ANNUAL REPORT

1994-95

RENEWABLE NATURAL RESOURCES RESEARCH CENTRE

BAJO, WANGDUEPHODRANG

RESEARCH, EXTENSION & IRRIGATION DIVISION
ROYAL GOVERNMENT OF BHUTAN
MINISTRY OF AGRICULTURE

C O N T E N T S

ABOUT THIS CENTRE

Established in 1982 as the Centre for Agricultural Research and Development (CARD) basically to undertake research on rice and rice-based crops, it has been renamed as the Renewable Natural Resources Research Centre (RNRRC) to incorporate research on livestock and forest that are inseparable components of the Bhutanese farming systems. The Centre is located at Bajo (1300 m) in Wangduephodrang, which is about 70 km west of the capital Thimphu.

RNRRC Bajo is designated as the coordinating centre for Field Crops (cereals, oilcrops, legumes) research and development at the national level. At the regional level, this Centre is mandated to undertake relevant research for its client dzongkhags of Wangdue, Punakha, Gasa, Tsirang and Dagana in arable agriculture, livestock and forestry. The Centre has a 30 ha research farm and its immediate future expansion plans include construction of a research complex to house offices, laboratories, training hall, library and a genebank.

The Centre undertakes an intensive program of research; extension through its onfarm research program; training of extension personnel and farmers; and other interdisciplinary activities both at the national and local levels. It introduces, adapts and develops technologies suitable for the local agroecological environments and helps farmers raise their standard of living through increased incomes and sustainable farm productivity and production. Research is based on the policy guidelines of problem orientation, disciplinary and inter-disciplinary focus, relevance, environmental and institutional sustainability and equity. Research strategies aim at improving the productivity, profitability, stability and sustainability of farming systems while conserving the fragile environment and fostering development of an integrated crop-livestock-forest system.

RNRRC Bajo receives technical support and improved germplasm from IRRI, AVRDC, CIMMYT, ICRISAT, ICARDA and a number of other regional agricultural research institutes. In addition to the RGOB core budget for recurrent expenditure, the Centre also receives support in the form of field and laboratory equipment, vehicles, technical expertise etc. from IDRC-SDC through the IRRI-Bhutan Rice Farming Systems Project, and other development projects of the region.

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ABOUT THIS REPORT

This is the tenth technical report produced from this research centre since 1984. Unlike the earlier reports that were based on calender years, the present report follows the RGOB's financial year that runs from 1 July to 30 June. This report covers research conducted during July 1994 - June 1995. The report refers to crops sown in November 1994 and harvested in April-May with respect to winter crops like wheat, oilcrops and vegetables. The summer crops are mostly planted in June-July and harvested in October - November. Some experiments are reported completely while others are ongoing and interim results are reported.

Following the recent reorganization at the ministerial level and the subsequent change in the nomenclature and even the mandate of this centre, the reporting format has been slightly modified. In order to facilitate the broadening of its mandate, the centre has adopted a more disciplinary research approach built on programs, subprograms and projects that cuts across commodities. This has necessarily altered the reporting format and structure of this technical publication.

In the process of reorganization, four programs- Field Crops, Horticulture, Livestock, and Forestry Program, were recognised at the national level in addition to the Systems Resource Management Program at the regional level. The report is presented program by program.

Abbreviations used in this report are listed in the following pages. The report uses the International System of Units (SI) with few exceptions. Control or check normally means an untreated control. Grain yield is calculated as rough rice at 14% moisture content (MC), wheat at 12% MC and oilseeds at 8% MC.

Yield refers to grain yield unless otherwise noted. Fertilizer amounts are given in terms of elements (N, P, K, Zn etc) and not in the older conventional oxide formulations.

Pedigrees are indicated by a slant bar (/) rather than by multiplication sign (x). Unless otherwise stated, the morphological characters of rice and insect pest damages are based on scales in the "Standard Evaluation System for Rice" published in IRRI, Philippines.

A single asterisk (*) means a significant difference at the 5% level of significance and ns means not significant. Separation of means in a table is usually by Duncan's Multiple Range test at 5% level of significance, unless otherwise stated.

This program report was edited by Mahesh Ghimiray supported by GB Chettri, Sangay Duba, TR Gurung and Yuden Dorji.

EXECUTIVE SUMMARY

ABBREVIATIONS & ACRONYMS

ADP	Area Development Project
AET	Advanced Evaluation Trial
AVRDC	Asian Vegetable Research and Development Centre
a.i.	active ingredient
BL	Blast
CAN	Calcium Ammonium Nitrate (see N)
CARD	Centre for Agricultural Research and Development
CIMMYT	International Maize and Wheat Improvement Centre
cm	centimeter
CRI	Crown Root Initiation
CV	Coefficient of Variation
DMRT	Duncan's Multiple Range Test
DOA	Department of Agriculture
DAT	Days after transplanting
DAS	Days after sowing
ESWYT	Early Spring Wheat Yield Trial
FAO	Food and Agriculture Organization
FLW	Flowering
FYM	Farmyard manure
gm	gram
GA	Genetic advance
GCV	Genetic Coefficient of Variation
ha	hectare
hr	hour
Ht.	height
IBWSN	International Bread Wheat Screening Nursery
ICRISAT	International Crop Research Institute for the Semi-Arid Tropics
ICARDA	International Centre for Agricultural Research in the Dry Areas
IDRC	International Development Research Centre
IET	Initial Evaluation Trial
IFAD	International Fund for Agricultural Development
IIRON	International Irrigated Rice Observation Nursery
INTHOPE	International Hot Pepper Trial Network
IPM	Integrated Pest Management
IPNS	Integrated Plant Nutrient Study
IRCTN	International Rice Cold Tolerance Nursery
IRDSN	International Rice Drought Screening Nursery
IRRI	International Rice Research Institute

INGER	International Network for Germplasm Evaluation of Rice
ISWYN	International Spring Wheat Yield Nursery
K	Potassium (K_20, Muriate of potash 60% K)
LSD	Least significant difference
m	meter
MAT	Maturity
MoA	Ministry of Agriculture
MP	Muriate of potash (see K)
N	Nitrogen (urea 46%, calcium ammonium nitrate 20% N)
NASEPP	National Seed and Plant Programme
NPPC	National Plant Protection Centre
no.	number
n.s.	not significant
NWAB	National Women Association of Bhutan
P	Phosphorus (P_20_5, single super phosphate 16% P)
PaCp	Phenotypic Acceptability
PCV	Phenotypic Coefficient of Variation
PON	Preliminary Observation Nursery
PE	Panicle Exsertion
PET	Production Evaluation Trial
PI	Panicle initiation
PRET	Pre-production Evaluation Trial
RCB	Randomised complete block
REID	Research, Extension and Irrigation Division
RGOB	Royal Government of Bhutan
RNRRC	Renewable Natural Resources Research Centre
SAVERNET	South Asian Vegetables Research Network
S.E	Standard error
S.E.S	Standard Evaluation System for rice
Sh.Bl	Sheath Blight
Sh. Rot	Sheath Rot
sqm	square meter
SSP	Single Super Phosphate (see P)
t or mt	metric tonnes (1000 kg)
w/w	Weight/Weight

P E R S O N N E L

Research Scientists

Ganesh B. Chhetri MSc (Plant Breeding)	Program Coordinator
Mahesh Ghimiray BSc (Agri)	Research Officer
Tayan Raj Gurung BSc (Agri)	Research Officer
Sangay Duba MSc (Agronomy)	Asst. Research Officer
Yuden Dorji BSc (Agri)	Asst. Research Officer

Field Technicians

Sangay Dorji Agri. Diploma	Senior Research Inspector
Dhurba D. Chhetri Agri. Certificate	Research Inspector
Sib Charan Kujur Agri. Diploma	Research Inspector
Chandra B. Tamang Agri. Diploma	Research Supervisor
Neelam Pradhan Agri. Diploma	Research Supervisor
Kezang Tashi Agri. Diploma	Research Supervisor

Administrative/support staff

Ram K. Chettri	Account Clerk
Sangay Gyaltshen	Store Incharge
Sita Chhetri	UDC Gr.1
Sonam Jamtsho	Tractor Driver
Hemlal Kattel	Tractor Driver
Desh B. Rai	Driver
Ugyen Tashi	Driver
Nidup	Driver

National Work Force/Field labourers

Male	14
Female	14
Total	28

Research Programs

Field Crops Research

FIELD CROPS RESEARCH

The principal research objective of this program is to increase and sustain the productivity and the production of rice, maize, wheat, mustard, vegetables and grain legumes. This program is segregated into 3 distinctive subprograms aimed at germplasm development, production management, and post-harvest management. These subprograms are further divided into a number of projects that contain a series of activities. As an interlink between the various programs at the national level, the Systems Resource Management Program is centralised within the REID of MoA. It comprises of projects on Farming systems research, Soil and water management, Agro-forestry, IPM and Irrigation management.

Integrated Germplasm Development

The main focus of this subprogram is to develop improved germplasm with high yield potential, superior grain quality, multiple resistance to major diseases and insects, and medium growth duration. This subprogram is essentially broken into 5 projects to embody rice, wheat, oilcrops, vegetables and fruits.

Rice

Attempts to improve Bhutanese rice germplasm date back to the late sixties. However, systematic and institutionalized efforts started only in 1982. The following are the major objectives of this project :

- ☞ To increase the productivity and the total production of rice at the national level
- ☞ To introduce, evaluate and recommend high yielding, improved rice varieties suitable under low to moderate input levels and at the same time responsive to higher inputs
- ☞ To improve the traditional rice varieties through breeding and selection
- ☞ To test and identify varieties suitable for different cropping patterns and for different agroecological zones.

The general methodology of assessing the performance of either introduced or locally bred varieties ensures that the entries are subject to moderate fertilizer and cultural management systems reflecting the farmers' actual practices. Seedlings are raised following semi-dry nurseries. Fields are cultivated using tractor-drawn spring tine harrow, and puddled with power tiller and levelled by planking. Seedlings are transplanted at 20 x 20cm spacing except for breeding lines where 30 x 30cm is used. Fertilizer doses applied are 70-30-20 kg NPK/ha, with half the N topdresses at PI. Weeds are controlled using Butachlor and spot weeding as necessary. Harvest and post-harvest operations are done manually.

To achieve the above stated objectives, following strategies are presently pursued :

1. Germplasm Introduction

Rice germplasm are introduced from regional and international research institutes and thoroughly evaluated under Bhutanese field conditions. In 1994-95, more than 300 varieties and breeding lines were tested in the research station as well as in the farmers' fields. Of these, about one-third were selected for further assessment.

1.1 Introduction Nursery (IN)

In the Introduction Nursery that consisted of 118 early maturing entries from IIRON, only 16 superior lines were selected for further observation (Table 1). Most of the entries were shorter than IR 64 in plant height and hence they were rejected. Several H-lines from Argentina were selected due to their superior phenotypes although they were not taller than IR 64. Some of the major selection criteria used were flowering and maturity days, plant height, tillering ability, and overall phenotypic acceptability at maturity. Insect and disease pressure was not adequate for differential rating.

Table 1. Selections from Introduction Nursery.

Designation	PaCp (0-9)	50% Flw days	Plt.ht cm	Origin
BKN85073-16	3	105	92	Thailand
CL SELECTION 56	5	105	88	Brazil
CL SELECTION 87	5	105	86	Brazil
CT8262-8-2-2-M-3P	3	107	85	CIAT
CT8455-1-13-1-M-2P	3	103	90	CIAT
CT8455-1-24-1P-M-4P	3	103	86	CIAT
H185-5-2-1	3	108	87	Argentina
H202-7-1-1-1	1	108	88	Argentina
H238-44-2-1-1	1	110	84	Argentina
H255-43-1-1-1	2	108	85	Argentina
H255-9-3-1	2	108	86	Argentina
H274-27-1-1	2	105	84	Argentina
H274-3-1-1	1	106	89	Argentina
PR23384-10	5	112	90	Philippines
TOPOLEA 64/76	3	102	92	Romania
ZHEN-GUI-AI1	5	107	90	China
IR 36 (Std. check)	5	103	77	IRRI
IR 64	3	113	84	IRRI
ZAKHA	5	116	118	Bhutan

1.2 Observation Nursery (ON)

Eighteen introduced and 17 cross-bred lines were assessed in single plots of 10 sqm. A total of 14 lines were selected (Table 2)for further testing based on maturity, plant height and PaCp. Many of the hybridized lines displayed sterility, non-uniformity and lateness in maturity. The selected entries will be further tested in yield nurseries.

Table 2. Selections from Observation Nursery.

Designation	PaCp (0-9)	50% Flw (days)	Plt.ht (cm)	Yield (t/ha)
BR1543-5-1-2-3	5	117	77	5.576
CT8249-2-7M-1P	5	123	85	5.727
CU8068	3	123	85	6.448
IR58100-144-3-2	5	121	95	4.263
RP2542-1639-50-57	3	116	84	6.308
KUNMING 830	5	100	105	6.493
RP1848-213-5-1	5	107	100	5.513
IR61328-1-92-2-3-1-1	5	100	117	5.064
IR61328-1-92-2-3-2-2	4	106	112	5.646
IR61328-1-136-2-1-2-3	3	104	86	6.746
IR61331-2-25-2-3-1-1	3	104	85	6.600
IR61331-2-25-2-3-2-2	1	104	88	6.871
IR61331-2-38-21-1-1	1	104	86	6.076
IR60553-2B-7-1-2	5	108	95	5.357
IR 64	3	121	78	5.786
IR20913	5	100	107	4.700
LOCAL ZAKHA	5	123	116	4.661

1.3 Initial Evaluation Trial (IET)

Following the standard evaluation procedure, 18 CARD breeding lines were tested along with standard check varieties. The CARD lines originated out of the crosses between Bhutanese locals (Maap or Kaap) and improved high yielding varieties. The objective of this trial was to identify varieties that have the desired maturity period, resistance to prevailing insect pests and diseases and high yield potential.

The entries were laid out in a randomized complete block with three replications. Inorganic fertilizers were applied at the rate of 70-40-20 kg NPK/ha, with half the N as topdress at PI. Seedlings were transplanted in 10 sqm plots at a spacing of 20 x 20 cm. Grain yield was estimated from 5.04 sqm and moisture content standardized at 14%.

Statistical analyses of grain yield and other characters are presented in Table 3. A cross-bred line IR56346-1-1-R-1-9-1 significantly outyielded the local check Zakha and most of the improved entries. Several CARD lines also performed very well outyielding Zakha. It was notable that many CARD lines involving IR 64 and local Kaap or Maap yielded more than IR 64, albeit not significantly. Occurrence of insect pests and diseases was negligible.

Table 3. Grian yield and other plant characters of varieties/lines in IET

Varieties	Yield t/ha	50% Flw days	Plt.ht cm
IR56346-1-1-R-1-9-1-1	7.699 a	103 fg	99 cd
CARD20-21-3-2-1-3-2	7.178 ab	105 de	86 gh
CARD20-21-3-2-1-1-1	6.950 ab	100 jk	88 fgh
CARD21-10-1-1-3-2-2	6.912 ab	105 de	98 cd
CARD20-21-3-2-3-1-1	6.902 ab	102 hi	89 efg
CARD21-15-4-1-2-2-1	6.771 abc	99 kl	109 b
CARD20-21-3-2-3-2-B	6.769 abc	102 hi	89 efg
CARD20-21-3-2-1-1-2	6.676 abc	99 kl	85 gh
CARD20-21-3-2-3-3-B	6.489 a-d	104 ef	95 cde
IR 64	6.470 a-d	114 a	82 h
IR60553-2B-7-1-2	6.389 bcd	106 cd	93 def
CARD20-21-3-2-1-3-1	6.345 bcd	101 ij	88 fgh
CARD21-13-2-1-3-1-B	6.140 bcd	104 ef	96 cd
CARD21-15-2-1-3-2-2	6.058 bcd	107 c	100 c
CARD20-21-3-2-3-1-2	5.952 bcd	98 l	93 def
CARD21-15-4-1-2-2-2	5.920 bcd	103 fg	108 b
CARD21-10-1-1-3-2-3	5.632 cde	100 jk	95 cde
CARD21-15-1-2-3-1-2	5.367 de	99 kl	94 c-f
ZAKHA	4.761 e	109 b	119 a
CV %	10.0	0.8	3.6

1.4 Advanced Evaluation Trial (AET)

Sixteen varieties and advanced breeding lines were evaluated in this experiment. The entries in this trial were among the best performers at the station level. The objective of the trial was to select the most promising varieties in terms of grain and straw yields, maturity period and resistance/tolerance to biotic stresses. The elite materials generated from this traial would then be tested in the farmers' field conditions.

The trial was laid out in a randomised complete block with three replications. Seedlings were transplanted in straight rows at a spacing of 20 x 20 cm in 10 sqm plots. Chemical fertilizer

was applied at the rate of 70-40-20 kg NPK/ha, with half the N topdressed at PI. Weeds were controlled by using Butachlor 5G at the rate of 1.5 kg a.i./ha. Spot handweeding was done whenever necessary. Grain yield was obtained from a harvest area of 5.04 sqm. Results are presented in Table 4.

Statistical analysis on grain yield showed that BG 850-1 and IR 64 produced significantly higher yield than the local Zakha and some other entries. Of the cross-bred lines, CARD21-3-2-1-1-3 and IR61331-2-148-B did very well producing over 7 t/ha. Maturity-wise, these lines were similar to Zakha. The occurrence of Sheath Blight was more pronounced in this trial. However, no significant insect damage occurred, precluding a differential rating among the entries. The elite selections from this trial will be evaluated in farmers' field trials in the ensuing season.

Table 4. Performance of varieties and advanced breeding lines in AET, RNRRC 1994.

Varieties	Yield (t/ha)	50% Flw (days)	Plt.ht (cm)
BG 850-1	8.258 a	111 d	76 b
IR 64	7.665 ab	122 a	87 ab
PK 1501-9-2-B-1	7.487 abc	109 de	101 ab
CARD 21-3-2-1-1-3	7.344 abcd	115 c	113 a
IR 61331-2-148-B	7.215 abcd	115 c	104 ab
CARD 21-15-2-1-3-2-1	6.968 abcde	104 f	106 ab
CARD 21-10-1-1-3-2-3	6.876 abcde	104 f	98 ab
CARD 20-1-2-B	6.817 abcde	104 f	108 a
IR 60073-3-4-1-2-B	6.697 bcde	111 d	113 a
IR 60023-6-43-B	6.618 bcde	111 d	112 a
CARD 21-17-4-1-2-B	6.362 bcde	106 ef	107 ab
IR 56346-BHU(R)-15	6.329 bcde	111 d	108 ab
ZAKHA	6.056 cde	118 b	114 a
CARD 20-1-3-3-B	5.999 de	106 ef	105 ab
CARD 21-15-3-B	5.924 de	104 f	103 ab
IR 20913	5.509 e	94 g	108 a
CV %	11.1	1.5	15.5

1.5 Preproduction Evaluation Trial (PRET)

Six varieties including checks were tested in the Preproduction Evaluation Trial (PRET) in the Wangdi-Punakha valley. The objective of this trial was to compare the yield and genetic stability of four promising lines with IR 64 and popular local cultivars under farmers' field conditions.

The trials were laid out in randomised complete blocks with three replications at five locations from 1250m to 1450m altitude. Seedlings were raised in semi-dry nurseries in the third week of May and transplanted between 2 June and 26 June at 20 x 20 cm spacing in lines in 2 x 5 m plots. Land was manured and prepared by cooperator farmers following local practice. Weeds were controlled by Butachlor 5G at the rate of 1.5 a.i./ha applied 3-6 DAT and spot weeding by hand. All the trial sites were topdressed with 35 kg N/ha at 35-40 DAT. Plot yields were obtained from the central 5.04 sqm from each plot, corrected for off-types, and computed at 14% moisture content.

Performance of varieties was examined by analysis of variance of the five sets of data combined across locations (Table 5). There were significant location, variety, and variety x location interaction (P = 0.05) effects. However, no significant variance was observed within locations. This reflects the variation among locations in altitude, fertility, soil types and the management but shows homogeneity within the trial sites. Averaged across locations, the standard check IR 64 was the highest yielding variety with a mean grain yield of 6.02 t/ha, which was 10% higher than that of the local cultivars. This indicates the superiority of this variety with regard to yield and suitability over a wider environmental conditions. CARD20-10-1-1-B and CARD20-21-3-1-1, both crosses of Local Maap and IR 64, yielded higher than the local checks but not significantly.

Table 5. Performance of six varieties in PRET in Wangdue-Punakha Valley

Lines	Richa	Chamam	Sopso	Kaka	Seri	Mean
IR 64 (Std. Check)	5.22 a	5.25 a	6.89a	4.85 a	7.98 a	6.02 a
CARD20-10-1-1-B	5.72 a	4.98 a	6.94 a	4.76 a	7.62 a	6.01 a
CARD20-21-3-1-1	5.42 a	5.44 a	5.88 bc	4.99 a	6.74 a	5.69 ab
Local Checks	5.58 a	5.64 a	5.02 c	4.52 a	6.66 a	5.48 ab
CARD21-10-1-3-2-1	3.92 b	5.26 a	5.85 bc	3.67 b	4.31 b	4.60 bc
CARD21-15-2-1-3-2-1	3.89 b	4.42 a	6.64 ab	3.44 b	3.08 b	4.29 c
CV %	12.51	15.18	7.57	8.42	11.62	15.9

1.6 Production Evaluation Trials (PET), in Wangdue-Punakha Valley

a) **Wangdue-Punakha Valley**

The objective of this trial was to test 2 cross-bred lines CARD21-10-1-1-B and CARD20-1-3-3-B in farmers' fields, under their management levels, for overall performance and yield stability across different growing environments in the mid-altitude agroecozone.

The trial was carried out at 9 sites covering Punakha, Wangdue and parts of Thimphu at altitudes between 1000-1800m. Seedlings were raised in April-May and transplanting was done in June-July. Land preparation and other management practices were carried out by the farmer-cooperators following their local practice. All farmers applied basal FYM (amount not quantified) and most topdressed with N at late tillering stage. Yield was determined at harvest from crop cuts measuring 5 sqm. Results are presented in Table 6.

Results could not be analysed due to lack of information on local check variety yields. Averaged across locations, CARD20-1-3-3-B produced the highest grain yield of 6.25 t/ha followed by CARD21-10-1-1-B (5.64 t/ha). The local varieties differentiated as Kaap and Maap gave 4.23 t/ha and 4.18 t/ha respectively (Table 6).

b) **PET in Paro**

A PET at Paro compared Chummro with the local cultivars at 5 locations. Chummro averaged 4.97 t/ha compared to 3.01 t/ha of the locals, indicating an yield advantage of 1.96 t/ha or 65% (Table 7). It may be noted that Chummro is a local variety (most probably improved through pure line selection) from the high mountains of Chummrong, in Nepal. It has red grains and resembles Maap varieties to a great extent. One of its biggest advantages is that Chummro has good resistance to blast disease.

c) PET in Chukha

PETs were also carried out in the rice growing areas of Chukha Dzongkhag using 2 improved released varieties and 2 CARD lines at 10 locations (Table 8). Comparison of yield performance was prejudiced because of unequal number of sites per variety. Nonetheless, CARD20- produced the highest yield at 4.88 t/ha at Bongo. BW 293 did not do well probably because of altitude. Less straw production from the improved varieties or lines was cited by farmers as a major shortcoming.

Table 6. Yield performance (in t/ha) of test entries in PET 1994

Varieties	PUNAKHA				WANGDUE			THIMPHU				MEAN
		Talo1	Talo2	Limbu	Guma	D/uma	Rubesa	Bjena		Baap1	Baap2	
CARD21-10-1-1-B		6.60	5.43	5.37	6.67	5.58	5.58	-		4.59	6.60	5.64
CARD20-1-3-3-B	6.47	-	-	-	-	-	5.86		5.65	7.01	6.245	
Locals - white				4.23								4.232
Locals - red								4.19				4.186

Table 7. Grain yield (t/ha) of Chummro and Locals in PET in Paro, 1994

Location	Grain yield	
	Chummro	Locals
Lango	7.33	-
Luni	4.55	2.11
Shaba	6.33	3.26
Wangchang	5.50	3.32
Shari	4.83	3.21
Dotey	5.63	3.40
Dogar	3.28	2.75
Chento	3.67	2.78
Naja	3.65	3.25
Average	4.97	3.01

Table 8. Grain yield of improved varieites/lines in PET in Chukha

Variety	Location	Yield (t/ha)	Farmers' feedback
CARD21-	Lokchina	1.56	Less straw production
	Lokchina	1.13	Less straw, short
	Bongo	2.38	Less grains, straw
	Bongo	4.29	Happy with grain yld.
Average CARD21		2.34	
Average Locals		2.02	Champasari, Chirangey
CARD20-	Bongo	4.88	Less straw
Local Variety		3.49	
BR 153	Bhalujhora	2.13	Matures early, bird damage
	Phuntsholing	2.13	---do---
	---do---	2.75	Good yield, less straw
Average BR 153		2.34	
Average Locals		2.18	Paijam, Thosar

BW 293	Bhalujhora	1.78	Less straw & grain yield
	---do---	1.97	Too short, less straw
	Phuntsholing	2.33	Higher yield; will grow again
	---do---	1.75	Short, early maturing, difficult to transplant due to low seedling height
	Lokchina	1.71	Too short, less straw
	---do---	1.29	----do----
Average BW 293		1.81	
Average Locals		1.85	Paijam, Thosar, Attey, Champasari

2. Hybridization

As a longer-term strategy for improving local rice cultivars, a shuttle breeding program has been in operation since 1985 in collaboration with IRRI. The major objectives are to improve traditional rices of Bhutan by incorporating desirable genes from improved parents and to develop varieties that are more appropriate for Bhutan's medium and high altitude rice environments.

2.1 Pedigree selection from bulk populations at station

A total of 452 pedigree lines were selected from 8 populations (Table 9). The major selection criteria were intermediate plant height (100-110 cm), plant vigor, uniformity in flowering and grain maturity, high fertility, insect-disease freeness, compact panicles and dense grains. The selected lines will be further evaluated in pedigree rows in the coming season. One of the populations, IR64429-B-B-R-B-B, involving Akihikari//Akihikari/Punakha Maap was bulk harvested owing to its uniformity in flowering and plant height.

Table 9. Bulk populations and pedigree selection at RNRRC, Bajo

Cross designation	Parents	Plants selected
IR62467-B-R-B-P	Suweon 358/Attey	77
IR62470-B-R-B-P	Suweon 358/Punakha Maap	86
IR62478-B-B-P	Suweon 359/Zakha	37
IR63332-B-B-B-P	Akihikari/Zakha	40
IR62745-B-R-B-P	Suweon 359//IR41996-/ Thimphu Dumja	43
IR62476-B-B-P	Suweon 359/Semtokha Map2	40
IR62472-B-B-P	Suweon 358/Sukhimay	61
IR65239-B-B-P	YR3825-11-3-2-3-1/Attey	68
Total		452

2.2 Pedigree selection from bulk populations at Paro sub-station

At the high-altitude sub-station at Paro, a total of 259 pedigree lines were harvested from 7 populations (Table 10). Crosses involved mostly cold-tolerant Suweon or YR lines and Chummro, Barket or Maap varieties of Paro and Thimphu. Apart from cold-tolerance, high yield and red grains, blast resistance is another important criterion for the improved types coming out of this breeding program. Pedigree row testing will be done for the selected lines.

Table 10. Bulk populations and pedigree selections at Paro

Cross designation	Parents	Plants selected
IR66408-B-P	IR55259-B-3-3-2-2/Chummro	39
IR66412-B-P	IR60060-AC2-1/Chummro	46
IR66068-B-B-P	YR3825-11-3-2-1// YR3825-11-3-2-1/Barket	37
IR62746-B-P	Suweon359//IR41996-118-2-1-3/Thimphu Maap	31
IR65892-B-B-P	No.11/Chummro	37
IR62734-B-P	Suweon 353//No.11/Th.Dumja	30
IR65232-B-B-P	IR60060-AC2-1/ YR3825-11-3-2-1	39
Total		259

3. Collection and conservation of local rice germplasm

Collection, rejuvenation, characterization and preservation of rice germplasm are considered as important activities in varietal development for increased and sustainable rice production. Lack of a gene bank so far has discouraged mass collection and conservation of traditional germplasm; however collections are made at the research stations for evaluation purposes as well as for future utilization. In 1994, 36 local cultivars from Wangdue, Punakha, Trongsa and Paro were rejuvenated at the station (Table 11). Basic characteristics such as plant height, flowering, maturity period, grain colour etc. of these varieties were also recorded.

Table 11. Local rice germplasm rejuvenated in 1994

Variety	Altitude grown(m)	Village	Dzongkhag	Pericarp color
Gyemja	1800	Changray	Trongsa	White
Raykar	1600	"	"	White
Raymaap1	2100	Essa	"	Red
Gyemja	2120	T/dingkha	"	White
Raymaap2	2100	Essa	"	Red
Chonaam	1800	Refey	"	Red
Raykar	1650	K/rabten	"	White
Gyemja S1	1980	Samcholing	"	White
Gyemja S2	1900	Samcholing	"	White
Zakha	800	Jangaray	Wangdue	White
Bonday	860	Adang	"	White
Mabnagchang	1350	Tagchha	"	Red
Kongteray	1350	Tagchha	"	White
Mabphokhum	1350	Tagchha	"	Red
Lhamzama	1330	Dorjipokto	"	Red
Tanditshering	1400	Khengna	"	White
Kathramathra	1120	Dagauma	"	White
Babukaap	1900	Gangkha	Punakha	White
Macha	1800	Dochu	"	Red
Kapchy	1950	Sari	"	Red
Janam	-	Taloo	"	Red
Bnaja	-	Taloo	"	White
Genja	-	Lapchakha	"	Red
Kaap	1200	Gangtey	Wangdue	White
Kap-Zakha	1500	Gogona	"	White
Hemjam	1500	Gogona	"	White
Bondame	-	Dangchu	"	Red
Reysap	1350	Gumakha	Punakha	White
Baybu	1230	Changyul	"	White
Gymokap	2400	Chento	Paro	White
Zamsakap	2300	Zamsa	"	White
Kuchum Map	2300	Phondo	"	Red
Reynaam	-	Sasamchoten	"	Red
Reykaap	-	Sasamchoten	"	White

Germplasm Improvement of Wheat

2.1 Introduction

The wheat research programme continued as in the previous years with emphasis on varietal improvement and crop management. Varietal screening was done based on the formalised procedure adopted in 1986. About 200 varieties/crosses were tested in different trials at the research station. Farmers' field trials with new materials were not carried out due to the lack of promising entries. However, various programs of demonstration and promotion were done using the released varieties in different dzongkhags.

2.2 Introduction Nursery (IN)

Over 60 lines and varieties, either bread wheat or early spring wheat types, introduced from CIMMYT were screened in this nursery to evaluate their yield attributing characters and disease reaction. Each entry was sown in a single 3 x 3.4 m plot size. Selected entries (Table 12) will be advanced to more intensive testing during the following cropping season.

Table 12. Selections from the Wheat Introduction Nursery

Entry No.	Variety	Yield (t/ha)	Plt.ht (cm)
3	JUN CN33483-C-7M-1Y-0M-20B-DY-2PT2-DY	2.38	92 (IBWSN)
9	MO88 CM64624-1M-4Y-0M-34Y-0M	2.01	90
15	F60314-76/MRL//CNO79 CM77694-A-IY-02M-05Y-1B-1Y-0B	1.60	99
31	SARA/THB//VEE CM87582-013TOPM-2Y-DH-DSY-IM-0Y	1.61	99
34	TAN/PEW//SARA CM88386-23M-0SY-0H-1Y-0M	1.27	96
41	ROLLER CM88930-12Y-0M-0Y-4M-2Y-OB	1.28	99
78	IRENA CM91575-34Y-0M-0Y-2M-0Y	1.27	85
118	PFAV/VEE#9//VRES CM94295-F-0M-0Y-0M-3Y-0B	1.25	96
151	OPATA/KILL CM97029-10Y-0B-0Y	0.83	91

Entry No.	Variety		Yield (t/ha)		Plt.ht (cm)	
200	CHECK (Local check)		0.85		91	
227	BUGU CM98248-0M-4Y-0AL-6Y-3Y-0Y		1.26		84	
253	MIMUS CM100684-B-0B-0Y		1.27		95	
272	BAU//BJY/COC CM100770-30Y-7B-10RES-030B-0Y	1.26		89		
325	KAUZ/GEN CRG 178-2-49B-0Y-030M-6Y-2Y-0M	1.51		85		
351	KAUZ* 2/YACO//KAUZ CRG873-2Y-010M-)Y		1.26		81	
374	KAUZ*2//SAPMON/3/KAUZ CRG969-2Y-010M-0Y	2.22		85		
72	150.83/SONNIE SWTY91.13-3FM-0FM		3.32		103 (ESWN)	
73	150.83/SONNIE SWTY91.13-4FM-0FM		2.48		112	
74	150.83/SONNIE SWTY91.13-6FM-0FM		2.89		117	
75	150.83/SONNIE SWTY91.83-7FM-0FM		1.66		114	
76	150.83/SONNIE SWTY91.13-8FM-0FM		2.46		119	
88	FD-693/VICUNA4 SWTY91.35-9FM-0FM		2.53		115	
92	6TB219/3/6TA876//6TB163/6TB/164/ 4/2TESMO1/MUSX603 SWTB89.314-11Y -3PAP-0ELV-0FM		2.48		111	
94	6TB277/2BULL1-1 SWTB89.314-11Y-3PAP -0ELV-0FM			3.82		110
98	CT822.81/2WALRUS1 SWTB89.248-5Y-5PAP-0ELVE		2.66		112	
104	AD622.81//2TESMO1/MUSX603 SWTB89.252-5Y-7PAP-0ELV-0FM		1.64		101	
106	LAD 622.81//2TESMO1/MUSX603 SWTB89.252-22Y-2PAP -0ELV-0FM		3.44		108	
108	LT1071.82/2SOR1 SWTB89.255-5Y-3PAP-0ELV-0FM		4.55		105	
118	150.83/2WALRUS1 SWTB89.279-1Y-4PAP-0ELV-0FM		3.34		110	
130	FD-693/2 NIMIR4 SWTB89.236-2Y-1PAP-0ELV-0FM		2.06		97	
132	FD-693/2/NIMIR4 SWTB89.236-I2Y-3PAP-0ELV-0FM		2.57		102	

2.3 Initial Evaluation Trial (IET)

The main objective of this experiment was to select lines having higher yield, suitable growth duration and resistance to rust diseases. Eight entries were seeded in November in an RCBD with a plot size of 3m x 3m. Seeds were sown at a row spacing of 0.20m. A fertilizer dose of 60-40-20 NPK kg/ha was applied with 50% N topdressed at CRI. The crop was irrigated thrice- once at CRI, tillering and flowering stages. Harvests were made from the centre of the plot measuring 7.5 m^2 and yield computed to tons per ha.

Results of the analysis are presented in Table 13. No line significantly outperformed the standard checks BK-1 (Bajoka-1), BK-2 and Sonalika. BOW/PRL/BUC, BOW/NAC/VEE/3/BJY/COC and VL 719 performed well and will be promoted to AET.

Table 13. Performance of entries in Initial Evaluation Trial

Variety	Yield (t/ha)	Plt.ht (cm)	Spike/sqm (no.)
Bajoka-1	1.61 a	80 b	533 a
BOW/PRL/BUC	1.46 ab	82 b	479 ab
BOW/NAC/VEE/3/BJY/COC	1.36 ab	80 b	447 abc
VL-719	1.33 ab	80 b	455 ab
FFN/VEE# 5	1.30 ab	78 b	355 c
VEE/KOEL	1.29 ab	84 b	427 bc
Bajoka-2	1.21 ab	99 a	402 bc
Sonalika	1.13 b	81 b	530 a
CV%	16.3	4.8	11.1

2.4 Advanced Evaluation Trial (AET)

The principle objective of this trial was to select promising varieties for high grain yield, medium maturity period, and resistance to rusts at the station level.

The trial was laid out in randomised complete blocks with 3 replicates. Nine test entries with 3 standard checks were seeded in lines at a row spacing of 20 cm in 10 sqm plots. Inorganic fertilizer was basally incorporated at the rate of 60-40-20 kg NPK/ha, with half the N topdressed at CRI. Weeds were controlled by handweeding. Grain yield was obtained from a harvest area measuring 5.28 sqm.

Results of the statistical analysis on yield and other characters are presented in Table 14. None of the varieties could significantly outyield the checks BK-1 and BK-2, although VL 725, TL 2801, and a few others yielded higher. Sonalika was significantly outyielded by 2 test entries - VL

725 and TL 2801. The incidence of rust diseases was very minimal and significant differences among entries were not recorded. The best performers from this trial will be tested in the farmers' fields.

Table 14. Yield and other parameters of varieties tested in AET

Variety	Yield (t/ha)	Plt.ht (cm)	Spike/sqm (no.)
VL-725	2.18 a	85 d	510 bc
TL-2801	2.13 a	101 b	559 ab
HB-208	1.99 ab	83 d	633 a
WK-429	1.78 ab	89 cd	583 ab
Bajoka-2	1.77 ab	109 a	554 ab
HPW-79	1.76 ab	85 d	588 ab
VL-728	1.70 ab	91 c	503 bc
VEE/KOEL	1.69 ab	88 cd	419 c
MAYA/NAC	1.64 ab	85 d	524 abc
Bajoka-1	1.62 ab	85 d	597 ab
VL-729	1.43 b	84 d	530 abc
Sonalika	1.38 b	88 cd	586 ab
C.V %	19.5	3.5	11.0

2.5 Preproduction Evaluation Trial (PRET)

The objective of this trial was to evaluate the overall performance of station-proven lines or varieties under farmers' field conditions. Three test lines and 3 check varieties were assessed at 4 locations in the Punakha-Wangdue valley representing medium altitudes. Seeds were sown in November-December in 10 sqm plot in an RCB design with three replications. Cultural management was done by the farmer-cooperators, however, all locations received an N topdress at the rate of 35 kg N/ha. Yield estimates were made from the central rows measuring 6 sqm.

Results are provided in Table 15. There was no significant yield difference amongst varieties when averaged across locations. BK-2 gave the highest average yield of only 0.91 t/ha which was reflective of an overall poor management. Among locations, Gaselo represented the “best” site with grain yields above a ton per hactare. A contrasting feature of BK varieties was that BK-2 tended to perform well in poor sites, whereas the performance of BK-1 was very poor in such sites.

Table 15. Evaluation of elite entries in PRET

Variety	Gaselo	Kakalung	Sopsokha	Chamam	MEAN
BK-2	1.71 a	0.37 a	0.70 a	0.69 a	0.59 a
BK-1	2.06 a	0.22 b	0.33 b	0.86 a	0.47 a
VL 725	2.06 a	0.29 ab	0.44 b	0.63 a	0.45 a
HPW -79	1.43 a	0.26 b	0.38 b	0.64 a	0.43 a
TL 2801	1.34 a	0.29 ab	0.33 b	0.54 a	0.39 a
Sonalika	1.10 a	0.37 a	0.35 b	0.79 a	0.50 a
L. Means	1.62	0.30	0.42	0.69	-
CV %	22.2	16.5	27.9	17.1	27.5

GRAIN LEGUMES

Chickpea Observation Trial - Desi High Yield and Multiple Resistance 1994/95

The main objective was to evaluate the performance of advanced generation breeding lines developed at ICRISAT and cooperating institutes at different levels.

The experiment was arranged in an RBD with two replications. The seeds were sown on 8th November 1994 in four rows of 4 m plots with a spacing of 10 cm row to row and 30 cm plant to plant in a depth of 5 cm. 50 kg SSP and 10 kg/ha MOP were applied as basal fertilizers. Hand weeding was done as and when necessary. Irrigation was given once as presowing irrigation and one post-emergence irrigation. The pods were harvested on 23rd May 1995.

Data were recorded for plant count 2 weeks after emergence (PCE), days to flowering (DF), disease ratings, days to maturity, insect damage score (INS), plant count at harvest (PCH) and grain yield per plot. For pod yield, 2 rows of 3.5 m long were harvested. Results are in Table 16.

Table 16. Yield and yield components of 19 Chickpea lines.

Entry No.	PCE	DF	INS	PCH	Yield (kg/ha)
1.	98.5 ab	94.0 a	21.45 abc	42.0 b	220.0 bcde
2.	92.0 b	93.5 a	12.75 c	52.5 ab	225.0 bcde
3.	90.5 b	95.0 a	11.15 c	73.5 a	250.0 bcde
4.	87.0 b	94.0 a	21.60 abc	55.0 ab	215.0 cde
5.	99.0 ab	91.0 a	11.45 c	48.5 ab	220.0 f
6.	90.5 b	93.0 a	18.70 bc	61.0 ab	200.0 cde
7.	91.5 b	94.0 a	21.15 abc	53.5 ab	167.5 de
8.	89.5 b	95.0 a	25.40 ab	54.5 ab	255.0 bcde
9.	87.5 b	94.0 a	19.90 bc	44.5 ab	232.5 bcde
10.	105.5 ab	94.5 a	10.80 c	62.5 ab	250.0 bcde
11.	105.5 ab	96.5 a	18.80 bc	62.5 ab	157.5 e
12.	98.5 ab	95.5 a	18.70 bc	51.0 ab	200.0 cde
13.	102.0 ab	83.0 b	12.35 c	42.0 b	220.0 bcde
14.	88.0 b	90.0 ab	14.60 bc	53.5 ab	235.0 bcde
15.	100.0 ab	90.0 ab	10.00 c	50.5 ab	330.0 ab
16.	93.5 ab	93.0 a	10.40 c	52.0 ab	272.5 a
17.	97.0 ab	89.0 ab	9.80 c	55.5 ab	280.0 abcd
18.	121.5 a	96.0 a	31.50 a	72.0 a	250.0 bcde
19.	104.5 ab	95.0 a	16.05 bc	67.0 ab	257.5 bcde
CV %	12.23	3.53	29.23	25.12	19.81

Among the entries, Entry No.15 yielded the highest though it took 90 days to 50 % flowering. Pod loss due to insect damage was also considerably less. Entry No. 11 yielded the lowest and it took 96.5 days to produce 50 % flowers. Insect damage was only 18.8 %.

Entry No.18 was highly susceptible to borer damage with a damage % of 31.5 % and therefore yield was reduced. It also took quite long (96 days) to produce 50 % flowers. Entry No.17 was found to be most resistant to borer damage with only 9.8 % of its pods damaged. Entries No. 2,3,5,10,13,15 and 16 were also significantly less damaged by borers.

The experiment plots were found to be very yellow and unhealthy which have been reported to ICRISAT but we did not recieve any response.

Seed Increase for Research

To ensure ready availability of seeds for research purposes, the Centre routinely multiplies seeds of released varieties as well as those varieties and elite lines that have reached the advanced stages of testing in farmers' field. The details of seed increase are presented in Table 17.

Table 17. Amount of seed increased for crops for research purposes in 1994-95.

Varieties/lines	Seed quantity (kg)
Rice	
IR 64	445
Barket	603
CARD21-10-1-1-B	340
CARD20-1-3-3-B	320
CARD21-10-4-3-2	84
CARD21-15-2-1-3-2	150
Kashmiri Basmati	60
Wheat	
BL 1093	84
BL 1022	44
LYP 73	11
WK 868	18
WK 866	23
NL 460	16
HD 2380	85
Oilseeds	
PT 30	50
T9	15
89LSVE	41
M27	27

HORTICULTURAL RESEARCH

Introduction

A major goal for the arable agriculture sub-sector in the 7 Five Year Plan is to increase the production of horticultural crops, both for export and domestic markets, leading to higher farm incomes, and greater economic growth and export revenues.

Horticulture is potentially the most important sub-sector in the RNR sector for providing foreign exchange, as well as in improving the nutritional status of rural communities. Because of its geographical situation, Bhutan has a comparative advantage in production of fruit crops for which agro-ecological conditions are more favourable than in neighbouring countries.

VEGETABLES

Cherry Tomato Advanced Evaluation Trial

The group "Cherry Tomato" includes any of several tomato types bearing bunches of small fruits that resemble cherries. The cherry tomato is believed to be the ancestor of present day tomatoes. The Asian Vegetable Research and Development Centre (AVRDC) maintains one of the world's largest collections of tomato genetic resources which has significantly enhanced the production and utilisation of tomatoes in the tropics with their characteristic taste, flavour and high fruit quality.

This experiment was conducted with the objective of evaluating and comparing the performance of four AVRDC cherry tomato lines with the Local cherry variety for their horticultural characters and their adaptibility to the Punakha-Wangdue environment.

The trial was laid in an RCB design in a plot size of 5 x 1 sqm with four replications. Seeds were sown on 18 January 1995 and transplanted in the field on 26 March 1995 with a spacing of 60 x 50 cm. Fertilizer dose of 60:50:10 NPK kg/ha + 30 t/ha FYM was applied basally. Additional 50 kg/ha N as CAN was applied as top dressing. The field was flood- irrigated during planting and continued at an interval of 15 days. Plots were kept weed- free by hand weeding at 15 and 35 days after planting. Bamboo poles were used as staking support after first flowering and the plants were tied to the stakes every week. Pinching/pruining was done before flowering every week. Cypermethrin was sprayed twice against fruit borer. There were 5-6 harvests. The first harvest was taken when 50% of the fruits had ripened. Yield and yield characters are represented in Table 1.

The total yield and marketable yields were significantly higher in CHT 160 (38.4 t/ha) and CHT 104 (38.2 t/ha). The lowest total yield was recorded in CHT 172, while the lowest marketable yield was found in CARD CHT. Total number of fruits per plot and the number of marketable fruits per plot were significantly higher in CARD CHT. Fruit length was longest in Early Big and CHT 160 while the diameter was largest in CHT 104. CARD CHT had the smallest fruit length (2.6 cm)

and diameter (2.72 cm) which attributed to the largest number of fruits per kg (60 fruits/kg) (Table 1a).

All the entries were sour and red in colour and had very good keeping quality. CHT 104 annd CHT 160 will be taken to farmers' fields for furthur evaluation in the ensuing seasons.

Table 1. Yield and yield characters of five Cherry tomato entries 1995

Variety	Total yield (t/ha)	Total Fruit. (Nos./plot)	Mkt.yield (t/ha)	Mkt.Fruit (Nos./plot)
CHT 104	38.20 a	736.0 bc	34.42 a	593.5 bc
CHT 160	39.40 a	854.8 b	35.58 a	664.3 b
CHT 172	27.14 b	632.3 c	25.34 c	474.3 d
Early Big	31.82 b	685.0 c	29.76 b	552.8 cd
CARD CHT	28.20 b	1076 a	24.42 c	780.8 a
CV %	20.3	22.9	19.05	19.35
LSD 5 %	2.305	126	1.96	81.74

Means followed by the same letter are not significantly different by DMRT at 5%.

Table 1a . Fruit characters of five Cherry tomato entries

Variety	Fr. length (cm)	Fruit dia. (cm)	Fr./cluster (Nos.)	Fr/kg (Nos.)	Colour	Taste
CHT 104	3.3	4.49	9-10	46	red/pink	sour
CHT 160	4.6	4.13	6-8	31	red	sour
CHT 172	4.3 3.63	5-8	25	red	sour	
Early Big	4.8	4.46	5-7	21	red	sour
CARD CHT	2.6	2.71	5-6 60	red	sour	

Onion Varietal Trial

Eight new onion varieties were tested and compared with popular variety Nasik Red for their yield and bulb characters. The varieties and their sources are given below :

Variety	Source
964	NASEPP
Red Cross	NASEPP
804	NASEPP
Texas Early Grano	NASEPP
Kaizuka Early	FAO 74.975
Red Creole	FAO 74.976
Morada de Amphosta	FAO 74.430
Senshu Red	NASEPP
Nasik Red	Suttons

The experiment was laid out in an RCBD with three replications. The seeds were sown in October 1994 and seedlings were transplanted in November. The first transplanting failed due to high mortality rate and all the plants were replanted on 24 January 1995. Transplanting was done at a spacing of 15 cm between rows and 30 cm between plants within a row. Each variety was grown in three rows of 2.5 m long with a spacing of 15 cm. The net plot size was 2.4 sqm. The result is presented in Table 2.

Yield performance among varieties differed significantly.Texas Early Grano gave the highest yield, followed by 804 and Kaizuka. Texas E Grano also showed the best yield contributing characters like bulb weight and diameter. However, it seemed to be more suitable for salad purposes since the colour is whitish green. The lowest yield was recorded in Red Cross and Nasik Red which bolted out. Weight per bulb was highest in Red Cross and Red Cerole. Bulb diameter and length/height were almost the same for all the entries. Mora de Amphosta had the longest bulb with 7.8 cm and proved to be the most disliked variety due to its oval shape. Varieties like Red Cross and Red Creole did not yield very high but bulb characters like size, colour and pungency were good. Some of these varieties willbe furthur evaluated in the next season.

Table 2. Yield and bulb characters of nine onion varieties, 1994-95

Variety	Yield (t/ha)	Bulb wt (gm)	Bulb dia.(cm)	B. Ht. (cm)	Shape/ colour
964	10.93 ab	10.00	6.33 bcd	6.46	Red/round
Red Cross	9.67 a	13.20	5.47 ab	5.50	L.red/round
804	24.40 e	6.66	6.59 d	6.89	White/round
Texas E.Grano	28.80 f	4.86	6.33 bcd	6.67	Gr/white/round
Kaizuka	20.13 de	6.17	5.71 abc	6.09	Yellow/round
Red Creole	15.40 bc	10.38	5.85 a-d	5.67	Red/Round
Morada de Amphosta	14.67 bc	8.92	5.37 a	7.77	L.red/Oval
Senshu Red	17.13 cd	7.86	6.52 cd	6.37	Red/Round
Nasik Red	9.53 a	11.45	5.52 ab	5.77	Red/Oval
CV %	14.9		7.6	15.0	

Beans Varietal Trial

Eleven entries of beans selected from previous years trial were further tested to determine earliness, yield and pod quality. The experiment was laid out in an RCB design with three replications. The seeds were sown on 25 April 1995 in 3 m x0.90 m plots. The pods were ready for harvest by 22 June 95 and could harvested six times. Results are presented in Table 3.

Pod yield was highest in Green arrow and Asparagus bean. Both these varieties were long-poded which accounted for the high yields. Snapbean also yielded quite high. The variety Triton had to be discarded due to low plant count. Lowest yield was recorded in Montano. Green arrow was yardlong type with pod length of 30.1 cm, followed by Asparagus 693 (16.1 cm). Montano and Borlotto were the shortest poded varieties.

Entry Master piece had very flat, thick pods which may not be accepted by the consumers though disease incidence was recorded very low (Table 3a). Slenderette is a dwarf variety with dark greenpods and was found to be very good in our conditions and needs to be further tested. Green arrow was late maturing but the pod quality was very good with light green colour. Top crop was early maturing with light green pods but was slightly affected by rust.

Table 3. Pod yield and pod charaters of 10 bean varieties.

Variety	Pod length (cm)	Pod width (cm)	Pod yield (t/ha)	No.of pods per plot
Emtright	16.0	0.7	23.21	850.0
Green arrow	30.1	1.7	40.12	642.3
Montano	11	0.9	9.36	302.3
Slenderette	13	1.0	20.71	955.0
Master piece	16	1.2	21.40	841.0
Top cro	13	1.1	21.86	649.0
Asparagus	17	0.8	37.97	432.0
Snapbean	15	1.0	34.91	1237.0
Borlotto	12.1	1.0	16.42	542.3
Asparagus 693	16.1	0.9	28.64	727.0
CV %		28.88	38.63	

Table 3a. Plant and pod characteristics of 11 varieties of beans.

Variety	Characteristics
Emtright	Climber, green pods, early maturing
Green arrow	Climber, light green pods, late maturing but good
Triton	Dwarf plant, long pods, medium maturing
Montano	Dwarf, green waxy pods with no strings, early
Slenderette	Dwarf, dark green waxy pods with no strings, medium
Master piece	Dwarf, thick light green flat pods with strings, late maturing
Top crop	Dwarf, light green pods, early maturing
Asparagus	Dwarf, light greenpods with strings, medium
Snapbean	Dwarf, waxy green pods,no strings, early maturing
Borlotto	Early, good pod quality
Asparagus 693	Climber type, long pods, late maturing

Okra Varietal Trial

Three varieties of Okra (Clemson Spineless, Gombo Puso, Gombo Pop) from FAO Rome, were compared and tested with best selected variety (Blue bell) from 1989-90 station trial and popular check variety Pusa Sawani for their yield and fruiting characteristics. The trial was laid out in a RCB design with three replications. Seeds were sown in plots of 1 x 3 m with a spacing of 30 cm between rows and 50 cm between plants in a row. Fertilizer was applied at the rate of 60:100:10 NPK kg/ha and 10 t/ha of farm yard manure. The plots were irrigated ten days after sowing and subsequently when required. Hand weeding was done to keep the plots weed free. The fruits were ready for harvesting by the 25 of August 1995. Results are presented in Table 4.

Total yield was highest in Gombo Pop followed by Gombo Puso and Clemson Spineless. However the marketable yield was highest in Gombp Puso. The non-marketable yield was also highest in these varieties. The loss was mainly due to very large size of the fruits which were hard and non-consumable. Blue Bell and Pusa Sawani yielded almost the same. Fruit sizes were almost the same but Gombo Pop had the longest fruit and Pusa Sawani had the shortest fruit. G.Puso had very tall plants and the fruits were smooth, long and pointed. The ridges of this variety were not very prominent. G.Pop also had very tall plants with long frutis. Blue Bell had very prominent ridges and the plant looks similar to Clemson spineless. Pusa Sawani was also a tall variety with very irregular shaped ridges. Most common pest was observed to be the Jassids.

Table 4. Yield and fruit characters of five okra varieties

Variety	Total yld (t/ha)		Mkt yld (t/ha)		NMkt yld (t/ha)		Frt len (cm)	Frt wid (cm)	Frt plt (no.)	Yld plt (kg)	Rid-ges (no.)
C.Spineless	89.3		15.8		63.5		18.7	2.6	3.8	0.18	7
G.Puso	95.4		21.2		74.3		21.4	2.2	5.0	0.24	5
G.Pop	108.3	16.5		91.8		25.7	3.0	2.2	0.12	5-7	
Blue Bell	68.1		15.5		52.7		20.2	2.7	11.0	0.47	5-6
P.Sawani	69.6		14.6		54.9		17.0	2.6	3.0	0.05	7
CV(%)			18.3								

TREE CROPS

Introduction

Citrus is by far the most important sub-tropical fruit crop grown in the region. The current mandarin has a very good market, but is constrained by a short shelf-life and short marketing season which also coincides with the production periods in neighbouring states of India. Opportunity of spreading the harvest periods due to wide range of agro-climatic condition will be an advantage for Bhutan. To improve citrus industry and area expansion, introduction and evaluation of frost tolerant and early to late maturing cultivars like Satsuma mandarins have been initiated at this centre.

Research on tree crops in this centre was initiated in late 1992. Initially, main focus was given on site development and plantation of wind breaks. The soil fertility development works like growing of green manure crops were being carried out in the trial site. In early 1994, materials like stone fruits, nuts and other sub-tropical fruits were introduced from northern India. This was followed by collection of local germplasm and introduction of Satsuma type mandarins and other sub-tropical fruits from Japan, India and Thailand. Performance data are not available for most of the tree crops as they are still in juvenile phase. The following are the list of activities on-going in the station.

Table 5. Ongoing subtropical fruit research at RNRRC, Bajo

Sl.No.	Activity	No.of entry	Objective
1.	**Varietal Evaluation of Sub-tropical fruits and nuts**		
	a) Peach	03	Evaluate and identify high yield, early maturing pest/diseases resistant adaptable for mid altitude areas. (Each tree is a replication)
	b) Plum	03	
	c) Apricot	02	
	d) Almond	08	
	e) Pecan	04	
	f) Pear	04	
	g) Mango	06	
	h) Pomegranate	05	
	i) Guava	04	
	j) Olive	03	
	k) Avocado	03	
	l) Grape	09	3 table types will be promoted to ON
	m) Medicinal plants	04	

2. **Materials under propagation**

a) Citrus (Satsuma type mandarin)	13	budded/grafted on rough lemon/local mandarin & R. trifoliate rootstocks
b) Strawberry	11	Under runner propagation
c) Avocado	01	will be used as stock for improved cultivars
d) Grape	03	Being propagated through cuttings for on-farm trials
e) GF-677	01	Seed production and stock raising

Grape Evaluation Trial

Six varieties of grape vines - three table (Perlette, Muscat, & Chasselas) and three wine (P.Blanc, Chardonny, & Cab Franc) types, were planted in 1994. Each vine type is planted in an individual terrace/plot with a spacing of 1.5 m between plant to plant and there are 10 plants per vine type. Initially, every plant received 500 gm mixture bonemeal and FYM. The vines were trained into Palmette/trellis system. The plants started to bear fruits in 1995. The cumulative harvests from three plants per vine was used to estimate the yield per acre. Results are presented in Table 6.

Chardonny and Cab Franc yielded comparatively lower than the rest of the varieites. The low yield in these two vines are associated to low cluster/vine and bunch/cluster. Pinot Blanc had early flower initiation, though the maturity was delayed. Muscat flowered late but matured earlier than other cultivars. Muscat had higher number of clusters/vine compared to all other varieties. Perlette and Muscat had the most vigorous vines (Table 6).

Perlette had markedly higher number of berries per cluster followed by Pinot Blanc and Chessalas. Chessalas had irregular berry filling, but the weight of its largest cluster was higher than any other varieties. The colour of berries was attractive in case of Muscat, Chessalas and Perlette. Muscat had aromatic taste with larger berries. The berries, however, had sooty-mold like substance and showed irregular ripening.

Among table cultivars, Perlette was the sweetest followed by Muscat and Chasselas. In wine lines Chardonny was the sweetest cultivar followed by Pinot Blanc and Cab Franc. Cab Franc also had the smallest berries with a distinct taste of unripe fruits.

Chardonny had light infestation by Powdery mildew and severe attack by wasps (Table 6a). The attack by wasps was more severe in sweeter cultivars. However, Perlette escaped the wasp

attack which was followed by high population build-up of flies. TSS could not be measured as refractometer was not available.

Table 6. Characteristics of 6 grape varieties tested at RNRRC, Bajo

Cultivar	Yield (t/Ac)	FLW (days)	Harvest (days)	Clu/vine (no)	B/clus. (no)	Wt.of Lar.clus
Perlette	1.54 a	421	77	14.75	151.30	209.10
Muscat	1.78 a	460	69	29.25	73.33	183.30
Chasselas	1.32 a	425	75	21.33	95.33	472.50
P. Blanc	1.59 a	416	93	24.67	104.30	53.33
Chardonny	0.17 b	425	83	5.33	61.00	53.33
Cab Franc	0.21 b	429	91	4.66	63.00	83.33

Table 6(a). Pest reaction and other traits of 6 grape varieties

Variety	Vigour (1-4)*	Sweetness (1-3)**	Colour	P/mildew (1-5)***	Wasp (1-5)****
Perlette	4	3	White	0	1
Muscat	4	3	Purple	0	2
Chesselas	3	2	White	0	1
P. Blanc	2	2	Green	0	2
Chardonny	2	3	Green	2	3
Cab Franc	1	1	Black	1	1

Note : * 1=less vigor; 4=vigorous
**1=less sweet; 3=sweetest
***1=clean; 5=completely affected
****1=clean; 5= completely affected

LIVESTOCK RESEARCH

Feed and Fodder Research

Minimal research on livestock was ccarried out in the past both at the centre and at the region as a whole. Basic information on livestock practices is lacking at present.

The main objective of this programme is to develop more productive and sustainable livestock options for wetland farmers and to strengthen crop-livestock systems research creating synergistic effect on the crop production. Efforts will be made to have better understanding of the system.

Some of the major constraints include inadequate feed/fodder, lack of fodder production technique, lack of appropriate fodder species, poor seed/plant propagation technology and poor livestock management.

The immediate activities under the feed and fodder development undertaken by the centre during the period 1994-95 are introduction and evaluation of native and exotic species to identify suitable species for the wetland production system. The following observation trials were done:

Winter fodder trial

a) **Chinese Milk Vetch** (Astragalus sinicus)

Apart from its usefulness as a post-rice green manure, Astragalus or the Chinese Milk Vetch is also promoted as a winter feed for the livestock. It can be sown directly under a standing rice crop. At the centre the seed was inoculated and sown on 28.10.94 after the harvest of rice by broadcasting into a 440sqm. plot The first flowering was recorded after 90 days of sowing and likewise the peak flowering was noted in the month of March and April; seed matured by first week of May. It was observed that the palatability was highest when fed to cattle before flowering. Average of three random crop-cuts from 1 sqm plot (of single cut/harvest) produced a fresh biomass of 14.6 t/ha. Laboratory analysis showed that it contains 16.6% Cp, 0.75% Ca, 0.04% Na, 4.61% K, and 0.35% P. Its seed production aspect was studied; it yielded 0.3 t/ha seed.

b) **Winter Vetch** (Vicia villosa)

There are about 150 species of Vetch in the temperate zones, both annual and perennial herbs climbing by tendrils. All Vetch species prefer cool temperature. It is a hay, green fodder and soil improving crop. Vetch species are mostly adapted in sandy soils and tolerate both acidity and alkalinity. Seed prodction is also not very difficult compared to other perennial legumes and seed can even be given to cattle as concentrate.

To evaluate its fodder value, an obervation trial was conducted at the station. Result indicated the it produced a total of 8 t/ha fresh biomass and grew to a height of 64 cm. Crop cuts from seed production plots revealed 0.55 t/ha seed yield. Laboratory analysis showed that it contains 26.6% Cp, 0.99% Ca, 0.05% Na, 4.14% K, and 0.42% P. The most important characteristic of Vetch is that it can grow very well under moisture-stressed soil conditions which indicate that the dry waste lands could be used to raise Vetch to meet feed requirement during lean periods.

c) **Lathyrus** (Lathyrus cicera)

This is a fast growing short-duration legume with easy establishment and seed production. Laboratory analysis results show that it has 18.6% Cp, 1.01% Ca, 0.04% Na, 4.18% K, and 0.25% P. In a trial at the station it grew to a height of 43 cm and produced fresh biomass 10.8 t/ha (dry matter content 3.6 t/ha). Pods per plant was 10 and seed per pod 4. Although the size of leaf is small compared to Astragalus and Crimsom clover Lathyrus is a good fodder.

d) **Crimsom Clover**

It was sown at the station as a green manure crop. Because of its vigorous growing character, tolerance to cold climatic conditions and cattle taking attractively it can be introduced as winter fodder species. During 94-95 the area sown was not enough to calculate its fodder yield since the crop was used for seed multiplication for the next season.

II Perennial Pasture

a) Obervation trial

Several perennial pasture species were tested as single plot observation trial at the station.The species were sown as single plot on 23 April, 1995 in an area of 7 m2 each to evaluate for their fodder productivity. Fresh biomass was estimated from from several cuttings from a 1 sqm. area. The results are presented in Table 1.

Table 1. Fresh biomass and plant characters of ten pasture species

Species	No.of harvest	Plant ht. (m)	Fresh biomass (t/ha)
Sudan	4	1.46	112.5
Seratro	3	0.50	27.50
G.L.D	3	0.53	20.00
Glycine	2	0.40	20.00
Guinea	3	0.55	20.25
Seteria	2	0.35	20.25

Molasses	2	0.25	20.55
Stylo	2	0.40	20.75
S.L.D	1	1.05	10.03
Dolichos	1	1.08	60.05

Sudan grass produced the maximum fresh weight of 112.5 t/ha and was the tallest species with 1.46 m followed by Dolichos with a biomass yield of 60.5 t/ha and height of 1.08 m. Out of the 12 species sown 2 species Paspalum and Centro did not do well and its fodder yield was not taken. Seed production for was not done except that of Sudan. Enough seed of Sudan grass was harvested and will be used for on-farm research and further seed multiplication at the station.

b) Demonstration trial

Three of sub-tropical grass species - Napier (Penisettum purpurium), Seteria (Seteria anceps) and Congo Signal (Bracharia decumbens), and three legume species- Maku lotus, Greenleaf Desmodium and Axillaries, were transplanted on 6 August 1993 for demonstration in the station. The three legume species, however, did not survive. The biomass was estimated from cumulative crop cut yields taken in each harvest. The tresults are presented in table...Napier gave the highest biomass yield with 100 t/ha.

Table 2. Biomass yield and other charateristics of three grass species

Species	No.of harvest	Biomass (t/ha)	Plt.ht.	Cp%	Ca%	Na%	K%	P%
Napier	3	100.00	1.06	8.7	1.17	0.01	9.29	0.39
Signal	3	39.02	0.78	5.4	1.08	0.01	9.99	0.40
Seteria	3	3.74	0.97	15.4	1.61	0.02	7.66	0.40

III. Fodder Trees

Beside the Pasture development activities the promotion of fodder trees or shrubs has also played very important role in livestock production. Most of the fodder trees remain green during the dry season, thus providing good quality fodder in the time of scarcity. Wastelands provide good opportunity for fodder trees plantation.

At the station for obervation few species - Ficus cunia, Ficus roxburghii, Ficus nemoralis, Robinia seudoacapcia, Gmelina arborea thave been planted o observe their growth, biomass yield and adaptability.

SYSTEMS RESOURCE MANAGEMENT

Introduction

The Systems Resource Management is an additional Program, at the regional level, to the four national programs. The program includes those activities that cuts across interlinkages between/among the four national programs such as farming systems development, integrated pest and nutrient management, and agroforestry. Following are some of the activities undertaken under this program during this financial year.

Integrated Nutrient Management

Farmyard manures and composts are by far the most important sources of plant nutrients in the traditional rice-based farming systems in the country. However, with the intensification of cropping patterns combined with the use of modern varieties, the rate of nutrient depletion is faster than replenishment and crop yields are declining. Research on integrated nutrient management, therefore, is of immense significance in developing integrated management packages that will encompass amalgamated use of FYM/compost and inorganic supplements; legumes; crop sequences and mixtures; and green manures and biomass utilization.

3.1 IPNS in a Rice-Wheat Rotation

Fertilizer recommendations are generally made for individual crops. For instance, certain NPK rates for rice and also for wheat are recommended. Given the possible carryover effects, integrated nutrient management for rice-wheat system will allow judicious apportionment of scant resources. In the high and medium-altitude valleys, farmers predominately apply FYM, which is known to adequately supply organic P, to their rice crop. Against this background, a long term trial on the integrated nutrient management for rice-wheat cropping systems was begun in 1989 with the following aims:

* when inorganic NPK is not limited in a rice-wheat rotation, should rice or wheat receive optimum FYM ?

* when inorganic N and K are not limited to rice or wheat, is there a carryover of inorganic P between the 2 crops ?

* when inorganic N and K are not limited to rice or wheat, is the P applied through FYM adequate ?

* assess the value of Sesbania aculeata as green manure in a rice-wheat rotation

The trial was established as an RCBD with 3 replications and 10 treatments in 21 m^2 plots with bunds to prevent surface movement of nutrients from one plot to another. Standard

management practices were followed for both rice and wheat. IR 64 or Milyang 54 and Sonalika or Bajoka 1 were used as varieties for rice and wheat respectively. Upon completion of 6 years (1989-94), interim results (Table 1) and conclusions are as follows :

FYM application

Application of FYM either to rice or wheat did not significantly affect the yield of either crops when NPK are not limited in a rice-wheat rotation (Table 45). However, rice yields were relatively higher when FYM was applied directly to rice rather than to wheat. In contrast, wheat yields did not improve with additional FYM. It implies that rice can utilize FYM more efficiently than wheat in the presence of adequate NPK. Addition of FYM (7t/ha) to the recommended NPK rates significantly increased rice yield by 0.76 t/ha (17%) when yields were averaged over the years.

Residual P

At constant N and K, there was no yield reduction in rice when P was applied only to wheat, indicating a possible carryover of P in a rice-wheat system. Likewise, wheat yields did not decline when P was applied only to rice. Application of P either to rice or wheat seems sufficient if these crops are grown in quick succession. Initial soil analysis data indicated a high level of P in all the plots. However, lack of post-trial soil analysis results precludes authoritative conclusions.

Supply of P by FYM

At constant levels of N and K and with the addition of FYM, the yield of either rice or wheat was not reduced in the absence of P. This suggests that the P requirement of rice and wheat was fulfilled by FYM. FYM supplies P 0.52% of the dry matter (Walter Roder, 1990). Assuming 50% moisture in fresh manures, 7 t of FYM would have contributed about 18 kg P/ha.

Contribution of green manures

Averaged over the years, incorporation of Sesbania aculeata as pre-rice green manure significantly increased rice yield by 1.21 t/ha (43%). Supplementing with NPK at the rate 35-40-20 kg/ha further increased the yield by 20%, enhancing rice yields statistically at par with the highest figure obtained from the recommended rates of NPK and FYM. Wheat yields were expectedly reduced in these plots as no additional fertilizers were applied. Continuous application of green manures improves the physical properties of soil, apart from sustaining high yield levels in a rice-wheat cropping system.

Table 1. Effect of integrated use of FYM, NPK and green manures on the yield of rice and wheat in a rice-wheat rotation, 1989-93.

RICE				WHEAT				1989		1990	1991		1992		1993	1994		
N	P	K	FYM	N	P	K	FYM	Rice	Wheat	Rice	Wheat	Rice	Wheat	Rice	Wheat	Rice	Wheat	Rice	Wheat
	kg per ha		t/ha		kg per ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	t/ha	
0	0	0	0	0	0	0	0	2.71 e	1.07 b	2.55 b	1.07 a	3.84 b	0.91 b	2.06 e	1.01 bcd	2.88 c	0.88 c	4.28 e	0.88 b
70	40	20	0	60	40	20	0	4.76 ab	2.89 a	4.77 a	1.34 a	4.82 ab	1.58 a	2.71 de	1.27 ab	5.15 ab	1.83 a	7.03 a	1.64 a
70	0	20	0	60	40	20	0	4.73 ab	3.11 a	4.69 a	1.27 a	5.49 a	1.77 a	3.41 cd	1.22 abc	5.29 ab	1.84 a	6.81 a	1.67 a
70	40	20	0	60	0	20	0	4.51 abc	2.93 a	4.50 a	1.69 a	5.07 ab	1.63 a	3.59 bcd	1.21 abc	5.02 ab	1.67 ab	6.59 a	1.67 a
70	40	20	7	60	40	20	0	5.07 a	2.92 a	4.64 a	1.46 a	5.61 a	1.91 a	5.05 a	1.33 a	5.64 a	2.07 a	7.24 a	1.70 a
70	40	20	0	60	40	20	7	4.55 abc	2.57 a	4.12 ab	1.47 a	5.44 a	1.73 a	3.58 bcd	1.41 a	4.69 ab	1.91 a	7.43 a	1.73 a
70	0	20	7	60	0	20	0	4.05 bc	2.81 a	3.46 ab	1.38 a	5.32 a	1.68 a	3.93 bc	1.34 a	5.38 ab	1.67 ab	7.08 a	1.62 a
70	0	20	0	60	0	20	7	4.36 bc	2.45 a	3.54 ab	1.40 a	5.24 ab	1.59 a	3.66 bc	1.19 abc	4.95 ab	1.44 abc	6.72 a	1.51 a
0	0	0	gm	0	0	0	0	3.30 de	1.63 b	3.49 ab	1.13 a	5.02 ab	0.88 b	3.80 bc	0.78 d	4.48 b	0.82 c	6.73 a	0.99 b
35	40	20	gm	0	0	0	0	3.89 cd	1.20 b	4.87 a	1.29 a	6.00 a	0.96 b	4.48 ab	1.05 bcd	4.94 ab	0.94 bc	7.42 a	0.92 b
CV %								8.9	17.1	16.6	31.4	13.8	13.5	12.9	13.2	9.7	27.0	11.2	9.4

Mean separation in a column by DMRT at 5% level.

TRAINING & EXTENSION PROGRAM

Training

Seminars

Publications

APPENDICES

Finances

Weather

Visitors

June 1994 to July 1995

03 Aug 1994 Dr. Egbert Pelinck, Director General, ICIMOD, Nepal on a familiarization trip to member countries

22 Aug 1994 Peter Goldsworthy, ISNAR, Netherlands, for Workshop from 22-25 August 1995

28 Sep 1994 Mr. Alan Carpenter, IDRC Project Consultant, for Project Review

01 Oct 1994 Dr. Klaus Lampe, IRRI Director General, Philippines for Field and Station visit

03 Oct 1994 EEC Evaluation Mission (DASA Project) for discussion

10-13 Oct 94 IRRI Bhutan Project Evaluation Team comprising of Mr. Alan Carpenter, Dr. S Franzel, Dr M Loevenseon, Dr. GL Denning

02 Nov 1994 Dr. Martin Menzi, Consultant, RNR Research & Extension, with Mr. Thinley, NPPC, to discuss proposal on rice disease management research

01 Mar 1995 Dr. Kamla Chowdhury, ICIMOD, India for centre visit

13 Mar 1995 Delegation from the Royal Thai, Thailand on a study tour

13 Apr 1995 Dr. Rudolf Denerer, Vice Director, Swiss Development Corporation (SDC) accompanied by his wife and members from Helvetas

14 Apr 1995 Dr.Sanmungusundaram, SAVERNET Director, AVRDC Taiwan to discuss about AVRDC and SAVERNET program

17 Apr 1995 Mr. Masaki Shintani, Technical Officer, APNAN to discuss about EM and Prof. Higa's visit

25 Apr 1995 Mr. Roy, General Surveyor, Calcutta, India, to check the irrigation materials

02 May 1995 Prof. Dr. Teruo Higa, Mrs. Higa, Dr. UR Sangakara and Mr. Hidehiko Okuba, APNAN Delegation on a visit

05 May 1995 Agri. Program Officer, FAO, Rome

10 May 1995 Dr. Tej Partap, Head, Mountain Farming Systems Division, ICIMOD and Mr. A. Bhatia, ICIMOD, on study tour

16 May 1995 Dr. Prang Roy, Team Leader, OPS-UNDP, IFAD Project Mission

16 May 1995 Ms. GC Loresto, Senior Associate Scientist, International Rice Germplasm Centre, IRRI, Philippines, to discuss on the SDC-funded project on rice germplasm collection with Bhutan

19 May 1995 Edward Mallorie, Economist, Holland Villas Road England and Peter F.Goldsmith, United Kingdom for Wang Watershed Project discussion

05 Jun 1995 Dr. Walter Roder, Upland Agronomist, IRRI and Prof. M. Menzi, and other Swiss delegation members to discuss about research, infrastructure and development of a master plan for RNRRC Bumthang

Table : IV Orchard Management and EM Technology Training for Extension Agents and Farmers within and outside the region

Sl. no.	D z o n g k h a g	Extension (No.)	Farmers (No.)
1	Punakha	11	30
2	Wangdue	17	30
3	Tsirang	01	120
4	Dagana	08	71
5	Chukha	11	26
6.	EM Technology P/kha & W/due	80	17
	Total	128	294

Table : V Training/Study Tours for Technical people working under Fruits section

Sl.no.	Purpose/subject of training	Country
1.	Study tour and collection of sub -tropical fruit tree germplasm	Thailand
2.	Study tour on EM Technolgy	Saraburi,Thailand