Disorder**

This disorder is defined as the sudden disappearance of most of the adult worker bees, without loss of the brood or queen. Typically the queen, brood and
a few newly emerged worker bees would be found. The disorder was distinct from some well known problems with mites, disease or pesticide poisoning. No significant numbers of dead bees would be seen in front of the affected hives. The treatment for CCD is achieved primarily by control of varroa mites and Nosema disease, avoiding pesticides as much as possible, and establishing the hives in good locations where honey plants and pollen plants are abundant.

**Varroa Mites**

The varroa mite is a reddish-brown external parasite of bees, about 1/16” across. It grows and reproduces in the capped brood and the mated female mites live on the adult bees. This parasite is by far the most serious enemy of honey bees. Varroa mites make viruses and nosema disease worse, by weakening the bees and stimulating outbreaks of these diseases. This mite can be seen easily, especially with a magnifying glass. To check your hive remove pupae from capped cells, especially drone cells, and examine them carefully. This is where most of the mites will be living during the warm season. Varroa mites are controlled with a combination of chemical and non-chemical methods. Chemical treatments should be used as infrequently as possible because they adversely affect the bees. All the above mites can be managed by dusting micronized sulphur on the frames or by burning Folbex strips (Bromopropylate) as a fumigant inside the hive. The mites can also be controlled by keeping absorbent cotton soaked in 65 per cent formic acid. Mite-resistant bees and “screened bottom boards” are the best approach. These bottom boards eliminate live mites that fall from the bees, and hence reduce mite populations.

**Tracheal mites**

This is a microscopic mite that lives in the “lungs”, or tracheal tubes, of the bee. Part of the problem is that the symptoms are not obvious when the mites are at low levels, unless the bees are examined by microscope. So it’s necessary to treat the hives regularly even when the bees seem to be doing fine. The symptoms of a bad infestation are bees crawling on the ground near the hive, unable to fly and bees with wings at an odd angle on one side. This is called “K-wing” because the wings and the body form the letter “K”. There are several treatments for tracheal mites. One is a mixture of vegetable shortening (like Crisco) and sugar. A one-pound patty of shortening and sugar, mixed 50:50, is placed inside the hive on a piece of wire screen where the bees will walk over it. A very fine coating of shortening on the bees kills the mites. Menthol, ApiLife VAR (a mix of plant oils) and Mite-away II (formic acid) are three products sold commercially. One of these may be placed inside the hive where they evaporate and act as fumigants.
European foul-brood disease, \textit{(Streptococcus pluton)}

The disease is believed to have been introduced along with \textit{Apis mellifera} imported from exotic sources. The disease is caused by non-spore-forming bacterium, \textit{Streptococcus pluton} along with \textit{Bacillus alveias} secondary invader. The disease affects larvae of all castes. The symptoms are: the larvae turn watery, yellow then brown and lastly dark coloured. The tracheal system becomes visible and larva dies in a coiled stage causing foul smell. In advanced stages, a hempy non-elastic thread is formed. Dead larvae are usually found in unkept cells with no predominant odour. Scales and larvae lie in any position. The disease occurs at a time when there is active brood rearing. Cells are poorly capped and mixed with normal cells. The use of antibiotic terramycin is most effective in treating the disease. Terramycin is given dissolved in sugar syrup @ 100 mg of active terramycin in a litre of syrup. The terramycin syrup (freshly prepared) is fed every seventh day. The disease can also be controlled by fumigation with ethylene oxide. Quarantine is a must to prevent entry of any of the bee diseases.

\textbf{Nosema (Nosema aphis)}

Nosema disease is caused by a microbe that infects the stomach of the adult bees. It weakens the bees and can cause defecation inside the hive and at the hive entrance. Since this disease interferes with food digestion, a nosema-infected hive will have a diminished brood nest. Nosema disease can greatly weaken them so that some bees will not make it home. Nosema infection in the queen is most serious, especially when she must digest enough food to produce 1000 or more eggs daily. When their queen is sick, the worker bees sense this in some way and initiate queen cells in the process of supersedure. Nosema disease cannot be identified without a microscope or sophisticated genetic analyses. Treatment for either type of nosema is with an antibiotic especially for this disease: fumagillin, sold as “Fumagillin B”. It is fed to the bees mixed in sugar syrup. The drug is administered by giving a feed of 100 mg fumagillin per colony in 250 ml of sugar syrup for 10 days continuously.

\textbf{Viruses}

Several types of viruses attack the adult bees or larvae. One is sacbrood which causes the larvae to become soft and watery like a sack filled with water. Other viruses cause the adult bees to tremble, become paralyzed or lose their hair. At least one virus is stimulated to kill bees when the colony is infested with varroa mites. Virus infections are difficult to control for several reasons. The symptoms are not always clear cut and unambiguous. Control is primarily by
keeping varroa mites at the lowest possible levels. Destroying comb with the
disease (if it’s sacbrood), and re-queening the colony may be other courses of
action, if the problem is bad or recurring. By re-queening the colony, the genetic
makeup of the hive will change. This will be beneficial if the new queen carries
traits for virus resistance. Also, viruses can hide in the queen’s reproductive
system and be passed on to her eggs. If she is eliminated, she will no longer be
a source of the virus.

Wax Moths

This insect does not attack bees, but can be very destructive of comb that is in
storage, or on a weak or empty hive. The moth larva consumes the wax and will
also weaken the wooden parts by chewing on them. The wax moth grows and
reproduces very quickly under warm conditions. The earliest signs are tunnels
in the comb, with silk “webbing” left by the smallest larvae. As the larvae grow,
the damage they do is greater. Many large larvae can consume all of the wax in
a frame in just a few days. A strong bee hive will keep all moths away from the
comb inside.

Wax moth damage can be prevented in several ways. Combs stored in
unheated locations during winter will be moth-free. For comb that must be stored
in a warm location, away from the bees, use paradichlorobenzene (PDB) available
in the name of “Paramoth”. It is an effective fumigant. Stackhive bodies on top
of each other with the frames and a few ounces of PDB on the top of the stack,
under the top cover. The PDB can be contained in a pan or cloth sack so that it
does not fall to the bottom. The top and bottom of the stack should be sealed
with covers and/or bottom boards. Holes should be sealed with duct tape so that
the fumes reach a high concentration inside the stack. In warm locations the PDB
will evaporate quickly and will then need to be replaced. Let the frames air out
away from the PDB for at least a day before returning them to the hives. Do not
use napthalene or other chemicals sold for clothes moth control.

Small hive Beetles

As a larva it is a worm-like creature which eats the comb including stored
honey and pollen. The larvae leave the hive when they are grown and burrow
into the ground near the hive. Underground they pass through the pupal stage,
and emerge as adults later. The adult beetle is a strong flyer and able to locate
hives from some distance by the hive odour. The black beetle is difficult to see
when it mingles with bees on a frame. Although it originates from a warm part
of the world, the beetle can survive cold winters in the bee cluster. The most
important way to minimize beetle problems is to keep the hive vigorous and full
of bees. The beetles seek the weakest hives and do their worst damage there.
The beetle traps are most effective in strong hives where the bees are numerous enough to chase the beetles into the traps.

**Mice**

Mice will make nests inside hives with or without bees, especially during winter. Mouse damage can be prevented by stapling 4-mesh screen across the hive entrance in October as part of the wintering preparations. The 1/4” holes in the screen allow bees to pass for flight when the weather is warm enough. The screen should be removed in March.

**Ants and other Minor Pests**

Ants, roaches, earwigs and spiders will live in the space between the inner cover and the outer cover. They are annoying but rarely do any damage, and will not affect the bees or the honey. The best thing to do is brush them out when you find them. Avoid using pesticides in the space above the inner cover, since they could contaminate the honey and poison the bees.

**Pesticide Poisoning**

Bees are killed very easily by insecticides. They have almost no resistance against these chemicals, while many of the insect pests on crops have developed considerable resistance. The sign of pesticide poisoning is the sudden appearance of many dead and weak bees in front of the hive. This happens when forager bees return to the hive carrying nectar and pollen laced with pesticides. The chemicals are passed among the house bees by trophallaxis, causing them to die and be carried out of the hive by other bees. If an application is necessary, the pesticides can often be applied at dusk when the bees are in the hives. By morning, at least some of the pesticide has dissipated. If problems cannot be resolved you may need to find a new apiary site. Other types of pesticides—like herbicides and fungicides—are not as likely to hurt the bees because they are not designed to kill insects. But these chemicals can drift or be carried by foragers to the hive, and contaminate the honey.

**Queenlessness**

The queen may be lost because of disease, because she did not return from a mating flight, or because the beekeeper accidentally killed her while examining the hive. If the queen disappears, a colony treats the problem as an emergency. The bees sense the loss of their queen within an hour or two, because the queen pheromone which is normally present in the hive disappears quickly. If the colony has young worker larvae, it has the ability to re-queen itself. As soon as the queen pheromone diminishes, worker bees create emergency queen cells from
cells with young worker larvae. These cells are typically among the worker brood cells, unlike swarm cells which are along the sides and bottom of the brood nest. Emergency queen cells are a reliable sign that a hive is queenless.

**Drone-laying queens and queens that produce bad brood patterns**

Queens will occasionally have unsuccessful mating flights, or have some other problem that prevents them from laying fertilized eggs. An unfertilized egg becomes a drone larva, and eventually an adult drone. Drone-laying queens tend to lay eggs in worker cells. The drones that develop in the smaller worker cells become smaller adults. So colony that has had a drone-layer for over a month will have many small drones, each about the size of a worker bee. A hive with much drone brood, and little or no worker brood, either has a drone-laying queen or laying worker bees. A queen which generates a bad brood pattern should be replaced with a good queen as soon as possible.

**Laying worker bees**

Worker bees are nearly always sterile females, but on occasion will be able to lay a few eggs. These laying workers develop if a colony has been queenless for several weeks. Their ovaries enlarge and they represent the colony’s last-ditch attempt to rear brood. The colony will eventually die if it remains queenless. Since worker bees are unable to mate, their eggs will not be fertilized and will develop as drones. Also, laying workers are not skillful in placing their eggs in cells. Consequently, there are clear signs of a laying worker colony: (1) many (often ten or more) eggs per cell, (2) the eggs are placed every which-way in the cell, not neatly at the bottom, (3) capped drone cells in worker comb, and (4) a “spotty” brood pattern, i.e. brood cells here and there rather than a continuous sheet of brood on a frame. These signs distinguish a laying worker colony from one with a drone-laying queen. A laying worker colony is difficult to re-queen. The best solution is to combine it with a normal hive.

**Absconding**

Bees are particular about where they live. If the hive is too small, too hot in summer, in a windy location, or frequently bothered by pests, the bees may take off for a better spot. In this case, all of the adult bees leave at once in a swarm. It looks like swarming, except that new queens are not reared and no bees are left behind. You may need to do a little detective work to decide whether the hive died or absconded. If it died, some evidence could be left there —signs of disease, mites or starvation. If your bees have absconded, determine what aspects of the hive conditions were undesirable, and fix them before re-establishing the hive.
**Drifting**

Bees will occasionally enter the wrong hive when they return from foraging, if another hive is near their own. Often they will then join that colony, coming and going as if they had always lived there. This drifting behavior can be worst when hives are in a windy location. The returning bees will be inclined to join the downwind hive, and soon that hive is full of bees while the others are depleted. It is also common when the hives are very close together. An irregular arrangement of hives, rather than a straight row, reduces drift. Landmarks like bushes or fences, and hives painted different colours will also limit drift by helping the bees identify their hives when they return.

**Moving Hives**

For the experienced beekeeper with a strong back and a willing friend, hive transportation is fairly routine. The hive must be prepared after sunset or before dawn when all of the field bees are inside. Prepare the hive by closing the hive entrance with screen mesh to keep the bees inside. Any openings at the top of the hive, or holes in the hive bodies, should also be sealed. A staple gun is ideal for securing the mesh across the entrance. Tie the hive together very tightly, from outer cover to bottom board with rope or straps. The big move should be done soon after closing the hive —when it is still dark or early in the morning, if possible. The bees will suffer if they are confined for a long daytime period. Lifting the hive into the truck or trailer is generally a two-beekeeper operation. One person on each side of the hive lifts while holding the bottom board, and the hive is then fastened securely on the truck or trailer. Consider your route before traveling. When you get to your chosen site, place your hive on a steady and level hive stand. Then untie the hive and remove the screen from the entrance. The bees will begin to fly around and will realize they that are in a new location. They will circle the area for the first day or two, memorizing landmarks: trees, houses, and other conspicuous objects. By the third day (or later if bad weather prevents flight) they will be coming and going as if they had always lived there. For the first week or so they will still be irritable from the disruption, so it’s best to avoid opening the hive in that time. If the weather is good and forage abundant, the bees will usually be very gentle one week following the move.

**Culling old frames**

Wax comb darkens as the bees use it, especially when the comb is used for rearing brood. Maturing larvae and pupae leave behind very thin skins (called exuvia) as they molt, and also tiny fecal pellets. In this way brood rearing thickens and darkens the comb. Pigments from pollen also add to the comb colour as
they leach into the wax. Most important, spores from nosemata, foulbrood and chalkbrood diseases persist indefinitely in and on the wax. Over five years as a substrate for brood rearing, new white wax becomes dark brown. Older comb becomes solid black. Frames with very dark wax comb, many drone cells, and holes through the wax should be culled. The best times to remove these frames from the hive are when the bees will not need them. In early spring the colony is too small for the bees to cover all of the frames in the hive. At this time, good frames or frames with new foundation can be substituted for the culled. Similarly in fall, the colony condenses and the beekeeper reduces the size of the hive - another good time to pull bad comb out of circulation.

**Increasing the number of bees by uniting weak colonies**

Weak colonies should be united with each other or with stronger colonies. The goal is to have a hive with at least eight to ten deep frames (most of one deep hive body or the equivalent) covered with bees. When estimating the population of bees in a hive, consider that the weather and time of day make a difference in the number of frames they cover. During cool weather the bees will cluster. The middle of a warm day, many field bees will be away from the hive.

**Products of the Hive**

**Honey:** Honey is a concentrated solution of sugars and other floral substances prepared by bees from nectar. To be ready for harvest, honey should contain 18% water or less. The remainder is mostly two sugars, glucose and fructose. Small amounts of other sugars, enzymes, vitamins and minerals are present, plus the floral components that give it a distinctive colour and flavor. Nectar is a watery, sweet liquid produced by the flowers of many types of plants. By offering this reward, certain plants attract bees and are cross-pollinated when the bees carry pollen from one plant to another. On returning to the hive, a bee places the nectar in a honey comb cell. Other bees then process the nectar by adding enzymes and fanning air across the nectar. Much of the water evaporates, and enzymes remove some of the water. Other enzymes produce natural antibiotics, make the honey slightly acidic, and convert sucrose sugar to glucose and fructose sugars. When the enzyme activity and the evaporation of water reduces the water content sufficiently, the honey is ripe. Each cell full of ripe honey is then covered with wax. Dark honey is higher in anti-oxidants than light honey. Foods with antioxidants reduce the risk of cancer. Many people feel that honey consumption reduces their pollen allergies. Honey has been used to treat wounds effectively.

**Crystallized honey:** Honey has such a high concentration of certain types of sugar that it will tend to form sugar crystals. Crystallized honey, also called granulated honey, is perfectly safe to eat. It has the same flavor as liquid honey,
but a different texture. Some people prefer it to liquid honey. You may hear it said that crystallized honey has “turned to sugar”. Strictly speaking this is incorrect since the sugar has always been there.

If you want to liquefy your crystallized honey, warm it gently by placing the jar in warm water for several hours. If the honey is overheated it will lose much of its fragrance and be spoiled. Plastic bottles are a problem – you must keep the temperature at 110°F for at least one day to slowly liquefy the honey without melting the bottle. Honey from certain plants is especially prone to crystallization. This is because some nectars have high glucose levels, and glucose crystals form very easily in honey. Canola, an oil seed crop with a bright yellow flower, is one plant with high-glucose nectar. Canola honey will even granulate in the honey comb. If you collect much canola honey, extract it as soon as possible and blend it with honey from another floral source.

**Fermented honey:** Very rainy weather makes it difficult for the bees to remove the moisture from the nectar in the honey making process. High water content allows yeast to grow, either in the comb or in bottled honey. The sign of fermentation is bubbles in the honey, and possibly an odour that indicates spoilage. Fermented honey is not good for human consumption. The best thing to do with this honey is either dispose of it or feed it back to the bees at a time when they will eat it rather than store it in the comb. The adult worker bees will then use the nutrients to sustain themselves and to rear brood.

**Pollen:** Pollen grains are the male germ cells of a plant. Some plants need bees or other flower visitors to move their pollen from flower to flower. This process of pollination initiates fertilization and then the creation of seeds. Plants usually produce much more pollen than they actually need for the cross pollination. The surplus serves as a rich food for the pollinators: protein, vitamins, minerals and other nutrients. When bees bring it back to the hive, they will store it in the comb. Some workers may eat the pollen right away, particularly the nurse bees which have active glands for feeding larvae and the queen. Pollen is needed especially in springtime, when thousands of hungry larvae are growing in each hive and the queen is laying 1000 or more eggs daily.

**Beeswax:** Beeswax is produced by a set of eight wax glands on the underside of the worker bee. A bee secreting wax will pull a tiny scale of wax from her gland, and add it to the wax comb. Using her mouth and antennae, she then shapes the wax scales into the hexagon pattern of the comb. A strong, healthy hive is a much better wax producer and comb builder than a weak one.

Over time, the wax will change from white to yellow. The wax will eventually become very dark where the bees are rearing brood. It is a consequence of the growth of the larvae, and pigments in pollen carried by bees walking over the comb. Old, black comb should be removed and replaced with new foundation. If you want to collect wax for crafts or candles, use new, light-coloured wax. The
cappings from the honey frames are best. The cappings will be left over when you have extracted your honey. Wax is cleaned first with warm water to remove any honey. It should be melted only under low heat. Hot wax is flammable.

**Propolis:** Propolis is sometimes called “bee glue”. We can see why when we try to open a hive which is well propolized. Bees use it to seal cracks in the hive, to close or narrow holes, and to control bee diseases through its antibiotic properties. Bees make propolis from plant resins. The resin is carried to the hive on the bees’ legs, like pollen, and it then may be mixed with beeswax. A lot of propolizing is done in the fall when the bees are sealing up the hive in preparation for winter. Some strains of bees are heavy propolizers and will even cover part of the entrance of the hive with this sticky substance. This habit gives propolis its name, “before the city” in Greek. This material has antibiotic properties which probably help the bees fight their diseases. Extracts of propolis in alcohol have been used by people to fight infections.

**Bee venom:** Injections of bee venom have been used to treat certain diseases. Arthritis and multiple sclerosis in particular are supposed to be cured by bee venom injections. Honey bees come with their own hypodermic needles, so this is often called “bee sting therapy”.

**Royal jelly:** The nutrient-rich food fed by bees to the larvae which are developing into queen bees can be collected by beekeepers. Royal jelly does have many of the nutrients needed by humans. But many of the concerns about pollen apply to royal jelly also. People have been known to suffer allergic reactions from royal jelly consumption. It degrades rapidly if not frozen. The nutrients in royal jelly are all available in a less expensive, conventional diet. Production and collection of royal jelly is laborious for the beekeeper, so it is quite expensive.

### The Honey Harvest Special Equipment

#### Queen excluders

Many beekeepers use a queen excluder, which is a wire or plastic grid that retains the queen in the lower part of the hive. It has spaces between the wires that are just wide enough to allow the workers through, but not the queen. The queen excluder is handy because it prevents the queen from laying eggs and starting a brood nest in the honey supers. When the time for honey harvest comes, it’s convenient to have only honey in the supers. One problem is that brood rearing leaves layers of cocoons in the cells. When it’s time to uncap the honey-filled cells, those with cocoon layers are very difficult to open with an uncapping knife. The excluder also prevents the whole colony from moving up and abandoning the lower hive bodies. This is a common occurrence, and part of natural bee behavior. A hive may make less honey with an excluder than without. This is because the effort needed to wiggle through the excluder can discourage
the worker bees from storing honey in the supers. And any drones trapped above the excluder will be caught and die in the excluder because they are too fat to pass through. Occasional adjustments can counter the problem of the queen moving up and hence the extruders can be avoided.

**Screened Bottom Boards**

Many beekeepers prefer bottom boards which have a large opening to the ground, which is covered with screen. These are used for control of varroamites. Many live mites fall from the bees inside the hive. The screened bottom allows the mites to fall to the grass below where it is almost impossible for them to return to the hive. This is an effective way for beekeepers to reduce mite infestations without chemical treatments or special procedures. This is fairly easy to do as long as the bottom board is sturdy and keeps to standard hive dimensions. The screen is purchased as “8-mesh hardware cloth”, with 8 holes to the inch. This prevents bees from entering through the bottom but allows the mites to fall through. This large opening at the bottom of the hive can help with ventilation, especially when the bees are ripening honey or dissipating heat on hot days.

**Pollen Traps**

A pollen trap is a device that fits across the entrance of the hive and removes the pollen loads from returning pollen foragers. It has small holes that the bees can just barely wiggle through. As they do, clumps of pollen fall from the bees’ legs into a drawer below. Pollen traps are used when the beekeeper wants to collect pollen for human or animal consumption, or to mix with sugar and water for bee feed at a later time. They also increase the number of bees which forage for pollen, making a hive a better pollinator of crops. However, a pollen trap deprives the bees of essential nutrients so it should not be left on a hive for more than a few weeks, it should never be used on a weak hive. The trap will weaken even a strong hive if on the hive for many weeks. And the bees will become irritable because of their efforts to wiggle through the trap. Pollen should be removed from the trap every week or so. Some types of pollen traps do not protect the pollen from rain. Wet pollen is spoiled. Pollen trapping is a special activity that requires some extra attention from the beekeeper.

**Basic Equipment**

To set up a modern honey processing plant to facilitate the production of refined high quality honey that could be utilized for bulk consumption in the pharmaceutical, cosmetic or food processing industry or can be sold in the lucrative international market. The plant would have sophisticated equipment
with adequate capability to process apiary as well as forest honey on a large scale.

Since moisture content of the raw honey varies and plays a critical role in determining the quality of the final product, the processing plants would be fitted with moisture reduction system.

The Plant would be set up on over 1 acre of Land and would have 4 key modules
1. Collection Center
2. Processing Zone
3. Bottling and Packaging Unit
4. Warehouse

**Honey Harvesting Tools**

- **Bee hive**: Bee hive consists of following major parts:
  - **Stand**: To support bottom board.
  - **Bottom board**: It is floor of the hive having an entrance for bees. On this board brood chamber rests.
  - **Brood chamber**: Chamber used for rearing of brood. Frames are placed in this chamber on which bees raise combs. The dimensions and number of frames vary with the type of hive. A wooden dummy board is used to limit the size of brood chamber and is placed at the end of brood frames.
  - **Frame**: Each frame consists of a top bar, two side bars and one bottom bar. Inner aspect of the top bar has a groove for fixing comb foundation sheet. Side bar has 4 holes for wiring the frame. The frame holds a comb.

**Dimensions of hive**

<table>
<thead>
<tr>
<th>Hive parameters</th>
<th>Langstroth type (B.I.S. C type for <em>A. mellifera</em>)</th>
<th>B.I.S. hive (A &amp; B type for <em>A. cerana</em>)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frames</td>
<td>Contains 10 frames</td>
<td>May contain 4, 8 or 10 frames</td>
</tr>
<tr>
<td>Super Chamber</td>
<td>Generally full super chamber is used</td>
<td>Half (shallow) super chamber is generally used.</td>
</tr>
</tbody>
</table>
| Brood/ Super frame size | Outside 448 X 232 mm, Inside 428 X 192 mm | Type A: Modified Newton type
|                 | Type B: Modified Jeolikote type                  | Outside 230 X 165 mm, Inside 210 X 145 mm |
|                 |                                                   | Type B: Modified Jeolikote type
|                 |                                                   | Outside 300 X 195 mm, Inside 280 X 175 mm |
| Bees space      | 10 mm                                            | Type A 7 to 9 mm, Type B 8 to 9 mm       |
**Super:** Dimensions may be same as that of brood chamber or half of it (depending on type of bee hive). This is the chamber where bees store surplus honey.

**Inner cover:** A board which acts as a partition between brood/super chamber and the roof.

**Top cover:** A type of lid acting as roof placed over inner cover.

In general for *A.mellifera* we use Langstroth hive (named after L.L. Langstroth) and for *A.cerana*, BIS (Bureau of Indian Standard) hive A and B type. In 1995, BIS introduced C type hive based on Langstroth hive, for *A.mellifera*. Well-seasoned wood of “Kail”, ”Toon”, teak or rubber can be used for making good quality bee hives. Wood having strong smell is not used.

**Nucleus hive:** Small bee hive for keeping 4-6 frames. These are used for mating of queens and division of colonies.

**Observation hive:** Small hive with glass sides so as to observe movements and behavior of bees.

**Comb foundation mill:** Used to print natural cell size of desired comb foundation sheet for *A.mellifera* and *A.cerana*.

**Bee veil:** No one should open a bee hive without a bee veil to protect the head. Most veils fit over a hat or helmet so that they surround the entire head and neck. The best veils are made of strong material, reinforced so that it is held away from the head. Several types of veils attach to a jacket by a zipper. These are nice because they are completely secure around the neck.

**Gloves:** Beginners will usually want to wear gloves. However, some experienced beekeepers prefer to work bees barehanded because it allows them to be more agile. With time and experience, a few stings on the hands may not seem as bad as the discomfort of wearing heavy gloves in hot weather. Some beekeepers wear gloves only when weather or other conditions will cause the bees to sting a lot.

**Uncapping knife:** The wax cappings on honey frames must be removed before the honey can be extracted. This is done with an electric uncapping knife. The knife contains a heating element that gets it hot enough to melt wax. The beekeeper slices the cappings off of the honey frame just before putting them in the extractor. If you have only a few frames to uncap you can get by with a capping scratcher (below) or any stout knife.

**Smoker:** The smoker consists of a metal container that holds smoldering material and a bellows to pump the smoke out. Smoke is very helpful in calming
the bees. When used correctly, it greatly reduces the tendency of bees to sting. Smoker fuel is usually dry wood shavings, twine, bark or pine needles. Wood shavings can be obtained from livestock supply stores, pet stores, and lumber mills. Burlap may be used, but only if it has not been treated with any chemicals.

**Feeder:** For feeding sugar syrup. Two types of feeders are used: i. slow feeders (friction top pail feeders) ii. Fast feeder (division board feeder).

**Swarm basket:** Basket to catch bee swarm.

**Queen cage:** Used to introduce a queen to new colony and also to transport the queen.

**Queen cell protector:** A spring like structure for protecting queen cells.

**Honey extractor:** A honey extractor is a large centrifuge that spins the frames so that the honey is thrown out of them. The honey collects at the bottom where a gate can be opened. Alternatives to an extractor are described below.

**Wax melter:** Double walled chamber for melting of bees wax for making comb foundation sheets.

**Bee brush:** To brush the bees from frames.

**Bee escape:** To provide one way passage to bees.

**Cappings scratcher:** This looks like a fork with many tines. It’s inexpensive and handy for opening the capped cells you can’t reach with the knife.

**A large basin:** This is to catch the honey cappings. You can purchase a stainless steel basin, or just use a large pan.

**Refractometer:** This is a device that measures the amount of water in honey. It’s a help when rainy conditions interfere with the ripening of honey.

**Hive tool:** The hive tool is simply a heavy-duty paint scraper. It is indispensable for separating hive bodies, removing frames from the hive, scraping debris, and many other chores. A quality control laboratory would also be recommended to set up that will assist in complying with the international quality standards, imperative for selling the product in the international market.

**Economics of Beekeeping**

After going through different aspects of beekeeping including seasonal management, it is important to work out the economics of this enterprise if one goes for commercial beekeeping. It requires information of expenditure and
income from a unit of an apiary. For commercial beekeeping it is recommended that one should start with minimum of 100 bee colonies. Details of expenditure and income are given below:

Expenditure for 100 *Apis mellifera* bee colonies

**Non Recurring**

<table>
<thead>
<tr>
<th>Expenditure head</th>
<th>Number</th>
<th>Rate/unit</th>
<th>Total amount (Rs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bee hives</td>
<td>100</td>
<td>Rs 1000/hive</td>
<td>100000</td>
</tr>
<tr>
<td>Bee colonies</td>
<td>100</td>
<td>Rs 1200/colony</td>
<td>120000</td>
</tr>
<tr>
<td>Honey extractor</td>
<td>1</td>
<td>Rs 2500</td>
<td>2500</td>
</tr>
<tr>
<td>Smoker, bee veil, Hive tool etc</td>
<td>1 set</td>
<td>Rs 500/set</td>
<td>500</td>
</tr>
<tr>
<td>Miscellaneous (honey cans, mating nuclei etc.)</td>
<td>-</td>
<td>Rs 5000</td>
<td>5000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>2,28,000 (A)</td>
</tr>
</tbody>
</table>

**Recurring (per year)**

For stationary beekeeping

<table>
<thead>
<tr>
<th>Expenditure head</th>
<th>No. of trips</th>
<th>Cost per trip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labour (full time)</td>
<td>1</td>
<td>Rs 3000/month</td>
<td>36000</td>
</tr>
<tr>
<td>Comb foundation sheets</td>
<td>1000</td>
<td>Rs 20/sheet</td>
<td>20000</td>
</tr>
<tr>
<td>Sugar for feeding</td>
<td>500</td>
<td>Rs 28/kg</td>
<td>14000</td>
</tr>
<tr>
<td>Chemicals for pest control</td>
<td>-</td>
<td>Rs 20/colony</td>
<td>2000</td>
</tr>
<tr>
<td>Miscellaneous</td>
<td>-</td>
<td>-</td>
<td>1000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td>73,000 (B)</td>
</tr>
</tbody>
</table>

For migratory beekeeping

<table>
<thead>
<tr>
<th>Expenditure head</th>
<th>No. of trips</th>
<th>Cost per trip</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transportation</td>
<td>4</td>
<td>Rs 2000</td>
<td>8000</td>
</tr>
<tr>
<td>By truck</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total (a+b)</strong></td>
<td></td>
<td></td>
<td>3,01,000 (C)</td>
</tr>
</tbody>
</table>

**Details of expenses**

<table>
<thead>
<tr>
<th>Stationary beekeeping</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest on non-recurring cost @15%</td>
<td>34200</td>
</tr>
<tr>
<td>Recurring cost</td>
<td>73000</td>
</tr>
<tr>
<td>Interest on recurring for 6 months @15%</td>
<td>5475</td>
</tr>
<tr>
<td>Depreciation on permanent articles except bees @ 10%</td>
<td>10800</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,23,475 (D)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Migratory beekeeping:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest on non-recurring cost @15%</td>
</tr>
<tr>
<td>Recurring cost</td>
</tr>
<tr>
<td>Interest on recurring for 6 months @15%</td>
</tr>
<tr>
<td>Depreciation on permanent articles except bees @ 10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
</tr>
</tbody>
</table>
Income from 100 Colonies

<table>
<thead>
<tr>
<th>Commodity</th>
<th>No./average yield</th>
<th>Quantity</th>
<th>Rate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey</td>
<td>15kg/colony</td>
<td>1500kg</td>
<td>Rs 75/kg</td>
<td>112500</td>
</tr>
<tr>
<td>Sales of divided colonies</td>
<td>30% colonies</td>
<td>30 colonies</td>
<td>Rs 1200/colony</td>
<td>36000</td>
</tr>
<tr>
<td>Beeswax produced</td>
<td>2% of honey produced</td>
<td>30 kg</td>
<td>Rs 150/kg</td>
<td>4500</td>
</tr>
<tr>
<td>Colonies for pollination</td>
<td>10% colonies</td>
<td>10 colonies</td>
<td>Rs 500/colony</td>
<td>5000</td>
</tr>
<tr>
<td>Commercial queen production (one breeding season) from selected stock</td>
<td>from 10% colonies</td>
<td>100 queens</td>
<td>Rs 400/queen</td>
<td>40000</td>
</tr>
</tbody>
</table>

**Total** 198000 (F)

<table>
<thead>
<tr>
<th>Commodity</th>
<th>No./average yield</th>
<th>Quantity</th>
<th>Rate</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Honey</td>
<td>35kg/colony</td>
<td>3500kg</td>
<td>Rs 75/kg</td>
<td>262500</td>
</tr>
<tr>
<td>Sales of divided colonies</td>
<td>40% colonies</td>
<td>40 colonies</td>
<td>Rs 1200/colony</td>
<td>48000</td>
</tr>
<tr>
<td>Beeswax produced</td>
<td>2% of honey produced</td>
<td>70 kg</td>
<td>Rs 150/kg</td>
<td>10500</td>
</tr>
<tr>
<td>Commercial queen production (one breeding season) from selected stock</td>
<td>from 10% colonies</td>
<td>100 queens</td>
<td>Rs 400/queen</td>
<td>80000</td>
</tr>
</tbody>
</table>

**Total** 401000 (G)

**Net Income**

Stationary beekeeping (F-D) 198000-123475 = Rs 74,525

Migratory beekeeping (G-E) 401000-132073 = Rs 2,68,925

Additional Benefits of bee keeping are increase in crop yield and it boosts employment in bee equipment related industry
Economics If Loan Taken From Bank For Purchase of Non-Recurring Items (migratory beekeeping)

<table>
<thead>
<tr>
<th></th>
<th>Year after start of beekeeping</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>a. Income</td>
<td>40100</td>
</tr>
<tr>
<td>b. Annual reducing interest on non recurring (expenditure @ 15% after payment of bank installment)</td>
<td>34200 (on 228000 as in A)</td>
</tr>
<tr>
<td>c. Bank installment (on principal amount as per A)</td>
<td>50000</td>
</tr>
<tr>
<td>d. Recurring cost &amp; interest on recurring &amp; depreciation (E-34200 i.e. interest on non-recurring cost, already included under ‘b’ in this table)</td>
<td>97875</td>
</tr>
<tr>
<td>Net income</td>
<td>218925</td>
</tr>
</tbody>
</table>
Cultivating Baby Corn as an Enterprise

Baby corn is a young finger like unfertilized cob of maize (*Zea mays*) with two to three centimeter emerged silk, preferably harvested within 1-3 days of silk emergence depending upon the growing season. Due to tremendous growth in Indian economy, baby corn and its processed products are having huge demand in market and its cultivation can fetch farmers a good profits. Being sweet in taste its unfertilized corn may be eaten raw. De-husked young ear can be eaten raw and included in diet in number of ways as salads, chutney, vegetables, pickles, Chinese cuisine, etc. By-products of baby corn such as tassel, young husk, silk, and green stalks are good cattle feed. The preferable size of baby corn (de husked) depending on variety, density of plants and growing season is 6 to 11 cms in length and 1.0 to 1.5 cms in diameter. According to the demand of the market the most liked colour of the corn is normally creamy or light yellow.

Considering the domestic consumption as well as import demand, it is very important crop as 3-4 crops can be grown successfully in a year in India conditions. India has highest potential in comparison to other countries as the cost of cultivation in Indian conditions is quite lower. Thailand leads in baby corn cultivation as well as export. Thailand in the early 1970s first started cultivating this crop for exports. Later other countries like Guatemala, Zambia, Zimbabwe and South Africa started cultivation. Today Thailand and China are the world leaders in baby corn production and its export. The growth of baby corn exports from Thailand have from 67 tonnes worth U.S. $38,059 in 1974 their exports had risen to more than 2 lakh tonnes worth than US 50 million.

Baby corn is a nutritious crop with which many products can be prepared. Baby corn industry offers opportunities for higher income and increase employment opportunities in rural areas.

The nutritious value of baby corn: Baby corn is equally nutritious to many vegetables. Baby corn is full of nutrients and is comparable with other vegetables. It is a good source of protein, vitamins and iron in addition to phosphorus. It contains 89.1 % of water, 0.2% of fat, 1.9 % proteins, 8.2% carbohydrates, 0.6% ashes and 86 miligrams of phosphorus per 100 gram of its weight.

Market of baby corn: Baby corn and its products are in high demand in metropolitan cities of the countries like- Delhi, Mumbai, Chennai and Bangaluru etc. Chanayakpuri, INA market, Khan market, Tilak Nagar are the prominent centres of baby corn in Delhi. In addition National Dairy Development Board has
also taken up the marketing of baby corn. The demand and supply of the baby corn in luxury hotels and restaurants is increasing day by day.

**Benefits of baby corn production**

- **Crop diversity:** It can be grown round the year leading to crop diversification. This crop is suitable for peri-urban areas.

- **Creation of employment opportunities:** The activities related to production, marketing, processing and export activities of baby corn offer employment opportunities.

- **More money in short time:** In general, a farmer is able to receive income from the crops after a long time and one has to wait till the end of cropping season (two crop seasons namely Rabi and Kharif) whereas baby corn is a shorter duration crop (50 to 120 days depending on season) and farmer receives the income in a short time.

- **Export Potential:** Baby corn is in high demand in international market. With the production of baby corn and its processing, the scope for earning foreign exchequer through export are very high.

- **Quality fodder for animals:** After harvesting of the baby corn from maize plant, the stems and leaves can be used as fodder for the animals and farmers may use their fodder land for other remunerative uses. Green fodder demands can be met through the left over portion after harvesting the baby corn from maize plant.

- **Value addition:** Many products like soup, salad, pakora, vegetable, pickle, candy, jam, sweets like laddu and burfi etc. can be prepared from baby corn. As such the profit may be earned from value added products in addition to fresh baby corn marketing.

- **Intercropping:** In order to earn extra income farmers may grow other vegetables, pulses, flowers etc as intercrop in the baby corn crop during the winter season and may earn the profits.

**Production technology**

In general, the cultivation practices of baby corn are similar to grain crop except

i) Preference for early maturing single cross hybrid

ii) Higher plant population

iii) Higher dose of nitrogen application because of higher plant population
(iv) De tasselling
(v) Harvesting within 1-3 days of silk emergence

However, to achieve higher productivity, following packages are to be considered and must be adopted

a) **Land Selection:** The baby corn can be successfully grown in well pulvorised sandy soil to clay soils. The soil for baby corn cultivation should have enough organic matter and the pH of the soil should be between 6 and 7. The soil should be well drained in addition to having sufficient arrangement for irrigation water.

b) **Selection of suitable varieties:** Short duration, prolific single cross hybrid with medium height should be selected. Pusa early, early composite, HM-4, Prakash, Syngenta 5414, WL 142 etc. are suitable hybrids for baby corn. The variety with equal growth nature and early flowering should be selected. For higher yields, the variety performing round the year may be selected.

To earn more profits in shorter period of time early maturing single cross hybrids are recommended which have a silking period of 45-50 days during **kharif**, 75-80 days during **Zaid** and 120-130 days during winters of northern India.

c) **Seed rate and seed treatment:** Optimum seed rate is 15 Kg/acre (with 85% germination percentage) depending upon the test weight of the hybrid. Seeds should be treated with fungicides and insecticides before sowing to protect it from seed and soil borne diseases and some insect-pests. The seed treatment with Bavistin/Captan/Thiram @ 2 g/kg seed is effective against fungal diseases like Pythium Stalk Rot. The seed treatment with Imidachlorpit @ 4 g/kg for termite and shoot fly is effective, however, the seed treatment with **chlorpyrophos** (20 E.C.) is necessary if the field is infested with termites. In addition one litre **chlorpyrophos** per acre need to be applied with first irrigation.

d) **Sowing time:** It can be sown round the year in southern India. In northern India, it can be sown from February to November. It can be grown through transplanting in furrows in December-January in northern India, for that nursery should be raised in November. Sowing of baby corn during August to November yields best quality baby corn. There should be sufficient moisture at the time of sowing of crop, in case of low moisture, pre sowing irrigation may be applied. At the initial stage 4-5 plants per hill are kept, later on three plants per hill are retained to maintain plant population.

- **Winter/Rabi Crop:** October – November (crop duration 60 days, sowing at flat bed)
• **Summer/Zaid crop**: February – March (crop duration 50 days, sowing at flat bed)

• **Rainy/Kharif Crop**: June – July (crop duration 50 days, sowing on ridges to facilitate drainage of excessive water)

e) **Land preparation**: At first stage the soil should be opened with mould bold plow and kept for drying so that the weeds and fungus causing the diseases are destroyed. The well rotten FYM at the rate of 5-10 tonnes per acre is applied two to three weeks before the sowing and mixed in the soil. 2-3 ploughings with disc harrow followed by one ploughings with cultivator is sufficient for the soil to be ready for sowing.

f) **Sowing methods** Sowing should be done on southern side of the ridges with 60 cm x 15 -20 cm plant x row spacing depending upon plant type (erect/spreading).

g) **Weed management**: The weeds create problem in baby corn crop especially in rainy season. During initial 40 days of crop the weeds need to be controlled.

Broad leaf weeds and most of the grasses can be controlled by pre-emergence spray of Atrazine @ 1.0-1.5 Kg/ ha in 500-600 litre of water. While spraying, the person who is doing spray should move backward so that the atrazine film on the soil surface may not be disturbed. Preferably, three nozzle booms may be used for proper ground coverage and saving time. One to two hoeing are recommended for aeration and uprooting of the remaining weeds, one at 20 days after sowing and another after 40 days of sowing of the crop. While doing hoeing, the person should move backward to avoid compaction and better aeration.

h) **Nutrient management**: Nutrient application should be based on soil test. Generally 150-180:60:25 Kg/ ha NPK and ZnSO$_4$ with 8-10 tons/ ha organic manures should be applied.

Full dose of phosphorus, potash and zinc and 10 % N should be applied as basal. The remaining dose of nitrogen should be applied in four splits as per details given below to avoid losses and meet the requirement throughout the crop cycle-

– 20% N at 4 leaf stage
– 30% N at 8 leaf stage
– 25% N before detasseling
– 15% N after detasseling

i) **Water management**: First irrigation should be applied very carefully. Water should not overflow on the ridges. The irrigation should be applied in furrows
upto 2/3rd height of the ridges. Irrigation should be given as and when required by the crop depending upon the rains and moisture holding capacity of the soil. Young seedlings, knee high stage, silking and picking are the most sensitive stages for water stress for crops and irrigation should ensured at these stages. Light and frequent irrigations are desirable for crop. During winter (mid December to mid February) soil should be kept wet to avoid frost injury.

j) **Intercropping:** Baby corn is very remunerative if it is cultivated with intercrop. As many as 20 crops, namely green pea, rajmash for green pods, potato, sugar beet, green onion, garlic, palak, methi, coriander, cabbage, cauliflower, knol-khol, broccoli, lettuce, turnip, radish, carrot, french bean, celery, gladiolus, etc. have been successfully tried in the winter season. Since, the season is long therefore, farmers can utilize lean period and get additional income through intercropping in baby corn. There is no adverse affect of intercrops on baby corn and vice-versa, rather, some of the intercrops help to improve soil fertility and protect the baby corn crop from cold injury. Intercrops protect the baby corn from northern cold wind because baby corn is planted on southern side and intercrops in northern side of the ridge. In general, short duration varieties of intercrops are preferred for intercropping with baby corn. Recommended dose of fertilizers of intercrops should be applied in addition to the recommended dose of fertilizers of baby corn. In *kharif* season, cowpea for green pods and fodder purposes, urd, mung etc can be intercropped with baby corn. Numbers of intercrops are option for the farmers but for commercial purpose, pea and potato can be taken on large scale during winter season. However Baby corn + Carrot and Baby corn + Potato are the most recommended intercropping patterns.
k) **Plant protection:** Stem borer (*Chilo partellus*), Pink borer (*Sesamia inferens*) and Sorghum shoot fly (*Atherigona spp*) are serious problems in kharif, rabi and spring seasons, respectively. Stem borer can be controlled by 1-2 spray of Carboryl after 10 and 20 days of germination. Spraying should be done in the central whorl of plant. First spray may be done with 500 grams of Carboryl in 500 litres of water whereas 750 grams of Carboryl may be used in 700-800 litres of water during second spray.

l) **Detasseling:** In general tasseling starts in 40-45 days of crop. To maintain the quality of baby corn, detasseling is an essential operation in HM 4 hybrid. It is done by removing the tassel of the plant as soon as it emerges from the flag leaf. It should be practiced row-wise. While detasseling, leaf should not be removed which will affect photosynthesis and reduce baby corn yield. It has been observed that the removal of 1 to 3 leaves along with tassel reduces 5-15 % yield. The removed tassel should not be thrown in the field as it is nutrient rich and should be fed to the cattle.

m) **Harvesting:** Silking starts after 3-5 days of detasseling. Picking should be done daily in *kharif* and on alternate days in winter season within 1-3 days of silk emergence from the leaf sheath depending upon the variety. Appropriate size of earcorn for harvesting is 7-10 cms in length and 1.0 -1.5 cms in diameter. Harvesting should be done when baby corn silk comes out 3.0-4.0 cm from the top of ears, preferably in the morning, when the baby corn moisture is highest and ambient temperature is low or in the evening. In single cross hybrid plant, 3-4 pickings may be required. Generally top ear is harvested first as they are similar in shape size and structure. Ear is separated from stalk with the hand to put it in bag and placed in shady place for preparing it for marketing on the same day. The removal of cover is done with knife in a shady place, the pedicle is removed or retained as per the market demand. Pedicle is removed from the harvest if it has to be canned. During the process care need to taken to avoid any damage to the upper part or ear corn.

n) **Yield:** It depends on potential of genotypes and climatic conditions. In a good crop, on an average 11-19 q/ ha dehusked baby corn or 55-144 q/ ha husked baby corn can be harvested. Green fodder yield is about 150-400 q/ ha that gives additional income.

o) **Post harvest Management:** Care need to be taken to store dehusked baby corn in a cool place if it has to be processed. Dehusking need to be done at an airy and shady place. Dehusked baby corn need to be stored in baskets, bags and jute bags, it should not be heaped. It should be immediately shifted to processing units immediately.
p) Categories of baby corn

<table>
<thead>
<tr>
<th>Category</th>
<th>Length (cms)</th>
<th>Diameter (cms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (Short)*</td>
<td>4-7</td>
<td>1.0-1.2</td>
</tr>
<tr>
<td>Medium *</td>
<td>7.0-10.0</td>
<td>1.2-1.4</td>
</tr>
<tr>
<td>Long**</td>
<td>11.0-13.0</td>
<td>1.4-1.5</td>
</tr>
</tbody>
</table>

*International market  ** Local market

a) Packaging: Packaging is performed differently in different processing units. It may be performed in tin, glass bottles and plastic bags. In order to store for longer period, the packaging in glass vessels is most appropriate. In a glass vessel 52% of baby corn and 48% brine solution is placed. At HPMC plant, Sundenagar, tins are used for packaging. However farmers use small poly bags in general for storage and sale.

b) Processing: Baby corn is processed in order to increase the shelf-life. The major processing methods are as follows:
- Canning
- Dehydration
- Freezing

c) Bi products: Many bi products can be produced from baby corn cultivation which includes; tassel cover, silk and green part. These all are very nutritious and they may be used for dairy and animal production purposes which may give additional income.

d) Marketing: Ensuring market is essential for taking up baby corn cultivation. India lacks systematic market of baby corn. It can be sold husked and dehusked as fresh and in the form of canned products, pickles and candies. Baby corn pickles and candies are in high demand in some of the European and American countries. So India has the great export potential in times to come. Panipat based company named Panchranga is already in the export of baby corn pickle, as such the potentials of business may be exploited in the future.

e) Problems and suggestions: Being remunerative and having export potential, the baby corn cultivation in India could not pick up due to following reasons:
- Lack of availability of quality seeds
- Low level of awareness regarding the use and taste of baby corn
- Lack of processing facilities
- Lack of marketing facilities in rural areas

There are sufficient technologies related to cultivation and use of baby corn. As such it is suggested that farmers' awareness regarding baby corn need to
be enhanced through trainings, demonstrations and use of media sources. To meet the seed requirements, the seed production of single cross early maturing hybrids need to taken up by public sector seed agencies, private seed firms and progressive farmers. The seed production is also an upcoming enterprise. Government and non government agencies need to chalk out setting of processing units. Processing plants at village/ block level in collaboration with cooperative societies and farmers’ interest groups as an agri enterprise may be promoted. Contract farming may be promoted to meet the continuous need of processing plants. For marketing of their produce and earning maximum benefits, farmers need to seek updated information from various sources.

**Precautions to be taken**

- Harvesting should be done within 1-3 days of silk emergence from the leaf sheath
- Detasseling should be done as soon as the tassel emerges
- Harvesting in summer should be done daily either in morning or in evening. While in winters harvesting can be done on alternate days

V) **Cost Benefit analysis of one crop season of baby corn**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Item</th>
<th>Cost (Rs/ Hactare)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Labour cost</td>
<td>25000/-</td>
</tr>
<tr>
<td>2</td>
<td>Seed cost</td>
<td>8000/-</td>
</tr>
<tr>
<td>3</td>
<td>Compost and fertilizers</td>
<td>5000/-</td>
</tr>
<tr>
<td>4</td>
<td>Plant protection chemicals</td>
<td>1500/-</td>
</tr>
<tr>
<td>5</td>
<td>Irrigation and monitoring</td>
<td>2500/-</td>
</tr>
<tr>
<td>6</td>
<td>Total investments</td>
<td>42000/-</td>
</tr>
<tr>
<td><strong>Total earnings</strong></td>
<td><strong>Total earnings</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Cost of Baby corn (dehusked) 1600 kgs @Rs.50/- per kg</td>
<td>80000/-</td>
</tr>
<tr>
<td>2</td>
<td>Green fodder 16000 Kgs @Rs 90/- per Kg</td>
<td>14400/-</td>
</tr>
<tr>
<td></td>
<td>Total earnings</td>
<td>94400/-</td>
</tr>
<tr>
<td></td>
<td>Net profit (Investments-Earnings)</td>
<td>52400/-</td>
</tr>
<tr>
<td></td>
<td>Cost : benefit ratio</td>
<td>1:1.25</td>
</tr>
</tbody>
</table>
Baby Corn HM4: Success case of Aterna village, Sonipat and Sh. Kanwal Singh Chauhan

The Aterna village is situated in the Sonipat district of Haryana. Until 1997 the farmers of this village were following traditional rice-wheat cropping system. In 1997, for the first time babycorn was introduced by the Pure Seed Company in this village in the field of Shri Kanwal Singh Chauhan. After two years, the company withdrew support as it suffered losses in the initial years. But Shri Kanwal Singh Chauhan sensed its entrepreneurial scope and continued its cultivation on small scale. Then he took the produce to the Azadpur Sabzi Mandi in Delhi for sale. There the wholesaler saw the quality of produce and quoted a price of nearly 150-200 rupees a kilogram as a result he got a substantial profit from his one acre of land. The wholesaler preferred his product because it was fresh and having better qualities than the imported babycorn. When he came to the village and shared about the babycorn marketing, some other farmers also got interested to grow this crop. They were purchasing seed from private companies at the rate of Rs.160-200/- per kilogram. Seed rate was 20-25 kg/acre. Thus, cost of cultivation was high.

Then Kanwal Singh Chauhan started searching about the cultivation know how of the babycorn and during this period he met, Dr. Sain Dass, Corn Breeder working at Regional Station of Chaudhary Charan Singh Haryana Agriculture University located at Uchani, Karnal. He told him about the Hybrid Maize -4 (HM-4) variety of baycorn. He obtained seed of HM-4 and introduced in his village for baby corn cultivation. He obtained seed at very cheap rate i.e. around Rs.50/- per kilogram of seed. Seed rate of this hybrid is 8-10 kg/acre. Therefore,
cost of cultivation was reduced. Produce of babycorn was brought in Azadpur Mandi in Delhi. Its demand increased due to desirable colour, size and taste of this hybrid. He invested less than Rs.10,000/- per acre and earned more than Rs.30,000/- per acre within 60 days of crop duration. He started growing HM-4 round the year. His fellow farmers also adopted this hybrid. In the mean time, Dr. Sain Das got transferred to Directorate of Maize Research, New Delhi as its Director. Then DMR, New Delhi adopted the village Aterna to develop as a ‘MODEL VILLAGE’ for babycorn cultivation. Even farmers gave positive response regarding babycorn cultivation. As a result, whole village started growing babycorn in their field. Because of this the Aterna village is popularly known as “Babycorn Village”. (Babycorn production technology and value addition, DMR, New Delhi, 2009)

Now every farmer is well experienced about advantages of babycorn cultivation using HM-4 hybrid. When the more farmers started growing babycorn, the problem of availability of quality seeds arose. Then farmers of this village also started producing hybrid seed of HM-4 after obtaining seed parent from the DMR, New Delhi. They are fulfilling seed requirement of (HM-4) of neighbouring villages
as well as farmers from different parts of the country. Training programmes on seed production and cultivation of baby corn were organized by the Directorate of Maize Research in the village. Babycorn has proved as a boon for the farmers of Aterna village. Socio-economic condition of the villagers has substantially improved. Every farm family has own pucca house, land, vehicles and other facilities.

When the number of babycorn farmers increased, the supply in the market increased and as a result, the price of babycorn started declining then farmers were forced to think for other alternatives for continuing the profitability from this venture. Again Shri Kanwal Singh Chauhan come forward as a leader and consulted the State Department of Agriculture, Haryana. They supported him in establishing the babycorn processing plant in the village itself by providing credit and subsidies. He also established a co-operative society, “Aterna Baby Corn Production and Marketing Cooperative Society Limited”.

With the establishment of processing plant and co-operative society in the year 2009, farmers again started getting good profit from babycorn. There was an agreement among the members that whenever the market price will be higher, farmers were free to sell their produce in the market but if the market price is low, they can sell their produce to processing plant at fixed price of Rs 45-50 per Kg. The processing industry consulted the exporting firms situated in Delhi and started supplying the processed product of babycorn for export.

At present every farmer of this village is engaged in cultivating baby corn and farm women are employed in the processing unit for cleaning, grading and packaging the produce. This has significant impact in their farm earnings resulting in socio-economic assets. A research study (Sinha Pankaj & Rashmi Singh, 2011) of village Aterna found that there was perceptible enhancement in income, increased employment and more savings getting reflected in increase in assets possessed, modern houses and increase in social prestige.
Hybrid Seed Production of Tomato in Low Cost Net House

India is the second largest vegetable producer in the world, after China. But in comparison to production capacity and quality, it lags behind the other countries. The reason for this low productivity is the less use of quality seed in crop production, limited use of production management practices, and effects of biotic stress on crops. In fact, the expression effect of all other factors depends on the quality of seed.

When the farmer wants to produce the vegetables, most of the seed varieties available in the market are hybrids and produced by private companies, who charge high rates. This is the reason by which a medium category farmer unable to grow vegetables. Other than this unavailability of quality seed, high market rates and lack of technical knowledge are also the obstacles in vegetable production. Some farmer entrepreneurs grow crop for seeds in open field conditions which are affected by biotic and abiotic factors and produce a poor quality seed. To come out from these problems and to produce good quality seeds, Net House method is useful, where crop can be saved from insect-pests, environmental fluctuations and other biological factors.

Tomato is an important vegetable crop in our country and it used throughout the year. In northern India growing season for this crop starts from November and ends with May, whereas for seed production December to January month period is important. But, the low temperature and frost situations can spoil the crop. In the recent years it is observed that open cultivation of tomato saved by using net covers is useful. This method results in early fruiting, which starts from 15th February and ends with last week of March. The temperature should be in between 12°C to 35°C if it crosses the limit, it may harm the crop.

What is a Net House?

This is a house like structure, which covers with a wire mesh net (40 mesh UV sterilized). This net provides controlled micro environment for plants and protects them from insects and pests.

Place of Construction of Net House

At the time of Net House construction, it should be taken care that the land should be fertile and source of water should in nearby. To make a
100 sq\textsuperscript{m} Net House the approximate cost is Rs 30,000/-. The Net House is made by using GI Pipes and angles, which sustain for around 5 to 7 years. If GI Pipes are replaced with bamboo sticks, then it can be done with very low cost but it will be susceptible for termite attack.

**Processes for Planting**

Tomato is grown through transplantation, where it is essential to use healthy and disease free plants. For open plot technique, sufficient amount of compost should be used. For growing plant in Net House plastic plug trays are essential. In Net House the ratio of pot mixture should be 3 parts cocopeat, 1 part vermiculture and 1 part pearlite. In nursery, there is the possibility of damping off disease, where application of Bavistin or DM-45 is very useful. To control the death rate at nursery, irrigation should be stopped before 4 to 5 days of transplanting. In north India, the hybrid male and female parents should be planted in fields till 15\textsuperscript{th} of October.

**Preparation of Planting in Net House**

In the Net House, foot-path should be two feet left on door side and the ridge basin should be 15-20 cm higher than the foot-path. The land is to be levelled and cow dung compost and formaldehyde (2 ml/ lit) should be sprayed, which makes the land pathogen free. In the Net House for hybrid seed production, the male and female parents should be planted in the ratio of 1:5 and should be tagged properly. The best time for planting is before 15\textsuperscript{th} November.

**Crop Management**

Special care should be taken for nutrient management during the production of hybrid seeds in the Net House. The application of micronutrients from time to time makes the plant healthy and it increases the seed production. When the tomato plant grows, proper support should given to it. The branches at the lower portion of the stem should be removed and its growth should be diverted upward with proper support.
Flowering

Tomato is a self pollinated crop, but for hybrids, manual cross pollination is necessary. Flowering starts by 15th of January or within 60 days of planting. Seed quantity and quality will be more in fruits which get stabilized during 15th January to 15th March. Farmer should take care about fruited plants and give them support by using wooden sticks and timely irrigation.

Pollination

Seed production of hybrid tomato is done by skilled workers by emasculation and manual fertilization. The emasculation of female flowers which are supposed to open on next day is done in the noon itself of that particular day. The anther is removed from the flower of the female parents, and care is taken that no harm should be done to the female parts. The opened flower on the female parents are removed. After emasculation, the anther from male parent are collected and kept for one night in a closed room. Again in the morning the anther are kept under sun light for 2 to 3 hours. Then the anther are shaken well in a closed pot by which pollens come out in powder form. Before noon, in the already emasculated female flowers, the pollen are touched to the style. Then the flowers should be tagged properly for identifying the pollinated fruits. The process of pollination should be stopped after 15th March. The fruits set during 15th January to 15th March have high number of quality seeds.

Insect and Disease Management

The Net House works as a physical barrier for the insects, but care less opening of door may result in the entry of insects. Thus, the Net House should be made with two doors. One door is opened to enter and then another door is opened only when the previous door is well closed.

Important Insect pests and diseases in tomato
1. **Stem rot**: The stem is broken down and the plant dies. Bavistin/DM-45 can be used 1 to 2 times by spraying for the control of this disease.
2. **Powdery Mildew**: It creates burning spots on leaves, which increase after infestation and the whole crops looks like burnt field. This disease may spread in Net House also due to more humidity and temperature. To control this disease proper aeration should be maintained by opening the windows. Two to three sprays of Metalaxyl is also useful.

### Insects and Pest

Due to careless handling some times, white flies, aphids and borers enter in to the Net House. To prevent this Malathion and Monocrotophos can be sprayed for 2 to 3 times for the control of termites. The solution of chlorpyriphos should be applied near the root from time to time. There is no remedy for toxic affected plants and hence they are to be uprooted and thrown away.

### Harvesting and Seed Extraction

The dark red fruits should be harvested and stored them in plastic trays. Fruits should be put for curing for 24 hours and after that the pury is made by crushing them properly. The pury is kept for 16 hours in closed container and then the seed is extracted after washing. The washed seed are dried in shade for 3 to 4 days, so that the moisture content reaches to 6-7%.

**Seed Production**: 3.0 to 3.5 kg /100 sqm.

### Structural Cost of Net House

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Materials</th>
<th>Quantity</th>
<th>Cost (₹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GI Pipe 1/2 &quot; Class-B (20 Feet)</td>
<td>15</td>
<td>12500</td>
</tr>
<tr>
<td>2</td>
<td>Insect Restrict Net (40 mesh UV Stabilized)</td>
<td>100 SQM</td>
<td>7500</td>
</tr>
<tr>
<td>3</td>
<td>Fixing material to Join the pipes (eg. iron plates 2&quot;x12&quot;x0.3&quot;, joints etc.)</td>
<td>20</td>
<td>4000</td>
</tr>
<tr>
<td>4</td>
<td>Labour Charges (Five skilled persons for one day)</td>
<td>1 Day</td>
<td>2500</td>
</tr>
<tr>
<td>5</td>
<td>Other spontaneous Charges</td>
<td>-</td>
<td>2000</td>
</tr>
<tr>
<td></td>
<td><strong>Total Cost</strong></td>
<td></td>
<td><strong>28500</strong></td>
</tr>
</tbody>
</table>

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71
## Cost-Benefit Ratio

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Economic Parameters</th>
<th>Cost (₹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Variable Cost</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Seed Price</td>
<td>140</td>
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<tr>
<td>2.</td>
<td>Field Preparation</td>
<td>4400</td>
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<tr>
<td>3.</td>
<td>Seed Sowing</td>
<td>2000</td>
</tr>
<tr>
<td>4.</td>
<td>Fertilizer Management</td>
<td>1200</td>
</tr>
<tr>
<td>5.</td>
<td>Weed Control/ uprooting</td>
<td>2910</td>
</tr>
<tr>
<td>6.</td>
<td>Irrigation</td>
<td>3750</td>
</tr>
<tr>
<td>7.</td>
<td>Disease Management</td>
<td>1800</td>
</tr>
<tr>
<td>8.</td>
<td>Seed Harvesting, Cleaning and Threshing</td>
<td>2600</td>
</tr>
<tr>
<td>9.</td>
<td>Roguing (Removal of Unwanted Plants)</td>
<td>500</td>
</tr>
<tr>
<td>10.</td>
<td>Pollination and Emasculation</td>
<td>600</td>
</tr>
<tr>
<td>11.</td>
<td>Nursery Management</td>
<td>850</td>
</tr>
<tr>
<td></td>
<td><strong>Fixed Cost</strong></td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Total Cost of Net House</td>
<td>28500</td>
</tr>
<tr>
<td>2.</td>
<td>Net House Value Depreciation @15%/year</td>
<td>4275</td>
</tr>
<tr>
<td>3.</td>
<td>Total Cost (₹/ Acre)</td>
<td>25025</td>
</tr>
</tbody>
</table>

### Economic Analysis

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Yield (Kg/ Acre)</td>
</tr>
<tr>
<td>2.</td>
<td>Seed Price*</td>
</tr>
<tr>
<td>3.</td>
<td>Gross Returns** (As seed ₹/ Acre)</td>
</tr>
<tr>
<td>4.</td>
<td>Net Returns (₹/Acre) from Seed Production</td>
</tr>
<tr>
<td>5.</td>
<td>Net Returns (₹/Acre) from Commercial Crop</td>
</tr>
<tr>
<td>6.</td>
<td>Growing Marginal Returns (₹/Acre)</td>
</tr>
<tr>
<td>7.</td>
<td>Cost- Profit (B:C) Ratio</td>
</tr>
</tbody>
</table>

* The Seed Prices are decided on the basis of 60% of Pusa Institute’s Sale Price.

**Production Cost for 125 days @ 200/ day labour cost (179/ day in Haryana and 203/labour in NCR). This work is taken care by farmer himself, by which production cost will be reduced and Cost-Benefit Ratio will increase.
Off Season Vegetable Production in Protected Structure

Keeping in view the increasing demand for off season, exotic and high value vegetables, fruits and flowers in several big cities of the country, there is a urgent need for diversification from the traditional agriculture by production of high value horticultural crops under different protected conditions for increasing their productivity and quality for getting high returns. Nursery raising under protected cultivation can be adopted as a agri-ventures in major vegetable growing areas of the country by unemployed youths. It is slightly skilled job but can be easily learnt by youth who want to pursue agriculture in scientific manner utilizing hi tech methods. Socially also it is much preferred as it provides enhanced status to them rather being called farmers only. Low cost protected technology like plastic low tunnels or walk in tunnels can be used for off season vegetable cultivation for getting high returns from off season produce. Similarly insect proof net houses can be used on a large scale for safe vegetable cultivation by way of minimizing the use of pesticides in vegetable cultivation and virus free seed crop production in large number of vegetables.

Commercial vegetable production for off season and vegetable seed production provides immense potential as agri-entrepreneurial ventures. They provide tools to earn more from the same land by targeting market potential of higher demand during off season. This is possible by growing vegetables in protected structures like polyhouses, shade nets and insect proof nets.

What is Protected Cultivation?

Protected cultivation exercises some level of control over plant micro climate to alleviate one or more of abiotic or biotic stresses for optimum plant growth which can be achieved in poly house/net house. Crop yields can be several times higher than those under open field conditions. Quality of produce is superior. Higher input use efficiencies are achieved. Net house and poly house technology has been recommended for the cultivation of different vegetables. Production of vegetables under protected conditions protects the crops mainly from adverse environment conditions such as temperature, hailstorms, scorching sun, heavy rains, snow and frost.

The production of off-season vegetable crops under net house conditions was evaluated for total yield, earliness and other characters and incidence of
insect pests. The cultivation of vegetables in net house can play a better role in improving quality, advancing maturity as well as increasing fruiting span and productivity. Cultivation of capsicum, brinjal and tomato is recommended in net house. Protected cultivation technologies are being utilized all over the world but the level and extent of their use may be different among different countries. Protected cultivation technology has reduced the dependence on environment and has capacity not only to increase the productivity of vegetables by many folds but also to improve the quality of vegetables by reducing the use of insecticides and pesticides. The effect of chemical and pesticides use is more harmful in vegetables as compared to other non-food crops. Certain protected technologies are simple and highly profitable under Indian conditions and more specifically for peri-urban areas, which can be adopted by Indian farmers for production of different horticultural crops in the following manners.

**Vegetable production in protected structure**

Production crop in open is generally attacked by crop pests and diseases. To avoid such problems innovative technology of crop and seed production in protected structure has been developed.

**a) Raising nursery in plug tray in protected structures**

To ensure high productivity and high quality of the produce, raising of quality seedlings through use of good quality seeds at right time and at a appropriate place is one of the cheapest but most important way. Most of the Indian farmers are raising their vegetables flowers and fruits seedlings under open field conditions, which are always inferior in quality, as the seedlings are infected with virus when raised in open during rainy and post rainy season. Under this system seedlings are raised in especially designed greenhouses or other protected structures. A large number of virus free healthy seedlings of different vegetables can be raised in a small area of green house in plastic plug-trays by using soil-less media for growing vegetables either for main season or for their offseason cultivation. With the use of this technology it is now almost possible to raise healthy vigorous seedlings of different cucurbits, otherwise it was not possible in earlier traditional system of nursery raising. During rainy days or thereafter, plants growing in the open atmosphere are vulnerable to a variety of infections, such as fungus and nematodes present in soil and other pests of plants. Farmers can protect their seedlings of tomato, eggplant (brinjal), capsicum etc., from biotic stresses by growing the nursery in plug tray in protected structure. Plants grown by this method have more potential to fight various diseases as the roots and stems of such plants are stronger enough. Farmers can produce nursery in protected structure and which later on may be transplanted in open field for commercial production and seed production purposes.
The farmers or unemployed agriculture graduate youths of our country can very successfully start nursery raising as agri entrepreneurs in major vegetable growing pockets of the country. This way the vegetable growers will get the virus free or off-season healthy nursery as per their requirement and it will also generate additional employment in agriculture sector is most important step for enhancing productivity and quality in horticulture. Thus, protected vegetable cultivation is most important step for enhancing productivity and quality in horticulture.

b) Vegetable production in low plastic tunnels

In most parts of our country the farmers are growing various vegetables during their main season of cultivation, but the prices of these vegetables are very low and sometimes the vegetable growers are even not getting back their cost of cultivation of the vegetables. But the same vegetables are sold at very high price during their off-season in several cities of our country. The demand of off-season vegetables is increasing day by day in several big and medium sized cities of the country, which provide wide scope of vegetable production through off-season cultivation of some vegetables mainly the cucurbits in peri-urban areas of the country. Plastic low tunnel technology is a simple and profitable technology for off-season cultivation of cucurbits during the winter season in northern plains of our country. Cucurbits like muskmelon, round melon, bottle gourd, cucumber, bitter gourd, watermelon can be advanced by 30-40 days over their normal growing season. During Rabi season seed production of cucurbits in India's northern and western plains can be taken up by adopting the low plastic tunnel method which provides protection of crop from frost and cold and increases the flowering period leading to more number of fruits and ultimately high quantity and quality of seeds produced.

Walk in tunnels are the temporary structures erected by using G.I. pipes & transparent plastic. Walk in tunnels are used for complete off season cultivation of vegetables like bottle gourd, summer squash, cucumber etc., during winter season (December - mid February). The basic objective & utility of walk in tunnels is to fetch high price of the off season produce to earn more profit per unit area. The ideal size of a walk in tunnel can be of 4.0 m width and 30m length (120m$^2$) and total cost of fabrication may be Rs. 12000-14000.

Objectives & Utility of the Walk in Tunnels

1. Off season cultivation of vegetables for earning more income.
2. Walk in tunnels are only erected over the crop during the peak winter months of December to mid-February and there after the structure is removed from the crop.
3. Since, the plastic is used only for two months (December to mid-February) therefore, life of the plastic can be 8-10 years.

4. These temporary plastic structures are suitable for off season vegetable cultivation in northern plains and low hills.

c) Seed and vegetable production in shade net house

During summer, the high temperature has adverse effect on the seed production of cucurbit crops, leafy vegetables and early cauliflower. For seed production, black net produces more shade and heat in comparison to green, white, and silver color shade nets. By this method of crop seed production 25-75 percent shade can be achieved which increases growing period of crop resulting in more fruiting and seed production.

d) Insect resistant net house

Net house is an insect proof galvanized steel structure in which the entry of insect pests can be controlled and the crop can be protected. Crops in net house are pest free, have almost double yield and produce better quality seed. Fewer sprays of pesticide are required during the whole crop season and the seed production yields and profits are more than the open conditions. A well maintained nethouse can be used for 3 to 5 years. This type of net house can be successfully used for the seed production of brinjal varieties like: Pusa hybrid 5, Pusa hybrid 6, and 9 during kharif season. The parents of such hybrids in the ratio of 4:1 (female: male) can be sown during 15-30 June and may be transplanted for seed production during July 15-30. Plant distance of 100 cm need to be maintained and the pollination may be done during morning hours between 7-11 am. Two to 2.5 kg of egg plant (brinjal) seeds can be produced from 100 square meter net house which may fetch a net profit of Rs 32000-40000 per year. Similarly 5.0 kg seed of Pusa hybrid 1 and Pusa hybrid 2 of bittergourd could be obtained from the area of 100 square meters net house which may result in an income of Rs. 12,500 per year.

e) Polyhouse

Polyhouse is a hut type of structure covered with UV ray resistant polyethylene of 200-800 microns thickness. It regulates micro climate for the plants. Polyhouse works on the principle of greenhouse where the sunlight during the day hours enters through the transparent polythene and raises the inside temperature by 4-5°C and continue to maintain the temperature of the polyhouse. During the construction of the polyhouse there should be provision of ventilators which may be opened if the temperature goes beyond 30°C. The ventilators should also be
covered with insect proof mesh of net. During *Rabi* the tomato hybrids of Pusa planted in the ratio of 1:4: (male: female) at a distance of 90 cm in the area of 100 m², is capable of producing 3.5 kg hybrid seed and Rs.70,000/- net income in this process may be earned in one year from an area of100 m² only.

**National Horticulture Mission Schemes**

*The assistance and subsidy for protected structures under National horticulture Mission*

<table>
<thead>
<tr>
<th>Item</th>
<th>Expected Cost</th>
<th>Type of Assistance</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Green house</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Small and Marginal farmers</td>
<td>Rs. 650/- per m² for high tech structure</td>
<td>50% of the cost with a ceiling of Rs. 325/- per m² for high-tech structures and Rs. 125/- per m². The maximum limit per beneficiary is 1000 m²</td>
</tr>
<tr>
<td></td>
<td>Rs. 250/- per m² for cost effective structure</td>
<td></td>
</tr>
<tr>
<td>Other farmers</td>
<td>Rs. 650/- per m² for high tech structure</td>
<td>33.3% of the cost with a ceiling of Rs. 215/- per m² for high-tech structures and Rs. 67/- per m². The maximum limit per beneficiary is 1000 m²</td>
</tr>
<tr>
<td></td>
<td>Rs. 250/- per m² for cost effective structure</td>
<td></td>
</tr>
<tr>
<td>Mulching</td>
<td>Rs.14000/- per hectare</td>
<td>50% of the total cost with a ceiling of Rs. 7000/- per hectare with a limit of two hectare per beneficiary</td>
</tr>
<tr>
<td>Shade net</td>
<td>Rs. 14/- per m²</td>
<td>50% of the total cost with a ceiling of Rs. 3500/- with a limit of 500 m² per beneficiary</td>
</tr>
<tr>
<td>Plastic tunnel</td>
<td>Rs.10 per m²</td>
<td>50% of the total cost with a ceiling of Rs. 5000/- per hectare with a limit of 5 hectare per beneficiary</td>
</tr>
</tbody>
</table>

**Parthenocarpic Cucumber cultivation in protected structure**

Cucumber (*Cucumis sativus*) is a widely cultivated plant of the gourd family Cucurbitaceae. It is a creeping vine that bears cylindrical fruit that are edible when ripe. There are three main varieties of cucumber: slicing, pickling, and parthenocarpic cucumber. Within these varieties, several different cultivars have emerged. Parthenocarpic cucumbers are sweeter and have a thinner skin than other varieties of cucumber and are reputed to be easy to digest and to have a pleasant taste. They can grow as long as 2 feet (0.61 m). They are nearly seedless, and have a delicate skin. Most commonly grown in greenhouses, these parthenocarpic cucumbers are often found in grocery markets, shrink wrapped in plastic. They are sometimes marketed as seedless or parthenocarpic cucumber, because the seeds and skin of other varieties of cucumbers are said to give generate gastric problems to some people.
Cultivation of parthenocarpic cucumber can be done in protected structure only. This may be grown in Low cost poly houses as well in naturally ventilated greenhouses in addition to high tech green house/ poly house. Hence, the cultivation practices and other details which remain same in all the three options are given as below:

**Low cost poly houses**

A low cost poly house is the main structures, which can be used successfully and efficiently for parthenocarpic cucumber production or for virus free healthy vegetables. These low cost poly houses can be erected by using GI pipes of 1.0 and 1/2 inch. The 1.0 inch pipe is useful in erecting the side walls up to 6-7 feet in height and on the top the 1/2 inch size bended GI pipes are fixed in the 1.0 inch size pipes. The width of these structures is 5 to 5.5 feet. The top of the structure is covered with plastic of 180-200 micron, whereas the sidewalls are first covered with insect proof net of 40 or 50 mesh up to 5-6 feet height from the ground after placing it in soil and a reliable plastic is fixed over the net. During summer one can roll the all side plastic for cross ventilation in the structure and it can be opened during the winter season to increase the inside temperature of the structure. These structures can be used for off-season or virus free cultivation of vegetable or for year round virus free healthy nursery raising of different vegetables. These structures can be made within Rs. 200-250 per m2 cost and the farmers themselves can make these structures according to their requirement at village level by using rural artisans.

**Naturally ventilated greenhouses**

Naturally ventilated greenhouses are the protected structures where no heating or cooling devices are provided for climate control. These are simple and medium cost greenhouses which can be erected with a cost of Rs.650-700 sq. meter and these greenhouses can be used successfully and efficiently for growing year round parthenocarpic cucumber, off season muskmelon, tomato and sweet pepper crops for 8-9 months duration. These structures are having a manually operated cross ventilation system as and when required. There is an increasing demand of high quality parthenocarpic cucumber in up markets of the metro and other big cities of the country all over the year. Thus, it is one of the most suitable and profitable crop for cultivation under naturally ventilated green houses in peri-urban areas of the country. Three successful crops of cucumber can be grown in a naturally ventilated greenhouse in a period of one year. Muskmelon is the second crop, which can be successfully cultivated for its complete off-season availability, which can fetch very high price of the off-season produce in the up markets of the metro and other big cities of the northern parts of the country. Now the
time has come when the vegetable growers in various parts of the country can use the naturally ventilated greenhouse technology for cultivation of high value vegetables for high profits.

**Required materials and cost of a Naturally ventilated greenhouse (1000 m²)**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Material</th>
<th>Cost (In rupees)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>G.I pipe (length 6-7 feet)(1.0 inch diameter)</td>
<td>50000</td>
</tr>
<tr>
<td></td>
<td>G.I pipe (length 5.5 feet) (0.5inch diameter)</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Plastic (180-200 micron)</td>
<td>21000</td>
</tr>
<tr>
<td>3</td>
<td>Insect proof net (40 mesh UV stabilized)</td>
<td>28000</td>
</tr>
<tr>
<td>4</td>
<td>Fixing material (plates, nut, bolts etc.)</td>
<td>20000</td>
</tr>
<tr>
<td>5</td>
<td>Labour</td>
<td>14000</td>
</tr>
<tr>
<td>6</td>
<td>Miscellaneous expenditure</td>
<td>10000</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>144000</strong></td>
</tr>
</tbody>
</table>

**How to grow ‘Parthenocarpic’ Cucumber**

Usually this is the most preferred crop for cultivation in net house/ poly house. ‘Parthenocarpic cucumber’ is a Cucumber variety in the cucumber genus with a scientific name of *Cucuminsativus*. Parthenocarpic cucumber is considered a hybrid cultivar. Some varieties of cucumber are marked as ‘Parthenocarpic cucumber’ because the seed sand skin of other varieties of cucumbers are not suitable for sensitive digestive systems of some people. The parthenocarpic cucumber variety is reputed to be easy to digest and have a pleasant taste. It is also required in most of the continental cuisine. This variety is a vegetable that typically grown as a annual which is defined as a plant that matures and completes its life cycle over the course of a single year. Parthenocarpic cucumber normally reaches in late spring. India is believed to be where parthenocarpic cucumber originates from. Its tender (blooming) time is late spring. Parthenocarpic cucumber needs a moderate amount of maintenance, so some level of previous experience comes in handy when growing these plants. Ensure that the grower is aware of the soil, sun, pH and water requirements for these plants and keeps an eye out for pests. Normal levels of nitrogen are required. Mature height of parthenocarpic cucumber is 30.0 cm/11.7 inches.

Plant in a location that faces full sun and remember to water often. Keep in mind when planting that parthenocarpic cucumber is very tender, so it is really important to plant out well. Ensure that the soil pH should range between 5.5 and 6.8 as parthenocarpic cucumbers like the weak acidic soil.
Growing Parthenocarpic cucumber from seed

Parthenocarpic cucumber seeds are sown directly. Sowing is done at a depth of approximately 0.47 inches (1.2 cm) and a distance of at least 11.7 inches (30.0 cm) between cucumber plants is maintained. Soil temperature should be maintained higher than 16°C/ 61°F to ensure good germination. Row to row distance of 2.40 meters/7.80 feet need to be maintained for proper growth and fruiting. Ensure that temperatures are mild and all chance of frost has passed before planting as parthenocarpic cucumber is a tender plant.

Diseases

Damping off (fungi)

Several fungi may cause damping off. This disease may take several forms including decay of the seed immediately following seedling or germination and post emergence damping off where the fungi attacks the stem at the soil line causing a constriction which causes the young seedling to topple over. Damping off fungi may also cause a root rot.

Control: Sow seeds treated with a fungicide. For green house grown plants, sterilize soil or use an artificial mix and drench seedling with an appropriate fungicide.

Leaf spot

Alternaria (fungus), angular (bacterium) leaf spots: Alternaria causes small circular spots which enlarge up to 2 cm in diameter with dark concentric rings with in the spots. Spots coalesce to affect large areas of the leaf. Angular leaf spot causes small angular spots that are irregular in shape and size. It may attack fruit, causing water soaked spots. Fruit rot follows after it.

Control: Follow a 1 to 2 year rotation. Apply a fungicide at first sign of diseases and at 7 to 10 days intervals. Use an alternating schedule with an organic fungicide for alternaria and fixed copper for angular leaf spots.

Economics of the production

<table>
<thead>
<tr>
<th>Area (m²)</th>
<th>Duration of crop</th>
<th>Production (ton/1000 m²)</th>
<th>Market price (Rs per Kg)</th>
<th>Total Earning (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000</td>
<td>4 Months</td>
<td>50</td>
<td>30</td>
<td>150000/-</td>
</tr>
</tbody>
</table>

Thus for 3 crops in a year, a total earning of (Rs 1,50,000 x 3) = Rs 4,50,000/- is expected.