P. Pankiw

D. L. NELSON
RESEARCH STATION
CANADA AGRICULTURE
BEAVERLODGE, ALBERTA, CANADA

REPORT OF THE
WORK PLANNING MEETING
ON
APICULTURE

MAY 11-12, 1970

RESEARCH BRANCH, CANADA DEPARTMENT OF AGRICULTURE,

OTTAWA, CANADA

CANADA DEPARTMENT OF AGRICULTURE

RESEARCH BRANCH

Policy on Apiculture

The Branch gave serious consideration to the report of the May 1970 work planning meeting on Apiculture. The following Research Branch policy is stated having regard for the fact that, in addition to the research with Italian bees, there is also research being conducted on solitary and other bees. This research has a direct bearing on the solution of some pollination problems.

1. Marketing and Product Research. The Canadian Beekeepers' Council has given top priority to marketing and production research with which the Branch concurs. However, since this problem must be dealt with by economists, it will be brought to the attention of CASCC and the Economics Branch.

2. The National Apiculture Research Program. In Canada there are presently 4.2 manyears of research scientists' time spent on apiculture problems. This is probably too low. Research Branch is prepared to increase its effort by adding one manyear to the current 2.7 manyears now expended. The proposal would add an apiculturist to Beaverlodge and leave the two apiculturists presently at the Central Experimental Farm with the Ottawa Research Station.

3. Contract Research. For specific problems where Research Branch does not have either the competence or sufficient resources, proposals for contract research by universities will be given sympathetic consideration. These proposals will be considered at the time other contracts are examined.

4. Coordinator for Apiculture. The Branch cannot see its way clear at the present time to appoint a coordinator specifically for apiculture research. The apiculture industry is encouraged to continue its contacts now established with the Research Branch.

B.B. Migicovsky,
Director General.

October 19, 1970.

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Word of Welcome

In his opening remarks, Dr. B.B. Migicovsky pointed out that the Research Branch was not concerned with policy but with Science and Research. Policy and Research are two separate entities. Our area is the amount of research and support that can be given to the various areas of Agriculture. The limit, of course, will never be reached. Therefore, ways have to be found to live within a framework of relatively fixed man-years or budget and growing needs of the Industry.

Dr. Migicovsky thanked all the persons present for coming to Ottawa. He expressed the hope that the group would look at the problems, and recommend what kind and amount of research would be necessary in order to support industry adequately.

B.B. Migicovsky,
Director-General
Research Branch

FOREWORD

Before you read this report in detail, I want to emphasize two points relative to this whole question of Apiculture in Canada and to the meaning of this report in particular.

In order to have a whole spectrum of opinions, we requested the presence of representatives of the Canadian Beekeepers' Council, Provincial Apiarists, and University Professors to discuss with our CDA research personnel. We all recognized that the top priority assigned by the Industry to Marketing and Product Research was indeed a valid one; that there was an urgent need to ascertain the domestic and export demand potential for Canadian honey and to evaluate the possible returns to the beekeeper based on the above potential. The fact that the report in Part II (6) does not show much in terms of text should not be interpreted as an indication that the matter was not discussed. It is due to the fact that we recognized that this problem should be dealt with by economists. This report recommends some action along this line and I will look into the various ways of bringing this problem to the attention of the proper authorities.

This work planning meeting had been in preparation long before I became research coordinator. There was considerable speculation prior to and still after the meeting as to what action CDA would undertake and what degree of coordination should be achieved. I thank all the participants for the excellence of their input into this meeting. I hope that you will find this report thorough and as close as possible to the reality. I am not a stenographer but I think that I have not changed significantly the meaning of your verbal interventions or of your texts. Your views have been of a great help to me in arriving at the suggestions that I will present to the Executive of the Research Branch.

J.J. Cartier,
Research Coordinator (Entomology)

RECOMMENDATIONS OF THE MEETING

1 - The National problems requiring immediate attention are:

(a) Marketing and Product Research
(b) Management for Honey Production and Pollination
(c) Wintering studies
(d) Pollination
(e) Honey-producing plants
(f) Bee diseases

2 - The National Program should be:

	Present m/y	Needed
Bee diseases	1.0	Contract Research
Marketing	-	C.A.S.C.C.
Product research	0.2	Contract Research
Management	0.7	Contract Research plus 2 man-years in CDA
Honey producing plants	0.5	Contract Research
Behavior	1.2	
Physiology	0.6	
	4.2 man-years	Add 2 CDA man-years and Contract Research.

3 - In order to have a realistic national program in Apiculture. CDA should increase its strength in Bee Management by 2 man-years.

4 - Contract research should be increased in order to diversify the inputs in the Apiculture program and this, at a relatively low cost to CDA.

5 - Because of the economics involved in wintering bees and queen bees especially, we should attain Canadian dependence by doing research on overwintering with the aim of shaking package bees.

6 - During the next two years, CDA should undertake the total evaluation of the needs of the industry through a study on the economics of honey production. It would be of great necessity to know what are the economic bounds of production.

7 - In order to maintain good relations with Beekeepers, Apiarists, University Professors and Provincial Apiarists, the CDA Research Coordinator (Entomology) should attend the Annual Apiculture Meeting and report on problems of national interest.

ATTENDANCE LIST

Mr. D.G. Peterson, Research Coordinator, CDA, Ottawa, Ont.

Dr. T.A. Gochnauer, ERI, CDA, Ottawa, Ont.

Dr. R. Boch, ERI, CDA, Ottawa, Ont.

Dr. P. Pankiw, Research Station, Beaverlodge, Alta.

Dr. S.C. Jay, Department of Entomology, University of Manitoba, Winnipeg, Man.

Mr. G.F. Townsend, Department of Agriculture, OAC., Guelph, Ont.

Dr. R.M. Shuel, Department of Agriculture, OAC., Guelph, Ont.

Dr. M.V. Smith, Department of Agriculture, OAC., Guelph, Ont.

Dr. P. Lee, Department of Biology, Carleton University, Ottawa, Ont.

M. Jean Guilbaut, Chef de l'Unité apicole, Ministère de l'Agriculture, Québec, P.Q.

Mr. P.W. Burke, Provincial Apiarist, Ontario Department of Agriculture, Guelph, Ont.

Mr. D. McRory, Extension Apiarist, 711 Norquay Bldg., Winnipeg 1, Man.

Mr. J.W. Edmunds, Supervisor of Apiculture, Dept. of Agriculture, Edmonton, Alta.

Mr. J. Corner, Provincial Apiarist, Vernon, B.C.

Mr. Don Pier, Nipawin, Sask.

PART I

THE PROBLEMS OF THE INDUSTRY AND OF APICULTURE IN THE PROVINCES

A - D. Peer, Nipawin, Saskatchewan. - A look at where industry is going.

(1) Over the last fifteen years, there was a shift in honey production from East to West. The West has now 80% of the colonies and accounts for 75% of the national honey production. In the East, production is static or dropping.

(2) It would be of great necessity to know what are the economic bounds of production.

(3) Rapeseed, as an alternate crop to wheat (4 to 6 million acres could be grown in the West) is likely to increase significantly the production of honey. The increase of forage crops and pastures will also result in an increased honey production.

(4) It was suggested that it would be to the advantage of the meeting not to get involved in pollination in depth. We should give further consideration to relations with each other and thereby improve our public relations. We have to face the fact that there is a lack of understanding.

(5) The industry should make its goal known, i.e. to be efficient and able to compete with the rest of the world.

(6) There is a serious lack of knowledge of the production problems. During the next year or two, CDA should undertake the total evaluation of the needs of the industry through a study on the economics of honey production.

B - J. Corner, Provincial Apiarist, Vernon, B.C. - A brief review of Beekeeping in British Columbia.

Beekeeping in British Columbia has been an active enterprise for over 102 years. The first bees (two colonies) arrived at Victoria in May, 1858.

During the intervening years honeybees have spread to all parts of the province and some 2,000 beekeepers now keep bees as a hobby or as a full-time or part-time business ventures. Agriculture in British Columbia is scattered in pockets over a wide area. The prevailing climate shows marked change from district to district. This unusual climate and topography has a profound influence on beekeeping, pollination and honey production.

In British Columbia our industry is affected by a rather unique geographical feature. In the North Eastern corner of our province the Western edge of the Great Plains juts into the province. In this area approximately 12,000 colonies are started from packages each spring and gassed in the fall. This being typical of the bee management presently practiced in the three prairie provinces. In the southern half of British Columbia over 20,000 colonies are overwintered each year. In this region packages of bees are purchased only as needed to replace winter losses or for increase where necessary.

Limited areas of land suitable for agriculture, together with a wide variety of climatic conditions and crops has dictated the need for our beekeepers to have a sound knowledge in modern beekeeping practices and a high degree of flexibility. Intensive management and maximum production per acre has forced many beekeepers in British Columbia to study and put into practice a program of planned pollination using honeybees on such crops as Tree Fruits, High Bush Blueberries, Vegetable Seed Crops, Cranberries, Small Fruits and such legume crops as Alsike Clover, White Dutch Clover, Red Clover and cucumbers grown in the field and under glass.

Of significance is the fact that British Columbia is:

1. the only province in Canada where holly is grown.
2. on the Creston flats grows the largest acreage of White Dutch Clover for seed in Canada.
3. has the most extensive acreage of High Bush Blueberries in Canada.
4. the only commercial producers of package bees in Canada.
5. the only commercial producers of honeybee queens.

PRESENT DOLLAR VALUE OF SPECIALIZED BEEKEEPING PROJECTS IN BRITISH COLUMBIA

Package Bees	5,000	packages valued at $6.00 each	$30,000
Pollen	20,000	pounds valued at $1.50 per pound	$30,000
Queens	4,000	valued at $2.00 each	$ 8,000
Pollination	5,500	colonies at $9.00 rental fee each	$49,500
		TOTAL	$117,500

NOTE: Package bees and queens to the value of $1,235,000 are imported annually into Canada from California and the Southern States. Canadian Apiculturists should be working hard to produce as many of these stock replacements as possible. By so doing we could:

1. make our industry less dependant on foreign sources of bees and queens.
2. cut back on the outflow of dollars being spent to purchase these items.

3. reduce the cost-price squeeze which is, at present resulting in extreme difficulties in financing existing beekeeping enterprises. This in turn is reflected in a sharp decrease in beekeeper and colony numbers.

Pollination is the number one reason why Canadian Agriculture should be seriously concerned about the welfare of the beekeeping industry. Many beekeepers in our province are now committed, and are annually involved in pollination services and contracts. At present the monetary returns for providing planned pollination services are only sufficient to make up the difference between the cost of producing honey and the dollar return from the sale of honey.

Were it not for the money being received from pollination rental services many of our producers would find it impossible to make ends meet.

There is, at present, a large volume of information and literature available on pollination and the results obtained by the use of honeybees and solitary bees. In view of the urgent need to diversify, it follows that some urgency should be given to pollination programs. Especially in relation to such cash crops as Buckwheat, Rape, Red Clover and White Dutch Clover, to mention just a few. All of which have real potential stabilizing Canadian Agriculture.

In British Columbia our most urgent research problems on beekeeping are:

√ 1. the need to overwinter large numbers of summer reared queens. This would enable us to expand our package bee industry.
2. pollination studies on Red Clover and White Dutch Clover for seed production.
√ 3. nutritional studies on pollen from common floral sources. This would provide a guide for beekeepers when trapping pollen to be used in feeding colonies for maximum production of package bees.
4. complete commercial pollen substitutes based on the type of work carried out by Dr. R. Boch.
√ 5. studies on procedures for detecting and processing Rape honey.
6. the problems of European Foulbrood in the Peace River region.

Finally, I would like this group to consider the possibility of establishing a small Apiculture Research Section on Vancouver Island. This area would be ideally suited for:

1. overwintering studies with the aim of shaking package bees.

2. studies on rearing, supersedure and overwintering of large numbers of queens.
3. pollen studies.
4. honey uses, honey wine, beeswax products, etc.
5. bee behaviour studies related to pollination (both field and greenhouse facilities available).
6. disease control by antibiotics and drugs.

Long periods of good flying weather, short winters, abundant pollen and a variety of vegetable and fruit crops would make this a very desirable area for meaningful research allowing maximum use of outdoor research facilities.

DISCUSSION: It was pointed out that, because of the economics involved in wintering bees and queen bees especially, we should aim at Canadian dependence (Peer). It was also said that following the trend in rape acreage and the potential increase in honey production, that some thought should be given to contract pollination (Pankiw). Someone indicated that he would like to have contact with people out West to verify to what extent sac brood virus is a problem (Lee).

C - J.W. Edmunds, Supervisor of Apiculture, Alberta Dept. Agr., Edmonton.

The discussion was opened on the philosophy and the nature of the debate. Although people may not realize it, the number one problem is production economics. There are some cases where honey is sold at 12¢ per pound when production costs are sometimes as high as 14¢ per pound. There should be a research program in production economics. As far as pollination is concerned, there is not a major concern at the present time. It might be more urgent to improve our public relations. Also, pesticides in the environment may be of some importance for the future of beekeeping. A project on wintering should aim at programming to get the queens and study the genetics of the queens. This project should also cover the mechanics involved, i.e. the engineering inputs to assure an adequate environment. Air composition monitoring devices and other aspects of the problem should be investigated. As far as the crop acreage picture is concerned, there apparently is a potential increase in clover with the associated problem of assuring a proper supply of bees for pollination. From the marketing standpoint, the potential is tremendous but would require a thorough study.

DISCUSSION: It was pointed out that a student interested in economics was available at Guelph (Smith). This could be a case where contract research might be appropriate (Peterson). Other areas (Quebec) are experiencing even more severe production problems as the production per hive is somewhat lower than in the West. They must also compete for a higher quality honey (Guilbault). In Saskatchewan, there are problems in particular with regards to transport and freight rates. The only way to stay in business is through increasing production for the export market (Peer).

D - D. McRory, Extension Apiarist, Winnipeg, Manitoba. - Areas for development of the Manitoba Beekeeping Industry.

The Present Situation

There are approximately 50,000 colonies of honeybees kept within Manitoba. The average commercial beekeeper operates 800 hives. The industry is worth approximately $2.5 million of investment by beekeepers and approximately $2 million invested in honey processing and packing.

If we look at the income of the commercial group we find:

10 year honey production average	150 lbs.
Average price last two seasons	$ .13
Gross per colony plus $1.00 wax receipts	20.50
Cash operating costs per colony	12.00
Return to operator labour and investment	8.50
	800
Total net income 800 colonies	$6,800.00
Average investment per colony	$ 45.00
Average labour input per colony	6 hrs.

From this summary it now appears that the average commercial honey producer is not in a competitive position for his capital and labour with present returns and costs. The industry must now take a serious look at why it exists and what products and services that it is supplying for our larger society. A reorientation of the industry objectives may be necessary and a serious look at the alternatives available to the industry to put it in a competitive position in our modern society will be necessary.

First we must determine an objective to obtain with the present resources involved in the industry. If we compare the beekeeper with other members of society, one might draw a parallel between a manager of an automotive repair garage who has specialized training, investment, and manages three or four men under his direction. If a reasonable rate of interest is charged on the investment, the return to operators labour is not competitive if he is to have a similar standard of living to those with similar investment and managerial ability.

The basic reasons that honey bees are beneficial to our total economy are for pollination of crops and production of beeswax and honey, which are products that society is willing to pay for. Pollination is the great question mark in the further development of this industry. I would submit that the majority of the resources now involved in honey production will not adjust over to pollination if this area develops. An understanding must be obtained of the pollination of the various crops to the point that measurements of pollinating insects can be taken and measurements of conditions necessary for pollination co-ordinated to offer a definite service in this area. Management of the bees and mechanization of the moving of the bees for pollination, will have to be developed to offer truly effective service. The potential exists at the present time with increased interest in special crops such as buckwheat, sunflowers and red clovers for development of pollination, but the costs of the services must be at a rate to the seed grower that he can gain an economic benefit from the added input.

Our present resources in the beekeeping industry are honey production oriented and it is very unlikely that a great percentage could be effectively transferred to pollination work. Thus a new group based on those who can and will reorient, will develop to fill this area. This leaves the present resources to be more effectively applied in the production of beeswax and honey.

With reference to Table I, there are a number of alternatives available to the industry. The greatest net income obtainable with the resources available is a reasonable goal. The evaluation and implementation of these alternatives will require further development and refinement of each area so that an effective extension job can bring about the adoption of practices which will add to the net income of the beekeeping community.

As the present resources are likely to remain in honey production, a large number of the alternatives have this orientation. If a pollination phase of the industry develops, many developments will also apply there.

The honey production business can be compared to a pipeline in which, if you change any part, adjustments must be made accordingly in the rest of the enterprise. Thus a system concept is needed for each scale of production.

Marketing is the one alternative which the individual producer cannot take directly into his control and must, of necessity, be dealt with at the industry level. General market research, which is carried out with those who are going to apply its findings (Canadian Honey Packers), may be effective in increasing our domestic consumption (example - Argentina) or finding new (example - Japan) and developing export markets (example - Great Britain). An increase of one cent per pound adds $1.50 per colony to the net income without increased costs. Thus, this is the easiest area to adopt and also blame for problems by the beekeeping industry. Basic demand for honey must be increased about production to bring about the desired result.

With reference to the pipeline analogy, the present beekeeping industry cannot make use of increases in the biological potential of the honeybee offered by many of the alternatives such as nosema control, reduced drifting in established colonies, etc., until we can physically attain the present potential of the colonies now operated.

When one takes a look at the economics of honey production, three areas of cost are outstanding - package bees, labour, and trucking. Labour is also the greatest limiting factor to increased production. Thus, the key to making use of greater potential in the biology of the honeybee colony, lies in engineering developments to reduce the labour inputs of honey production to levels which provide an economic return to labour. Twenty to twenty-five percent gain in production per colony can be attained by removal of the crop as it comes in. Mechanized systems according to the scale of operation are urgently required to increase the labour efficiency of this industry.

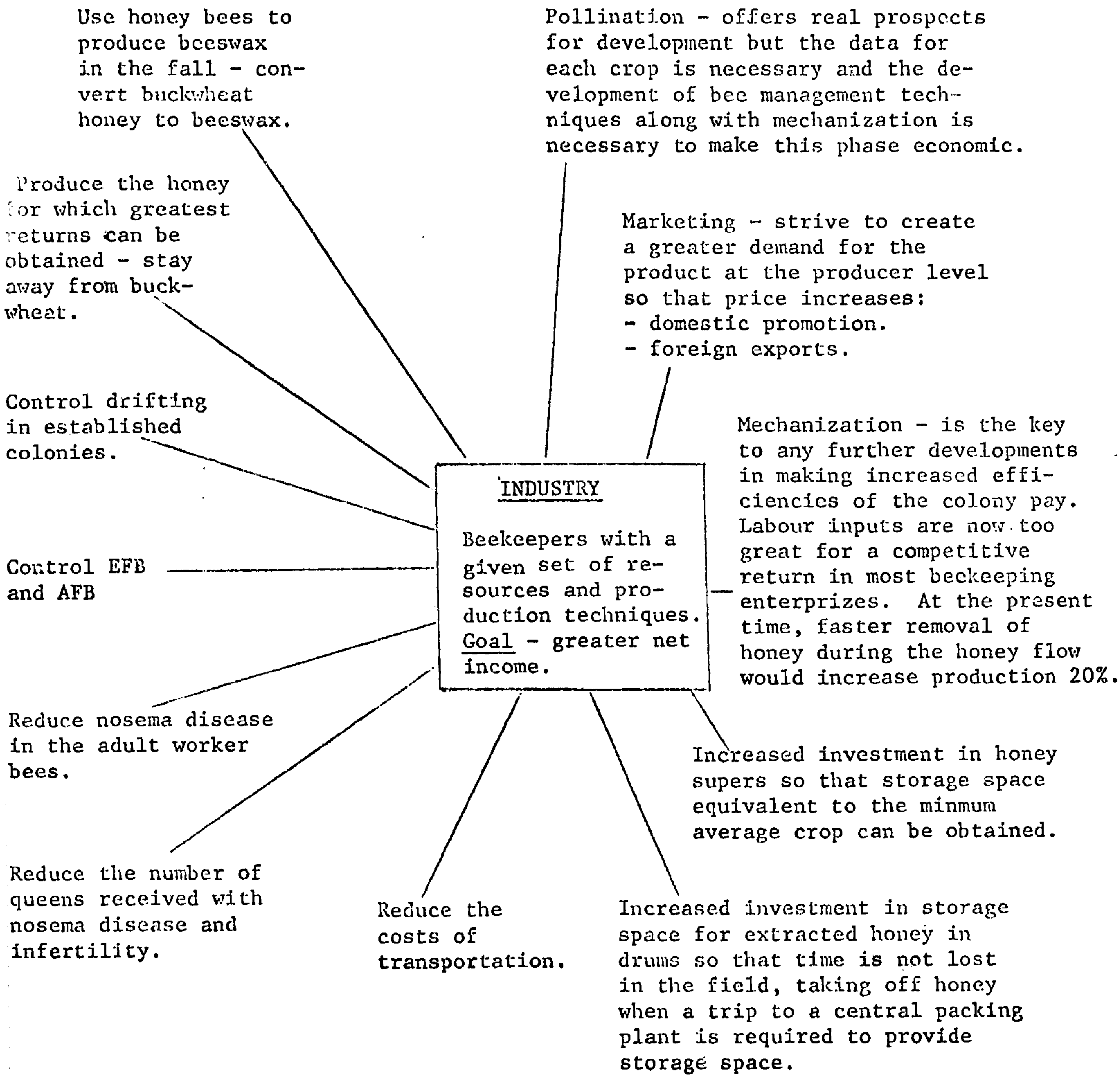
The next area of concern to the honey producer is to provide sufficient super space to the colony during honeyflow to hold the optimum crop. If forty pounds of extracted honey are produced per super and two hundred pounds is a desirable production level, five supers above brood nests are necessary or extraction and replacement of one or more of these during the flow season. The majority of beekeepers extracting about one hundred supers per day will get around part of the colonies with sufficient storage room to meet this type of production.

During the extracting season most beekeepers do not have space to store drums of extracted honey. They must haul drums into the packing plant or truck depot. This takes time and equipment when it should be most effectively used in the honey removal process.

As gas and trucking is one of the largest cost areas, it should be critically looked at from an economic viewpoint to produce the most efficient system possible. Two-thirds of a beekeeper's trucking is highway travel hauling bees and honey. The use of labour is often related to transportation facilities for material handling.

The various biological phases of increasing the potential of the honeybee colony offer many alternatives to increasing the net return of the beekeeper. At the present time we have a great deal of information about some of these areas. The adoption of most of this biological information required the development of practical application methods at the beekeeper level before this potential can be realized as added net income to the beekeeper. Alternatives such as reducing drifting, increasing hive populations earlier, EFB and AFB control,

TABLE I
ALTERNATIVES OPEN TO THE
MANITOBA BEEKEEPING INDUSTRY



are alternatives which can be researched as many have been, and applied by beekeepers to their benefit.

The reduction of nosema disease, first in the queens and then in the worker bees, offers a real potential to the beekeeper for increasing the production. Research has been carried out to show this potential and develop a control method. Now application techniques which fit the management system are necessary to bring about adoption of these principles at a level to increase the income level of the beekeeper.

A real potential exists within the honey industry to be competitive for the investment and labour of the beekeeper if a reappraisal of the present situation is made and the development of new techniques and applications of mechanization occurs. The major areas of applied research to bring these are:

(i) mechanization of honey handling according to scale of operation.
(ii) market research and development.
(iii) practice application of nosema control.
(iv) development of biological management techniques of the honeybee by beeyard units.

DISCUSSION: It was pointed out that as regards pollination and related services, the industry is not ready nor sufficiently informed to consider all the aspects of the problem. There is a need to develop a new type of beekeeper. The industry has not applied all the biological knowledge now available. Nosema control remains a high priority since disease may cause damages of the order of 20 to 25 per cent. We may not have the relevant data to establish clearly the correct figures for labour input. It could vary from 3.5 to 6 hours per colony (Edmunds). The economics of honey production revolved around very many factors (Peer).

E -J. Guilbault, Chef de l'unité apicole, Ministère de l'Agriculture, Québec.

Honey production in Quebec was of the order of 2.5 million lb. in 1968 to 3.5 million lb. in 1969. Quebec consumes 10 to 12 million lb. per year. Nosema is an important problem and wintering loss is of the order of 10 to 12 per cent. Bees in the spring are slow starting because of cool weather. Priorities in research are as follows: heat developed by bees, Nosema, new lines of bees, new varieties of crops for pollen production, production of nuclei at La Pocatière of disease free bees and wintering.

F - P. W. Burke, Provincial Apiarist, Guelph, Ontario.

The tentative agenda looks like a rather heavy one, and therefore it appears that the first item of business for the meeting should be to arrange a schedule and arrange for priorities on the discussions so that all of the items will get some consideration. There will also be priorities for the research program that will be established.

One of the top priority items, if not the most important, is the general question of bee diseases and conditions which cause severe losses in queen and package bees. I feel quite certain that the representatives from Western Canada will place this in high priority. During the past few weeks, I have attended several regional meetings of apiary inspectors held in the southern part of Ontario and have received many reports indicating that colonies have suffered severely during the past winter and fall period. A large number of colonies in many areas dwindled or suffered from what has been generally referred to as "autumn collapse" during the period from about the end of September to mid-December so that there would be insufficient populations to survive the winter. This is a condition that has been reported as existing in most areas during the past five years or so where honeybee colonies are carried over winter. Earlier this year, the Ontario Beekeepers' Association passed a resolution that was forwarded to Dr. Mountain requesting that some work be done on this problem to find the cause and a possible solution.

In dealing with all of the ramifications of research, C.D.A. should be, in my opinion, concerned with and involved in problems that are national in scope. Earlier this year, the Ontario Beekeepers' Association forwarded to Dr. Mountain another resolution requesting that the Apiculture Division, Entomology Research Institute, be strengthened and left at Ottawa where it has been established for a great number of years. This resolution came probably as a result of some speculation that there would be effort to move the Apiculture Section away from Ottawa to some other location, perhaps in Western Canada. Another influencing factor was the consideration of the reorganization here at the University of Guelph and some possibilities that the Department of Apiculture might be taken into the Department of Zoology. A small discipline such as Apiculture could be reduced in scope through changes in personnel, attitude, etc. However, no decision has been reached on this question and will not be finalized for a few months. At the present time, most of the honey production in Canada is in the Western provinces and we do seem to have an imbalance with both the Department of Apiculture here and the Apiculture Section, Ottawa, located within the same province. While I do not wish to disagree with the feelings of the Directors of the Ontario Beekeepers' Association, I realize that there would be benefits in having a research establishment in Western Canada.

I suppose after the discussions of May 11 and 12 it might even be considered that it would be beneficial to have two Federal research facilities, that is, one in Eastern Canada as well as one in Western Canada.

For a number of years, the person who headed up the Apiculture work at the Central Experimental Farm carried the title of "Dominion Apiarist". There is a strong feeling among the members of the Canadian Beekeepers' Council and the Canadian Association of Apiculturists that there is need for the appointment of a co-ordinating or a liaison officer who could in effect perform similar duties to the former Dominion Apiarist as well as do the administrative work involved with Apicultural Research whether this research be done at the Federal laboratory or on a contract basis. This person should be one with empathy for the industry whereby he would appreciate the needs for research and the problems of the research personnel as well as being able to carry out some duties that might fall within the area of extension. Also, he could be a liaison officer between various departments of Government, and Governments that would be involved with Apiculture in its broad sense.

This industry in itself is relatively small compared to other aspects of Agriculture, but in many parts of Canada, it is immensely important to other producers. In Ontario the industry might be valued at roughly two and a half million dollars annually. However, the value of fruit crops where honeybees play a part in pollination service is considered to be roughly twenty-five million dollars. In Western Canada more people are engaged in a larger way commercially. In the expansion of buckwheat, rape seed and legume seed production, honeybees will become increasingly more important. Like other branches of Agriculture, the beekeeping industry is in a depressed condition, but the problem is accentuated by the fact that the industry is made up of a number of very individualistic persons who are spread very thinly across a very wide part of this country and in the main are not very well organized. While research per se is an important part of professional apiculture, many of the problems that confront the industry are of an administrative nature. A co-ordinating officer or a liaison officer should be able to deal with such problems as contracting research work, dealing with problems of product analysis such as tests for purity of beeswax, co-ordinating of enquiries regarding exporting of honey and dealing with matters in the general extension field. Some problems could be unattended to the detriment of the industry because of there being no one with a complete over-view of the industry and therefore such an officer would be able to render a worthwhile service.

In Ontario for the past few years, the honey producing industry has just been holding its own because of the increasing acreage of corn and a reduction in nectar producing plants. No doubt, the invasion into Ontario of the alfalfa weevil is going to have some effect on honey production. It is possible in the future that beekeepers in Ontario will become specialists in pollination and honey production will become secondary. There will be a greater need for sophisticated information relative to selection of honeybee strains and their management in connection with pollination service. Establishment of studies on honeybees in relation to crop pollination should receive relatively high priority, not only because of the use of honeybees in Eastern Canada, but also because of the role that honeybees might play in the production of rape seed and buckwheat as well as legumes on the prairies and fruits in British Columbia.

During recent years, with the increasing acreage of rape seed grown in the Western provinces, there have been more and more problems with the packaging of honey. These have manifested themselves mainly in hard granulation of "creamed" honey or in the undesirable granulation of packs that were intended to remain liquid for some time. Some priority should be given to methods of handling this honey in order to control the granulation tendency in the liquid packs. I note that some progress has been made in the breeding of rape seed strains such as "Oro" with a much reduced erucic acid content and it might be possible to consider the breeding of this plant to include the elimination of the factors creating the granulation problem and even increase the nectar secretion.

G - P. Pankiw, Research Station, Beaverlodge, Alta.

(a) By provinces:

Colonies, production see P. 54 "Report of Statistics Committee" 29th Annual Meeting, March 4-6, 1970.

Future trends

1. British Columbia

- Increased wintering of colonies for divisions or package bee production.
- If rape acreage increases in Peace block, increased number of colonies.
- If contract seed production of legumes increases, possibility of increasing or diverting colonies for contract pollination from honey production.
- Cultivated acreage may increase but at a much reduced rate. Corporation farming still breaking new land. Farmers slight increase in cultivation.

2. Alberta

- Increased acreage of rape and legume crops will result in an increased number of colonies for honey production though not a great one.
- Cultivated acreage may increase but at a very slow rate.
- Acreage of legumes may increase with contract seed production and some colonies may be diverted to contract pollination.

(b) Legume seed

Data supplied by Plant Products Division of the Canada Department of Agriculture.

Production of Alfalfa Seed by Provinces

Year	Ont.	Man.	Sask.	Alta.	B.C.	Canada
				(000 pounds)		
1964-68 Av.	701	820	485	1,305	89	3,400
1966	843	750	125	371	50	2,139
1967	207	1,750	1,000	2,452	200	5,609
1968	40	250	500	990	100	1,880
1969 a/	118	250	300	350	50	1,068

a/ Preliminary

Production of Red Clover Seed (Double-cut) by Provinces

Year	Mari-times	P.Q.	Ont.	Man.	Sask.	Alta.	B.C.	Canada
1964-68 Av.	26	323	3,285	-	11	17	140	3,802
1966	30	315	2,298	-	12	-	120	2,775
1967	15	375	1,480	-	10	43	202	2,125
1968	-	300	4,800	-	20	45	150	5,315
1969 a/	-	450	2,540	-	150	300	80	3,530

a/ Preliminary

Production of Red Clover Seed (Single-cut) by Provinces

Year	Ont.	Man.	Sask.	Alta.	B.C.	Canada
				(000 pounds)		
1964-68 Av.	244	610	660	5,646	765	7,925
1966	87	1,500	1,500	6,500	700	10,287
1967	168	500	750	6,000	1,000	8,418
1968	120	150	500	6,800	1,250	8,920
1969 a/	170	640	1,500	3,000	400	5,710

a/ Preliminary

Production of Alsike Clover Seed by Provinces

Year	Ont.	Man.	Sask.	Alta.	B.C.	Canada
				(000 pounds)		
1964-68 Av.	23	51	132	7,867	2,285	10,358
1966	2	20	250	7,565	2,450	10,287
1967	42	50	200	6,100	2,100	8,492
1968	25	75	200	5,500	2,000	7,800
1969 a/	25	-	200	4,500	1,000	5,725

a/ Preliminary

Production of Sweet Clover Seed by Provinces

Year	Ont.	Man.	Sask.	Alta.	B.C.	Canada
				(000 pounds)		
1964-68 Av.	174	3,000	1,650	3,694	890	9,408
1966	103	3,500	1,500	2,100	850	8,053
1967 b/	83	2,000	1,250	4,332	400	8,065
1968	5	1,000	1,000	4,580	500	7,085
1969 a/	-	5,350	7,000	6,000	200	18,550

a/ Preliminary   b/ Amended

Production of Bird's-Foot Trefoil Seed by Provinces

Year	Ontario	Manitoba	Alberta	Canada
		(000 pounds)		
1964-68 Ave.	811	-	-	811
1966	708	-	-	708
1967	525	-	-	525
1968	985	15	24	1,024
1969 a/	910	50	11	971

a/ Preliminary

In addition to the above, new crops like sainfoin and others e.g. zig-zag clover may be in the offing. There is a marked increase in demand for legume seeds due to "Operation Lift" and this trend will depend on the tenure of this program.

Of increasing importance is the concept of contract seed production, brought about by the importation of foreign unlicensed varieties mainly of red clover and also of Canadian varieties under contract. The figures of the number of acres under contract appears to be a closely guarded secret in some provinces but in 1969 it was estimated at over 4,000 acres and in 1970, it could be 8,000 or more mainly in Alberta and B.C. The trend of formation of fruit and legume pollination associations is a good one both from the standpoint of coordination of efforts between beekeepers and seed grower and also for the purpose of collecting factual data on various crops and varieties.

PART II

SOLUTIONS TO PROBLEMS THROUGH RESEARCH

1 - Management of Honey Production and Pollination.

(a) Removing dependence on good weather and forage for colony development (R. Boch).

In recent years there has been a continuous decline in the quality of package bees shipped from the southern United States. This situation has caused great losses to the beekeeping industry in Canada because of the slow build-up of colonies, supersedure of queens, and diseases.

The southern shipper of package bees and queens has great difficulties because of the early date the packages are being demanded. This date is 2-3 weeks earlier now than it was 10-15 years ago for shipments to Canada. Frequently, the colonies do not build up fast enough for early shaking, and consequently, the packages contain a greater proportion of older, over-wintered bees with not much life left in them. The older bees are also more likely to carry Nosema disease.

In the south, the build-up of colonies depends on a sufficient supply of early pollen. However, frequently, pollen is very scarce in January, February and March, and bad weather may prevent the bees from foraging for necessary pollen. Many areas in the south have become unsuitable for package production beekeeping in recent years (intensive agricultural practices; monocultures of corn, grasses, etc.; insecticides and herbicide application, urban developments, drainage, clearing and flooding).

Nosema disease is a stress disease. Bees under stress are more susceptible to this disease than bees not under stress. The package is an abnormal condition, and the bees are under considerable stress. If the bees in the package are old and in poor nutritional condition, Nosema disease will hit them hard.

When the packages arrives in the North, they are often hived when there is still snow on the ground, and it may be weeks before fresh pollen is available for brood rearing. Although beekeepers put pollen combs into the hive, this is often not enough for brood rearing to continue at top rate. Frequently, colonies run out of pollen and brood rearing slows down, resulting in reduced honey yields later on.

This clearly shows that the quality and health of the package colony could be improved, and the honey yield could be increased if sufficient pollen would be available at all times in the South before shaking and in the north after hiving. Well fed bees are less susceptible to Nosema, European foulbrood and sacbrood.

The need for supplementing the supply of pollen in times of deficiency has long been recognized. After many years of testing substitute diets for bees, Haydak recommended a mixture of defatted soy-bean flour and dried brewer's yeast. This substitute helps brood rearing when pollen is lacking. However, it is equally clear that the bees eat this substitute very reluctantly and they refuse it altogether as soon as there is only a little pollen available again in nature.

The substitutes lack a feeding stimulant that is present only in pollen. Farrar found that bees accept a substitute when he added about 20% pollen which he had trapped the previous season in pollen traps. Keith Doull found that an alcohol extract of pollen was as attractive as pollen. Steve Taber found that after extraction, the pollen was no longer attractive to the bees but that they gathered any dust to which a small amount of extract was added.

Three years ago, I began work aimed at identifying the attractive principle in pollen. Working together with chemists, we identified one attractant. Its chemical name is Octadeca-*trans*-2-*cis*-9, *cis*-12-trienoic acid. This acid has now been synthesized in London, Ontario, by Dr. Alvin Starratt.

Although we found the synthetic acid to be attractive to bees, we feel that it is too expensive to make. We are looking for a cheaper way of synthesis and also we are trying to identify other attractants in pollen, and we hope to find a cheap material.

Development of an attractive and nutritionally adequate substitute for pollen would, in the opinion of many, be a big step forward in practical beekeeping in Canada and elsewhere.

(b) To reduce swarming tendencies of colonies by chemical (e.g., pheromone) methods may substantially lower the cost of colony management (R. Boch.)

The worker bees in a honey bee colony are constantly aware of the presence of their queen. Butler in England, Pain in France, Verheijen-Voogd in Holland, Gary in the U.S., and others have shown that queen recognition is based on the so-called Queen Substance which is produced in the queen's mandibular glands.

Worker bees are attracted by this substance. It has several functions. One function is that it inhibits the construction of queen cells and the rearing of new queens in the colony.

If Queen Substance is absent or in short supply - either because the queen died or is failing to produce sufficient secretion - then the bees begin to build queen cells and raise new queens.

The reason for colonies to build queen cells prior to swarming has been traced to a relative shortage of Queen Substance in colonies preparing to swarm. There is not enough Queen Substance because of the queen releasing it in insufficient amounts or because of an increased demand for this substance in the early summer and particularly when the workers get crowded in the brood nest.

In many instances it is possible to prevent swarming by giving the colonies sufficient space for expansion of their brood nest. Providing room for brood rearing is the basis for all swarm prevention methods commonly used today. However, in some areas of Canada, swarming is nevertheless a serious problem, and some methods of honey production (comb honey) require some crowding of the bees in their hives.

Currently, Dr. Lensky of Israel and I have been working on a new method of swarm prevention by supplying colonies with additional queen substance. I can report that the results obtained so far from our tests are very encouraging.

Swarm prevention by supplying synthetic Queen Substance may or may not be economically feasible depending on the cost per treatment. A crude synthesis of 9-oxodec-trans-2-enoic acid is fairly cheap, and only milligram quantities are required per colony. The purification of this material is rather expensive. Therefore, we wanted to know whether one can safely and effectively use the impure synthetic material.

Dr. Murray Blum of the University of Georgia and I have investigated whether impurities in the crude materials would interfere with the effectiveness of the 9-oxodec-trans-2-enoic acid. No such interferences were found in our experiments.

In screening the various materials, we made use of the fact that 9-oxodec-trans-2-enoic acid is the sex pheromone of the honeybee queen. Drones in flight are attracted in great numbers by this substance when it is elevated 20-30 feet in the air by means of a balloon.

It is known that the sex pheromones of moths are frequently inactivated by small amounts of their geometric isomers. Dr. Blum and I have investigated whether the natural sex attractant - 9-oxodec-trans-2-enoic acid is inactivated by its geometric isomer, 9-oxodec-cis-2-enoic acid. We thought that if this were the case, we would be able to inactivate the Queen Substance in the colony and thus cause the workers to supersede their queen. However, 9-oxodec-trans-2-enoic acid was not inactivated by its geometric isomer.

(c) Detection and diagnosis of bee diseases (T.A. Gochnauer).

The several bee diseases can be detected in a number of ways:

appearance, odor, adult behavior, etc. In some infections, microscopic examination is required. A detailed examination of each unit of each hive, the most specific method, is high in labor costs, and methods for mass-sampling, mass detection, and simple diagnosis would help reduce costs and lessen the tedious aspects of this work.

Some suggested routes to better detection and/or diagnosis include:

Detection of Bacillus larvae infection by specific odor components. The odor of this infection is pungent and characteristic. We have shown (T.A. Gochnauer, J. Apic. Res. 8: 23-28, 1969) that it is a mixture of mercaptans and ether-soluble substances one of which is probably phenylacetate. The isolation and identification of the various odor compounds hopefully will follow the availability of the gas-liquid chromatograph-mass-spectrograph set up in Analytical Chemistry. Identification of a specific odor-causing volatile substance could lead to specific chemical detectors which might identify infected colonies without initial detailed examination.

Detection of B. larvae spores in honey or other material by immunofluorescent techniques. Development of some method of this sort might answer the request by Mr. Corner for a method to detect contaminated honey and/or pollen. If a sensitive method were developed, examination of incoming honey at major packing plants could reveal major sources for fall or following spring examination. A sample of honey might be taken, diluted, passed through a membrane filter, the spores treated with strained antibody and examined.

Detection of virus in samples of adult bees or larvae could be done in sections treated similarly with antibody, or in extracts of bees examined by immunodiffusion methods.

Detection of generalized high levels of Nosema infection has been described elsewhere. Plates or dishes of water are placed in the apiary where maximum flight occurs and the plate washed off or water examined for spore counts. This could be used as a crude area-sampling method.

Area sampling for Nosema incidence -

In the spring, when bees are foraging on early bloom, they may be captured on the bloom-dandelion, fruit bloom, etc. A quick examination of a collection of 10 bees caught in early May in the CEF area showed that they contained a mean of 16 million spores per bee.

In some circumstances it may not be desirable to make a direct examination of bees in a given apiary site. In this way an estimate can be quickly gained of the need for closer examination or treatment of bees in a source area, such as a package bee or a nucleus-producing area.

DISCUSSION: EFB and AFB are difficult to diagnose in the early stage. Perhaps a detector of some kind could identify the typical odors. Controlling the disease with antibiotics is an expensive solution. Tissue culture might be of a great help in this problem (Gochnauer). A breeding program for resistance and disease free bees might be considered (Pankiw). A breeding program is not practical because antibiotics are economically available. We should develop a team approach to field problems and assess the losses resulting from fall dwindling. Serious consideration should be given to package bees and investigate all the possibilities (Peer). Such defects as "queen rejection" might be resolved with pheromones (Gochnauer). Queen substance is being investigated with dead specimens in order to identify the sex attractant (Boch). It was suggested that better management could suppress the incidence of diseases (Smith) but it might prove impractical to treat with heat all the equipment. As to the exact dosages, there seemed to be diverging opinions about the thresholds. Resistance to antibiotics could eventually build up (Corner).

(d): Control of unwanted behavior patterns by antipheromones (alarm, aggression, etc.) (R. Boch).

Worker honey bees communicate alarm by releasing alarm substances from glands that are associated with their sting and mandibular glands. Dr. Shearer and I have identified isopentyl acetate from the sting apparatus, and 2-heptanone from the mandibular glands.

If an intruder (wasp, skunk, bear, beekeeper, etc.) disturbs the colony, some bees release these alarm substances which alert other bees. The so alarmed bees are ready to fly off at the slightest provocation and will attack objects in the vicinity of the hive. Moving dark objects will be attacked most readily.

Dr. John Free at Rothamsted has shown that the alarmed bees are attracted to and will sting objects with sting odour on it. This shows that the odour from the sting left behind by a stinging bee serves as a target marker for subsequent attacks. This is the reason why it is likely to get stung again after the first sting has been received, and that the angry bees tend to sting at the same spot.

We have identified the chemical signals by which bees communicate alarm. Together with Dr. Rothenbuhler of Ohio State University, I have investigated whether the propensity to sting of certain strains of bees is due to their more effective alarm communication. Indications are that this is so. Bees from fierce colonies contained more alarm substance than did bees from less aggressive colonies. We are now studying the genetics of this variation in the hope to develop a guide method of testing. This would be useful in breeding a gentle strain of bees.

Another avenue to reducing the aggressiveness of honey bee colonies is by interfering with their alarm communication. This calls for inactivation of their alarm pheromones by antipheromones.

Recently, Metcalfe and Metcalfe of the University of Illinois reported that hexanyl chloride obliterated the alarm communication of the ant Conomyrma pyramica whose natural alarm substance is 2-heptanone.

I plan now to investigate whether 2-heptanone and/or isopentyl acetate of the honey bee is similarly inactivated by hexanyl chloride or some other chemical.

(e) Possible avenues of biological control of certain bee diseases (T.A. Gochnauer)

The question of drug resistance by bee pathogens and drug contamination of honey or pollen in colonies fed drugs is a constant concern in any chemotherapeutic program. Some disease control agencies believe that Bacillus larvae infection can be completely controlled by "test and slaughter" procedures, although others feel that spread of infection to healthy colonies can be prevented by timely treatment before infection is established therein.

Professor Morse at Cornell University maintains that the "second class bee diseases" such as sac brood, European foulbrood, and nosema are "stress diseases" which are normally unseen and unimportant in a colony until some stress - such as chilling, shipping or insecticide treatment - is placed upon it. The control in the latter instances might be to avoid the stressor, in whatever form this may take. For example, part of the north-south debate on package bee quality has to do with the supposed harmful effects that long truck shipments of package bees plus the stress of hiving them in Canada in mid April in a spell of bad weather have on the development or failure of the packages. Might these be avoided in some way?

European workers place great emphasis on the naturally-occurring antibacterial substances as a factor in suppression of pathogens which otherwise might swamp a densely populated colony.

An Armenian visitor, Dr. E.G. Afrikian, from the biological control laboratories in Erevan, ASSR, noted the many fatty acid fractions isolated from pollen by Dr. Boch, and wondered whether these fractions had been tested for such activity. Mr. Tom Rinderer, a former student of Rothenbuhler's at Ohio

State University, had shown in his M.S. thesis a lowered sensitivity by drone larvae to direct inoculation with B. larvae spores. He proposed this could be the result of higher pollen content of the drone larval food, and set up a study to fraction pollen and try to isolate anti-B. larvae components. Unfortunately, although we had the support of our director to start a short term project along these lines, the available support money had been committed elsewhere.

Nevertheless, should there be an active, anti-B. larvae fraction in samples of pollen, it could, with present knowledge and techniques be extracted and enriched; in a single component or a small family of components could be found active, the use of synthetic or purified naturally occurring compounds might be substituted for present therapeutic agents.

Likewise, H.L.A. Tarr noted (Ann. Appl. Biol., 24: 377-384, 1937) that only the spore stage of B. larvae was infective for honey bee larvae. He suggested that "if a method of maintaining B. larvae in the vegetative stage could be developed" control might be simplified. Most agents now used prevent the germination and/or growth of B. larvae. J. W. Foster et al. (J. Bacteriol., 59: 463-470, 1950) studied anti-sporulation compounds in normal bacteriological media. Bacillus larvae cultures would grow better and produce many more spores in media treated with activated charcoal or with added starch. No attempt was reported then or since to recover the antisporulation factors from the media used, to see whether they could be identified, concentrated and tested. Dr. Foster did not report further on the investigation, and it may have been tried without success.

Ever since the 1956 Entomology Congress in Montreal, reports have appeared in Russian literature that specific bacterial viruses could be used to reduce infections with B. larvae of American foulbrood or with S. pluton of European foulbrood. These reports suggest the viruses are as effective as are the antibiotic agents for the same purpose, although nothing is said about costs. In a preliminary test with a single strain of virus and a pure strain of sensitive B. larvae, Dr. L'Arrivee and I did get a marked reduction of infection in inoculated, virus-treated larvae compared with those given spores alone. Perhaps a concentrated preparation of virus could be used as a control agent without chemical contamination of the colony.

The control of Nosema apis of the honey bee is a problem which has been approached primarily by trial and error. Its life cycle is complex; it has not yet - to my knowledge been grown in culture. The only generally accepted chemotherapeutic agent, fumagillin, is not mass-produced and is correspondingly expensive. Tens, hundreds, or even thousands of tests have been made on the inhibitory effect of all sorts of organic, and inorganic compounds. Antiamebic compounds, antimalarial compounds, general disinfectants, antibiotics, various teas, extracts from frogs eggs, etc., ad inf. have been tried without success.

Furgala and Boch (J. Apic. Res. in press, 1970) have shown clearly the effects of nosema infection on honey yield in inoculated colonies, and the counter effects that fumagillin has in preventing infection and maintaining honey yield. Nevertheless, alternative methods must still be sought.

One approach began with the suggestion of a former apiculture technician, J. W. Vandermeer, that the behavior of spores undergoing "heat shock" (a common method used to activate bacterial spores prior to growth) be examined. Using techniques developed in Siddiqui and Furgala's honey research, we found a constant pattern of sugars released by the treatment. These were identified by Drs. Wood and Siddiqui, and include as a major component, α,α-trehalose, a reserve carbohydrate associated with dormant stages of some yeasts, in dormant stages of insect development, and spores of some fungi. The storage, mobilization and use of this sugar seems to be closely tied in to the growth and development of these other forms, and is probably important in N. apis as well. An enzyme capable of hydrolyzing trehalose was isolated from washed spores of N. apis which were ground in liquid nitrogen to rupture the very resistant spore wall. Since a major component of bee hemolymph is trehalose, Drs. Wood and Siddiqui felt that a gas-liquid chromatographic study of trehalose levels in healthy and diseased bees might be most revealing, but once again, a commitment to support this line of research could not be obtained in present circumstances.

One answer to the above is selection and breeding for resistance to the diseases considered. A second is to select and breed from disease-free stock. The latter was Pasteur's method for producing disease-free silkworms, for example. The difficulty here is the massive production of bees, and the mobility of bees and beekeepers which aids cross-contamination. The breeding of resistance to Bacillus larvae infection has been undertaken by workers in the U.S.D.A. and at Iowa State University, for example, but the results - from a commercial standpoint - have not been rewarding.

DISCUSSION: Genetics of bees may be related to EFB (Pankiw). The importance of strains is of particular concern in importation. A USDA line susceptible to EFB was exported to Canada in many areas. Nutrition and resistance to EFB are two related problems (Townsend). The disease sometimes disappears suggesting cyclic factors. We should know more about the genetic background (Pankiw). Transportation and handling of bees may favor the spread of the disease. The exact causes are not known. A new method in California is apparently centered on a new type of shipping containers (Peer).

2 - Pollination of crops by honey bees (P. Pankiw)

(a) Bee behavior, bee vision, foraging.

As part of this topic is basic, I will endeavour to cover only those phases which deal with immediate practical solutions to some of our problems.

Bee behavior - insofar as it applies to bee preferences of certain crops and their behavior in pollinating these crops. This involves such factors as preference to crop, whether the bees collect nectar, pollen or both, their work speed, distances they fly, temperatures at which they work, nectar secretion and availability. In essence we also have to know the components of seed yield of crops as they are related to insect behavior. These include nectar secretion and concentration, floret development, longevity and range of floret populations in various crops.

Bee vision - this is a basic study which may be a factor affecting bee behavior and includes such items as color, ultraviolet light, etc.

Foraging - the foraging behavior of honey bees is a critical factor affecting the purity or conversely the contamination of pedigreed seed by other sources. In this respect, isolation distances, acreages of crops enter into the picture. Beaverlodge is particularly interested in this facet and together with Saskatoon and Melfort have concluded studies on sweet clover, are now conducting studies on alfalfa, and Beaverlodge will shortly conduct studies on red clover. This information is vital in making recommendations to Canadian Seed Growers Association re isolation distances and also age of stand as these are primarily affected by contamination of other sources of pollen.

These studies have to be conducted under optimum concentrations of bee populations similar to that recommended for pollination. Such studies require large acreages, e.g. study on alfalfa involves some 40 acres of land for 3 tests and this does not include the isolation distance to other fields. These studies require the coordination of legume seed specialists and apiculturists.

(b) Legume seed production

Although considerable work has been done here and elsewhere on the value of honey bees for pollination and the need of cross-pollination of legumes for maximum seed production, and the relative preferences of bees for certain crops (Table 1), there are several problems.

The relative value and economic consideration of maximizing yields of legume crops.

Alfalfa - confined to areas of the imported leaf cutter bee (southern Alberta, southern Saskatchewan and southern Manitoba) and to areas with abundance of native bees, e.g. northern Alberta, Saskatchewan and Manitoba.

Alsike - Alberta and B.C. Aurora and Tetra alsike being grown under contract, work on contract pollination, e.g. seed yields obtained, bees used, etc., recommendation 1 colony per acre.

Red Clover - Diploid single cut - Alberta, B.C. and smaller lots in Saskatchewan and Manitoba.

Diploid double cut - Ontario, Manitoba, Alberta and B.C.

Tetraploid - B.C., Alberta and Manitoba.

This is our problem legume because of the relative preference of honey bees for other crops if grown in association and because of the low rating as a nectar crop. It is of particular importance in seed production and also in contract pollination. Research is urgently required in the effect of high populations of bees (2 colonies per acre) on seed production of the crop and nectar production of colonies.

Sweet Clover (Alberta, Saskatchewan and Manitoba) - A crop that is particularly valuable for honey production but should be critically evaluated for high seed production possibilities. Two new varieties licensed Yukon (Melilotus officinalis) and Polara (M. alba) with low coumarin may be a factor in increasing consumption of this crop. Recommendation 1 - 1½ colonies per acre.

Birdsfoot Trefoil - Ontario, Manitoba, Alberta.

The newness of this crop in western Canada brings with it management problems of establishment, weed control and harvesting. Once these have been solved or alleviated, we will have no problem with pollination. Recommended rate of 1 colony per acre (could be reduced).

Sainfoin - Alberta, Saskatchewan (at present).

A new crop, no problem with pollination and rate of 1 colony per acre.

The most crucial problem is that of contract pollination. With the emphasis on switching wheat acreage to that of other crops, primarily forage crops, it becomes very important for us to give recommendations that are meaningful both in terms of what the bees can accomplish in the matter of seed production but also in terms of reduction of honey production. Just think what is happening in the concentrated effort of alfalfa pollination by the imported leaf-cutter bee. We have one specialist in Canada working full-time and about 3 in the U.S.A. In my opinion, red clover alone demands a full-time specialist particularly as it affects seed production of Canadian and foreign varieties for our own use and for export.

Table 1A. Relative populations of honey bees and native bees on several crops and the respective seed yields.

Crop	1959 Bees 100 sq yds Honey	1959 Bees 100 sq yds Native	1959 Seed yield lb/acre	1961 Bees 100 sq yds Honey	1961 Bees 100 sq yds Native	1961 Seed yield lb/acre	1962 Bees 100 sq yds Honey	1962 Bees 100 sq yds Native	1962 Seed yield lb/acre
Sweet Clover									
Erector	37	1	570*	38	1.2	676	61	1.4	309
Arctic	53	3	701*	44	0.4	1140	80	2.8	682
Alfalfa									
Vernal	39	.05	71	45	0.1	135	55	.1	3*
Red Clover									
Ulva	-	-	-	4	3.5	122	20	7.2	168
Altaswede	3	8	344	14	2.9	420	14	7	224
LaSalle	1	3	226	5	2.0	90	7	1.8	101
Alsike Clover									
Common	12	0.5	268	29	1.0	426	45	1.3	211
Tetra	13	1	331	21	1.6	388	39	1.3	221
Rapeseed									
Arlo	23	0.5	810*	5	0.8	1241	37	0	1356
Argentine				41	0.9	1420	71	0.8	1196
Birdsfoot Trefoil									
Empire				11	1.0	168	7	0.3	93

* - some shattering

Table 1B. Relative yields of several crops in cages with and without honey bees as pollinators.

Crop	1959 Without bees	1959 With bees	1961 Without bees	1961 With bees	1962 Without bees	1962 With bees
Sweet Clover						
Erector	23	401	11	780	0	459
Arctic	221	691	106	740	8	680
Vernal	12	313	9	900	8	149
Red Clover						
Ulva			8	301	4	179
Altaswede	27	264	25	600	24	301
LaSalle	23	206	11	192	8	109
Alsike Clover						
Common	31	279	20	653	40	211
Tetra	18	375	3	426	0	221
Rapeseed						
Arlo	217	505	1094	1715	363	1093
Argentine			1443	1784	899	1085
Empire			1	280	8	93

A topic which has had mixed emotions in the past decade is that of breeding a strain of honey bees for red clover seed production. We have ample evidence of the success of the alfalfa pollen collecting strain of Nye and Mackensen. However, progress will be slow and would require the full-time effort of one scientist, and probably working in conjunction with workers in other countries.

Other crops, rapeseed. Limited data indicating seed yields of Brassica compestris (Polish rape) varieties can be increased using pollinators to supplement wind pollination. Just think of the 3,800,000 acres being cropped this year. Would this not justify research in the economic aspect of honey bee pollination of rapeseed?

Buckwheat - Negligible research in Canada. Foreign research, e.g. Russian, would indicate a requirement similar to red clover. Research to be conducted in cooperation with breeders or in area of production primarily Manitoba.

DISCUSSION: It was realized that practically very little is done in Canada in new products and new uses of honey. Operating grants should be made available to food technology specialists (Peterson). Provinces are gradually occupying the area of research on foraging and pollination (Jay). Very little information on pollination contracts is available. Perhaps beekeepers could not probably pollinate for less than thirteen dollars. However, the shift from hardgrain to other crops is going to create a demand for more bees and bees are not going to be available everywhere (Peer). As far as seed production is concerned, more data on management of seed production and actual value of seed pollination are needed to support pollination services (Pankiw). In Quebec, there are data on blueberry pollination (Guilbault).

3 - Bee diseases

(a) Nosema in packages and wintered colonies.

Package bees - Work done in 1954 to 1956 indicated a very low incidence of nosema in package bee colonies from California (3 bee shippers) and treatment with fumagillin did not appear to have any effect on honey production.

However in 1967, 60 colonies were hived on April 4 and samples, taken 3 weeks after installation, averaged over 12 million spores of nosema per bee. Even with a feeding of fumagillin at this time to protect the emerging bees, the colony strength on June 19 (2½ months after hiving) was only 6 lbs which was similar to the strength of nosema-free colonies hived a month later on May 3.

Wintered colonies - The effect of nosema on wintered colonies may best be illustrated by data collected in 1966-67 of colonies wintered at Agassiz, B.C. These were given 50 mg fumagillin in September of which 12 colonies did not take up all the syrup. These bees were fed 50 mg fumagillin on March 2.

Table 1. Effect of nosema on production of package bees from wintered colonies in the winter of 1965-66.

Amount of nosema infection 1st March (106 spores per bee)	No. of colonies	Bee production packages of bees (kg)
0 - 1.0	25[1]	5.6
1.0 - 2.0	6[2]	4.1
2.0 -	8[3]	1.0

[1] one colony with a failing queen
[2] one colony queenless and weak
[3] two colonies queenless and weak and three colonies dead

Previous studies of wintering had indicated a build up of nosema during the winter months to highs of 10 - 15 million spores per bee by mid April. This may have contributed to the poor results obtained.

(b) Fall dwindling.

This problem is particularly important in the areas who winter colonies and reduction of colony populations in the fall tends to make for less desirable wintering units and consequently there is a lower potential for spring build-up of such colonies either for divisions or package bee production.

This problem could best be studied in Ontario, Quebec or B.C.

(c) High loss of queens and bees during build-up.

From 1960-1969 records kept of bee colonies installed and the number of failing queens, i.e. unaccepted, failing or superseded queens, indicate a serious problem.

	No. of packages installed	Number of producing colonies June 15	Failing queens	% loss
1960	60	46	14	23
1961	60	41	19	32
1962	60	57	3	5
1963	48	45	3	6
1964	48	43	5	10
1965	50	50	0	0
1966	60	54	6	10
1967	84	58	26	31
1968	50	46	4	8
1969	67	60	7	10

These data of 10 years (1960-69) indicate a wide variation of 0-32 and with an average of 13.5 per cent.

This in itself is far too great. Using the same method of queen introduction, we have got good results in 1965 to the very poor of over 30% in 1961 and 1967. In 1967 the queens that were recovered were tested and all had nosema.

The survey of queens conducted by the Apiculture section at Ottawa also indicated factors other than nosema.

However, the fact that commercial beekeepers have had queen losses comparable or greater than that mentioned in the table above, has greatly increased their costs of production primarily from loss of potential colonies, and in many instances replacement queens were no better than the originals and those that were accepted had lost ground and were not able to build-up as a nectar-collecting or pollination units. Secondly, the added cost of ordering replacement packages to make up the required colonies and the change in management procedure to accommodate this replacement is a problem that would be alleviated if the problem of failing queens could be reduced to 5 per cent.

How do we overcome this problem, which may stem primarily from the methods of queen breeding. A plausible initial project would be to select breeders with various management procedures, e.g. single and double grafting, types of queens used (possible in breeding), types of cell builder colonies used, types of nuclei used for hatching queens, amount and type of bees in cell builders and nuclei, feeding of fumagillin. Although this appears to be infringing on human rights, it may go a long way towards improving the present situation. In addition, type of queen cages (work has been done on it by Jay and others),condition and age of bees in packages, transportation, time between shaking and hiving are other factors that have to be considered.

(d) Disease control by drugs and antibiotics.

At Beaverlodge, Ottawa, Guelph, and the U.S.A. work has been carried out on disease control by drugs and antibiotics and the present status is: AFB controlled by sulfa, oxytetracycline, tetracycline.

EFB controlled by oxytetracycline, tetracycline, erythromycin, tylosin, streptomycin. Only the first two recommended at present.

Nosema - controlled by fumagillin.

Sacbrood - no control.

Other forms of paralysis.

One of the problems is the use of 2 or more antibiotics or drugs. There appears to be evidence that fumagillin and oxytetracycline are incompatible so far as the activity of the fumagillin is concerned. This presents a problem in the treatment of nosema and EFB in package bee colonies or wintered colonies. Fumagillin and sulfa appear compatible.

Although we can control nosema with fumagillin, it is expensive and also the eradication of nosema is dependent upon not only producing or importing nosema free bees and queens but also sterilizing the bee equipment. Two chemicals, glacial acetic acid and ethylene trioxide (E.T.O.) have been tested as has heat treatment. Their use has to be tested on a commercial basis to determine their feasibility.

One study that may or may not prove fruitful is breeding for nosema resistance. A discussion on this aspect may prove of some value particularly if it would involve the study of the organism itself, its method of insection, effect of environment and other stress factors.

A factor that requires serious consideration is the probability of evolvement of strains of the diseases resistant to antibiotics. Although such strains have been reported, they have not all been tested to prove the validity of such reports.

<u>Disease control by drugs and antibiotics</u> (T.A. Gochnauer)

The export of honey to Europe will depend in some part on what international standards are developed under Codex Alimentarius by the various governments. It is somewhat reassuring to note that the interdepartmental studies on honey under the general topic of the above suggest that Canadian honey conforms in many if not most respects to the requirements. The sugar content is generally adequate. European desires to see certain enzyme levels in honey are not apparently in conflict with the flash pasteurization methods used in Canadian processing plants. There may be a problem with filtered honey if a general requirement on pollen content is established.

Control of bee pathogens by specific viruses (T.A. Gochnauer)

The Soviet literature makes rather frequent references to control of both bacterial diseases of larvae by the application of specific bacterial viruses. The claim is made that control approaches the effectiveness of presently used chemotherapeutic agents. The cost is not mentioned. Dr. L'Arrivee and I did a preliminary experiment with a virus preparation here which indicated that virus fed directly with the spores was protective. We can expand this effort without too much difficulty, as we have tested a method which seems to produce good infection in 5-frame colonies with a low known number of spores. We can add the virus either directly with the food or could add it over the combs as might be the method used for control. In artificial cultures, virus-resistant cells arise rapidly, but perhaps in nature, with the very short period of susceptibility of the larvae, this might not occur. The Soviet work claims to be based on a pooled source of virus which presumably prevents the rapid selection of virus resistant strains of organisms.

Control of bee pathogens by gamma radiation (T.A. Gochnauer)

Non-destructive disinfection of combs and other equipment exposed to various infections which would permit re-use would help reduce losses due to such diseases as well as limit their spread. Gamma radiation as a means of disinfection of American foulbrood was first proposed by H. Studier (personal communication, 1954); with the aid of his brother at the Argonne Laboratories, U.S. A.E.C., samples of disease-containing comb were irradiated at levels between 0 and 10^6 r, placed in combs of healthy colonies, and observed for fresh infection. Treatment above 100,000 r disinfected the combs. Bacteriological studies in my laboratory at the University of Minnesota showed clearly, however, that viable spores were still present.

In collaboration with the Commercial Products Division, AECL, tests were made of the effects of various dosages of gamma irradiation on infectivity and on spore viability in culture tests. It was found (T.A. Gochnauer, and H.A. Hamilton, J. Apicult. Res. 1970, accepted for publication), that infectivity was nearly completely eliminated by exposure to 2×10^5 rads, while spore viability was not completely eliminated at 10^6 rads. Cost factors have not, to my knowledge, been estimated on this basis. In an extension of this work, similar studies were conducted on the effect of irradiation on European foulbrood disease (P. Pankiw, L. Bailey, T.A. Gochnauer and H.A. Hamilton, 1970) which indicated, somewhat unexpectedly, that higher dosages were required to disinfect combs from this source than with the spore-borne infection. Thus the method cannot be expected to control the latter infection.

No tests have been made, to my knowledge, of the effect of treatment on the other infections, with the exception of Nosema apis spores (H. Katznelson and J.A. Robb, Can. J. Microbiol. 8: 175-179, 1962) which were disinfected at about the same level as B. larvae spores. It may be worthwhile to examine the effects of irradiation of the viruses.

4 - Wintering studies (P. Pankiw)

(a) Evaluation of wintering areas and northern areas. Areas of successful wintering fall into several categories.

1. Areas where added insulation is not required or only for a very limited time and where natural pollens are available earlier in the season. B.C., Fraser Valley, Southern Vancouver Island, Okanagan Valley, Kootenays.

2. Areas where insulation is used and wintering is economical. Ontario, Quebec and Maritimes.

3. Areas where insulation is required but wintering is borderline, Alberta, Saskatchewan and Manitoba.

Area 1. Our work in the Fraser Valley has indicated that for each colony wintered up to 7 two-pound packages can be realized, with an outlay of 88 lbs honey, 6 pounds pollen supplement in addition to 5 frames of pollen, and feeding of fumagillin (50 mg) in early October and late February.

Other beekeepers have had satisfactory results and are becoming established particularly from the Peace River region.

The Okanagan is a good area and closer to southern Alberta. An estimate of 5 two-pound packages is considered as an objective.

The Kootenays are probably less preferred but are particularly adapted to those keeping bees south of Calgary because of the shorter distance. Four 2-pound packages is considered a good return by beekeepers.

Transportation costs and distances are probably the limiting factors in wintering in these areas.

Area 2. I would leave this topic to the scientists and provincial apiarists from Ontario, Quebec and the Maritimes.

Area 3. Northern areas.

This is the area that provides the greatest challenge to research as it has the greatest potential and also there is an increased interest in wintering. We had conducted wintering from 1955-1960, comparing fiberglass and shavings packs. Our first 4 winters were not successful due to chinooks (and starvation), and nosema. In the last two years our mortality of colonies was down to 5 per cent, but we only managed to make an average of 1 division. With a consumption of 58 lbs honey in 7 months, and the added costs of wintering this was not considered economical. A return of 3 equivalent two-pound packages for each colony wintered would encourage beekeepers to winter. There appear to be 4 important criteria.

1. Use strong colonies in fall, i.e. those that rear brood in September.

2. Adequate protection during the periods of December to mid-March.

3. Provision of environment after March 15 for increasingly brood production to replace old bees and to allow for divisions.

4. Adequate nutrients, honey, pollen and disease control (nosema). In relation to pollen or pollen supplements there appears to be some variation in acceptance of pollen supplements made of various forms of pollen viz., frozen air dried, and also the age of pollen and method of storage.

(b) Cellar wintering, outside wintering.

Research both at Brandon and Beaverlodge would suggest that inside wintering even under controlled conditions was not as effective as outside wintering. The amount of brood rearing which determine the build-up of a colony was less for the colonies wintered inside.

It has been shown (Pankiw, 1968) that colonies in darkness produce less brood than colonies in normal daylight. Because of this factor, inside wintering may be useful for the stress periods of low temperatures in December, January and February after which colonies could be moved outside with some protection.

Research into this aspect needs to be conducted.

DISCUSSION: From a technological standpoint, it was suggested that the problem is solved. However, in Quebec storage facilities and quality of the environment are two particularly urgent problems in wintering bees. Temperature control seemed to be also important (Guilbault).

5 - Honey, pollen, wax and other products.

In the past, Food and Drug Directorate has been concerned mainly about the legal standards and definition of honey as contained in the definitions under those regulations. F&D had done some studies on ash content, etc. In early days of chemotherapy, some inhouse studies at Ottawa indicated that colonies treated with sodium sulfathiazole, a very stable agent, sometimes produced honey with a very high level of the drug, although the assay was questioned because of occasional high blank readings.

Recently, Mr. Corner submitted a sample of honey stated to have caused nausea and dizziness in the persons who consumed it, and F&D on analysis did find some toxins in it. Unfortunately, more of the sample is not presently available. Mr. Corner has also queried me about the possibility of aflatoxins being present in pollen which might have become mouldy in the rather damp climate in parts of B.C., because of the current interest in these compounds in other moulded food products. An informal approach has been made to have F&D look into the matter should more samples become available. This would involve detection of toxin-producing types of fungi and the chemical detection of the toxins themselves.

The Biologics Control Laboratory furnished a spore suspension of the Bacillus subtilis strain used for the detection of tetracycline in the syrup stored by wintering colonies in British Columbia referred to above.

One may ask whether the facilities of the Directorate have been used as fully as possible, and whether some of the studies on food-related items might not be done in collaboration with this unit.

Antibiotics in honey:

The question of contamination with antibiotics is a prevalent European - and North American - concern. H.P. Chambonnaud (Bull. Apicole, 11: 133-200, 1968) has published his extensive thesis paper on the subject. He used an S. aureus bioassay, but required an extraction of the honey with acetone to separate the tetracyclines from the natural inhibitory substances in honey. Corner and Gochnauer, J. Apicult. Res., 1970 (submitted) found that tetracycline activity could be measured directly in bee manipulated syrup without prior extraction if the standard assay organism, Bacillus subtilis ATCC 6633 was used. Confirmation of the results might be obtained by field sampling where known drug feeding was being administered, etc. The method was basically used to determine residual activity in medicated sucrose syrup fed to wintering colonies in the fall.

If the method will detect low concentrations of tetracyclines and not respond to natural inhibitors in a wide variety of untreated honey samples, it could be used as a very simple screening test for freedom from this class of antibiotics in honey.

Sugars of honey:

The first suggestion, to my knowledge, of a quick, fairly accurate method for sugar analysis in honey was suggested by Professor S.A. Barker, University of Birmingham, England, during a visit to Dr. Siddiqui at the FRI. He brought our attention to the developing methods of gas-liquid chromatography of sugar mixtures made volatile by treatment with Tri-Sil reagent. Drs. Boch and L'Arrivee made initial investigations of the method on the Aerograph instrument temporarily located by FRI in the apiculture building. Dr. Siddiqui, however, felt that the instability of the anomers (different forms of glucose and fructose) would make quantitative analysis difficult or impossible. However, Portallier (Bull. Apicole, 10: 209-212, 1967) did use the method to develop what he felt was a reproducible and reliable assay, and this is currently proposed by Apimondia as an analytical method. Siddiqui did feel that sucrose, which does not form anomers in the reagent, could be quantitatively measured in this way (see below).

Initial attempts to use automated chemical analysis of honey sugars by the Autotechnicon device - a version of the presently standard method of amino acid determinations - were of limited use because of difficulties with the columns; this method is not presently being developed, to our knowledge, and takes highly sophisticated operation and a high capital investment.

Drs. Siddiqui and Furgala developed a simple paper chromatographic method which would measure accurately the monosaccharides of honey, glucose and fructose. This has been developed by Siddiqui and Nunes, FRI, and was used to make quantitative determinations of sugars in the recent Codex survey. It does not measure sucrose separately, however, as accurately as one would like. Turanose, another naturally occurring non-reducing disaccharide, does not separate in this method, and gives high sucrose readings (apparent sucrose).

Beeswax - Government should provide occasionally an analysis service for Beeswax. Testing procedures may have varied so that reports are sometimes conflicting.

6 - Marketing and Product Research.

This is a subject of great concern to industry. It was felt that the international standards for honey and pollen should be reviewed. Granulation is an important problem. Honey analysis is also a recurrent problem and it was felt that more research was needed (methods in particular) in order to meet the standards.

Importation of package bees and queens

According to the statistics on "Canadian Importation of Package Bees" there has been a marked increase from 1959 of

143,000 to 249,000 in 1967 or 100% increase. This increase coincides with the increase in colonies of nearly that amount taking into account queen losses and reduction in package bees. This also represents an increase of some $800,000 in the annual cost to the industry. It is this added cost that I feel we should alleviate by wintering both for making divisions and for package bee production.

The queen problem which has been partly discussed under the topics of disease and failing queens has encouraged us looking for other sources that may be available. Concomitant with the importation of some 1100 queens from New Zealand in 1969 and also over 3,000 in 1970 we are evaluating the stock. Two years data have shown this stock to be comparable to California stock for honey production. There is an indication that wintered colonies headed by New Zealand queens do not produce as many packages as California stock; but further data is being collected.

The aspect of multiple wintering of queens or other methods of wintering queens may offer a partial solution to the queen problem. However, considerable research and subsequent testing has to be conducted before it becomes a reality.

PART III

RESEARCH REQUIREMENTS

A - Aiming at a realistic balanced program.

There was considerable discussion on how much research, what type of research and where should we do the research in order to support industry adequately. There was the usual debate on applied and basic research. We finally agreed on a realistic balanced program, summarized as follows:

National Program

	Present m/y	Needed
Bee diseases	1.0	Contract Research
Marketing	-	C.A.S.C.C.
Product research	0.2	Contract Research
Management	0.7	Contract Research plus 2 man-years in CDA
Honey producing plants	0.5	Contract Research
Behavior	1.2	
Physiology	0.6	
	4.2 man-years	Add 2 CDA man-years and Contract Research

B - Research in CDA, Universities and Provinces.

With 2.7 man-years, the input from CDA in Apiculture was unanimously considered too low. CDA should recruit two Entomologists to support the bee management program. It was also suggested by some that CDA should reorganize its research program and establish an Apiculture Section in Western Canada. This met with considerable objections from representatives of Eastern Canada. We could not reach an agreement on this proposition. The matter was left to CDA to decide where and how this problem can best be solved so as to retain a high quality research program within given resources.

It was unanimously agreed that Contract Research should be encouraged wherever possible, and particularly at the University of Alberta, the University of Manitoba, the University of Guelph, and the University of Ottawa. Contract research was seen as a way of diversifying the inputs in the Apiculture program at relatively low cost to CDA.

The conference was unanimous in recommending that the relations between Provinces, Universities and CDA people be kept very active. Provincial Apiarists have had a very important role in this work planning meeting. It was generally agreed that good lines of communication would be of absolute necessity since Provinces are carrying the functions of extension and also conducting some research of their own. The CDA Research Coordinator (Entomology) should attend the Annual Apiculture Meeting and report on the problems of national interest.

APPENDIX

RESOLUTIONS RECEIVED FROM VARIOUS ORGANIZATIONS

Resolutions related to the work planning meeting were received from the Ontario Beekeepers' Association, the Canadian Association of Apiculturists and the Canadian Beekeepers' Council. They are listed below in the order that they were received.

1 - Resolution from Ontario Beekeepers' Association, December 23, 1969.

At the 1969 Convention of the Ontario Beekeepers' Association held at Toronto on December 4th and 5th, 1969, the following resolution was passed:

> "Whereas there is an insidious disease affecting colonies of honeybees in many areas of Canada which manifests itself in the disappearance of the adult bees just prior to the main nectar flow and in conditions such as "Autumn Collapse" in which the adult population is drastically reduced; and whereas much excellent work has been done on research concerning bee diseases at the Apiculture Section, Entomology Research Institute, Research Branch, Canada Department of Agriculture, for which the beekeepers of Ontario express their appreciation.
>
> Therefore, be it resolved that the Apiculture Section, Entomology Research Institute, Canada Department of Agriculture be requested to investigate thoroughly this "disease" of honeybees and make recommendations as to its effective control".

Resolution from Ontario Beekeepers' Association, February 2, 1970.

> "Whereas there has been unconfirmed speculation that some consideration may be given to moving the Apiculture Section, Entomology Research Institute, Canada Department of Agriculture from Ottawa;
>
> Therefore be it resolved that this Association express its concern and objection to such a move to Dr. W. B. Mountain, Director, Entomology Research Institute, and further request that the Apiculture Section be strengthened and left at Ottawa which has been in the past, and will be in the future, an effective location for Apiculture research work."

2 - Recommendations of the Canadian Association of Apiculturists, April 15, 1970.

" (1) "That the CBC recommend to the CDA that a National Coordinator for Apiculture be appointed."

Explanation: It is suggested that because of the multi-disciplinary approach of apiculture today that this person should have a broad knowledge of apiculture and research relating to apiculture, as well as a broad knowledge of areas relating to the pollination of seed, fruit, and vegetable crops. He would, in effect, be the liaison officer between the CDA and all areas relating to apiculture at the provincial, national, and international levels.

(2) "That the CBC present the problems of the beekeeping industry on a national basis and according to priorities, to the CDA at the Work Planning Meeting in Apiculture (1970)."

(3) National Problems Requiring Immediate Attention

(a) Marketing and Product Research

√ (b) Management for Honey Production and Pollination
  (a) costs of producing honey or pollination studies
  (b) management studies relating to these

√ (c) Wintering Studies
  (a) queens
  (b) colonies

(d) Pollination
  - priorities by crops, e.g. rapeseed, red clover, buckwheat, fruits, vegetables

√ (e) Honey-producing Plants
  - problems associated with special crops, e.g. rape, buckwheat

(f) Bee Diseases
  (a) Nosema in packages and wintered colonies
  (b) Fall dwindling
  (c) High loss of queens and bees during build-up "