250. PROFILE ON BEE VENOM, PROPOLIS, POLLEN AND ROYAL JEELY PROCESSING PLANT

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I. SUMMARY

This profile envisages the establishment of a plant for the production of bee venom, propolis, pollen and royal jeely with a capacity of 15,000 tonnes per annum.

The present demand for the proposed product is estimated at 25,000 tonnes per annum. The demand is expected to reach at 47,143 tonnes by the year 2020.

The plant will create employment opportunities for 79 persons.

The total investment requirement is estimated at Birr 8.51 million, out of which Birr 6.21 million is required for plant and machinery.

The project is financially viable with an internal rate of return (IRR) of 21% and a net present value (NPV) of Birr 3.99 million discounted at 8.5%.

II. PRODUCT DESCRIPTION AND APPLICATION

Honey bees are the sole sources of honey and bees wax, a fine wax with usual qualities. Honey bees also produce propolis, a gummy substance made from tree sap that has anti-bacterial properties, and royal jelly and pollen for human consumption.

Honey bee venom is extracted for the production of anti-venom therapy and is being investigated as a treatment for several serious diseases of the muscles, connective tissue, and immune system, including multiple sclerosis and arthritis.

The common problem with the use of bee venom is that some people are allergic to bee stings and this may cause death. These people would have problems of breathing, a fast heart rate, and could die within 30 minutes. People with bee venom allergies should not try this treatment for any reason.

Bee venom, propolis, pollen and royal jelly are extracted from bee hive keeping, and this operation is widely known and practiced in many African and Asian countries. Honey and wax are products known in Ethiopia. However, value-added can be obtained by producing propolis, pollen and royal jelly.

III. MARKET STUDY AND PLANT CAPACITY

A. MARKET STUDY

1. Current Demand and Supply

The best known primary products of beekeeping are honey and wax, but pollen, propolis, royal jelly and venom are also marketable primary bee products. While most of these products can be consumed or used in the state in which they were produced by the bees, there are many additional uses where these products form only a part of all the ingredients of another product. Because of the quality and sometimes almost mystical reputation and characteristics of most primary bee products, their addition to other products usually enhances the value or quality of these secondary products.

According to a publication by Food and Agriculture Organization of the United Nations “Value-Added Products from Beekeeping” 2005, China as of 2004 is the world's leader in bee pollen, propolis, royal jelly and venom production with approximately 210,000 tonnes. However, china is the second largest exporter, loosing first place to Argentina since 2001. China is affected by the Honey Suspension Agreement with the US, where the price exported from China to the US is determined by a reference point set six months prior to actual trading.

Argentina was estimated to have produced 180,000 tones in the year 2004. Almost all its production is exported (mostly in bulk), making this country the largest exporter in the world in 2004, ahead of China. Argentina’s key market is the US. The highest share of Argentina’s export of the products is accounted by royal jelly (77.01%) followed by pollen (16.31%) and propolis (6.68%). See Table 3.1

Table 3.1

ARGENTINA'S HONEY PRODUCTS EXPORT BY PRODUCT (2004)

Product	Quantity (Tone)	% share
Pollen	29,356	16.31
Propolis	12,023	6.68
Royal jelly	138,613	77.01
Venom	8	0.004
Total	180,000	100.00

***Source** ; Value-Added Products from Beekeeping, FAO 2005*

The US is the second largest importer after Germany, with imports of 78,000 tonnes of bee pollen, propolis, royal jelly and venom in the year 2004.

Germany only produced approximately an average of 25,000 tones annually. Germany is a viable export market for large producers. In the year 2004, Germany imported more than 88,000 tonnes of bee pollen, propolis, royal jelly and venom, making it the largest importing country in the world.

Accordingly based on the above discussion it can be assumed that locally produced bee pollen, propolis, royal jelly and venom demand could be conservatively estimated at 25,000 tones which is only 15% of the total quantity of US and Germany import during 2004. Moreover, assuming that Argentina's export who is the leading exporter reflects proportion of demand for each product is used to estimate the share of each product from the total estimated demand. (See Table 3.2)

Table 3.2

SHARE OF EACH PRODUCTS FROM THE ESTIMATED DEMAND

Product	Quantity	% share
Pollen	4,078	16.31
Propolis	1,670	6.68
Royal jelly	19,253	77.01
Venom	1.11	0.004
Total	**25,000**	**100.00**

2. Demand Projection

The demand for bee pollen, propolis, royal jelly and venom seems to be growing rapidly in industrialized countries due to increasing numbers of health conscious consumers. Moreover, industrial application of the products will continue to grow as they find more acceptances in medicinal uses and as more cosmetic manufacturers realize their benefits and marketing value. Therefore, it can be realistically assumed that the demand for the products will grow at annual average growth rate of 5%. Accordingly, taking the estimated present demand for the products and applying a 5% growth rate the projected demand in given in Table 3.3.

Table 3.3

PROJECTED DEMAND

Year	Products				
	Pollen	**Propolis**	**Royal jelly**	**Venom**	**Total**
2008	4,281	1,754	20,215	1	26,251
2009	4,495	1,841	21,226	1	27,564
2010	4,720	1,933	22,287	1	28,942
2011	4,956	2,030	23,402	1	30,389
2012	5,204	2,131	24,572	1	31,908
2013	5,464	2,238	25,800	1	33,504
2014	5,737	2,350	27,090	2	35,179
2015	6,024	2,467	28,445	2	36,938
2016	6,326	2,591	29,867	2	38,785
2017	6,642	2,720	31,360	2	40,724
2018	6,974	2,856	32,928	2	42,760
2019	7,323	2,999	34,575	2	44,898
2020	7,689	3,149	36,303	2	47,143

3. Pricing and Distribution

According to American Bee Journal, in 2005 dried pollen prices in the USA range from USD 5 to 13 per kg wholesale and USD11 per kg retail and the prices for raw propolis is about USD 30. The international wholesale price of royal jelly, based on that of Argentina, the largest supplier, was USD 50-80 per kg. Bee venom price varied greatly between USD100 and USD200 per gram of dry venom.

Accordingly based on current market prices the recommended factory get price for the envisaged plant is shown in Table 3.4

Table 3.4

RECOMMENDED PRICE

Product	**Recommended Price**
Pollen	62.3/Kg
Propolis	222.5/Kg
Royal jelly	534/Kg
Venom	890/Kg

B. PLANT CAPACITY AND PRODUCTION PROGRAMME

1. Plant Capacity

The market study on bee pollen, propolis, royal jelly and bee venom indicates that demand of the assorted products on bee hive keeping rapidly grows due to an increasing use of the products in the health and cosmetic sectors. In 2008, the demand for pollen, propolis, royal jelly and venom will be 4281 tonnes, 1754 tonnes , 20215 tonnes, and 1 tonne, respectively. In 2020, these figures will grow to 7689 tonnes, 3149 tonnes, 36303 tonnes and 2 tonnes, respectively. In view of the project demand (Table 3.3) of the assorted products, and considering small scale production of the products, the envisaged plant will have production capacity of 15.5 tonnes of the assorted products. This consists of 2.0 tonnes of pollen, 3.0 tonnes pf propolis, 10.0 tonnes of royal jelly and 0.5 tonne of bee venom.

2. Production Programme

Production will start at lower capacity to provide adequate time for skill development on bee products. Therefore, the envisaged plant will start production at 65% of capacity during the first year. Production will then grow to 75%, 85% and 100% during the second, third and fourth year, respectively.

Table 3.4
PRODUCTION PROGRAMME

Year		**1**	**2**	**3**	**4 and above**
Capacity utilization (%)		65	75	85	100
Production	Pollen (kgs)	1300	1500	1700	2000
	Propolis (kgs)	1950	2250	2550	3000
	Royal jelly (kgs)	6500	7500	8500	10000
	Venom (kgs)	330	380	430	500
	Total (kgs)	**10,080**	**11,630**	**13,180**	**15,500**

IV. MATERIALS AND INPUTS

A. RAW AND AUXILIARY MATERIALS

The basic raw material for beekeeping are the bee colony, natural and man-made flower plantation, and auxiliary inputs required to facilitate the harvesting of flowers. The natural forests found in the three identified woredas are believed to be potential sources for the products. Moreover, the project will have to carry out new flower farms in the vicinity of the areas where beehives are located. It is assumed that a total of Birr 250,000 to Birr 350,000 will be sufficient to rehabilitate the natural forests and carryout new flower plantation.

B. UTILITIES

Electricity and water are utilities required for the envisaged project. Annual requirement of these inputs is estimated to be Birr 20,000.

V. TECHNOLOGY AND ENGINEERING

A. TECHNOLOGY

1. Production Process

The production process consists of the following operations:

a) Pollen collection
b) Propolis collection
c) Royal jelly collection
d) Venom collection

a) Pollen collection

Extreme care should be taken that pollen is not contaminated by bees collecting from flowers treated with pesticides. During, and for several days or weeks after treatment of fields or forests in an area of several squate kilometers (in a circle of at least 3-42 km diameter) around the apiary, no pollens hould be collected. This is independent of the method of pesticide application. Even systemic pesticides have been shown to concentrate in pollen of, for example coconut. Since a pollen pellet is collected from many flowers, even small quantities of pesticides per flower can be accumulated rapidly to reach significant concentrations.

Though pollen pellets are collected before they enter the hive, treatment of colonies for bee diseases, can contaminate the pollen pellets. Though, for example, cleaning of debris from the hive and bees regurgitating syrup, nectar or honey during collection of the pellets.

Pollen pellets are removed from the bees before they enter the hive. There are many designs of pollen traps some easier to clean and harvest, others more efficient or easier to install. The efficiency rarely exceeds 50%, i.e. less than 50% of the returning foragers loose their pollen pellets. Bees are ingenious in finding ways to avoid losing their pellets, like small holes or uneven screens and may even rob pollen from the collecting trays, if access is possible. Under some circumstances, pollent collection methods and regimes may interfere with normal colony growth or honey production. Therefore, standard beekeeping manuals should be consulted for the timing of collections.

Pollen should be collected daily in humid climates but less frequently in drier climates. To avoid deterioration of the pollen and growth of bacteria, moulds and insect larvae, pollen should be dried quickly. Ants can remove considerable amounts from pollen traps. Studies indicate that losses can be to 30% in temperate climates.

Pollen needs to be dried to less than 10% moisture content (preferably 5% or 8% according to some laws) as soon as possible after harvesting. A simple method uses a regular light bulb (wE and carton or tray so that the pollen doesnot heat to more than 40 or 45^{o}C. For solar drying, the pollen.. 20W and 220V) suspended high enough above a pollen itself should be covered to avoid direct sunlight and overheating.

After drying, the pollen needs to be cleaned of all foreign matter. A tubular tumbler out of a wire mash with a fan can clean considerable quantities of pollen pellets. Simpler winning methods can be used too.

Most types of pollen traps are currently only fitted to standard frame hives, are fitted to traditional log, clay or straw hives, small modifications are necessary.

Quality control of pollen is difficult and under most circumstances impossible. It is therefore very important that the buyer knows the supplier well and can trust him. A reliable supplier should have all necessary storage and processing facilities and use them. Furthermore the production area, not only the residence or processing centre, should be free of agrochemicals

and industrial pollution (and chemical treatment of the colonies). Pollen, like other protein rich foods, loses its nutritional value rapidly when stored incorrectly. Fresh pollen stored at room temperature loses its quality within a few days. Fresh pollen stored in a freezer loses much of its nutritive value after one year. Longer, improper storage leads to the loss of a few particular amino acids, which cause deficiencies in brood rearing (Dietz, 1975). When dried to less than 10% (preferably 5%) moisture content at less than 45^{o}C and stored out of direct sunlight, pollen can be kept at room temperature for a several months. The same pollen may be refrigerated at 5^{o}C for at least a year or frozen to-15^{o}C for many years without quality loss as tested by feeding to honeybee colonies and recording brood rearing rate.

Since sunlight, i.e UV radiation, destroys the nutrient value of pollen, other more subtle characteristics probably suffer worse damage. Storage of dry pollen in dark glass containers, or in dark cool places, is therefore a requirement.

Only a few countries, such as Switzerland and Argentian, have legally recognized pollen as a food additive and established official quality standards and limits. Though sold in many health food stores, pollen is not considered an additive and it does not have to comply with special standards. It is, however in the producer's own best interest to maintain the highest standards of cleanliness for his product.

Pollen used for cosmetic purposes should have the same, if not a better, quality than destined for consumption as food. The first quality control is assessment of gross contamination with foreign substances, i.e., parts of bee and hive debris. Further controls might include measurement of moisture content and a bacterial count. Determination of various agrochemicals, including drugs used inside bee colonies are possible and may be required in some circumstances. These analyses require sensitive, expensive chromatographic equipment.

Since air pollutants and agro-chemicals have been shown to accumulate in pollen collected by bees pollen should originate from unpolluted areas with the lowest chance of contamination by agrochemicals, industrial pollutants and drugs applied by beekeepers. Producers from such areas should make particular note of this in their advertising.

Degradation of pollen nutrients by inadequate collection, drying and storage can only be tested by bioassay, i.e feeding pollen to honeybee colonies and observing the quantity of brood reared, which is a very lengthy and laborious process. Therefore, only reliable primary products who have the required knowledge and facilities should be considered as supplies.

b) Propels Collection

The average production of propolis per colony per year has been described as 10 to 300 g but the production depends on the bees, the climate, the forest resources and the trapping mechanism. According to personal observations, it may occasionally be considerably higher. If there is any selection by queen breeders and beekeepers, it has been against heavily propolizing bees, since they make work in the apiary more difficult. Bees which produce larger quantities of propolis could be selected if required.

Contamination of propolis with wax, pieces of wood, paint and other debris should be avoided. The cleanest collection methods employ special traps placed on top of a hive, below the covers or next to lateral walls inside the hives. Thus bees do not mix as much wax with the propolis and no contamination occurs during harvesting. Trap harvesting is also faster and may be more productive.

Traps are basically screens or special plates with small holes which simulate cracks in the hive walls. Bees try to seal the holes and thus fill the trap with propolis. The most economic trap design is an inner cover with a large hole, covered with regular nylon fly screen, secured in place by the points of nails and a perforated frame. However, to avoid contamination with wax, the screen should be touch the top of the frames. The total area exposed by a screen may have to be varied according to the bees and local conditions. Trap harvested propolis usually fetches a better price because of its cleaner and therefore of better quality.

Light, and in particular air circulation are important to stimulate propolis use. Accordingly, traps placed on top of hives should be covered but the hive cover needs to be propped opened slightly to increase air circulation and to allow in some light. In tropical regions it may be

necessary to prevent the entry of too much rain. Also, when using a type of bee sensitive to disturbances or likely to abscond, the lid should not be opened too far otherwise bees might escape. Newly established colonies should be given some time to establish themselves before they are used for trapping.

Propolis is removed from traps by cooling the plastic sheets or fly-screens for a few hours in a refrigerator or freezer. Once cooled, the propolis becomes brittle and can be removed from the screens by simply flexing and brushing them, pulling over a table edge or by using a special high pressure air device. The trap is then ready for re-use.

Before the advent or recent trap designs, most propolis was collected by scraping the "bee glue" off walls, frames, entrances and covers. Marletto (1983) noted that the propolis collected from the cover or top frames was usually cleaner than that collected near the entrance. Even contaminated scraped material can be used and purified by repeated extraction and filtering.

In order to avoid contamination with too much wax, scrapings from frames or bottom boards and lids should be kept separate from each other and from propolis collected with traps. Chunks and pieces should never be combined into large balls. Enquiries should be made with potential buyers to see how they prefer propolis. Large pieces often have to be ground or broken into smaller chunks first.

For better quality propolis, some authors recommend collection after the major nectar flow. This may be true in temperate climates where bees are preparing for over-wintering and therefore collecting more propolis. In tropical climates, no studies are available which demonstrate seasonal variation, or its absence. It is possible that at the beginning of the rainy season, propolizing will be more active. Internal traps may be more advantageous, but some experimentation is required.

Unprocessed propolis should always be acquired in the form of chunks or small pieces and never lumped into larger pieces or balls. Some buyers prefer large chunks and others like

smaller pieces, but preference for the latter is usually related to trap collected propolis, since small scrapings often have a high level of contamination.

In general, propolis is fairly stable, but proper storage is important. Propolis and its extracts should be stored in airtight containers in the dark, preferably at less than $10^{o}C$-$12^{o}C$ and away from excessive and direct heat. For similar reasons, very old propolis from the hive should not be mixed with fresher propolis. Over 12 months of roper storage, propolis will lose very little or non of its antibacterial activities. Alcohol extracts may be stored even longer.

The shelf-life of propolis containing products depends very much on their composition and has to be determined for each case. The more the other components of a product are susceptible to decomposition, the shorter will be the shelf-life of that product. This is the reason for compromises that are necessary in the selection of artificial and/or natural and traditional ingredients, preservatives and larger production for extended markets. However, propolis and its extracts function as a mild preservative due to their antioxidant and antimicrobial activities and thus may actually prolong the shelf live of some products.

Since propolis comes in many colours, odours and composition, it is very difficult to give precise guidelines. Most fresh propolis has a pleasant resinous odour. Wax content and visual contamination should obviously be as low as possible. Old propolis becomes very hard and brittle and may also be very dark. However, frozen or recently frozen propolis is also very brittle.

Official quality standards exist for propolis in various East European countries, but most standards refer to the cleanliness or adulteration of the raw product and sometimes, its extracts. Maximum and minimum limits for certain chemical groups are set, but few standardized tests are available to determine the biological activities of various of various components.

c) Royal Jelly Collection

Royal jelly is produced by stimulating colonies to produce queen bees outside the conditions in which they would naturally do so (swarming and queen replacement). It requires very little investment but is only possible with movable comb hives. Expert personnel are required, who are able to devote considerably more time than is commonly required for the production of other bee products. Without this prerequisite it is possible to only occasionally collect the contents from cells of natural swarms-and this amounts to no more than a gram or two per hive.

A well-managed hive during a season of 5-6 months can produce approximately 500 gm of royal jelly. Since the product is perishable, producers must have immediate access to proper cold storage (e.g. a household refrigerator or freezer) in which the royal jelly is stored until it is sold or conveyed to a collection centre.

The most rational and economic methods for large scale production are variations of the Doolittle method of queen rearing. Usually, the starter colony is omitted and cell cups, with transferred larvae, are directly introduced into the finisher colonies. Strong queen right colonies are preferred, in which the queen chamber is separated from the cell rearing chamber by queen excluder. The only required adaptation is to shorten the cycle in the finishing colonies (3 days versus 10) before cells are removed for harvesting. For occasional and small scale production any other queen rearing method can be used. However, there are many queen rearing methods which differ only in hive design and the use of starter and /or finisher colonies.

The basic requirements are movable comb hives, preferably some queen excluders, queen cups (made from wax or plastic), a transfer needle, a spoon or suction device to remove royal jelly, dark glass vials and a refrigerator. Special hive modifications may be used for large scale production. Feeding with sugar syrup (1:1 in sugar/water) increases cell acceptance, even when flowers are available.

Individual queen cells should not contain less than 200 mg of royal jelly. Low cell content means that there are too many cells for the finisher colony or that the colony is not in a condition to provide for queen rearing. There are racial differences in productivity and specially selected strains can be obtained. However, importing queens may not guarantee higher production in a different environment and carries a considerable risk of importing new or resistant diseases, thus reducing productivity and economic feasibility.

Mature queen cells, i.e those with larvae four days old (3 days after grafting), must be brought quickly into the extraction room. The open, narrow part of the cells is cut to facilitate and speed up collection. Then the larvae are removed with a pair of soft forceps, taking care not to harm them and contaminate the jelly. The royal jelly is extracted by emptying each cell with a small spatula, by sucking it up with a special moth operated device, with a pump operated device or by centrifugal extraction. Following extraction the cells are immediately ready for another rearing cycle.

The royal jelly must be filtered using a fine nylon net (nylon stockings are excellent) to eliminate fragments of wax and larvae. Metal filters should not be used. The jelly should be placed into dark glass vials or food-grade plastic containers, avoiding any excessive exposure to air. It should be refrigerated immediately. Any material or equipment contacting royal jelly- including hands-must be clean and disinfected using heat or pure alcohol. The laboratory must be kept impeccably clean and extraction should never be done outside or in sunlight.

The commercial production of royal jelly requires a methodical approach, good organization and precise timing. Constant attendance is essential as one day off can eliminate two days of production. In order to have a weekly day of rest (e.g Sunday) no queen cells would be introduced on Thursday, which means that there will also be no collection on the following Wednesday.

These techniques are suitable for both small and quite large enterprises. Depending on the intended market, the approach can be either one of low cost or one in which all collecting,

processing and distribution takes place in highly controlled environments. The latter will result in a product which is better suited for industrial use.

Royal jelly has a limited shelf-life. Early beliefs in the extreme instability of royal jelly activity, based on the alleged rapid loss of the “queen determination” factor have not been confirmed. Since neither the mode of activity nor the actual effects of royal jelly are known, there are no data available on changes in its biological effectiveness on human after long term storage.

Information is, however, available on changes in composition due to long term storage, such as a higher acid titre, a large insoluble protein fraction, less free amino acids, less glucose oxidase and others. Such changes make it appear likely that also biological activity is influenced by storage. Refrigeration and freezing delay and reduce the chemical changes. Although freeze-dried jelly is the most stable form of royal jelly, some still take place.

On the basis of the above, we can conclude that refrigeration of royal jelly at 0-to 5^{o}C is a minimum precaution. Still better is storage, whenever possible, at temperatures below -17^{o}C, which is attainable in most household freezers. Since royal jelly is an emulsified product and not cellular tissue, freezing presents no particular problem and common household freezers can be used.

As there are no criteria for establishing “safety” limits for product activity, storage and shelf-life should be kept as brief as possible. For products sold in Europe, the average recommended storage time after production is 18 months under refrigeration. For products stored at -170^{o}C, storage can be extended to 24 months. After defrosting and packaging, the product should not be stored in a refrigerator for more than 12 months.

Freeze-dried royal jelly and royal jelly based products are generally stored at room temperature, sometimes for several years. Freeze-dried royal jelly is certainly more stable than the fresh product, but it was reported that only during the first two months of storage at room temperature no signs were observed of any deterioration. Therefore, also in this case cold storage is recommended to minimize changes and products should be kept on the shelf for as short a time as possible.

The storage recommendations for fresh and dried royal jelly are valid in the same way for all wet or dry products to which royal jelly has been added. Contrary to many recommendations on packages, these products should be stored in the same manner as the pure, fresh jelly.

Like all other bee products, royal jelly has its own microbiological protection and presents few microbiological storage problems when it is in its natural state. This protection however is not absolute and certain hygiene precautions must be observed during production and storage. Hygienic working conditions and clean containers are a minimum requirement, and airtight containers should be used to provide additional protection not only against contamination but also against oxidation.

d) Venom Collection

Early collection methods required surgical removal of the venom gland or squeezing each individual bee until a droplet could be collected from the tip of the sting. Since the early 1960's, extraction by the electro-shock method has been continuously improved and is now standard procedure.

Different extraction or collection methods result in different compositions of the final products. Venom collected under water to avoid evaporation of very volatile compounds seems to yield the most potent venom. Venom collected from surgically removed sacs showed different protein contents from the collected with the electroshock method. Gunnison (1966) used a cooling system with the standard electro-shock collecting apparatus in order to preserve more of the volatile compounds.

Venom collection apparatus for placement at different levels within a segmented bee colony structure, said apparatus comprising:

a) A housing member having a front wall, opposing, sidewalls and a back wall and being dimensioned to fit within the segmented colony structure;
b) A frame member removably mounted in said housing and having a central opening therein to permit the movement of bees there through.

c) An array of spaced electrical conductors extending across the opentining in said frame member, said conductors being spaced to permit the passage of bees there through;

d) First access means opening adjacent to at least one wall of said housing member and positioned beneath said frame member to provide an external access path for bees in the colony;

e) Means for establishing a voltage difference between adjacent conductors in said array whereby bees passing through said array from said first access means encounter adjacent conductors and are eclectically stimulated; and

f) Collection means removably mounted in said housing member for withdrawal there from and located beneath said first access means and external access path, said collection means receiving venom from bees excited by contact with adjacent conductors in the spaced overlying from member.

The various trap designs stimulate bees by applying a mild electric shock through wires above the collecting tray.

When shocked, bees sting the surface on which they are walking. In some traps, this may be a glass plate or a thin (0.13 mm thick) plastic membrane, nylon taffeta or silicon rubber under which a collecting plate (preferably made of glass) or absorbent tissue receives the venom. Venom dries rapidly on glass plates and can be scraped off with a razor blade or knife. Absorbent tissue is washed in distilled water to extract the venom, which then should be freeze-dried. Collection on glass is generally easier and produces a product which is easier to store, ship and process. During handling of dry bee venom, protective gloves, glasses and dust masks should be worn to avoid any contact with, or inhalation of the highly concentrated venom.

It is unlikely that a bee will eject all the contents of its venom sac, even after repeated stinging. Therefore, typically, only 0.5 to 1.0 jil of venom can be collected per bee, with an average of ten stings per bee. This results in less than 0.1 ijg (0.11 jig-Crane, 1990) of dry venom per bee. Consequently, at least 1 million stings are required to make one gram of dry bee venom. Dotimas and Hider (1987) report that 1 g of venom can be collected from twenty hives over a two hour period.

Of collecting bee venom, adult bees may be used to sting the patient directly. This is the way to apply the venom in its freshest, most complete and cheapest form. To collect the bees, a small hole is made in the brood chamber, super or inner cover. To avoid colony disturbance, the hole is opened and a collecting jar placed over it until a sufficient number of bees have come out. Small groups (10-100) of workers can be maintained at home for up to 2 weeks. They should be kept in the dark, in a small box (with one side made of fly-screen) and with access to sugar syrup. Care needs to be taken to keep ants away. Alternatively, bees can be collected from frames or the hive entrance by a suction device similar mouthpiece to prevent any bees from reaching the mouth.

Bee venom may be sold as whole bee extract, pure liquid venom or an injectable solution, but in either form the market is extremely limited. Most venom is sold in a dry crystalline form.

Since venom does not need to be processed, it can be prepared wherever bee venom therapy finds sufficient support. Production in small quantities is easy, as long as stringent sanitary controls and aseptic working conditions can be provided.

For injections, the venom can be mixed at the time of injection with injectable fluids, such as distilled (sterile) water, saline solutions and certain oils, or it may be taken from prepared ampoules. Ampounles with set doses of ready-to-inject venom should only be prepared by certified pharmaceutical laboratories, because of the need to maintain stringent aseptic conditions and to measure the dosages very precisely.

There are creams available which include bee venom which are used for external application on arthritic joints but neither the ingredients nor their proportions are known to the author.
Tablets can be impregnated with quantities of bee venom, but Sharma and Singh (1983) recommended the removal of toxic proteins, such as Melittin and the use of colours to indicate different dosages. The tablets should be placed under the tongue, but, no indication is given to the effect or usefulness of such a preparation.

Even dried bee venom should be stored refrigerated or preferably frozen and it should always be kept in dark bottles in the dark. All producers and buyers should closely observe these

conditions. Dried bee venom can be kept frozen for several months, but should not be kept refrigerated for more than a few weeks. Liquid venom and diluted venom can be stored fro similar periods if maintained in well sealed, dark glass containers.

Collecting be venom requires careful work with the highest degree of cleanliness, since the venom will be injected directly without further processing of sterilization. Protection of the collector against the disturbed bees and highly irritative dry venom is very important, too. Since people up to several hundred meters away might get stung by the highly irritated bees, further precautions at the time of collection in the apiary must be considered.

When handling dry venom, laboratory gowns, gloves and face masks should be worn to avoid getting venom dust into the eyes and lungs. All equipment should be carefully washed afterwards. Contact between other people and contaminated material should be avoided. People who do not regularly handle bees, who only get stung occasionally or are exposed occasionally to venom dust, run the risk of developing allergies.

2. Source of Technology

The major equipment required for the proposed project are beehives, refrigerators, collecting equipment and other accessories. These equipment can be procured from local manufacturers. Bee hives can easily manufactured by Micro and Small Enterprises Training and Development Centre located in Awassa. The Federal Micro and Small Enterprises Development Agency is also another national centre that can produce the equipment required by the project under study. It is therefore advisable to communicate the agencies.

B. ENGINEERING

1. Machinery and Equipment

Table 6.1 below shows equipment required for production for the assorted products from beekeeping.

Table 6.1
LIST OF PRODUCTION EQUIPMENT

No.	Description	Qty	Cost ('000 Birr)		
			LC	FC	TC
	A. Pollen				
	Pollen collecting equipment - Pollen trap with plastic sheet as screen (3mm thick) with holes of 4.7 mm diameter - a tubular tumbler made of wire mash with a fan - dark glass containers (for storage) - deep freeze (heavy duty refrigerator - pollen trays for drying the trapped pollen - electric bulbs for pollen drying (220v, 20w) - other auxiliary equipment as deemed necessary	 20 Reqd.	 - 5	 30 -	 30 5
2	Beehives (standard size)	10,000	3000	-	3000
	B. Propolis				
1	Propolis trapping equipment - screens or special plates with holes and perforated frame - Brushes	10 sets	25.0	-	25.0
2	Refrigerator (300 cc)	1 unit	-	7.5	7.5
3	Air tight containers (plastic)	Reqd	-	2.5	2.5
4	Other auxiliary equipment	Reqd	-	5	5
	C. Royal Jelly				
1	Movable comb hives with queen excluders, queen cups (made from wax or plastic), transfer needle, a spoon or suction device to remove royal jelly	10,000 hives	3000	-	3000
2	Refrigerator (300cc)…	1 unit	-	7.5	7.5
3	Pump-operated device for extracting the royal jelly from cells	1 unit	-	7.5	7.5
4	Fine nylon net for filtering the royal jelly	Reqd	-	5	5
5	Darkglass vials or food grade plastic containers (for storage)	Reqd	-	7.5	7.5
6	Laboratory equipment	Reqd	-	45	45
	D. Venom				
1	Venom collecting apparatus	20	-	30	30
2	Laboratory gowns, gloves, face masks	20 sets	-	30	30
3	Emergency kit	2	-	2.0	2.0
4	Other auxiliary equipment	Reqd	-	5	5
	Total	**-**	**6030.0**	**184.5**	**6214.50**

2. Land, Building and Civil Works

It is assumed that 10,000 hives shall be required to collect pollen. Other 10,000 hives shall also be required for royal jelly production. These hives will be located at different areas in the three woredas identified for the project. It is proposed that a total area of 16,000 m^2 will be sufficient to accommodate the 20,000 hives. All these hives will be required to produce all the assorted beekeeping products. At the rate of Birr 1.0 per m^2, and for a period of 80 years, the total land lease value will be Birr 1.28 million. However, for the purpose of this project, it is proposed that the government of SNNPR provide land free of charge for the sake of encouraging investment in the sector. In view of this, no land lease value shall be considered as part of the investment of the project. But to accommodate the managerial function of the project, a total area of 1000 m^2 shall be secured in Masha town. Of this built up area will be 600 m^2, and at the rate of Birr 2000 per m^2, the investment on buildings will be Birr 1.2 million.

3. Proposed Location

Location of a plant is determined on the basis of proximity to raw material, availability of infrastructure and establishment of potential market outlets. Moreover, consideration will be given to fair distribution of industrial projects among the woredas of SNNPRS. Consequently, three woredas, namely Masha, Yeki and Mizan Teferi Zuria, have been identified. It is proposed here that beehives be located at different sites of these woredas. However, it is to be noted that the selected sites will have to be areas with plenty of water (streams, rivers) and endowed with flowery plantation. The managerial staff will be housed in a building to be established in Mashe town.

VII. MANPOWER AND TRAINING REQUIREMENT

A. MANPOWER REQUIREMENT

The envisaged plant requires both production workers and managerial staff. The details are given in Table 7.1 below.

B. TRAINING REQUIREMENT

Training is required for production workers for a period of two weeks. It is proposed that a total of Birr 30,000 will be sufficient to execute the training propgramme at the project sites.

Table 7.1

MANPOWER REQUIREMENT AND RELATED WAGES

Sr. No.	Job Title	Nos.	Monthly Salary	Annual Salary
	A. Administration			
1	Plant manager	1	2000	24000
2	Secretary	1	600	7200
3	Cashier	1	600	7200
4	Personnel	1	800	9600
5	Sales man	1	600	7200
6	Guards	4	250	12000
	Sub total	9		67,200
	B. Production			
1	Production supervisor	1	1500	18000
2	Production workers	50	600	360,000
3	Laborers	20	250	60,000
	Workers' benefit (25% BS)			126,300
	Total	79		631,500

VII. FINANCIAL ANALYSIS

The financial analysis of the bee venom, propolis, pollen and royal jeely project is based on the data presented in the previous chapters and the following assumptions:-

Construction period	1 year
Source of finance	30 % equity
	70 % loan
Tax holidays	5 years
Bank interest	8%
Discount cash flow	8.5%
Accounts receivable	30 days
Raw material local	30days
Work in progress	5 days
Finished products	30 days
Cash in hand	5 days
Accounts payable	30 days

A. TOTAL INITIAL INVESTMENT COST

The total investment cost of the project including working capital is estimated at Birr 8.51 million, of which 16 per cent will be required in foreign currency.

The major breakdown of the total initial investment cost is shown in Table 7.1.

Table 7.1

INITIAL INVESTMENT COST

Sr. No.	Cost Items	Total Cost ('000 Birr)
1	Land lease value	80
2	Building and Civil Work	1,200.00
3	Plant Machinery and Equipment	6,214.50
4	Office Furniture and Equipment	100
5	Vehicle	200
6	Pre-production Expenditure*	646.28
7	Working Capital	78.66
	Total Investment cost	**8,519.4**
	Foreign Share	16

** N.B Pre-production expenditure includes interest during construction (Birr 496.28 thousand) training (Birr 30 thousand) and Birr 130 thousand costs of registration, licensing and formation of the company including legal fees, commissioning expenses, etc.*

B. PRODUCTION COST

The annual production cost at full operation capacity is estimated at Birr 2.45 million (see Table 7.2). The material and utility cost accounts for 15.05 per cent, while repair and maintenance take 3.05 per cent of the production cost.

Table 7.2

ANNUAL PRODUCTION COST AT FULL CAPACITY ('000 BIRR)

Items	Cost	%
Raw Material and Inputs	350.00	14.24
Utilities	20	0.81
Maintenance and repair	75	3.05
Labour direct	378.9	15.42
Factory overheads	157.88	6.42
Administration Costs	252.6	10.28
Total Operating Costs	1,234.38	50.22
Depreciation	761.45	30.98
Cost of Finance	461.92	18.79
Total Production Cost	**2,457.75**	**100**

C. FINANCIAL EVALUATION

1. Profitability

According to the projected income statement, the project will start generating profit in the first year of operation. Important ratios such as profit to total sales, net profit to equity (Return on equity) and net profit plus interest on total investment (return on total investment) show an increasing trend during the life-time of the project.

The income statement and the other indicators of profitability show that the project is viable.

2. Break-even Analysis

The break-even point of the project including cost of finance when it starts to operate at full capacity (year 3) is estimated by using income statement projection.

$$BE = \frac{\text{Fixed Cost}}{\text{Sales} - \text{Variable Cost}} = 34\ \%$$

3. Pay Back Period

The investment cost and income statement projection are used to project the pay-back period. The project's initial investment will be fully recovered within 4 years.

4. Internal Rate of Return and Net Present Value

Based on the cash flow statement, the calculated IRR of the project is 21 % and the net present value at 8.5% discount rate is Birr 3.99 million.

D. ECONOMIC BENEFITS

The project can create employment for 79 persons. In addition to supply of the domestic needs, the project will generate Birr 2.82 million in terms of tax revenue. The establishment of such factory will have a foreign exchange saving effect to the country by substituting the current imports.