NATIONAL FIELD CROPS RESEARCH STRATEGY AND PROGRAM TENTH FIVE YEAR PLAN (2008-2013)

ROYAL GOVERNMENT OF BHUTAN
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1 BACKGROUND

The Field Crops Research Program (hereafter FCRP) is one of the four National Research Programs of the Council for RNR Research of Bhutan (CoRRB). The national co-ordination of the FCRP will be undertaken from RNR Research Centre at Bajo, Wangduephodrang and it will be implemented at the regional level through the RNR Research Centres (RNRRCs) at Khangma, Jakar and Yusipang and their sub-centres. The Field Crops refer to staple cereals (rice, maize, wheat including other cereals), oilseeds and grain legumes. The research program supports the attainment of national goal of food security and food self-sufficiency.

This document reviews briefly the present situation on field crops, major research issues, challenges and future opportunities. It then outlines the objectives, program structure of the FCRP including sub-programs and projects. The details of outputs and indicators for monitoring and evaluation are provided in tables at the end of the document.

2 REVIEW OF 9FYP

2.1 Highlights of key physical and financial achievements

Physical Achievements

2.1.1 Cereals

The focus of research in cereal crops in the 9th plan was to identify suitable genotypes for different growing environments and to develop appropriate agronomic practices to minimize cost of production. Presented below are some of the highlights of research achievements in cereals during the plan period.

Rice

- For the first time rice cultivation was successfully introduced in Bumthang at an altitude of 2600 masl and above.
- Two promising rice lines –KP3-32-7 and KP6-35-21 have been identified for the high altitude rice environments for further testing.
- Upland rice cultivation has been successfully tested and demonstrated as an alternative crop to maize in high altitude dry land areas.
- Rice varieties – Khangma Maap and Machapuchray 3, were tested as promising varieties for upland cultivations
- The rice varieties – Khumal 2 (provisionally released) and Khumal 6, were identified as promising varieties for the mid-altitude rice environments for eastern Bhutan. Kumal 6 has been released by VRC in August 2006.
- The three cultivars – GUOGING 4, B2983B-SR-85-3-2-4 and SPR87036-7-1-1-2 have been found to be promising for mid-altitude areas of West-Central region
- Rice varieties-HB 242, IR72102-3-115-1-3, and TOX3098-2-3-1-2-1 have been evaluated as promising for further testing for low altitude rice environments in eastern Bhutan.
- Two new rice varieties ITA344 and SPR87028-6-1-1-1 have been identified as promising cultivars for the low altitude rice areas in southern foothills
- The traditional production practices of rainfed rice in southern foothills have been documented

- The study on the effect of three different transplanting methods on yield confirmed that there is no significant difference in yield attributable to the method.
- Sampling procedures and methods for measuring field crops yields have been developed for taking crop-cuts by extension agents
- The pre-rice green manuring crop, Dhaincha (*Sesbania aculeata*) was reintroduced in the low altitude rice growing areas
- The impact of rice research on overall rice production and household food self-sufficiency has been studied and documented.

Maize

- High altitude maize production practices (>1800 masl) have been documented for developing future interventions (RC Wengkhar, Annual Report 2002-03).
- Seven new varieties – Ganesh 2, Arun 2, B.T.Z.T Synthetic 4, Khumal Yellow, and Manakamana 1 have been identified as promising cultivars for high altitudes
- Entry SO 3502 E.T/PS was identified as a promising mid-altitude variety for advanced evaluation
- Quality Protein Maize (QPM) varieties were introduced and evaluated for their potential for high protein as human and animal feed
- A variety of Super Sweet Corn from Philippines has been identified for consumption as green corn
- An improved package of practices for maize cultivation has been developed
- A manual for maize variety maintenance and seed production was developed
- On-farm conservation of local maize genetic resources (PGR) has been initiated at Dremetse, Khaling and Kanglung in Trashigang dzongkhag.
- Metribuzin (Sencor) has been tested and identified as an effective weedicide against weeds in maize and maize-potato system
- Farmers and extension agents were trained on maize seed selection and conservation and breeding
- Impacts of maize research on maize production, household food self-sufficiency and socioeconomic contributions have been studied and documented.

Wheat

- The research centre promoted and maintained the seeds of the earlier released improved wheat varieties
- New varieties from the neighboring countries like India, Bangladesh and Nepal were introduced and evaluated under our conditions.
- Collaborative research on wheat rust disease was conducted with the regional CIMMYT office based in Nepal.

Oilseeds

- Earlier released improved varieties were promoted through farmer managed on-farm trials
- New varieties from India were introduced and evaluated.
- A new rapeseed variety – Legend, was identified as promising cultivar for high altitudes growing environments
- A project proposal for oilseeds is currently under development with ICAR and DFID.

Grain Legumes

- A soybean variety GC8601-427-3 was released for commercial cultivation as Khangma Libi. This variety was released specifically for intercropping with maize as it was found to be the best suited variety.
- Work on groundnut varieties was continued to identify high yield and disease tolerant lines.
- Black soybeans from Japan and China were introduced and assessed in all the RCs.

Other cereals

- The production practices of minor cereals such as buckwheat, barely, millet, etc have been studied and documented for developing future interventions.
- An improved Japanese Sweet Buckwheat variety was found promising for advanced evaluations
- Three malting barley varieties – Otis, Marina, and Dan Yanka, were found promising for growing Bumthang
- Some Triticale lines were evaluated and found more promising than local wheat. However, farmers did not prefer them since it was harder to thresh.

2.2 Main problems and lessons learned

- Limited access to improved germplasm was a major setback to the program. This situation particularly affected the wheat and oilseeds research program.
- Lack of adequate number of Research Officers to lead research on major commodities was the second important problem. There is no qualified staff to lead research on oilseed, grain legumes, and wheat programs.
- Past experiences show that genetic materials straight from the CIMMYT global program are not suitable under our conditions and their evaluation takes up a lot of time and efforts. To shorten the time spent on germplasm evaluation it would be advantageous to introduce semi-finished entries from the neighboring countries such as India and Nepal, having similar agro-ecological conditions.

Financial Achievement:

As of end of the 4th year (30th June 2006) of the 9th Five Year Plan, the financial achievement against the total plan outlay (of Nu.71.587 m) stands at 70.57%. Out of which the capital budget achievement is 50% of its total outlay of Nu.11.764 m. It is optimistic that a 100% achievement of the total plan outlay is realizable by end of the 9th FYP i.e by June 30, 2007.

3 CURRENT SITUATION

3.1 Rice

Rice is indispensable in the Bhutanese culture, tradition, religion, way of life and the livelihood itself. Traditionally rice was sufficient, but today the annual import amounts to over 50,000 MT. Obviously, there is a clear need to increase domestic production and there are opportunities to do so. The main development theme of the 10th Five Year Plan is poverty reduction. Increasing the present level of rice production and thereby food security is an important goal of the Ministry of Agriculture.

Current production and production areas

In 2004, rice was cultivated on an area of 46,585 acres and it continues to be the preferred staple food in the country (Agri Stats, 2004). The total production in 2004 was estimated at 54,325 MT. Over the years, the total rice area has been gradually decreasing mainly due to urban and infrastructure development. However, rice yields per unit area have increased. The top five rice producing dzongkhags are Samtse, Sarpang, Punakha, Wangdue and Paro (Table 1).

Table 1: Rice area and production, 2004

Dzongkhag	Area (acres)	Production (MT)
Samtse	8220	6640
Sarpang	7636	9762
Punakha	4401	6906
Dagana	3406	2967
Wangdue	3129	4883
Paro	2990	4876
Tsirang	2951	2511
Trashigang	2553	3913
Samdrupjongkhar	1832	1385
Trongsa	1620	1487
Thimphu	1523	1965
Mongar	1317	1500
Lhuntse	1282	1405
Chukha	1279	1507
Zhemgang	1092	956
Trashiyangtse	939	1257
Haa	169	138
Gasa	130	117
Pemagatshel	110	140
Bumthang	7	11
TOTAL	46,585	54,325

Source: Agri Statistics, DoA, 2004.

The average yield of rice is 1166 kg/acre. Paro has the highest average yield of 1631 kg/acre followed by Punakha, Wangdue, Trashigang, Trashiyangtse and Thimphu. The southern districts of Samtse and Samdrupjongkhar, although with large area, have the least average yields, largely due to problems of soil fertility and insect pests and diseases.

Available rice technologies

Since the beginning of rice research several improved varieties and cultivation practices have been developed. There are 15 improved varieties for different agro-ecological zones. Of these, 2 varieties are for low altitude areas, 3 for high altitudes and the rest primarily for mid altitudes. Concomitant with the high yielding varieties, several improved production packages have been developed both for improved and traditional crop varieties. These packages include appropriate establishment times and methods, nutrient management methods, weed and pest control etc. for specific rice agro-ecological zones. Besides, about

500 local rice varieties have been collected and conserved for future use in technology development.

Rice trade and prices

Rice self-sufficiency levels are estimated in the range of 39-56% (Shrestha, 2004). The remaining requirement is met through imports from India. The Food Corporation of Bhutan (FCB) and private enterprises are the main importing agencies. The average annual imports from mid 1990s amount to about 35,231 MT, however, in recent years imports have crossed 50,000 MT. In terms of rice export, about 100 MT of mostly red rice is exported to the US and Europe annually. A few export houses are involved in collecting the local rice (rough) from different parts, process, bag and ship it through India. The market price of local rice is comparatively higher than for the imported rice. The price for a kilogram of local rice ranges from Nu 20–30, whereas the average price for imported rice is in the range of Nu 10–15.

Main issues/constraints

There are several constraints besetting rice production in the country. Some of the major ones are listed below.

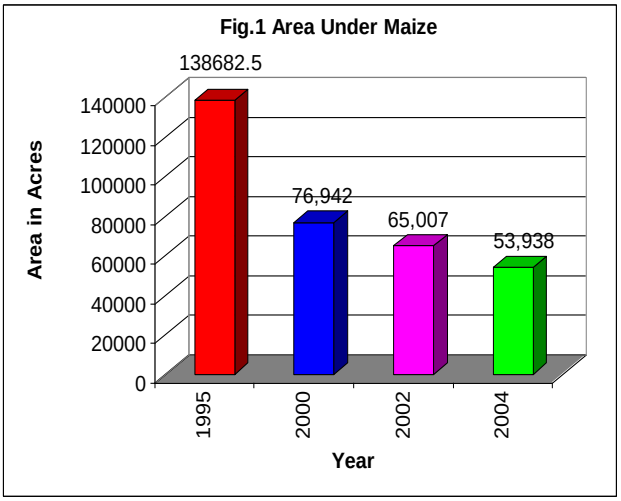
- Low yield potential and productivity of varieties, especially local varieties
- Yield loss due to insect pests, diseases and weeds
- Poor soil fertility and management leading to low yields
- Lack of assured/inadequate irrigation water, particularly in the south
- Poor milling equipment and grain quality loss
- Lack of organized internal marketing for rice and other cereals

3.2 Maize

Maize is the most important cereal crop grown in Bhutan in terms of area and production. The total area under cultivation in 2004 was 53,938 acres with a production of 90,566 MT (DoA, 2004). Maize is grown in all the 20 dzongkhags of Bhutan and about 69% of the households in the country are dependent on maize cultivation, with a concentration in the six eastern dzongkhags.

Area and production trends

The available data indicates that the area under maize is decreasing while the production and the yield show an increasing trend compared to 2000. Production in the mid altitude has increased due to the wide adoption of improved technologies. Data from RNR 2000 show that a total of 189 geogs produce maize.



Uses and Trade

About 99% of the total maize produced is consumed. Maize is consumed as a staple food in the form of Kharang (grits), flour, roasted or boiled cobs and by popping. Tengma (pounded maize) is a much-liked product as a snack. A substantial

portion is distilled into Ara for religious and other purposes. The by-products also serve as important source of animal feed. The green maize plants are one of the most important sources of green fodder for cattle. Although the major portion of maize produced is consumed, some transaction takes place at the household level. At the national level, some maize is also imported. The main products imported include cornflakes, whole grain, maize flour and animal feeds.

Increase in production and yield

As a result of improved production technologies there has been a substantial increase in maize production. The national maize production has increased by 21% from 1995 to 2004. This production achievement is be mainly attributed to the adoption of high yielding varieties, use of improved seed and other production management technologies. The national maize yield has increased from 1.20 t ha^{-1} in 1986 to 4.19 t ha^{-1} in 2004. A recent survey in the eastern dzongkhags has revealed that more than 68% of farmers are aware of the improved technologies and an overwhelming 71% have reported an increase in yield.

Generation of technologies

Since its inception the maize research program has identified genetic and non-genetic technologies. The three released high yielding varieties have made a very good impact on the overall maize production. To improve crop husbandry, improved packages of practices have been developed. As maize is intercropped with soybean a suitable soybean variety Khangma Libi 2 (GC8601-427-3) as an intercrop has been released. The improved agronomic practices developed by research are regularly updated and packaged as technical recommendations and circulated among the Extension staff. A manual for variety maintenance and seed production has been developed. For weed control, Metribuzin (Sencor) has been successfully tested.

Challenges and Lessons

- **Evaluation of germplasm**

The primary focus of the maize variety research has been the subtropical Zone II. Until now, a huge amount of materials have been brought in and screened. However, the present capacity to handle diverse kind of materials is limited. It is therefore very important to keep the focus by prioritizing needs and seeking targeted introductions of semi finished materials.

- **Limited capacity of maize research**

Compared to rice, the capacity to undertake research on maize within the field crops research program is weak. This is mainly because of the small size of the maize research program, regional focus and limited capacity building.

- **Lack of initiatives on processing and marketing**

The present capacity for value addition and processing in maize is very weak. Maize market is non-existent despite the occasional interest shown by FCB. A Kharang processing unit was started at Chenary but it could be utilized fully due to the lack of sustained grain supply and had to be finally disposed. The only means of marketing at present is by converting it to *tengma,* which also has a limited consumer base.

- **Seed degeneration**

Growing diverse varieties results in out-crossing and varietal contamination, leading to poor yields. Traditionally, the rate of seed replacement is very low. Organizing farmers into groups

for community based seed production and enhancing their technical skills on proper seed production and variety techniques maintenance could help stabilize their yield.

- **Wild animal damage and post harvest losses**

Wild animal damage has been the single biggest hurdle of the maize farmers. It is discouraging many farmers and could possibly be one of the reasons contributing to the decrease of maize area. A comprehensive intervention to help the farmers to cope with this problem is urgently required.

3.3 Wheat

Area and production

Among the cereal crops grown wheat ranks third after rice and maize. About 18% households grow this crop and it contributes about 2% to the total cereal production (DoA, 2004). Wheat is generally grown in dry land (53.9%) and also in wet lands after rice. Current area under wheat is 7585 acres (Table 2) with a total production of 4192 MT. The national average yield is 553 kg/ac.

Table 2: Area and production of wheat

Dzongkhags	Area acres	Production (kgs)	Avg Yield (kg/acre)	AEZ
Bumthang	564	514000	911.0	Alpine/CT
Punakha	591	226000	382.0	Alpine/CT/DST
Trongsa	552	239000	433.0	Alpine/CT/DST/WT
Trashigang	44	24000	545.0	Alpine/CT/DST/WT/HST
Haa	597	337000	564.0	Alpine/CT/WT
Gasa	111	54000	486.0	Alpine/CT/WT
Thimphu	496	529000	1067.0	Alpine/CT/WT
Wangdue	1513	736000	486.0	CT/DST
Paro	988	557000	564.0	CT/WT
Mongar	20	7000	350.0	DST
Lhuntse	91	80000	879.0	DST
S/Jongkhar	108	31000	287.0	DST
Tashi Yangtse	14	8000	571.0	DST
Pemagateshel	6	5000	833.0	HST
Chukka	639	323000	505.0	HST
Tsirang	87	20000	230.0	HST
Zhemgang	272	95000	349.0	HST
Dagana	207	118000	570.0	HST
Sarpang	58	31000	534.0	HST
Samtse	627	258000	411.0	HST/WST
Total	**7585**	**4192000**	**10957**	

(Source: DoA, 2004)

Present trend of wheat cultivation

There is 53 percent reduction in area under wheat crop however there was increase in average yield by 32.1% between 2000 and 2004. The increase in production was observed only in

HST zone. On the other hand reduction in cropping area in Cool Temperate, Warm Temperate and Dry Sub Tropical zones must have contributed to overall reduction in national area under this crop.

Recommended varieties

Wheat research started in 1982 when CARD was started at Bajo. Out of 2724 entries evaluated, three varieties were released for altitude up to 1800m (spring season) till date. They are Sonalika, Bajoka-1 and Bajoka-2. There was increase in yield trend in HST zone due to the released varieties though there was reduction in cropping area.

Potential for Wheat Production

Wheat is an important crop next to rice and maize as the two staple food grains. It can be grown in areas where rice cannot be grown. Potential areas according to percentage contribution of wheat to total cereal production and maximum household growing wheat are Ha, Bumthang, Thimphu, Gasa, Wangdue, Paro, Chukha, Trongsa and Punakha.

Trade

On an average Bhutan imports 9804 MT (Trade Statistics, 2004) of wheat grain annually. The grains are imported mainly for alcohol processing. Wheat flour import is also very high and it is mainly used for making bread and other food items. The average annual import value of wheat flour is worth about Nu. 131,183,901.

Challenges and Future Research

- **Limited technologies/varieties**

Wheat has so far received very little research attention and focus, therefore there is a general lack of improved technologies including suitable varieties. The three recommended varieties are of spring type and adapted below 1800 m, hence there are no recommended varieties for winter type and for high altitude areas.

- **High production cost of domestic wheat**

Due to high labor costs, it is always cheaper to import from India than to produce wheat domestically. Hence there is no incentive for farmers to expand their area. It must also be recognized that the food grain crops in general have to compete with other crops as far as income generation is concerned at the farm level and all the evidence is that rice and wheat offer the least returns to investment and the lowest gross margins of all crops.

3.4 Oilseeds

Oilseeds form a major agricultural crop in the country. Mustard and rapeseed are the predominant oilseed crops grown from 200 m to 3000 m elevation. An estimated 7993 acres of land falls under one season cultivation of oilseeds (DoA, 2004). Rapeseed-mustard have been grown by most of our farmers since a long time back, however, the acreage is gradually diminishing because it is not economically viable due to limited choice of cultivars and the relatively high cost of production. The import of cheaper oil is said to depress domestic production. In the wetlands, there are other competing crops such as wheat and vegetables grown in rotation with rice. In the dry land, mustard is grown only as a secondary crop under marginal and rainfed conditions.

Table 3: Area (acre) and Production (MT) of Mustard, 2004

Dzongkhag	Havested Area	Total production	Yield (kg/Acre)
Bumthang	115	28	246
Chhukha	412	119	290
Dagana	308	125	405
Gasa	43	12	267
Ha	26	12	450
Lhuentse	55	43	778
Mongar	105	28	266
Paro	180	56	312
Pemagatshel	27	23	863
Punakha	375	136	364
S/Jongkhar	281	96	341
Samtse	424	128	301
Sarpang	328	110	336
Thimphu	165	59	360
Trashi Yangtse	94	11	113
Trashigang	289	136	472
Trongsa	213	202	946
Tsirang	370	177	477
Wangdue	461	175	379
Zhemgang	232	92	395
Total	**4,503**	**1,767**	**392**

Source: DoA

Consumption of edible oil

The per capita consumption of oil in the country is estimated at 6 - 12 kg per annum. Assuming 10 kg per capita per annum consumption and 0.877 million population by the year 2010, the country would require 8770 MT of edible oil. The current domestic production is only about 1548 MT (DOA 2005), which is less than 10% of the requirement.

Major constraints

- Lack of suitable improved varieties for different agro-ecological zones.
- Non-availability of quality seeds of improved varieties
- Sub-optimal agronomic practices and non-adoption of improved agro-technology.
- Use of higher seed rate for sowing leading to poor plant growth, reduced branching, low seed yield and high production cost.
- Incidence of diseases (white rust, downy mildew and Alternaria blight) and pests (Sawfly and aphids) and non adoption of plant protection measures.
- Inadequate infrastructure for oilseed research in Bhutan
- Lack of crop promotional program on mustard in remote areas.
- Absence of collaboration with leading international organizations involved in oilseeds research.

Opportunities

- Considering the agro-climatic conditions, increase in oilseeds production can be attained by increasing productivity and area expansion under mustard, improvement of oil processing sector and better linkages with support services.
- In eastern parts of country, soybean cultivation can be expanded if price incentive and market support is provided.
- The research work on rapeseed-mustard should be strengthened immediately. Adaptive research be carried out for immediate solution of identified field problems in case of soybean and Sunflower.
- The increased production of oilseeds shall improve the living standard of rural households by creating avenues for income generation and supplement food security. The installation of oil extraction units would provide employment opportunities to rural mass which will reduce migration to urban areas.
- The availability of oilcake with the increase production shall help in improving the cattle health and enhancing milk production.
- It can contribute to household food security and income

4 MAJOR RESEARCH ISSUES AND OPPORTUNITIES IN 10FYP

4.1 Rice

Soil Fertility

Soils in general are poor in nutrient content which contributes to low yields. Farmers apply very little chemical fertilizer apart from the FYM which they apply in the average range of 10-12 t/ha. While for traditional varieties the applied amount of nutrients may be adequate, the maximum yield potential of high yielding varieties (HYVs) cannot be realized. Moreover, specific fertilizer recommendation for various AEZs are lacking due to the variations in soil nutrient contents and conditions.

Limited or no access to inputs such as fertilizers and herbicides by the farmers is an issue in many districts. Although Commission Agents (CAs) are appointed through out the country not all are effectively providing their services. Hence the inputs supply can be fully privatized so that services can be improved.

Integration of green manuring crops in rice cropping systems offers tremendous opportunities in Southern Bhutan. Practice of cultivation of Dhaincha as pre-rice green manure needs to be revived.

Sustainable land management technologies should be tested and extended to the farmers in a sustainable manner to support rice production in the years to come.

Inadequate Irrigation

Despite the fact that numerous irrigation channels were being built and renovated through out the country, still it does not suffice to optimize the paddy production. It is mainly due to the fact that small villages and isolated households are left out of the mainstream schemes. Our irrigation policy does not allow construction of an irrigation channel unless certain command area is covered or certain numbers of households are covered. In the country there are many households isolated from the main village and there are equally as many paddy field separated and isolated. Some wetlands are rain dependent and usually the yield is low as the rainfall is very erratic and not dependable.

Water harvesting techniques are being explored and the technique should be fully explored for the benefit of the rain-fed areas. The irrigation policies should be revised and made favorable to all rice growers. Where irrigation water source is available all defunct irrigation channels should be renovated and new channels constructed.

Plant breeders should put more effort in developing varieties that are drought resistant. Upland paddy cultivation possibilities should be also be explored and the technology disseminated to the farmers.

Lack of HYVs in the Low AEZs

This was mainly due to the closure of the Bhur sub-station where research for low altitude paddy was done. Although the sub-station is up and running there is still shortage of staff manning the station. The cultivar BR153 is the only improved rice variety available and more efforts need to be put in to breed and improve the local variety to boost production in

the lower rice growing belt. Improvement of rainfed rice germplasm and overall improvement in low yield must receive priority.

Pests and Diseases

Pest and diseases reduce yield substantially in the rice production system. For the vertebrate pest there is an urgent need to amend policies safeguarding the crops. The present conservation policy has totally ignored the plight of the farmers. The pesticide policy also needs to be reviewed so that the sale of these inputs are privatized and made easily available to the common people.

The major rice diseases like blast in the high altitudes, brown spot and whitehead in the lower altitudes must receive top priority. Breeding for blast resistance must continue.

The battle against weed is not only time consuming and labor intensive but deprives the crop off its nutrient through competition. There are some obnoxious weeds like the *shochum* which are very difficult to control. Weedicides are expensive and farmers can not afford them. The sale of the chemicals also needs to be privatized so that it is cheaply and readily available to the farmers

To complement pest control, researchers also need to put more effort in breeding pest and disease resistant varieties. Adoption of IPM on large scale will also reduce pest and disease incidence. The effect of continued use of Butachlor on the rice ecosystem must be studied.

High production cost

High production cost is largely due to high labor costs. Farm mechanization could be another option and AMC needs to put in extra effort in their research in producing technology based on our farmers need and suiting our conditions. Adoption of technology from elsewhere proves to be difficult as our environment of paddy cultivation is unique and difficult. Small labor saving tools and implements suiting our conditions can be researched and developed by AMC. Another option to ease the cost of production could be to levy subsidy on inputs at various stages. This needs careful consideration as rice is the staple crop of the country and our farmers are subsistent farmers growing rice in a very difficult environment.

Efforts to mechanise the major labour intensive operations in rice production – land preparation, planting, weeding, harvesting, etc must be looked into.

Poor milling and grain quality

High ratio of broken rice grains in milled rice is a concern. The quality of milled rice is affected by moisture content at harvest, the storage conditions, and poor quality equipment in use for milling. High quality milling machines are either not available or are extremely expensive for our farmers. AMC needs to explore quality and affordable milling equipment for our farmers.

Attention will also be given to identifying limiting factors under storage systems and in the field.

4.2 Maize

Processing and Marketing

The machinery and equipment available for processing maize are not very efficient and effective. The quality of tengma presently produced is not up to mark. The quality can still be improved and also its packaging and presentation. Presently farmers are producing enough maize to spare for the market but there is no market as such for the grains unless it is processed and value added. Producing quality tengma and other by-products and the use of grains for animal feed could be viable solutions.

Soil Fertility

Maize in the eastern parts (major growing area) is grown in the dry lands in steep slopes. In most of the area soil fertility is a problem. Farmers use only FYM and the top soil is prone to erosion. Research in intercropping with legume and other land management practices need to be taken up to increase maize production. Effort will also be given to integrate green manuring crop in the maize cropping system wherever possible.

Pest and Diseases

Common pest and diseases of maize need to be identified and documented for future reference and to devise control measures. Storage pest of maize accounts for one of the highest losses. Yangtsepa variety is especially prone to weevils. Storage technology needs to be improved and resistant varieties needs to be developed to counter this problem. There is also a scope to explore for organic repellants which will be environment friendly and safe and cheap to use. To counter the vertebrate pest (wild boar), the environment policy needs to be relaxed or made more rational to safeguard the interest of the farmers.

The emerging Turcicum leaf blight disease (*Exserohilum turcicum*) in the high altitude maize environments needs attention. Effort to introduce/develop tolerant maize varieties to Turcicum side by side with improved agronomic practices will be looked into.

Management of weed calls for high labor input which is not cheap and easily available. This increases the cost of production. The use of chemical weedicides and other local appropriate technologies should be explored to ease the weed problem.

Seed Production

Being a cross pollinated crop the seed available with the farmers have out crossed and is not true to type. One way to producing seed in large quantity would be to mobilize the community. Forming groups of seed growers in a certain locality will not only enable growing seed in large quantity but will also benefit the farmers in terms of cash income. Efforts will be given to develop appropriate method to produce and maintain quality seeds at farmers' levels.

4.3 Oilseeds

Inadequate Promotion of Oilseed Crop

Due to the interrupted research effort in oilseed crop not many varieties are developed and promoted. The few varieties promoted are not popular with the farmers and the seed quality rapidly degenerated in the hands of the farmers.

The link with other institutions outside the country needs to be revitalized in order to obtain genetic materials for testing and adoption. Another challenge to oilseed production increase in the country is the high production cost and availability of cheap oil in the market. If the country is to increase oilseed production and reduce import, then subsidy and the price of oilseed and its products need to be studied and safeguarded.

In the past what ever promotion was done, it was done in the potential and accessible area. Remote area farmers are more vulnerable and dependent on this crop for oil. These are the marginal farmers who have limited purchasing capacity, subsistence in nature and have little produce for sale and no scope for marketing due to its remoteness. From food security point of view oilseed crops need to be vigorously promoted in the remote areas.

Low production is also due to poor crop management – particularly low input, practiced by farmers. A demonstration using improved management practices will be conducted.

The research on oil crops will strive to introduce new varieties of rapeseed mustard and focus in the remoter areas to develop oil self-sufficiency.

Non-availability of Processing Equipment/Technology

Presently most of the villagers travel to the town for processing whatever amount of oilseed they produce. This is not only time consuming but they lose the cake behind which they could be used for cattle feed due to long distances they have to travel. The present available oil processor is not rural and small growers friendly.

Some farmers are still using the traditional method of oil extraction not because of its effectiveness but having no choice. This method is rudimentary, time consuming, labor intensive, inefficient and the oil they get out of it is very crude.

Portable, efficient and solar powered expellers would be congenial for our farmers. With the electricity rapidly spreading in our villages electric powered oil processing equipment could now be useful but they should be affordable and efficient.

Pest and Disease

Poor performance of oilseeds coupled with pest and disease incidence and labor shortage have led to abandonment of this crop cultivation in some pocket areas. The yield of crops in some cases have been reported to be nil due to pest and diseases. Effective strategies for pest control and availability of inputs could change the oilseed crop production scenario. Research emphasis will be placed on Aphid control, nematode control and other pests.

4.4 Wheat

Soil Fertility

Wheat is grown in the wetland after paddy in wetland system and in the dry-land as spring crop. Hardly any chemical fertilizer is used although some farmers apply FYM. So wheat is grown under very poor nutrient conditions and yields are very low. Opportunities to increase yield exist if fertility management is taken care of.

Lack of HYVs for Dryland Wheat

In the past decade not much research attention has been given to the dry-land wheat. This is mainly due to unavailability or access to improved germplasm and also the fact that there are

no trained and qualified researchers working on wheat. There is a need to develop links between our research system and IARCs and NARCs to access improved technologies.

Recently the acreage and production has gone down under wheat and barley. A study needs to be conducted immediately to find out the cause so that further research efforts can be based on the finding of this study. The research centers also need to allocate manpower and other resources for research on wheat.

Pest and Diseases

Pest and diseases are a problem in all the crops. Researchers therefore need to breed varieties that are resistant to pest and diseases. Presently pesticides and other chemicals are not readily available to the farmers. The vertebrate pests are a nuisance to farmers and a balanced approach should be taken so as to minimize the attack on crops.

Lack of understanding the role of wheat

No doubt wheat has played an important role in the past as a staple crop in the higher altitude as well in the lower altitude where rice is grown. Time has changed and so also the food habit. Substitute crops like potato are more economic and rewarding to the farmers. There is a general lack of understanding on the role of wheat in the diet and economy of the Bhutanese farmers. Hence there is an urgent requirement to conduct studies on the role of wheat in farming.

Storage Losses

Wheat grains too are prone to storage losses. The traditional storage system needs to be replaced with more efficient technologies. Bio insect repellent could be explored. Storage technology should be studied and adopted if feasible in our condition.

4.5 Other Cereals

Lack of Improved technology

In the past, the other cereals like buckwheat, millets and oat did not receive enough research attention due to the lack of resources. No doubt these cereals are only grown in niche areas but are contributing significantly in terms of household food security and self sufficiency. Hence all the local cultivars need to be studied and documented. Its contribution to the food-basket of the local communities should also be studied.

The crops should be researched into and improved variety developed for the local communities. For this researchers should be placed and links with the national and international institutions developed to obtain information and materials for further study. This is in line with the pro-poor and poverty reduction theme of the 10FYP.

Decline in cultivation

A decline in the cultivation of the other cereal crop has been noticed. The reasons could be many. Disallowing tseri cultivation, attack by pest and disease, less research effort, poor processing, lack of internal and external market, changing food habit are the major reasons. Efforts to promote the minor cereals as healthy food and for income should be made in the 10FYP.

Emphasis will also be given to collect and characterise the land races for ex-situ conservation and use.

4.6 Grain Legumes

Inadequate Research and Development Focus

Although legumes have been traditionally grown by the farmers they have not received much research attention as their contribution to the food basket or for cash income is thought to be small. However given the right impetus in the research and development of these crops, they will play an important role in the fertility management, food and cash income for the farmers.

Although there are a large number of legume crops, important ones like soybean, peas and mungbeans could be prioritized for research. Manpower and other resources should be allocated for grain legumes.

Processing and Marketing

Processing of legumes has been limited so far but opportunities exist for processing and value addition. The products could be diversified and value added for internal and external markets. Products like nuggets, tofu and sauce could be tried. Since the crops are naturally grown there could be potential in the organic/natural sector as well. Markets and marketing channels should also be looked into.

Germplasm Accessibility

Without established linkages with outside research institutions, access to germplasm of grain legumes is a problem. Linkages need to be established and a focal researcher for grain legumes identified. Presently our research capacity is limited and this needs to be enhanced.

5 OBJECTIVES OF FCRP

The national field crops research program is an important component of the Ministry of Agriculture especially in the pursuit of an enhanced level of grain self-sufficiency and food security of the Bhutanese people. The program is crucial in developing, introducing and adapting suitable technologies which can increase the productivity and the total production of cereals, oilseeds and grain legumes in the country. It plays an important role in developing and refining research methodologies to improve the efficiency of research and thereby the output of the system. It also provides technical backstopping to the dzongkhag extension system for the overall improvement of food production and household security. As part of the triple gem approach of Production, Access and Marketing (PAM), there is a need to focus more attention towards access and marketing in the 10FYP as far as field crops program is concerned. There is also a need to orient the program to include and cover pro-poor regions, households and farmers in different parts of the country.

The overall objectives of FCRP are:

- To identify appropriate post production technologies and facilitate marketing
- To improve crop production through integrated management of soil, water, pests and farm mechanization
- To increase yield using improved varieties
- To understand social issues, production economics and disseminate information

6 RESEARCH STRATEGIES AND APPROACHES

6.1 Rice Research thrust/focus in the 10FYP

The research thrust in Field crops in the 10FYP will be on post production & marketing, crop management, crop improvement and socio-economics policies and publications. Post production and marketing will attempt to identify appropriate post production technologies and facilitate marketing. While crop management research will focus on improving crop production through integrated management of soil, water, pests and farm mechanization. Similarly crop improvement research will focus on increasing yield using improved varieties. To document the above studies and assess the impacts, socio-economics policies and publications project will focus on documentation and publication of technologies, impact assessment studies and also conduct diagnostic and socioeconomic studies.

6.2 Strategies

The above objectives will be pursued through the following strategies:

- Improve grain/product quality and develop technologies to minimize losses and explore, facilitate & link production with market.
- Improve local varieties and develop improved varieties of rice, maize, oilseeds, wheat and other cereals and grain legumes specific to different AEZs.
- Adapt and evolve appropriate crop husbandry and management practices, including soil nutrients and water management, for optimizing crop production processes.
- Identify or develop suitable integrated pest management (IPM) methods to minimise yield losses caused by weeds, diseases and insect pests.
- Conduct relevant research on post production technologies and recommend appropriate measures for grain/product quality improvement.
- Conduct diagnostic and socioeconomic studies to understand major problems and recommend appropriate measures for yield reduction.

6.3 Research Approaches

In line with the 10FYP theme of poverty alleviation, as much as possible, the research embarked will be pro-poor and participatory action oriented. The pro-poor focus will be achieved by identifying and working with remoter/ far-flung communities. Research will be based on needs needing immediate to longer term solutions involving multi-disciplinary approach to addressing field problems where needed. Participatory action research will be supported by outreach programs and adopted villages where researchers and farmers come together to single out technologies that are relevant to the locality. The current demonstration/technology parks will be strengthened to showcase by incorporating technologies that are in the pipeline and making them more farmer-friendly. Community-based approaches will be employed to wherever it will help to optimize in the management and use of resources.

6.4 Research program structure for the 10th FYP

FCRP is divided into sub-programs, projects and activities for simplicity of implementation and monitoring. The proposed projects will be of multidisciplinary nature incorporating inputs of crop breeders, agronomists, pathologists, entomologists, agricultural economists and

other relevant specialized fields. Six sub-programs on rice, maize, oilseeds, wheat, grain legumes and 'other cereals' instead of 'minor cereals' are suggested. Four sub-programs on each of the commodity are suggested (Table 4). Within the sub-programs, there are various projects aimed at addressing the identified and recognized constraints to higher production. Depending on the thematic areas and specialization, these projects are expected to be led by disciplinary scientists based at different RNRRCs under the broad guidance of the Coordinating Centre. The Field Crops Programme results matrix and the sub-programme/Project details are presented in **Annexure 1 & 2.**

The research approach will be mostly participatory action research based on needs for immediate solution of the identified field problems. Technologies that are in the pipeline will be made available through frontline demonstration/technology park and outreach programme/adopted villages approach. The basic strategy for the FRCP research is to draw as far as possible on relevant information and technology from outside Bhutan - from both the International Research Centres (IRRI, CIMMYT, ICAR etc.) as well as relevant regional and national programs. A precondition of this ability to draw on such information is having access to information and at present this is very limited especially for 'other cereals'. Exploring and building linkages with relevant international organization will be helpful in research and development of the commodities indicated. Self assessment of research studies through timed impact assessments will guide researchers in understanding the needs of the farmers and accordingly fine tune future research works to match the needs. Dissemination of semi-finished technologies through frontline demonstration, technology parks and research outreach program should continue. Similarly publications in the forms of leaflets and documents will ensure that the information is available to all the stakeholders.

Table 4: Program Structure for FCRP

Subprogram 1: Rice	**Projects**	**Responsible focal centre**
Project 1	Post production & marketing	RC-Bajo
Project 2	Crop Management	RC-Bajo
Project 3	Crop improvement	RC-Bajo
Project 4	Socio Economics Policies and Publications	RC-Bajo
Subprogram 2: Maize		
Project 1	Post production & marketing	RC-Wengkhar
Project 2	Crop Management	RC-Wengkhar
Project 3	Crop improvement	RC-Wengkhar
Project 4	Socio Economics Policies and Publications	RC-Wengkhar
Subprogram 3: Wheat		
Project 1	Post production & marketing	RC-Yusipang
Project 2	Crop Management	RC-Yusipang
Project 3	Crop improvement	RC-Yusipang
Project 4	Socio Economics Policies and Publications	RC-Yusipang
Subprogram 4: Oilseeds		
Project 1	Post production & marketing	RC-Bajo
Project 2	Crop Management	RC-Bajo
Project 3	Crop improvement	RC-Bajo
Project 4	Socio Economics Policies and Publications	RC-Bajo
Subprogram 5: Grain Legumes		
Project 1	Post production & marketing	RC-Yusipang
Project 2	Crop Management	RC-Yusipang
Project 3	Crop improvement	RC-Yusipang
Project 4	Socio Economics Policies and Publications	RC-Yusipang
Subprogram 6: Other Cereals		
Project 1	Post production & marketing	RC-Jakar
Project 2	Crop Management	RC-Jakar
Project 3	Crop improvement	RC-Jakar
Project 4	Socio Economics Policies and Publications	RC-Jakar

7 HUMAN RESOURCE DEVELOPMENT

7.1 Existing staff strength and proposed staff requirement

Human resource development is an important component of the Field Crops Research Program (FCRP), which would determine the success of the program. Although FCRP is one of the oldest programs of the Ministry of Agriculture, its staff strength is not commensurate with the given mandate and the importance of the programs. Presently there are only 6 Program and Research Officers in the FCRP who are spread in all the RNRRCs. These staffs handle several commodities and there is a lack of specialization. The existing expertise within the RNRRCs lies mainly in crop breeding and agronomy. The expertise in allied disciplines such as soils, pests, mechanization and post harvest and processing lies in organizations outside of CoRRB or the research system. Considerable time and resources are spent in sourcing such expertise to complement the ongoing research and development in FCRP. In terms of Research Assistants (RAs), there are currently 16, based in different centres and sub-centres.

In the 10FYP, additional staff, both officers and assistants, needed to be recruited to strengthen the FCRP. Additional staff are necessary to cover major agro-ecologies and the number of commodities under FCRP. It is envisaged that the major commodities of the FCRP (rice, maize, wheat, other/minor cereals, oilseeds and grain legumes) have at least one trained and dedicated staff at the scientist level, supported by adequate RAs. As such, additional 8 Research Officers and 15 Research Assistants are proposed for the 10FYP for the FCRP.

It is also strategically important to strengthen the research sub-centres at Bhur, Gelephu and Mithun, Tsirang in the 10FYP. These two sub-centres are strategically located where technological opportunity for increased production is maximum. Bhur covers the low altitude zone including the districts of Samtse and Samdrupjongkhar, besides Sarpang. Currently, the FCRP is manned by a single RA, which is grossly inadequate to cater to the research and development needs of the region. Mithun covers the mid/humid subtropical zone which is distinct and demands a different research approach. The proposed additional staff requirement takes these into consideration.

Table 5: Existing and required research staff by Centre for the FCRP

RNRRC/Sub-Centre	Existing staff strength		Additional staff in 10th FYP		ESP reqt.	Remarks
	RO	RA	RO	RA		
1. Bajothang*	5	10	6	11		From the proposed staff, ROs are distributed as: 2 for field crops; 2 for soils; 1 for FS agronomy; and 1 for WMR. Among RAs: 8 for FS sector and 4 for FCRP
1.1 Tsirang Subcentre	-	1	1	1	28	The Centre is being revived and there was no allocation of ESP in the 9th plan
2. Yusipang	2	2	-	2		
2.1 Dharla	-	1	1	1		
3. Jakar	1	2	1	2		
3.1 Tingtibi Outreach	-	-	-	1		
3.2 Bhur-SubCentre	-	1	2	3		
				-		
4. Wengkhar	1	2	1	2		
4.1 Khangma Subcentre	-	1	1	1		
4.2 Lingmethang Subcentre	-	1	-	1		
Total	9	21	13	25	28	

Note: Out of 9 existing staff at RO level, only 6 ROs are full time staff working for FCRP while rest are allied subject mater specialists who supports the Farming Systems research at the Bajo. Similarly, out of 21 RAs, only 16 are involved in FCRP full time while rest work with the FSS.

* The staff strength under existing and proposed includes staff working under Farming Systems Sector both at RO and RA levels at Bajo. For other Centres, the additional FSS staff will be accounted for by their respective centre plan.

Mithun Sub-Centre which remained non-functional since 1992 will be revived. The existing infrastructures at Mithun were rehabilitated in the 9th plan through the support of SDC/Helvetas funded Project. Few staffs have been already deployed and some research works have been also started. It is planned that in the 10th plan Mithun Sub-Centre will become fully operational to support research for the humid subtropics. In order for the centre to be fully operational, the centre will require a minimum of 28 Essential Support Personnels (ESP) to support establishment of research trials on field crops, horticulture, livestock and forestry. It is assumed that ESP staff will be made available and the centre's 64 acre area justifies for maintaining this number of ESP.

Bajothang has an allocation of 32 ESPs and there is no need for additional ESP requirement during the 10th Plan.

7.2 Staff training

Generally, MSc is recognized as the basic degree necessary to carry out any research work. Most researchers in the FCRP have this qualification, but a few existing staff and those who will join the system in the future would require to upgrade themselves. It is also foreseen that the existing RAs would have to upgrade themselves to BSc level as required by the Position Classification System (PCS) once NRTI becomes a degree college. As such, 8 BSc and 4 MSc slots are provisioned for the FCRP and for the Farming Systems Sector at Bajo in the 10FYP (Table 6).

In terms of priority, MSc programs would receive higher priority as this is a basic requirement, but PhDs should also form an essential component of an HRD strategy for a research system. With the maturity of the research system and the emerging challenges confronting research, PhD provides an opportunity to have higher competence among staff. Present day research issues need deeper knowledge and specialization to be able to come up with viable options. Scientists need PhD degree to be able to exchange and understand the information available from outside of our system. Higher degree provides the needed research knowledge/skills, introduces new methods into the research system, and can take up basic research on a specific and relevant subject. At least 3 PhDs are foreseen for FCRP in the 10FYP. Priority areas are breeding and agronomy of major commodities.

Table 6: Degree training needs for FCRP in the 10th FYP

Year	Postgraduate study			Field of study	Remarks
	BSc.	MSc.	PhD		
1	1	1	-	Agronomy/Plant Breeding	Oilseed
2	2	-	1	Agronomy/Plant Breeding/soils	Rice/maize
3	2	2	1	Agronomy/agri-economics	Rice/maize
4	2	1	-	Agronomy/plant protection	Minor cereals
5	1	-	-	Agronomy/Plant Breeding	Rice/legume
Total	8	4	2		

Besides the formal degree programs, the short-term training programs are instrumental building capacity of staff thereby improving the performance of staff. Some of the broad short-term training needs are listed below. Other relevant training needs would be identified and taken up during the course of implementation of the program.

Table 7 provides the broad area of study, the number of slots allocated and budget for human resource development for Field Crops program.

Table 7: Proposed area, slots and budget for HRD, Field Crops program

Level	Broad Field of Study	No. of slots - In-Country	No. of slots to be conducted Ex-Country			Duration (months)	Budget (Nu. Million)		Total Budget	Target Group	Priority	Budget Status
			Dev Country	South-East Asia	South Asia		In-Country	Ex-Country				
1	Rice/Maize		2			24		0.131	3.144	Sr. Resh Offcier, FC	**2**	Not committed
2	Cereals/legumes/oilseed		2			48		0.131	6.288	Resh Offcier, FC	**1**	Not committed
3	Water management/Crop Agronomy/Farming/agri systems			5		50		0.068	3.400		**1**	Not committed
5	B.Sc. Agriculture				8			0	0.000	Ras/AROs	**1**	Not committed
5	B.Sc. Agriculture	**10**						0	0.000		**1**	Not committed
7	Cereals/legumes/oilseed			11		8.25		0.428	3.531	Filed Crops Resh Staff	**1**	Not committed
8	Conference/Seminar/workshop/study tour			10		2.5		0.293	0.733		**3**	Not committed
	Total								**17.096**			
	Total (4RCs+ISC+HQ)								**100.066**			

Training Code

1 = Ph.D/ Specialization after Masters
2 = Masters
3 = Post Graduate Diploma
4 = Post Graduate Certificate
5 = Bachelors
6 = Diploma
7 = Short-term Course
8 = Special Training Arrangement (mentoring/attachment/on-the-job training)

- Plant genetic resources
- Oilseed agronomy and breeding
- Legume agronomy and breeding
- On-farm research/Participatory technology development

- Survey design and analysis
- Project proposal development
- Identification of research needs
- Participatory plant breeding
- Farmers' need assessment
- Crop breeding/ agronomy (rice, wheat, maize, oilseed, legumes, minor cereals)
- Experimental design and analysis
- Organic/ Sustainable agriculture
- Scientific writing
- Plant protection
- Nutrient management
- Water management
- Agriculture economics
- Research planning and management
- Soil improvement
- Research proposal development
- Inter/multi disciplinary research
- Gender analysis
- Watershed management
- Community-based Natural Resource Management
- Integrated rural development

8 INFRASTRUCTURE AND FACILITIES

All the RNRRCs have reasonably good infrastructures already in place or in the pipeline for conducting research, including fields, modest laboratories and working space for researchers. It is also assumed that the future requirements for FCRP are inbuilt within the Master Plans of the RNRRCs, as the program implementation takes place through the regional RCs. To function optimally, the focal centres and the various test locations should have adequate facilities.

Most major infrastructure requirements have been fulfilled during the 9FYP, including the construction of office building-cum-laboratory at Bhur and the renovation of the Mithun sub-centre at Tsirang. However, the office building at Mithun is old, small and inadequate to suffice future needs. In view of this, a new office building cum meeting hall is proposed for Mithun in the 10 FYP. There should also be some provision for acquiring field and laboratory equipment, both replacement and new as needs emerge, for smooth running of the planned activities. Past experiences have shown that the provision of pool vehicles is important for the researchers to go beyond the station into farmers' fields in identifying research needs, taking materials and ideas into farmers' fields, and in providing necessary backstopping to extension staff.

The following capital works are proposed to be taken up during the 10 FYP period.

1. Construction of new office cum meeting hall at Mithun, Sub-Centre in Tsirang
2. Soling and blacktopping of approach road to Mithun Sub-Centre
3. Resurfacing of parking area and approach road to RC Bajothang
4. Concrete lining of drainage networks within the RC Bajo area (3 different sections)
5. Fencing on eastern boundary of the Centre's research area
6. Field and laboratory equipment
7. Purchase 2 nos. of Pool vehicles

9 PROGRAM PLANNING AND IMPLEMENTATION

The 10 FYP Strategy for Field Crops will provide broad guidelines and directions for FCRP. The annual program planning will be based within this framework and the emerging issues and research needs from the field. The annual National Field Crops Workshop provides the forum for review and planning of the research activities where researchers from all the RCs and allied organizations including the field extension participate. The workshop is coordinated by RNRRC Bajo.

9.1 Implementation methods/mechanism

Nationally coordinated from RNRRC Bajo, the FCRP will be implemented through the regional RNRRCs and their sub-centres. For effective implementation, the focal centres and test locations have been identified, matching the agroecological conditions and the maximum potential of a given commodity (Table 8). The focal centres would serve as focal points for technical matters concerning the assigned commodity. The focal centres would ensure implementation of the planned activities and provide progress and other reports as necessary.

9.2 Reporting

In addition to other reports, the FCRP will prepare periodic Program Reports, twice in a plan period, highlighting the progress of the program. A mid-term review of the program will be held halfway through the 10FYP reviewing resource allocations and technical progress and may propose changes in program content and objectives where appropriate.

A review of the FCRP will be made at the end of the 10FYP on resource allocations, technical outputs and outcomes from the FCRP. Such reviews and the field level assessment will provide the basis for the preparation of the FCRP for the next FYP. Some important reporting instruments will be the biennial program report, mid-term report, final review report and other periodic reports.

Table 8: Field Crops Program Implementation Framework

Commodity	Focal Centre	Main Test Location	Agro-ecological Zone	Lead RNRRC
Rice	Bajo	Wangdue Thimphu/Paro Tsirang/Chukha Bhur	Dry subtropical Warm temperate Humid subtropical Wet subtropical	Bajo Yusipang Bajo/Mithun Bhur/Jakar
Maize	Wengkhar	Khangma Pemagatsel Bumthang Bhur	Dry subtropical Humid subtropical Cool temperate Wet subtropical	Khangma Khangma Jakar Bhur/Jakar
Wheat	Bajo	Bajo, Wangdue Bumthang	Dry-subtropical Spring; irrigated Cool temperate Winter; rainfed	Bajo Jakar
Minor Cereals Millet Barley/Buck-wheat	Wengkhar Jakar	 Weng/Pemagatsel Bumthang	 Dry subtropical Cool temperate	 Khangma Jakar
Oilseeds	Bajo	Bajo Wengkhar Bumthang Bhur	Dry sub (irrigated) Dry sub (rainfed) Cool temperate Wet subtropical	Bajo Khangma Jakar Bhur/Jakar
Grain legumes	Khangma	Bajo Wengkhar Bhur Bumthang	Dry subtropical Dry subtropical Wet subtropical Cool temperate	Bajo Khangma Jakar Jakar

Note :
Focal Centre: Focal point pertaining to technical matters concerning the assigned commodity. Communicates with other RNRRCs and ensure implementation of planned activities in all the regions.
Lead RNRRC: Leads the program for the assigned AEZ and commodity in collaboration with the Focal Centre. Arranges and coordinates trial/test kits, data analysis and reports.
Main Test Location: Primary site to conduct station-level experiments

10 MONITORING AND EVALUATION

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The 10FYP research strategy for agriculture of CoRRB will provide the overall framework for the management of the FCRP. A detailed monitoring and evaluation framework for FCRP programme has also been developed (Annexure 3).

The FCRP coordinator will make visits to the RNR-RCs twice a year to review the progress on implementation of the agreed activities under the FCRP. An annual meeting of the FRCP will be held to review the annual national program, to develop the coordination mechanisms and to plan implementation of activities in the coming year. The coordinating centre and the focal centres will work in close collaboration with the centrally executed programs and projects drawing in their expertise and experience.

11 BUDGET REQUIREMENT FOR THE 10TH PLAN

The present budgeting system followed by RGoB or MoA allocates resources for the Centre as a whole and provides little flexibility for program budgeting. It is therefore felt that it will be futile to attempt to allocate resources among sub-programs and projects within the FCRP. While the program budgeting will be very crucial to do financial resource allocation by sub-programs and projects to emphasise their relative importance and use of resources more efficiently, the national budgeting system needs to be realigned to allow this.

As in the previous plans, it is expected that RGoB will continue to provide the recurrent costs in addition to funding of selected capital works for the FCRP. Under the current budgeting practice, the respective RNRRCs are responsible to budget for the FCRP for their region based on the FCRP implementation framework. The program will source funds for technical assistance for the FCRP from various ongoing and future projects.

For the RNRRC Bajo which has a mandate for the West-Central Region, the proposed 10th Five Year Plan Outlay is **Nu.130.82m** (Table 9). Its allocation by sub-programme is in **Annexure 4**. The plan outlay is in keeping with the Guidelines for Preparation of the Tenth Plan from Planning Commission and the program priorities drawn up for both the national and regional mandates of the Centre. The SDC/Helvetas has been the major donor supporting the FCRP in the 9th Plan. It is very unlikely that same donor support will continue in the 10th Plan. Under such circumstances it is understood that that the total Plan Outlay will have to be funded by RGoB. Notwithstanding, the Centre will make every effort to seek donor fund support particularly for capital works.

Table 9: Estimated 10th Plan Outlay for RNRRC Bajo

Budget Head	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	
HRD						
TA	0.000	1.000	1.000	1.000	0.000	
Infrastructure	3.000	6.100	2.100	1.500	0.000	
Total	**3.570**	**7.100**	**3.100**	**2.500**	**-**	
Personnel emolument	5.982	6.000	6.100	6.300	6.500	
Othe Pers emolument	1.223	1.223	1.223	1.223	1.223	
Operational cost	18.050	14.010	14.490	15.400	16.190	
Total	**25.250**	**21.230**	**21.813**	**22.923**	**23.913**	
G. Total	**28.250**	**28.330**	**24.910**	**25.423**	**23.913**	**130.820**

At the national level, the allocation of resources between the four programs (Field Crops, Horticulture, Livestock and Forestry) is based on the importance of the program (Table 10). The Field Crops program receives 24% of the total allocation.

Table 10: Program-wise and centre-wise resource allocation for 10FYP.

	Budget (Nu. In Million)					
	Yusipang	Bajo	Jakar	Wengkhar	Program Budget	% for Program
Forestry Research	52.58	6.55	19.62	7.75	86.50	16%
Field Crops Research	26.29	52.36	19.62	31.01	129.28	24%
Livestock Research	13.15	13.09	52.33	7.75	86.32	16%
Horticulture Research	26.29	32.73	26.16	62.02	147.20	27%
RNR Systems Program	6.57	19.64	6.54	23.26	56.01	10%
RCO	6.57	6.55	6.54	23.26	42.92	8%
Centre Budget	131.45	130.90	130.82	155.05	548.22	100%
Annual Allocation for centre (Nu. Million)	26.29	26.18	26.16	31.01		
% Centre	24%	24%	24%	28%		
% of overall budget						

Apart from the National Mandate, the RC Bajo has the regional mandate to support RNR Extension Agents and farmers of Gasa, Punakha, Wangdue, Tsirang and Dagana Dzongkhags. To deliver the regional mandate, the Centre is organized into six sectors/programs – the Field crops, Horticulture, Livestock, Forestry, Natural Resources, and the Communications sector. Within the regional programs, the financial resources are allocated as below. The proportionate allocation is in keeping with the 10th plan objectives of improving food security and income of the farming communities.

Field crops	: 40.0%
Horticulture	: 20.0%
Livestock	: 10.0%
Forestry	: 5.0%
Farming System and Support Services	: 20.0 %
Research Communication	: 5.0%

12 ANNEXURES

Annexure 1: Field Crops Research Program Matrix for 10FYP

Result level	Indicator description	Baseline indicator	FYP targets	Link to DoA/MoA 10FYP targets
Impact: Increased self-sufficiency in food grains	Proportion of population self sufficient	50% of rural hhs self-sufficient (RNR 2000)	5% increase by 2013	
Outcome 1: Increased crop production	Total production	Rice: 54325 t, Maize: 90566, Wheat: 4191, Mustard: 1767 (DoA, 2004)	Increase in total aggregate production by at least 10%	
Output 1.1: Improved crop varieties made available to farmers	No of high yielding varieties of cereals, oilseeds and legumes	24 improved varieties of field crops	At least 6 new varieties developed	
Output 1.2: Local varieties conserved and improved	No of local germplasm conserved.	400 local rice varieties collected/conserved	At least 100 more local varieties of field crops conserved	
Output 1.3: Soil fertility improved for higher production	Proportion of hh practicing balanced nutrient mgt	1 % of total farming hh practice balanced nutrient management	Increased by at least 5 %	
Output 1.4: Pest management practices adopted	% pest incidences and crop loss	Generally, 10-15% crop loss	Crop loss reduced by 5%	
Output 1.5: Better water management and water availability for crops	No of irrigation schemes with low conveyance loss	20-30% conveyance loss	Conveyance loss reduced by 10% at least in 2-3 schemes	
Outcome 2: Improved post production technologies and market mechanisms	No of post production technologies; no of market outlets	Limited or none post production technologies; no organized marketing for food grains	At least 5 post production technologies; 3-5 market outlets	

Output 2.1: Technologies made available to reduce losses	Proportion of hh using post harvest technologies	Less than 1% use technologies to reduce losses	5% rural households use improved technologies	
Output 2.2: Quality of grains and other products improved	No of improved processing equipment in use	Nil improved rice milling machines	At least 10 improved rice mills	
Output 2.3: Improved market mechanisms and linkages	No of entrepreneurs and middlemen in cereal marketing	Nil or few entrepreneurs involved in internal marketing	At least 10-20 entrepreneurs and middlemen	
Outcome 3: Improved understanding of socioeconomic issues and information availability	No of baseline surveys and information documentation	3 baseline surveys done, limited documentation	5 studies conducted and written up	
Output 3.1: Diagnostic studies done	No of studies	10 studies done	5 more studies conducted	
Output 3.2: Impact assessment studies done	No of impacts studies	Only 2 major impact studies done	2 studies done	
Output 3.3: Technologies packaged for users	No of technologies packaged	25 number of extension materials	15 research technologies packaged and disseminated	

Annexure 2: Subprogram, project and other details of FCR for 10FYP

Sub-program/ project	Impact/output/ outcome	Program/ project type	Geographical coverage/ Beneficiaries	Start date	End date	Lead agency	Collaborating agencies
1. Rice							
1.1 Post production and marketing	**Impact** : 1. Increased self-sufficiency in food grains **Outcome**: 2. Improved post production technologies and market mechanisms **Output**: 2.1. Technologies to reduce losses made available 2.2. Quality of grains and other products improved 2.3. Improved market mechanisms and linkages	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Bajo	NPHC, AMC, AMS, NPPC, DoA, MoA, Dzongkhags
1.2 Crop management	**Impact**: 1. Increased self-sufficiency in food grains **Outcome**: 1. Increased crop production **Output**: 1.3. Soil fertility improved for higher production 1.4. Pest management practices adopted 1.5. Better water management and water availability for crops	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Bajo	NSSC, AMC, NPPC, DoA, MoA, Dzongkhags
1.3 Crop improvement	**Impact**: Increased self-sufficiency in food grains **Outcome**: Increased crop production **Output**: 1.1. Improved crop varieties available to farmers	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Bajo	NSSC, NPHC, NPPC, DoA, MoA, Dzongkhags

	1.2. Local varieties conserved and improved						
1.4 Socio-economics, policies and publications	**Impact**: Increased self-sufficiency in food grains **Outcome**: Improved understanding of socioeconomic issues and information availability **Output**: **3.1**: Diagnostic studies done **3.2**: Impact assessment studies done **3.3**: Technologies packaged for users	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Bajo	ICS, DoA, MoA, Dzongkhags
2. Maize							
2.1 Post production and marketing	**Impact** : Increased self-sufficiency in food grains **Outcome**: Improved post production technologies and market mechanisms **Output**: **2.1.1**. Technologies to reduce losses made available **2.1.2**. Quality of grains and other products improved **2.2.3**. Improved market mechanisms and linkages	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Wengkhar	NPHC, AMC, AMS, NPPC, DoA, MoA, Dzongkhags
2.2 Crop management	**Impact**: Increased self-sufficiency in food grains **Outcome**: Increased crop production **Output**: **2.2.1**. Soil fertility improved for higher production **2.2.2**. Pest management practices adopted **2.2.3**. Better water management and water availability for crops	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Wengkhar	NSSC, AMC, NPPC, DoA, MoA, Dzongkhags

2.3 Crop improvement	**Impact**: Increased self-sufficiency in food grains **Outcome**: Increased crop production **Output**: **2.3.1**. Improved crop varieties available to farmers **2.3.2**. Local varieties conserved and improved	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Wengkhar	NSSC, NPHC, NPPC, DoA, MoA, Dzongkhags
2.4 Socio-economics, policies and publications	**Impact**: Increased self-sufficiency in food grains **Outcome**: Improved understanding of socioeconomic issues and information availability **Output**: **2.4.1**: Diagnostic studies done **2.4.2**: Impact assessment studies done **2.4.3**: Technologies packaged for users	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Wengkhar	ICS, DoA, MoA, Dzongkhags
3. Wheat and Other Cereals							
3.1 Post production and marketing	**Impact** : Increased self-sufficiency in food grains **Outcome**: Improved post production technologies and market mechanisms **Output**: **3.1.1**. Technologies to reduce losses made available **3.1.2**. Quality of grains and other products improved **3.1.3**. Improved market mechanisms and linkages	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Yusipang and Jakar	NPHC, AMC, AMS, NPPC, DoA, MoA, Dzongkhags
3.2 Crop management	**Impact**: 1. Increased self-sufficiency in food grains **Outcome**: 1. Increased crop	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Yusipang and Jakar	NSSC, AMC, NPPC, DoA, MoA,

	production **Output**: 1.3. Soil fertility improved for higher production 1.4. Pest management practices adopted 1.5. Better water management and water availability for crops						Dzongkhags
3.3 Crop improvement	**Impact**: Increased self-sufficiency in food grains **Outcome**: Increased crop production **Output**: 1.1. Improved crop varieties available to farmers 1.2. Local varieties conserved and improved	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Yusipang and Jakar	NSSC, NPHC, NPPC, DoA, MoA, Dzongkhags
3.4 Socio-economics, policies and publications	**Impact**: Increased self-sufficiency in food grains **Outcome**: Improved understanding of socioeconomic issues and information availability **Output**: **3.1**: Diagnostic studies done **3.2**: Impact assessment studies done **3.3**: Technologies packaged for users	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Yusipang and Jakar	ICS, DoA, MoA, Dzongkhags
4. Oilseeds							
4.1 Post production and marketing	**Impact** : 1. Increased self-sufficiency in food grains **Outcome**: 2. Improved post production technologies and market mechanisms **Output**: 2.1. Technologies to reduce losses made available 2.2. Quality of grains and other	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Bajo	NPHC, AMC, AMS, NPPC, DoA, MoA, Dzongkhags

	products improved 2.3. Improved market mechanisms and linkages						
4.2 Crop management	**Impact**: 1. Increased self-sufficiency in food grains **Outcome**: 1. Increased crop production **Output**: 1.3. Soil fertility improved for higher production 1.4. Pest management practices adopted 1.5. Better water management and water availability for crops	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Bajo	NSSC, AMC, NPPC, DoA, MoA, Dzongkhags
4.3 Crop improvement	**Impact**: Increased self-sufficiency in food grains **Outcome**: Increased crop production **Output**: 1.1. Improved crop varieties available to farmers 1.2. Local varieties conserved and improved	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Bajo	NSSC, NPHC, NPPC, DoA, MoA, Dzongkhags
4.4 Socio-economics, policies and publications	**Impact**: Increased self-sufficiency in food grains **Outcome**: Improved understanding of socioeconomic issues and information availability **Output**: **3.1**: Diagnostic studies done **3.2**: Impact assessment studies done **3.3**: Technologies packaged for users	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Bajo	ICS, DoA, MoA, Dzongkhags
5. Grain Legumes							
5.1 Post production and	**Impact** : 1. Increased self-sufficiency in food grains	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Wengkhar/	NPHC, AMC, AMS, NPPC,

marketing	**Outcome**: 2. Improved post production technologies and market mechanisms **Output**: 2.1. Technologies to reduce losses made available 2.2. Improved quality of grains and other products 2.3. Improved market mechanisms and linkages					Yusipang	DoA, MoA, Dzongkhags
5.2 Crop management	**Impact**: Increased self-sufficiency in food grains **Outcome**: Increased crop production **Output**: **5.2.1**. Soil fertility improved for higher production **5.2.2**. Pest management practices adopted **5.2.3**. Better water management and water availability for crops	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Wengkhar/ Yusipang	NSSC, AMC, NPPC, DoA, MoA, Dzongkhags
5.3 Crop improvement	**Impact**: Increased self-sufficiency in food grains **Outcome**: Increased crop production **Output**: **5.3.1**. Improved crop varieties available to farmers **5.3.2**. Local varieties conserved and improved	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Wengkhar/ Yusipang	NSSC, NPHC, NPPC, DoA, MoA, Dzongkhags
5.4 Socio-economics, policies and publications	**Impact**: Increased self-sufficiency in food grains **Outcome**: Improved understanding of socioeconomic issues and information availability **Output**: **5.4.1**: Diagnostic studies done **5.4.2**: Impact assessment studies	Non-infrastructure	Nationwide Farmers	July 2008	June 2013	RC Wengkhar/ Yusipang	ICS, DoA, MoA, Dzongkhags

	done **3.3**: Technologies packaged for users						
6. Infrastructure and HRD							
6.1 Office construction, Mithun	**Impact**: Improved organizational capacity **Outcome**: Efficient working condition **Output**: Office-cum meeting hall	Infrastructure	Mithun sub-centre, Tsirang	July 2008	June 2010	RC Bajo	Donors
6.2 Approach road soling/ blacktopping, Mithun and Bajo	**Impact**: Improved organizational capacity **Outcome**: Improved access **Output**: Soled and blacktopped road to the offices	Infrastructure	Mithun, Bajo	July 2008	June 2010	RC Bajo	Donors
6.3 Drain construction, fencing, resurfacing parking area, Bajo	**Impact**: Improved organizational capacity **Outcome**: Improved infrastructure **Output**: Proper drainage and fencing in place	Infrastructure	RC Bajo	July 2008	June 2010	RC Bajo	Donors
6.4 Human resource development (BSc : 8 MSc : 4 PhD : 3 Short courses: 40-50)	**Impact**: Organisational capacity enhanced **Outcome**: Individual capacities enhanced **Output**: Trained and skilled staff	Non-infrastructure	All RCs and all Field Crops related staff; ROs and RAs	July 2008	June 2013	RC Bajo	Donors
6.5 Purchase of pool vehicle (2 nos); lab equipment	**Impact**: Improved organizational capacity **Outcome**: Better mobility **Output**: Improved reach	Infrastructure	RC Bajo, Mithun	July 2008	June 2013	RC Bajo	Donors

Annexure 3: Monitoring and Evaluation of Field Crops program

Result level	Indicators	Baseline	Target	Data source	Reporting frequency	Responsibility	Report to
Increased crop production	Total production	Rice- 54325 T Maize- 90566 Wheat – 4191 Mustard- 1767	Increase by 10%	DoA statistics	Annual	RCs, Dzongkhag Extension	CoRRB DoA
Improved crop varieties	No. of HYVs of cereals, oilseeds & legumes	24 varieties (2006)	6 new varieties	VRC records	Every 2 years after	RCs	CoRR`B
Local varieties conserved	No of local varieties conserved	400 rice varieties	100 local varieties	RCs, NBC	Biennial	RCs NBC	CoRRB
Improved fertility management	Proportion of hh practicing balanced nutrient management	1 % of hh using balanced nutrient management	Increase by at least 5 %	DoA/NSSC records	Biennial	RCs, NSSC Dzongkhag	CoRRB
Better pests management	% pest incidence & crop loss	10-15% loss	Loss reduced by 5%	DoA/NPPC records	Twice in 10 FYP	RCs, NPPC, Dzongkhag	CoRRB
Efficient water management	No of irrigation schemes with low conveyance loss	20-30% conveyance loss	Loss reduced by 10%	Irrigation records	Annual	RC, DoA, Dzongkhag	CoRRB
Post-production and marketing	No of post production technologies, no of market	Limited or none post production technologies, no organized	5 post production technologies,3-5 market	RC, NPHC, AMC	Annual	RC, NPHC, AMC, DoA, Dzongkhag	CoRRB

	outlets	markets	outlets				
Reduced post harvest losses	Proportion of hh using post harvest technologies	Less than 1% use technologies to reduce losses	5% of rural hh use improved technologies	RCs, NPHC, AMC	Every 2 years	RC, NPHC, AMC, DoA, Dzongkhag	CoRRB
Improved grain quality and other products	No of processing equipment	Nil improved rice mills;	At least 10 improved rice mills and ….tengma and packaging machines	AMC, DoA, RCs	Biennial	RC, NPHC, AMC, DoA, Dzongkhag	CoRRB
Functional market linkages	No of entrepreneurs & middleman in cereal marketing	Nil or few entrepreneurs in internal marketing	At least 10-20 entrepreneurs and middleman	AMS, MoA, RCs	Biennial	RC, AMS, MoA, Dzongkhag	CoRRB
Improved understanding of socioeconomic issues	No of baseline surveys	3 baseline surveys	5 baseline surveys	RCs, CoRRB	Biennial	RCs, DoA, Dzongkhags	CoRRB
Diagnostic studies done	No of studies	10 studies	5 studies	RCs, CoRRB	Biennial	RCs, DoA, Dzongkhags	CoRRB
Impacts assessed	No of impact studies	2 major studies	2 studies	RCs, DoA, CoRRB	End of plan period	RCs, DoA, Dzongkhags	CoRRB
Technologies packaged for users	No of technologies packaged	25 extension materials	15 research technologies packaged & disseminated	RCs, ICS CoRRB	Annual	RCs, ICS, DoA, Dzongkhags	CoRRB

Annexure 4: Programme Budget Summary for 10 FYP

Project/Component	Estimated Budget Requirements (Nu. in million)			Funding Source	Funding Type	Remarks
	Recurrent	Capital	Total			
Field Crops Program						
Post-production and Marketing (Rice/Maize/Wheat and Other cereals/Oilseeds/Grain Legumes)	18.100	-	18.100	RGoB		Ongoing
Crop Management (Rice/Maize/Wheat and Other cereals/Oilseeds/Grain Legumes)	18.100	-	18.100	RGoB		Ongoing
Crop Improvement (Rice/Maize/Wheat and Other cereals/Oilseeds/Grain Legumes)	9.050	-	9.050	RGoB		Ongoing
Socio-economics, policies and publications (Rice/Maize/Wheat and Other cereals/Oilseeds/Grain Legumes)	18.100	-	18.100	RGoB		Ongoing
RNR Systems Program						
Organic Farming	4.525		4.525	RGoB		Ongoing
Farming Systems	22.626		22.626	RGoB		New
CBNRM	4.298	1.575	5.870	IDRC-Canada		Ongoing ; till 2008 Dec.
Infrastructure Development	-	12.700	12.700	??		New
Human Resource Developemnt	-	28.85	28.85	??		New
Total	**94.799**	**43.125**	**137.924**			