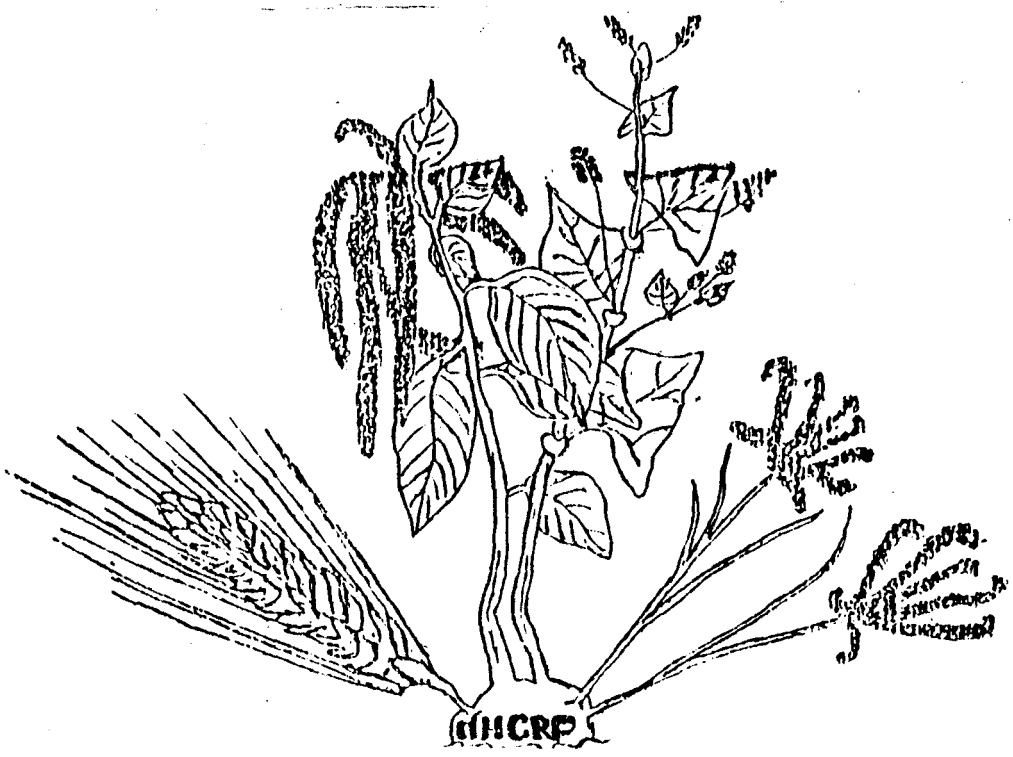
FINAL TECHNICAL REPORT
(July 16, 1988 - July 15, 1991)

OF

NATIONAL HILL CROPS RESEARCH PROGRAM



His Majesty's Government of Nepal
Ministry of Agriculture
Nepal Agricultural Research Council (NARC)
National Hill Crops Research Program (NHCRP)

Kabre Agricultural Farm, Dolakha, Janakpur Zone, Nepal
And
International Development Research Centre (3P-87-0021)

September, 1991

FOREWORD

The first phase of support to National Hill Crops Research Program (NHCRP) from IDRC, Canada started July 16, 1988 and completed successfully in July 15, 1991. It is my great pleasure to mention that IDRC has already agreed to provide fund for the second phase of three years period. Continuation of IDRC in this second phase indicates that IDRC was satisfied with the progress of first phase. This continued support is very much appreciated by NHCRP.

In this final Technical Report efforts are made to summarize the progress made in the fields of institutional and technical aspects of NHCRP as per the objectives mentioned in the project documents and the guidelines provided by IDRC personnel. This report contains the overall trend of hill crops production during the past four years, institutional development, staffing, collaboration with national and international organizations, findings, publications, and other subjects related to hill crops. The findings and recommendations of different workshops and surveys also are presented for reference.

The aim of this report is to provide general informations about the progress and findings on hill crops during the project period. It is expected that this summary report will be useful mainly to policy makers and planners as well as to some extent it may be useful to the concerned scientists too.

NHCRP is grateful to National AGricultural Research Centre's (NARC) personnel and all other persons working in the testing sites. All the staff of NHCRP Headquarters and liaison office at Khumaltar also are greatly appreciated for their sincere cooperation and works. Dr. K.W. Riley, Advisor, IDRC/NHCRP deserves special thank for providing valuable helps and supports during this phase. These are the people who made this program a success.

On the behalf of program and personally also I would like to extend my sincere thank to IDRC, Canada for providing different types of supports in the first phase to this program. I like to take this opportunity to request for long term and somewhat bigger project in future.

September, 1991.

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Highlights of NHCRP Achievements of Phase I

NHCRP is working on the finger millet, barley, buckwheat and grain amaranth as its mandate crops. These traditional crops are mainly grown in hills and have high scope to improve in hill agricultural systems and support the rising population in this region.

The summary of achievements during the first phase of the project are as follow:

1) During three year the production of finger millet and barley increased by 54 and 15 percent respectively, and that of buckwheat also had increased substantially.

2) A strong, coordinated multi-disciplinary NHCRP has been established with its headquarters, liaison office and establishment of some physical infrastructures. Strong research collaboration has been established with different testing sites, central divisions located at Khumaltar, NGO's, HMG/N other organizations. And a close linkage has also been established with different international organizations and some universities.

3) National Agriculture Research Centre (NARC), the parent organization of NHCRP, was approved as an autonomous organization for agricultural researches in Nepal. More flexibility is expected to work and the congenial research environment is being created.

4) Although the required numbers of staff was not deputed for this program, the existing staff were locally trained, some got training abroad, four temporary people were added and some local people also were trained.

5) A hill crops working group consisting people from different testing sites and divisions had been established, it met twice a year to review and plan the researches, and the same group took part in different types of tours and visits. Two special training/workshops one each on finger millet and barley were organized. The findings and recommendations of workshops were incorporated in over all planning of hill crops.

6) The varietal improvement of hill crops was started systematically by collection, selection and breeding. Germplasm of different hill crops had been collected from many sources. They were characterized and used for further development. The available materials were evaluated in different trial sets in different locations and selection was done by establishing the selection criteria. The promising cultivars had been tested at farmer's condition across Nepal. Breeding works on finger millet, barley and

buckwheat had been started. Finger millet variety Kabre Kodo-1 and barley variety Solu-Uwa, had been released, and many promising lines are in the pipe line for release.

7) The major diseases and insects of hill crops had been identified and a number of cultivars were found either immune or resistant to major diseases, and some control methods also were established. Not much works were done on insects due to lack of manpower.

8) Some technologies were developed on the date of sowing, plant population, fertilizer doses and experimental design on hill crops. The findings on agronomical aspects have direct effects on the production in the farmer's conditions.

9) The available hill crops technologies were transferred to general farmers by the program itself; and with the help of district based extension agents and other organizations. Now, Nepalese farmers are more aware about hill crops and they are demanding seeds of these crops.

10) Several monitoring tours, rapid rural appraisal treks and two special surveys were organized. These types of activities proved great help to understand the actual field conditions, farmer's needs, formulate research plans and approaches.

11) NHCRP had published 41 reports on different tour/visit surveys proceeding, annual and other reports; and limited copies were distributed to different people.

12) The equipments received through IDRC fund for local travel and working group research allocation and advisor proved very much useful to make the first phase an effective and fruitful.

FINAL TECHNICAL REPORT - PHASE I

(July 16, 1988 to July 15, 1991)

Introduction

Over half of Nepal's population of about 10 million people live in the hills and mountains. Over 90% of these people are directly dependent on agriculture, but in hills and mountains all most all people depend on agriculture only. Although the history of agriculture research in Nepal has been very short, the majority of research was concentrated in the southern plain of Nepal and, little attention was paid to research problems in hills until recently. This resulted no technology in the hills and consequently the productivity of major food crops declined in the hills and food deficit problem was faced in 47 districts out of 55 hilly districts of Nepal, and people started to migrate to other parts from hills.

Nepalese government realized this problem, and started to initiate agriculture researches in hill during early eighties. National Hill crops Research Program (NHCRP) was the out come of this shift of government policy to start work in hills too. NHCRP was established in 1986/1987 (July 16, 1986) with finger millet, barley, buckwheat and grain amaranths as its mandate crops and they have potential for more food production in the hilly regions of Nepal. After the establishment of NHCRP, Agricultural Research and Production Project (ARPP/USAID/N[illegible] provided different supports for two years, and from fiscal year 1988/1989 (July 16, 1988) IDRC, Canada started supporting this program in the phasewise way. The first phase of 3 years was completed in July 15, 1991. In this final technical report, efforts will be made to highlight the administrative aspects and research findings from the commencement to completion of the first phase as per mentioned in the IDRC guidelines, and stick with the objectives mentioned in the MGC.

Objectives of the Project

The objectives of project specified in the Memorandum of Grant conditions are as follow:

The overall objective of the research project was to establish a hill crop improvement program to increase and sustain production and productivity of neglected hill cereals

Specific Objectives

Institutional Develoment

a. To carry out effective improvement of finger millet, buckwheat, barley and amaranth in Nepal through the development of a coordinated multidisciplinary hill crops

improvement program,

b. To recruit and train sufficient staff to make this program effective,

c. To establish a hill crop working group to review and plan hill crop research.

Technical Development

d. To develop improved varieties of hill crops through collection, selection and in some cases breeding,

e. To identify the most serious pests and diseases of hill crops and develop effective control measures, with emphasis on developing genetic resistance,

f. To develop the most appropriate production practices for hill crops for the varied agro-ecological conditions where these crops are grown,

g. To collaborate with farming systems and other agencies in order to identify research problem, develop appropriate hill crop varieties and production practices, and ensure that improved technology and seed reaches the farmers,

h. To carry out surveys on the importance of hill crops so as to gain a better understanding of the needs of hill farmers.

Achievements

Efforts were made to achieve the above objectives since the establishment of this program, and the process was accelerated after IDRC, Canada started funding in 1988.

With respect to the main objective, the National Hill Crops Research Program was recognized as a national coordinated research program and at national level the area, production, and productivity of finger millet had increased by 21, 54 and 28 percent respectively in three years and that of the barley were 2, 15, and 3 percent only. But the picture is not clear for buckwheat and grain amaranths, because there is no reliable source for statistical data of these two crops. The national figures are as follow:

Table 1. Area, Production and Productivity of finger Millet and Barley

Crop	Fiscal Year				Percent change in 3 Yr
	1987/88	1988/89	1989/90	1990/91	
Finger Millet					
Area (ha)	164770	182560	193490	198570	21
Production (mt)	150130	183090	224780	231630	54
Productivity (mt/ha)	0.9112	1.0029	1.1617	1.1665	28
Barley					
Area (ha)	29110	29450	29540	29610	2
Production (mt)	24290	27020	27390	27840	15
Productivity (mt/ha)	0.8344	0.9175	0.9272	0.9402	13

The initial estimate of area and production of buckwheat were 43,000 ha and 23,100 mt, respectively, and that of grain amaranths were 8250 ha and 7,000 mt in 1986. However, there is every indication that the area and production of buckwheat had been increased substantially, and nothing is known about grain amaranth.

The area, production and productivity of hill crops are increasing in the faster rate in the hill and mountain and there is trend of decreasing area of finger millet in plain area.

Thus as per the main objective of NHCRP is concerned, NHCRP has been established and more food is being produced in the hill after commencement of the project in 1988.

Objective a: To carry out effective improvement of finger millet, buckwheat, barley and amaranth in Nepal through the development of a coordinated multidisciplinary hill crops improvement program.

In the past three years, NHCRP had gained maturity as a full-fledged multi-disciplinary National Coordinated Research Program with its headquarters and testing sites across Nepal. A strong collaboration had been established with different research stations, central disciplinary divisions and NGO;s working in Nepal. Similarly, HMG/N organizations other than under Ministry of Agriculture and foreign aided projects were in close collaboration with NHCRP. Again a close linkage has been established with different Indian, USA, Canadian, Andean countries, and International organizations such as ICARDA/CIMMYT, ICRISAT, ICIMOD etc. and Asian Development Bank.

Table 2. Collaborative Hill Crops Research Stations

Development Region	High hills	Mid hills	Terai, Inner Terai and Valley
Eastern	-	Pakhribas	Terai
Central	Kakani	Kabre & Khumaltar	Rampur
Western	Marpha	Lumle	Khairanitar
Mid-Western	Jumla & Dolpa	-	Surkhet
Far-Western	-	-	Doti

Khumaltar has eight disciplinary divisions and testing sites.

The National Agricultural Research Centre (NARC) had received final approval as the autonomous organization responsible for agricultural research in Nepal. This break through was a great turning point in the history of agricultural research in Nepal. It has entrusted with a lot of flexibility in administration, personal management and working conditions, and it is expected that a congenial research environment will be created for scientists to work with. As NHCRP and other cooperating sites fall directly under NARC, this shift in policy has resulted many positive changes.

Objective b: To recruit and train sufficient staff to make this program effective.

When the program was started in 1986, there was no manpower at all and few temporary persons ran the program from Khumaltar. By 1987, partial manpower of Kabre Agricultural Farm, Dolakha was allotted to NHCRP. Recently NHCRP was fully authorized to use all 26 manpower and other resources of this farm and this farm has been recognized as the headquarters of this program. There is some improvement in the staff situation after the project started in 1988. The staffing situations of NHCRP Headquarters and other stations are divisions is presented in Table 3, 4, 5, and 6.

But the lack of staff remains a severe constraint in the development of this program. At present, a group of 26 permanent staff and 4 temporary people are responsible to run the national program of the four hill crops. Present scientific staff stands at 6 gazetted officers and 19 non-gazetted technicians and 5 administrative staff. Thus, during the first three years of IDRC support, three temporary junior technicians and one gazetted assistant agronomist were employed by this program. Similarly, four local high school graduates also were trained to handle the technical works. Based on the agreement NHCRP was supposed to have 8 gazetted officers, 17 technicians and 10 administrative staff.

In spite of staff shortage, NHCRP personnel received training on finger millet and barley both in Nepal and abroad. This has been great help to start research in the new areas of hill crops

improvement and to improve the quality of research.

Table 3. **Staff at NHCIP, Kabre**

S.N.	Post	Name	Class	Remarks
	Technical staff			
01.	Chief Officer	Vacant	Gaz. I	
02.	Deputy Production Officer	Bimal K. Baniya	Gaz. II	
03.	Asst. Agronomist	Kishor K. Sherchand	Gaz. III	
04.	Asst. Plant Pathologist	R.C. Prasad	Gaz. III	
05.	Asst. Agronomist	K.N. Adhikari	Gaz. III	Study leave
06.	Junior Technician	Vacant	Non-Gaz. I	
07.	JTA	D.B. Aale	Non-Gaz. II	
08.	Field Assistant	I.B. Karki	Non-Gaz. III	
09.	Field Man	R.B. Dahal	Non-Gaz. IV	
10.	Field Man	G.B. Ghimire	"	
11.	Field Man	D.B. Khatri	"	
12.	Field Man	D.B. Dahal	"	
13.	Field Man	C.P. Dahal	"	
14.	Field Man	T.P. Dahal	"	
15.	Worker	R.N. Nepal	No Class	
16.	Worker	K.N. Shrestha	"	
17.	Worker	R.M. Shrestha	"	
18.	Worker	K.P. Dahal	"	
19.	Worker	D.R. Gautam	"	
20.	Worker	T.M. Girel	"	
21.	Worker	R.B. Khatri	"	

Contd.../...

S.N.	Post	Name	Class	Remarks
	Administration staff			
22.	Nayab Subba	U.N. Mishra	Non-Gaz. I	
23.	Kharidar	J.S. Thakur	Non-Gaz. II	Working as an Accountant
24.	Mukhiya	K.B. Thapa	Non-Gaz. III	
25.	Peon	G.B. Dahal	No Class	
26.	Peon	J.N. Shrestha	No Class	

Table 4. **Technical Assistance**

Mr. Govind K.C.	Asst. Agronomist	DOAG
Dr. Ken W. Riley	Advisor	IDRC
Mr. D.M. Singh Dangol	Research Assistant	IBPGR/WI
Mr. N.R. Dhungel	Research Assistant	IBPGR/WI
Mr. K.B. Karki	J.T.A.	Jiri Tech. School /trainee

The acute shortage of manpower for this program has already been realized by higher authority and the additional following manpower is expected in near future:-

1.	Agriculture graduate	-	14
2.	Junior technician	-	12
3.	Supporting staff	-	11
	Total	-	37

Table 5. **Collaborating Scientists in other Disciplines**

S.N.	Name	Post	Location
01.	Mr. K.M. Singh	Asst. Agronomist	DOAG, Khumaltar
02.	Mr. K.R. Regmi	Deputy Ag. Botanist	DOAB, Khumaltar
03.	Dr. C.B. Karki	Asst. Plant Pathologist	DOPP, Khumaltar
04.	Ms. S. Sharma	Asst. Plant Pathologist	DOPP, Khumaltar
05.	Mr. B.K. Gyawali	Deputy Entomologist	DOE , Khumaltar
06.	Mr. B.P. Triphathi	Asst. Soil Scientist	DOSSAC Khumaltar
07.	Mr. R.C. Munankarmi	Asst. Soil Scientist	DOSSAC, Khumaltar
08.	Dr. M.S. Upadhaya	Asst. Agri. Botanist	PGRU, Khumaltar

Table 6. Collaborating Stations and testing sites

S.N.	Collaborator	Institution/Station
01.	Mr. D.B. Gharti and Mr. A.K. Gautam	Jumla Agricultural Station
02.	Staff	Surkhet Agricultural Station
03.	Staff	Marpha/Dolpa Centre
04.	Staff	Lumle Agricultural Centre
05.	Staff	Pakhribas Agricultural Centre
06.	Staff	Tarahara Agricultural Station
07.	Mr. B.P. Regmi	Rampur Agricultural Centre
08.	Staff	Khairanitar Training Centre
09.	Staff	Doti Agriculture Farm
10.	Mr. A.K. Karn	Kakani Agriculture Farm

Training

1. Mr. K.N. Adhikari left for M.Sc. on Dec. 15, 1989 to University of Manitoba, Canada. He is doing M.Sc. on buckwheat and is expected to re-join the program in January 1992.

2. Mr. Shesh Raman Upadhyaya received a four month training on finger millet during Sept. 5, 1990 to January 18, 1991 at All India Coordinated Small Millets Improvement Programme, Bangalore, India.

Again this program used the manpower and resources available in eleven research stations situated across Nepal and seven Central divisions located at Khumaltar. The collaborative testing facilities were and are available at Jumla, Lumle, Pakhribas, Dolpa, Marpha, Surkhet, Doti, Tarahara, Rampur, Kakani and Khairenitar. Similarly close linkage had been established with five central disciplinary divisions, farming systems research division and socio-economic research division located at Khumaltar, Lalitpur. their manpower and resources also were partially used for conducting the hill crops researches. With their support, different trials are carried out at sites across the high hills, mid hills and planes where our four mandate crops are important.

Objective c: To establish a hill crops working group to review and plan hill crops research.

During the past three years, locations for testing hill crops researches have been identified and in some cases the personnel to be involved also have been assigned from eleven research stations situated across Nepal and eight central divisions located at Khumaltar. As a regular activity this group met twice a year presented the research done during the respective seasons and they made suggestions for the planning for the next year. Again the group of related scientists from different faculties

organized several monitoring tours for summer and winter crops regularly and many RRA Treks also were organized during three years. These groups tried to understand the needs of the farmers and the actual situation of of different places. Based on their suggestions the hill crops research was modified and planned accordingly. During the first phase a functional hill crops working group has been established, and the works are underway.

Workshop and Training/Workshop

As a regular activity two workshops - one on summers crops and other on winter crops were organized each year. Two special Training workshops on barley and finger millet also were organized.

Table 7. **Workshops Held During Three Years**

Name	Place	Duration
1. Barley Working Group Meeting	Bhairahawa	Sept. 8, 1988
2. Finger Millet, Buckwheat, and Amaranth Working Group Meeting	Rampur	Jan. 20-21, 1989
3. Barley Working Group Meeting	Bhairahawa	Sep. 12-13, 1989
4. Finger Millet, Buckwheat and Amaranth Working Group Meeting	Parwanipur	Feb. 5-9, 1990
5. Barley Working Group Meeting	Bhairahawa	Sep. 10-14, 1990

The findings and recommendations of 1 and 2 are presented in Appendix I that of 3 and 4 in Appendix II and that of 5 in Appendix III.

Table 8. **Training/Workshops Organized in Hill Crops**

Name	Place	Duration
1. Barley Training/Workshop	Kathmandu	Feb. 24 to Mar. 2, 1989
2. Finger Millet Training/ workshop	Kathmandu	Oct. 7 to Oct. 12, 1990

The gist of recommendations and findings of 1 and 2 are given in the Appendix IV and V respectively.

Objective d: To develop improved varieties of hill crops through collection, selection and in some cases, breeding.

Varietal improvement is the most effective, widely accepted and economical technology to improve the productivity of any crop. So, NHCRP put maximum effort to develop as many varieties/lines as possible during the past three years. The discussion will be concentrated under the above mentioned three headings collection, selection and breeding on the four NHCRP mandate crops.

Collection

Germplasm of finger millet, barley, buckwheat and grain amaranth were collected locally and from abroad. The following number were collected from different sources:

Table 9. Hill Crops Germplasm Number

Crop	No. of Local Collection	Foreign collection	
		Number (about)	Sources
Finger millet	630	400	India, Zimbabwe ICRISAT, Ethiopia
Barley	355	300	ICARDA, India, USA Canada, Andean Countries
Buckwheat	155	100	Canada, Japan, USSR
Grain Amaranth	57	50	USA

The local collections were made in different times by many exploration groups. The collected germplasm were grown during the past years, and a detail characterization was done as per the IBPGR descriptors of the respective crops. The selected lines are being used for the crop improvement program, and the representative samples are preserved for future uses.

The exotic materials of different crops were received in different times and were evaluated mainly for the agronomical traits.

Selection

In varietal selection several steps involved, and the procedures are common to all four mandate crops. The generalized steps are as follow:

Observation Nursery: Introduced, local collections and advanced materials from breeding program are evaluated, generally in unreplicated single or 2-row plots, 1 to 2 m long with or without replicated checks. Testing of a large number of entries is

carried out in 1 or 2 locations. The best selections are promoted to Advanced Observation Nursery (AON).

Advanced Observation Nursery: The lines selected from observation nursery are evaluated in unreplicated or 2 replications, in 2 to 4 locations with plot size 1 row to 4 rows, 1 to 2 meter long. The number of entry, generally below 100 and more than 20. The selected materials are promoted to Initial Evaluation Trial (IET).

Initial Evaluation Trial: Plots are 4 to 6 sq. m. with 3 to 4 replications with 9 to 25 entries at 3 to 6 locations. In finger millet, this set is divided into mountain, hill and terai sets, and in barley, only mountain and hill sets were tested. This is the first real yield assessment at different environments. Selections are generally advanced to Coordinated Varietal Trial (CVT).

Coordinated Varietal Trial: Plots are generally 4 to 6 sq. m., 3 to 4 replications, with 9 to 16 entries, evaluated in 4 to 10 locations. In finger millet the sets are divided into mountain, hill and Terai, and again hill set is sub-divided into mono and relay with maize sets. Barley has only mountain and hill sets, buckwheat has sweet and better sets. Evaluation of varietal stability or adaptability in different environments is made in this stage. The selected materials are promoted to Farmer's Field Trial (FFT).

Farmer's Field Trial: The best 4 to 6 selections from CVT's are tested in the farmer's field at different agro-climatic conditions across Nepal; and the trials are managed by the scientists at farmers conditions and assess farmer's reactions. The plot size will be 6 to 12 sq.m. with only one replication in one place and more than 50 locations. The selections from FFT are promoted to Minikit distribution.

Minikit Distribution: The selected few lines and recommended varieties are distributed throughout the crop growing areas with the objective of final test in the farmer's field in their own management and to encourage farmers to save seed if they like the particular genotype. Only one genotype for one location in 100 to 500 sq.m. area, more than 1000 minikits are distributed annually.

Finally, if a line performed well in all the above stages, it is officially released, and the seed multiplication starts in large scale.

The selection criteria of hill crops for different recommendation domain are as follow:

Table 10. Selection Criteria of Hill Crops

Recommendation Domain	General	Specific Crops			
		Finger Millet	Barley	Buckwheat	Grain Amaranth
High hills	Early maturing, cold tolerant, more biomass, high yield, wide adaptation	Leaf spot, resistant	Yellow rust and powdery mildew resistant	High seed seting powdery mildew resistant	Resistant to water lodging good popping quality
Mid hills	Early to late maturing, more biomass, high yield, wide adaptation	Good competitive ability with maize Blasts and leaf spot resistant good malt quality	Yellow rust resistant	High seed seting powdery mildew resistant	Resistant to water lodging, good popping quality
Terai	Early to late maturing, high yield, heat tolerant, wide adaptation	Blast resistant good malt quality	High malt quality	High seed seting	Resistant to water lodging, good malt quality

During the last three years, selection was extensively followed and same achievements were made in this field.

Finger Millet

The findings are as follow:

1. The available germplasm were grouped into three broad groups (a) early (b) early-to-medium and (c) late, and they were tested in high hills, mid hills and terai (plain) areas respectively.

2. Nearly 2000 head-to row selections were evaluated in 1989 using local germplasm. Selection in the medium-to-late group averaged 60% higher grain yield than the improved check. Early selections averaged 19 days earlier maturing than the local checks in early set.

3. In observation nurseries and IET sets the following numbers of cultivars were selected.

Table 11. Finger Millet Selected Number

Trial	1988/89	1989/90	1990/91
1. Observation Nursery	35	About 1800 heads	85
2. Advanced Observation Nursery	-	16	17
3. IET High hill	3	7	6
Mid hill	6	8	9
Terai	4	6	4

Most of the selected lines were promoted to the next stage of evaluation and selection was followed.

4. In CVT's the performance of top three high yielders are as follow:

Table 12. Grain Yield kg/ha of Finger Millet Cultivars in CVT's

Year	Rank	CVT High hill	CVT Mid hill		CVT Terai
			Mono	Relay	
1988/89	1	-	Okhale -1	GE 5026	-
	2	-	NE 6401-26 (Kabre Kodo-1)	Rilli Carbo	-
	3	-	SLO-007	Okhale - 1	-
1989/90	1	NE 1703-34	GE 5001	GE 5016	GE 5059
	2	NE 94	PR 202	GE 002	Dalle-1
	3	GE 74	Okhale - 1	GE 5001	GE 5026
1990/91	1	NE 94	PR 202	GE 0122	GE 5016
	2	GE 150	Okhale - 1	GE 5016	GE 5177
	3	GE 5182	GE 5001	GE 5166	HR 374

Note: 1. During 1988/89 there was only one set for all locations.
2. Local checks were excluded in tabulation.

Some of these promising genotypes were promoted to farmer field trials (FFT) and minikit distributions.

5. Performances of some of popular lines in FFT and minikit distribution are as follow:

Table 13. Gain Yield kg/ha of Finger Millet Cultivars in FET's

Cultivar	1988/89	1989/90	1990/91
1. Okhale - 1	1973	2915	2585
2. NE 6401-26 (Kabre Kodo-1)	2105	3429	2037
3. Dalle-1	1823	1498	1799
4. Local	2237	2879	1804
5. GE 002	-	2987	2139
6. GE 5059	-	3261	2364
7. NE 1703-34	-	500	1917
8. NE 94	-	900	2167
9. GE 5017	-	1518	1275
10. Rampur Local	-	1709	1425

Table 14. Grain Yield kg/ha of Finger Millet in Minikit

Cultivar	1988/89	1989/90	1990/91
1. Okhale - 1	1251	1589	1307
2. Kabre Kodo -1	1178	1790	1482
3. Dalle-1	4600*	1531	1327
4. NE 1703-34	3300*	385	1624
5. PES 176	1260	650	-
6. MI 30	-	1311	-
7. Rampur Local	3400*	-	-

* No. of observations was only 2.

Now Okhale-1, Kabre Kodo-1, Dalle-1 and other varieties/lines are very much popular among the common Nepalese farmers in many areas.

Barley

The findings are as follows:

1. The available germplasm were grouped mainly (a) early maturing for high hills and (b) medium and maturity for mid hills and plain.

2. Head selection was practiced in the local germplasm, and impressive improvement was achieved.

3. In observation nursery and IET sets the following numbers of cultivars were selected.

Table 15. Barley Selected Number

Trials	1988/89	1989/90	1990/91
1. Observation Nursery	49	42	76
2. Advanced Observation Nursery	-	-	24
3. IET - High Hills	4	2	9
- Mid Hills	5	10	11

4. In CVT's the top three high yielder cultivars are as follow:

Table 17. Grain yield kg/ha of Barley in CVT's

Year	Rank	CVT High hills	CVT Mid hills
1988/89	1	CPRO-409 TDI 170	NB 1003-37
	2	Bonus	WI 2291/Mag. 102
	3	NB 1003-11	Bonus
1989/90	1	NB 1003-37	Bonus
	2	Bonus	NB 1003-37
	3	14th IBON-172	NB 5603 x CI 10448
1990/91	1	LG-51	14th IBON-172
	2	WI 2291/Mag.102	WI 2291/Mag.102
	3	B.N. Hona	NB 5603/CI 10448

Note: The local checks were excluded.

5. Performance of some of the popular lines in FFT's and minikits are as follow:

Table 17. Grain Yield kg/ha of Barley in FFT's

Cultivar	1988/89	1989/90	1990/91
1. Bonus	2354	2321	1980
2. NB 1003-11	1948	2198	1761
3. NB 1054 (Solu-Uwa)	1336	1323	2127
4. HBL 240	1784	-	-
5. Local	2412	2065	1279
6. NB 1003-37	-	2284	1817
7. WI 2291/Mag.102	-	2158	2247
8. Dolma	-	3332	-
9. HBL 231	-	2671	-
10. NB 1207/CI 10448	-	-	2052
11. B.N. Hona	-	-	1823
12. NB 5003 x CI 10448	-	-	1552

Table 18. Grain Yield kg/ha of Barley in Minikit

Cultivar	1988/89	1989/90	1990/91
1. Bonus	1559	1836	1368
2. NB 1054 (Solu-Uwa)	1220	1110	1668
3. Ketch	775	-	-
4. NB 1003-11	-	-	1810
5. NB 1003-37	-	-	1560

Bonus is popular in the mid hills and Solu-Uwa is getting popularity at high hills. Similarly B.N. Hona, NB 1003-11, NB 1003-34, NB 1207 x CI 10448, etc also are liked by many farmers.

Buckwheat

1. Preliminary selection was initiated in the broad based random mating selection. The selected materials are in the process of improvement.

2. CVT is divided into sweet and bitter groups.

Table 19. Buckwheat SElected Number in Different Trials

Trial	1988/89	1989/90	1990/91
1. Observation Nursery	141	20	-
2. Advanced Observation Nursery	-	10	7
3. Initial Evaluation Trial	8	9	7
4. Buckwheat Cooperative Test (Canada)	-	7	3

3. The top three higher yielder in CVT.

Table 20. Grain Yield kg/ha of Buckwheat in CVT's

Trial	Rank	1988/89	1989/90	1990/91
1. CVT Combined	1	-	GF 210	-
	2	-	GF 68	-
	3	-	GF 209	-
2. CVT Sweet	1	-	-	GF 209
	2	-	-	Canadian #85603
	3	-	-	GF 5233
3. CVT Bitter	1	-	-	GF 216
	2	-	-	GF 212
	3	-	-	GF 110

CVT was started from 1989/90 and in 1990/91 sweet and bitter sets were developed.

4. Buckwheat FFT and minikit distribution: Some genotypes of buckwheat were tested in FFT and minikit demonstration in the beginning of the project started, but the systematic testing was started only in 1990/91. Cultivars like Shinano Natsu-Soba, IR-13, GF 5233, GF 42 and Shinano Ichigo were tested in FFT and IR-13, Darja and Sinsu-O-Soba were distributed in minikit at some selected sites. However, the performance was not upto the expectation.

3. Grain Amaranths

Very few selections had been done in the crop.

The number of selections done in different trials during the three period were as follow:

Table 21. Grain Amaranth Selected Number in Different Trials

Trial	1988/89	1989/90	1990/91
1. Observation Nursery	66	-	-
2. Advanced Obser. Nursery	-	14	8
3. Initial Evaluation Trial	8	14	-
4. Coordinated Vatietal Trial	-	3	6
5. Farmer's Field Trial	-	-	4

Upto now no minikits have been distributed, and only two lines namely GA 5025 and GA 5041 are promising in grain amaranths.

Breeding

In varietal improvement hybridization and promotion of progenies/populations to the genotypes status play vital role. In spite of acute shortage of manpower, some crossing works had been started in finger millet, barley and buckwheat.

Finger Millet

Crossing techniques were identified and small scale crossing was started in 1989 by contact method. 10 F_1 and 9 F_2 progenies are being advanced in the field, and about 100 different crosses have been made this year. The hybridization was done mainly to develop diseases resistant, high grain and fodder yielder, more adaptive and in some cases early maturing types. The combination of crossing are best local x African, best local x Indian, local x local and best local x Indaf lines.

Barley

NHCRP first started breeding works on barley. At present, materials of different generations are being advanced with careful selection. Local lines were crossed with the desirable exotic sources. The main focus of barley breeding is to develop lines resistant to stripe rust resistant, high yield and adaptive to different agro-climatic conditions.

Progenies available in different generations are:

F_1 - 269
F_2 - 167
F_3 - 34
F_4 - 91

Buckwheat

Sweet buckwheat is a cross-pollinated crop, and the population improvement methods are quite different than self-pollinated crops.

Broad based population mostly comprising local landraces selections and some exotics materials from Japan, Yugoslavia, USSR and Canada were allowed to random mating and selection were done. So, we have the base population and selected population, and every year these are grown in partial isolation and selection is practiced.

Dr. Campbell from Canada sent some broad based population, and limited selection and improvement by half-sub ruminant seed method is under way.

Variety Release

NHCRP was able to release one variety of naked barley and one variety finger millet in Aug., 1990. This is our first achievement to release varieties in hill crops after its establishment in 1986. NB 1054 naked barley was released by the name of SOLU-UWA and NE 6401-26 finger millet by the name of KABRE KODO-1. Solu-Uwa was recommended for high hills and Kabre Kodo-1 for mid hills ecological zones.

Objective e: To identify the most serious pests and diseases of hill crops and develop effective control measures with emphasis on developing genetic resistance.

So far as the following pests and diseases of hill crops have been identified:

Table 22. Diseases and Insects of Hill Crops

Crop	Diseases	Insects
Finger millet	Cercospora leaf spot, Foot rot, Smut, Wilt, Brown spot, Blasts	Pink stem borer, White borer, White grubs, Cut worms, Different beetles, Grass hoppers
Barley	Yellow rust, Stripe disease, Powdery mildew, Covered smut Loose smut, Stem smut Spot blotch, Net blocth, Scald, Leaf rust, Root rot, Blast	Aphids, Army worms, Cut worms, Borers, Thrips, White grubs, Wire worms, Grass hoppers, Mites,
Buckwheat	Powdery mildew, Root Rot (Wilting), Leaf spot	Aphids
Grain Amaranth	Leaf spot, Root rot, Wilting Alternaria blight	Aphids, Bug, Mites, Stem weevil, Termites

In finger millet blasts and leaf spot, in barley yellow rust and stripe disease, in buckwheat powdery mildew and root rot and in amaranth wilting are the main diseases. Some works have been done to find the solutions on this diseases, and nothing was done on the insect aspects due to lack of manpower.

Diseases

In barley diseases, some chemical methods of controlling were found.

(a) Seed treatment with Vitavax-2000, Sumi-8 and Hexathir were found effective to control barley stripe disease.

(b) Bayleton spray was very effective to control yellow rust.

(c) In barley, the different local landraces have different levels of tolerancy.

In finger millet (a) Bavistin was found highly effective to control leaf spot. This was found in Lumle study. (b) Butachlor, 2,4-D Na Salt and Basalin were effective to control weeds in finger millet field.

As mentioned in the objective, the main emphasis was to identify genotypes either immune or had low scores. Some of the identified lines for different major diseases of hill crops are as follow:

Table 23. Disease Resistant Cultivars of Barley and Finger Millet

Crop	Lines/Cultivars		
	Blast		Cercospora Leaf Spot
Barley	Bonus, Cebada Desnuda-1, X Veola-3, X Veola-44, BDON-37, BDON-38, DD-14, DD-37, DD-38, Lignee-640, Lignee-527, 14th IBON-76, 14th IBON-62, Nacta, Jet, Tetrakreuzung-1066, PID-10342, Nigrate-8535, CI 7117/Dier All		DD-14, DD-60, LG-100, LG-51, ACC. 82-109-3, 14th IBON-13, 14th IBON-76, 14th IBON-173 CORI "S", and many other lines.
Finger Millet	NE 1703-34 GE-356, GE-150 GE-74, GE-77, GE-147, GE-02, GE-194, GE 180, GE-346, GE-481, GE-122,GE-5016, GE-5166,GE-5026, GE-5168,GE-5182, GE-5174,GE-5026, Okhale-1,PR-202, PL 86-163, Rilli Carbo	GE-194,GE-180, GE-77, GE-346, GE-381, GE-74 GE-356, GE-5016, GE-5026, GE-5058, GE-5168, GE-5169, GE-5174, GE-5182, GE-5203, GE-5200, PR-202, Okhale-1, Kabre Kodo-1, Rilli Carbo, LSO-007-IGE	GE-122, GE-73, GE-150, GE-356, GE-357, GE-5016 GE-5182, Okhale-1, PL 86-163

IGE 3486, IGE 3526, IGE 3493, IGE 3087, IGE 3093, IGE 3539 and IGE 3472 are resistant to all 3 types of blast disease.

The buckwheat genotypes GF 5099, GF 5233, GF 216, GF 212 and GF 5283 were tolerant to powdery mildew.

Similarly, GA 5020 and GA 67-3 were found tolerant to amaranth leaf spot as well as GA 67-3, and GA 5025 were either immune or tolerant to wilting or root rot amaranth diseases.

Objective f: To develop the most appropriate production practices for hill crops for the varied agro-ecological conditions where these crops are grown.

Some preliminary agronomical works were started in finger millet, barley and buckwheat. The highlights of some main findings are as follow:

a. Finger Millet

1. At Kabre, the optimum date of transplanting of 30 day old seedling was late June or first week of Asadh.

2. To achieve the maximum total production in maize/finger millet relay, transplanting finger millet after 45 days of maize planting is the best. In contrast, direct seeding of finger millet at the maize planting time reduced the maize yield sharply.

3. In the fertilizer trial N:P:K @ 80-60:30-40:30-10 kg/ha seems effective for high grain and straw yield in mono-condition.

4. The application of 15 mt organic matter per hectare also produced more grain and straw yield.

5. Farmers level of compost with 20 kg N as top dressing also gave as high as with N:P:K application of 80:30:10 kg/ha.

6. The early maturing finger millet cultivar gave higher yield when number of seedling per hill was increased from one to three, but the effect was not effective in medium maturity variety i.e. Kabre Kodo-1.

b. <u>Barley</u>

1. Barley sterility has been observed in eastern and western areas of the country. Causes of sterility at Kabre is believed to be associated low pH, poor organic matter content in the soil, whereas at Lumle the cause was apparently due to abrupt temperature fluctuation i.e. cold, frost or snow, during flowering stage. At Kabre, a soil-induced sterility affected most exotic barley being grown here. In a observational survey it was thought that the main cause of sterility at Kabre was the lack of organic matter in the soil. This was confirmed later by field trials and pot experiments.

2. The use of lime and phosphorus has some effect to reduce barley sterility and increase grain and straw yields.

3. In the seed rate trial, the high tillering and low-tillering variety. Bonus produced higher grain and fodder yield than the low tillering variety Solu-Dwa.

4. The addition of 20 kg/ha of N as top dressing along with compost also appeared effective in increasing yields.

5. At Jumla N doses from 30 to 90 kg/ha along with P 20 and K 30 kg/ha gave increased yields and at Khumal condition application of 60 to 90 kg N, with 20 kg P and 10 kg K/ha gave higher yields.

6. In an attempt to find out the effectiveness of different experimental designs for hill terrace condition, the lattice design was found more efficient than the

randomize block design. Now, the lattice design is being used in yield trials of all hill crops. This design is effective to reduce CV and LSD.

7. In the terrace condition, the use of two-row plots and frequent check plots controlled variation in an unreplicated observation nurseries.

8. In the hill condition, a plot size of 4 rows with 4 replications appeared to be optimum for the best use of limited area and skilled manpower.

c. **Buckwheat**

A seed rate trial was initiated in 1990 but the result was not conclusive.

Objective g: To collaborate with farming systems and other agencies in order to identify research problems develop appropriate hill crop varieties and production practices, and ensure that improved technology and seed reaches the farmers.

NHCRP has functional working relationship with Central Farming System and Outreach Research Division, Central Socio-Economic Division and other six disciplinary divisions based at Khumaltar. Similarly, this program has the privileges to conduct researches in other twelve research stations located at different areas across Nepal. First research project is proposed to the respective research panels, and when the project is passed by NARC, the divisions and stations have obligation to conduct the trials. Again, the divisions and research stations also conduct location specific and other trials on all crops.

As a regular activity, two workshops are organized on summer and winter crops every year. All the concerned scientists are invited, the works done during the season are presented and discussion will take place for the next year program. During this workshops, research problems, the technologies and seed situations are discussed, and try to find out the solutions.

Again the program has close collaboration with the extension network in the hills and many NGO's. They are helping NHCRP to disseminate hill crops technologies and seeds.

Objective h: To carry out surveys on the importance of hill crops so as to gain a better understanding of the needs of hill farmers.

During the three years project period the scientists working in this program made several travels and visits which are as follow:

a. Monitoring tours twice a year,

b. Rapid Rural Appraisal (RRA) Treks to different hill crops

growing areas as needed, and

c. Special surveys on the particular fields of hill crops.

The descriptions of these monitoring tour and RRA Treks and surveys are as follow:

a. Monitoring Tour

A multi-disciplinary group of hill crops scientists routinely join in the monitoring tours for the summer and winter crops twice a year. They mainly visit the research stations and assess the actual status of the on-going trials sent by NHCRP and observe other hill crops activities. Again, they visit near by farmer's fields and observe the on-going hill crops activities, discuss with the farmers and try to understand the needs and problems of hill crops growing farmers. After the tour, the group will prepare a detail tour report with the problems, solutions and suggestions. This type of tour turn out very much helpful and useful to plan the next year program.

Table 24. Monitoring Tour Conducted During the Project Period

Personnel	Period	Place	Objective
1. 11 different scientist	Sept. 28 to Oct. 12, 1988	LAC, Kabre Khairanitar Rampur Tarahara Khumaltar & field	To monitor summer hill crops
2. 5 different scientists	Setp. 25 to Oct. 5, 1989	Surkhet, LAC, Kabre Khumlatar, and farmers field	To monitor summer Hill Crops
3. B.K. Baniya & K.W. Riley	Nov. 20 to Nov. 23, 1989	PAC	To observe and discuss hill crops
4. 7 different scientists	March 26, to April 2, 1989	PAC, LAC, Kabre, Khumaltar & farmers' field	To monitor Winter Hill Crops
5. Different scientists	May 26, to May 31, 1988	Jumla	To monitor barley

Contd.../...

Personnel	Period	Place	Objective
6. Different scientists	Sept. 28, to Oct. 12, 1988	Different places	To monitor summer Hill Crops
7. Different scientists	Dec. 17, 1988	Kakani	To monitor barley
8. Different scientists	Dec. 14, 1988	Naldung Farming Sys. site	To monitor barley
9. Different scientists	Dec. 17, 1988	Sinkalama Proj. site at Varadeyo	To monitor barley
10. Different scientists	Dec. 21, 1988	Farmers Fields in Kabre area	To monitor different Hill crops
11. Different scientists	Jan. 19, 1989	Chitawan	To monitor Buckwheat
12. Different scientists	Apr. 14, 1989	Farmer's Field in Yarsa village Dolakha Dist.	To monitor Barley
13. K.K. Sherchan K.W. Riley K.D. Joshi	Apr.10-14, 1990	LAC	To monitor barley trials
14. K.K. Sherchan K.W. Riley D.B. Gharti	May 16-18, 1990	Jumla	To monitor barley trials
15. Gobind K.C.	May 16-19, 1990	Dolpa	To monitor barley trials
16. K.K. Sherchan C.B. Karki Gobind K.C.	June 1-11, 1990	Mustang	To monitor barley trials
17. A. Seetharam, B.K. Baniya K. Sherchan K.K. Shrestha S.K. Shakya M.R. Upadhyay D.M. Shakya J.D. Ranjit	Oct. 8 to Oct. 9, 1990	Kabre	To monitor finger millet crop and works on it.

Contd.../...

Personnel	Period	Place	Objective
18. K.W. Riley S. Vishwanath B.P. Regmi K.M. Singh Govind KC B.R. Sthapit P.M. Pradhanang S.R. Devkota P. Shrestha, B.K. Dhital, M. Subedi S.C. Gupta	Oct. 8 to Oct. 9, 1990	Lumle	To monitor finger millet crop and works on it.
19. People of above two groups	Oct.10, 1990	Khumaltar	To monitor finger millet crop and works on it.
20. K.K. Sherchan K.W. Riley M. Yoshida Y.K. Karki and Shrestha	Oct. 29 to Nov. 3, 1990	Dolpa	To monitor buck-wheat and millets crops.
21. Govind KC	May 14 to May 27, 1990	Jumla	To monitor Barley
22. K.K. Sherchan	May 24 to May 31, 1991	Mustang	To monitor Barley

b. **RRA Treks**

NHCRP was newly established program in 1988, and very little was known about hill crops. Many RRA treks were organized to different hill crops growing areas of Nepal. Generally 2 to 4 scientists took part in this trek and travailed five to twenty days in hilly areas, and mostly discussed with the individual and group of farmers and collected the informations about hill crops and their related fields. They documented the findings of RRA treks.

Table 25. RRA Treks Organized During Three Years

Personnel	Period	Place	Objective
1. R.P. Upreti K.N. Adhikari K.W. Riley	Mar. 10 to Mar. 17, 1989	Solukhumbu Ramechap Dolakha	Rapid Rural Apraisal Treck of Hill Crops
2. K.W. Riley Karki A.K. Gautam D.M.S. Dangol	May 16 to May 25, 1989 Jun. 1 to Jun. 6, 1989	Jumla Dolpa Mustang F. Field	Rapid Rural Apraisal Trek of Hill Crops
3. K.K. Sherchan K.W. Riley M.Yoshida D.M.S. Dongol Y.B. Thapa B. Rajbhandari	Nov. to Dec. 1990	Eastern & Central regions	To assess the place of buckwheat for Nepalese agriculture.
4. B.P. Regmi K.K. Sherchan M. Yoshida K.W. Riley Govind KC B. Rajbhandari	Feb. 4 to Feb. 8, 1990	Chitwan	To assess the place of buckwheat for Nepalese agriculture.

c. Special Surveys

During the project period a special survey on finger millet in Nepal and the special survey on statistical data on buckwheat in chitwan district were organized. A consultant group of three persons surveyed finger millet in representative zones using RRA Treks and covered wide finger millet growing areas. The findings and suggestions of this study seems useful to this program. The recommendations of this survey is given in Appendix VI.

List of Special surveys:

1. Survey of Finger Millet in Nepal
2. Buckwheat Survey of Chitwan District

The monitoring tours, RRA Treks and special surveys provide informations about the needs of farmers and status of hill crops. The observations, the suggestions and findings are incorporated in the program and planning of hill crops. Based on the experiences on these trips, many modifications have already made in the trials and other strategies also have been changed.

International Visits

The following international visits were supported by IDRC, Canada.

Table 26. International Visits in Three Years

1.	K.R. Regmi R.P. Upreti K.W. Riley	Apr. 24 to May 4, 1989	Jabalpur & Karnal in India	To attend 3rd All India Small Millet Workshop and visit Barley in Karnal
2.	K.K. Sherchan	May 28 to Jul. 22, 1989	ICARDA CIMMYT	To learn about Barley
3.	K.R. Regmi	May 24 to May 26, 1989	Perediniya of Sri Lanka	To participate Second SAARC counterpart scientists meeting of Finger millet
4.	B.K. Baniya	Jul. 10 to Jul. 15, 1989	Oreal of USSR	To attend 4th International Symposium on Buckwheat
5.	K.M. Singh & Y.B. Thapa (PAC)	Aug. 21 to Aug. 29, 1989	Vivekanand Laboratory Almorah, India	To observe hill crops research in Northern India
6.	B.K. Baniya, K.W. Riley, K.M. Singh Y.B. Thapa	Oct. 16 to Oct. 28, 1989	Coimbatore New Delhi Bangalore India	To observe small millet research under AICSMIP, and discuss coopera-tors on buck-wheat and finger
7.	B.K. Baniya	Apr. 9-15, 1990	Tirupati, A.P., India	To participate the 4th All India Small Millets Annual Workshop
8.	K.W. Riley K.K. Sherchan P.M. Pradhananga R.J. Khadka B.K. Baniya	Apr. 8-12, 1991	Bulawayo Zimbabwe	To participate Second Interna-tional Small Millets Workshop
9.	C.B. Karki	Apr. 18 to May, 3, 1991	ICARDA, Syria	To get acquain-tance with barley disease

Specific Achievements

Efforts have been directed towards defining the researchable constraints, and strengthening the technical research program on each of the 3 major hill crops successively during each of the 3 years of the project.

Barley in Year I: Barley was seen as the crop which could most readily make a impact as good technology is available out side Nepal (CIMMYT and ICARDA) and the major improvement objectives (earlier, stripe rust resistant varieties of barley) were known. A series of Rapid Rural Appraisal Treks TR 4/88, 2/89, 3/89, 5/89, 6/89 and visits of national barley scientist to ICARDA and CIMMYT July Aug. 1989 (Reports listed on page 25 to 26) helped to furtehr define research objectives and approach for barley improvement. In February 1989, barley scientists from ICARDA, and CIMMYT attended the National barley training workshop. The recommendations from this workshop (Appendix IV) and closer interaction with ICARDA CIMMYAT, resulted in a stronger national barley program, initiation of breeding, and release of Solu-Uwa variety of hulless, early barley in August 1990. High yielding, early rust resistant varieties fromthe crossing program are now entering final stages of selection. These crosses are expecting to provide a quantum jump in terms of improved barley cultivars. The monitoring tours to the barley testing sites continue on a regular basis (TR 2/91, 3/91).

Finger Millet in Year II: A strong emphasis was placed on defining and developing the finger millet activities in Year II. A similar process of a series of RRA Treks/monitoring tours for finger millet took place (TR7/89, 9/89). Close linkages with the All India Coordinated Millets Improvement Program were established and Nepal scientists now regularly attend the Annual millets workshop in India. (TR 4/89, April 1990 report, TR 8/89).

In 1990 October, a National Finger Millet Training Workshop was held which included scientists from Africa, and India who have now established long term links with this program. The recommendations from the workshop (Apprndix V) are a guide to present finger millet improvement efforts in Nepal. A systematic production to consumption systems survey of finger millet across the varied ecological zones in Nepal, was carried out Oct. - Jan. 1990. The recommendations from this survey report have also helped to strengthen millet improvement program planning (Appendix VI). These efforst along with earlier testing have resulted in the release of Kabre Kodo-1 finger millet variety in Aug. 1990. A large landrace improvement effort (p. 12) has resulted in substantial improvement of local landraces. A crossing program has produced a small number of crosses between Africa and Nepalese parents which has generaged existing diversity in F_2 populations.

Buckwheat in Year III: Priority was given to develop the buckwheat program in Year III. Very little improvement work, besides germplasm collection and evaluation had started on this

crop. In 1990-91 a series of Rapid Rural Appraisal Treks (TR 5/90, 6/90, 1/91) have made recommendations on needed research priorities for this crop. Collaboration has, at the same time developed with other countries, with good flow of introduced sweet buckwheat through Japan and Canada.

More systematic multilocation testing of these materials is now in land inthe NHCRP program, and random-mating population improvement efforts are under way. It is hoped that technical assistance from Canada expected in 1992-93 will go a long way in strengthening buckwheat improvement.

Publications

NHCRP tried its best to document all the papers dealing with its mandate crops. The following tour/visit, survey/training and proceeding/annual reports were published during the past three years:

Reports produced by NHCIP Personnel during 1988-89

a) Tour/Visit Reports:

1. Hill Crops Observation Tour Report Jumla area
2. Hill Crops Monitoring tour report
3. NHCIP Travel Report 1/88 - Kakani Agricultural Farm
4. NHCIP Travel Report 2/88 - Naldung Farming Sys.site
5. NHCIP Travel Report 3/88 - Sinkalama Project Site at Varadeyo
6. NHCIP Travel Report 4/88 - Farmers Fields in Kabre area, Dolakha
7. NHCIP Travel Report 1/89 - Buckwheat in Chitawan
8. NHCIP Travel Report 2/89 - Rapid Rural Appraisal Trek to Solukhumbu, Ramechhap and Dolakha Districts
9. NHCIP Travel Report 3/89 - Visit to Farmer's Fields in Yarsa village, Dolkha District
10. NHCIP Travel Report 4/89 - All India Small Millet Annual Workshop, Jabalpur
11. NHCIP Travel Report 5/89 - Rapid Rural Appraisal Trek to Jumla, Dolpa and Mustang District

12. NHCIP Travel Report 6/89 - Barley Monitoring tour Report, Eastern, Central and Western Development regions

13. NHCIP Travel Report 7/89 - Finger Millet/Amaranthus Monitoring Tour Report

14. NHCIP Travel Report 8/89 - Training/visit to Millet Centres in Almora, Coimbatore, Bangalore and Delhi

15. NHCIP Travel Report 9/89 - Tour Report to Pakhribas and Tarahara

16. Report on a visit to ICARDA, Syria

17. Report on a visit to CIMMYT, Mexico

18. Report to Buckwheat Symposium in Russia

19. NHCIP Travel Report 1/90 Monitoring tour of barley

20. NHCIP Travel Report 2/90 Monitoring tour of barley

21. NHCIP Travel Report 3/90 Monitoring tour of barley

22. NHCIP Travel Report 4/90 Monitoring tour of barley

23. NHCIP Travel Report Participation in the April 9-16, 1990 IV Annual Workshop of All India Coordinated Small Millets Improvement Project

24. NHCRP Travel Report: 5/90. Buckwheat and Millets in Farming Systems in Dolpa Area.

25. NHCRP Travel Report: 6/90. Buckwheat in Central and Eastern Hill of Nepal.

26. NHCRP Travel Report: 1/91. Buckwheat in Chitwan Valley.

27. NHCRP Travel Report: 2/91. Barley Monitoring Tour Report to Jumla.

28. NHCRP Travel Report: 3/91. Barley Monitoring Tour Report to Mustang.

b) <u>Survey/Training Reports</u>

1. Training Report on Finger Millet Manual for Finger Millet Improvement in Nepal. February 8, 1991.

2. A consultancy report on: Finger Millet in Nepal: Importance, Utilization and Farming Systems in a Socio-Economic Context. February, 1991.

3. Barley Training Workshop Proceeding Feb. 24 - March 2, 1991.

4. Finger Millet Training Workshop Proceeding Oct. 7-12, 1990. June 1991.

5. Buckwheat Survey in Chitwan District.

c) Proceedings and Annual Reports:

01. Hill Crops Workshop Proceeding March, 1990

02. Hill Crops Workshop Proceeding November 1990

03. NHCRP Annual Report January 1990

04. NHCRP Annual Report July 1990

05. NHCRP Annual Report July 1991

d) Other Reports

01. Discussion on Operational Program Aspects and Workplan - Dec.2, 1989

02. NHCIP planning meeting - June 15 and 17, 1989

03. Hill Crops Planning Workplan - Dec. 7, 1989

Physical Developments

Within last three years, this program has established the following constructions with support from external donors:

1. Office cum lab. building (USAID) Threshing floor (IDRC)
2. Two residence buildings (USAID)
3. Store cum shade house (IDRC)
4. Two screen houses (Secondary Crops)
5. Dormitory building (USAID/ARPP)
6. Construction of about 400m long stone paved walking road inside the farm
7. Connection of electricity to its headquarters (SCDP support)
8. At Kabre, the terraces have been broadened to accommodate research trials. During the three years about 2 ha. of hilly terraces have been improved (IDRC support and HMG)

Benefit from Working Group Research Allocation

In case of hill crops this fund proved extremely useful. We did not have sufficient agronomy farms at high hill conditions under NARC. We made use of this fund to conduct the trials in some of the horticultural farms such as Kakani, Marpha and Dolpa. We paid only for the labour and materials cost, and their own manpower

was used for this purpose. Again, when NHCRP fell to conduct the special trials in some of the NARC system agronomy farms, we used this fund in this case too i.e. Jumla and Agronomy Division, Khumaltar. Sometime this same fund was used even to survey hill crops. So, in the present contest, this fund became very much useful for conducting the trial.

Equipments received (through IDRC Project)

During first phase the following equipment were received.

1.	Balance	3	2.	Moisture meters	2
3.	Camera	1	4.	Altimeter	2
5.	Motor cycle	2	6.	Thresher	1
7.	Calculators	5	8.	Sleeping bags	5
9.	Jeep (Pajaro)	1	10.	Microscope	1
11.	T 1200 Computer	1			

Most of above equipments are in Kabre Agricultural FArm; and these are being used for the specific purposes. The Jeep, one calculator one motor cycle and one sleeping bag are kept in liaison office, Khumaltar and being used for the program.

Benefit from local travel funds

The per diem provided by HMG/Nepal is extremely low, thus most the scientists and other staff are reluctant to travel. This funds were used for the following purposes.

1. Attending working group meetings.
2. Travelling for monitoring tours and RRA Treks
3. Travelling for distributing the minikits, and FFTs and trial sets.
4. Sometimes, attending other meeting too.

During the first phase of NHCRP, a lot of travels and tours were made due to the insentive of this fund.

Advisor

Dr. K. W. Riley joined NHCRP as the advisor in 1989 and worked until the end of the first phase in July 15, 1991. Basically he worked in the following fields:

a. Documentation, editing and preparation of the reports

b. Take part in monitoring tours and RRA Treks

c. Assist to conduct some of the trials

d. Development of concepts regarding the improvement of researches, collaboration with international bodies.

e. Organize trainings, workshops, meeting etc.

The service rendered by advisor to this program was very much effective, and this program is considered one of the successful one. The main credit goes to Dr. Riley. The impact of adivsor to this program proved extremely fruitful in the difficult and initial stage of this program.

Appendix I

THE FINDINGS AND RECOMMENDATIONS OF 1988/89 SUMMER AND WINTER HILL CROPS WORKING GROUP MEETING:

1. Finger Millet

A) Okhale-1 and NE 6401-26 are top yielders both in relay and mono conditions. They have performed well in farmer's field also. NE 6401-26 is about 5 days earlier to flower and mature than Okhale-1, and is being considered for release.

B) GE-002 gave higher yield in relay condition. GE-5026 and Rilli Carbo are also promising cultivars for relay condition.

C) For Terai environments, PL 85-182 and GE-5017 are the promising lines.

D) Some lines like NE 1703-34, NE 94, PL 86-163 are early maturing entries and can be tested for high hills. Most of the medium and late maturing genotypes did not mature at high hill conditions.

E) In relay condition, tall and full season maize varieties reduce finger millet yield up to 80%, but the short plant height and early maturing maize varieties reduce only up to 40% of finger millet yield. So, short plant types and early maize varieties are the suitable maize type for relay condition with finger millet.

F) PR-202 finger millet cultivar introduced from India as the SAARC trial, gave high yield and matured early at two locations.

G) In the initial evaluation trial, 3 cultivars for high hills, 6 cultivars for mid-hills and 4 cultivars for Terai environments are found promising.

H) Different genotypes from Nepal, India, Zimbabwe, Uganda and Ethiopia have been shown promise. They are being tested for different agro-climatic conditions in Nepal.

I) In Kabre condition, the optimum time of transplanting of finger millet is the first fortnight of Asadh.

J) Finger millet can be cultivated by direct seeding in mono and relay condition with maize at Kabre and similar environments.

K) Okhale-1 finger millet gave higher grain and straw yield, when 60 or more kg N/ha was applied.

L) Cercospora leaf spot disease is more common in the high hill

area and the blast disease is predominant in lower hills.

M) Finger millet relayed with maize was found to have less disease severity than in mono finger millet crop.

N) GE-5005, GE-5016, GE-5009, GE-042 and Okhale-1 are moderately resistant to cercospora leaf spot disease.

O) About 9.4% responses were obtained from finger millet minikit distribution during 2045/2046. The performance of six cultivars are encouraging.

2. **Barley**

A) A wide range of variation was observed in local landraces and exotic materials. The Andean lines showed more desirable traits than CIMMYT/ICARDA lines.

B) In IET IBON-119, IBON-172, B.N. Hona, IBON-96 and IBON-134 were high yielder. LB 100/ACC. 9017, LG 11/ACC. 480and IBON-184 were early maturing.

C) In CVT, NB 1003-37, WIC 2291/Mag.102 and Bonus were high yielder.

D) In FFT, Bonus was the highest yielder and liked many farmers; NB 1054 was the earliest maturing one.

E) In minikit distribution, 47% feed back cards were received. Bonus performed well and preferred by many farmers, but NB 1054 performed well only at high altitude areas and was liked by some farmers.

F) Stripe rust is the main disease and many lines were susceptible to this disease. Its severity was more at mid-hills than in other zones. Barley stripe disease, powdery mildew, loose and covered smuts are other important diseases of barley.

G) A severe sterility problem was observed in some barley genotypes at Kabre Farm.

3. **Buckwheat**

A) Germplasm from Canada, japan, USSR, Poland, India, Yugoslavia, South AFrica, China, Czechoslavia, USA, Sweden and local germplasms were evaluated in NHCRP, Kabre, 29 at Khumaltar and 11 at Jumla.

B) Sweet and bitter types are different in maturity, Plant height, test weight, number of branches, seed setting yield, and reaction to diseases.

C) Sweet buckwheat lines Tokya-S, GF 209 Mustang, GF 88 Humla, Shinshu Ichigo and IR-13 are promising. Similarly, bitter

buckwheat lines like GF 236 Mustang, GF 210 Khumal, Humla-T, Tanahu-T and Kabre-T performed well in initial evaluation trial.

4. Amaranth

A) Local and exotic germplasm of amaranth were tested in Kabre, Khumaltar and Jumla. The lines selected were 14 from Kabre and Khumaltar each and 7 from Jumla.

B) Amaranth cultivars A 44-2, A 12-2, A 18-3, A 102, A 36-4, and A 67-3 are promising for high hill and A-1020, A-1011, A-1027 and A-1028 are high yielder for Doti environment.

Appendix II

THE FINDINGS AND RECOMMENDATIONS OF 1989/90 SUMMER AND WINTER CROPS WORKING GROUP MEETING:

1. Finger Millet

A) The genotypes NE 1703-34, NE 94 and GE 0074 are promising for high hills condition.

B) GE 5001, PR 202, GE 5026 and GE 002 are good for mid hill mono cropped condition. Similarly GE 5016, GE 002, and Rilli Carbo are suitable for mid hill relayed (maize) cropped condition.

C) GE 5056, GE 5001, GE 5059 and Rampur local are good for terai condition.

D) The Indian entries in the SAARC finger millet trial area earlier than Nepalese entries, but were equal in grain + straw yields.

E) Extremely wide variation was found among Nepalese landraces. This variation will be a strong foundation for rapid improvement.

F) If the finger millet is relayed with early maturing maize varieties after silking, the overall reduction due to the shading of maize canopy will not be more than 15% at Kabre condition.

G) The preliminary results show that there is the need of evaluation of finger millet germplasm in the relayed condition in the early stage of testing materials.

H) In IET, 7 cultivars for high hills, 7 cultivars for mid hills and 6 cultivars for Terai environments are found promising.

I) In herbicide trial Butachlor was more effective in controlling weeds in finger millet than Basalin and 2,4-D Nasalt.

J) In Kabre condition, the optimum time of transplanting of finger millet is the first week of Asadh. (June 15-20)

K) Grain and straw yields of finger millet increased with chemical fertilizer upto 80 kg/ha. N and 30 kg/ha. P_2O_5; while response of K was negligible. Compost applied at farmers practice gave yields not significantly lower than the best yields with chemical fertilizer.

L) Leaf, finger and neck blasts and cercospora leaf spot are the main diseases of finger millet.

M) Leaf blast is severe at seedling stage and recovers after transplanting, early maturing genotypes have more finger and neck blasts, and varietal differences were observed in the diseases reaction. GE 5016, PR 202, GE 5168, GE 0346, GE 5165, GE 0381, GE 5174, GE 5203 and GE 5200 may have blast tolerance.

N) Cercospora leaf spot is problematic in cooler areas and its severity was more in mono cropped and high fertility condition. GE 5016, GE 0122, GE 0073, and GE 357 have low leaf spot infection.

O) Smut, and root rot are other finger millet diseases.

P) In FFT, for mountain NE 94, for mid hill NE 6401-26, NE 5059 and NE 002 and for Terai Rampur local and GE 5017 were found better. NE 6401-26 was found the most promising new variety for mid hill.

Q) About 31% responses were obtained from minikit distribution. NE 6401-26 was liked by many farmers, and it gave the highest grain yield as compared to other released and pre-released cultivars.

2. <u>Barley</u>

A) In minikit demonstration, NB 1054 performed well and was liked by many farmers of the high hill.

B) NB 1003-11 and NB 1003-37 were high yielder in FFT. NB 1003-37 was one of the high yielder in CVT test also. C) NB 5603 x CI 10443 and BN Hona were found promising in multilocation test.

D) In multilocation IET test, LGSI/Acc 7152, NB 1207 x CI 10448, NB 1003-64 and NB 1003-103 were found higher yielders, and LG 100/Acc 9017, Desnuda Desconocida-60, - 21 and -37, LG II/Acc 480 and 14th IBON 119 matured earlier.

E) Lines from ICARDA and CIMMYT had partial or full sterility, but plant type of CIMMYT or Andean lines was better than that of ICARDA lines. Several Andean lines were higher yielder at Khumal and resistant to stripe rust . Local landraces passes many desirable traits, so these should be used extensively.

F) The common insect-pests of barley in Nepal are wire worms, aphid, army worms, white grub, termites, cut worms and borers. Though 30 insects and non-insects associated with barley crop were listed in late sixties, only few of them are destructive to barley.

G) One of the reasons of barley sterility is cold weather, and other reasons are soil related factors. Local landraces are more tolerant than exotic sources.

H) In the first year test, there were no responses of different dosages of lime and phosphorus on the biomass yield, plant height and sterility of barley.

I) Barley in Nepal is affected by about a dozen diseases. Among them stripe rust (Puccinia striformis f.sp. hordei), stripe disease (Pyrenophora graminea), powdery mildew (Erysiphe graminea f.sp. hordei), covered smut (Ustilago hordei) and loose smut (Ustilago nuda) are the major barley diseases Barley stripe rust is the most destructive disease, and it is causing about 15-20% grain yield loss in Nepal.

J) Some of the barley varieties i.e. DD-60, 14th IBON-173, NB 5603 x CI 10448 and Tukuche local showed considerable variation in stripe rust severility and reactions. Many lines/varieties were found resistant to stripe rust at Kabre and Khumal conditions.

K) Seed treatment with two fungicides Sumi 8 and Vitavax 200 were found effective to control barley stripe disease.

L) NB 1003-37 was found more tolerant to stripe rust than NB 1054.

M) At Kabre condition, the yield loss due to stripe rust was found upto 39% on NB 1054.

N) The severity of stripe rust is maximum at 12.0% to 14.5 ^{o}C average daily temperature during February 1 to 11 in Kabre.

O) In pot experiment, some positive responses were observed to correct sterility by the application of molybdenum and agricultural lime.

P) Investigation in statistical methods for testing on hill terraces has shown the ways to increase precision by the use of frequent checks, small plot size and lattice design.

3. **Buckwheat**

A) In sweet type, Tokyo, IR-13 and GF 209 and in bitter type GF 68 and GF 210 are found superior.

B) In the preliminary trials, all together 14 lines were found promising.

C) A lot of variability was observed in observation nursery.

D) Powdery mildew, leaf spot, blight and wilting are the common buckwheat disease.

E) There is a need of separate set of trials for sweet and bitter types.

4. **Amaranth**

A) In CVT, GA 5025, GA 5028, and GA 5020 were better genotypes, and GA 44-2, GA 5015, GA 5041, GA 139, GA 5038 and GA 42-3 were promising in IET.

B) 158 different local germplasms from different districts possess high level of genetic variability.

C) Upto now foot rot, leaf spot and stem blacking are the observed amaranth diseases.

D) The NHCIP team has felt that amaranth research works should be limited to selected stations only.

Appendix III

THE FINDINGS AND RECOMMENDATIONS OF 1990/91 SUMMER AND WINTER HILL CROPS WORKING GROUP MEETING:

1. **Finger Millet**

A) Direct seeding of finger millet germplasm under maize was found a successful method for screening a large number of materials for improved competitive ability under maize.

B) In early testing sets GE 5190, GE 5206 and GE 5220 were found adapted to diverse climatic conditions.

C) In different Initial Evaluation Trial sets, GE 0122, GE 0484 and four other promising genotypes were found. Similarly, GE 0018, GE 0249 and four other cultivars were found promising for tarai.

D) In the high hill Coordinated Variety Trial, NE 1703-34 was found to be both a high yielder and early maturing. NE 94, GE 0150, GE 0356 and GE 5182 were high yielder and VL 122, GE 0074 and GE 0077 were early maturing.

E) GE 0122 and GE 5016 performed well in mid hill under both mono and maize relayed conditions, possessing higher grain and straw yields, and low incidence of cercospora leaf spot. In addition GE 5016 had low incidence of finger blast. PR 202 and GE 5169 were superior particularly in mono conditions, while GE 5166 was very good in relayed condition.

F) GE 5001 and PR 202 were both found to be early maturing, high yielding varieties. GE 5001 performed best in the midhills under relay with maize, while PR 202 performed best in the terai as a mono crop.

G) Early and medium maturing maize varieties were suitable for relaying with millet. Increased competition between maize and millet affected several agronomical traits of both component crops.

H) Direct seeding of finger millet at Kabre was found to be a successful method and comparable to transplanting in some conditions.

I) Increasing competition between finger millet and maize, decreased the grain yields of maize more than those of finger millet. Combined grain yields were the highest when millet was transplanted 60 days after maize planting.

J) N:P:K at the rate of 80:30:10 kg/ha gave the highest grain and straw yields of finger millet. Farmers level of compost with 20 kg/ha N as the top dressing gave higher grain yield.

K) In an early maturing variety, higher grain yield was obtained when 3 seedlings per hill were planted as compared to one seedling, which is the traditional method, but the reverse trend was observed in the medium maturing variety.

L) Some Indian lines IGE 3486, IGE 3526, IGE 3493, IGE 3087 and IGE 3093 were found immune for 3 types of blasts and IGE 3539 and IGE 3472 were found resistant to leaf, finger and neck blasts. Nepalese germplasm GE 194, GE 180 and GE 346 showed resistant reaction to neck and finger blasts.

2. **Barley**

A. In CVT mountain set WI 2291/Magnif 102 and LG-51 were early maturing and high yielder. Similarly NB 1207/CI 10448, Solu Uwa and NB 1003-64 were early maturing and B.N. Hona was higher yielder.

B. In CVT hill set 14th IBON-172, NB 5603/CI 10448, WI 2291/Magnif 102 and B.N. Hona were high yielder and NB 1003-11, NB 1003-37, LG-51, NB 1003-64, DD-14, LG-11 and NB 1207/CI 10448 were early maturing cultivars.

C. In IET mountain set, six genotypes earlier maturing and seven were higher yielder, and in IET hill set, seven high yielder and four early maturing genotypes were identified.

D. In advanced Observation Nursery, based on the maturity, grain yield, disease reaction and plant type 24 lines were selected. DD-9 was selected in all locations.

E. Out of 1388 world naked barley collections seventy six accessions were selected for further evaluation.

F. Out of 429 local barley germplasm characterization, wide variation was observed for the 26 traits used in the characterization, and correlations among traits revealed many useful relationships. Naked and covered barleys show some distinct differences in their characters.

G. By the use of 28 (6 + 22) selected parents 157 (6 + 151) crosses were made and these will be evaluated by different methods.

H. At Kabre condition, N:P:K @ 60:30:0 kg/ha. gave higher yield, and in Jumla condition N. @ 90 kg/ha. gave higher yield. At Khumal condition 60 to 90 kg N, 20 kg P_2O_5 and 10 kg K_2O per ha. gave 4.8 to 5.3 m.t. grain/ha.

I. Use of organic matter greatly helped to alleviate barley sterility. Raising pH alone in the absence of O.M. did not over come the sterility problem.

J. In the seed rate trial, two different barley cultivars responded differently. Yield of Bonus (covered) increased with increasing seed rate, but yield decreased with increased seed rate in Solu Uwa (naked). In both the lines, no. of tillers/m^2 and total biomass increased with higher seed rate.

K. In CVTs and IETs multi-location test, DD-14, 14th IBON-119, B.N. Hona, IX VEOLA-6, DD-37, 14th IBON-62, DD-38, X VEOLA-32, DD-60 and BDON-2 showed fairly low yellow rust severity and were found superior to other cultivars from yellow rust infection point of view.

L. Similarly, in observation nursery X VEOLA-9, X VEOLA-53, X VEOLA-58, BDON-16, ACC. 1586, DD-9, IX VEOLA-21 and IX VEOLA-47 had low yellow rust reaction and many VEOLA lines were found free from yellow rust at Jumla condition.

M. In the study of experimental design for hill, the findings were a). in unreplicated observation nurseries, the use of 2-row plots and frequent checks control the variation b). in replicated trial of barley, a plot size of 4 rows with 4 replications is optimum for limited conditions and c). lattice design increase the quality and precision of hill experiments by reducing CV and LSD respectively. These

findings should be applicable for small grained crops.

N. In a pot experiment using Kabre soil 6 t/ha. lime and 20 t/ha. FYM gave higher grain and biomass yields. Lime and copper application increased effective number of tillers.

O. In the yellow rust tolerance study, the yield loss by this disease was upto 94%. Bayleton was effective to reduce the infection of yellow rust and to increase total biomass, grain yield, grain filling period and test weight.

P. In the yellow rust epidemological study, the tested varieties show different disease reactions in term of rate and time of infection, and varietal tolerant ability.

3. Buckwheat

A. Based on one year result, the same Nepalese bitter buckwheat germplasm can be planted both in spring and autumn, but sweet type germplasm performed differently during two seasons, and are difficult to grow in spring season.

B. Nepalese buckwheat germplasm showed wide genetic variability for many traits, and in general bitter type has wider variability than that of sweet type.

C. The sweet cultivars # 85603, GF 5283, # 85624 and GF 5153 were promising for mid hill and GF 209 was found high yielder at Marpha condition.

D. In bitter set, GF 216 and GF 212 performed well across the location.

E. In the preliminary evaluation ACC 2198, ACC. 2220, ACC 2225, ACC. 2227 and ACC. 2234 were found promising across the locations.

4. Amaranth

A. The cultivars GA 5025, GA 5028, GA 3020, GA 18-3, GA 67-3 and GA 5041 were promising.

B. In Jumla GA 130, GA 220, GA 1018, GA 42-2 and other four cultivars yielded more than 2000 kg/ha.

5. Outreach Research

A. In high hill finger millet genotypes NE 94 and NE 1703-34 matured early than locals, but gave low yield, and in mid hill GE 5059, Kalobhunde and GE 002 performed better than the local checks.

B. In minikit demonstration of finger millet 18% feed back cards was received. NE 1703-34 yielded higher than the recommended three finger millet varieties.

C. In minikit demonstration of barley NB 1003-11 and Solu Uwa performed well. Similarly the yield of NB 1003-37 also was as par with the standard released variety Bonus. 222 response cards out of 619 minikit (35.8%) were obtained.

D. In high hill FFT of barley set Solu Uwa was earlier and NB 1003-37 at par with local check, and in mid hill Bonus is high yielder and the two promising lines NB 1003-37 and NB 1003-11 also were equally good.

E) Initial outreach research works on buckwheat and grain amaranth also were started this year. In buckwheat Shinano-Ichigo, Sinsu-O-Soba and Darja and in grain amaranth GA 5025, GA 5041 and GA 18-3 were found promising.

Appendix IV

RECOMMENDATIONS FROM NATIONAL BARLEY TRAINING WORKSHOP FEBRURARY, 1989

1. Locations/Environments

1.1 Nepal possesses extreme diversity in its barley growing areas. It was agreed that better definition of barley growing environments are required for an effective barley improvement in Nepal:

- The use of LRMP data, especially, land capability, land use and topotraphical maps can be used to locate the barley areas and to plan suitable strategies for improvement.

- More information on temperatures, rainfall, soil moisture during crop growing period are other important parameters to be used to define barley environments.

- Verification of this information is required through Samuhik Bhraman/Joint trek which consists of people of different specialist bakcgrounds to identify constraints, and strategies for improvement.

1.2 Classification of environments using barley genotype responses is an extremely useful method for stratifying similar and different environments.

1.3 Jumla is the most important location for testing barley in high altitude area of Nepal. Increased testing capabilities at that location is desirable. In mid-hills Lumle, Pakhribas and Khumaltar are the major centres for continued testing. More high altitude testing sites in different development regions are needed, and general up-grading of the hill stations is recommended.

2. Germplasm

2.1 Nepal has great diversity of barley germplasm, which possess many desirable characteristics.

2.2 Although many germplasm expeditions have taken place in Nepal and many barley landraces have been collected, there is need for further systematic collection; especially above 3000 m in isolated barley areas. Evaluation, documentation and preservation of these materials also equally important.

2.3 ICARDA have agreed to act as back up long term storage of Nepalese barley germplasm collections as bulk.

2.4 Further collection expeditions should take place immediately, as a successful national barley improvement program is likely to replace many landraces with improved varieties.

2.5 It is recommended that more national facilities are needed for systematic collection, evaluation, documentation, utilization and preservation of barley germplasm.

3. Breeding

3.1 Since early seventies barley improvement was started by collection, introduction, selection and hybridization with the objective of developing improved varietal for different barley growing areas of Nepal.

3.2 In spite of many limitations local and introduced varieteis with improved performance have been identified. However, the impact of these varieties have not been widely felt.

3.3 Local landrace selections have been shown to possess high yields, stability and good adaptation in many locations in Nepal. It is recommended that these best varieties should be released in the specific areas.

3.4 More emphasis should be given to further improving landraces through pure line selection.

3.5 The introduced bonus variety has given good yields across several locations and stable over years, which is likely due to stripe rust resistance. Several recent introductions from ICARDA/CIMMYT have shown promise. Specific introduction possessing useful traits include earliness, stripe rust resistance, and tolerance to sterility may be useful for direct use in specific environments. Other introductions, possessing some specific desirable traits can be used as parents in a cropping program.

3.6 It was recommended that limited hybridization be initiated for the medium and long term improvement of barley varieties.

3.7 The national program will identify the specific genotypes to be used as parents. The hybridization and advance of progenies would be carried out concurrently in ICARDA (Mexico and Syria) and Nepal.

3.8 Most impact in Nepal from the barly improvement program in the diversed environments with limited sources can be anticipated by the consideration of the following strategies:

- develop specific testing methods for the hills on terraces having high variability.
- reduce of number of entries, with increased replication in advanced lines.
- management of trials should be carried out under the level of inputs that the farmers can achieve over time (sustainable level of inputs).
- emphasis on developing stable genotypes at a particular location, which perform well over a long period of time.
- special attention should be given for the food barley in relation with nutrition and food quality. This includes increased works on naked barley for high and mid hills, and evaluate food quality in collaboration with ICARDA/Syria.

4. Plant Protection

4.1 Diseases and insects are constraints for barley production in Nepal. Stripe rust, leaf stripe disease, smuts and powdery mildew are the major barley diseases. Genetic resistance is the most economical way of controlling these diseases.

4.2 Close collaboration with the ICARDA/CIMMYT program will be useful in developing varieties with multi-disease and multi-race resistance.

4.3 Further investigation of mechanisms of either tolerance or adult plant resistance in local materials was recommended.

4.4 The identification of prevalent races of stripe urst in Nepal using appropriate differentials is important. To accomplish this study, ICARDA has agreed to collaborate. Information on epidemiology is needed at least for major barley diseases and this needs to be studiesd in furture at some disease prone areas of Nepal.

4.5 Insect pests research strategy need to be further investigated in collaboration with ICARDA.

4.6 Research to control insects by the economic ways should be studied.

5. Sterility

Sterility is a serious problem in many exotic barley genotypes presently being tested here. There are several possbile causes,including low soil pH, micronutrient deficiencies, temperature fluctuations and frost damage during flowering. Soil and other investigations should be continued to identify the problem. Since local landraces have seldom shown sterility, development of improved genotypes with resistant to sterility is essential.

6. Manpower

6.1 Considering the importance of barley in Nepal, there is a need of barley leader with full responsibility for this crop.

6.2 At present, these are very few people trained in barley, it is recommended to train Nepalese scientists at ICARDA/CIMMYT as a visiting and short term training. ICARDA is willing to cooperate in this aspect.

7. General

7.1 The group has recommended to organize International Barley Workshop in Nepal in the near future. The workshop will focus to tackle the challenges of barley production in high altitude area of different countries.

7.2 On the basis of above recommendations, national scientists will develop the future action plan for the barley improvement in nepal. If needed, national scientists will consult the ICARDA scientists.

Appendix V

RECOMMENDATIONS OF THE NATIONAL FINGER MILLET TRAINING WORKSHOP, OCTOBER 1990

The following recommendations were made following the group discussion.

1. Varietal Improvement/Breeding

1.1 The NHCRP should develop suitable finger millet varieties for four adaptation domains as identified on the basis of physiographic environment of the country. They are:

a. Mid Hill: Maize + Millet - Fallow system of varying maturing groups.

b. Mid Hill: Maize + Millet - Winter crop, possibly of early maturing group.

c. High Hill: Early and more cold tolerant group.

d. Terai and Inner Terai: Heat tolerance in varying maturity groups.

1.2 Because of remarkable temperature and rainfall differences between the east and the west, study first the environmental parameters in relation with the millet genotypes and develop adaptation domains separately for the eastern and western hills.

1.3 There is lack of testing sites in the mid hills of far and midwestern regions and in the lower mid hill of western region; therefore identify suitable testing sites for those regions. Farming system testing sites of the far and mid western regions and Khairenitar Agriculture Training Centre of the Western region.

1.4 Continue to make three trial sets as at present viz. Mountain set, Hill set and Terai set. Under relay condition, late heading but fast grain filling selection criteria may be suggested.

1.5 Continue head to row selection from local landraces to improve existing cultivars.

1.6 Use contact method of hybridization between identified local and exotic sources to recombine their useful traits as a part of long term improvement program.

1.7 In view of substantial dependence by the farmers on millet for fodder, select for traits which are associated with fodder yield and fodder quality. Stress more on the total biomass rather than on the harvest index (HI).

1.8 Start making qualitative test for better food processing and alcohol or rakshi making (malting quality) in collaboration with the National Food Laboratory and other international institutions.

1.9 In order to maintain purity of the seed, grow foundation seed in the field where no millet was grown in the preceding year.

1.10 Seek cooperation from NGOs as well, for the dissemination of improved technology. Strengthen FFT and Minikit distribution for effective improved seed distribution. Pilot production program may also be suggested.

1.11 Collect millet germplasms from areas where little or no collection was done in the past.

1.12 During the course of collection and characterization, identify and specific traits that a germplasm possesses.

2. Agronomy and Farming Systems

2.1 Give highest priority to the study of Maize/Millet competition, which should be carried out under different physiographic environments.

2.2 In the light of the important maize/millet system in Nepal, establish good collaboration with the National Maize Program to develop more suitable millet varieties. Greater role of Farming System Research Division to bring coordination may be suggested.

2.3 Study optimum plant population in early as well as late maturity variety under relay condition. A delayed head emergence but fast ripening variety to minimize the effect of maize interception may be suggested for selection.

2.4 A study on direct seeding vs transplanting under maize may also be suggested particularly in view of minimizing weed problem by transplanting on one hand and saving labour by direct seeding on the other.

2.5 Study on the conservation and maintenance of soil fertility by introducing winter legumes after maize/millet.

2.6 Carry out a field study in different farms and locations for fertilizer recommendations for a top dressing without ignoring the strongly based traditional compost manuring in the maize field. Fertilization recommendation for optimum growth of the millet nursery should receive priority.

2.7 Continue the on-going Rapid Rural Appraisal (RRA) particularly the interior areas off the main road to better understand the specific constraints.

3. Plant Protection/Disease Resistance

3.1 Carry epidemiological and loss assessment studies and screening of finger millet against cercospora and blight in the hills and against blast in the hills as well as terai.

3.2 Identify possible cercospora free areas in the hills where cercospora susceptible but high yielding varieties can be grown without yield loss.

3.3 More information may be needed on Helminthosporium blight particularly from introduced materials of African origin.

3.4 Collaborate with the Division of Plant Pathology and Entomology to assign Plant Pathologist each to work on

finger millet at the centre.

3.5 Weeds may be a major problem in finger millet in some areas. With the support of weed scientist from the Division of Agronomy, identify major weed species and develop efficient weed control measures under transplanting as well as direct seeding in the maize/millet system.

4. Post Production and Socio-economics

4.1 Study the effect of long term storage, a common practice in many farm houses, on the nutritional quality of finger millet.

4.2 Initiate exploring improved finger millet processing techniques or borrowing improved technology developed by CFTRI, Mysore, India for food and malt purposes.

4.3 Collaborate with the Department of Agriculture Marketing and Statistics to study and establish finger millet marketing in the rural area.

5. Research Collaboration

5.1 Establish collaborative approach with the national and international institutions such as All India Coordinated Small Millet Program, Bangalore, India and Millet Program of SADDAC/ICRISAT, Zimbabwe for germplasm/elite material exchange, crossing program, plant disease problem, quality testing, training and visits and participation int he workshop.

5.2 Establish strong linkage with the in-country NGOs for extension and outreach activities.

Appendix VI

RECOMMENDATION FROM THE SURVEY REPORT OF "FINGER MILLET IN NEPAL (A RAPID RURAL APPRAISAL)"

1. Finger millet has an important role to play in meeting the needs of farmers and consumers as a food and cash crop, and in sustaining productive farming systems. Government and other development programs should play a vigorous and effective role in promoting and developing this crop.

2. The development of finger millet varieties with high fodder and yield potential for upper mid hills and high hills is suggested. The varieties should include the characteristics like cold tolerance and resistance to cercospora and hailstone damage.

3. As finger millet (far western hills) was grown as mono crop and in drier conditions in Doti area, the development of a

variety with high yield potential specially for Doti area is recommended. As the finger millet is followed by winter crop (mostly wheat) in most of these areas, early maturity is a desirable character to be considered.

4. Cropping system experiments are needed in mid hills of eastern region aimed at increasing the rate of winter cropping, especially to fit barley or wheat in maize/millet system without hampering the following maize crop.

5. Many local landraces like Dalle, Nangkatuwa in Dhankuta, Urchho, Keraunte and Kalobhunde in Kaski, were found tolerant to the stress of edaphic and foggy weather conditions. These landraces, which are performing better in terms of crop yield and grown in limited pocket, need further selection and extension to suitable areas.

6. Time saving technology for operations such as transplanting, weeding, harvesting, milling and alcohol preparation should be developed or adopted if such technology exists.

7. Finger millet production is to be encouraged as a staple food specially in deficit areas and as a source for income generation, where markets exist for it.

8. As finger millet has malting and fermenting quality, its use in preparing weaning food for undernourished children needs to be promoted through recipe developments.

9. It is recommended that different promising finger millet varieties be tested for their nutritive values, which would help in formulating different types of foods.

10. Jandh and Tumba (fermented alcoholic beverages) consumption has traditionally been practiced by Rai, Limbu and Magar communities. The children and lactating mothers of these communities are also given those fermented stuffs. Further studies on nutritive values and effect of these beverages on the health and nutrition of children and lactating mothers are suggested.

11. Finger millet has been increasingly used as cash crop specially in the eastern mid and high hills. Although markets for finger millet exist there, they need to be organized properly. while the western and the far western mid hills require the marketing systems to be developed.

THE END