OILSEEDS RESEARCH AND DEVELOPMENT IN BHUTAN

A Report Prepared for
The Ministry of Agriculture
Royal Government of Bhutan
And
Rice Farming Systems Project
International Rice Research Institute - Bhutan

K W Riley
Crops and Animal Production Systems
Agriculture, Food & Nutrition Sciences
International Development Research Centre

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FOREWORD

I was asked to come to Bhutan, to carry out a consultancy on oilseeds under the IRRI-Bhutan Project Workplan. Although the IRRI-Bhutan project focusses on developing rice based cropping systems, my terms of reference were to look at the potentials and constraints for increased oilseed production for the whole country.

During my two week visit, I had discussion with staff in the Ministry of Agriculture, Departments of Agriculture, and Animal Husbandry, FAO, and UNDP. During my tour to Wangdiphodrang, Tongsa, Bumthang, Gaylegphug and Chirang, I was able to meet research staff at CARD at Wangdiphodrang, Bhur and Damphu farms, District Agricultural Officers, and extension staff, oilseed mill operators and farmers. Mr Kinley Dorji has generously loaned me a great many reports which provided background on agriculture and oilseeds in Bhutan. I would like to thank all those who gave their time, and helped during my very well arranged tour.

There is likely to be increased emphasis to achieve self sufficiency in oilseed production in Bhutan. Therefore, this report attempts to address what action might be taken to achieve this goal.
### ABBREVIATIONS AND ACRONYMS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tr>
<td>AMC</td>
<td>Agricultural Machinery Centre</td>
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<tr>
<td>BNPP</td>
<td>Bhutan National Potato Project</td>
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<tr>
<td>CARD</td>
<td>Centre for Agricultural Research and Development - based at Wangdiphodrangi.</td>
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<tr>
<td>DAH</td>
<td>Department of Animal Husbandry</td>
</tr>
<tr>
<td>DOA</td>
<td>Department of Agriculture</td>
</tr>
<tr>
<td>DOA</td>
<td>District Agricultural Officer</td>
</tr>
<tr>
<td>FAO</td>
<td>Food and Agricultural Organization of United Nations</td>
</tr>
<tr>
<td>FCB</td>
<td>Food Corporation of Bhutan</td>
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<tr>
<td>IRRI</td>
<td>International Rice Research Institute, Philippines</td>
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<tr>
<td>NASEPP</td>
<td>National Seeds and Plants Propigation Project</td>
</tr>
<tr>
<td>NGU</td>
<td>Ngultrum, the currency of Bhutan 1 Ngultrum = 1 Indian Rupee.</td>
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<tr>
<td>UNDP</td>
<td>United Nations Development Program</td>
</tr>
<tr>
<td>UNV</td>
<td>United Nations Volunteer</td>
</tr>
<tr>
<td>VSO</td>
<td>Voluntary Services Overseas (British)</td>
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<tr>
<td>WFP</td>
<td>World Food Program</td>
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</table>
RECOMMENDATIONS

1. Bhutan has the potential to achieve self sufficiency in oilseeds, without displacing other crop production.

2. The present high oilseed prices in Bhutan and favourable climate for high oil yields are factors that could be exploited to develop oilseeds as a cash crop commodity, which can improve farmers' income.

3. It is suggested that an Oilseeds Research and Development Sub-program under CARD be formed, aimed at achieving self sufficiency in 10 years.

4. Such a sub-program will require careful attention regarding research, extension, processing, marketing seed production, and linkages with programs outside Bhutan to bring in useful improved technology.

RESEARCH

5. A modest, but carefully formulated rice-oilseeds cropping system research program should be immediately initiated at Wangdiphodrang, with collaboration at Chirung and Bhur substations. This program should aim at increasing production of oilseeds in the present rice-fallow areas in the lowland, and mid hills. A second focus should be to increase production in the maize-mustard areas, where mustard is presently being grown, with a third focus on the high altitude areas to develop sunflower, rapeseed, and winter type mustard.

6. A full time oilseed research officer is necessary if CARD is to carry out necessary research and development aimed at oilseed self sufficiency.

7. Since CARD staff and area of focus are limited, area development projects and BNFP should continue their efforts to develop oilseed production in collaboration with CARD. This includes sunflower and biennial mustard in the high elevation areas (Bumthang, Paro, Thimpu), and groundnuts and soybeans in Eastern areas. Joint plans should be developed with CARD for oilseed research in these areas.

8. A scientist from Pantnagar University who has developed improved mustard should visit Bhutan in January 1989 to assist in drawing up an oilseeds workplan, once the first years activities have been carried out.
EXTENSION

9. Collaboration with extension activities as well as area development programs and BNPP will be essential to help CARD formulate an effective oilseed research program; to carry out multi-location and on-farm testing; and to establish the technologies with farmers.

10. The formation of the proposed Research and Extension Division should lead to more effective extension, and better research-extension linkages. Specifically, twice-yearly research-extension meetings should be scheduled when both research and extension activities are reviewed and plans for next seasons activites are made for both extension and research programs. Such planning workshops should be initially scheduled at Wangdiphodrang, and later in the other districts. Personnel from area development projects, BNPP, AMC, NASEPP, and FCB should participate in these meetings.

PROCESSING

11. The installation of oil extraction units in many villages and towns in Bhutan has encouraged the farmers to produce more oilseeds. Farmers travel great distances to have their oilseeds extracted. It is recommended that AMC evaluate, how well the oil expellers which they have distributed are functioning, and compare the different small expellers which are available in India. Extension personnel might identify other remote areas with potential for increased oilseed production, where small units be installed. These units should be capable of expelling sunflower seed oil as well as mustard oil. Staff from AMC should visit centres in India and Pakistan where evaluations of small scale oilseed extraction units are being carried out.

12. A careful evaluation is needed before a solvent extraction plant is established in Bhutan. Such a plant could extract soybean oil, and maize oil, and carry out a second extraction of expeller oil cake. A solvent extraction plant is generally large scale and expensive. Increased oilseed production should first be achieved before considering the establishment of a solvent extraction plant. This further evaluation of the feasibility of this plant might be carried out by a Post Production Specialist with IDRC, New Delhi, in conjunction with a visit looking at wider post production areas in Bhutan.
13. Continued strong demand for mustard cake for livestock feed is essential if oilseed production is to continue to increase. It is suggested that the present feed formulations being developed by DOH, which include mustard cake, be evaluated for any toxic effect. If toxic effects are found a heat treatment may be necessary.

MARKETING

14. The present high price for oilseeds, is likely to be sustained, as India is committed to achieve self sufficiency in oilseed production. The free trade between India and Bhutan, should enable Bhutan to take advantage of this high price to stimulate increased oilseed production. Nevertheless, there is evidence that the large amount of imported rapeseed and palm oil which is sold at about 40% less than locally produced oil, is discouraging increased production of oilseeds in Bhutan. It is recommended that FCB increase oilseed prices of imported palm and rapeseed oil, to be competitive with mustard oil. Alternately, it would be desirable if a quota was set to limit imports of cheap oil.

15. In areas near the Indian border, farmers are being offered attractive prices for their oilseeds. Free market forces should operate in Bhutan's favour to increase oilseed production. The establishment of a support price for oilseeds or additional subsidies is not recommended. The existing good network of roads should encourage greater marketing of oilseeds.

16. Prices of mustard seed and mustard oil should be included in the list of commodities whose prices are monitored in local weekly markets by FCB. This would enable closer monitoring of the differential in price between imported oil and domestically produced mustard.

SEED PRODUCTION

17. It is recommended that a seed release committee be formed. For the present, CARD should have the responsibility to recommend a new mustard variety once it has been tested. The area of adaptation and method of cultivation for the new variety should also be defined. NASEPP should be provided with 1-2 kg. of Breeder Seed for seed production, with remnant pure seed retained by CARD, which will be used as the standard for that variety. Toria is an outcrossing crop, which will necessitate special care in seed production to maintain purity.
INTERNATIONAL COLLABORATION

18. It is recommended that Bhutan become a member of the Oilseeds Network. Varieties and germplasm of oilseeds can be received through the network on exchange basis from countries in South Asia and Africa. A regular Oilseeds Newsletter and oilseeds workshops are part of the Network. Links with oilseed programs in Canada, India and Nepal and Ethiopia would be especially beneficial. FAO Rome, organizes a cooperative sesame variety trial, which may be a source of useful material.

TRAINING/VISITS

19. Only short term training and short visits are recommended, so that essential manpower is not taken out of the program for an extended length of time. The following training visits are suggested:

- A six months practical short course on toria/mustard after rice at Pantnagar University in 1988 November.
- A six month course on sunflower at Bangalore University in 1989/90.
- A short visit of AMC personnel to 2-3 centres in Bhopal, Kanpur and Pantnagar Centres in India which are evaluating small scale oilseed expellers.
Both supply and demand of edible oil appears to have risen very quickly in Bhutan in recent years. According to the statistical handbook for Bhutan (1986), domestic oilseed production has risen from 1,900 tons in 1981 to an estimated 3,700 tons in 1986, an average 15% increase per year. Assuming a 33% oil extraction rate, this production would provide 1,2220 tons of edible oil. In the same year total imports of oil (Private sector, FCB, WFP and others) totalled 2753 metric tons. Domestic production therefore, accounted for only 30% of 1986 domestic requirements. Imports of oil also appear to be rising quickly. FCB's imports rose from 480 tons in 1985 to 875 tons in 1986.

Domestic oilseed production in Bhutan is largely for subsistence purposes. In 1984, the amount of oilseeds marketed was only 537 tons, or 15% of total production. The increase in domestic production seems to have been in response to increased subsistence demand.

There are no duties on taxes on oil or oilseeds moving between India and Bhutan. This encourages the oilseed price in Bhutan to follow the prices in India. India has made a strong commitment to achieve oilseed self sufficiency within the next 5-10 years. To do this, India must maintain high oilseed prices so as to encourage domestic production. In the past year, oil prices in India have risen by approximately 40%.

Oilseed prices quoted by traders, oilmill operators and farmers, indicated that farmers near the Indian border were offered Indian prices of 6-7 Ngultrums per kg. of mustard seed. Further away from the border, in Tongsa and Bumthang, the price was only 4 Ngultrums per kg. Farmers near the border are becoming increasingly commercialized, and benefit from the high Indian prices, while farmers higher in the hills market very little, and receive lower prices for what they do market.

In all areas visited, domestic mustard oil was quoted at 25-30 Ngu./kg. compared to 15 Ngu/kg. for imported FCB oil. This indicates a strong preference for mustard oil, over the imported palm and rapeseed oils. However, continued imports of cheaper palm and rapeseed oil, is likely to cause people to become used to these oils; the higher mustard oil price will drop, and domestic mustard production will be discouraged.
Bhutan is predominantly an agricultural society, with more than 90% of the workforce engaged in agriculture. Present arable land is reported to be 142,000 ha which is less than 9% of the total land area of Bhutan. The remainder is forest (70%) or snow and barren land (21%). The production and area of the major crops in Bhutan are shown in Table 1.

Rice is the staple cereal in Bhutan, and is cultivated on an estimated 37,000 hectares, giving an estimated production of 84,500 tons. Most rice is grown on terraced paddy fields, from 200 metres to 2500 metres elevation, transplanted in July, and harvested in November. Maize is the predominant cereal in the unterraced rainfed lands. The main maize crop is grown from March to July, with total reported production equal to that of rice. Potatoes, wheat, buckwheat, and occasionally mustard are planted in rice paddies from November to January, while millets, soybean or mustard follow maize, usually planted in September or October. Cropping intensity on the maize and rice land may average about 140%. There are numerous other cropping systems, governed by the great variety of agricultural environments in Bhutan.

Mustard is the predominant oilseed crop in Bhutan. In Bhutan mustard refers to brassica oilcrops in general. The same terminology will be followed in this report. The principal species is *Brassica campestris* type *toria,* This crop is also grown in North India and Nepal, where it is known as *toria* or *tori.* *Brassica juncea* or Indian mustard was found in only one field, where it had been recently introduced. Mustard is grown in Bhutan from 200 m to over 3000 m elevation. National reported seed yields of mustard work out to 710 kg./ha, which is equal or higher than those in India. There appeared to be a wealth of genetic diversity that can form the basis of improved mustard varieties in Bhutan.

Most of the mustard in Bhutan is grown in the unterraced rainfed areas, (bari lands), with roughly 10% of the mustard produced on paddy lands after rice (khet lands).

A small amount of niger seed (*Guizotia abyssinica*) is grown in lowland areas having low fertility, while confectionery type sunflowers are found in kitchen gardens, in mid to high altitude areas.
**TABLE 1 - Crop Production in Bhutan**

<table>
<thead>
<tr>
<th>Major Crop</th>
<th>1981 Area (000 Ha)</th>
<th>1981 Prod. (000 MT)</th>
<th>1984 Area (000 Ha)</th>
<th>1984 Prod. (000 MT)</th>
<th>1986 Area (000 Ha)</th>
<th>1986 Prod. (000 MT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy</td>
<td>28.0</td>
<td>57.4</td>
<td>30.4</td>
<td>65.0</td>
<td>37.0</td>
<td>84.5</td>
</tr>
<tr>
<td>Wheat/Barley</td>
<td>12.0</td>
<td>13.3</td>
<td>14.4</td>
<td>16.0</td>
<td>16.6</td>
<td>22.5</td>
</tr>
<tr>
<td>Maize</td>
<td>56.8</td>
<td>80.7</td>
<td>58.5</td>
<td>78.3</td>
<td>52.4</td>
<td>85.1</td>
</tr>
<tr>
<td>Buckwheat/Millets</td>
<td>15.5</td>
<td>12.3</td>
<td>20.6</td>
<td>16.8</td>
<td>15.0</td>
<td>12.7</td>
</tr>
<tr>
<td>Pulses</td>
<td>4.0</td>
<td>2.4</td>
<td>3.0</td>
<td>2.6</td>
<td>5.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Mustard</td>
<td>2.9</td>
<td>1.9</td>
<td>5.0</td>
<td>3.5</td>
<td>5.5</td>
<td>3.9</td>
</tr>
<tr>
<td>Potatoes</td>
<td>3.7</td>
<td>24.9</td>
<td>4.2</td>
<td>32.6</td>
<td>5.1</td>
<td>50.0</td>
</tr>
<tr>
<td>Vegetables</td>
<td>3.1</td>
<td>12.2</td>
<td>1.7</td>
<td>5.3</td>
<td>2.8</td>
<td>11.2</td>
</tr>
<tr>
<td>Oranges</td>
<td>6.2</td>
<td>25.6</td>
<td>7.8</td>
<td>38.7</td>
<td>8.0</td>
<td>53.0</td>
</tr>
<tr>
<td>Apples</td>
<td>1.5</td>
<td>3.3</td>
<td>1.6</td>
<td>3.5</td>
<td>1.9</td>
<td>8.8</td>
</tr>
<tr>
<td>Cardamom</td>
<td>5.9</td>
<td>2.8</td>
<td>8.8</td>
<td>3.0</td>
<td>6.6</td>
<td>4.1</td>
</tr>
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PRODUCTION AND POTENTIALS FOR OILSEEDS
IN DIFFERENT AREAS OF BHUTAN

The agricultural areas, visited in Bhutan, can be roughly divided into different zones based on altitude.

High Altitude Zone - 2300-3200 m. (Bumthang, Paro, Thimphu)

Initial research and surveys have been carried out by the BNPP agronomist in the Bumthang area. Two different mustards are grown: 1) a biennial (or winter dormant) type, planted in June, in a buckwheat mixture, and harvested next May and 2) an annual type grown from April to September. An annual type also was found at 3000 m. between Tongsa and Wangdiphodrang, which was harvested in January. These local lines may have unique high altitude adaptation to cool conditions, and are being collected. Estimated farmers yields range from 420 kg./ha to 1000 kg./ha. All highland mustard was cultivated in dryland conditions. Generally, rainfall in the high altitude zone is fairly low (600 to 800 mm. per year) and erratic.

There is potential for sunflower as a summer crop. Initial tests near Bumthang produced over 3 tons/ha of seed in the best entries. However, the seed is now mixed and of poor quality and new oilseed sunflower introductions are needed. Sunflower seems to have good potential as a summer crop (April-September) in these high elevation, dry regions.

Mustard seed produced in the Bumthang area has a very high oil content. The small German-made expeller at Bumthang expelled over 5 tons of mustard seed in 1987 with an average extraction rate of 42%. Sunflower can also be expelled in this machine. A modest research program to increase oilcrop production in high elevation areas should:

i. Collect and select improved local varieties of mustard. Both annual and biennial forms may be selected for increased yields through simple mass selection;

ii introduce and test suitable oil type sunflower composites from Eastern Europe, Zambia or Canada;

iii develop suitable rotations with potatoes, buckwheat and cereals;

iv work out compost and fertilizer requirements for stable yields in these rotations.

The research capacity at Bumthang is very limited; the BNPP agronomist has very little time to devote to oilseeds work. If increased oilcrop production is given a high priority, an additional research assistant will be needed at Bumthang. The varieties and practices found to be promising in Bumthang should be tested in Paro and Thimphu area.
Mid-hills 1380-2300 m. Tongsa-Shemgang-Chirung

Agricultural land in this zone is broadly divided into terraced, bunded land growing rice, and rainfed unterraced land growing maize.

**Terraced Land** - in Wangdiphodrang and Punakha areas, there are 300-600 hectares of mustard on irrigated land following rice, planted late, in November-December. This amounts to about 10% of the rice terraces in the area. Experiments at Wangdiphodrang (CARD) indicate that fairly good yields (1.2 tons) of Type 9 Toria (introduced from India) can be obtained, even with November planting. The yield of Varuna Indian mustard was slightly higher (1.3 tons) but late in maturity. It is likely that an earlier planting of mustard would produce higher yields in irrigated conditions after rice.

There appears to be good potential to increase the rice-oilseed cropping pattern on rice fallows in the mid hills. The 1986 CARD annual report estimates the cropping intensity on rice paddies in the Punaka, Wangdiphodrang Project area to be about 140%. In addition to mustard, wheat, and vegetables are grown following rice. However, over half the rice paddies are left fallow after rice is harvested. A similar proportion of the paddy terraces were left fallow in other areas, such as Tongsa and Chirung.

There may be two constraints which could explain why farmers have not expanded the rice-mustard cropping pattern:

i. the farmers present rice varieties are generally harvested late, from October to November. Planting of mustard is then delayed into November-December, which appears to reduce yields.

ii. soil moisture or irrigation may be insufficient for the late-planted mustard crop.

It is suggested that a research program be aimed at overcoming these constraints as a first priority. Specific research should include:

i. develop an improved rice variety that can be harvested earlier, allowing mustard to be planted in October;

ii. test local collections and introductions of mustard for lines which perform well when planted in October, as well as testing lines which can tolerate a delay in planting up to December;

iii. test whether earlier planting of mustard reduces seed bed preparation, improves stand establishment, reduces irrigation requirement, and improves mustard yields;
iv establish compost and fertilizer requirements of the rice mustard system. Special attention may be needed to ensure mustard has sufficient levels of available soil phosphorus. A green manure crop has given considerable yield increase in rice at Wangdiphodrang. Attempts should be made to fit a green manure crop into the rice-mustard system.

Safflower and niger seed may have potential as a post-rice oilcrop where irrigation is not available. Sunflower may have more potential where at least 1-2 irrigation can be given, and linseed in areas where frosts are a problem.

It is suggested that this research take place at Wangdiphodrang, with confirmation trials at Chirung (Damphu farm)

Unterraced Land – Most mustard (about 70%) was planted in unterraced rainfed (Bari) lands, in September and October, following the maize crop. Harvesting takes place from December to February. It was observed that the early planted fields were producing higher yields. The maize-mustard system seems to be a stable, well suited system for unterraced rainfed land. Early planting of mustard should be encouraged. Present farmers’ varieties seem generally well adapted. There was great diversity in the mustard types found in different fields. These should be collected and evaluated. A toria introduction from India called T-27 toria does well. Seed production of this variety, which is now supplied from NASEPP, should be increased. The Indian mustard varieties, Varuna and T-52, are however, reported by farmers to be poorly adapted in this area.

Initial research to improve the maize-mustard system should include:

i. testing of improved local varieties and introductions of mustard at Wangdiphodrang that show promise when planted in October;

ii determine fertilizer and compost response and establish realistic levels that can improve the productivity of the maize mustard system.

The FAO supported fertilizer project should specifically include testing of compost and chemical requirements in maize-mustard systems.

As CARD’s activities are presently limited to rice-based systems, extension staff should be utilized to carry out simple mustard variety trials in the maize-mustard areas. Arrangements with the Department of Agriculture and the Dzongkag administration would have to be made in order to allow them to carry out these experiments.
Lowland areas - 200-1000m (Gaylegphug)

These areas generally receive high rainfall from June to October (Over 5000 mm per year at Gaylegphug). Soils are generally coarse textured with medium to low fertility. As in the mid altitude zone, most bunded and terraced land was planted to rice with maize predominating on the unterraced land. Mustard was planted in rain fed, unterraced land in October, usually following maize. At Bhur farm near Gaylephug, a late (November) experimental planting of a mustard variety trial (SAARC trial) was devastated by aphids. There is no good resistance to aphids in mustard. Therefore, planting of mustard cannot be delayed after October in lowland areas.

If a rice-mustard system is to succeed in lowland areas, an improved early rice which will allow an October planting of mustard, must be developed. There is potential for a rice-oilseed system using other oilseed crops. In addition to mustard, groundnuts, sesame, safflower, and sunflower should be tested for suitability following rice. Research on oilseeds at Bhur farm should be similar to the trials suggested for Wangdiphodrang with more stress on early planting, and more specific evaluation of pest and disease incidence.

Eastern Region

The Tashigang Mongar Area Development Project has reported initial trial results with oilcrops in their 1987 report at Chinary and Khangma. These results can be summarized as follows:

- Mustard grown during the summer (June-October) produced excellent seed set.
- Local mustard varieties are earlier than the introduced types which include Type 27 and Varuna.
- Varuna Indian mustard may require higher seed rates;
- Groundnuts and Soybeans when grown from June to September have good performance.

No suggestions or recommendations, are possible, as I was not able to visit the area. However, this area is reported to have good potential for oilseed production.
PROCESSING, MARKETING AND UTILIZATION OF OILSEEDS

PROCESSING

Agricultural Machinery Centre (AMC) has provided loans and assisted in the installation of 25 table top expellers manufactured in India and Japan, and two larger Viking oil mills, manufactured in Calcutta. AMC has not had the personnel to evaluate the performance of the machines, or to carry out a pre-installation evaluation. Such evaluation should be carried out. The performance of older (5-15 years old) Viking oil expellers at Wangdiphodrang, Kinga Raptens (Near Tongsa) and Gaylegphug were observed or discussed with the operators or farmers.

In general, there was an agreement that the machines had helped to increase production. Farmers would come from 3-days walk away, or 45 km. to bring the seed to be milled. Most farmers paid 1/10 of their seed as the cost of extraction, and took back both cake and oil. It is evident that farmers value both cake and oil. The cake was valued at 1-2 Ngu/kg. and the oil at 25-30 Ngu/kg. The cake is usually mixed with maize and rice bran, cooked, and fed to livestock.

The following is evidence that mustard oil is valued much more than imported rape and palm oil, and that cheap imported oil has not yet undermined domestic demand:

- The imported oils are sold by FCB at 15-18 Ngu/Kg or 40% less than domestic mustard oil.

- There was no report that FCB oils were ever resold at a higher price.

- Mustard oil is sometimes added to the imported oil, and sold as pure mustard oil at a higher price.

- Mustard oil was reported to be necessary for traditional dishes.

The only demand for imported refined oils may come from urbanized dwellers in Thimpu or other centres. It appears unlikely that there is sufficient justification for producing refined oil in Bhutan.

The oil mills were utilized at between 50% and 10% of full capacity. This under utilization did not bother the operators, who had other employment when the mill was not operating. Many of the oil mills had worn out parts, and expelled the seed very slowly, requiring large amounts of power for the amounts of seed crushed. Only 1-2 quintals of seed per day were expelled. These mills could not process sunflower, or oilseeds called "singma" pachay" or "dome" from forest trees.
It is suggested that small oil mills, located closer to production areas, could help to stimulate more production in isolated areas, and reduce the time people spend in walking to more distant large mills. There was one unconfirmed report that a small Japanese mill was overheating after a short period of operation. It is recommended that an evaluation of the newly installed oil mills take place before more are installed. The German-made mill at Bumthang can expell both mustard and sunflower seed. It is efficient, and extracts a high percentage of oil. It has not required maintenance after 18 months of running. The only drawback of this small expeller seems to be its cost-120,000 Ngu. The Viking oil mills, in comparison, cost only 28,000 Ngu.

None of the farmers interviewed was still using the traditional hand-operated press. All went to the oil mill to have their oil expelled.

It is suggested that AMC personnel also visit the centres in India and Pakistan that are evaluating small scale oil extraction equipment. These evaluations are being carried out as part of an IDRC-assisted project. Addresses of the Centres are found in Appendix-3.

MARKETING

It was observed that some farmers in Gaylegphug had become very conscious of market prices, and received high prices for their mustard; 6-7 Ngu/kg for brown mustard, and 8-9 Ngu/kg for yellow mustard. Farmers located further away from the border were marketing very little seed, and reported receiving 4 Ngu/kg. It is likely that inland prices are low because insufficient amount is marketed to be of interest to traders. If local small mills operate efficiently, it is unlikely that large amounts of oilseed will be marketed until the local area is approaching self-sufficiency.

It is suggested that FCB include mustard seed prices, and mustard oil prices in the lists of commodity prices collected from "Sunday markets". These prices, and quantities marketed can help determine if a local area is nearing self-sufficiency in oilseed production.

It is highly unlikely that there is justification in constructing a solvent extraction plant until oilseed production increases to the point where significant amounts of oilseeds are being marketed. It is suggested that Dr Richard Young, a Post Production Specialist at the IDRC Delhi office, visit Bhutan. One part of his visit could be devoted to making an evaluation of the feasibility of installing an oilseed solvent extraction unit and oil refining unit.
Mustard meal contains 40 to 42% of high quality protein. However, the presence of breakdown products of glucosinolates can interfere with iodine metabolism and cause palatability problems, especially in monogastric animals and poultry. Farmers in Bhutan are apparently effectively mixing mustard meal with other ingredients before feeding to livestock so that the glucosinolate products are reduced to nontoxic levels. As in other countries, the commercial price of high glucosinolate mustard meal is somewhat lower than other oilseed meals. A commercial feed mill has been set up at Phuntsholing, which uses mustard meal in its formulations. It is noted that pig meal and poultry meal would contain 15% and 5% respectively which should be well below the toxic level. Cattle feed may contain up to 40% mustard meal. Since cattle are more tolerant, it appears unlikely that the higher proportion of mustard meal would be toxic to cattle. Since the Department of Animal Husbandry is planning animal feeding trials, the present level of mustard meal in the feed formulations should be evaluated for any toxic effect. Isocyathanate toxicity if found, can be reduced by heat treatment. Further, information is available in the following:

"Problems and Potentials of the Oilseed Brassicas - R K Downey in Oilcrops Proceedings of a Workshop held in Cairo, 3-8 September 1983; PP 153-161."

This report has been left with CARD at Wangdiphodrang. The feed mill is presently faced by a shortage of by-products for use as animal feeds. However, continuing strong demand for oilcake is essential if oilseed production is to continue to increase. It should be noted that the total value of the oil cake is approximately equal to the value of the oil itself.
SUGGESTED ORGANISATION OF OILSEED RESEARCH AND DEVELOPMENT

IN BHUTAN

It is suggested that oilseeds sub-program be formed under CARD and given responsibility to coordinate research and development activities on oilseeds in Bhutan. Staffing in CARD is limited, therefore, close collaboration with many organizations is essential if the potential for oilseed development is to be realized.

CENTRE FOR AGRICULTURAL RESEARCH AND DEVELOPMENT (CARD)

CARD, started activities in 1984 under the Department of Agriculture with the main centre at Wangdiphodrang (1300 m) and sub-centres at Bhur Farm (200 m) and at Damphu, Chirung (1560 m). CARD has developed a focus on improving rice-based farming systems, with support from the IRRI/IDRC-Bhutan project. CARD is evaluating large numbers of rice varieties and initiating some rice breeding in collaboration with IRRI. Improved rice varieties and cultural practices have now been identified, and are being tested with farmers in on-farm trials. Improvement of oilseeds after rice should fit well into the present focus of CARD, and should be the initial focus of an oilseed sub-program under CARD. Development of oilseeds following rice, as well as oilseeds in unterraced lands and high altitude areas will require CARD to take the initiative to coordinate oilseed research and development with several other organizations.

EXTENSION

Extension services provided by the Department of Agriculture are decentralized, and are now controlled at the Dzongkhab, at the district level. Extension Officers, Block Extension Workers and Supervisors are responsible to the District Agricultural Officers under Dzongkhah (District Head), who in turn is responsible to the Home Ministry.

The involvement of extension personnel in the oilseeds sub-program will be essential in collecting local germplasm, providing information on constraints to improved production, carrying out on-farm trials, and finally ensuring that the improved seed and technology reaches the farmers. These activities should be part of the workplan which extension carry out. Permission to carry out these activities should be passed through the Dhongdhag at the district level. In areas, such as the rainfed mustard area around Tongsa, where no area development project or CARD sub-station exists, the extension personnel may have to take the initiative to carry out simple researcher managed on-farm trials. The Extension Officer, and Extension Advisor (UNV) that we met at Tongsa, for example, would certainly be capable and willing to carry out carefully formulated on-farm research trials from CARD.
FERTILIZER PROJECT

An FAO-sponsored project is carrying out simple fertilizer trials with 10 treatment on different crops, across the country. Response curves from NPK and compost can then be derived from these results. The 1987 work plan for this project calls for 16 such fertilizer trials to be laid out on mustard. These trials are an important first step in developing appropriate fertilizer and compost recommendations. It is hoped that such trials can specifically examine fertilizer and compost response in oilseeds after rice on irrigated land, after maize in dryland, and in higher altitude areas. There is close collaboration between CARD, and extension in this project.

PLANT PROTECTION PROJECT

This project, with EEC support, is strengthening the Department of Agriculture capabilities to provide plant protection advice to researchers and extension. Initial disease and pest surveys, followed by closer involvement with major problems on oilseeds, especially control of aphid on mustard may be required, in collaboration with CARD, and extension.

BHUTAN NATIONAL POTATO PROGRAM (BNPP)

This program with Helvitas (Swiss) support, under the Department of Agriculture, is working directly, with extension and with farmers in providing seed potatoes and advising on improved potato growing technology. Some work on mustard and sunflower at high altitude has taken place at Nashephyl farm near Bumthang (altitude 2700 m). Both mustard and sunflower appear to have potential in rotation with potato. Since CARD has no sub-station in high altitude areas, it is suggested that BNPP will need to take the initiative in carrying out research and development on oilseeds at high altitudes, in collaboration with CARD. Since BNPP staff is limited, an additional staff may be required to carry out the oilseed work for high altitude areas. Initial work should focus on collecting local mustard types; testing and selection of local and introduced mustard and sunflower, identifying production constraints; and carrying out on-farm tests of improved varieties and cultural practices. Testing at either Paro Thimphu or Ha, of improved varieties and practices for oilseeds at high elevations, should also be initiated, if there is available manpower.

AREA DEVELOPMENT PROJECTS

Several area development projects include on-farm testing and demonstration of oilseeds. These include: Chirang Hill Irrigation Project; Punakha-Wangdi Valley Development Project; and Gaylegphug Area Development Project. Present CARD sub-stations are located in each of these project areas. The area development projects and CARD should liaise closely in developing location specific oilseed technology for these areas.
THE TASHIGANG AND MONGAR AREA DEVELOPMENT PROJECT (IFAD II)

IFAD II operates in Eastern Bhutan where CARD does not presently have testing capability. A specific oilseed testing program should be developed for this area, with collaboration from CARD. Mustard, Groundnuts, and Soybeans all appear to have potential in this area.

NATIONAL SEED AND PLANT PROPOGATION PROJECT (NASEPP)

This project is based in Paro, but has multiplication farms in Gaylegphug and Bumthang. Mustard varieties T 27 (toria) T 52 and Varuna (juncea) are presently being multiplied and supplied to District Agricultural Oficers on request. At present, there is no Seed Release Committee in Bhutan, nor are there required performance standards for new varieties. It is suggested that a Seed Release Committee be established with membership from CARD, NASEPP, and Extension to set up performance standards and ensure areas of adaptation are defined for varieties before they are released. In the meantime, CARD should take the initiative to ensure that new varieties are adequately tested, and areas of adaptation defined for each new variety. Breeder seed (1-2 kg for mustard) should then be given to NASEPP for multiplication. Remnant pure breeder seed should be retained by CARD to verify seed purity. CARD personnel should also visit NASEPP seed production fields to advise on isolation requirements and other criteria for seed production of the new variety.

AGRICULTURAL MACHINERY CENTRE (AMC)

The AMC has been involved in placing approximately 25 small scale oil expellers in small communities across Bhutan. The development of local oil expelling capability has encouraged increased oilseed production, and there seems to be strong demand from subsistence farmers for oilseed expelling. The correct placement of appropriate small scale oilseed expellers is likely to be an important factor in continuing the expansion of oilseed production in Bhutan.

An evaluation of the best type and placement of oil expelling equipment should be carried out before more expellers are placed in local communities. This evaluation should be carried out with the involvement of CARD and Extension personnel.

An evaluation of performance of the expellers should be carried out by informal discussions with farmers and oilseed mill operators. A wider assessment of production and utilization constraints can also be made, which will be of use in developing future strategies.
FOOD CORPORATION OF BHUTAN (FCB)

FCB is a government corporation, under the Ministry of Agriculture. It provides auctions at border towns for agricultural exports from Bhutan. FCB also imports rice and edible oils through the Food Corporation of India. Most of the edible oils imported were palm or rapeseed. Import of FCB oil is sold in FCB outlets around the country for 15 Ngu per kg, or 40% less than local mustard oil. The availability of inexpensive oil has, no doubt, been a benefit to the consumer, especially those with some monetary income. On the other hand the availability of inexpensive oil is a disincentive to farmers to produce and market more oilseed. There is evidence that this disincentive is stronger in the hills, away from the Indian border. It is suggested that FCB maintain imports at existing levels for one year, then slowly reduce edible oil imports, and at the same time slowly raise prices until they are equal to mustard oil prices. FCB should be kept informed by CARD about the adoption by farmers of improved oilseed production technology. It is important that farmers increased production commands a steady and attractive price. Therefore, the reduction of oil inputs and raising of domestic oil prices should depend on capacity for domestic oilseed production. If FCB stops edible oil imports too quickly, this action could cause rapid increase in prices and unnecessary hardship to the consumer.

RESEARCH AND EXTENSION DIVISION

This proposed division in the Department of Agriculture would help to strengthen research and extension linkages including linkages with the area development program. As part of this division's activities, seasonal planning workshop should take place, where the past activities of both extension and research are reviewed, and plans made for the coming season. Sufficient time must be allocated to enable activities on each crop, in each area, to be reviewed and planned. Pre-workshop meetings could take place in each area followed by crop-by-crop reviews and planning at the workshop itself. This planning would enable the different organizations to participate, plan and execute a focussed oilseed program.
POSSIBLE SCENARIO FOR ACHIEVING SELF SUFFICIENCY IN OILSEEDS PRODUCTION

Statistics indicate that the present shortfall of oilseeds is 7200 tons which is presently being met by 2400 tons of imported oil. At present mustard yield levels, (700 kg/ha) an additional 10,500 ha of land under oilseeds is required. This increase could occur if:

a. mustard area doubles in the next five years (as it did from 1981 to 1986, according to statistics). This would provide an additional 5,500 ha on unvegetated dry land.

b. The development of improved rice-oilseed cropping patterns leads to an additional 5,500 ha of rice fallows being used for oilseed production. There are presently 37,000 ha of rice, of which an estimated 22,000 ha are fallowed after rice. This would increase cropping intensity on rice land from the present estimate of 140% to 155%.

c. An estimated 5% annual increase in demand is offset by a corresponding 5% increase per year in yield per hectare.

The above calculation makes a number of assumptions:

a. that oilseeds price remain attractive;

b. that suitable high yielding rice varieties can be identified, which will allow oilseeds to be planted by October on rice fallows;

c. that suitable oilseeds are identified, which can produce good yields using stored soil moisture, or 1-2 irrigations, where available;

d. that the cattle, which usually graze the rice stubble can be kept off the post-rice oilseed crop;

e. that the reported increase for mustard area from 1981 to 1986 continues for the next five years;

f. that an annual 5% yield/ha increase is sustainable and can be achieved through improved varieties and farming practices.

g. that appropriate small scale oilseed expellers are placed in rural communities;

h. that rising imports of oil are limited, or priced to ensure an attractive internal market price for oilseeds;

i. that improved seed and other necessary inputs are made available.
Appendix-1

Description of Oilcrops with Potential in Bhutan

1. Toria (Brassica campestris var. toria)
   Description

Toria is the main oilcrop grown in Bhutan. It is widely grown in North India and Nepal. It is usually planted in September, and harvesting in December. In higher elevation areas in Nepal, where soil moisture is sufficient, the crop is planted up to November. Toria is generally a short season crop and considerably earlier than the other Brassica oilcrops. Brassica campestris can be distinguished from other brassica oilcrops by the clasping of the lower leaves around the stem (Figure-1). Best yields of toria are generally obtained when early plant establishment and growth occurs under slightly warmer temperatures, with flowering and seed filling taking place at cooler temperatures. However, toria is susceptible to frost, especially in the early pod filling stage. Toria is also susceptible to alternaria disease especially when planted before the rains end, and aphids, which often are more serious on a late planted crop. Toria seed colour is generally reddish brown.

Improvement of Toria

Work to improve toria in India has been in progress for many years. The most successful research has been done at Pantnagar University, where Type-9 was released many years ago. Recently, rice has increased in Northern India, and Toria is now being planted later in October, after the harvest of the rice. Two varieties, PT 30 and PT 303 have been released with reported yields 18-20% higher than T-9. A new toria line called PT 507 B is ready for release from Pantnagar. This line is reported to yield more than PT 30 or 303. Toria is an outcrossing crop, which makes selection and maintenance of pure line difficult. Mass selection and recurrent selection are the best methods to improve toria. Local collections of toria may be best sources of cold resistance and adaptability.

2. Yellow Sarson (Brassica campestris var. sarson)
   Description

Yellow sarson has similar leaf shape to toria, but often has much fatter pods known as bilocular pods. This trait has been difficult to stabilize, and does not seem to produce higher yields. The main advantage of yellow sarson is the yellow seed, which have a 2-5% higher oil content. Generally yield of yellow sarson are slightly lower than that of Toria. In two locations in Bhutan, yellow sarson had less aphid attack, indicating that it might be suitable for late planting when aphid attack is expected.
Figure - 1 - Leaf attachment of *Brassica Campestris* - Toria (M-27, T.9)
- Sarson
- Canadian "Polish" rape
Improvement

Yellow sarson is the only *B. campestris* type which is self pollinating. This makes it easier to maintain pure lines. Single plant selection and pedigree selection are useful to improve yellow sarson. Several improved varieties have been produced from Pantnagar University. These are given YS numbers, specific lines are mentioned in Dr Basudeo Singh’s paper in the 1986 Oilcrops Network Workshop proceedings.

3. **Canadian "Polish" Rapeseed (B. Campestris ssp olerifera).**

This subspecies is grown in more northernly areas of Canada and northern Europe. It is faster maturing than the *B. napus* rapeseed. This crop is long-day photo sensitive so it may not flower in the September-February period in Bhutan. It may however, have potential as a spring planted crop in high elevation areas. Torch and Span are two improved Canadian varieties. Span is showing some promise as a spring planted crop in Kashmir.

4. **Indian Mustard (Brassica juncea).**

**Description**

Indian mustard is usually planted later than toria in north India usually in November or December, when wheat is planted. Most of the crop grows entirely on stored soil moisture, yields of Indian mustard are often higher than those of toria when grown under similar conditions. Aphids, white rust and frost often reduce yields in farmers fields. Figure 2 shows the characteristic leaf attachment of Indian mustard. The seed is similar to that of toria.

**Improvement**

Indian mustard is primarily a self pollinating species, so single plant selection and pedigree selection are usually practiced. High yielding varieties and varieties with special traits are listed by Dr Hari Singh in his paper in the 3rd Oilcrops Network Proceedings. In Bhutan, it was reported that T-52 (an Indian mustard variety) takes too long, from the beginning to the end of flowering resulting in some green pods, when others are shattering. Uniform maturity may be an important characteristic to select for in this species. The variety Varuna is a high yielding line, but long in maturing. Kranti, and Krishna from Pantnagar and RH 30 from Hissar are faster maturing. "Porbhi raya" is the fastest maturing type used by plant breeders in India. Early varieties may have potential on both dryland and in rice paddies in lowland areas and mid hills of Bhutan.
Figure 2: Leaf attachment of *Brassica juncea* - Indian Mustard (M 52) (Varuna)
5. **Ethiopian Mustard (Brassica carinata)**

The species is presently only grown for oil in the Ethiopian highlands up to 2500 m elevation. It is generally late in maturity, but early types have been collected. This species is more tolerant of aphids, disease and low soil phosphorus conditions than other Brassica species when tested in Ethiopia. The crop produces high seed yields, over 4 tons/ha, under ideal conditions. The crop is usually grown from June-September, under 13 hr. daylength, however, maturity was hastened when planted in December in Ethiopia, indicating this crop has a short day flowering response. Early introductions could be made in mid hills and lowlands in Bhutan, in post-maize and post-rice cropping systems.

6. **"True" Rapeseed (Brassica napus)**

Most Canadian and European oilseed production comes from this crop. In Europe, winter dormant forms are often grown, while in Canada, spring types predominate, as the Western Canadian winter is often too cold for winter types. Winter types, however, generally produce higher yields. The winter dormant type, or biennial type, reported in the Bumthang area (3000 m) in Bhutan may be a *Brassica napus*, but other species of Brassica can have winter forms as well. *Brassica napus* varieties are long-day sensitive, and are unlikely to flower during the short days of November to March. Winter types and spring types however, should be tested in the high altitude areas of Bhutan.

7. **Sunflower (Helianthus annuus)**

This crop does well on fertile soils, but can tolerate dry conditions. It prefers cool conditions but has a fairly wide temperate adaptation. The high yields obtained in initial tests in Bhutan, indicate that sunflower has potential as an oil crop. Older lines were self incompatible, requiring pollination by bees. Seed filling was often poor. The older lines also had thick, often striped seed coats, large seeds, and low (30-40%) oil content. New lines are self compatible, with higher oil content, (40-50%) caused by thinner-hulled and smaller seeds. Seed colour is usually jet black. Almost all sunflower grown in North America and Europe are hybrids. It is very difficult to extract pure breeding lines from these hybrids, and the companies producing the hybrids will generally not release the parents. Several sunflower breeders, however, have populations that they will send upon request. These populations may have to be purified for a few years in Bhutan. Both the International Sunflower Network, based in Rumania, and the FAO, Rome may supply open-pollinated sunflower varieties or composites upon request. Sunflower appears to have potential as a summer crop in high elevation areas and should be tested in both mid hills and low hills following rice or maize in Bhutan.
8. **Niger seed (Guizotia abyssinica)**

This crop is presently grown in small areas in Bhutan during the summer. It is planted late in the monsoon in midhills, and lower hills. Niger seed is able to produce a crop even on land which is low in fertility. This crop is known to compete well with weeds. The seed is small, with a good quality oil and a fairly low oil content (35%). The Ethiopian types are rather different in that they grow well on waterlogged soils with very low oxygen content. Niger seed is relatively small and should be expelled in the present expellers in Bhutan without problem. There may be scope for increased areas grown on soils of low fertility in Bhutan. There is considerable area of Niger seed in the mid, and low hills of Nepal.

9. **Safflower, Carthamus tinctorius**

This crop can make excellent use of residual soil moisture with a root system that can grow very deep. The spikes on the leaves also discourage cattle from browsing. This crop has been traditionally grown in the cool, dry Mediterranean winters for use as a vegetable dye. It is primarily grown as an oil crop in the deep black soils of Central India and Rajasthan during the dry cool season. This crop has lower potential yields but makes better use of stored soil moisture than does sunflower. Both crops have fairly large seeds and may need special arrangements for oil extraction. However, both crops produce a light, high quality oil.

10. **Groundnuts (Arachis hypogaea)**

This crop may have potential in the lowlands as either a summer or winter crop. It has a high heat requirement but may do well in the warm winters around Gaylegphug. Groundnuts require light non-compacted soils. Short season types may have potential. ICRISAT could supply an observation trial. Groundnuts may do well in the low land and mid-hills during the summer season, during the rains, but would displace the maize or rice crop. There may also be a place for early groundnuts before the main rice crop, in irrigated areas.

11. **Sesame (Sesamum indicum)**

It is surprising that there are no reports of sesame growing in Bhutan. Sesame area has expanded quickly in the terai area of Nepal, displacing maize. Sesame is also grown in the mid hills and valleys of Nepal. The high price offered for sesame seed makes it an attractive cash crop. White seed usually commands a higher price but black seed has higher oil content (upto 60%). Yields are often low (less than 500 kg./ha) but the types found growing in the terai of Nepal reportedly yield 1000 kg. on the farmers' fields. Mr. Jayaswal, of the Nepal National Oilseed Development Program has collected this seed, and may be able to
exchange some. Sesame may also have potential as a relay crop in rice. In a type of cultivation known as "utera" in India, sesame is scattered just before rice is harvested. It is grown without much further attention in the rice stubble. Sesame may also have potential as a pre-rice crop on irrigated land. It is generally a fast maturing crop, maturing in less than 90 days.

12. **Linseed (Linum usitatissimum)**

Linseed is usually an industrial, rather than an edible oil crop, due to its high content of the unsaturated fatty acid called linolenic, which is easily oxidized, causing rancidity. Nevertheless, linseed oil is widely consumed in Ethiopia and by some people in India. Recently, however, a low linolenic linseed has been produced, and it may be worth testing.

Dr. Abbas Omran in Ethiopia should be able to help with seed. Linseed is a cold tolerant crop and may do well after rice, when frosts are expected.

13. **Oilseeds from forest trees**

With the extensive forests in Bhutan, oilseeds from the forest may have considerable potential. One called "Singma" is a tree that spontaneously grows in land used for shifting cultivation. Other native oil bearing trees are known as "Ponsi" and "Mafua". More information on cultivation methods and uses of oils from these trees could help to increase the cultivation and utilization of those with potential.
Appendix-2

Suggested First Year Workplan for Oilseeds Research

a. Local Collection: - Collection of mustard types growing in farmers fields. Notes on location, altitude, and use of the crop should accompany each collection. A log book (accession register) at CARD should record this information and assign accession number to each collection.

b. Introduction - Specific requests for seeds from scientists or organizations in other countries. Addresses provided in Appendix 3.

c. Preliminary observation necessary (PON) of both introductions and collections, along with a local and improved check after every 5-10 entries - unreplicated. 2 rows per entry. Selection of best lines, or best single plants for post-rice, post maize, or high altitude conditions.

d. Evaluation of improved early rice varieties, which will allow mustard to be planted in October.

e. Time of planting trial with toria (T 9) Sarson, Indian Mustard, and early local lines. Planted from September to December. Yield reduction, pest and disease incidence with different planting dates should be noted. Note ease or difficulty of seed bed preparation, initial stand establishment, and number of irrigations needed for each planting date.

Notes:

- The PON should be planted in 3 different situations (high altitude, post maize, and post-rice) if there is enough seed.

- A PON for sunflower for Bumthang should be also developed.

- Initial research should concentrate at Wangdiphodrang, with Bhur Farm (low altitude) and Bumthang (high altitude). Chirung is a good mid altitude location.

- Pure seed can be maintained by placing muslin cloth bag over several mustard plants in each entry, just prior to flowering.

- A more complete workplan can be drawn up once first year's results are evaluated. The oilseed rapeseed scientist from Pantnagar University in January 1989 could help.
Appendix - 3
Addresses of Useful Contacts
for Collaboration and Genetic Material

Dr Abbas Omran
Oilseeds Network Advisor
Holetto Research Station
Box 23464
Addis Ababa
Ethiopia

Dr Basudeo Singh
Oilseeds Coordinator
G B Pant University of Agriculture
and Technology
Pantnagar 263 145
District Nainital

Dr P R Kumar
Rapeseed/Mustard Coordinator
Indian Council of Agricultural Research
Hissar Agricultural University
Hissar, Haryana.

Dr R K Downey
Head, Oilseed Section
Agricultura Canada Research Station
107, Science Crescent
Saskatoon, Saskatchewan
Canada

Mr M L Jayaswal
coordinator
National Oilseeds Development Program,
Nawalpur, Sarlafi
Janakpur Zone, Nepal

Information on seeds of most oilcrops.

Indian Mustard:
Krishna, Kranti

Toria: PT 30, PT 303
PT 507-B, Yellow
Sarson: PYS-6

Any released variety of Rapeseed or Mustard in India.

Early lines of spring rapeseed for high altitude spring planting. Winter rapeseed for high altitude summer planting.

Locally adapted toria, sesame, and SAARC Brassica lines.
Mr Gayham Garod, Manager
Lumle Agricultural Centre
C/O British Embassy
Box 106
Kathmandu
Nepal

Pakrebas Agricultural Centre
C/O British Embassy
Box 106 Kathmandu
Nepal.

Dr Zhang Yan
Associate Professor
Agricultural Commission of
Shanghai No. 30
Fu Zhou Road
Shanghai

Dr Amran Ashri
Hebrew University of Jerusalem
Faculty of Agriculture
P O Box 12
Rehovot 76100
Isreal

Dr Hiruy Belayneh
Regional Director
Institute of Agricultural
Research Holetta Station
Holetta Station
P O Box 2003
Addis Ababa
Ethiopia

Dr C R Pineda
Agricultural Officer AGPC
Room C 769
FAO
Via Termedi Caracalla
00100 Rome, Italy

The Coordinator
National Oilseeds Development Programme
Mount Makulu Research Station
Private Bag 7
Chilonga, Zambia

Toria types adapted to hills in Nepal
Information on rapeseed/mustard lines.
Wide range of sesame materials
Early maturing Brassica carinata lines, linseed, sunflower niger seed, sesame
FAO Cooperative Trials. Sesame and Sunflower materials
Sunflower composites and synthetics
Dr Walter Dedio  
Sunflower Breeder  
Agricultural Canada Research Station, Morden  
Manitoba, Canada

Dr A V Vranceanu  
Research Institute for Cereals  
8264 Fundulea  
Bucharest, Romania

Dr Jose Fernandez Martinez  
National Institute for Agricultural Research  
Department of Oilcrops  
INIA, Apartado 240  
Cordoba, Spain

National Bureau of Plant Genetic Resources  
Pusa Campus  
New Delhi 110012  
India

Dr Duncan McDonald  
Principal Groundnut Scientist  
International Crops Research Institute for the Semi-arid tropics  
Patancheru  
P O Andhra Pradesh 502 324

Dr Singidi  
Sunflower Coordinator  
University of Agriculture Sciences  
GKVK Campus  
Bangalore 560 065

Dr M P Bharati  
His Majesty's Government  
Department of Agriculture  
Division of Agronomy  
Grain Legume Improvement Program  
P O Box 404 G P O  
Kathmandu  
Nepal

Sunflower lines, composites and uniform populations

Sunflower lines, composites uniform populations

Sunflower lines, composites uniform populations

Nodal Agency for exchange of materials with India

Groundnut

Sunflower

Soybeans with hill adaptation
Processing

Director
Centre Institute of Agricultural Engineering, NABI Bagh
Berasia Road
Bhopal, M.P.
India

Post Production Section
Agricultural Engineering Dept.
G B Pant University of Agr. and Technology
Pantnagar 263 1435
Nainital, U.P.
India

Dr S A Khan
Chief Scientific Officer
Pakistan Council for Scientific and Industrial Research
Shahrah-e-Jalal-ud-din Roomi
Lahore 16
Pakistan

Safflower and sesame processing

Rapeseed and sunflower processing

Small Scale oilseed processing
Appendix-4

SUGGESTED TEXT BOOKS ON OILCROPS


Appendix - 5

INFORMATION ON OILCROPS PROVIDED TO CARD

Proceedings of First Oilseeds Network Workshop - 1983
Proceedings of Second Oilseeds Network Workshop - 1985
Proceedings of Third Oilseeds Network Workshop - 1987
Oilcrops Newsletter No. 2 - June 1985
Oilcrops Newsletter No. 3 - June 1986
Appendix - 6

USEFUL REPORTS ON AGRICULTURE IN BHUTAN

1. Agriculture Irrigation and Planning Project
   Royal Government of Bhutan, Asian Development Bank
   Acres International Limited - August 1985:
   Volume 1 - Main Report
   Volume 2 - Manpower and Training - Annex 1
   Volume 3 - Agricultural Marketing - Annex 2
   Volume 4 - Soil Conservation and Catchment Management - Annex 3
   Volume 4 - Irrigation - Annex 4
   Volume 5 - Agriculture - Annex 5


## Appendix - 7

### People met, and places visited in Bhutan

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<th>Place</th>
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<td>Mr Mani Thapa, Assistant-Planning Officer</td>
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<td>Mr Erwin Koenick, Co-Manager,BNPP</td>
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<td>Researcher in CARD (who accompanied me on remainder of the trip).</td>
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<td>Bumthang</td>
<td>January 8 1988</td>
<td>Mr Dominique Guenat</td>
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<td>Mr Hannath Dhungel, Innovative Farmer</td>
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Appendix - 8

Selected Discussion Notes

1. Discussion with farmers, oilmill owner and Extension Officer (Kenzang Wangdi) at Kinga raptans (25 km. South of Tongsa) (Mid-altitude Zone)

a. Oil Mill

- Privately owned, purchased from Deki Corporation in Photsoling, manufactured in India. Cost 28,000 rupees when purchased in 1983. Expeller type with 6 hp. diesel engine. No filter. Cultivation of rapeseed has increased because of the oil mill.

- Sunflower seed will not work, as it clogs up the expeller. There are two oilseeds that come from forest trees called "singma" (buckwheat sized seed) and "dome" (maize-sized seed). The expeller cannot handle "dome" seed.

- The mill operates for one month a year, generally crushing 2-3 qu. per day. The cake must be passed through the expeller 5 times in order to extract all the oil. The mill owner charges 17 Ngu. for expelling a 16 litre tin of seed. The farmer takes back both his oil and his cake. The cake is used for making a chutney, but mostly as livestock feed.

- Mustard oil produced is a clear yellow colour, sells for 20 Ngu. per 750 ml. bottle. Rapeseed or Palm oil from FCB available at 12 to 15 Ngu. per bottle.

b. Mustard Varieties

The farmer (K Dorji at Tashidinka) had planted 4 different types. This was the first time she had planted mustard (on upland). She had obtained the seed from a neighbour. We were able to meet only the husband. Planting was done at 3 times during October. Five distinct mustard types were found:

- Indian Mustard (B. Juncea) later identified as M 52. It was at early flowering stage.

- Toria (B. Campestris) later identified as M 27. It is locally called "Peka Naap". (Translated as black seeded brassica). It was setting seed.
- A short, bunchy dark green type which appeared to B. napus. It was about to start flowering. No information on its origin could be obtained.

- A semi wild type which had the appearance of B. Campestris, with very pronounced hairiness on the lower stem and underside of leaves. Likely due to introgression with weedy types.

- A fifth type with a radish-like root growing in the kitchen garden near the oil mill was said to produce yellow seeds, maturing in 6 months. However, it seems to be a biennial type.

There was slight white rust on both B. juncea and B. Campestris types. No aphids were observed. Pests and diseases reported not to be a problem.

We are greatly assisted by Kenzang Wangi, Extension Officer at Kinga Raptans.

2. Discussion with innovative farmer Mr Hamnath Dhungel - 15 km. West of Bhur, January 11, 1988 (Low land Zone)

- Yellow sarson (yellow seeded) fetches a premium of 1 to 2 rupees/kg. (It has 3-4% more oil)

- More land preparation needed (3 times ploughing) for yellow sarson.

- Yellow sarson has less aphids than toria.

- Urea fertilizer was not used as it makes the soil hard.

- Only manure was from animals tethered on the field, for one month prior to planting. Good crop was produced.

- Planting in September is best, October is the latest date for planting toria and sarson.

- Maize was the preceding crop, harvested in June. Toria/Sarson cannot be planted before September or it will become diseased (Alternaria) during the rains.

- This farmer prefers heavy seeding rate 15-20 kg./ha probably because this gives better weed competition.

- Planking definitely improves yields.
- Farmer would not mind a longer maturing crop, as long as it does not get attacked by aphids.

- Farmer expects a good price for his crop: 6-8 rupees/kg. for toria and up to 9 rupees for yellow sarson.

- The farmer is carrying out his own research on time of planting (he has 4 dates), number of cultivations (1 or 3) and variety (sarson and toria).

- The farmer tried toria after rice (November planting) but it failed (lack of moisture and aphids).

- The farmer obtained the sarson seed last year from another farmer near Gaylegphug. He paid 10 rupees/kg. for the seed.

- Price offered by traders will drop if Indian price drops.

BHUTANKR
KWR; BG
International Development Research Centre
Regional Office
11, Jor Bagh
New Delhi, India.