

BEEKEEPING : MALAYSIA
RESEARCH AND DEVELOPMENT
(1987 - 1990)

proposed by

Malaysian Beekeeping Research and Development Team

(UPM, RRIM, MARDI, DOA and RISDA)

CONTENTS

| | |
|---|-----------|
| 1. BACKGROUND | 1 |
| 1.1 <i>Malaysian Beekeeping Research and Development Team</i> | 1 |
| 1.1.1 <i>Research</i> | 2 |
| 1.1.2 <i>Extension</i> | 2 |
| 1.1.3 <i>Training</i> | 3 |
| 2. JUSTIFICATION | 4 |
| 3. OBJECTIVES AND METHODOLOGY | 4 |
| 3.1 <i>Main Objectives</i> | 4 |
| 3.2 <i>Sub-objectives and Methodology</i> | 5 |
| 3.2.1 <i>Sub-objective</i> | 5 |
| 3.2.2 <i>Methodology</i> | 7 |
| 4. BENEFICIARY | 11 |
| 5. INSTITUTIONS | 11 |
| 5.1 <i>Research Personnel From The Participating Agencies in Malaysia</i> | 11 |
| 5.2 <i>Contacts With External Scientists</i> | 13 |
| 6. PHASES AND PROJECT DEVELOPMENT | 13 |
| 7. CONTRIBUTION BY RECIPIENT AND IDRC | 13 |
| 7.1 <i>Summary of Recipient Contribution (1987-90)</i> | 13 |
| 7.1.1 <i>Salaries and Allowances</i> | 13 |
| 7.1.2 <i>Other Inputs</i> | 14 |
| 7.2 <i>Summary of IDRC Contribution (1987-90)</i> | 15 |
| 7.2.1 <i>UPM Administered Portion</i> | 15 |
| 7.2.2 <i>IDRC Administered Portion</i> | 15 |
| 8. BUDGET NOTES | 16 |
| 8.1 <i>Recipient Administered Portion</i> | 16 |
| 8.2 <i>IDRC Administered Portion</i> | 17 |
| APPENDIX I | |
| UPM Administered Portion | 18 |
| IDRC Administered Portion | 19 |

APPENDIX II

| | |
|-------------------------------------|----|
| 3. IDRC Contribution | 20 |
| 3.1 UPM Administered Portion | 20 |
| 3.2 IDRC Administered Portion | 22 |

APPENDIX III

| | |
|----------------------------------|----|
| • Summary of Work Schedule | 24 |
|----------------------------------|----|

APPENDIX IV

| | |
|--------------------|----|
| Publications | 26 |
|--------------------|----|

BEEKEEPING : MALAYSIA
RESEARCH AND DEVELOPMENT
1987-1990

1. BACKGROUND

Beekeeping, a traditional subsistence industry, integrates well in the culture of the rural folk in Malaysia. This is seen by the use of honey in traditional medicines, their folklore on bees (e.g. "The Tiger and the Gong of Prophet Solomon"), the incantations relating to the harvesting of honey from wild bees, the diverse methods employed in the honey-hunting of the Giant Honey bee (A. dorsata) and the religious belief in the virtues of honey.

Malaysia imports most of its honey from Australia, China and U.S.A. Local honey supply from honey-hunting does not meet local demand and fetches premium prices at the market as compared to imported treated pure foreign honey. Local honey is preferred to foreign honey because of the local taste preference. Therefore, there is a tremendous market for local honey production in Malaysia.

Despite the availability of abundant species of nectar and pollen floral sources, the full potential of modern beekeeping has yet to be realised. Beekeeping, if promoted, would enable the rural poor to participate and supplement their income because it requires small investment of time and money, the operation and labour scale is flexible, and even the landless can raise bees. Honeybees are considered the most accessible microlivestock in coconut small-holdings. Feral colonies of A. cerana are easily found in coconut tree trunks, outhouses, coconut kilns and dwellings in these areas. They are there readily to be hived into boxes for rearing which otherwise are left unattended. The fact that there are several indigenous species of honeybees (A. cerana, A. dorsata and A. florea) in Malaysia, augers well for the beekeeping industry to flourish in Malaysia.

1.1 Malaysian Beekeeping Research and Development Team

Presently, the beekeeping industry in Malaysia is being promoted through research and development by the Malaysian Beekeeping Research and Development Team (MBRDT). Formed in 1981, MBRDT was established with the objectives of undertaking research and extension activities to promote modern beekeeping in the country. Members of the group comprised of research and extension personnels from the various institutions viz. Universiti Pertanian Malaysia (UPM), Malaysian Agricultural Research Development Institute (MARDI), Malaysian Industry Smallholders Development Authority (RISDA), Rubber Research Institute Malaysia (RRIM) and Department of Agriculture (DOA) which are directly involved in agriculture. Initially, the group activities were partly financed by the International Development Research Centre (IDRC) for the four-year period from 1983-1986. Contributions from IDRC includes training of personnel, purchase of equipment and chemicals for research.

Likewise, the institutions involved contributed in terms of research personnel, office space and financing of incidental and routine operations.

1.1.1 Research

Research activities were conducted in the fields of apifauna, pollination, hive and seasonal management, honey analysis, pests and diseases and the biology of other Apis species, namely Apis dorsata. In line with IDRC's pragmatic research approach, emphasis was given to research that is of immediate benefit to the ultimate beneficiaries i.e. the rural poor. The original eight members of the research group have completed the research tasks assigned according to schedule, except for pollination and honey standard analysis. The latter two areas of research were relegated in plan midway through the project due to budget constraints and a shift in project emphasis. However, the honey analysis project will be included in this proposal for continuance of project funding.

So far, the team has identified locally important honey plants and their seasons, recommended hive designs suitable for local conditions, made headway on the use of suitable comb foundation and super, devised a requeening technique, improved methods of moth and wasp control, monitored the extent of Varroa mite damage to Apis cerana colonies, identified constituents of coconut honey, identified potential commercial rubber clones for beekeeping under rubber, made some progress in preliminary research on Apis dorsata (pheromone and suspended hive plank) and conducted an experiment on pollination of cashew with honeybees.

Some of this work has been or is being disseminated through journals, extension bulletins and conferences locally and abroad (Appendix IV). Twelve students enriched the work on local bee research by choosing these projects on various areas of bee biology during their final year in the Universiti Pertanian from the Faculty of Agriculture, Faculty of Science, Faculty of Economic Resource and Agribusiness and Faculty of Food Science as partial fulfillment of their academic requirements.

1.1.2 Extension

One of the biggest tasks faced by the group was in the area of extension. The response to campaigns on modern beekeeping from the public for beekeeping techniques was beyond expectation. This was attributed to the exposure of the public to beekeeping through the mass media (TV news and documentaries, radio programmes, newspapers and bulletins) and acquaintance with successfully trained beekeepers. Therefore, changes in the original extension plans were made to meet this demand at the expense of research project funds i.e. more allocation for beekeeping courses.

Encouraging results were achieved by the research team from the standpoint of technology transfer to the beneficiaries. Poor farmers in coconut, rubber and orchard growing areas benefited from the technology transfer through basic beekeeping courses, extension bulletins and extension visits. To present, more than 200 farmers and 80 agricultural related personnel were trained by the group within the past three years through seven beekeeping courses conducted at UPM and a one day courses conducted by DOA at Batu Pahat. Such efforts

have now begun to bear multiplier effects on the ground. For instance, these trained beekeepers in turn have disseminated their skills to other farmers in their communities and further afield. In fact, there are even those (farmers and extension personnel) who have organised beekeeping courses for other farmers or agricultural-related government personnel.

The successful beekeepers have managed to raise their income substantially. It is estimated that the project has established more than 400 people either part-time or full-time in beekeeping in the country. Interest from agricultural-related government agencies and the public is indicated by the requests for more than 5,000 beekeeping bulletins from UPM and mass media coverage in the past three years.

Of particular importance is that a beekeeping cooperative was established with the funding from the Canadian High Commission through the Mission Administered Fund (MAF). The self-help cooperative comprising of 149 members, was established with the aim of streamlining the marketing of beekeepers' products and for extension purposes in the district of Batu Pahat, Johor. This endeavour was spearheaded by the beekeeping research and development team to cater for the need of beekeepers in the coconut growing areas of Johore where the majority of beekeepers are found. The response from coconut growers in the area was overwhelming. Similar positive response were noted in other coconut growing areas in Selangor and Perak where farmers form groupings for marketing purposes. By and large, various government agricultural agencies equipped themselves for the extension requests by sending technicians and officers for the basic (8 courses) and advanced (1 course) beekeeping courses conducted by the MBRDT.

This unexpected response and success prompted efforts in extension to be carried out earlier than originally scheduled in order to accommodate requests from the target groups as well as others. Consequently, work on the extension schedules for the 3rd and 4th year were brought forward and spread over the period between 2nd through the 4th year instead. Beekeeping courses, extension bulletins, visits to trained beekeepers for advisory follow-up service, mass media publicity (newspapers, radio and television) and importantly co-research with farmers has been the extension strategy adopted in promoting beekeeping among smallholders which also accelerate technology transfer.

Apart from training of beekeepers, the DOA is also involved in providing regulatory and quarantine services to people who imports A. mellifera into the country. It is recommended that honeybee importers must not import any bees together with combs and hive boxes into the country, but queen and worker bees only. The measure is intended to prevent accidental introduction of the foulbrood diseases.

1.1.3 Training

Beside training beekeepers, the team managed to train five technicians from the participating agencies on beekeeping management in Poona, Bangalore and Amritsar, India. Three research personnel

visited beekeeping institutions, conferences and beekeeping areas in Indonesia, Thailand, Sri Lanka and Africa in the past three and a half years. The exercise aimed at injecting experience and new ideas among the members of the research and development team as well as to provide a forum for discussion with foreign bee scientists and hence to give them insight into the current efforts of promoting the beekeeping industry in Malaysia.

2. JUSTIFICATION

The progress achieved in the last three and a half years of research and extension in beekeeping, underscores the need to further enhance research and development efforts to at least sustain the status quo of the project and industry by the research and development team.

The IDRC project 1983-1986 stimulated interest in beekeeping among the rural poor beyond expectation and the initial success of some farmers has had a snow-balling effect in the desire of the farmers to take up beekeeping. It is imperative that this success be sustained and consolidated to prevent this agrobusiness from collapsing in its vulnerable initial stages. Further research and extension work is therefore vital for the future.

Importantly, the financial contribution by IDRC in the previous project has been crucial in terms of rallying researchers to embark and collaborate on the beekeeping project. This is by far one of the few successful examples of research collaboration projects ever undertaken concertedly by the various agricultural research institutions in Malaysia. It will be a landmark in inter-institutions and inter-disciplinary research and development locally. Collaboration between researchers from the various institutions had been exemplary and should be sustained. The research team is confident of the beekeeping project success if given the chance to continue their efforts.

To maintain status quo, the project needs further technical and financial support from the various institutions and IDRC to render similar support forge ahead in the project.

3. OBJECTIVES AND METHODOLOGY

3.1 Main Objectives

Taking past achievements and shortcomings into consideration, the following objectives are proposed for the next four years. The main objectives are:

- * to continue research activities on identified problems and prospective areas to give impetus and to sustain the growth of the industry.
- * to intensify efforts on beekeeping extension by various avenues in order to promote the growth of the beekeeping industry.
- * to further promote modern beekeeping with indigenous bees among smallholders and private enterprise in coconut, rubber and orchard growing areas.

3.2 Sub-objectives and Methodology

3.2.1 Sub-objectives

The specific objectives are:

a) Extension in Beekeeping

- i) To conduct basic and advanced beekeeping courses for technicians and farmers in coconut, orchard and rubber growing areas.
- ii) To conduct a workshop on honey-hunting technique for professional honey-hunter of A. dorsata.
- iii) To publish and distribute materials for extension in beekeeping.
- iv) To establish a national beekeepers' association.
- v) Informal training to beekeepers at regional apiary sites.
- iv) To strengthen extension system through the government and semi-government administrative infrastructure e.g. DOA, RISDA, LPP etc.

b) Hive Management

- i) To prepare wax foundation from local sources (A. cerana and A. dorsata) of wax supply. Also to conduct acceptability tests on the various wax foundation made from combination of A. cerana and A. dorsata for comb foundation in super and brood section of A. cerana colonies.
- ii) To test the acceptance of A. dorsata comb sections as super combs in A. cerana colonies for storage of honey in the colony.

c) Bee Breeding

- i) To breed honeybee queens for higher honey yield through mass selection of queens from higher yielding colonies in the various beekeeping areas in Peninsular Malaysia. The target is to increase colony yield of 5 to 10 kilos of honey production per year.
- ii) To distribute selected queens by trained beekeepers in queen rearing to other beekeepers.

d) Pest and Diseases

- i) To improve existing method and develop new method of wasp control.
- ii) To test the effectiveness of chemicals (KK 79) for the control of Varroa mites.
- iii) To test the effectiveness of Bacillus thuringiensis as control method of wax moth (Achrosia grisella and Galleria mellonella).

- iv) To devise several cultural control methods for the control of Eucophylla smaragdina (red ants).
 - v) Detection of diseases.
- e) Honey Analysis**
- i) To prepare honey standards for major sources of local honey (e.g. rubber, coconut, starfruit tree, coffee etc.).
 - ii) To design a honey heat exchanger for smallscale beekeeping industry in Malaysia.
- f) Bee Botany**
- i) To complete the preparation of a pollen atlas on local pollen sources as identified from previous project.
 - ii) To prepare an extension bulletin on local honey plants.
 - iii) To prepare a bee garden of the major local sources of pollen and nectar in the UPM apiary.
- g) Beekeeping Under Rubber**
- i) To study the effects on nectar secretion between tapped and untapped rubber trees.
 - ii) To study on the effects of application of latex stimulant (on the bark of tapped rubber tree) on the nectar secretion of rubber.
 - iii) To determine the foraging range of A. cerana bees under the pure rubber stand of recommended planting density practiced by smallholders.
- h) Economic of Beekeeping as a Subsistence Industry**
- i) To study the optimal apiary size for part time and full time beekeeping under coconut complex agroecosystem.
 - ii) To survey the economic-activity pattern of A. dorsata professional honey-hunters as supplementary income.
- i) Research on Beekeeping with A. dorsata**
- i) To devise a method of baiting A. dorsata colonies to settle on suspended plank hive.
 - ii) To develop the technique of queen rearing with A. dorsata.
- j) Preliminary Research on Trigona bees**
- i) To study the colony structure, comb/cell architecture and foraging behaviour at food source of Trigona bees.
 - ii) To design a hive suitable for Trigona spp. bees.

3.2.2 Methodology

a) Extension in Beekeeping

- i) Basic and advanced beekeeping courses will be conducted throughout the four year project. Two courses will be offered in a year for 30-35 beekeepers in each course. The advanced beekeeping courses will cater for extension agents and those beekeepers who have made some progress in their beekeeping practice. Preference will be given to farmers in the coconut, rubber and orchard areas. The DOA will train new beekeepers at the regional apiary at Parit Botak.
- ii) A workshop on professional honey-hunters of A. dorsata will be conducted to provide a forum for them to exchange information and ideas on the techniques of honey-hunting among themselves. The successful honey-hunters in the A. dorsata stronghold areas will be selected to attend the course. It is hoped that the Bee Research & Development Team will gain information on improving and on learning the technique of traditional honey-hunting with A. dorsata. The workshop will be held to coincide with the inauguration of the Malaysian Beekeepers' Association in August 1988.
- iii) Bulletins on honey bee pest control, hive management and others will be published for beekeepers. This is a strategy to help the DOA and RISDA in the extension division. Slide duplicates and videotapes on beekeeping will also be produced for distribution to these agencies.
- iv) A national beekeepers' association will be established in 1988. The formation of the association is aimed at improving the extension efforts in beekeeping and safeguarding the interest of the beekeepers in the long run. A revolving fund will be established to meet the financial aspect of the association to run its activities. Some of the probable activities of the association will be the production of newsletters and bulletins, awards to beekeepers and students, etc. A separate budget proposal will be submitted to IDRC to initiate the establishment of the association in early 1988.
- v) Provision of government subsidies to enable farmers to engage in beekeeping or to attend formal training in beekeeping. The personnel and administrative infrastructure of RISDA and DOA will be utilised to conduct these activities.

b) Hive Management

- i) Local sources of wax for the production of comb foundation from A. dorsata and A. cerana will be tested for acceptability by the A. cerana colonies. Combination ratios of the two sources of wax will be tried too. Investigations on the properties of the waxes from both sources will also be conducted.

- ii) Small scale and field trials on the use of cut-comb sections of A. dorsata honey comb will be tried for super comb in A. cerana colonies. Comparison of acceptance in terms of acceptance for honey storage will be compared with the conventional super comb.

c) Bee Breeding

- i) Mass selection of high honey-yielding colonies from beekeepers' colonies from various parts of the country will be conducted. The target for breeding is to increase honey production from the present yield of 5 kilos to at least 10 kilos per colony per year. Traits of colonies in terms of swarming rate, aggressiveness and honey and brood ratio will be assessed subjectively for breeding selection purposes. This experiment will involve farmers' cooperation in queen rearing and recording of data.
- ii) Selected strains of queens will be recommended for distribution to farmers through sales of queens by trained farmers in queen rearing. Such a scheme (Commercial Extension) will instill the spirit of enterprise and self-reliance among beekeepers. It is hoped that the beekeeper-researcher cooperation requeening project will help to establish the vital bred queen supply in the industry. The extension agents from RISDA and DOA will be involved in the project.

d) Pests and Diseases

- i) The wasp trap design will be improved for adaptation to local conditions and for better efficacy. Experimental trials to suit the purpose will be conducted during the wasp season (i.e. wet season) in beekeepers' apiaries in various parts of the country.
- ii) Chemical control of Varroa mites using chemical compound KK 79 will be used to control mites. Time interval of applications and timely application of the compound will be considered. Since this problem is not serious, the experiment will be confined for trials at UPM and MARDI Serdang only.
- iii) Bacillus thuringiensis has been reported to be effective on the control of Lepidopterous larvae. Therefore its effectiveness in the control of Achroia grisella and Galleria meionella (wax moth) will be tested at limited scale.
- iv) Red ants or Eucophylla spp. has been reported to be serious pests of honey bees in orchard growing areas. It can cause a colony to abscond within 5-10 minutes in the event of an attack by the red ants on bee colonies. Several cultural control methods of using stickers/tanglefoot materials as practised by beekeepers in various parts of South East Asia will be tested.
- v) Monitoring of disease occurrence will be conducted on hives of selected farmers in the extension areas and A. mellifera importers.

APPENDIX I

2.1 UPM administered portion

| Items | Units | Costs (Ringgit) |
|---|------------------|-----------------|
| Beekeeping courses & workshop | 8 times | \$ 81,000.00 |
| Books and periodicals | 4 years | 6,000.00 |
| Cabinets | 4 | 1,000.00 |
| Chemicals for | | |
| HPLC analysis (honey & pheromone) | | 5,200.00 |
| Pheromone (swarm) | | 4,000.00 |
| Varroa control (kk 79) | | 800.00 |
| Pollen atlas | | 1,000.00 |
| Pollen subs. ingredients | | 300.00 |
| Autoradiography | | 3,000.00 |
| Columns (HPLC) | 2 | 1,500.00 |
| Diskettes | 5 boxes @\$55.00 | 275.00 |
| Film negatives and positives | 4 pkt. of 20 | 800.00 |
| Filters, bottles and caps (HPLC) | | 2,000.00 |
| Local travels | 4 years @ \$5000 | 20,000.00 |
| Microcomputer | 1 | 5,000.00 |
| Planner (electric) | 1 | 450.00 |
| Projector & slide trays | 1 | 3,000.00 |
| Portable refrigerator | 1 | 700.00 |
| Postage and publication of bulletins | 4 years | 6,000.00 |
| Printer | 1 | 3,700.00 |
| Refractometers | 4 | 3,200.00 |
| Refrigerator-Deep Freeze (-20°C) | 1 | 7,000.00 |
| Repair, Maintenance & Fuel of vehicle | | 20,000.00 |
| Research Assistants | | 14,000.00 |
| Shipping and handling | 4 years | 6,000.00 |
| Slide duplicator | 1 | 2,000.00 |
| Tape recorder & blank tapes (small) | 1 | 600.00 |
| Timers | 2 | 800.00 |
| Wood, plywood, paints & wire mesh | 4 years | 20,000.00 |
| Fabrication of heated-air honey exchanger | | 20,000.00 |
| | | 239,325.00 |

e) Honey Analysis

- i) Samples of local honey sources will be analysed for chemical constituents. The data will be compiled for the establishment of local honey standards. The findings of the study will enable the group to submit recommendations to the government for the verification of pure honey imported into Malaysia. This project is a continuation of the previous honey analysis project.
- ii) A low-cost and smallscale heat exchanger will be designed and fabricated for use by smallholders (especially beekeeping cooperatives) to treat honey for the local market. The heat exchanger will treat the honey to give it a longer shelf life by reducing or killing the yeasts as a contaminant source. Part of the project is already carried out by project students in the Food Technology Department in Universiti Pertanian. A heat exchanger prototype in Sumatra will be the model for design improvement to local needs.

f) Bee Botany

- i) Major local pollen sources identified in the previous project will be collected for pollen atlas documentation. A compendium of these slides of pollen types visited by bees will be used for reference. In particular, it will be useful in the forensic studies of imported honey sold as local honey by honey vendors in order to fetch higher price.
- ii) Local names of a particular bee plant species varies in different parts of the country and has been a source of confusion in communication. Pollen and nectar sources identified will be published in photographic form in bulletins or booklets to provide a source of reference in identification. Local or common names used at different localities will be included together with the scientific and family name. The publication will be distributed during extension work and exhibitions.
- iii) A bee garden of major nectar and pollen sources will be planted in a two-hectare beehouse site at Universiti Pertanian campus. Priority will be given to species that flower throughout the year and to rare species. The bee garden will be equipped with bee colonies and laboratory facilities. UPM will allocate a labourer to manage the bee garden and bee house. The site will also serve as a centre for beekeeping courses conducted at UPM.

g) Beekeeping Under Rubber

- i) The differential nectar secreting ability between tapped and untapped rubber trees, if any, will be sampled to gauge the performance between the two categories of rubber trees. The significance in such an experiment is that, there are times of the year when rubber trees are tapped sparingly because of low latex production. Also the turgor pressure of the plant will be sampled for correlation with nectar secretion.

- ii) Latex stimulants have been popularly used judiciously to induce more latex production. Whether similar effect on nectar secretion results from latex stimulant application will be sampled for further analysis. If so, then the critical nectar secreting period in the leaf flushing season will be exploited for greater honey production by honey bees in subsequent experiments.
- iii) To determine the foraging range of A. cerana colonies in a given rubber planting distance will be conducted by using autoradiography method or other means. Technical assistance from the PUSPATI (Center for Radioactive Studies) will be sought. The results from the experiment will help in the distribution of hives in the rubber holdings and stocking density of hives in rubber holdings.

h) Economics of Beekeeping as a Cottage Industry

- i) farm management studies on beekeepers in coconut growing areas will be conducted to find out the labour distribution in the farm vis-a-vis beekeeping. The management of the apiary, as practised by beekeepers in comparison to other farm job like harvesting coconut, weed maintenance, marketing etc, will be studied closely to obtain an optimal work balance for efficient bee farm management. Categories of beekeeping-coconut complex to be studied will be: (i) coconut-coffee, (ii) coconut-pineapple-coffee, (iii) coconut-rubber, (iv) others. How much a beekeeper can expand his apiary or how small an economical apiary can be will be ascertained from the study on beekeepers in coconut growing areas.
- ii) Most of the A. dorsata professional honey-hunters are part timers (seasonal). Primarily they are also fishermen, rattan gatherers and odd-jobs seekers. The significance of honey-hunting as supplementary source of income to the honey-hunter will be studied from economic surveys to be conducted on honey-hunters from the stronghold areas in Kedah, Negri Sembilan, Trengganu, Perak and Melaka.

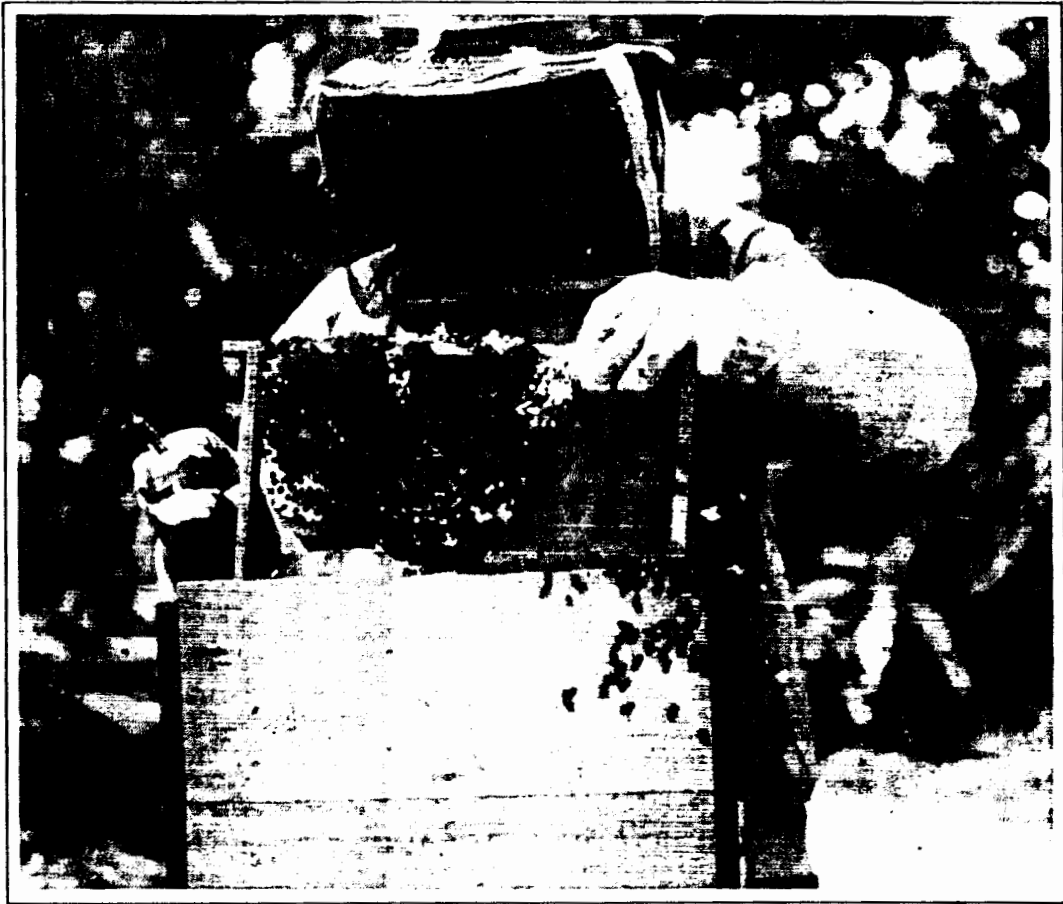
i) Research on Beekeeping with A. dorsata

- i) The research techniques of beekeeping with A. dorsata will be spearheaded by devising suspended plank hive or using hive bait smeared with A. dorsata wax. The suspended hive planks will be tried on sites that are annually frequented by the A. dorsata bees for colony sites on leaves of buildings and tall trees in the jungles for trapping efficacy.
- ii) A technique of queen rearing with A. dorsata will be tried using the same principle of the conventional queen rearing with A. cerana and A. mellifera. Mixture of A. cerana royal jelly will be tested for acceptance in queen rearing. This experiment is aimed at increasing materials for further studies. A study on the life cycle of the species will be conducted initially to extrapolate the probable period of queen rearing. Assistance from professional honey-hunters will be sought.

BEEKEEPING: MALAYSIA

RESEARCH AND DEVELOPMENT

1987-90



Proposed by:
**MALAYSIAN BEEKEEPING RESEARCH AND
DEVELOPMENT TEAM**
(UPM, RRIM, MARDI, RISDA and DOA)

j) Preliminary Research on *Trigona* bees

- i) The basic biology, foraging behaviour, colony structure and architecture of a few species will be studied to investigate the potential of the species for rearing and crop pollination in orchards. At present this genus has been noted for the successful adaptive radiation of species in the tropics and it competes successfully with *A. cerana* and *A. dorsata* at foraging areas. There are at least 22 species of *Trigona* bees in Malaysia.

4. BENEFICIARY

This project is intended to benefit the rural poor in coconut and rubber growing areas. These farmers are greatly hit by the drop of farm commodity prices. Hopefully the beekeeping project will help to diversify and increase their income. Several beekeeping courses will enable at least 250 farmers from these areas to be trained in beekeeping as a viable cottage industry. The present relationship between researchers and farmers in addressing beekeeping problems will be enhanced through the adoption of farmers as co-researchers in field experiments. In this respect several beekeepers will benefit directly from the rapport. A workshop will be held to attend the needs of the professional *A. dorsata* honey-hunter too.

Apart from honey production, the beekeepers will also gain through increase in crops, yield as a result of bee pollination. Other secondary economic activities, such as sale of queens, hive parts, package bees etc. will also benefit the rural agricultural sector. Marginally, other by-products from beekeeping like wax for candle-making, bee pollen, propolis, royal jelly production, bee venom is foreseeable in the not too distant future.

5. INSTITUTIONS

5.1 Research Personnel from the Participating Agencies in Malaysia

There are five agricultural institutions involved in the project. Each agency will contribute in terms of manpower as well as infrastructure facilities. The followings are the break-down of the contribution by the participating agencies.

1. Universiti Pertanian Malaysia (UPM)

Plant Protection Department

Roles

1. Mr. Makhdzir Mardan - Pheromone, hive plank and workshop on *A. dorsata* and national beekeepers' association (Project leader on study leave).
2. Dr. Muhamad bin Muid - Wax foundation and breeding of *A. cerana* colonies. (Acting Project Leader).

3. Mr. Noor Azhar Zainal - Extension in beekeeping and conducting beekeeping courses.
4. Dr. Rohani Ibrahim - Pests of honey bees.

Food Science Department

5. Mrs. Hassanah Mohd. Ghazali Honey analysis of local honey (Honey standards).
6. Mr. Zulkifly Mat Hashim - Fabrication of honey heat exchanger.

Biochemistry Department

7. Dr. Johari Ramli - Pheromone analysis and hive baits.
- Honey analysis.

Biology Department

8. Dr. Ruth Kiew - Bee Botany.
9. Dr. Azhar Phoon Chum Guan Trigona spp. studies.

Department of Management Studies

10. Dr. Nasir Hj. Shamsudin - Economic analysis of beekeeping.

Department of Agribusiness

11. En. Mohd. Mansur Ismail - Economic analysis of beekeeping.

II. MARDI

12. Mr. Mohd. Rani - pests and predators of honeybee and autoradiography.

III. Rubber Research Institute Malaysia (RRIM)

13. Dr. Abu Bakar Atim - Beekeeping in rubber (latex stimulant and tapped and untapped rubber nectar secretion) autoradiography.
14. Mr. Ali Sujan - Beekeeping extension in rubber areas.

IV. Department of Agriculture (DOA)

15. Mr. Chan Jenn Kwang - Beekeeping extension.
16. Mr. Azizan Asmuni - Beekeeping extension.

V. Rubber Industry Smallholder Development Authority (RISDA)

17. Mr. Salim Wahid - Beekeeping extension (rubber areas).

The Universiti Pertanian Malaysia at the Serdang Campus, which is leader of the collaborative research group, is retained as the centre for the administration of the project. It is situated about 20 kilometers from Kuala Lumpur and is close to MARDI head-quarters. The present infrastructure of the administration shall be retained.

5.2 Contacts With External Scientists

The Bee Research and Development Team is establishing research rapport with foreign scientists from the University of Guelph, Canada i.e. Dr. P.G. Kevan and Dr. Gard Otis. Both of them are the consultants in the present beekeeping project. Contacts with Dr. J.B. Free from the University of Cardiff, Swansea, England and few other bee scientists from Thailand and India have been established. We are now establishing contacts with bee scientists in the United States Department of Agriculture (USDA). Our relationships with the International Bee Research Association is being maintained.

6. PHASES AND PROJECT DEVELOPMENT

It is suggested that the proposed project should commence as soon as the present project expires by the end of this year (1986). This is to ensure continuity and that no hiatus is experienced by the project. Hopefully, this proposal will be accepted for project continuation from January 1987 until 1990 i.e. duration of four years instead of the conventional IDRC tenure of 3 years. This is to fit into the Fifth Malaysian Plan in Agriculture.

The project is to be executed in two phases. Phase one (year 1 and 2) will be geared to conduct research and extension activities continued from the previous project (1983-86). It will emphasise problems identified in the previous project such as honey analysis, A. dorsata practical beekeeping, pests and diseases and training in extension. At the end of the Phase one the project will be reviewed by the group and consultant for adjustment if necessary.

Phase two (year 3 and year 4) of the project will consolidate efforts in extension to establish soundly the industry well-being in the long run. This will lead to the foundation of a National Beekeepers' Association. New research areas such as on Trigona spp. and A. dorsata beekeeping will be ventured.

7. CONTRIBUTION BY RECIPIENT AND IDRC

7.1 SUMMARY OF RECIPIENT CONTRIBUTION (1987-90)

7.1.1 Salaries and Allowances

(Commitment of personnel in man hours equated in salary)

A. Universiti Pertanian

| Positions | No. | Percent Time Involved | Ann. Salary | Total Pay/Year |
|------------------------|-----|-----------------------|--------------|----------------|
| 1. Associate Professor | 1 | 15% | \$ 55,000.00 | \$ 8,250.00 |
| 2. Timescale Lecturers | 5 | 30% | \$140,700.00 | \$ 42,210.00 |
| 3. Timescale Lecturers | 2 | 75% | \$ 60,000.00 | \$ 45,000.00 |
| 4. Agr. Ass. Officer | 1 | 100% | \$ 10,200.00 | \$ 10,200.00 |
| 5. Lab. Assistants | 8 | 25% | \$ 62,400.00 | \$ 15,600.00 |

\$121,260.00

B. MARDI

| | | | | |
|-----------------------|---|------|--------------|--------------|
| 4. Research Officer | 1 | 45% | \$ 28,120.00 | \$ 12,663.00 |
| 5. Research Assistant | 1 | 100% | \$ 9,360.00 | \$ 9,360.00 |

\$ 22, 23.00

C. RRIM

| | | | | |
|------------------------|---|-----|--------------|--------------|
| 6. Research Officer | 1 | 60% | \$ 29,340.00 | \$ 17,604.00 |
| 7. Research Assistants | 2 | 50% | \$ 28,800.00 | \$ 14,400.00 |

\$ 32,004.00

D. Department of Agriculture (DOA)

| | | | | |
|---------------------|---|-----|--------------|--------------|
| 8. Agric. Officers | 2 | 25% | \$ 48,000.00 | \$ 12,000.00 |
| 9. Field Assistants | 5 | 25% | \$ 48,000.00 | \$ 12,000.00 |

\$ 24,000.00

E. RISDA

| | | | | |
|-----------------------|---|----|--------------|-------------|
| 10. Director of Extn. | 1 | 5% | \$ 54,000.00 | \$ 2,700.00 |
|-----------------------|---|----|--------------|-------------|

Overall (salary equivalent) Man Power Contribution by the Participating Agencies per year

\$201,987.00

Therefore the overall contribution for the four year period of the project can be estimated at about
 (\$201,987.00 x 4) = \$ 807,948.00

7.1.2 Other Inputs

The other inputs from the participating agencies include intangible provision of office space, hospitality, medical benefits, insurance, additional vehicle for transport during beekeeping courses, drivers, etc. All these contribution is difficult to assess but can be estimated at not less than (Ringgit) \$ 200,000.00 in four years.

Therefore the overall contribution by UPM and counterparts in terms of commitment of prsonnel in man hours in the suggested four years project is estimated at \$1,007,948.00

7.2 SUMMARY OF IDRC CONTRIBUTION (1987-90)

7.2.1 UPM administered portion

| Categories of items | Year 1 | Year 2 | Year 3 | Year 4 |
|---------------------------------------|------------------|------------------|------------------|------------------|
| Local travel | 5,000.00 | 5,000.00 | 5,000.00 | 5,000.00 |
| Equipment | 25,000.00 | 15,000.00 | 12,025.00 | - |
| Shipping & handling | 1,500.00 | 1,500.00 | 1,500.00 | 1,500.00 |
| Books & periodicals | 1,500.00 | 1,500.00 | 1,500.00 | 1,500.00 |
| Postage & Publcn. Bull. | 1,500.00 | 1,500.00 | 1,500.00 | 1,500.00 |
| Chemicals | 5,200.00 | 4,000.00 | 5,100.00 | - |
| Repair, maintenance & fuel of vehicle | 5,000.00 | 5,000.00 | 5,000.00 | 5,000.00 |
| Research assistance | 3,500.00 | 3,500.00 | 3,500.00 | 3,500.00 |
| Beekeeping courses & workshop | 18,000.00 | 27,000.00 | 18,000.00 | 18,000.00 |
| Wood materials etc. | 5,000.00 | 5,000.00 | 5,000.00 | 5,000.00 |
| Sub-total | 71,200.00 | 69,000.00 | 58,125.00 | 41,000.00 |

Total Recipient administered portion \$239,325.00

7.2.2. IDRC administered portion

| | Year 1 | Year 2 | Year 3 | Year 4 |
|----------------------|------------------|------------------|------------------|------------------|
| International Travel | 5,000.00 | 15,000.00 | 5,000.00 | 5,000.00 |
| Consultants | - | 10,000.00 | - | 10,000.00 |
| Equipment | 29,500.00 | 5,800.00 | - | - |
| Chemicals | 300.00 | - | - | - |
| Training | 15,000.00 | 10,000.00 | 10,000.00 | - |
| Vehicle | - | 38,000.00 | - | - |
| | 49,800.00 | 78,800.00 | 15,000.00 | 15,000.00 |

Total of IDRC administered portion \$158,600.00

Therefore total IDRC contribution is about \$ 397,925.00

8. BUDGET NOTES

8.1 Recipient Administered Portion

Local Travel - A great portion of the local travel allocation will be utilised for the economic survey on beekeeping in coconut growing areas throughout the country. The expenses will include the allowances of several research assistants to conduct the survey. Other than that it will be utilised for extension visits to beekeeping areas and research projects in beekeeping areas (researcher-beekeeper rapport in extension). This includes, if necessary travel to Sabah and Sarawak.

Equipment - The equipment required for the research and extension project are itemised in the appendix. It is budgeted according to priority of needs.

Shipping and Handling - The amount allocated for this category is grossly estimated to cover the cost of handling charges at the airport for the importation of the equipment purchased by IDRC.

Books and Periodicals - Publications related to beekeeping and bees in periodicals and books are required for researchers reference. Beekeeping journals published in Canada, United States, India, Europe and elsewhere will help members to keep abreast the development of the rest of the world.

Postage and Publication - This is to cover the expenses in administrative communication with IDRC office and publication of research findings in journals.

Chemicals - Chemicals can be purchased locally for projects on pollen atlas, honey analysis, electron-microscope scanning, latex stimulants, pheromone etc.

Repair and Maintenance - This is to cover the cost of maintenance and repair of vehicle, refrigerator, servicing of HPLC equipment, computer and etc.

Research Assistants - Skilled labour and trained technicians will be required for conducting experiments using HPLC, Electron microscope scanning, surveying beekeeping by questionnaires, transfer of A. dorsata colonies from tall trees in the jungle, guides in the forests.

Beekeeping Courses and Workshop - Altogether 8 basic beekeeping courses and a A. dorsata professional honey-hunter workshop will be conducted in this project.

Wood and Hive Materials - Bricks, wood, plywood, wiremesh, nails, aluminium foils, angle irons, paints and other hive materials will be needed for making hives.

8.2 IDRC Administered Portion

International Travel - several researchers will be sent abroad to attend conferences and symposiums, refresher courses and others to establish links with external scientists in their respective area. High allocation in 1988 is due to consideration of sending several delegates to a conference on *A. cerana* in the Asian region and Fourth International Conference in the Tropics in Egypt. Probably a researcher will be sent to the 11th International Beekeeping Congress if sufficient fund is available.

Consultants - Two consultants will be requested to review the project during the second year and final year. However, the suggestion of their coming will be flexible.

Equipment - Equipment is cheaper to purchase abroad is included locally to cut cost due to tax etc.

Chemical - Specifically, the only chemical which is very difficult to obtain here for the honey analysis is barbituric acid. This chemical is a restricted item because it is considered to be a dangerous drug and vulnerable to abuse. Most chemical companies refused to supply this compound due to the great risks involved.

Training - Training and refresher course will be emphasised at the progressive farmer and research staff levels. The strategy in extension at the farmers' level will be to train one or two successful beekeepers on beekeeping in Sri Lanka or elsewhere. This method of training had been very successful in the past, in that it stimulates local interest and development in beekeeping. Also interested and enterprising newcomers will be trained basic beekeeping courses at UPM and DOA apiary station. Training for extension agents and farmers will be held separately. Technicians in the team will be trained for advanced beekeeping in Canada and United States to gain access to the latest technology of beekeeping. Senior staff of the team will also be sent for study tours in their respective disciplines in beekeeping.

Vehicle - Another vehicle is certainly needed for the project. The present vehicle is not a four-wheel drive and posed problems when going into rugged roads in inland villages and jungles. A four-wheel drive is needed for assignments in those areas. Besides, by 1988 the present vehicle is already due for reconditioning and repair.

2.2 IDRC administered portion

| <i>Items</i> | <i>Units</i> | <i>Costs (Ringgit)</i> |
|--|-----------------------|---------------------------------|
| <i>Bench Saw</i> | <i>1</i> | <i>3,000.00</i> |
| <i>Camera accessories (Macro lens)</i> | <i>1</i> | <i>1,000.00</i> |
| <i>Camping gear tent (for 6 people)</i> | <i>1</i> | <i>2,000.00</i> |
| <i>Carpentry tools</i> | <i>1</i> | <i>4,000.00</i> |
| <i>Chemicals (barbituric acid)</i> | | <i>300.00</i> |
| <i>Consultancy (2 consultants)</i> | | <i>20,000.00</i> |
| <i>Extractors (German design- Sri Lanka)</i> | <i>2</i> | <i>3,000.00</i> |
| <i>Infra-red thermometer gun</i> | <i>1</i> | <i>6,000.00</i> |
| <i>Infra-red camera/binoculars (film accessories)</i> | | <i>7,000.00</i> |
| <i>International Travel (workshop, conferences & study tour)</i> | | <i>30,000.00</i> |
| <i>Micropipettes</i> | <i>6 packs of 200</i> | <i>800.00</i> |
| <i>Pfund Grader</i> | | <i>1,500.00</i> |
| <i>Thermohydrographs</i> | <i>2</i> | <i>3,000.00</i> |
| <i>Training of staffs (refresher courses)</i> | | <i>35,000.00</i> |
| <i>Vehicle (4 wheel drive)</i> | <i>1</i> | <i>38,000.00</i> |
| <i>Walkie talkie (wireless)</i> | <i>3</i> | <i>2,000.00</i> |
| <i>Wax foundation</i> | | <i>2,000.00</i> |
| | | <hr/> <i>\$158,600.00</i> <hr/> |

APPENDIX II

3. IDRC Contribution

3.1 UPM administered portion

Year 1

| | | |
|--|---------|--------------------|
| Beekeeping courses | 2 times | 18,000.00 |
| Books and Periodicals | | 1,500.00 |
| Cabinets | 2 units | 500.00 |
| Chemicals | | |
| HPLC (honey analysis & pheromone) | | 3,000.00 |
| Varroa control | | 800.00 |
| Pollen atlas | | 500.00 |
| Pollen subs. ingredients | | 300.00 |
| Autoradiography | | 600.00 |
| Columns (10 and 5 microns) | | 1,500.00 |
| Diskettes | | 150.00 |
| Film negatives & positives | | 400.00 |
| Filters, bottles & caps. (HPLC) | | 1,000.00 |
| Local travel | | 5,000.00 |
| Planner (electric) | | 450.00 |
| Projector and slide trays | | 3,000.00 |
| Portable refrigerator | | 700.00 |
| Postage & publication of bulletins | | 1,500.00 |
| Printer (Twinwriter) | | 3,700.00 |
| Refractometers | 4 units | 3,200.00 |
| Refrigerator (Deep -Freeze -20°C) | | 7,000.00 |
| Repair, maintenance & fuel of vehicle | | 5,000.00 |
| Research Assistants (skilled labour) | | 3,500.00 |
| Shipping & handling | | 1,500.00 |
| Slide duplicator | | 2,000.00 |
| Tape recorder (mini) & blank tapes | | 600.00 |
| Timers | 2 units | 800.00 |
| Wood, plywood, ahgle irons, paints etc. | | 5,000.00 |
| | | <hr/> |
| | | \$71,200.00 |
| | | <hr/> |

Year 2

| | | |
|--|---------|--------------|
| Beekeeping courses & workshop | 2 times | 27,000.00 |
| Books & Periodicals | | 1,500.00 |
| Chemicals | | |
| Pheromone/plank hive | | 2,000.00 |
| Autoradiography | | 2,000.00 |
| Local travel | | 5,000.00 |
| Microcomputer | | 5,000.00 |
| Postage & Publication of Bulletins | | 1,500.00 |
| Repair, maintenance & Fuel of vehicle | | 5,000.00 |
| Research assistants (skilled) | | 3,500.00 |
| Shipping & handling | | 1,500.00 |
| Wood, plywood, angle irons, paints etc. | | 5,000.00 |
| Fabrication of heated-air exchanger | | 10,000.00 |
| | | <hr/> |
| | | \$ 69,000.00 |

Year 3

| | | |
|--|--|--------------|
| Beekeeping courses | | 18,000.00 |
| Books & Periodicals | | 1,500.00 |
| Cabinets | | 500.00 |
| Chemicals | | |
| HPLC analysis (honey) | | 2,000.00 |
| Pheromone | | 2,000.00 |
| Pollen atlas | | 500.00 |
| Autoradiography | | 600.00 |
| Diskettes | | 125.00 |
| Film negatives & positives | | 400.00 |
| Filters, bottles & caps (HPLC) | | 1,000.00 |
| Local travel | | 5,000.00 |
| Postage & publication of bulletins | | 1,500.00 |
| Repair, maintenance & fule of vehicle | | 5,000.00 |
| Research Assistants (skilled) | | 3,500.00 |
| Shipping & handling | | 1,500.00 |
| Wood, plywood, angle irons, paints etc. | | 5,000.00 |
| Fabrication of heated-air exchanger | | 10,000.00 |
| | | <hr/> |
| | | \$ 58,125.00 |

Year 4

| | | |
|--|---------|-------------|
| Beekeeping courses | 2 times | 18,000.00 |
| Books & Periodicals | | 1,500.00 |
| Local travel | | 5,000.00 |
| Postage & publication of bulletins | | 1,500.00 |
| Repair, maintenance & fuel vehicle | | 5,000.00 |
| Research Assistants (skilled) | | 3,500.00 |
| Shipping & handling | | 1,500.00 |
| Wood, plywood, angle irons, paints etc. | | 5,000.00 |
| | | <hr/> |
| | | \$41,000.00 |

Total UPM administered portion is \$ 239,325.00

3.2. IDRC administered portion

Year 1

| | | |
|---|---------|--------------|
| Bench Saw | | 3,000.00 |
| Camera accessories (macro & Standard lens) | | 1,000.00 |
| Camping gear (a tent for 6 people) | | 2,000.00 |
| Carpentry tools | | 4,000.00 |
| Chemicals (barbituric acid) | | 300.00 |
| Extractors (German design - Sri Lanka) | 2 units | 3,000.00 |
| Infra-red thermometer gun | | 6,000.00 |
| Infra-red binoculars/camera (film accessories) | | 7,000.00 |
| International travels | | 5,000.00 |
| Pfund grader | | 1,500.00 |
| Training of staffs | | 15,000.00 |
| Walkie talkie (wireless) | 3 units | 2,000.00 |
| | | <hr/> |
| | | \$ 49,800.00 |

Year 2

| | | |
|-------------------------|----------|-------------|
| Consultant | | 10,000.00 |
| International travel | | 15,000.00 |
| Micropipettes | | 800.00 |
| Thermohydrographs | 2 units | 3,000.00 |
| Training of staffs | 2 people | 10,000.00 |
| Vehicle (4-wheel drive) | | 38,000.00 |
| Wax foundation | | 2,000.00 |
| | | <hr/> |
| | | \$78,800.00 |

Year 3

| | | |
|----------------------|--|--------------|
| International travel | | 5,000.00 |
| Training of staffs | | 15,000.00 |
| | | <hr/> |
| | | \$ 20,000.00 |

Year 4

| | | |
|----------------------|--|--------------|
| Consultant | | 10,000.00 |
| International travel | | 5,000.00 |
| | | <hr/> |
| | | \$ 15,000.00 |

Total IDRC administered portion is \$ 158,600.00

APPENDIX III

SUMMARY OF WORK SCHEDULE

Year 1

| Project Titles | Personnel | Institutions |
|------------------------------------|-------------------|--------------|
| 1. Wax foundation | Muhamad Muid | UPM |
| 2. Breeding queens | Muhamad Muid | UPM |
| 3. Wasp traps design | Rani & Rohani | UPM & MARDI |
| 4. Red ants control | Rani & Rohani | UPM & MARDI |
| 5. Honey analysis | Hassanah & Johari | UPM |
| 6. Honey heat exchanger | Zulkifly | UPM |
| 7. Pollen atlas | Ruth Kiew | UPM |
| 8. Bee garden | Ruth & Noor Azhar | UPM |
| 9. Nectar scrtn. of tapped rbr. | Abu Bakar | IPGM |
| 10. Optimal apiary management | Shaari & Mansur | UPM |
| 11. Biology of <i>Trigona</i> spp. | Azhar Phoon | UPM |
| 12. Beekeeping courses | All members | All agencies |
| 13. Extension bulletins | All members | All agencies |

Year 2

| Project Titles | Personnel | Institutions |
|---------------------------------------|--|------------------------|
| 1. Wax foundation | Muhamad Muid | UPM |
| 2. <i>A. dorsata</i> super comb | Makhdzir & Muhamad | UPM |
| 3. Breeding queens | Muhamad Muid | UPM |
| 4. Wasp traps design | Rohani & Rani | UPM & MARDI |
| 5. <i>Varroa</i> chemical control | Rohani & Rani | UPM & MARDI |
| 6. Red ants control | Rohani & Rani | UPM & MARDI |
| 7. Honey analysis | Hassanah & Johari | UPM |
| 8. Honey heat exchanger | Zulkifly | UPM |
| 9. Honey plants bulletins | Ruth, Makhdzir & Muhamad Muid | UPM |
| 10. Bee garden | Ruth & Noor Azhar | UPM |
| 11. Latex stimulant | Abu Bakar | RRIM |
| 12. Optimal apiary management | Shaari | UPM |
| 13. <i>Ec. activity</i> honey hunters | Mansur | UPM |
| 14. <i>A. dorsata</i> queen rearing | Makhdzir | UPM |
| 15. Biology of <i>Trigona</i> | Azhar Phoon | UPM |
| 16. Beekeeping courses | All members | All agencies |
| 17. <i>A. dorsata</i> workshop | Makhdzir | UPM |
| 18. Extension bulletins | All members | All agencies |
| 19. Beekeepers' association | Makhdzir, Muhamad, Chan, Azizan, Salim & Ali Sujan | UPM, DOA, RISDA & RRIM |

Year 3

| Project Titles | Personnel | Institutions |
|-------------------------------------|---|---------------------------|
| 1. Wax foundation | Muhamad Muid | UPM |
| 2. <u>A. dorsata</u> super comb | Makhdzir & Muhamad | UPM |
| 3. Distribute selected queens | Muhamad, Salim Chan & Azizan | UPM, RISDA, & DOA |
| 4. Varroa control | Rahani & Rani | UPM & MARDI |
| 5. Honey analysis | Hassanah & Johari | UPM |
| 6. Honey heat exchanger | Zulkifly | UPM |
| 7. Bee garden | Ruth & Noor Azhar | UPM |
| 8. Latex stimulant | Makhdzir & Abu Bakar | UPM & RRIM |
| 9. Foraging range | Abu Bakar | RRIM |
| 10. Optimal apiary management | Shaari & Mansur | UPM |
| 11. Ec. activity honey hunter | Shaari & Mansur | UPM |
| 12. Suspended plank hive | Makhdzir | UPM |
| 13. <u>A. dorsata</u> queen rearing | Makhdzir | UPM |
| 14. Biology of <u>Trigona</u> | Azhar Phoon | UPM |
| 15. Hive design of <u>Trigona</u> | Azhar Phoon | UPM |
| 16. Beekeeping courses | All members | All agencies |
| 17. Extension bulletins | All members | All agencies |
| 18. Beekeepers' association | Makhdzir, Muhamad, Chan, Azizan, Salim, & Ali | UPM, RISDA, DOA & RRIM |

Year 4

| Project Titles | Personnel | Institutions |
|-------------------------------------|----------------------------------|---------------------|
| 1. Wax foundation | Muhamad Muid | UPM |
| 2. Breeding queens | Muhamad Muid | UPM |
| 3. Distribute selected queens | Muhamad, Salim, Chan & Azizan | UPM, RISDA & DOA |
| 4. Wax moth control | Rani & Rohani | MARDI & UPM |
| 5. Honey analysis | Hassanah & Johari | UPM |
| 6. Honey heat exchanger | Zulkifly | UPM |
| 7. Bee garden | Ruth & Noor Azhar | UPM |
| 8. Foraging range | Abu Bakar | RRIM |
| 9. Latex stimulant | Abu Bakar | RRIM |
| 10. Optimal apiary management | Shaari & Mansur | UPM |
| 11. <u>A. dorsata</u> queen rearing | Makhdzir | UPM |
| 12. <u>Trigona</u> hive design | Azhar Phoon | UPM |
| 13. Beekeeping courses | All members | All agencies |
| 14. Extension bulletins | All members | All agencies |

APPENDIX IV

The followings are publications produced by the members of the group and their associates in journals, bulletins, undergraduate thesis and proceedings.

Abd. Majid, S., Mardan, M. (1981).

Morphometrical study of the honeybee worker, A. cerana F. in the west coast of Peninsular Malaysia. (Undergrad. thesis research). Plant Protection Department, Universiti Pertanian Serdang, 54 pp.

Ahmad, E.M., Majid S.A., Mardan, M (1984).

Penyelidikan lebah di Muar, Johor menggunakan analisa faktor (Factor analysis on morphometric studies of honeybees in Muar, Johor) (undergrad. thesis research), Jabatan Matematik, Universiti Pertanian, Serdang. 76 ms.

Asmuni, A., Mardan, M. (1981).

Kajian awal morfometrik ke atas ratu lebah madu, Apis cerana di Pantai Barat, Semenanjung Malaysia (Preliminary morphometric studies on honeybee queens, Apis cerana in the West Coast of Peninsular Malaysia. (Undergrad. thesis research), Jabatan Perlindungan Tumbuhan, Universiti Pertanian, Serdang. 50 ms.

Atim, A.B. (1986).

Production of honey by A. cerana from rubber nectar. 2nd. Int. Conf. Pl. Prot. in the tropics. Genting Highlands. 17-20 Mar. 1986.

Azhar, Phoon, C.G., Berahim Embong. (1986).

Pollination of the coconut (*coccoloba nucifera*) in Malaysia. (Undergrad. thesis research), Biology Department, Universiti Pertanian, Serdang. 15 pp.

Goh, T.L., Mardan, M. (1984).

Pengawalan suhu dan kelembapan oleh lebah madu (A. cerana) dalam tiga jenis haif (haif biasa, haif simen dan gelodog) di bawah tiga jenis keadaan (naungan penuh, separa naungan dan kawasan teduh). (Temperature and humidity regulation by Apis cerana in three types of hives (plank hives, cement hives and 'gelodog') under three shade

conditions (full shade, partial shade and semi shade). (Undergrad. thesis research), Jabatan Perlindungan Tumbuhan, Universiti Pertanian, serdang. 71 ms.

- Hamzah, A., Abdullah, N., Mardan, M. (1984).
Kajian komponen-komponen kelenjar Nasanov A. dorsata dan A. cerana dan kesan feromon sintetik terhadap perkelompokan. (Studies on the Nasanov glands of Apis cerana and Apis dorsata and the effects of synthetic pheromone on the clustering activity of Apis cerana worker bees). (Undergrad. thesis research) Jabatan Biokimia, Universiti Pertanian, Serdang. 101 ms.
- Hashim, T., Muid, M. (1985).
Kesan makanan tambahan terhadap perkembangan populasi lebah madu Apis cerana diluar musim pengaliran (Effects of food supplement on the population growth of honeybees, Apis cerana, during non nectar flow period). (Undergrad. thesis research). Jabatan Perlindungan Tumbuhan, Universiti Pertanian. 45 ms.
- Keong, S.M., Ghazali, H. (1985).
Effect of storage temperatures on the physico-chemical changes of a Malaysian honey (coconut honey). (Undergrad. thesis research). Jabatan Sains Makanan, Universiti Pertanian. 84 pp.
- Khairuddin, T.K., Kiew, R. (1985).
Nilai gula dan struktur nektar bagi beberapa tumbuhan utama lebah Malaysia. (Quality of sugar and nectary structure of several bee plants) (Undergrad. thesis research), Jabatan Biologi, Universiti Pertanian, Serdang. 70 ms.
- Mardan, M., Rinderer, T.E. (1980).
Effects of carbon dioxide and cold anaesthesia on the hoarding behaviour of the honeybee. *J. Apic. Res.* 19(3) : 149-153.
- Mardan, M. (1982).
Population estimates and comb surface area of Apis cerana feral colonies in coconut growing areas of Peninsular areas. *Symp. Biologi Kebangsaan, Bangi*, 179-182.
- Mardan, M. (1982).
Panduan Asas Pemeliharaan Lebah. (Basic guide to beekeeping), *Bull. Pengembangan* 6. 34 ms.
- Mardan, M. (1985).
Current status, problems, prospects and research needs of A. mellifera in Malaysia. *Proc. Expert consultation on beekeeping with A. mellifera in tropical and sub-tropical Asia.* Bangkok, 191-197.
- Mardan, M., Osman, Md.S. (1980).
Beekeeping in coconut smallholdings in Pontian, Johor, West Malaysia. *Proc. 2nd Int. Conf. Apic. Trop. Climates, New Delhi*, 148-155.

- Mardan, M., Kiew, R. (1985).
Flowering periods of plant visited by honeybees in the areas of Malaysia. *Proc. 3rd Int. Conf. Apic. Trop. Climates, Nairobi*, 209-216.
- Mardan, M., Muid, M. (1984).
Potensi perlembahan moden di kawasan getah (The potential of modern beekeeping in rubber areas). *Persidangan Kebangsaan Pekebun Kecil, Dis. 84, Serdang. Pracetak No. 18*.
- Mardan, M., Muid, M. (1986)
Potensi, masalah dan syor bagi pemesatan perusahaan perlembahan (Potential, problems and suggestions for the development of the beekeeping industry). *Bengkel Pemesatan Pembangunan Pekebun Kecil Getah Negeri Johor. April, 86, Batu Pahat, Kertas Kerja No. 2*.
- Muhamad, O., Mardan, M. (1982).
Kajian morfometrik ke atas pekerja lebah madu, A. cerana F. di Pantai Barat, Semenanjung Malaysia (morphometric studies on worker bees, Apis cerana, in the West Coast Peninsular Malaysia). (Undergrad. thesis research), Jabatan Perlindungan Tumbuhan, Universiti Pertanian. 67 ms.
- Muid, M., Mardan, M. (1985).
The effects of introducing honeybee (A. cerana) colonies on the fruit sets and formation of cashew. *Proc. 3rd Int. Conf. Apic. Trop. Climates. Nairobi*, 116-122.
- Ramli, J., Abdullah, N., Hamzah, A., Mardan, M. (1985).
The attractiveness of synthetic swarm pheromone on the clustering activity of the Giant honeybee (A. dorsata). Presented at First Regional Symposium on Biological Control. Serdang, Sept. 85.
- Saha, S., Mardan, M. (1984)
Pengaruh isipadu 'gelodog' terhadap pemilihan tapak sarang oleh koloni liar lebah madu Apis cerana (influence of nest cavity volume on the choice of nesting sites in feral Apis cerana colonies). (Undergrad. thesis research). Jabatan Perlindungan Tumbuhan, Universiti Pertanian. 71 ms.
- Sh. Abdullah, R., Harun, M., Mardan. (1985).
Kajian kos dan pulangan keatas perusahaan lebah madu sebagai usaha sampingan petani negeri Johor (Cost-Benefit analysis on beekeeping activity as a subsistence industry among farmers in the state of Johor). (Undergrad. thesis research). Jabatan Perniagaantani, Universiti Pertanian. 177 ms.
- Sharif, A.R., Muid, M. (1985).
Kajian kesan makanan tambahan terhadap perkembangan koloni lebah madu. Apis cerana dibawah kawasan kepala (Effects of food supplement on the colony development of Apis cerana under coconut holding). (Undergrad. thesis research). Jabatan Perlindungan Tumbuhan, Universiti Pertanian. 62 ms.