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ROYAL GOVERNMENT OF BHUTAN

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FOREWORD

It is an immense pleasure to publish the 37th Annual Technical Report of Agriculture Research and Development Centre (ARDC), Bajo, coinciding with the financial year 2022-23. It is a synthesis of the research and development activities carried out in the fields of field crops, horticulture, technical support services, and project supported activities by the Centre and its Sub-Centre at Menchhuna, Tsirang.

ARDC-Bajo implements activities focusing on its national mandate for coordination of field crops research and development, regional mandate for horticulture research and development, and commodity mandates for rice, citrus and water management research and development. It carries out the activities in close collaboration and consultation with the Ministry of Agriculture and Livestock, Department of Agriculture and its central agencies, projects, Local Government agencies, and most importantly with the farmers and other beneficiaries.

The Centre has spearheaded and executed a wide array of initiatives, including rigorous evaluations of rice varietals and diverse wheat varieties. Furthermore, it has made commendable strides by establishing horticulture germplasm blocks, conducting vegetable trials, and overseeing fruits crops trials and demonstrations. Notably, the Centre has achieved resounding success in implementing the million-fruit tree program (MFTP). Building on its accomplishments, the Centre has now embarked on a journey of innovation, exemplified by groundbreaking projects such as the Walipini greenhouse and the Bentonite clay water harvesting pond. These pioneering endeavours showcase the Centre's commitment to sustainable practices and resource management. Additionally, during the fiscal year 2022-23, the Centre played a pivotal role in facilitating skill development and engagement programs for diverse groups of beneficiaries. By fostering these initiatives, the Centre has empowered individuals and communities with the necessary tools and knowledge to thrive in their respective fields.

ARDC-Bajo successfully completed all planned activities for the financial year 2022-23, as outlined in the Annual Performance Agreement (APA) and in the Individual Work Plan (IWP). These achievements were made possible through tremendous support from central agencies, projects, and the unwavering dedication of the staff at ARDC-Bajo, ARDSC-Menchhuna, and Chimipang Royal Project. Their significant efforts contributed towards reaching the targets set for planned activities as well as ad-hoc initiatives. We remain steadfast in our commitment to making a positive difference in farming communities and express our gratitude to all those who contributed to the Center's achievements in 2022-23. I would like to entreat all seniors, colleagues, supporters, and stakeholders to continue to provide full cooperation, support and best wishes.

This report is intended not only to serve as an account of activities implemented in the last one year but also possibly as technical reference and guidelines to all stakeholders involved in agricultural research and rural development to achieve national food and nutrition self-sufficiency, economic self-reliance and eventually the overarching national goal of Gross National Happiness in Bhutan.

Tashi Delek La!

Pema Chofil
Program Director

GLOSSARY OF ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
AET	Advance Evaluation Trial
APA	Annual Performance Agreement
ARCM	Agriculture Research Coordination Meeting
ARDC	Agriculture Research and Development Centre
ARDSC	Agriculture Research and Development Sub-Centre
AVRDC	Asian Vegetables Research and Development Centre
AWD	Alternative Wetting and Drying
BAMS	Bhutan Agri-microbial Solution
BFDA	Bhutan Food and Drug Authority
BJA	Bhutan Journal of Agriculture
CIMMYT	International Center for Wheat and Maize
CRP	Chimipang Royal Project
CV	Coefficient of variation
DAO	Dzongkhag Agriculture Officer.
DBT	Days before transplantation
DoA	Department of Agriculture
DTF	Date to Flowering
DTM	Date to Maturity
EPB	Evolutionary Plant Breeding
EM	Effective Microorganism
FAW	Fall Armyworm
FMCL	Farm Machinery Corporation Limited
FSAPP	Food Security and Agriculture Productivity Project
FY	Financial Year
FYM	Farm Yard Manure
GAFSP	Global Agriculture and Food Security Program
GCF	Green Climate Fund
GEF	Global Environment Facility
HDPE	High-Density Polyethylene
HLB	Huanglongbing
HPYT	Harvest Plus Yield Trial
HYV	High Yielding Varieties
IET	Initial Evaluation Trial
IFAD	International Fund for Agricultural Development
IHPP	Integrated Horticulture Promotion Project
IIRON	International Irrigated Rice Observation Nursery
ICT	Information and Communication Technology
IPM	Integrated Pest Management
IPNM	Integrated Plant Nutrients Management
IRRI	International Rice Research Institute
IoT	Internet of Things
IWP	Individual Work Plan
JICA	Japan International Cooperation Agency

LBR	Late Blight Resistant
LCR	Large Cardamom Repository
MAP	Medicinal and Aromatic Plants
MET	Multi Environmental Trial
MFTP	Million Fruit Tree Plantation Project
MoAL	Ministry of Agriculture and Livestock
NBC	National Biodiversity Centre
NCR	National Citrus Repository
NCT	National Coordinated Trial
NCOA	National Centre for Organic Agriculture
NPK	Nitrogen Phosphorus Potassium
NPPC	National Plant Protection Centre
NSC	National Seed Centre
NSSC	National Soil Services Centre
ORP	Outreach Programme
PET	Participatory Evaluation Trials
PST	Project Support Team
RCBD	Randomized Complete Block Design
RNR	Renewable Natural Resources
SLM	Sustainable Land Management
TSS	Total Soluble Sugar
VET	Varietal Evaluation Trial

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FIELD CROP RESEARCH AND DEVELOPMENT PROGRAM

1. Rice

1.1 Rice Advance Evaluation Trial (AET)

In the Rice Advance Evaluation Trial (AET), six lines were selected from the Initial Evaluation Trial (IET) of the previous year (FY 2021-22). The purpose of this trial was to assess and advance the most promising lines for further testing, based on specific selection criteria. The AET was conducted using a Randomized Complete Block Design (RCBD) with three replications. Each plot had a size of 4m x 2m, with a spacing of 20cm x 20cm between the plants. To ensure optimal growth, a recommended fertilizer dose of 70:40:40 NPK kg/ha was applied. To control weed growth, Butachlor at a rate of 1.5 kg a.i/ha was used. Throughout the trial, various agronomic parameters were carefully recorded to evaluate the performance of the selected lines. These parameters include growth rate, yield potential, disease resistance, and other relevant characteristics.

The AET aims to identify and advance the most promising rice lines based on their performance in the trial. This process is crucial in the selection of superior varieties that can contribute to improving rice production and meeting the needs of farmers and consumers.

Table 1. ANOVA for yields of rice AET lines

Source	DF	SS	MS	F-value	P
Replication	2	43909	21954		
Treatment	6	3480638	580106	9.19	0.0007
Error	12	757808	63151		
Total	20	4282355			
CV (%) = 13.13%		Mean = 1913.7 Kg/acre			

In summary, the analysis indicates that the treatment has a significant effect on the yield and that there is relatively low variability in the data. The average yield obtained from is 1913.7 kg/acre.

Table 2. Least Significant Difference (LSD) Test summary

ENT NO	SVCODE	50% FLW	Plant height(cm)	Tillers/hill (no)	Maturity Days	Yield kg/acre
37	SVIN329	96.33^{a}	110.33^{a}	11.66^{ab}	145^{a}	2147.33^{a}
71	SVIN357	96^{a}	99^{a}	14^{a}	142.33^{a}	2149.33^{a}
43	SVIN031	94.33^{a}	93.33^{a}	13^{ab}	144.66^{a}	2145.67^{a}
73	SVIN360	100^{a}	439.33^{a}	12^{ab}	151.33^{a}	1463.67^{b}
24	SVIN319	100^{a}	104.33^{a}	13.33^{a}	151^{a}	174.44^{a}
70	SVIN356	98.33^{a}	100.66^{a}	0.44^{b}	145^{a}	2125.67^{a}
BK1	Check	105.66^{a}	105^{a}	13.33^{a}	143.66^{a}	1115.67^{b}

α= 05. Mean followed by the same superscript letter in the same column are not significantly different

The study evaluated several rice varieties (SVIN329, SVIN357, SVIN031, SVIN360, SVIN319, and SVIN356) in comparison to the check variety Bajo Kaap 1 (BK1) using various parameters. The mean values for each parameter were compared to identify any significant differences. Here are the key findings:

1. Flowering (50% FLW): SVIN031 displayed the earliest flowering, with the lowest mean value. In contrast, BK1 showed significantly delayed flowering compared to the other varieties.

2. Plant height (cm): SVIN360 exhibited unusually high plant height, while SVIN031 had the lowest value. BK1's plant height was similar to the other varieties.
3. Tillers/hill (no): SVIN356 had the fewest number of tillers per hill, significantly different from the other varieties. SVIN357 and SVIN360 had the highest tiller count, but there was no significant difference between them and the other varieties.
4. Maturity Days: SVIN357 had the shortest maturity period, while SVIN360 and SVIN319 had the longest. BK1's maturity time was similar to the other varieties.
5. Yield (kg/acre): SVIN360 and BK1 had significantly lower yields compared to the other varieties. SVIN319 had the lowest yield, while SVIN357, SVIN329, SVIN031, and SVIN356 had similar and relatively higher yields.

SVIN357 appears to be the best rice variety when compared to the check variety (BK1). It exhibits earlier flowering, reasonable plant height, high tiller count, shorter maturity days, and a high yield comparable to SVIN329, SVIN031, and SVIN356

1.2 Evaluation of Nepal Lines

The Department of Agriculture (DoA) along with National Rice Coordinator have identified several rice varieties from Nepal that show potential for evaluation and adaptation to Bhutanese conditions. In line with this, the DoA has procured seeds for nine rice varieties through the existing seed sharing protocols. Bhutan and Nepal are both signatories to the IRRI-sponsored Seeds Without Border Agreement, which facilitates the sharing of tested and approved seeds between the two countries. To evaluate the performance of these varieties, the field crop sector conducted trials using a Single plot design, with a spacing of 20cmx20cm between plants and rows. The recommended fertilizer dose of 70:40:40 NPK kg/ha was applied, and Butachlor at a rate of 1.5 kg a.i/ha was used for weed control. Essential agronomic practices, including irrigation and weeding, were carried out as needed. Timely collection of all mandatory data was ensured, followed by thorough analysis.

Table 3. Agronomic performance of Nepal Lines

Variety	No. tillers per hill	Plant height (cm)	Panicle length (cm)	Maturity days	Presence of awn	Yield kg/acre
Sukha Dhan 3	14.20	89.50	24.90	145.00	No	3077.68
Sukha Dhan 4	16.60	94.00	24.30	150.00	No	3209.23
Sukha Dhan 5	17.50	105.00	21.80	147.00	No	2950.44
Hardinath 1	14.90	89.50	23.20	150.00	No	2237.77
Hardinath 3	16.09	94.90	24.90	145.00	No	2780.55
IR98846-2-1-4-3	16.60	90.00	24.60	148.00	No	2819.86
IR14L362	15.90	91.40	20.80	145.00	No	1972.40
PR 126	12.60	87.00	21.50	146.00	No	450.00
NR2169-10-4-1-1-1-1-1	9.80	99.50	21.70	146.00	No	3540.10

1.3 Effect of Nano-Urea in rice cultivation

Nano-Urea is relatively new fertilizer developed and tested by Indian Farmer Fertilizers Cooperative Limited (IFFCO), and in general, there are limited researches on it particularly in rice. The objective of the project was to evaluate the yield response of rice to Nano-Urea. The study was conducted through multi-location trials across major rice growing regions in the country during the 2022 growing season. The study was conducted using a completely randomized block design (CRBD) with five treatments and three replications at ARDC, Bajo. Treatment plots

measuring 10 sq. meter were used, and the plant population of 250 hills was maintained. Bajo Kapp 3 was the rice variety used for the research.

Table 4. Experimental treatments in on-station research

Treatments	% NPK + Nano-Urea	Basal Dose (Suphala: gm/plot)	Top-Dressing	
			Urea (gm/plot)	Nano-Urea(ml/l/ac)
T1: Treatment 1	0 + 0	0	0	0
T2: Treatment 2	100 + 0	400	5	0
T3: Treatment 3	50 + 50	200	2.5	2
T4: Treatment 4	25 + 75	100	0.6	3
T5: Treatment 5	0 + 100	0	0	4

ANOVA was performed using R statistical packages to check for statistical significance of the results. In ARDC-Bajo, T3 (50:50) has the highest grain yield of 2.71 Mta^{-1}, and the lowest of 1.95 Mta^{-1} in Control plot. Although results didn't show significant yield increase as a result of Nano-Urea application in all the sites including on-farm trials, there was a general tendency of higher yields in the Nano-Urea plots over the Control plots. On average, Nano-Urea plots have 14.85% higher yield than the Control plots in on-station trials.

Table 5. Average grain yield of different treatments in on-station study

Treatment (% Urea+Nano)	Mean Grain Yield (Mt/ac)
T1 (0 + 0)	1.95[b]
T2 (100 + 0)	2.61[a]
T3 (50 + 50)	2.71[a]
T4 (25 + 75)	2.62[a]
T5 (0 + 100)	2.23[b]

*Mean followed by the same superscript letter in the same column are not significantly different

This study did not find any evidence to support that Nano-Urea has increased the yield of rice, and these results are inconsistent with the studies done by IFFCO. It has been pointed out that rainfall, which has hindered scheduled spraying of Nano-Urea in the research sites could have possibly affected the results.

1.4 International Rice Observational Nursery

In the FY 2022-23, a total of thirty-two sets of International Upland lines and 40 sets of Irrigated lines were tested as observation nurseries on-station (Annexure 2 & 3). The purpose of these trials was to screen and advance promising lines for further testing based on specific selection criteria. All trial procedures were conducted following the prescribed protocol. The trial design for both upland and irrigated lines consisted of single observation plots of different dimensions and a spacing of 20cm X 20cm. The recommended fertilizer dose of 70:40:40 NPK kg/ha was applied in a timely manner. To control weed growth, the herbicide Butachlor was used at a rate of 1.5 kg a.i/ha. During the trial, crop cut samples were taken from five random samples for analysis. All mandatory data were collected promptly and subjected to thorough analysis. Among the upland rice lines, the maximum yield of 3047.55 kg/ac was observed for line SV0755, while the minimum yield of 260.56 kg/ac was computed for line SV0046. Based on the results, promising entries were selected for further evaluation. However, two entries (SV0713 & SV0056) exhibited very late maturity and did not yield under the given conditions.

Regarding the irrigated lines, SVO713 demonstrated the highest yield of 3158.28 kg/ac, whereas SV0442 had the lowest yield of 867.00 kg/ac. Two lines, SV0866 and SV0861, did not yield due

to late maturity. These findings provide valuable insights for selecting and advancing promising lines in both upland and irrigated rice cultivation. Further evaluation will be carried out to determine the suitability and potential of the selected entries for future testing and development.

1.5 Improving local rice varieties through cross-breeding

In the FY 2022-23, the process of rice cross-breeding was continued to enhance local rice varieties. The female parents used were Bonday, Tan-Tshering, and Ngabja, while the male parents were IR 64 and BK3. A total of 30 samples were taken, resulting in five successful crosses between the different varieties. However, no panicles were harvested from any of the crosses made.

Table 6. Results of Rice cross-breeding

SN	Female parent	Male parent	Remarks
1	Ngabja	IR64	No panicle harvested
2	Tan-Tshering	IR64	No panicle harvested
3	Tan-Tshering	BK3	No panicles harvested
4	Bonday	BK3	No panicles harvested
5	Ngabja	BK3	No panicle harvested

1.6 Demonstration of released rice varieties

The Centre entertained lot of visitors with different learning objectives. Farmers showed interest in seeing new crop varieties; extension personnel were keen on new technologies; and trainees, guests and visitors had specific objectives to visit the Centre. In general, many were interested in technologies available or adopted in the Centre. To showcase and disseminate technology to farmers, students and extension staff, a demonstration plot consisting of nine released rice varieties was established at the research station. The following rice varieties were demonstrated on-station. Necessary agronomic practices such as irrigation and weeding were done based on the requirement.

Table 7. Yields of released rice varieties at demonstration plots

Varieties	Plant height (cm)	Tillers/hill	Maturity days	Grain yield (kg/ac)
Bajo Kaap1	109	11	140	1956
Bajo Kaap 2	112	23	155	1560
IR 20913	115	12	120	1231
Bajo Maap 2	114	14	150	1342
IR 64	100	19	146	1452
Bajo Maap 1	112	14	135	1230
Black rice (local)	132	12	155	870
Vietnam rice	120	10	152	790
Bajo Kaap 3	107	15	150	1532

1.7 Paddy seeds produced, multiplied and maintained

The Centre produce and maintain seeds of promising varieties of cereals every year basically to maintain the seed for research and to meet unforeseen circumstances and support the Dzongkhags during their time of need. ARDC Bajo is also mandated to supply breeder seed to National Seed Centre (NSC) upon their request. In the FY 2022-23, the Field Crop Sector produced 5.74MT paddy seed was produced from ARDC Bajo and ARDSC Menchunna. Paddy seeds of the released varieties such as Bajo Kaap1 and 2; Bajo Maap1 and 2; Bajo Kaap3; IR-64; IR20913; Wengkhar RaykaapII, Khangma map and bulk 20 were produced and maintained as seed for next season and to support promotional programs in the Dzongkhags.

Table 8. Paddy seed produced from released and potential varieties in 2FY 022-23

SN	Variety	Qty (kg)	Centre	Remarks
1	IR 64	250.00	ARDC Bajo	Released variety
2	IR20913	250.00	ARDC Bajo	Released variety
3	Bajo Kaap 1	520.00	ARDC Bajo	Released variety
4	Bajo Kaap2	550.00	ARDC Bajo	Released variety
5	Bajo Maap 1	200.00	ARDC Bajo	Released variety
6	Bajo Maap 2	570.00	ARDC Bajo	Released variety
7	Bajo Kaap 3	900.00	ARDC Bajo & ARDSC Mechhuna	Released variety
8	Bulk-20	500,00	ARDSC Menchhuna	Evaluation trial
9	Khangma Maap	350.00	ARDSC Menchhuna	Seed purification for upland rice
10	Wangkhar Ray Kaap-II	150.00	ARDSC Menchhuna	
11	Mixture	2000.00	ARDC Bajo	
Total		**5740.00**		

From the 5.74MT of paddy seed produced some seed has been distributed to other agencies and farmers under promotional program. The table below details the paddy seed supply under promotional program.

Table 9. Paddy seed supply under promotional program in the FY 2022-23

Gewogs/Centres	Dzongkhag	Variety	Quantity (kg)	Remarks
NSC	Bajo	Bajoa Kaap III, IR64, Bajoa Maap I	204	As breeder seed (68 kg each)
ARDC- Wengkhar	Mongar	Bajo Kaap III	66	Trial
Nahi Gewog	Wangdue Phodrang	Bajo Kaap III	236	6 HHs
Guma Gewog	Punakha	Bajo Maap II	34	1 HHs
Kazi	Wangdue Phodrang	Bajo Kaap III & IR64	68	1 HHs
Tshetsho	Wangdue Phodrang	assorted	192	1 HHs
Sergithang	Tsirang	Bulk 20	125	On-farm trial
Tseaza Gewog	Dagana	Khangma maap 2	120	
Goshi Gewog	Dagana	Bajo kaap III	200	
Kikhorthang.	Tsirang	Bulk-20/ khangma maap	115	
Rangthaling	Tsirang	Bajo Kaap-III	150	
Tsangkha Gewog	Dagana	Bulk 20	10	
Total			**1316.00**	

2. Wheat

2.1 Initial Evaluation Trial of 10th HPYT CIMMYT lines

Sixteen lines of bread wheat along with the released variety Bajosokhakaa were tested in a replicated trial in 2022-2023 wheat season to ascertain their performance under our existing local conditions. The lines were the selected ones from the previous season. Out of sixteen, only nine lines were selected based purely on grain yield and previous parameters; plot uniformity, lodging incidence, agronomic score and spike observation. The lines rejected were either due to low yield, late maturity and non-uniformity.

The trial was laid out in a RCBD design with three replications. A seed rate of 100 kg ha^{-1} was used, and a spacing of 20 cm x 20 cm was maintained between the rows to facilitate weeding and intercultural operations. An inorganic fertilizer at the rate of 80:40:40 (NPK) kg $ha^{-1}$was applied with half of N and full dose of P and K as basal during final land preparation. The remaining N was applied at tillering stage; a month and a half later after planting. The crop received four irrigations during its entire crop period, and hand weeding was done as and when required. Among the weeds, little seed canarygrass (*Phalaris minor*) was the most dominant and problematic weed. At maturity, data on different agronomic traits were gathered and grain yield was estimated from 6 m^2 crop cut area. The crop management practices and data collection were same for all the following wheat trials unless specified otherwise. Crops in both the seasons were planted in early December and harvested in early to mid-May, taking roughly about 175 days. In both years, the preceding crop in the trial site was rice.

The new lines produced comparable or higher than the check in all the measured agronomic traits (Table10). These selected lines will be further evaluated in a replicated trial (advance evaluation trial (AET)) in 2023-2024 wheat seasons to further ascertain their performance.

Table 10. Agronomic traits of 10th HPYT of bread wheat lines

Entries	No. of days to Heading	No of days to Maturity	Plant height (cm)	Spike length (cm)	Grain yield (t ha^{-1})
30	97	160	77.4	6.3	3.2
85	95	145	83	7	3.1
42	103	155	89.5	8.1	4.2
10	102	155	87.5	7.1	3.7
32	97	147	80.8	8	3.7
86	103	155	91.1	8	3.5
75	95	145	80.9	7	4
23	95	150	84.5	7.3	3.2
6	102	152	85.9	6.3	3.3
Bajosokha kaa (check)	98	148	97	8	3.4

2.2 Initial Evaluation Trial of 11th HPYT CIMMYT lines at ARDSC, Menchunna.

From the observation nursery that was carried out in the previous season, only eighteen lines were selected out of 50 entries. These eighteen lines underwent an initial evaluation trial in 2022-2023 season at ARDSC, Menchunna. Out of eighteen, only nine lines were selected this season. The main objective of the introduction was to evaluate the performance of CIMMYT wheat lines for varietal development under Bhutanese agro-ecosystem.

The trial was laid out in a RCB design with two replications. Consisting of 6m^2 plot size for each treatment. Spacing of 20 cm x 20 cm was maintained to facilitate weeding and intercultural operations. An inorganic fertilizer at the rate of 80:40:40 (NPK) kg ha^{-1} was applied and in addition adequate amount of farm yard manure (FYM) was also applied as basal dose. Intercultural operations were carried out as and when required.

Entries 443, 441, 407, and 410 seems to have better performance in terms of production and higher yield potential as compared to the controlled variety Bumthangkaadrukchu. The results of the trial are presented in Table 11.

Table 11. Agronomic traits of 11th HPYT of bread wheat lines

Entries	Days to 50% to Heading	Days to 50% to Flowering	Plant height (cm)	spike length (cm)	No. of spikelet	Days to Maturity	1000 Grain weight (gm)	Yield/plot (kg)	Yield (t ha^{-1})
448	56	73	60.6	7.05	10.5	146	38.5	0.81	1.35
446	57	73	64.5	7.15	9.5	146	48	0.86	1.43
443	57	76	76.2	7.85	11.5	138	51.5	1.5	2.42
430	64	87	67.9	7.4	10	160	34	0.55	0.92
426	63	83	63.6	7.4	9.5	146	45	0.86	1.47
417	68	88	65.6	7.85	9.5	154	41.5	0.74	1.23
414	63	86	65.2	6.45	10	148	47.5	0.87	1.45
410	62	83	64.5	7.1	9.5	149	48	1.19	1.98
407	56	75	67.8	6.75	9	136	47	1.55	2.58

2.3 Participatory Evaluation Trials (PETs) of Biofortified wheat lines

In 2022-2023 wheat season, ARDSC, Tsirang was chosen as one of a site for multi-location production trial along with ARDC, Bajo. The trials were laid out in a RCBD design with three replications. The replications were separated by 50 cm, spacing of 20 cm x 20 cm was maintained between the rows to facilitate weeding and intercultural operations. The seeds were sown in lines; maintaining ten rows in a plot. An inorganic fertilizer at the rate of 80:40:40 (NPK) kg $ha^{-1}$was applied with half of N and full dose of P and K as basal during final land preparation. The remaining N was applied at tillering stage; a month and a half later after planting.

At ARDC, Bajo, the crops received four irrigations during its entire crop period whereas in ARDSC, Menchunna since, the trial was established in the dry land after maize harvest, the crop was not irrigated but depended entirely on seasonal rainfall. The trial was established in late September and harvested in March at ARDSC, Menchunna. At ARDC, Bajo, the seeds were sown in early December and harvested in early to mid-May and the preceding crop was rice. Among the weeds, littleseed canarygrass (*Phalaris minor*) was the most dominant and problematic weed here in ARDC, Bajo field. False smut disease was observed emerging during the heading till flowering stage at ARDSC, Menchunna. Roughing was carried out in both the stations. At maturity, data on different agronomic traits were gathered and grain yield was estimated from 6 m^2 crop cut area.

Amongst the tested bio fortified wheat lines at ARDC, Bajo, BF412 yielded the highest with 5.2 t ha^{-1} followed by BF450 with 5 t ha^{-1}. In ARDSC, Menchunna, BF447 yielded the highest 1.8 t ha^{-1} followed by BF415 with 1.7 t ha^{-1}. These lines will be further evaluated in farmer's field. The results of the trial data are presented in the following table 12 and 13.

Table 12. Agronomic traits of Biofortified wheat lines at ARDC, Bajo

Entries	Days to Heading	Days to Maturity	Plant height (cm)	Spike length (cm)	1000grain weight (gm)	Grain yield (t ha^{-1}
BF450	97	145	85.8	6.8	1.6	5
BF447	92	145	85.4	8.8	1.5	3.8
BF415	92	145	89.6	7.4	1.6	4.5
BF422	102	145	81.2	7	1.5	4.6
BF412	92	145	85.2	6.7	1.4	5.2
BF411	102	145	90.8	8.1	1.4	3.8
Check (Bumthangkaadrukchu)	102	145	91.6	7.8	1.7	4.5

Table 13. Agronomic traits of Biofortified wheat lines at ARDSC, Menchunna

Entries	Days to Heading	Days to Maturity	Plant height (cm)	Spike length (cm)	1000 grain weight (gm)	Grain yield (t ha^{-1}
BF450	77	162	72.7	8.5	47	1.2
BF447	75	153	73.2	8.5	41	1.8
BF415	81	145	76	8.5	52	1.7
BF422	87.3	168	72.8	8.6	44	1.2
BF412	85	169	69.5	9	42	1
BF411	81	163	71.1	7.6	45	1.3
Check (Bumthangkaadrukchu)	78	158	76.1	8.1	43	1.3

2.4 Evaluation of spring wheat line NL-1073 under irrigated rice-based system.

The purpose of the study was to assess the performance of Wheat line NL-1073 under irrigated rice-based system. This line has exceedingly performed well under the rain-fed conditions in dry land without any supplementary irrigation. However, performance of this line in an irrigated field was not carried out so, this study was carried out to see its performance under rice-based system. The line was compared with the existing wheat varieties in ARDC, Bajo field. NL-1073 was evaluated in a large plot on station at bajo. Sowing was done after rice; last week of December. Crops were irrigated as and when required. The crop matured in early May. The results of the trial are presented in the table 14.

Table 14. Agronomic traits of NL-1073 wheat line with the released varieties

Varieties	Plant Height (cm)	Maturity Range (Days)	Maturity Group	Panicle Length(cm)	Presence of awn	1000 grain weight(gm)	Yield t ha^{-1}
NL-1073	80-85	130-135	Early	8.5	Yes	35-40	3.6
Bumthangkaadrukchu	90-95	150-160	Medium	11	Yes	40-45	3.4
Bajosokha kaa	90	155-160	Medium	10	Yes	40-45	3.6
Gumasokha kaa	90-95	150-160	Medium	10	Yes	40-45	3.3

2.5 Seed production and maintenance of released wheat varieties

The following quantity of seeds of different released and promising varieties were produced and maintained at the research centre for future research use.

Table 15. Wheat seed produced from released and potential varieties in FY 022-23

SN	Varieties /Lines	Quantity produced (Kg)	Centre	Remarks
1.	Bajosokha kaa	290	ARDC, Bajo	Released varieties
2.	Gumasokha kaa	220	ARDC, Bajo	
3.	Bumthangkaadrukchu	370	ARDC, Bajo	
4.	NlL-1073	60	ARDC, Bajo	
5.	Mixture (trial borders)	370	ARDC, Bajo	
6.	NL-1073	200	ARDSC, Menchunna	
7.	Assorted (Gumasokha kaa, Bumthangkaadrukchu)	3000	Chimipang Royal Project (CRP)	
	Total	**4510.00**		

3. Maize

3.1 Maize performance evaluation trial

In the FY 2022-23, ARDSC-Menchunna has conducted an on-station maize performance trial of four promising maize varieties in a single large plot to evaluate performance. 50 cm row to row and 30cm plant to plant distance was maintained. The recommended dose of FYM and synthetic fertilizer was applied in time. Weeding two times 35 days after sowing; 60 days after sowing, thinning was carried out. Timely data were collected. No major pests and diseases were observed during the growth stages. Three crop cut samples were taken with a sample size of $7m^2$ each and then computed to kg per ac as reflected in table 16.

In the FY 2022-23, ARDSC-Menchunna conducted an on-station maize performance evaluation trial of four promising maize varieties. The trials were conducted in a single large plot. The trial maintained a row-to-row distance of 50 cm and a plant-to-plant distance of 30 cm. The recommended dose of Farm Yard Manure (FYM) and synthetic fertilizer was applied on time. Weeding was performed twice, 35 days and 60 days after sowing, and thinning was carried out as required. Data collection was conducted in a timely manner, and no significant pests or diseases were observed during the growth stages. For analysis, three crop cut samples were taken, with each sample covering an area of $7m^2$. The results of the samples were then computed and presented in the table 16.

Table 16. Agronomic traits of promising maize varieties

Variety	Average plant height		No. of cobs	Average length of cob (cm)		Average yield (kg/7m2)		Yield (kg/ac)
	Mean	*SD*		Mean	*SD*	Mean	*SD*	
Ganesh II	2.07	0.24	17	18.13	0.51	3.96	0.55	2286.62
Chaskharpa	2.63	0.34	23	19.10	2.01	4.30	0.52	2482.94
Yangtsipa	2.02	0.19	24	18.57	1.25	3.90	0.36	2251.97
Sweet corn	2.24	0.21	16	16.10	1.15	2.48	1.21	1432.02

3.2 Improved maize varieties seed production and promotion

As entrusted with the developmental mandate, ARDSC Tsirang produced and maintained seeds of different released maize varieties. These seeds are exclusively used in the on-farm demonstration, support to client Dzongkhags on request and other ad-hoc requests from both Department and Commodity Programs. In 2022-23. A total of 863.00 kg of assorted maize seed has been produced and distributed to farmers on a promotional basis for Tsirang Dzongkhag which covered more than 55 acres of dryland. This is expected to make a substantial contribution to overall cereals production.

Table 17. Promotion of improved maize seed, Tsirang Dzongkhag 2021-2022

SN	Variety	Qty issued (kg)	HHs covered	Area (ac)
1	Ganesh II	212	10	14.13
2	Yangtsipa	224	11	14.93
3	Chaskharpa Ashom	400	22	26.67
4	Sweet corn	27	0	0.00
Total		**863**	**43**	**55.73**

4. Other Cereals

4.1 Evaluation of quinoa varieties

In the FY 2022-23, quinoa evaluation varietal trial was conducted on-station at ARDSC Tsirang. Essential agronomic practices including irrigation and weeding were carried out as needed. Timely collection of all mandatory data was ensured. For analysis, three crop cut samples were taken with each sample covering an area of 1m². The results of the samples were then computed and presented in the table 18. It is important to note that the computed yield per acre is comparatively low when compared to the previous year. This decrease in yield can be attributed to delayed rainfall and prevailing drought conditions during the growing season, which adversely affected the crop's performance.

Table 18. Agronomic traits of on-station quinoa evaluation trial

Variety	Yield (kg/1m²)					Average yield (kg/ac)
	sample i	sample ii	sample iii	Mean	SD	
Quinoa Real	0.02	0.04	0.47	0.17	*0.25*	707.5505
Ivory 123	0.07	0.17	0.18	0.14	*0.06*	559.835

4.2 EPB demonstration rice trial at Kabesa, Punakha

The Research Centre in collaboration with National Biodiversity Centre (NBC) and Dzongkhag Agriculture Sector has been conducting "Participatory technical assessment of evolutionary plant breeding (EPB)" trials on mid-altitude rice in Punakha and Tsirang. The EPB trials are introduced in Bhutan for the first time through the EPB project which is funded by International Fund for Agricultural Development (IFAD) through Biodiversity International. In Bhutan, the EPB project is nationally executed by NBC in collaboration with ARDCs (Yusipang, Bajo and Samtenling) and Dzongkhags. EPB trials in Bhutan have been initiated on rice and beans. The EPB trials on rice are ongoing in Punakha and Tsirang representing the mid-altitude rice-growing areas. The evolutionary populations for the crops were prepared by mixing the most popular traditional and improved varieties collected and contributed by farmers and ARDCs from specific locations.

Table 19. ANOVA for yields of EPB demonstration rice trial at Kabesa, Punakha

Source	DF	SS	MS	F-value	P
Replication	2	138694	69347	0.819	0.457
Treatment	6	215131	35855	0.33	0.9091
Error	12	1308740	109062		
Total	20	1662565			
CV (%) = 15.52%		Mean = 2135.55 kg/ac			

Based on the analysis, the yields of the different rice varieties do not significantly differ from each other. The coefficient of variation (CV) is 15.52%, indicating a moderate level of variability in the data. The mean yield across all varieties is 2135.55 kg per acre

Table 20. Least Significant Difference (LSD) Test summary

Treatment	Tillers/ hill	Plant height (cm)	Maturity days	Panicle length (cm)	1000g grain weight	Yield kg/acre
V1=IR64	18.70^{a}	125.00^{a}	147^{c}	23.67^{a}	19.49^{abc}	2113.33^{a}
V2=BM1	14.13^{a}	138.53^{a}	150^{bc}	23.87^{a}	19.48^{abc}	2157.77^{a}
V3=Dawa (local)	14.53^{a}	119.53^{a}	155^{a}	23.47^{a}	18.95^{bc}	2153.33^{a}
V4=Nabja (local)	13.47^{a}	115.87^{a}	153^{ab}	23.20^{a}	21.42^{a}	2324.44^{a}

V5=TanTshering (local)	13.80[a]	130.80[a]	149[c]	22.93[a]	20.14[ab]	1966.66[a]
V6=Bonday	14.53[a]	122.07[a]	153[ab]	22.27[a]	17.8[c]	2122.22[a]
V7=Mixture 2-6	16.00[a]	143.60[a]	150[bc]	22.73[a]	20.18[ab]	2111.11[a]
CV (%)	21.54	17.59	1.29	6.01	6.28	15.52

CV= Coefficient of variation. α= 05. Mean followed by the same superscript letter in the same column are not significantly different

4.3 EPB demonstration rice trial (2022) at Dzomlingzor, Mendrelgang,Tsirang

Table 21. ANOVA for yields of EPB demonstration rice trial at Mendrelgang,Tsirang

Source	DF	SS	MS	F-value	P
Replications	2	0.02363	0.01182	0.73	0.930
Treatment	5	1.28146	0.25629	2.21	0.1337
Error	10	1.15902	0.11590		
Total	17	2.46411			
CV (%) = 17.42		Mean = 1.961 kg/ac			

The yields of different treatments are not significantly different with the overall mean yield of 1233.38 kg/ac.

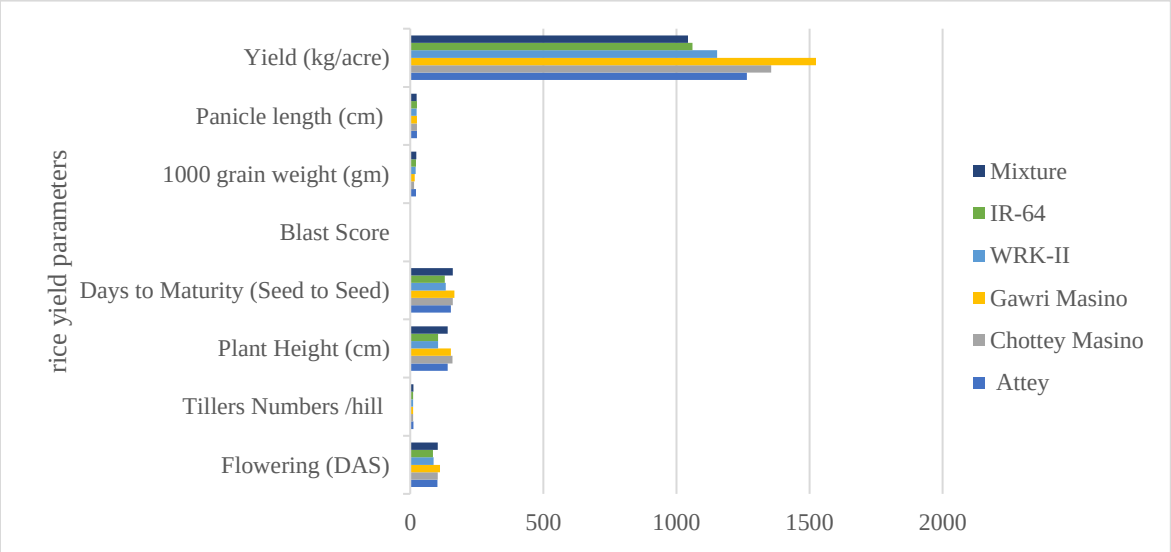

Figure 1. Comparing different yield parameters among the different rice varieties.

Gawri Masino rice variety took the longest days to flower and IR-64 the least. The highest number of tillers was observed in the "Attey" rice variety. The plant height varied from 104.13 cm to 158.2 cm. The rice variety "Chottey Masino" had the tallest plants, followed by "Gawri Masino". The number of days required for maturity ranged from 129.33 to 166 days. The rice variety "Gawri Masino" took the longest time to reach maturity. Blast Score was based on a scale of 1 to 9, where a lower score indicates less susceptibility to blast disease. "WRK-II" and " IR-64" had the lowest scores, indicating higher resistance to blast. The 1000 grain weight varied significantly among the varieties, ranging from 14.66 g to 22 g. The highest weight was observed in the "IR-64" line. The "Attey" line had the longest panicles, followed by "Chottey Masino" and "Gawri Masino". The highest yield was obtained from the "Gawri Masino" line, followed by "Chottey Masino" and "Attey".

4.4 EPB trial (2022) for climber beans- Mendrelgang, Tsirang

Table 22. ANOVA for seed yields of climber beans

Source	DF	SS	MS	F-value	P
Replications	2	0.02363	0.01182	0.73	0.930
Treatment	5	1.28146	0.25629	2.21	0.1337
Error	10	1.15902	0.11590		
Total	17	2.46411			
CV (%) = 17.42		Mean = 1.961 kg/ac			

The factor of treatment, with 5 degrees of freedom (DF), shows a potential effect on seed yields. The F-value of 2.21 for the treatments suggests some variation in seed yields among the treatment groups. However, the associated p-value of 0.1337 is greater than the common significance level of 0.05, indicating that the observed effect is not statistically significant. The mean seed yield across all treatments and replicates is 1.961 kg/ac.

Table 23. Least Significant Difference (LSD) Test summary

Treatments	Disease score (scale 1-5) where 1= no diseases symptoms observed, 5= severe incidence	Mean pods/	Days to maturity (seed to seed)	Mean pod length	Number of seed per pod	Seed yield kg (after sun drying)	1000 grain weight (gm)
Gew Bori	1.66^{a}	14.66^{d}	111.66^{a}	12.56^{c}	4.33^{c}	1.5^{b}	486^{a}
Kalo Gew Bori	1.33^{a}	19.66^{c}	111.66^{a}	12.56^{c}	4.33^{c}	1.96^{ab}	552.33^{b}
Pole bean (White)	1^{a}	27.44^{a}	106.1^{b}	16.44^{b}	8.44^{a}	1.84^{ab}	241^{c}
Pole Bean (Gray)	1^{a}	24.33^{ab}	101.33^{c}	17.56^{b}	8.33^{a}	1.99^{ab}	307.33^{d}
Boshi Bori	1^{a}	22.33^{bc}	106.66^{b}	21.96^{a}	9.33^{a}	2.36^{a}	364^{e}
Mixture	1.66^{a}	19.66^{c}	112^{a}	17.36^{b}	6^{b}	2.12^{a}	415.33^{f}
CV (%)	30.87	10.31	0.94	8.56	8.38	17.42	4.98

CV= Coefficient of variation. α= 05. Mean followed by the same superscript letter in the same column are not significantly different

4.5 EPB trial (2022) for dwarf beans- Tashipang, Mendrelgang, Tsirang

Table 24. ANOVA for seed yields of beans dwarf

Source	DF	SS	MS	F-value	P
Replications	2	0.04526	0.02263	1.601	0.242
Treatments	4	0.07218	0.01804	2.21	0.1337
Error	8	0.09741	0.01218		
Total	14	0.21485			
CV (%) = 17.42		Mean = 0.444 kg/ac			

In summary, neither the replication factor nor the treatment factor appears to have a significant effect on the response variable. The variability in the response variable is relatively high, with a coefficient of variation of 17.42%. The mean value of the mean yield across all the treatments and replicates is 0.444 Kg/ac.

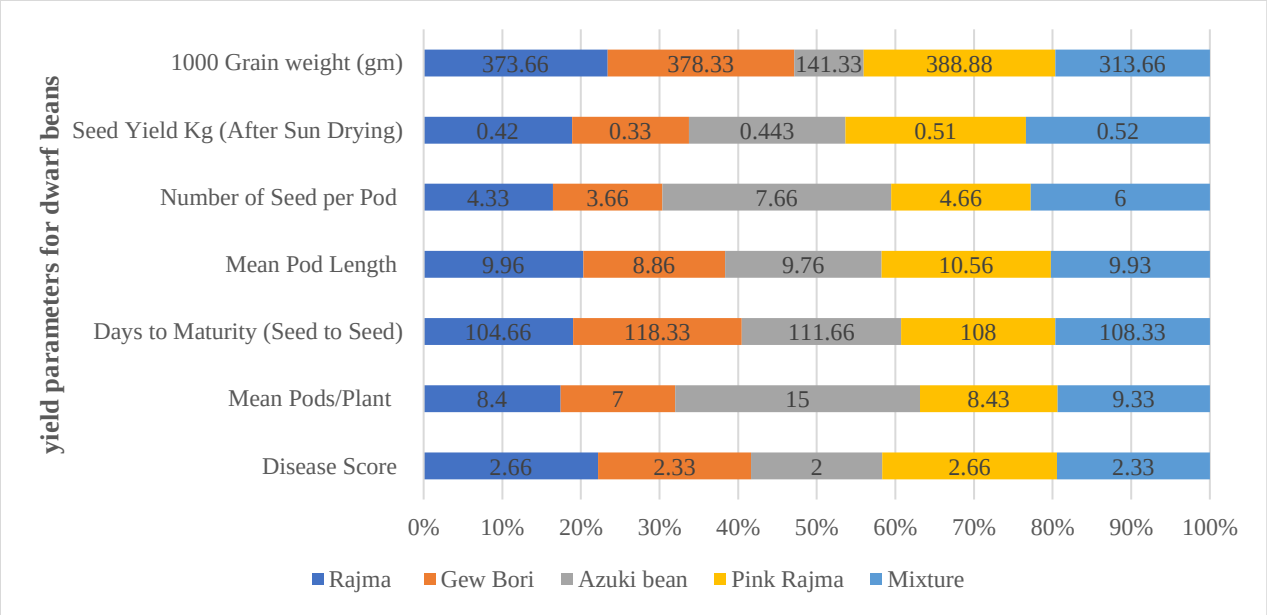

Figure 2. Comparing different yield parameters among the dwarf bean varieties.

4.6 Chick pea advance evaluation trial (NCT)

An advance evaluation trial (NCT) was conducted to assess the performance of three chickpea lines (JG 14, NBeG3, and BTNI 1654) received from ARDC, Samtenling. The trial aimed to observe yield, adaptability, production, and resistance to pests and diseases. It was carried out at Dzomlnigzor, Mendrelgang Geog, Tsirang Dzongkhag, based on resource availability and feasibility of the trial area.

The trial was established using a randomized complete block design (RCBD) with three treatments and three replications. Each treatment plot measured 3 meters x 5 meters, totaling 15 m2, with a separation of 50 cm between replicate plots. The entire experimental block covered an area of 135 m2, divided into 9 plots. A basal application of 50 kilograms of chicken manure was used to improve soil nutrient content. Inter-cultivation practices such as hoeing, weeding, and thinning were performed simultaneously. Light urea top dressing was applied after hoeing and weeding to address nitrogen deficiency in certain plants. The trial site was protected with nets to prevent crop damage from animals.

Table 25. Agronomic performance of chick pea varieties

Plot No	Treatment Name	50% FW days	Plant Height	Days to Maturity	Plot yield (Kgs)	Yield (kg/ac	Pest/ diseases
R1	JB-14	77	47	151	0.18	48.6	pod borer
R1	BTNI 1654	67	50	144	0.19	51.3	pod borer
R1	NbeG3	71	54	151	0.15	40.5	pod borer
R2	BTNI 1654	67	53	144	0.17	45.8	pod borer
R2	JB-14	78	48	151	0.2	53.9	pod borer
R2	NbeG3	71	47	151	0.26	70.1	pod borer
R3	BTNI 1654	67	53	144	0.22	59.4	pod borer
R3	NbeG3	71	51	151	0.365	98.5	pod borer
R3	JB-14	77	47	151	0.24	64.7	pod borer

Timely monitoring was conducted to collect agronomic information, including germination date and flowering period. During the vegetative and early reproductive stages, the crop showed good performance with minimal pest damage from caterpillars feeding on leaves. However, during pod formation, a significant infestation of pod borer caterpillars was observed, resulting in nearly empty pods before maturity. Approximately 80-90 percent of chickpea pods were infested by the pest, leading to empty grain formation. No chemicals were used in the trial to assess crop performance under farmers' management practices. Variation in flowering timing was observed, with 20-30 percent of plants found to be sterile without pod formation.

In conclusion, the advance evaluation trial highlighted challenges related to pod borer caterpillar infestation, leading to poor pod development and empty grain formation. The observations provided valuable insights into the performance and potential limitations of the evaluated chickpea lines.

HORTICULTURE RESEARCH AND DEVELOPMENT PROGRAM

5. Fruits, Nuts, Spices, Flowers

ARDC-Bajo has developed orchards for both warm temperate and sub-tropical fruit and nut germplasm. These orchards are utilized as sites for generating and demonstrating technology, offering practical training for researchers, extension agents, and farmers. Additionally, they serve the purpose of evaluating and identifying superior cultivars to enhance fruit cultivation diversity. These germplasms are tagged for varietal identification of fruit plants. Currently, ARDC-Bajo maintains a collection of 26 cultivators' germplasm.

Table 26. Fruit crop varieties established in the germplasm block at ARDC Bajo

Crops	Varieties
Peach	Kurataki (3), Nonomewase (3), Floridasan (3), Beauty cream (3), Local (4)
Apple	Bajo apple (12)
Apricot	Khasha (2), New Castle (2)
Pear	Yakumo (3), Niitaka (3), Hosui (3), Kosui (3), Shinko (3), Chojuro (3), Local (4)
Kiwi	Hayward (19), Wengkhar Yellow (29), Wengkhar Green (24), Bajo Red (19), Male (8)
Grape	Steuben (15), Perlette (10), Campbell (32), Kyoho (7) Risamate (2), Nsehelena (2), Portland (7)
Dragon fruit	Gewai ringa (44)
Pomelo	R3P4 (40), R4P5 (40), Banpeiyu (25)
Lemon	Frost Eureka (28)
Loquat	Mogi (8), Tanaka (14)
Avocado	Brogdown (9), Hass (10), Bacon (7), Fuerte (10), Reed (6) Zutano (10), T1 (5), T2 (8), T3 (10), M1 (6), M2 (5)
Persimmon	Jiro (25), Fuyu (28), Yubeni (11), Zinjimaru (4), Taishu (3), Japan Astringent (2), Thimphu astringent (2), Local (4)
Plum	Honey Rosa (3), Santa Rosa (3), Soldum (3), Kiyo (3), Oishi wase (3)
Wine grape	Cabernet Sauvignon 337 (48), Syrah 470 (48), Cot 598 (48), Sauvignon Blanc 906 (48), Chardonnay 96 (48), Pinot Noir 72 (48), Merlot 181 (48), Petit Manseng 573 (40), Cab Franc (40)
Guava	Thai guava (48), Bajo white (4), Bajo red (4), Babji white (2), Guma red (2), Pink flesh (2), Thai giant (2), Allahabad Safeda (2)
Mango	Himsagar (3), Dashehari (5), Langra (14), Amrapali (3), Irwin (2), Tommy Atkin (3), Himsagar (3), Dunkin (3), Alphanso (2)
Chestnut	Unknown (2)
Pomegranate	Amarsurin, Chawla, Bedana, Bajosendu-1
Pecannut	Burket, Mahan, Nellis, Bajo Thasa Taku-1, Bajo Thasa Taku – 2, Kingwa, Cheyenne, Desirable
Sacha Inchi	One cultivar
Macadamia	Unknown
Walnut	Bajo-1(17)
Citrus	Cant star ruby, MC Mahon, Affourer, Taracco Ippolito, Caffin, Dorokha local
GS677	Root stock for stone fruits
Ziziphus budhensis	One cultivar (10)
Passion fruit	Summer queen

5.1 Fruits and nuts germplasm maintained at ARSDC-Menchhuna

ARDSC Menchhuna has also maintained germplasm collection of different fruit crops. They are peach (5 varieties), plum (5 varieties) pear (4 varieties), sub-tropical apple (1 variety), pecan (4 varieties), kiwi (4 varieties), and citrus (5 rootstock varieties) and persimmon (2 varieties). The varieties of these fruit crops have been planted mainly for bud wood and fruit production. The scion wood is used for seedling production and is also supplied to private nursery growers. These varieties have been released or found to be promising and can be promoted for farmer's fields.

5.2 Dragon fruit production evaluation trial

Dragon fruit production at ARDC Bajo takes place from July to September 2023, with harvesting taking place twice a week. On average, the production of dragon fruit is 16.5 kg, with an average TSS (Total Soluble Solids) content of 18.7%. The average weight, girth, and length of the dragon fruit are 418.8 g, 8.8 g, and 10.7 g, respectively, as shown in the table. To ensure successful orchard management, various practices are implemented. These include basin preparation, application of manure such as bokashi, biochar, vermicompost and suffala. Additionally, cutting is done for nursery raising, and the plants are wrapped with paddy straws to protect them from frost damage.

Table 27. Agronomic traits of dragon fruit in the FY 2022-23

No. of harvest	No. bearing plants	Total no. of fruits	Average wgt (g)	Avg. girth(cm)	Avg. length(cm)	Avg. TSS (%)	Total Prdn(kg)
1st	7	12	491.70	9.20	10.70	16.60	5.80
2nd	20	69	413.80	8.60	10.70	18.20	27.98
3rd	32	90	384.40	9.50	10.30	18.70	30.00
4th	11	21	402.10	8.20	11.02	19.70	8.44
5th	16	25	402.10	8.30	10.70	20.10	10.32
Average	**17.20**	**43.40**	**418.82**	**8.76**	**10.68**	**18.66**	**16.51**

5.3 Varietal evaluation of pecan nut plants

The on-going varietal evaluation of pecan nut plants was conducted, focusing on morphological characteristics such as nut weight, nut size, shell thickness, and kernel weight. Six varieties were evaluated, namely Mahan, Burket, Nellie, Desirable, Cheyenne, and Kiowa. In addition to these varieties, two local varieties, Bajo Thasa Targo-1 (Western Schelly) and Bajo Thasa Targo-2 (Wichita), were tagged for varietal identification. Cultural practices were carried out to ensure optimal growth and development of the pecan nut plants. These practices included basin preparation, manuring, ploughing of interspaces, and timely irrigation. Furthermore, pruning and thinning of branches were performed to enhance plant health and productivity. Based on the findings presented in table 28 the Neils variety showed promising results, as the size of the nuts and overall production were comparable to the released varieties.

Table 28. Agronomic traits of pecan nuts (in average)

Variety	Sample size	Nut wgt (g)	Nut Length (cm)	Nut diam (cm)	Kernel wgt (g)	Shell thickness (mm)	Prodn (Kg)
Western Schley	5	8.58	3.65	2.50	5.04	0.78	5.70
Wichita	5	7.88	4.33	2.12	4.86	0.81	4.30
Neils	5	7.60	3.74	2.35	4.12	0.83	3.20
Desirable	5	4.04	2.76	1.92	2.00	0.75	0.92
Burket	5	4.18	2.87	1.92	2.16	0.65	7.10
Mahan	5	4.08	2.57	2.00	2.24	0.68	7.00

5.4 Varietal evaluation of wine grapes

A morphological evaluation of wine grape varieties was conducted, comparing nine different varieties. Data was collected on various parameters including plant height, trunk girth, size and length of cordon branch, number of branches, and leaf area. A total of 32 plants were included in the study, with 11 plants selected as samples from each variety, as shown in Table 3. The plants were tagged for varietal identification purposes. Cultural practices were implemented to ensure the optimal growth and development of the wine grape plants. These practices included weeding, basin preparation and manure application using bokashi, suphala, and biochar. Additionally, timely sprays of pesticide and fungicide were conducted.

Table 29. Morphological characteristics of wine grapes

Variety	Total Plants	Total sample	Trunk Girth (cm)	Plant height (cm)	No. of branches	Girth branch (cm)	Length cordon branch (cm)	Girth cordon branch (cm)	Leave area (cm^2)
Malbec/ Cot	30	10	1.52	150.5	9.6	0.65	86.9	0.83	100.38
Petit Mensang (White-var)	30	10	1.61	166.9	9.6	0.53	44.7	0.82	93.78
Merlot	32	11	1.76	178.45	9.55	0.65	69.36	0.95	106.66
Sauvignon Blanc (White-var)	32	11	1.68	146.27	11.18	0.65	59.09	0.98	88.1
Cabernet Sauvignon	31	10	1.72	156.8	7.9	0.64	62.8	1.11	87.15
Chardonnay (White-var)	30	10	1.4	149.56	7.11	0.55	74	0.83	66.62
Pinot noir	31	11	1.87	227.36	7.64	0.6	46.27	0.83	74.5
Syrah	30	9	2.33	256.56	8.89	0.74	79.44	1.13	98.15
Cab Franc	32	11	1.95	190.73	11.18	0.62	71.18	1.1	86.65

Note: sample plants selected as serial no; 2,3,5,8,11,14,17,20,23,26,29,31.
For leave area sample: measured small, medium and large leaves

5.5 Sacha Inchi performance evaluation trial

Sacha Inchi *(Plukenetia volubilis)*, also known as Inca peanut or mountain peanut, belongs to the Euphorbiaceae family. It is a perennial vine that is native to the Amazon basin in South America. It is a perennial vine that is native to the Amazon basin in South America. Sacha Inchi is a monoecious plant, capable of open-pollination or cross-pollination. It is widely cultivated in Peru and Southern Colombia and can thrive at elevations ranging from 200 masl to 1500 masl, with a temperature range of 10-15°C. The seeds of Sacha Inchi are rich in nutrients, containing approximately 25-30% protein, 35-60% lipids, and vitamin E, making them suitable for dietary use. These seeds can be processed to extract oil or consumed directly through roasting, boiling, or steaming. While propagation can be achieved through seeds or vegetative means, the preferred method is often vegetative propagation.

To evaluate the performance of Sacha Inchi, an observation trial was conducted at the ARDC, Wengkhar, with support from seedlings. The trial was set up in the fiscal year 2020-21, initially consisting of 19 vines. However, over time, six vines died, resulting in a total of 13 remaining

vines for data collection during the fiscal year 2022-23. The data collected includes information on yield, phenology, number of seeds per plant, seed size, and seed weight, following the protocol.

Table 30. Data on yield and yield parameters of Sacha Inchi

Total Plants (nos.)	13	
Total weight with shell cover (g)	1806	
Total weight of seeds (g)	597	Remarks: there were 19 vines while establishing the trial but over the period of time six vines died so now there are only 13 vines.
Mean (with shell cover)	138.92	
SD (with shell cover)	101.14	
Mean (seed)	45,92	
SD (seed)	32.81	
Mean (seed weight in grams)	1,39	

5.6 Citrus Varietal Evaluation Trial

Varietal evaluation of six different types of citruses (Citrus reticulata) is ongoing at ARDC-Bajo for the third year to evaluate the promising varieties for release. Except Dorokha Local, the source of all cultivars is from Australia.

Table 31. Experimental design for Citrus varietal evaluation

Variety	Cant star ruby, MC Mahon, Affourer, Taracco Ippolito, Caffin, Dorokha local (check)
Design	RCBD
No. of treatment	6
No. of plants per variety	5
No. of Replication	5
Layout	P-P= 3 m, R-R = 4 m
Established	27.7.2020

Data are collected based on the plant health, adaptability in the region and pests and diseases The Mc. Mohan and Cant Star Ruby varieties indicated poor performance and were highly susceptible to trunk borer in comparison with the rest of the varieties. The Affourer and Dorokha local remain better variety in Bajo condition but not the best. However, the experimented variety will remain for some more years in the station and after a thorough examination, it will be taken as FFT.

5.7 Performance evaluation trial of passion fruit

On-station performance evaluation trial for passion fruit is setup in this FY. The trial involved laying out a plot with dimensions of 2m x 3m and implementing 5 replications, following the specified protocol. To prepare the planting area, pits were dug with dimensions of 45cm x 45cm. Biochar, compost, and bokashi were added to the pits as amendments to enhance soil fertility and plant growth. Additionally, a total of 7 passion fruit vines were planted in each replication.

5.8 Varietal evaluation of avocado fruit plants

Evaluated morphological characteristics of avocado fruit plants for variety identification. Fruit parameters like fruit shape, weight and size, pit shape, weight and size, pulp colour and taste and leave parameters like leave shape and size are assessed. As per the observation of fruits there would be more than ten different varieties other than two released varieties (Bajo Guli-I and II). Flower characteristics would be assessed. Brogdon variety has been assessed (Table 32). This variety produced a total of 830 fruits with an overall production of 60 kg per tree.

Table 32.Morphological characteristics of avocado (Brogdon variety)

Fruit (Average)			Pit (Average)			Skin thickness (cm)	Flesh thickness (cm)
Wgt (g)	Girth (cm)	length (cm)	Average wgt (g)	Girth (cm)	length (cm)		
80.71	4.95	7.16	14.28	2.77	3.18	0.49	1.19

5.9 Study on Miyazaki mango shoot tip grafting

The Miyazaki/Irwin mango is renowned for its high value and requires precise techniques and timing for successful propagation. The research study on mango grafting (shoot tip) was initiated on August 26, 2022 on-station research farm. The objective of the study is to compare the effects of grafting time and technique on the success rate of the Miyazaki mango variety. The mango grafting research commenced on August 26, with a total of 7 understock plants being grafted using one-season-old bud wood. After 12 days of grafting (September 6, 2022), 3 plants exhibited successful grafting signs with bud break. Another 3 plants displayed bud break after 18 days (September 12, 2022), while the final plant exhibited bud break after 24 days (September 18, 2022). The graft take rate was 100 percent within the chosen timing. However, after 31 days (September 25, 2022), one plant was found dead, resulting in a mortality rate of 14.29 percent. The cause of death was confirmed to be a fungal attack on the roots of the understock.

On August 31, the second grafting session took place, involving a total of 6 understock plants grafted with one-season-old bud wood. After 10 days of grafting (September 9, 2022), 2 plants exhibited successful grafting with bud break. Additionally, 3 more plants displayed bud break after 16 days (September 16, 2022), and the final plant exhibited bud break after 24 days (September 29, 2022). The graft take rate was 100 percent within the chosen timing. However, after 30 days (September 25, 2022), one plant was observed to be dead, resulting in a mortality rate of 16.67 percent. The cause of death was identified as a fungal attack on the roots of the understock.
On September 5, the third grafting session commenced, involving a total of 17 understock plants grafted with one-season-old bud wood. After 13 days of grafting (September 18, 2022), one plant exhibited successful grafting signs with bud burst. Another bud break was observed after 25 days (September 25, 2022) of grafting. The graft success rate was very low at 11.76 percent, with a high mortality rate of 88.24 percent. The elevated mortality rate was attributed to unfavorable temperature conditions for bud break and inactive bud wood.

The experiment demonstrated 100% success rate in grafting mangoes during the month of August using the techniques outlined in the methodology section. However, it was observed that the growth rate significantly declined when grafting after August. This decline can be attributed to various factors, including a drop in temperature and other variables that should be carefully documented. Based on the findings, it is recommended that mango grafting in Bajo and similar regions should not be conducted after August until March, particularly for commercial purposes.

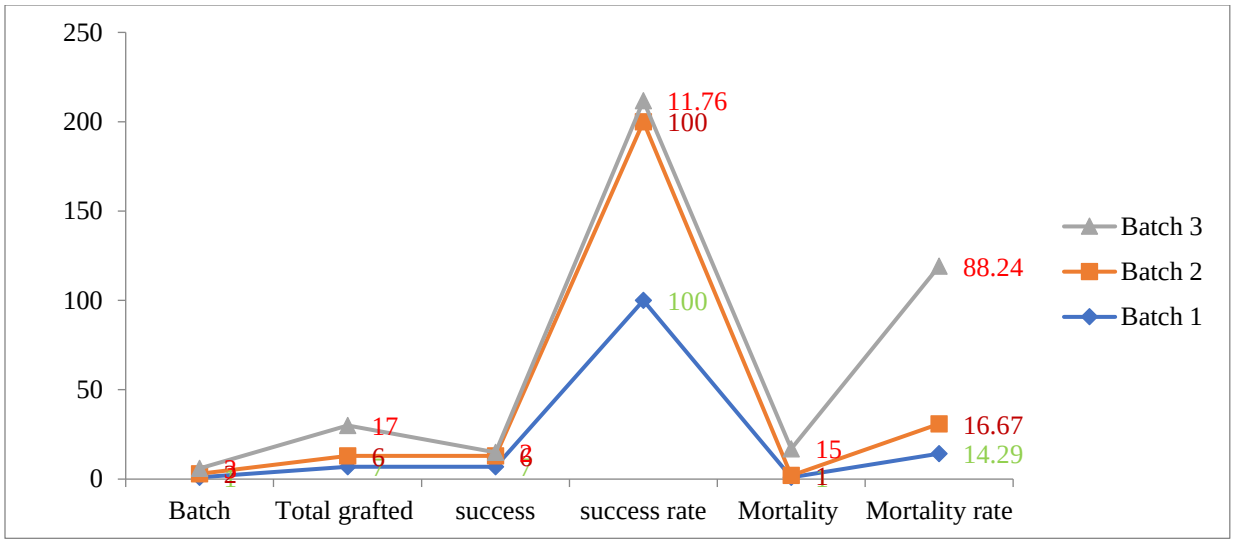

Figure 3. Effect of grafting time and technique on success rate of mango

5.10 Evaluate and maintain Citrus Repository Germplasm

While progress in citrus research on production management is progressing, a system of a nursery to marketing through production must be further explored and institutionalized to sustain increased production and yield especially when the whole world's citrus industries are getting streamlined due to dreaded graft transmissible diseases (Huanglongbing (HLB) Citrus Tristeza virus, citrus exocortis viroid, phytoplasmas). Therefore, this citrus repository is a cornerstone for initiating and institutionalization of the citrus nursery system to enable the supply of health-tested citrus planting material in the country. The overall objective is to increase citrus production and productivity through sustainable research and development. As of June 30, 2023, NCR has been able to collect 120 numbers of citrus germplasm cultivar species through bud wood cutting and seed in total. These cultivars are maintained in the National Citrus Repository as foundation plants. The cultivars are collected from Australia, Japan, Nepal and locally from Bhutan.

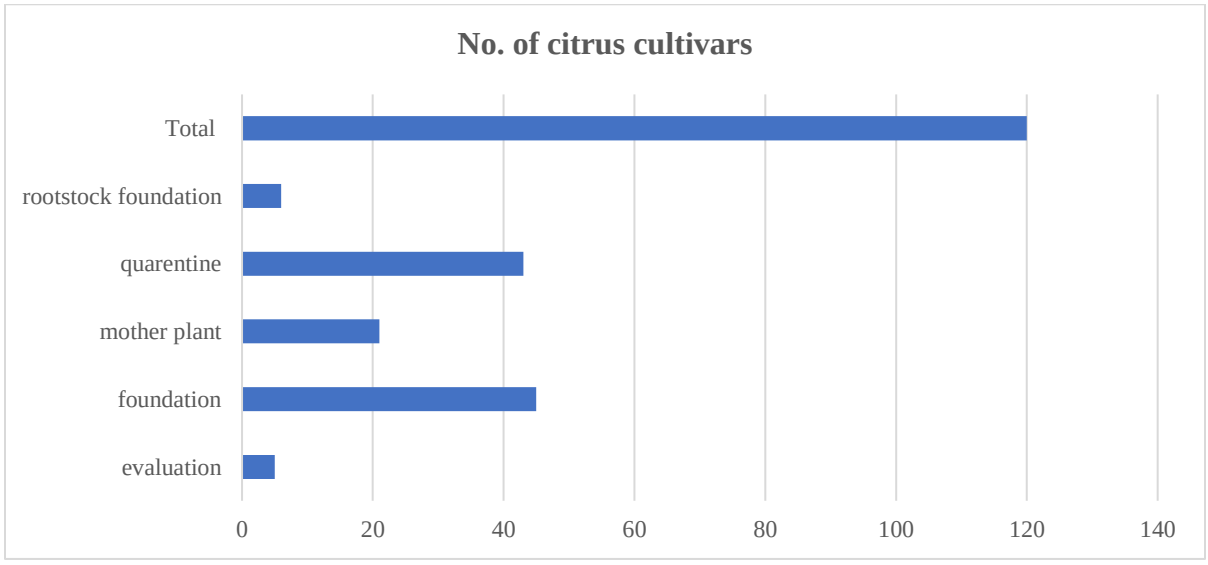

Figure 4. Crop stage of citrus germplasm at NCR

The National Citrus Repository has successfully achieved its annual target of 120 citrus germplasm collection under the Annual Performance Agreement (APA), of which 74 and 46 citrus germplasms are collected locally and globally respectively. However, 22 collections are in quarantine house growing for Huanglongbing (HLB) test in the future. Five collections are in biological indexing house screening for HLB through biological indexing and TR PCR by NPPC. 4th batch of TR PCR test is completed by NPPC scientists and has detected 2 samples as HLB positive which will be retested by NPPC scientists in the next batch. Negatively tested plants will move to the foundation house as germplasm through propagation. Eight varieties are given to ARDC, Samtenling, 9 varieties to NCOA, Yusipang, 16 varieties to Chimipang Royal Project (CRP), 20 varieties to NSC, Tashi Yangtse, 15 varieties to Floriculture Land Amenity Centre (FALC) Dechencholing, Thimphu, 11 varieties to ARDC, Bajo, 26 varieties to ARDSC Tsirang, 7 varieties to RDTC and 5 to ARDSC, Panbang for its performance evaluation research in the multi-environment of 500, 1000, 1500 and 2000 masl.

A total of 490 foundation plants are well maintained in an insect-proof screen house as germplasm. A total of 13 varieties are being developed for characterization in the repository for research and development purposes. Five new varieties are being put into protected cultivation trials with high density in farmer's fields in collaboration with the Dagana Dzongkhag Agriculture sector. Required equipment and reagents are being sourced to initiate Micro grafting (STG) in the NCR laboratory which is the only technique to convert HLB positive to negative. Installation of smart irrigation is completed. Standard protocol is well maintained in managing the citrus repository.

5.11 Production of quality seeds and seedlings

The grafted and non-grafted seedlings of both released and promising cultivars of fruits and nuts are produced and maintained yearly at the Research Centre. Scion woods are collected from these varieties from November to January. Grafting activities are done towards the end of February (green house) and February-March (open field). In the FY 2022-2023, a total of 4480 quality fruits seedlings are produced through grafting, cutting and seed. The fruit nursery block serves as management technology generation and demonstration sites for providing hands-on training for researchers, extension agents and farmers. It is also to generate nursery management technologies for the production of quality seeds and seedlings.

Table 33. Details of fruit seedlings produced

SN	Crops	Variety	Qty produced (Nos)		Remarks
			ARDC Bajo	ARDSC Menchhuna	
1	Citrus	*Poncirous trifoliate*	50	0	Grafted
2	Avocado	mixed	400	925	Seedlings
3	Dragon fruit		300	0	Cuttings
4	Loquat	Tanaka	100	254	Seedlings
5	Persimmon	Fuju & Jiro	300	115	Grafted
6	Peach	Floirda sub, beauty cream, kuratake	100	410	Grafted
7	Plum	Wase queen, soldum	100	286	
8	Kiwi	Heyward	0	440	Cutting
9	Walnut		700	0	
Total			**3300**	**4970**	**4480**

5.12 Nationally Coordinated Trial (NCT) of Ginger and Turmeric

Bhutanese farmers cultivate different cultivars of ginger, the identity of which is location specific and hence have different vernacular names depending on where they are grown. The varietal research on ginger and turmeric conducted in Bhutan is extremely limited and as of now, no ginger or turmeric varieties have been introduced or released. This provides a scope to document varietal information on different cultivar of ginger and turmeric available across the country, evaluate and identify potential genotypes for release to improve crop production and crop improvement.

During the fiscal year 2022-23, the Agriculture Research and Development Centre (ARDC) in Samtenling dispatched ten ginger accessions and three turmeric accessions to the Agricultural Research and Development Sub-Center (ARDSC) in Tsirang for evaluation under the National Coordination Trials (NCT) program to evaluate ginger and turmeric accessions for agronomic parameters under different agroclimatic conditions (multilocation. The trial took place on-farm at Tashi Yangjhong, Kikhorthang Gewog, Tsirang, situated at an elevation of 990 msl.

Turmeric and Ginger experimental plot was established separately on ridge and furrow planting method maintaining 50cmx 50cm plant to plant and inter distance. Five clumps or plants is randomly selected from the inner three rows for data collection. All required data were recorded.

Table 34. NCT ginger and turmeric accession ID and yield per plot

Ginger		Turmeric	
Accession ID	**Yield (kg)**	**Accession ID**	**Yield (kg)**
ZI1904	4.3kgs	T20A1	6.2kgs
ZI1905	6.1kgs	T2OA2	7.8kgs
ZI1906	5.7kgs	T20A3	7.8kgs
ZI1907	3.9kgs		
ZI1908	5.9kgs		
ZI1909	5.1kgs		
ZI1910	4.8kgs		
ZI1917	6.2kgs		
ZI1921	5.7kgs		
ZI1922	5.9kgs		

The trial was successfully completed within the designated time frame, and based on our observations, both crops showed promising results. Despite the suboptimal soil conditions, the yield was satisfactory. We diligently collected and compiled the necessary data in accordance with the trial requirements, and subsequently submitted the data to ARDC Samtenling for further analysis and evaluation.

5.13 Million Fruit Trees Plantation Project

The Million Fruit Tree Plantation Project (MFTP) is a Royal Command Initiative by the Department of Agriculture in collaboration with Desuung National Services. Its main objectives are to provide nutritional supplements, enhance incomes, and uplift the wellbeing of rural communities. Additionally, the project aims to foster youth appreciation for rural heartlands and acknowledge the vital role of farmers in our lives. Key stakeholders involved include Desuung National Services, Department of Agriculture, National Seed Centre, ARDCs, Dzongkhags, local government, and farmers. The programs under MFTP were:

- **Desuung Skilling Program**

In total 53 Gojay Desuung (annexure…) were trained at ARDC-Bajo and ARDSC, Tsirang for a period of five days from 24 January to 28 January, 2023 on planting of fruit plant saplings and

collection of socio-economic data from the fields. The trained Gojay Desuups further train the fellow desuups who were responsible to help gewog agriculture officers in plantation to cover 54 fruit trees growing gewogs under Bajo region.

Plantation of the saplings are divided into two categories such as temperate and sub-tropical. In additional to new plantation, the replacement of the first phase was also carried out simultaneously. In the first phase 22 types of crops were selected compared to eleven (11) best crops selected this year for the distribution to the farmers. Temperate fruit plants consist of almond, apple, persimmon, pear, walnut, cherry, apricot, kiwi, peach, chestnut, pecan nut and plum in 2022, whereas in 2023, only four crops such as almond, pecan nut, walnut and kiwi were selected. Sub-tropical fruit plants are avocado, banana, citrus, dragon fruit, mango, passion fruit, litchi, guava, papaya and pomegranate in 2022.

- **MFTP Plantation and Replacement**

The sub-tropical fruit plants in the FY 2022-23 includes avocado, dragon fruit, Miyazaki mango, Dekopon citrus, Soursop, Macadamia nut and seedless lime. The crops such as Miyazaki mango, Dekopon citrus, Soursop and Macadamia nut though high value crop, are new to the farming communities of Bhutan. The plantation of MFTP was carried out on a dzongkhag-wise basis, as indicated in the table provided.

Table 35. MFTP Plantationfruit plants plantation through MFTP

SN	Dzongkhag	No. of plants		Area Coverage (Ac)
		Temperate	Subtropical	
1	Gasa	1792	83	15.45
2	Punakha	6279	17183	159.06
3	Wangdue Phodrang	5722	15733	145.40
4	Tsirang	7565	69974	497.66
5	Dagana	11376	66408	507.27
Total		**32734**	**169381**	**1324.84**

A total of 32,734 temperate fruit and 169381saplings has been distributed to farmers in the West Central Region, covering approximately 1324.84 acres of land.

A survey on mortality rate has been conducted by Desuung National Services and the Department of Agriculture, the national level mortality rate was found to be 32% from the first phase whereas, the West Central Region recorded an average mortality rate of 33% as of 30th June, 2023.

Table 36. Dzongkhag wise mortality and replacement of both temperate and sub-tropical

Dzongkhag	Planted	Total dead	% dead
Gasa	5250	1514	29
Punakha	32227	14414	45
Wangdue	48620	20157	42
Tsirang	55795	14512	26
Dagana	84212	24533	29
Total	**226104**	**75130**	**33**

5.14 Hands on training on plant nutrient application

Citrus holds significant economic value in Bhutan as it is considered one of the major cash crops, providing a substantial portion of fresh fruit production and contributing to the country's foreign reserves. It serves as the primary source of income for over 38.5% of rural households, benefiting

more than 60% of the population. However, the citrus industry in Bhutan faces significant challenges due to the adverse impacts of climate change. These challenges include increased occurrences of pests and diseases, drought, erratic rainfall patterns, changes in growth patterns, and limited management practices.

In response to the limited management practices, ARDC-Bajo has initiated canopy management techniques for citrus cultivation in various locations across different dzongkhags (districts). Canopy management, coupled with soil fertility improvement, forms the foundation for rejuvenating fruit plants. To further support these efforts, the national citrus program conducted practical training sessions for farmers. These training sessions included practical demonstrations to enhance the farmers' understanding and implementation of effective citrus cultivation practices. 66 households were covered from six gewogs under Dagana Dzongkhag in the FY 2022-23.

- **Materials and Methods**

The trench of 45 cm wide and 45 cm deep were dug. The distance between the trunk and the pit is exactly one meter, which was scientifically proven to extract the maximum nutrients by the fibrous roots. 30 kilograms of compost, 300 gm of suphala were applies as nutrient followed by the composting materials (grasses, maize leaves or materials that decomposes easily) at the top followed by irrigation. To support the farmers, 2715 kg of chemical fertilizer (suphala) was supported by the Centre.

Table 37. Details on training on plant nutrient application

SN	No of participants	Gewog	Male	Female	Total Participants	Suphala issued (kg)
1	10	Daga	0	3	3	100
2	14	Tshangkha	6	8	14	300
3	9	Khebesa	1	8	9	1000
4	9	Kana	2	7	9	350
5	26	Goshi	3	23	26	950
6	5	Tashiding	1	4	5	15
Total			**13**	**53**	**66**	**2715**

- **Conclusion/recommendation**

Farmers found the training to be highly beneficial, acknowledging their previous neglect of management aspects concerning their citrus orchards. The training sessions not only emphasized the trench method of fertilizer application but also covered important topics such as citrus fruit fly management and the application of Bordeaux mixture, highlighting the associated benefits. The training also addressed soil fertility management, and the distribution of fertilizers was a part of the program. It is recommended to continue such training sessions in the future, as they play a crucial role in bolstering the citrus industry by equipping farmers with knowledge and resources for effective orchard management and soil fertility enhancement.

5.15 Technical support in establishment of trellis

A trellis is a sturdy support structure designed to assist the growth of fruit vines. It consists of posts and wires that provide stability and allow the vines to climb. The trellis system helps optimize sunlight exposure, air circulation, and fruit management. It supports the vines, prevents them from sprawling on the ground, and facilitates easier access for pruning and harvesting. By training the vines along the trellis, kiwifruit production is enhanced, and the risk of disease and pests is

reduced. The trellis system plays a crucial role in maintaining vine health and maximizing fruit yield. During the FY 2022-23, the Centre has catered technical support to established three trellises through deposit work as mentioned in the table ….

Table 38. Trellis established in FY 2022-2023

SN	Location	Type of trellis	Area/No. of plants	Remarks
1	Goenshari (Othbar Mountain horticulture promotional Project)	Ms angle and GI wire (pergola System)	2 acres	Kiwi trellis
2	Kabjisa (Six sense hotel)	Ms angle and GI wire (pergola System)	8 plants	Kiwi trellis
3	Thimphu (Ramtokto)	Ms angle and GI wire (pergola System)	21 plants	Grape trellis

5.16 Oyster mushroom spawn production and supply for mushroom cultivation

The cultivation of mushrooms in Bhutan has led to the creation of employment opportunities due to its high market value. However, the lack of quality spawn supply in the market has hindered large-scale production. To address this issue, the Department of Agriculture (DoA) has entrusted all the regional Agricultural Research and Development Centers (ARDCs) with the responsibility of producing spawns and providing technical support for mushroom cultivation in their respective regions. The National Mushroom Centre provides technical assistance to the ARDCs as well.

During the fiscal year 2022-23, a total of 1827 bottles of oyster spawn and supported to 52 households in the West-Central Region, as shown in table 39. The supply of spawns was based on demand and provided after thorough technical verification, taking into account the groundwork carried out by the farmers.

Table 39. Quantity of spawn supported in the Region in the FY 2022-2023

SN	Dzongkhag	Mushroom spawn Supplied (Qty)		Remarks
		Bottles	House holds	
1	Punakha	868	21	Private farm
2	Wangdue Phodrang	844	22	Private farm
3	Dagana	35	3	Private farm
4	Tsirang	15	2	Private farm
5	Thimphu	20	1	Private farm
6	Lhuntse	25	2	Private farm
7	Trongsa	20	1	DSP

During the fiscal year 2022-23, the Centre provided technical support for Shiitake mushroom cultivation to two households (HHs) through farmer training programs in Wangdue Phodrang and Punakha Dzongkhags with 3050 billets. This support was offered based on the extension demand and aimed to enhance the knowledge and skills of farmers. The Centre's technical services are available to the five Dzongkhags of the West-Central regions.

6. Vegetable Research and Development

6.1 Evaluation of World Vegetable Chili Lines (NCT)

Chili farming in Bhutan has become a lucrative cash crop with great market potential. However, the country faces challenges due to limited varieties with high yield potential and resistance to diseases such as blight, damping off, root rot, and pests like pod borer. Currently, only three chili varieties are registered, restricting the agriculture department's access to potential high-yielding

varieties resistant to major diseases and pests. Recognizing these issues, the need to source blight-resistant varieties was emphasized during the 3rd Regional Research and Coordination meeting held at ARDC, Samteling in 2020. Consequently, NCOA, Yusipang collaborated to conduct the evaluation experiment with the objective to evaluate chili varieties from the World Vegetable Centre for adaptability, yield, and disease resistance under various agro-climatic conditions. The five lines were tested at ARDC Bajo in the FY 2022-23.

The experiment followed a randomized block design (RCBD) with three replications. Each plot consisted of a 5m x 1m bed, with chili plants spaced at 45cm between plants and 60cm between rows. Each plot had two rows, totaling 20 plants, with 10 plants per row. The trial was established in April 2022 and completed in November 2022. Data on yield and fruit characteristics were collected, while disease scoring was not conducted due to a lack of expertise. However, disease scoring is planned for the next year's evaluation in collaboration with NPPC. The preliminary yield data for the lines evaluated at ARDC Bajo is presented in Table 40.

Table 40. Preliminary yield data of WVC chilli lines at ARDC Bajo

SN	Chilli lines	Yield per/acre(kg)	Plant height (cm)	Fruit length (cm)	Fruit width(mm)
1	AVPP9703	1578	44	9	12
2	AVPP0520	0	0	0	0
3	VI062407	1166	54	6	14
4	AVPP1509	1614	50	10	13
5	AVPP1502	1935	65	9	10
6	AVPP1517	2794	59	9	14
7	AVPP1508	2478	30	11	13

Among the AVPP lines evaluated, AVPP1517 demonstrated the highest yield at 2794 kg/acre, followed by AVPP1508 with a yield of 2478 kg/acre. However, the AVPP0520 line suffered complete crop damage due to blight, resulting in no harvest. To further study the blight resistance traits, a repeat trial for all lines will be conducted in the fiscal year 2023-24.

6.2 Fast Track Evaluation Pak Choi variety “Tasty Green” (NCT)

Pak choy (Brassica rapa var chinensis) is a versatile leafy vegetable originating from south China. It is highly valued for its edible whole plant and can be cooked in various ways. It is cultivated in several countries, including Japan, Malaysia, Indonesia, Philippines, Europe, and America. Pak choy is known for its nutritional benefits, containing carbohydrates, fiber, folic acid, vitamins (such as beta carotene and vitamin C), and minerals like calcium (Tay and Taxopens, 1994). As dietary habits change and the importance of consuming leafy greens is emphasized, the demand for these nutritious vegetables is increasing. By increasing the production of leafy greens, Bhutan can improve access to nutritious food and contribute to nutritional security. To meet the growing demand, there is a need for new high-yielding and high-quality leafy greens. In 2021, the VRC recommended testing the Pak Choy hybrid variety - Tasty green, which is known for its good taste and quality, alongside the check variety Tas sai.

The experimental setup followed a randomized complete block design with two treatments and 13 replications, totaling 26 plots. Each plot measured 2m x 1m and contained 12 plants, with a spacing of 25cm between rows and plants. The spacing between beds was 30cm, and there was a 50cm gap between replications. Seeds were sown in August 2022, and the crops were harvested in October 2022. Data were collected from 5 randomly selected plants in each treatment plot, representing 63% of the total plant population. The treatments included:

i. Pak Choy, Variety: Tasty green
ii. Tai Sai (check variety)

The yield computed for Pak Choy (Tasty Green) was 6418kg/kg.

6.3 Sweet potato varietal performance evaluation

On station adaptability and performance trial of sweet potatoes was carried out. The trial was laid out using a randomized complete block design with two treatments and three replications. The vine cuttings containing seven nodes were planted at ARDC Bajo farm field, located at an altitude range of 1210masl. All the management practices were carried out as per the vegetable cultivation guidebook. However, it was observed that during the evaluation year 2022-2023, it was ascertained that there are no significant differences in the yield between the treatments.

Table 41. ANOVA for yields of sweet potatoes

Source	DF	SS	MS	F-value	P
Replication	2	43308	21654.0	0.48	0.42
Treatment	2	15771	7885.7	0.13	0.8856
Error	2	251779	62944.8		
Total	8	310859			
CV (%) =37.24%		Mean = 673.74gm			

Table 42. Least Significant Difference (LSD) Test summary

Treatment	No. of tubers	Total Weight (gm)	Average diameter of tuber (mm)	Tuber length (mm)	No. of infested tubers	No. of stem	No. of infested stems
Gorojima	5.13[a]	727.03[a]	55.03[a]	13.96[a]	0.76[a]	11.23[a]	1.33[a]
Orange Flesh	10.1[a]	669.4[a]	48.8[ab]	12.0[ab]	1.1 [a]	6.7[a]	1.4[a]
Purple flesh	8.1[a]	624.8[a]	34.7[b]	15.8[b]	0.1 [a]	10.9[a]	1.0[a]

6.4 Brinjal (Solanum melongena) evaluation trial

Brinjal *(Solanum melongena*) belongs to Solanaceae or nightshade family. n Bhutan, the only variety of brinjal released and available for cultivation is Pusa Purple Long. However, to enhance the diversity of eggplant varieties in Bhutan, four varieties of Japanese eggplant were assessed for their potential yield at ARDC-Bajo.The experiment was carried out using a Randomized Complete Block Design (RCBD) with three replications. All the management practices for brinjal cultivation, including those outlined in the vegetable cultivation guidebook and research protocol, were followed during the evaluation process. These practices ensure proper guidelines and protocols are adhered to in order to obtain accurate and reliable results for the evaluation of different eggplant varieties.

Table 43. Agronomic performance of brinjal varieties

Variety	Average fruit length (cm)	Average fruit size (cm)	Yield (t/a)
Nagaoka	14.85	4.79	3.78
Manryo	16.80	5.36	3.23
Shinkurowase	16.22	5.95	2.78
Senryo	14.30	4.66	2.35
Pusa Purple Long (Check)	17.15	3.46	2.80

Based on the evaluation conducted, the results revealed that the Nagako variety exhibited the highest yield potential, computed at 3.78 tons per acre. Following Nagako, the Manryo variety also demonstrated a substantial yield. However, it is noteworthy that among all the evaluated varieties, Senryu had the lowest yield, even lower than the Pusa Purple Long variety used as the check variety. These findings provide valuable insights into the comparative performance of the different Japanese eggplant varieties in terms of their yield potential in the specific evaluation conducted.

6.5 Evaluation and Germplasm maintenance of Traditional Bean varieties

Germplasm for nine traditional bean cultivars is maintained on the station. The germplasm of these varieties will be maintained at the station for future improvement purposes. Through this, some of the potential varieties can be preserved for future crop improvement and cultivation as traditional lines are considered resilient and tolerant to some biotic and abiotic stress. These lines are collected locally from the farmers' field.

Table 44. Germplasm maintenance of Traditional Bean varieties

SN	Cultivars	Type	Yield (Kg/ac)
1	White local	climbing	2800
2	Brown Local	climbing	2600
3	Pink local	climbing	2300
4	Chaskharpa Shepey	climbing	2100
5	Punakha Local	climbing	3100
6	Kengkharpa	climbing	2550
7	Muka Orey	climbing	1800
8	Kalo Bori	climbing	2600
9	Black bean	climbing	2280

6.6 Watermelon varietal evaluation trial

Water melon performance trial of one variety (Yellow flesh) was carried out on-station with sugar baby as check. The objective of this trial was to evaluate the performances of these varieties for variety release since these varieties were evaluated with good yield and taste traits.

Table 45. Agronomic performance watermelon varietal evaluation

Treatment	Weight (Kg)	Height (cm)	Diameter (cm)
Sugar baby	2.88[a]	18.23[a]	17.78[a]
Yellow flesh	2.91[a]	17.78[a]	17.86[a]
CV (%)	40.09	17.26	16.68

The Yellow Flesh variety weight is computed at 2.91kg per fruit which is higher compared to the Sugar baby (check).

6.7 Breeder seed production and maintenance

As ARDCs are mandated to maintain the breeder seeds of various vegetables released from their Centres and make them available whenever the National Seed Center (NSC) require. Breeder seed of fourteen vegetable varieties that were released from ARDC Bajo is under maintenance of breeder seed at the Centre. During the FY 2022-23 the Centre could produce more than 200 kg of assorted vegetable seeds as mentioned in Table….

Table 46. Breeder seeds produced, issued and maintained in stock

SN	Crop variety	Quantity produced (kg)	Quantity issued to (kg)	
			NSC	Other
1	Bean- Borloto	4.50	0.00	
2	Bean-Green Prime	49.50	0.00	Autumn season
3	Bean- Pusa Parvati	9.00	0.00	
4	Beans (white poles)	18.70	0.00	
5	Beans (White dwarf)	7.60	0.00	
6	Bean- Top Crop	15.00	0.00	
7	Cauliflower (White Top)	8.85	0.00	
8	Broccoli (Dessico)	8.45	0.00	
9	Broccoli (Ryokurei)	0.91	0.00	
10	Radish (Gensuke)	49.00	0.00	
11	Brinjal- Pusa Purple Long	0.60	0.00	
12	Carrot- Early Nantes	21.00	0.00	
13	Spinach- All Green	10.30	0.00	
14	Tomato- Roma	0.30	0.00	
15	Tomato-RRTO	1.50	0.00	
16	Tomato -Ratan	0.37	0.00	
17	Tomato- Master	0.70	0.00	
18	Water melon-Black ball	1.00	0.3	
19	Water melon-Sugar baby	0.20	0.00	
20	Bunching onion (Kaja & kuju)	1.04	0.00	
21	Chinese cabbage	1.77	0.00	ARDSC Menchhuna
22	Water melon-Kabuki	1.00	0.30	
23	Okra	3.71	0.00	ARDSC Menchhuna
24	Zucchini (yellow)	1.30	1.00	
25	Zucchini (green)	0.98	0.00	
Total		**217.28**	**1.60**	

6.8 Walipini- The Suken Garden Farming

The Centre has come up with new innovations Walipini- the Sunken Garden under protected structure, leading to the initiation of research in walipini farming. Currently, the Centre is conducting research with various crops in the sunken garden. The Centre has achieved successful cultivation of tomatoes during the winter season. At present, the walipini structure is being utilized for cultivating black pepper and watermelon.

The tomato cultivation in the walipini structure proved to be highly successful. The planting was done in December 2023, and harvests were possible until the end of April 2023, resulting in a total of seven harvests. The yield achieved was an impressive 3691.12 kg per acre, which is three times higher compared to traditional open-field cultivation.

This research demonstrates the potential and advantages of walipini farming, where crops are grown in a controlled environment maintaining high temperature. Additionally, the walipini structure has provided favorable conditions for extended growing seasons, enabling successful cultivation of crops even during the winter months. The significant increase in yield highlights the potential of adopting these innovative farming techniques to enhance productivity and maximize crop yields.

ARDC Bajo has played a significant role in supporting agricultural innovations. As a technology demonstration, the Centre has facilitated the installation of walipini structures, which are underground greenhouses, in Suknen Gardens located in Laya (Gasa), Khotoka, and Gangtey (Wangdue Phodrang). The Centre also provided technical assistance in crop production within these gardens. This showcases ARDC Bajo's commitment to promoting innovative agricultural practices and sustainable food production, as well as their dedication to supporting farmers and enhancing food security in Bhutan.

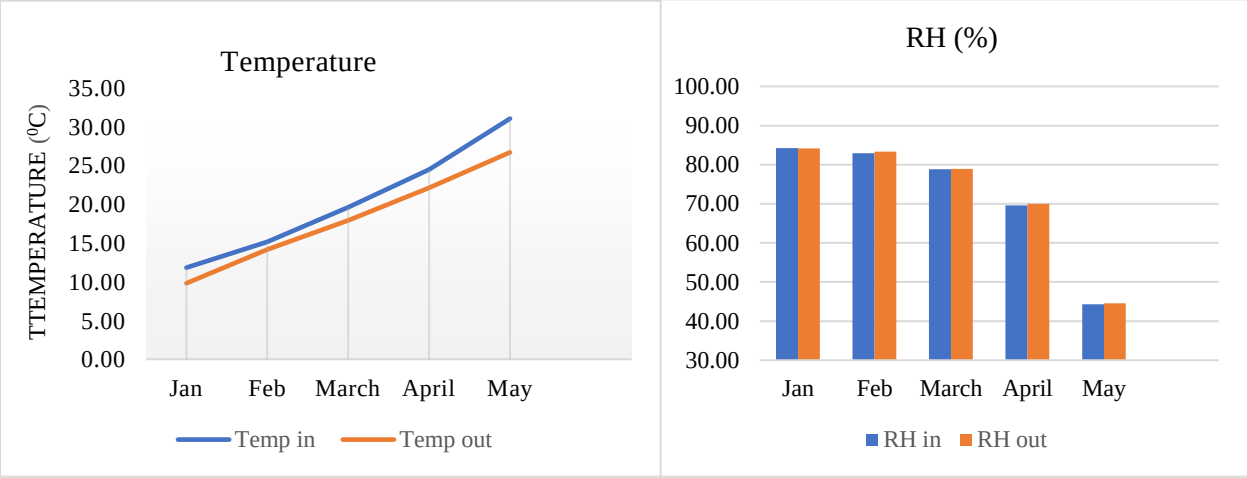

Figure 5. Temperature and Relative Humidity recording in & outside Walipini greenhouse

6.9 Dessung Skilling Program (DSP) on Horticulture and Highland vegetable production

The Dessung Skilling Program (DSP) on Horticulture and Highland vegetable production took place at the National Seed Center Farm, located in Gangtay Gewog, Wangduephodrang. The practical field for the program is situated at an altitude of approximately 2900 meters above sea level (MASL). The program was designed to span three months and aimed to provide theoretical and practical skills to the participants, who are Dessups (Bhutanese volunteers).

To ensure effective training, an international expert named Mr. Michael Snow from the United States, with extensive farming experience, was appointed to train the Dessups. He imparted his knowledge and expertise on various aspects of horticulture and highland vegetable production. ARDC Bajo was responsible for providing technical support to the international expert during the DSP. Mr. Tashi Dorji, a Senior Agriculture Officer from ARDC-Bajo, was nominated as the Co-Trainer for the program. His role was to assist the trainees and support the expert in delivering the training effectively.

The skilling program covered a wide range of topics, including nursery bed preparation, seed sowing, crop management, harvest, and the marketing/sale of agricultural products. The trainees received hands-on training throughout the entire process, allowing them to gain practical experience and develop the necessary skills.

The trainees had the opportunity to work on a four-acre plot of land, focusing on various aspects of agriculture, such as land preparation, soil fertility improvement, vegetable cultivation, pest and disease management, and the economic aspects of farming. The program aimed to equip the trainees with the necessary skills and knowledge to become successful horticulturists and contribute to the agricultural sector in Bhutan. The summary of the activities:

Polyhouse Land Preparation: A polyhouse measuring 5m by 20m was prepared for cultivation. The land was prepared by incorporating farmyard manure, biochar, and bokashi to improve soil structure and fertility. Additionally, nursery beds were prepared for seed sowing, and nursery trays were filled with potting soil media to facilitate seed germination.

Hands-on Training: Trainees received practical training on preparing potting soil media using biochar, bokashi, topsoil, and soil suitable for raising vegetable nurseries. They learned seed sowing techniques for both nursery bed and seed tray methods. The trainer also demonstrated proper seed sowing depth in line sowing and irrigation techniques to optimize seed germination.

Soil Testing: Soil samples were collected from the field and sent to ARDC-Bajo's Soil and Land Management unit for analysis. The soil test results will guide decisions on soil amendments and fertilizers necessary for improving soil quality.

Production Planning and Material Estimation: Trainees engaged in production planning, estimating seed requirements, determining farm tool needs, assessing space requirements, selecting suitable varieties, and considering season extension and succession sowing techniques. Mathematical calculations were performed to ensure efficient resource utilization.

Heap Composting: Trainees received hands-on training in heap composting using grasses and sedges found in and around the greenhouse. This composting method aids in recycling organic materials and enhancing soil fertility.

Field Layout and Irrigation: The expert trainer provided instruction on main field layout, including the development of irrigation channels. Trainees also learned seed rate calculations specific to different crops such as Cole crops, leafy vegetables, and root crops. This knowledge enables trainees to determine the appropriate seed quantity required for a given area and promotes judicious and economic resource use.

Overall, the DSP provided a comprehensive training experience, combining theoretical knowledge with practical application, to empower the Dessups in horticulture and highland vegetable production.

6.10 Enhancing Floriculture Production at ARDC Bajo

ARDC Bajo has been actively involved in floriculture research and mass production since 2016. The center has established an on-station site dedicated to floriculture, featuring a diverse collection of ornamental plants, herbs, and medicinal plants. In addition to ARDC-Bajo, ornamental multiplication has also been successfully carried out at ARDSC-Menchhuna.

During the fiscal year 2022-23, the center received a directive to produce potted flowers for the annual Royal Flower Exhibition. Responding to this, the center successfully cultivated 2,6000 potted flower plants. However, due to unforeseen circumstances, the exhibition was canceled, leading to the center being tasked with selling the flowers independently. As of June 2023, the Center has sold out 606 flowers. Unfortunately, 500 plants have flowered and subsequently perished as it is annual flowering plants, which naturally complete their life cycle after blooming. At present the Centre has 25289 plants left in the nursery. In addition, the Centre also engaged 20 Dessups in flower production for a period of five months (annexure).

SUPPORT SERVICES RESEARCH AND DEVELOPMENT PROGRAM

7. Integrated Pest Management

7.1 Fall armyworm (FAW) management research

The FAW is indigenous to the Americas but has fast spread to other parts of the world. FAW is highly destructive, highly mobile(Westbrook et al., 2016), and has high fecundity now present in Africa and Asia. It feeds on more than 350 plant species including economically important crops such as maize, millet, wheat, potato, soybean, cowpea, peanuts, sorghum, rice, sugarcane, vegetables and cotton. This recent discovery of FAW poses a significant threat to the country's food security as it can suddenly become a major pest. The presence of ideal climatic conditions and maize-based cropping systems (as of summer and winter crops) present in many parts of the country further aggravates the threat as the pest may become endemic/established and remain a significant pest not only for maize but also for other important crops. Fall armyworm (FAW) management research was conducted at the research station, as part of NCT with NPPC. One season experiment indicated effective control of FAW by new generation pesticides, Chlorantraniliprole and Emmamectin benzoate. The experiment consisted of Neem oil (1000 ppm) and Corn flour bait (poisoned with Emmamectin benzoate). Of the different treatments, Chlorantraniliprole performance was the best.

Skilling and demonstrations on sustainable pest management practices (Integrated Pest Management) to reduce crop losses to mitigate economic, social and environmental impacts.

- Clubroot Management in Crucifers at Sephu, Wangdue Phodrang (07-08/09/2022): Thirty farmers were familiarized with the cause, symptoms, transmission, and management options of Clubroot disease in Cabbage and Crucifer crops. The Activity was in collaboration with National Plant Protection Centre, and Wangdue District Agriculture Office: Garlic rust and White grub management at Dangchu, Wangdue Phodrang (September 14-15, 2022): Forty-six farmers of Dangchu Gewog were familiarized with Garlic rust disease, its cause, symptoms, transmission, and management options. Also, the farmers were briefed on the management of white grubs in different crops in the area. The activity was in collaboration with Wangdue District Agriculture Office.
- Knapsack Power Sprayer operation and maintenance at Khamoed, Gasa-August, 2022 : Eighty-six Farmers of Khamoed, Gasa were skilled on the operation and maintenance of Knapsack Power Sprayers. This was conducted to skill the farmers for effective spray and armyworm management in paddy. Five Knapsack Power Prayers were also supported to the gewog with fund support from PPD, DoA.
- Citrus trunk borer and aphid management for COVID-19 displaced youth from Dagana in November 2022. These youth farmers, who were affected by COVID-19 were given skilling by ARDC Bajo organized by Dagana Agriculture Office.
- Integrated pest management on vegetables at Gasel Tshowongm, Wangdue Phodrang - November, 2022: A total of 16 farmers were familiarized on different methods of pest management, available technologies of pest management in the country, and consequences of syntheytic pesticide use. Farmers were also briefed on the importance and use of personal protective gears.

Research activities

- Fall armyworm (FAW) management research was conducted at the research station, as part of NCT with NPPC. One season experiment indicated effective control of FAW by new generation pesticides, Chlorantraniliprole and Emmamectin benzoate. The experiment consisted of Neem oil (1000 ppm) and Corn flour bait (poisoned with Emmamectin benzoate). Of the different treatments, Chlorantraniliprole performance was the best.
- Pre-test on the herbicidal effect of bamboo vinegar on common potato weeds at Gangtey-Phobjikha Valley; As a pre-test, 30% bamboo vinegar was prayed to different weed species at two sites at Gangtey. The effects of bamboo vinegar was assessed visually based on the per cent damage in the weed plants. Control and treated plots are placed as alternate bands in the field. The pre-test was conducted in preparation to study the potential of the bamboo vinegar to control the weeds in the study area. The pre-test indicated; wood vinegar should be sprayed during sunny days with sunshine hours more than six hours after treatment, and more than 30% v/v Wood vinegar is required for effective control of the weeds. Sheep's sorrel (*Rumex acetosella*), *Typhonium diversifolium*, and *Viola bulbosa* were some of the weeds difficult to control, due to their underground propagation parts.
- Thirty-five litres of Bamboo vinegar were produced. This was in preparation to conduct a weed management study at Gangtey and Phobjikha during the Potato season.
- Pre-study on Glyphosate use at Gangtey-Phobjikha Valley; Using a simple questionnaire, information was collected from a few of the farmers from the two gewogs. Glyphosate is mainly used as a pre-emergence herbicide and pre-harvest herbicide. Pre-emergence herbicide is aimed to kill the weeds before potato shoot emergence while the pre-harvest one is applied after the drying of potato foliage to kill the weeds in preparation to harvest. On average, Gangtey farmers use glyphosate at 160 times dilution while Phobjikha farmers use it at 120 times dilution. On average, glyphosate application reduces the potato tuber harvest by half the time and cost. Gumboots are the most used personal protective gear while spraying herbicide. Other PP gears used were masks and glasses. Before the availability of glyphosate, metribuzin was used as a herbicide. Metribuzin is not effective on some of the major weed species or takes a long time to effects. Further metribuzin is comparatively costlier than glyphosate (Metribuzin is about two times costlier than glyphosate currently). These factors contribute to the preference for glyphosate over metribuzin. One of the respondents doesn't use glyphosate as a pre-harvest herbicide as her potato is cultivated in an area which becomes marshy near the harvest. The marshy condition and glyphosate application are said to heighten the rotting of the tubers.

Pest surveillance

- Hopper burns at Chubu Gewog with around 20% of fields infected, September 2022. The same pest was also reported from Gasel Tshogwom.
- Fall armyworm monitoring was conducted using 5 different Dutch Pheromone lures. The data was submitted to NPPC.

Technology and Technical Supports

- Five numbers of Knapsack Power Sprayers were supported by farmers of Khamoed, Gasa.
- During the outbreak of armyworm in paddy nurseries at Gasa, five-member team assisted the management of armyworm in Khamoed, Gasa covering 50 households.
- 1 Wood Vinegar Extraction Unit each was supported by selected GAP site farmers of Gangtey and Phobjikha, Wangdue Phodrang.

- Weed management support was provided to two farmers, one each of Wangdue and Punakha. Wood vinegar and Niram Oils were used for the weed management program.

7.2 Participatory research on sustainable land management technology, Salamji

ARDC Bajo, in collaboration with the Dagana Dzongkhag Agriculture sector, implemented Sustainable Land Management (SLM) activities in Salamji village, Tsangkha Gewog, from 2006 to 2008. This initiative received financial support from the United Nations Development Program's small grant projects (SGP). During this period, the Salamji Phashing Zinchoung Tshokpa was established, benefiting 16 households and managing approximately 494 acres of land using various SLM technologies. The implemented technologies included contour stone bunding, terracing, hedge row plantation, fruit plant plantation, community forest management, and check dam establishment.

In December 2022, a participatory research study was conducted to assess the impact of SLM technologies and explore the potential for scaling them up in other parts of the country. Structured questionnaires were administered to 16 beneficiaries from the Salamji Phashing Zinchoung Tshokpa to evaluate the effects of SLM technologies and determine the need for their expansion with the objectives to carry out validation and viability assessment of SLM technologies through participatory research with farmers for scaling up, To enhance farmers' adaptive capacity to the changing climate with the adoption of appropriate SLM technologies and to assess and validate the impacts of SLM technologies practiced.. At present, there are 17 household living with their families in 494 acres of sustainably managed land consisting of forests, farmland and residential area. Salamji is one of the first villages in west central Bhutan where SLM technologies were successfully implemented. 14 years after the SGP on SLM was concluded, the participatory research was conducted involving the 15 beneficiaries of the project. The whole village falls under the tropical parts of the agro-ecological zone of Bhutan with altitude ranging from 250 to 750 meter above sea level (masl).

The Salamji Phashing Zinchoung Tshokpa, consisting of 17 members as of December 2022, remains an active and functional community group. The members share a close bond, working cooperatively and supporting one another during the survey conducted. The group holds elections for the positions of President, Secretary, and Treasury every three years.

Currently, the main cash crops cultivated by the community are banana, lychee, mango, vegetables, and papaya. Additionally, they generate income through non-wood forest products and engage in livestock rearing. Marketing of their agricultural produce is smoothly carried out at stalls along the Wangdue-Tsirang highway, without facing any significant issues.

The popular SLM technologies assessed and implemented in Salamji village include bench terracing, contour stone bunding, fruit orchard establishment, hedgerow plantation, check dams, and community forest management. These SLM technologies are widely embraced by Bhutanese farmers. Before implementing SLM activities, the community engages in participatory action planning, involving discussions and consultations with farmers. The participants undergo a week-long training and demonstration, encompassing both theoretical and practical sessions. The structured questionnaires are used to interview the 16 farmers to collect data and information. Various cash crops cultivated and are sold through local markets. 33% of the total annual income comes through selling of cardamom followed by lychee and banana with 19% percent as indicated in the figure 6.

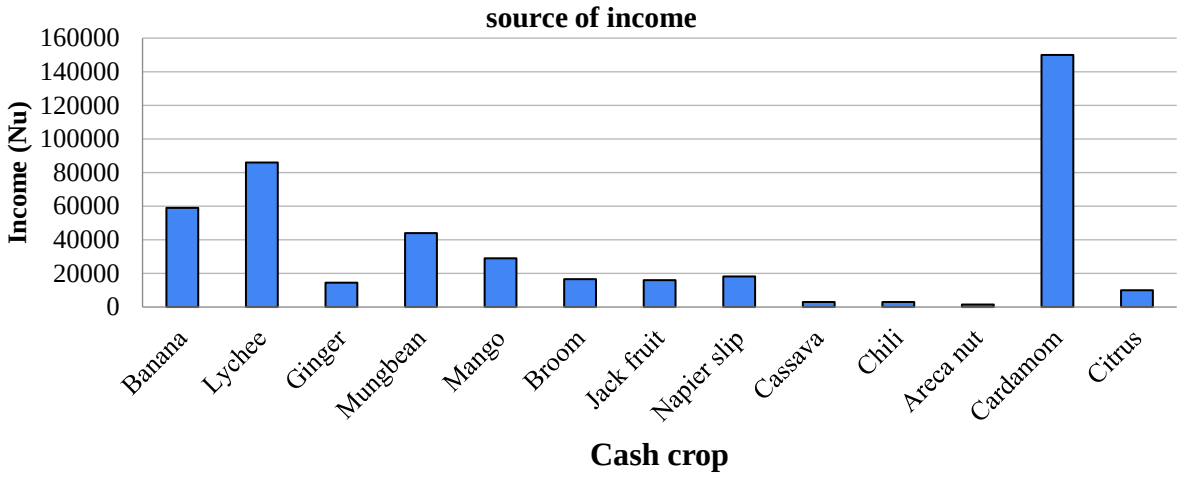

Figure 6. Sources of income to farmers from various fruit plants

After the training and demonstration on SLM technologies conducted in 2006, 100 percent of the participants implemented the SLM technologies in their land. Popular SLM technologies carried out are stone bunding, bench terracing and hedge row plantation. They all were aware about the climate change and its impact on agricultural activities and 81% of them believed that it has negatively impacted their crop productivity and soil health. More than 60 percent of them are of the view that SLM technologies did not help in increasing the water use and energy use efficiency in their farm land. It was also found that the Gewog Agriculture Officer also visits the village frequently and provided his technical support. They informed us that the intervention of SLM technologies has helped them in reducing the number of people moving out of their village. The details of SLM technologies benefits are given in table 47.

Table 47. Socio-ecological benefits of the SLM technology

SN	Benefits	Yes (No.)	No (No.)	Yes (%)	No (%)
1	Increased in yield of crops	16	0	100	0
2	Increased in water saving	5	11	31	69
3	Increased in energy saving	6	10	38	63
4	Decreased in out migration	16	0	100	0
5	Aware about the climate change	16	0	100	0
6	Impact of climate change on crop productivity	13	3	81	19
7	Impact of climate change on soil health	13	3	81	19
8	Has extension officer visited your farm	16	0	100	0
9	Adoption of SLM technologies	16	0	100	0

The farmers in Salamji village received support in the form of tools and equipment, seeds and seedlings, as well as plant protection lures to control fruit fly infestation in mangoes. Almost all of the beneficiaries recognized the value of investing in SLM technologies. They found these technologies to be cost-effective in the long run and effective in reducing land degradation and soil erosion. Women's participation in SLM activities was highly positive, and they believed that women's involvement increased when land was stabilized and terraced, making it easier for them to work. SLM technologies improved workability for women in the community.

Scaling up SLM technologies involves several challenges and issues that need to be addressed. Firstly, implementing SLM in sloppy land is laborious and difficult to mechanize. Additionally,

there may not be immediate short-term benefits, which can discourage adoption. Careless implementation of SLM can result in the loss of topsoil. Moreover, not following proper technical procedures can hinder the effectiveness of SLM activities.To overcome these challenges and promote the scaling up of SLM technologies, certain recommendations should be considered. Firstly, focusing on areas prone to land degradation is crucial for successful scaling up. Strengthening the capacity of local organizations such as Dzongkhag and ARDCs (Agricultural Research and Development Centers) is important to effectively carry out SLM activities. Furthermore, capacity development initiatives targeting farmers and youths can enhance their knowledge and skills in practicing SLM technologies.

7.3 Seed samples tested for various parameters

The National Seed Testing and Referral Laboratory at ARDC-Bajo plays a crucial role in conducting basic tests on seed samples. The laboratory serves a wide range of clients, including ARDCs, BFDA, NSC, farmers and private seed companies. The specific seed parameters tested are determined based on the clients' interests and the laboratory's capacity to perform the tests. Typically, seed samples submitted through BFDA are tested for germination percentage, purity percentage, and moisture percentage. On the other hand, seed samples from farmers are usually tested for germination and purity percentage only. laboratory provides the results and recommendations to the respective beneficiaries.

Seed samples collected for testing predominantly comprise vegetables and cereal crops. In the fiscal year 2022-23, the laboratory received only two seed samples for testing from BFDA, specifically for paddy and wheat seeds. The figure below provides a summary of the seed sample test results conducted during the FY 2022-23.

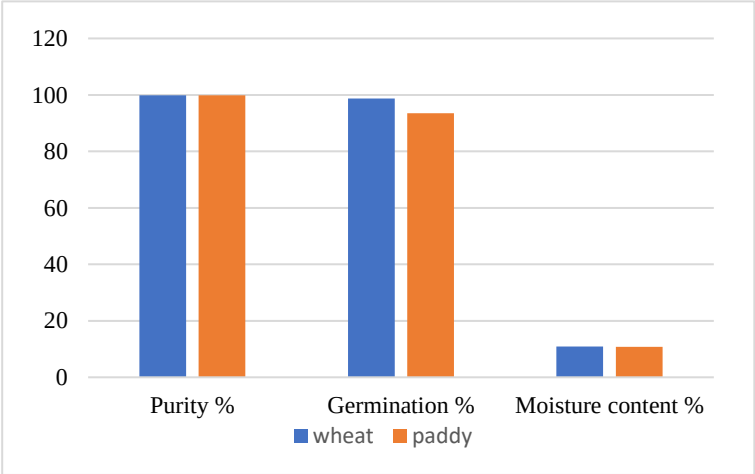

Figure 7. Germination and purity % of seed tested

8. Agriculture Technologies Generated

8.1 Release of improved varieties and technologies

During the fiscal year 2022-23, the Centre proposed the release of one crop variety and two climate-smart technologies through the Variety Release Committee (VRC) and Technology Release Committee (TRC). These releases aim to provide improved options for farmers and promote the adoption of climate-smart practices.

The newly released crop variety and climate-smart technologies have undergone thorough evaluation and approval processes by the VRC and TRC. The Centre's objective is to ensure that these innovations meet the necessary standards and demonstrate potential benefits such as improved yields, resilience to climate change, and sustainable agricultural practices. Once released, the Centre plans to disseminate these crop varieties and technologies to farmers and other stakeholders. The goal is to encourage widespread adoption and facilitate the transition towards more efficient and climate-smart agricultural practices. By providing farmers access to these

improved varieties and technologies, the Centre aims to enhance agricultural productivity, resilience, and sustainability.

Table 48. New varieties and technologies proposed and released in FY 2022-23

SN	Variety/Technology	Traits	Remarks
1	Wheat variety NL-1073	High grain yield potential computed at 1174kg per acre; good agronomic traits. Adaptability is proven. Highly resistant to rusts. Excellent for bread & chappati. Early maturing	Released as Bajoka2023
2	Walipini- The Sunken green house	Walipini is a sunken bed greenhouse is built by digging a pit which uses geothermal energy from the soil. Light and heat energy from the sun is absorbed by underground structure and berms. Enhance food and nutrition security for high altitude area. Provides an environment for growing new vegetables and crops. Protects crop from external harsh weather by providing favourable temperature.	Released as new technology as protected cultivation
3	Bentonite Clay Water Harvesting Pond	Bentonite clay water harvesting pond is made from Bentonite clay soil, which is the primary component for blocking seepage and retaining water. The Bentonite Clay Pond technology offers a practical solution for optimizing water resources in agriculture farming. Bentonite clay pond design ensures stability, maximum water storage capacity and has a long lifespan of over 1000 years, providing a reliable & sustainable water source	Released as new water harvesting technology

8.2 Publication of scientific journal papers and information

As a Research Centre, it is essential to publish scientific journal papers regularly. In the fiscal year 2022-23, the Centre successfully published a number of papers, contributing to the dissemination of research findings and knowledge. The table 49 presents the list of technical publications along with their details.

Table 49. Technical journal papers produced by the Centre, 2022-2023

Publication Title	Author	Publisher (in)	Remarks
The fruit flies (Diptera, tephritidae) in Bhutan: new faunistic records and compendium of fauna	Ugyen Dorji & team	'Fauna and Systematics'	2023
Supporting farmers' adoption of new technologies in Bhutan brings positive impact on farming	Tanka Maya Pulami	APAARI https://www.apaari.org/asia-pacific-women-in-research - and-extension-advancing-gender-equality-in-innovation/	2023
Inventory of Insect in Wheat field at Bajo. Wangdue, Bhutan	Dorji U, Yeshey Dema	BJNRD, CNR https://www.bjnrd.org/index.phb/bjnrd/article/view/99	2023

In the FY 2022-23, the Centre has developed a series of publications in the form of pamphlets, posters, technical reports, training manuals, an annual report, and a guidebook. These publications provide valuable information on the varieties and technologies developed by the Centre.

Table 50. List of pamphlets published 2022-2023

SN	Type of publication	Name of Publication	Remarks
1	Pamphlet	Wheat NL-1073	Package of practices
2	Pamphlet	Walipini- The Sunken green house	Technology
3	Pamphlet	Bentonite Clay Water Harvesting Pond	Technology
4	Poster	Azocompost- The alternative to synthetic Fertilizers	Technology
5	Pamphlet	Wood Vinegar	Technology
6	Training manual	Training manual on installation of irrigation and greenhouse automation	Updated version
7	Course Curriculum	BASIC Kiwi Cultivation	Training module
8	Technical Report	Participatory research on sustainable land management technology, Salamji	Social Study
9	Technical Report	Annual Report 2022-23	Centre's annual report

9. Green Climate Fund (GEF)

9.1 Investment in innovative farming techniques (Hydroponics)

Hydroponics is a soilless cultivation method that provides controlled growing conditions, efficient resource utilization, higher crop yields, and year-round cultivation opportunities. Its importance lies in its potential to address sustainability challenges, maximize productivity, and offer greater food security in various environments. In Bhutan, hydroponics was introduced as a new agricultural technology at the beginning of 2019. The Department of Agriculture recognized the need to implement this technology in order to reduce laborious tasks and make agriculture an attractive enterprise for entrepreneurs and youth who are interested in farming in Bhutan.

During the fiscal year 2022-23, the Green Climate Fund (GEF) provided support of BTN 8.86 million for the establishment of a demonstration hydroponic farming project in a farmer's field. To effectively utilize this innovative farming technique, the Centre conducted hands-on training on hydroponic farming for 23 youth farmers from the West-Central Region for 21 days (annuxure….)

At the conclusion of the training, the selection of the beneficiary for the hydroponic farming project was done through a voting process among the participants. The selection criteria included an assessment score received by each participant. Using a secret ballot, the participants were asked to rate and vote for their top three choices. Points were assigned to the individuals based on their ranking, with 3 points for 1st position, 2 points for the 2nd position and 1 point for 3rd position.

Passang Tamang, a 25-year-old school dropout (12th grade) from Lhamoidzingkha, Dagana, emerged as the top scorer with an assessment score of 40. His area of residence also fell within the treatment area of the GCF project. Passang Tamang works as the main laborer on his parents' 80-decimal land in the village of Loongsilsa, Lhamoidzingkha. Their agricultural activities include growing areca nuts, vegetables, and raising livestock and poultry.

The necessary materials for constructing the hydroponic structure were procured directly from the proprietors by the Centre and delivered to the site. Activities such as site selection, land clearing and levelling, and setting up of the hydroponic system were carried out with technical assistance

from ARDC Bajo. Currently, the hydroponic farming project is fully operational, and they have started growing vegetables such as leafy greens, tomatoes, and chili inside the hydroponic structure.

10. Global Environment Facility/Least Developed Country Fund (GEF-LDCF)

During the financial year 2022-2023, the Global Environment Facility/Least Developed Country Fund (GEF-LDCF) project has been allocated budget of BTN 1.86 million in first phase and BTN 3.63 million. The objective of this project is to enhance the sustainability and climate resilience of forest and agriculture landscapes while improving community livelihoods. Under the GEF-LDCF project funding three major activities are planned to be implemented in the FY 2022-23.

10.1 Demonstration of climate-smart technologies

This activity aims to showcase the implementation and benefits of climate-smart technologies in agriculture and other sectors. Climate smart agriculture (CSA) is an approach that helps guide actions to transform agri-food systems towards green and climate resilient practices. CSA supports reaching internationally agreed goals such as the sustainable development goals. It aims to tackle three main objectives, sustainably increasing agriculture productivity and incomes, adapting and building resilience to climate change and reducing or removing greenhouse gas emissions where possible. Under this activity, ARDC-Bajo have executed various activities for demonstration of climate smart technologies.

- **Bokashi** (fermented rice bran fertilizer): Bokashi is organic fertilizer and plays pivotal role in sustainable agriculture production as it helps reduce dependence on pesticides and chemical fertilizers, reduce greenhouse gas emissions and prevents ground water leaching. It also improves the soil fertility and structure for successful production. Through the financial support from the GEF-LDCF project, the Centre has procured rice bran and produced 1800 kg of rice bran bokashi.
- **Rice husk biochar:** Rice husk biochar (RHB) is produced by low temperature pyrolysis of these rice husk and has been traditionally used in Japan as a soil ameliorant. Pyrolysis of biomass is a thermal degradation process in the absence of oxygen and produces gas, tar, and char. It is added to soil as amendment for soil improvement and also helps in carbon sequestration. Rice husk procured and 1100kg of rice husk bio char was produced.
- **Wood vinegar production:** Production methods of pyroligneous acids commonly known as 'wood vinegar', which can be used for different functions in agriculture were demonstrated. Wood vinegar can be used as herbicide, insecticide and soil amendments. Further, it can be used for seed priming. Materials required, standards of production systems, and functions of the different structures of the oven were also explained. Through the project supported, The Centre produced 1300 lts of wood vinegar.
- **Bhutan Agri-Microbial Solution (BAMS):** This solution is similar to an effective micro-organisms solution and plays an important role in practicing organic farming in the country. The multiplying ratios of the mother solution to apply in different usages were explained along with its benefits. BAMS is utilized as a compost enhancer, deodorants, preparation of bokashi, preparation of plant extract and preparation of pesticides. The demonstration on the preparation of plant extract using BAMS was also done and an application rate of BAMS was also clearly explained along with its benefits. About 1500 lts of BAMS was produced in the FY 2022-23.

- **Open Air Bio-char:** The training cum demonstration on open-air Bio-Char include was carried out where the benefits of open-air biochar in agriculture with the procedure of preparation; the pyrolysis process and carbon sequestration in agriculture soil; the ways and methods to produce quality biochar using a stirring technique; and the quenching process to stop the fire was demonstrated.
- **Vermin compost tea:** Vermicompost tea is a liquid extract made from vermicompost, which is compost produced through the action of earthworms. This organic liquid fertilizer is created by steeping vermicompost in water and allowing the beneficial microorganisms, nutrients, and soluble components to be released into the water. Vermicompost tea is rich in nutrients and beneficial microorganisms, making it an excellent natural fertilizer and soil amendment This bio-fertilizer spray is made by adding100 gm of sugar in one kg vermi compost in 5 liters s of water. Then we have to keep starring for 24 hours using electrical appliance. After the steeping period, the vermicompost tea is ready for use. Strain the liquid to remove any solid particles, and it can be applied as a foliar spray or directly to the soil around plants. The tea can also be diluted with water if desired, depending on the specific requirements of your plants. By using this method, you are creating a nutrient-rich and microorganism-packed liquid fertilizer that can contribute to the health and vitality of your plants, promoting growth, and improving soil fertility.
- **Bentonite clay water harvesting pond**: Utilizing bentonite clay to construct ponds that store rainwater for irrigation purposes.
- **Walipani greenhouse- The Sunken Garden:** A specialized greenhouse design that helps maintain optimal growing conditions in high-altitude regions.
- **Smart drip irrigation with automation:** Intelligent irrigation systems that provide water precisely where and when needed, conserving water resources.

After procuring the necessary materials, the Centre conducted demonstrations on the preparation of bokashi, rice husk biochar, BAMS and wood vinegar. These demonstrations were open to visitors, including farmers, school dropout youths, students, and extension workers who visited the Centre. During the demonstrations, the visitors had the opportunity to learn about the process of preparing these organic products and understand their benefits in agriculture. Through these demonstrations and promotions, the Centre aimed to showcase the effectiveness and benefits of these climate-smart technologies, encouraging their adoption among farmers and promoting sustainable agricultural practices.

Furthermore, the products, like wood vinegar and BAMS, were distributed to farmers, private farms, institutions, and other agencies upon request. This distribution allowed wider access to these beneficial inputs, enabling more individuals and organizations to utilize them in their agricultural practices. By disseminating knowledge and providing access to these organic products, the Centre aimed to promote sustainable farming techniques, improve agricultural productivity, and contribute to the overall resilience of the farming community and the environment.

10.2 Promotion and awareness on utilization of quinoa as climate resilient crop

ARDC Bajo, supported by GEF LDCF with a budget of Nu.0.5 million, conducted a program to promote and create awareness about the utilization of quinoa as a climate-resilient and nutrient-dense cereal in Gewogs supported by GEF. The program took place in Sergithang and Phuentenchu Gewogs in Tsirang Dzongkhag, involving 37 farmers from Sergithang and 21 farmers from Phuentenchu Gewog (Annexure…).

The program aimed to achieve the following objectives:

- Promote quinoa for food and nutritional security
- Enhance food and nutritional security of rural households
- Diversify the cropping system

The program covered various topics related to quinoa, including its nutritional significance, utilization, agronomics, post-harvest practices, cultural practices, and marketing aspects. The participants, including farmers, Gup Tshogpa, and Gewog Agriculture Extension Officers, gained a deeper understanding of quinoa through the program. Farmers in Sergithang had limited knowledge about quinoa, while those in Phuentenchu were completely new to it.

The training program, conducted by the field crops sector of ARDC-Bajo and ARDSC-Tsirang, motivated the participants to grow quinoa for household food and nutritional security, as well as for income generation. Alongside the awareness training, quinoa seeds were distributed to the farmers, enabling them to start cultivation and experience the benefits of this climate-resilient crop. Field monitoring was conducted but the germination rate of quinoa was poor so farmers were supplied seed for second time.

As part of the project support, five quinoa dehusking machines were procured and distributed to farmers in Serthigang, Phuntentshu (Tsirang), and Drujegang (Dagana). The machines were handed over to the farmers in groups, and demonstrations on how to handle and operate the machines were provided. This initiative aimed to diversify and utilize quinoa effectively.

In addition to the distribution of dehusking machines, the Centre also provided hands-on training to the farmers on product diversification. This training helped the farmers explore different ways to utilize quinoa and expand their product range. By diversifying the use of quinoa, farmers could maximize its potential and enhance the economic value of their harvest.

10.3 Research (demo) of wood vinegar use to control weed in potato cultivation

Wood vinegar is proposed to be utilized in potato cultivation as a means of managing blight, weeds, and insect pests. Wood vinegar is a natural byproduct of wood pyrolysis and has been shown to have potential agricultural benefits, including its pesticidal properties. This activity aims to demonstrate the effectiveness of wood vinegar in potato farming, promoting more sustainable pest and weed management practices.

The Plant Protection Unit proposed the establishment of a Wood Vinegar Extraction Unit at Kilkhorthang, Phobjikha, with the aim of promoting organic pest management among farmers. The unit will benefit a total of 21 members, specifically for weed management in potato and other vegetable cultivations. Additionally, the unit will be used for studies to evaluate the effectiveness of wood vinegar extraction in pest management. The construction of the wood vinegar extraction unit has been completed, and it is set to demonstrate vinegar extraction and its various uses in the near future. The project incurred expenses for purchasing construction materials and will provide training to the farmers at a later stage. This initiative aims to encourage the adoption of organic pest management practices and explore the potential of wood vinegar in sustainable agriculture. The ongoing research on weed control using wood vinegar in potato cultivation conducted by the Centre holds the promise of providing valuable insights and recommendations. As the research progresses, data is being collected and analyzed to understand the effectiveness of wood vinegar in managing weeds in potato fields.

Once the research is completed, the Centre will thoroughly examine the findings and draw conclusions based on the collected data. The results will shed light on the potential of wood vinegar as a weed control method and its impact on potato cultivation. The Centre will also assess any associated benefits or challenges that may arise from the use of wood vinegar. Based on the research findings, the Centre will develop recommendations for farmers, agricultural practitioners, and relevant stakeholders. These recommendations may include guidelines on the proper application of wood vinegar for weed control, the optimal dosage or concentration to use, and any precautions or considerations to be taken into account. The aim is to provide evidence-based insights that can support farmers in making informed decisions about weed management strategies in potato cultivation. Additionally, the recommendations may contribute to the development of sustainable and environmentally friendly practices in agriculture, promoting efficient and effective weed control while minimizing the use of synthetic herbicides.

10.4 Intensify upland rice production

The project aims to intensify upland rice production as a climate-resilient strategy to mitigate rice deficiency. With a budget of BTN 0.50 million, the Centre has implemented several initiatives to support this objective. One of the key actions was the procurement and supply of 1450 kg of paddy seed for upland cultivation. This seed was distributed to 91 households, covering a total area of 59 acres across different dzongkhags.

Table 51. Upland rice seed distribution through GEF-LDCF project

Dzongkhag	Gewog	Seed supply	Quantity (Kg)	Area (Ac)	No. of HHs
Dagana	Tshangkha	Khangma maap	450	18	41
Dagana	Tshangkha	Electric rice mill	3	In groups for Namlaythang village	
Tsirang	Serigthang	Khamtay	560	22.4	26
Tsirang	Sunkosh	Khamtay	40	2	3
Punakha	Limbukha	Khangma maap	400	16	32
Total			**1450**	**59.4**	**101**

In Tshangkha gewog, Dagana dzongkhag, 450 kg of Khangma maap paddy seed was supplied to 41 households for cultivation on 18 acres of land. Additionally, three electric rice mills were provided to the Namlaythang group in Tshangkha to enhance rice processing capabilities. In Serigthang gewog, Tsirang dzongkhag, 560 kg of Khamtay paddy seed was distributed among 26 households for cultivation on 22.4 acres of land and 40 kg of Khamtay paddy seed was allocated to three households for cultivation on 2 acres of land in Sunkosh. Furthermore, in Limbukha gewog, Punakha dzongkhag, 400 kg of Khangma maap paddy seed was provided to 32 households for cultivation on 16 acres of land.

These efforts aim to increase upland rice production, enhance food security, and reduce rice deficiency in the respective regions. By providing farmers with improved seed varieties and supporting rice processing infrastructure, the project strives to strengthen the resilience of upland rice farming communities.

The other on-going activities with support from GEF-LDCF projects are 1. Demonstration of saffron production in protected condition and 2. Evaluate production of high value and quality fruits (mango) in protected structure. These activities aim to diversify agricultural production, enhance crop quality and value, and improve the resilience of farmers to climate change impacts. By introducing protected cultivation methods and sharing best practices, the Centre strive to promote sustainable and climate-resilient agricultural practices in the respective regions.

11. Food Security and Agriculture Productivity Project (FSAPP)

During the FY 2022-23, the Centre incurred BTN 4.70 million from FSAPP to implement the project activities. The major activities carried out are:

11.1 Demonstration of micro-efficient irrigation schemes with automation

Agriculture faces a great challenge in coping with growing water scarcity and increasing demands for food production. Various initiatives are being made to increase the efficiency of the agricultural irrigation system. With the increased availability of the Internet of Things (IoT) and Information and Communication Technology (ICT), it is now possible to real-time monitor/control different processes of irrigation and water management in agriculture. The smart irrigation system is using water-saving technologies such as micro-irrigation systems combined with different IoT-based technologies for automation funding of BTN 3.00 million was obtained to conduct demonstrations of SMART Irrigation with automation and greenhouse automation in each of the project gewogs in Dagana Dzongkhag. This initiative aims to showcase and promote the use of advanced irrigation techniques and automation systems to enhance water efficiency and optimize greenhouse operations in agricultural practices. The funding will support the implementation of these demonstrations and provide valuable insights for farmers and stakeholders in adopting smart and automated irrigation methods.

The selection of beneficiaries was carried out by the Dzongkhag, taking into account their keen interest in participating in these activities, as well as prioritizing progressive farmers who already possessed orchards and greenhouse setups. The activities were successfully implemented through a collaborative effort between the Dzongkhag and five project gewogs, demonstrating effective execution. Field verification and layout tasks were conducted in partnership with Dzongkhag Extensions, and estimates were calculated accordingly. To ensure a smooth implementation process, the required materials were procured and promptly delivered to the designated sites. The activities were carried out in three distinct phases: field verification and layout, followed by pipe setting and fixing, and finally automation.

Table 52. SMART Irrigation and Greenhouse Automation through FSAPP

SN	Gewog	Location	Automated Green House	SMART Irrigation automation (orchard)	Remarks
1	Kana	Chinathang	3	3	
2	Drujeygang	Thangna	3	1	
5	Lhamoizingkha	Lhamoizingkha	1	2	
6	Karmaling	Karmaling	1	2	
7	Nichula	Gangtokha	2	1	
8	Lhamoizingkha	Chongsamling	1	1	
	Total		11	10	

11.2 Rice genetics/breeding and nutrient analysis

Three days intensive training program focused on rice breeding, genetic analysis, and nutrient analysis was conducted at ARDC, Bajo. The training program was attended by a total of 17 researchers from three ARDCs Bajo, Samtenling and NCOA, Yusipang.

The primary objective of this training program was to equip participants with a comprehensive understanding of the principles and techniques involved in rice breeding, genetic analysis, and

nutrient analysis. The program encompassed a combination of theoretical lectures and practical sessions held at the laboratory of the College of Natural Resources (CNR), Lobesa. These sessions were expertly facilitated by experienced lecturers from CNR.
The training program proved to be successful, providing participants with invaluable insights into the field of rice breeding, genetic analysis, and nutrient analysis. Through hands-on experience and engaging sessions, the participants were able to enhance their practical skills and knowledge in these areas. The program received positive feedback from the participants, who found it both informative and stimulating.

11.3 Conduct Write-shop for Researchers and Extension Agents (EA)

Through the financial support from FSAPP, the Centre could facilitate to conduct a five days write-shop for the researchers and extension staff, with the objective to build the capacity of the officials to write authentic success stories depicting the impact of the project's implementation in the field. The write-shop was attended by 15 participants (6 EAs from Dagana project gewogs, 1 from CRP, Chimipang, 6 from ARDC Bajo and 2 from ARDC Samteyling). The write-shop was facilitated with two resource persons from FAO TA-FSAPP.

The comprehensive write-shop training covered various aspects to enhance the participants' writing skills and project visibility. The training included guidance on the basic writing process, tips for effective writing, and different writing styles relevant to the project's requirements. Additionally, participants learned how to develop engaging social media posts to increase the project's visibility and received tricks and tips on utilizing social media effectively.

The training also focused on data types and collection, basic data analysis using MS Excel, interpretation of data, and techniques for presenting data to non-technical audiences. Furthermore, participants received insights on photography tips to capture compelling visuals.

During the write-shop, each participant was assigned the task of creating one or two success stories related to the project's impact. These success stories were then presented to the entire group. Ultimately, a total of nine success stories were produced by the participants. These stories were submitted to FAO TA-FSAPP for editing and subsequently published on various platforms. At the conclusion of the training, an action plan was formulated to submit a total of 13 success stories by the end of June 2023, highlighting the project activities and their outcomes. This action plan reflects the commitment of the participants to document and share the progress and impact of the project. By adhering to this timeline, the project will be able to showcase its achievements and effectively communicate its positive contributions within the specified timeframe.

11.4 Skilling and engagement programs in Climate Smart Technologies

During the FY 2022-23, ARDC Bajo could provide training to farmers and youths in the project Dzongkhag (6 Gewogs of Dagana Dzongkhag) on climate-smart agriculture technologies in collaboration with Dagana Dzongkhag through financial support from FSAP Project. The objective of these training programs was to impart knowledge and skills related to climate-smart agriculture technologies, with a focus on sustainable and climate-resilient farming practices. The training programs were conducted in close collaboration with Dagana Dzongkhag, and their successful implementation was made possible through financial support from the FSAP Project. The Climate Smart Agricultural Technology Training the following topics:
Rice Husk Biochar: Demonstration on the process of converting waste biomass into biochar, a valuable soil amendment with carbon sequestration benefits.

Fermented Rice Bran Bokashi: Hand on training on the production of organic fertilizer from rice bran and its advantages over compost.
Bhutan Agri-Microbial Solution: Introduced a solution similar to effective micro-organisms for compost enhancement and other agricultural uses.
Azolla: Showcased the benefits of using Azolla for nitrogen fixation in paddy fields and as mulching material in vegetable cultivation.
Bio-digester: Demonstrated the collection and fermentation of cattle urine for use as a nutrient source in organic farming.
Open Air Bio-char: Explained the benefits of open-air biochar and demonstrated its production process.
Integrated Pest Management: Conducted a session on plant pest and disease management, covering topics such as crop rotation, irrigation management, nutrient management, and seed treatment. Demonstrated the production and uses of wood vinegar and gelatine solutions for pest control.
Improved Potting Media & Commercial Vegetable Production: Provided training on seed sowing, seedling thinning, nutrient preparation, and improved potting media for commercial vegetable production.
These training programs aimed to promote climate-smart agriculture, organic farming practices, pest management techniques. They aimed to enhance farmers' knowledge and skills, improve agricultural productivity, and provide alternative livelihood options in rural areas. ARDC Bajo facilitated the skilling of 51 farmers (2 days) and 38 youths (11 days) from the project gewogs of Dagana Dzongkhag attached in annxure.

11.5 Promotion of black pepper production

Black pepper, scientifically known as *Piper nigrum,* is one of the most commonly used spices around the world. It is highly valued for its distinct flavour and aroma, but it also possesses several health benefits. Black pepper is widely used in cooking due to its pungent and versatile flavour. It enhances the taste of various dishes, including soups, stews, marinades, sauces, and salads. Beside its culinary uses, it has high medicinal uses. Black pepper is gaining momentum in Bhutan due to since it is a high value crop.

Through the support of the FSAP Project, the Centre has promoted the cultivation of black pepper intercropped with betel nuts on more than five acres of land in Karmaling gewog. This initiative aims to enhance income generation capacity of farmers contributing to food security attainment. In total, 63 households (annexure…) of Karmaling gewog have benefited from this project, with over 2300 black pepper seedlings being distributed to them. This distribution ensures that farmers have the necessary resources to start their black pepper cultivation.

To ensure the success of this venture, the farmers were provided with detailed information and guidance on black pepper cultivation techniques prior to receiving the seedlings. This briefing session equipped them with the knowledge and skills required to effectively grow and maintain black pepper plants.

The intercropping method employed in this project is particularly innovative. By combining the growth of black pepper with the support of the betel nut crop, the farmers are capitalizing on the natural support system provided by the betel nut plants. As the climbing black pepper vines find support in the betel nut trees, it maximizes land utilization and promotes a symbiotic relationship between the two crops.

This integrated approach not only enhances the productivity of the land but also diversifies the income sources for the farmers. By cultivating both black pepper and betel nuts, the farmers can optimize their agricultural activities and generate additional revenue streams.

Overall, this project demonstrates the commitment to sustainable agriculture and economic empowerment in the Karmaling gewog. Through the support of the FSAP Project, the Centre has taken a significant step towards improving the livelihoods of farmers, fostering food security, and promoting innovative farming techniques in the region.

In addition, The FSAP Project has supported the capacity enhancement of the National Citrus Repository at Menchuna, nested at ARDSC Menchhuna. This support includes the procurement of a growth chamber and refrigerators to improve the production, preservation, and maintenance of disease-free citrus germplasm. The growth chamber provides an optimized environment for citrus plant growth, while the refrigerators preserve the germplasm by inhibiting pathogen growth. This enhanced capacity enables researchers to collect, evaluate, document, and conserve diverse citrus varieties, safeguarding Bhutan's citrus genetic resources. By ensuring disease-free citrus germplasm availability, the project contributes to a resilient citrus industry, promoting its long-term productivity and sustainability.

FINANCIAL REPORT

Table 53. Financial report as of June 30 2023

Title source	Approved budget (Nu. M)	Expenditure (Nu. M)	Balance (Nu. M)
RGoB	58.319	56.997	1.322
RDCCRP/GEF-LDCF	5.490	5.489	0.001
Green Climate Fund (GCF)	0.856	0.856	0.00
FASP Project	4.700	4.698	0.002
Total	**69.365**	**68.04**	**1.325**

In the FY 2022-23, ARDC Bajo received the total approved budget across all sources is Nu. 69.365 million, and the total expenditure stands at Nu. 68.04 million. This leaves an overall balance of Nu. 1.325 million.

ANNEXURES

Annexure 1. Agronomic performance of Rice IET line

ENT NO	SVCODE	50% FLW	Plant height (cm)	Tillers/hill (number)	Maturity Days	Yield kg/acre
Replication 1						
37	SVIN329	90	111	11	150	2121
71	SVIN357	100	100	15	144	2225
43	SVIN031	105	98	11	141	1998
73	SVIN360	101	105	11	150	2112
24	SVIN319	100	101	15	150	2123
70	SVIN356	98	98	11	1145	2112
BK1	Check	95	103	15	132	1112
Replication II						
37	SVIN329	99	110	12	140	2101
71	SVIN357	89	97	15	142	2111
43	SVIN031	100	90	14	147	2314
73	SVIN360	99	110	14	149	1123
24	SVIN319	100	108	12	153	2112
70	SVIN356	99	97	11	145	2145
BK1	Check	102	103	12	150	1115
Replication III						
37	SVIN329	100	110	12	145	2220
71	SVIN357	99	100	12	141	2112
43	SVIN031	78	92	14	146	2125
73	SVIN360	100	1103	11	155	1156
24	SVIN319	100	104	13	150	2510
70	SVIN356	98	107	10	145	2120
BK1	Check	120	109	13	149	1120

Annexure 2. Agronomic performance of International Upland Rice Observation Nursery

Entry code	Designation	SV Code	Plant height (cm)	Tillers/ hill	Panicle length	Presence of Awn	Yield kg/ac
ING081		SV0049	99.00	15.70	26.00	No	2832.20
ING081		SV0049	101.50	18.00	25.80	No	2375.84
ING071		SV0038	99.50	12.97	24.50	No	2618.87
ING071		SV0038	101.50	18.00	25.80	No	2792.13
ING085		SV0054	98.50	18.23	22.44	No	2440.55
ING085		SV0054	99.50	12.97	24.50	No	2701.68
ING075		SV0042	95.80	19.00	25.16	No	2161.72
ING075		SV0042	102.50	16.40	20.77	No	1382.94

ING088		SV0057	99.00	17.60	24.40	No	2161.72
ING088		SV0057	104.00	14.30	21.20	No	2216.57
ING092	IRRI 132	SV0716	96.20	13.60	18.40	No	2225.30
ING092	IRRI 132	SV0716	101.50	18.00	25.80	No	2990.52
ING064		SV0028	99.00	15.70	26.00	No	2813.53
ING064		SV0028	109.00	14.60	25.23	No	2945.77
ING065		SV0030	78.50	15.00	23.70	yes	2664.14
ING065		SV0030	104.37	14.40	24.80	No	2967.07
ING070		SV0037	99.50	12.97	24.50	No	2926.61
ING070		SV0037	89.60	14.60	22.40	No	2812.23
ING072		SV0039	89.60	14.60	22.40	No	2606.22
ING072		SV0039	110.37	17.00	23.44	yes	2479.56
ING076		SV0044	114.00	12.20	25.40	Yes	2123.20
ING076		SV0044	95.80	19.00	25.16	No	2156.96
ING080		SV0048	93.33	20.60	24.40	No	2662.19
ING080		SV0048	101.50	18.00	25.80	No	2001.87
ING068		SV0033	102.50	16.40	20.77	No	1746.95
ING068		SV0033	97.37	16.20	25.80	No	2322.43
ING084		SV0052	100.20	17.60	24.00	yes	2202.37
ING084		SV0052	100.50	16.18	24.20	No	2023.00
ING091	IRRI 123	SV0713	late maturity				
ING091	IRRI 123	SV0713	93.33	20.60	24.40	No	2382.94
ING069		SV0035	99.00	17.60	24.40	No	2566.96
ING069		SV0035	89.60	14.60	22.40	No	2244.69
ING066		SV0031	96.20	13.60	18.40	No	2146.96
ING066		SV0031	104.37	14.40	24.80	No	2439.10
ING087		SV0056	late maturity				
ING087		SV0056	78.50	15.00	23.70	yes	2471.12
ING083		SV0051	95.34	13.45	18.30	No	2516.34
ING083		SV0051	102.50	16.40	20.77	No	1880.18
ING093		SV0721	114.00	12.20	25.40	Yes	2859.17
ING093		SV0721	100.90	15.00	23.42	No	2473.08
ING077		SV0045	90.80	17.00	23.80	No	1419.15
ING077		SV0045	100.50	11.00	24.00	No	2025.16
ING089		SV0058	93.33	20.60	24.40	No	2317.72
ING089		SV0058	106.00	14.60	27.10	No	2726.58
ING082		SV0050	102.50	16.40	20.77	No	2902.14
ING082		SV0050	110.37	17.00	23.44	yes	2070.20
ING079		SV0047	100.20	17.60	24.00	yes	1585.47
ING079		SV0047	100.20	17.60	24.00	yes	2568.35
ING095	SAHBHAGI DHAN	SV0851	96.42	15.80	23.63	No	2439.10

ING095	SAHBHAGI DHAN	SV0851	106.00	14.60	27.10	No	2245.50
ING088		SV0057	104.00	14.30	21.20	No	2216.57
ING074		SV0041	106.00	14.60	27.10	No	2295.58
ING074		SV0041	100.20	17.60	24.00	yes	2182.94
ING078		SV0046	98.50	19.30	23.44	No	2013.52
ING078		SV0046	96.42	15.80	23.63	No	260.56
ING086		SV0055	106.50	15.09	24.77	No	2110.74
ING086		SV0055	100.20	17.60	24.00	yes	2551.75
ING067		SV0032	100.20	17.60	24.00	yes	1600.94
ING067		SV0032	101.50	18.00	25.80	No	2382.94
ING094	IRRI 163	SV0755	102.50	16.40	20.77	No	3047.55
ING094	IRRI 163	SV0755	96.42	15.80	23.63	No	2407.63
ING073		SV0040	90.80	17.00	23.80	No	1244.29
ING073		SV0040	104.00	14.30	21.20	No	2978.57
ING090		SV0061	106.50	15.09	24.77	No	2280.94
ING090		SV0061	106.00	13.40	27.10	No	2195.30
LC1	Early duration		90.80	17.00	23.80	No	1386.33
LC1	Early duration		78.50	15.00	23.70	yes	2532.32
LC2	Blast resistant		98.50	19.30	23.44	No	2688.34
LC2	Blast resistant		104.37	14.40	24.80	No	2173.33
LC3	BB resistant		100.90	15.00	23.42	No	1275.98
LC3	BB resistant		102.50	16.40	20.77	No	2567.86
LC4	BPH resistant		114.00	12.20	25.40	Yes	2400.63
LC4	BPH resistant		99.00	15.70	26.00	No	2975.83

LC=Local Check

Annexure 3. Agronomic performance of International Irrigated Rice Observation Nursery

SV Code	Entry code	Designation	Plant height (cm)	Tillers/ hill	Panicle length (cm)	Presence of Awn	Yield kg/ac
SV0806	ING028	IRRI 195	98.50	19.30	23.44	No	2772.26
SV0434	ING001		95.80	19.00	25.16	No	1734.00
SV0713	ING021	IRRI 123	99.00	17.60	24.40	No	3758.28
SV0436	ING002		96.20	13.60	18.40	No	2427.60
SV0452	ING010		99.00	15.70	26.00	No	2865.92
SV0664	ING018	IRBB 62	78.50	15.00	23.70	yes	2427.60
SV0147	ING020	IR 64	99.50	12.97	24.50	No	2607.42
SV0460	ING013		98.50	19.30	23.44	No	2772.26
SV0518	ING019						2625.93
SV0442	ING005		95.80	19.00	25.16	No	1338.29
LC1	Early duration		99.00	17.60	24.40	No	2690.24
SV0462	ING014		96.20	13.60	18.40	No	2023.00
SV0856	ING031	SAMBHA MAHSURI	99.00	15.70	26.00	No	1650.13

SV0204	ING029		78.50	15.00	23.70	yes	2735.87
SV0842	ING034		99.50	12.97	24.50	No	2023.00
SV0196	ING025	IRRI 180	89.60	14.60	22.40	No	1739.78
SV0438	ING003		114.00	12.20	25.40	Yes	2107.29
LC5	BPH resistant		90.80	17.00	23.80	No	2247.78
SV0202	ING027		93.33	20.60	24.40	No	2355.67
SV0876	ING035		101.50	18.00	25.80	No	1483.53
SV1102	ING015		102.50	16.40	20.77	No	2562.47
SV0448	ING008		100.20	17.60	24.00	yes	2265.76
SV0196	ING025	IRRI 180	97.37	16.20	25.80	No	2890.00
SV0866	ING033	SWARNA-SUB1	late maturity destoryed				
SV0462	ING014		95.80	19.00	25.16	No	2818.20
SV0195	ING024		99.00	17.60	24.40	No	1059.47
SV0202	ING027		96.20	13.60	18.40	No	1059.47
SV0861	ING032	SWARNA	late maturity				
SV0204	ING029						2796.71
LC3	Blast resistant		89.60	14.60	22.40	No	2124.15
SV0454	ING011		114.00	12.20	25.40	Yes	2890.00
SV0460	ING013		90.80	17.00	23.80	No	2589.44
SV0193	ING023		93.33	20.60	24.40	No	1618.40
SV0446	ING007		101.50	18.00	25.80	No	1640.27
SV0806	ING028	IRRI 195	102.50	16.40	20.77	No	2427.60
SV0456	ING012		100.20	17.60	24.00	yes	2733.78
SV0440	ING004		104.37	14.40	24.80	No	2484.39
SV0713	ING021	IRRI 123	96.42	15.80	23.63	No	1855.96
SV0185	ING022		100.90	15.00	23.42	No	2940.70
SV0518	ING019		104.00	14.30	21.20	No	2427.60
SV0193	ING023		110.37	17.00	23.44	yes	2362.70
SV0842	ING034		106.00	14.60	27.10	No	2713.11
LC4	BB resistant		106.50	15.09	24.77	No	1938.98
SV0198	ING026	IRRI 186	102.50	16.40	20.77	No	2661.84
SV0185	ING022		100.20	17.60	24.00	yes	2395.66
SV0206	ING030		100.50	16.18	24.20	No	2247.78
SV0450	ING009		106.50	15.09	24.77	No	1556.15
SV0438	ING003		100.50	11.00	24.00	No	1696.44
LC1	Early duration		99.00	15.70	26.00	No	2809.72
SV0446	ING007		78.50	15.00	23.70	yes	2528.75
SV0147	ING020	IR 64	99.50	12.97	24.50	No	2995.97
SV0444	ING006		98.50	19.30	23.44	No	1685.83
LC3	Blast resistant		101.50	18.00	25.80	No	2461.07
SV0448	ING008		102.50	16.40	20.77	No	2293.65
SV1107	ING016		100.20	17.60	24.00	yes	980.45

SV0206	ING030		104.37	14.40	24.80	No	1663.55
SV0436	ING002		96.42	15.80	23.63	No	1414.69
LC2	Medium/Late duration		100.90	15.00	23.42	No	2274.62
SV0664	ING018	IRBB 62	104.00	14.30	21.20	No	1348.67
SV0861	ING032	SWARNA	110.37	17.00	23.44	yes	1557.71
SV0003	ING017		106.00	14.60	27.10	No	2019.63
SV0440	ING004		101.50	18.00	25.80	No	1739.78
SV1107	ING016		102.50	16.40	20.77	No	2247.78
SV0876	ING035		100.20	17.60	24.00	yes	2629.90
LC2	Medium/Late duration		104.37	14.40	24.80	No	2023.00
SV0454	ING011		96.42	15.80	23.63	No	1062.08
SV0456	ING012		106.00	14.60	27.10	No	1078.93
SV0856	ING031	SAMBHA MAHSURI	109.00	14.60	25.23	No	1264.38
SV0444	ING006		106.00	13.40	27.10	No	1888.13
LC5	BPH resistant		89.60	14.60	22.40	No	2124.15
SV1102	ING015		114.00	12.20	25.40	Yes	2326.45
SV0198	ING026	IRRI 186	90.80	17.00	23.80	No	1791.80
SV0452	ING010		93.33	20.60	24.40	No	2023.00
SV0003	ING017		101.50	18.00	25.80	No	2697.33
SV0195	ING024		102.50	16.40	20.77	No	1618.40
SV0434	ING001		100.20	17.60	24.00	yes	1156.00
LC4	BPH resistant		104.37	14.40	24.80	No	1456.56
SV0866	ING033	SWARNA-SUB1	96.42	15.80	23.63	No	1387.20
SV0442	ING005		100.90	15.00	23.42	No	867.00
SV0450	ING009		104.00	14.30	21.20	No	2023.00

LC= Local Check

Annexure 4. Implementation of skilling and engagement programs

Desuups Gozays Skilling on Fruit Orchard Management at ARDC-Bajo

Date: January 24th to 28th January, 2023

SN	Name	Gender	CID	Contact	Dzongkhag
1	Ngawang Pelden	M	10608003407	17626102	Wangdue
2	Kinzang Lhazin	F	10602000990	77653024	Wangdue
3	Nidup Dorji	M	11503004451	17424288	Wangdue
4	Dechen Pelden	F	11904000554	17650638	Wangdue
5	Phintsho Namgay	M	10102001468	17235119	Wangdue
6	Tshewang namgyel	M	10302003025	77240634	Wangdue
7	Karma zangmo	F	10904003744	17877149	Wangdue
8	Pema Tsheden	F	10308002248	17900749	Wangdue
9	Kezang Dorji	M	11508000195	17666488	Wangdue
10	Tandin Norbu	M	10401000669	77266374	Wangdue
11	Passang Dorji	M	11512006657	17824584	Wangdue
12	Dawa Tshering	M	11504000436	17732889	Wangdue
13	Sonam Choden	F	11111002579	17263949	Wangdue
14	Karma Dema	F	11913000800	17405485	Wangdue
15	Chimi Om	F	11401000250	17446616	Wangdue
16	Damcho Om	F	10402000468	17878534	Gasa
17	Phub Lham	F	10402000429	17611174	Gasa
18	Damcho Rinchen	M	10402000066	17697651	Gasa
19	Wangmo	F	11005000924	17641510	Punakha
20	Deki Choden	F	11007000797	17998180	Punakha
21	Karma yangzom	M	10907001861	17831242	Punakha
22	Kinley Tshering	M	11006000547	77761400	Punakha
23	Tandin Tshewang	M	11915000610	77263889	Punakha
24	Wangdi Gyeltshen	F	10606001739	17916996	Punakha Punakha
25	Sonam Zangmo	F	11005002630	17957232	
26	Kinley Tenzin	M	11502000783	17698167	Punakha
27	Kinley Choden	F	11002001892	17458562	Punakha
28	Tshering Zam	F	11004002095	17557260	Punakha
29	Rinchen Dorji	M	11007000834	17632742	Punakha

Desuups Gozays Skilling on Fruit Orchard Management conducted at ARDSC-Tsirang

Date: 24th to 28th January, 2023

SN	Name	Gender	CID	Contact	Dzongkhag
1	Karma Lhamo	F	11805001979	77636292	Tsirang
2	Passan Wangdi	M	1030600061 1	77200772	Tsirang
3	Sonam choki	F	11812001712	17391438	Tsirang
4	Ugen Tenzin	M	11810002266	77833069	Tsirang
5	Ugen Lham	F	10206001459	77316056	Tsirang
6	Parmila Chhetri	F	11808003042	17437582	Tsirang
7	Kinle Gyeltshen	M	11812002037	17431002	Tsirang
8	Anita sangbo Limboo	F	10311000345		Tsirang
9	khandu Wangchuk	M	10607000836	77460920	Tsirang
10	Pema Wangmo Tamang	F	11802001648	17413434	Tsirang
11	Ngwawang Samphel	M	11812001402	1 7761810	Tsirang

12	Purni Maya Rai	F	11812001841	77358463	Tsirang
13	Dechen Cheki	F	11102007357	17815395	Dagana
14	Passan Dawa She	M	10309000843	17236564	Dagana
15	Passang Lhaden Sherpa	F	11304001105	17835647	Dagana
16	Tandin Wangmo	F	11410003100	77695400	Dagana
17	Tulashi Ram Powrel	M	10305004000	17760658	Dagana
18	Zeenita Rai	F	10313000297	17657435	Dagana
19	Rinchen Tshogel	F	12003000335	77276924	Dagana
20	Hari Maya Powdrel	F	10305003991	77360264	Dagana
21	Nima Zangpo	F	12002001143	17405941	Dagana
22	Sonam Wangmo	F	11107006502	77801630	Dagana
23	Radhika Chuwan	F	10304001136	17970983	Dagana

Desuups Skilling and engagement of flower nursery production at ARDC Bajo
Date: 6th Feburary to 15th June, 2023

SN	Name	Gender	CID #	DID	Mobile no
1	Yeshi Choden	F	11513005013	DS(45)21-20460	17279256
2	Tashi Penjor	M	11912001392	DS(46)21-22152	17704867
3	Karma Drupchu	M	10708000336	DS(44)21-18534	17657703
4	Tshewang Norbu	M	11506006126	DS(40)20-9956	17781437
5	Ugyen Jigme Thinley	M	11608002337	DS(42)20-15128	77858270
6	Tandin Dema	F	10705004823	DS(45721-24568	17473494
7	Tandin Wangmo	F	11603001581	DS(42)20-16576	17396396
8	Pema Deki	F	11602002497	DS(42)20-16075	17608733
9	Bhim Bahadur Limbu	M	11210000035	DS(45)21-21837	17769615
10	Kuenzang Pema	F	11513004485	DS(46)21-22460	17312342
11	Tshewang Lhamo	F	11303003231	DS(40)20-11764	77382090
12	Tashi Phuntsho	M	10904001947	DS(42)20-15937	17480507
13	Tshering Yangzom	F	11513002807	DS(43)20-17913	17894336
14	Thinley Norbu	M	11303001377	DS(50)22-29827	17235563
15	Ugyen Zangmo	F	10302000276	DS(40)20-10902	17702892
16	Kinzang Wangdi	M	11303002787	DS(49)22-27340	77395275
17	Bishal Gurung	M	11308006141	DS(45)21-20494	17444247
18	Chura Muni Ghalley	M	11204003054	DS(44)21-19237	17910750
19	Rupa Gurung	F	11201000577	DS(43)20-17253	17867863
20	Nawang Tshetrim	M	10603001227	DS(44)21-19555	77315943

Dessung Skilling Program on Horticulture and Highland vegetable production

SN	Name	Contact no	Organization	Remarks
1	Kumbu Lhamo		DSP	
2	Wangmo Sherpa	17959422	DSP	
3	Tshering Samdrup	77204360	DSP	
4	Sonam Tshering	17608288	DSP	

5	Tashi Tobden	17381969	DSP	
6	Karma Dolkar	17935952	DSP	
7	Pema Tshering		DSP	
8	Namgay Thinley	77226543	DSP	
9	Rinzin Chophel		DSP	
10	Ugyen Tshomo	17531008	DSP	
11	Bhim Bdr Limbu		DSP	
12	Lachi Maya Bista	77882010	DSP	
13	Tshewang Jamtsho	17274143	DSP	
14	Sonam Lhadon	17710225	DSP	
15	Kuenzang Choden	17870770	DSP	
16	Pema Dema	77459155	DSP	
17	Kuenzang Pema	17312342	DSP	
18	Phuntsho Wangmo	77975599	DSP	
19	Tshering Dendup		DSP	
20	Kuenzang Peldon	16910622	Punakha Dzongkhag	Lead Field officer
21	Tashi Dorji	17984674	ARDC Bajo	Resource person

Annexure 5. Farmers training on Soil nutrient management (11-17/8/2023)

SN	Name	Gender	CID No.	Dzongkhag	Gewog
1	Rinzin	M	11903000787	Dagana	Daga
2	Samdrup Wangchuk	M	11903000929	Dagana	Daga
3	Migmar	M	11903000748	Dagana	Daga
4	Tashi Dema	F	EA	Dagana	Daga
5	Pema Choden	F	10311001270	Dagana	Tsangkha
6	Pem Lham	F	10311001088	Dagana	Tsangkha
7	Dawa Dem	F	10311001302	Dagana	Tsangkha
8	Jit Bdr.Rai	M	10311000429	Dagana	Tsangkha
9	Harka Bdr. Neopaney	M	10311002413	Dagana	Tsangkha
10	Birkha Man Moktan	M	10311000097	Dagana	Tsangkha
11	Kiran Orari	M	10311002452	Dagana	Tsangkha
12	Lal Dorji Mongar	M	10311000253	Dagana	Tsangkha
13	Nilam Tamang	M	10311000572	Dagana	Tsangkha
14	Yam Bdr. Mongar	M	10311000011	Dagana	Tsangkha
15	Mon Kumar Jogi	M	10311003022	Dagana	Tsangkha
16	As Maya Tamang	F	10311000564	Dagana	Tsangkha
17	Budi Maya Tamang	F	10311000675	Dagana	Tsangkha
18	Lango Drukpa	M	10311000575	Dagana	Tsangkha
19	Jambay	M	10203002295	Dagana	Tsangkha
20	Damber Singh Rai	M	10306002397	Dagana	Khebisa
21	Dhan Bdr. Singer	M	10306001470	Dagana	Khebisa
22	Budhiman Tamang	M	10306001376	Dagana	Khebisa
23	Lhakpa Dorji	M	10306002618	Dagana	Khebisa

24	Bir Bdr Rai	M	10306001430	Dagana	Khebisa
25	Ram Bdr. Tamang	M	10306001380	Dagana	Khebisa
26	Lal Maya Singer	F	10306001441	Dagana	Khebisa
27	Suk Raj Rai	M	10306002444	Dagana	Khebisa
28	Chojay Wangdi	M	10112001370	Dagana	Khebisa
29	Kharka Bdr Basnet	M	10305002171	Dagana	Kana
30	Aita Singh Gurung	M	10305002262	Dagana	Kana
31	Laythro	M	10305002258	Dagana	Kana
32	Chokimo	F	10305002252	Dagana	Kana
33	Kharka Bdr Mishra	M	10305002456	Dagana	Kana
34	Karma	M	10305002349	Dagana	Kana
35	zeko Dem	F	10305002362	Dagana	Kana
36	Ganga Ram Chauwan	M		Dagana	Kana
37	Amber Bdr. Bhattarai	M	10303000995	Dagana	Kana
38	Tshering Wangchuk	M	EA	Dagana	Kana
39	Dawa Tshering	M	10304001832	Dagana	Gozhi
40	Ugyen Sonam	M	10304001660	Dagana	Gozhi
41	Mon Bdr Ghising	M	10304001671	Dagana	Gozhi
42	Karna Ghising	M	10304001674	Dagana	Gozhi
43	Suk Bdr Kalden	M	10304001708	Dagana	Gozhi
44	Sher Man Yonzan	M	10304002413	Dagana	Gozhi
45	Chatur Singh Thingh	M	10304002084	Dagana	Gozhi
46	Ratna Bdr Tamang	M	10304002364	Dagana	Gozhi
47	Pratap Singh Moktan	M	10304001129	Dagana	Gozhi
48	Makar Bdr Moktan	M	10304001978	Dagana	Gozhi
49	Pem Tshering Moktan	M	10304001610	Dagana	Gozhi
50	Som Bir Ghising	M	10304001662	Dagana	Gozhi
51	Lal Bdr Ghising	M	10304002192	Dagana	Gozhi
52	Shree Maya Thingh	F	10304000380	Dagana	Gozhi
53	Budhi Maya Moktan	F	10304001982	Dagana	Gozhi
54	Bishnu Maya Moktan	F	10304001052	Dagana	Gozhi
55	Ram Kumar Yonzan	M	10304002407	Dagana	Gozhi
56	Ganesh Lama	M	10304001707	Dagana	Gozhi
57	Dhan Singh Tamang	M	10304001825	Dagana	Gozhi
58	Chalips Tshering	M	10304001659	Dagana	Gozhi
59	Phurba Singh Tamang	M	10304001055	Dagana	Gozhi
60	Santa Maya Tamang	F	10304001709	Dagana	Gozhi
61	Lachu Man Waiba	M	10304001460	Dagana	Gozhi
62	Bik Bdr Thingh	M	10304001511	Dagana	Gozhi

63	Harka Bdr. Yonzan	M	10304002506	Dagana	Gozhi
64	Chabilal Yonzan	M	10304002408	Dagana	Gozhi
65	Puran Lama	M	10303001330	Dagana	Gozhi
66	Sanjit Kumar Pokhrel	M	10308003585	Dagana	Tashiding
67	Krishna Kumar Thingh	M	10308001394	Dagana	Tashiding
68	Chandra Bdr Darjee	M	10308001276	Dagana	Tashiding
69	Kaushila Bista	F	10308003618	Dagana	Tashiding
70	Tobden Dorji	M	10308001434	Dagana	Tashiding
71	Prem Dhan Limbu	M	11204000213	Dagana	Tashiding

Annexure 6. Skilling farmers on operation and maintenance of power sprayers, Gasa (6 to 8/11/2022)

SN	Name	Gender	CID #	Dzongkhag	Village	Gewog
1	Namgay Lham	F	10401000034	Gasa	Yemina	Khamoed
2	Dechen Lhamo	F	10401000499	Gasa	Yemina	Khamoed
3	Pema Dema	F	10401000038	Gasa	Yemina	Khamoed
4	Damcho Wangmo	F	10401000242	Gasa	Yemina	Khamoed
6	Kinzang Thinley	M	11004000459	Gasa	Yemina	Khamoed
7	Lhadon	F	10401000506	Gasa	Yemina	Khamoed
8	Tandin Pemo	F	10402000174	Gasa	Yemina	Khamoed
9	Sonam Wangchuk	M	10402000314	Gasa	Yemina	Khamoed
10	Sonam	M	10401000173	Gasa	Yemina	Khamoed
11	Kinzang Lham	F	10401000089	Gasa	Yemina	Khamoed
12	Kinley	M	10401000061	Gasa	Yemina	Khamoed
13	Karma Dema	F	10402000163	Gasa	Yemina	Khamoed
15	Sangay Wangmo	F	10401000319	Gasa	Yemina	Khamoed
16	Zangmo	F	10402000241	Gasa	Yemina	Khamoed
17	Damcho Thinley	F	10401000071	Gasa	Yemina	Khamoed
18	Kinley	F	10401000052	Gasa	Yemina	Khamoed
19	Dorji	M	10402000161	Gasa	Yemina	Khamoed
20	Phub Gyeltshen	M	10402000216	Gasa	Yemina	Khamoed
21	Gyelmo	F	10401000486	Gasa	Yemina	Khamoed
22	Damcho Dorji	M	10401000489	Gasa	Yemina	Khamoed
23	Chimi	F	10401000791	Gasa	Yemina	Khamoed
24	Damcho Tshering	M	10401000420	Gasa	Damji	Khamoed
25	Kinley Dorji	M	10401000177	Gasa	Damji	Khamoed
26	Karma	M	10401000168	Gasa	Damji	Khamoed
27	Gyelmo	F	10401000078	Gasa	Damji	Khamoed
28	Sangay Dem	F	10401000242	Gasa	Damji	Khamoed

29	Shanchum	F	10401000253	Gasa	Damji	Khamoed
30	Kinley Dorji	M	10401000172	Gasa	Damji	Khamoed
31	Kinley Penjor	M	10401000110	Gasa	Damji	Khamoed
32	Sangay Om	F	10401000655	Gasa	Jabesa	Khamoed
33	Karma Lhamo	F	10607001671	Gasa	Damji	Khamoed
34	Karma	M	10401000476	Gasa	Damji	Khamoed
35	Karma Cheki	F	10401000628	Gasa	Damji	Khamoed
36	Dorji Om	F	10402000356	Gasa	Jabesa	Khamoed
38	Lham	F	10401000102	Gasa	Jabesa	Khamoed
39	Pema Yangchen	F	10401000009	Gasa	Jabesa	Khamoed
40	Gemba	M	10401000286	Gasa	Jabesa	Khamoed
41	Shelka	F	10401000281	Gasa	Jabesa	Khamoed
42	Zangmo	F	10402000013	Gasa	Jabesa	Khamoed
43	Pemo	F	10401000014	Gasa	Jabesa	Khamoed
44	Sonam Lham	F	10401000243	Gasa	Dzomina	Khamoed
45	Shena	F	10401000224	Gasa	Dzomina	Khamoed
46	Wangchuk	M	10401003032	Gasa	Yemina	Khamoed
47	Kencho Zam	F	10401000527	Gasa	Dzomina	Khamoed
48	Passang	M	10401000541	Gasa	Dzomina	Khamoed
49	Pala	M	10401000287	Gasa	Jabesa	Khamoed
50	Thujimo	F	10401000146	Gasa	Damji	Khamoed
51	Kencho Zam	F	10401000146	Gasa	Damji	Khamoed
52	Kinley Pem	F	10401000184	Gasa	Damji	Khamoed
53	Pema	F	10401000151	Gasa	Damji	Khamoed
54	Dorji Wangmo	F	10401000151	Gasa	Damji	Khamoed
55	Damchen Wangmo	F	10401000380	Gasa	Damji	Khamoed
56	Passang	F	10401000136	Gasa	Damji	Khamoed
57	Zeko Dem	F	10401000530	Gasa	Dzomina	Khamoed
58	Kencho Lham	F	10401000096	Gasa	Damji	Khamoed
59	Tshering Lham	F	10401000307	Gasa	Jabesa	Khamoed
60	Tandin Gyem	F	10401000282	Gasa	Jabesa	Khamoed
61	Rinchen Dema	F	10401000775	Gasa	Jabesa	Khamoed
62	Kencho Om	F	10401000095	Gasa	Jabesa	Khamoed
63	Kinley Yuden	F	10401000539	Gasa	Dzomina	Khamoed
64	Samten Lham	F	10401000549	Gasa	Dzomina	Khamoed
65	Choden	F	10401000189	Gasa	Damji	Khamoed
66	Damcho Om	F	10402000197	Gasa	Khailo	Khamoed
67	Pem Zam	F	10401000358	Gasa	Khailo	Khamoed
68	Dawa Lham	F	10401000226	Gasa	Khailo	Khamoed

69	Pema	F	10401000387	Gasa	Khailo	Khamoed
70	Kencho Lham	F	10401000374	Gasa	Khailo	Khamoed
71	Lam Dorji	M	10402000191	Gasa	Khailo	Khamoed
72	Tshangyel	M	10401000206	Gasa	Khailo	Khamoed
73	Dechen	F	10402000184	Gasa	Khailo	Khamoed
74	Dawa Lham	F	10401000256	Gasa	Khailo	Khamoed
75	Pema Lham	F	10401000372	Gasa	Khailo	Khamoed
76	kencho Wangdi	M	10401000384	Gasa	Khailo	Khamoed

Annexure 7. Youth Skilling Program Modern Agriculture Farming – Hydroponic (8-28/8/2023)

SN	Name	Gender	CID No.	House No.	Dzongkhag	Gewog
1	Lachu Man Mongar	Male	11806002053	Ba-7-83	Tsirang	Mendrelgang
2	Tshering Dhendup	Male	11906000159	Ba-7-248	Tsirang	Mendrelgang
3	Sangay Needup Sherpa	Male	11809002209	Ba-7-210	Tsirang	Rangthaling
4	Dhan Maya Subba	Female	11809001821	Ba-2-316	Tsirang	Rangthaling
5	Phuntsho Namgay	Male	11808000392	Ba-9-245	Tsirang	Puentenchu
6	Bikash Mafchan	Male	11810000190	Ba-10-20	Tsirang	Shemjong
7	Tshering Dhendup	Male	10305001161	Ga-5-145	Dagana	Kana
8	Abi Narayan	Male	10309000934	Ga-8-373	Dagana	Tsendagang
9	Tandin Wangchuk	Male	10311001495	Ga-10-224	Dagana	Tsangkha
10	Passang Tamang	Male	11309000398	Ga-13-380	Dagana	Lhamoyzingkha
11	Bhagi Man Gurung	Male	10304000687	Ga-4-07	Dagana	Gozhi
12	Karma Cheki	Female	10401000628	Nga-4-81	Gasa	Khamoed
13	Sangay Choden	Female	10403000874	Nga-2-136	Gasa	Laya
14	Kencho Wangmo	Female	10401000095	Nga-4-19	Gasa	Khamoed
15	Namgay Zam	Female	11004000285	Tha-5-153	Punakha	Guma
16	Kinley Zangmo	Female	11005002381	Tha-5-153	Punakha	Guma
17	Tshering Dhendup	Male	11002000534		Punakha	Dzomi
18	Pema Wangda	Male	11004000866	Tha-10-nil/108	Punakha	Toedwang
19	Dorji Dhendup	Male	11508002882	Tha-	Punakha	Toepisa
20	Jigme Thinley	Male	10904003018	Tsha-4-29	Wangdue	Rubesa
21	Sonam Pelden	Female	11913001552	Tsha-13-134	Wangdue	Rubesa
22	Gyem Dorji	Male	11909000616	Tsha-9-17	Wangdue	Nahi
23	Phub Dorji	Male	11912002074	Tsha-12-334	Wangdue	Phobjikha
24	Ugyen Pemo	Female	10104000947		FMCL	Athang
25	Rinchen Sonam	Male	10904000565		FMCL	Athang
26	Karma Pelden	Male	10602001612		ARDSC	Menchhuna

Annexure 8. FSAPP Implementation of skilling and engagement programs in Climate Smart Technologies

SN	Name	Gender	CID #	House #	Dzongkhag	Gewog
1	Sangay Dorji	M	11304000271	Ga-12-179	Dagana	Karmaling
2	Purna Subba	M	11304000833	Ga-12-172	Dagana	Karmaling
3	Budhi Maya Limboo	F	11304002192	Ga-12-333	Dagana	Karmaling
4	Kelzang Dolma	F	11507002108	Ga-12-178	Dagana	Karmaling
5	Jamyang Dema	F	11304002278	Ga-12-	Dagana	Karmaling
6	Budhi Man Subba	M	11304000377	Ga-12-37	Dagana	Karmaling
7	Ash Bdr Subba	M	11304000523	Ga-12-04	Dagana	Karmaling
8	Nima	M	11304002274	Ga-12-176	Dagana	Karmaling
9	Man Bir Gurung	M	11304001766	Ga-12-119	Dagana	Karmaling
10	Mohan Gurung	M	11304001938	Ga-12-96	Dagana	Karmaling
11	Mon Bdr Pradhan	M	10313001128	Ga-12-91	Dagana	Karmaling
12	Pema Sherpa	M	11304000097	Ga-12-293	Dagana	Karmaling
13	Passang Wangdi	M	11304000071	Ga-12-138	Dagana	Karmaling
14	Bishnu Maya Moktan	F	10205004531	Ga-12-	Dagana	Karmaling
15	Rudra Bdr. Gurung	M	10304000003	Ga-12-296	Dagana	Karmaling
16	Tika Majhi	M	11304000156	Ga-12-212	Dagana	Karmaling
17	Peam Zangmo Sherpa	F	11304002094	Ga-12-198	Dagana	Karmaling
18	Devi Maya Gurung	F	11304000019	Ga-12-301	Dagana	Karmaling
19	Meena Kumari Gurung	F	11304002562	Ga-12-187	Dagana	Karmaling
20	Deki Maya Tamang	F	11304000953	Ga-12-237	Dagana	Karmaling
21	Purna Maya Gurung	F	10205005540	Ga-12-107	Dagana	Karmaling
22	Phurba Dendup Sherpa	M	11203002095	Ga-12-328	Dagana	Karmaling
23	Sancha Maya Ghishing	F	11304001454	Ga-12-174	Dagana	Karmaling
24	Pema Norbu Sherpa	M	11304001271	Ga-12-72	Dagana	Karmaling
25	Mon Bdr Gurung	M	10307000484	Ga-7-60	Dagana	Lajab
26	Gita Maya Gurung	F	10306002412	Ga-7-50	Dagana	Lajab
27	Kalu Maya Gurung	F	10307000419	Ga-7-52	Dagana	Lajab
28	Prakash Mongar	M	10307000812	Ga-7-111	Dagana	Lajab
29	Raju Gurung	M	10307001447	Ga-7-107	Dagana	Lajab
30	Birkha Bdr Gurung	M	10307000300		Dagana	Lajab
31	Bali Raj Gurung	M	10307000117	Ga-7-762	Dagana	Lajab
32	Nar Bdr Gurung	M	10307000220	Ga-7-31	Dagana	Lajab
33	Harka Bdr Gurung	M	10307000522	Ga-7-65	Dagana	Lajab
34	Dhan Bdr Gurung	M	10307000587	Ga-7-167	Dagana	Lajab
35	Nar Bdr Bhattarai	M	10302002737	Ga-7-150	Dagana	Lajab
36	Kana Bdr Gurung	M	10307000632	Ga-7-117	Dagana	Lajab
37	Karma Gyeltshen	M	11514004143	Ga-2-149	Dagana	Drujegang

38	Ram Bdr Tamang	M	10302003910	Ga-2-436	Dagana	Drujegang
39	Dhan Maya Jogi	F	10311002238	Ga-2-141	Dagana	Drujegang
40	Lia Bdr	M	10303000967	Ga-2-376	Dagana	Drujegang
41	Jit Bdr Bhattarai	M	10302002741	Ga-2-345	Dagana	Drujegang
42	Jiten Dema	F	11081001508	Ga-2-155	Dagana	Drujegang
43	Gyem Lhamo	F	10302000148	Ga-2-113	Dagana	Drujegang
44	Tshering Wangmo	F		Ga-2-372	Dagana	Drujegang
45	Tenzin Wangmo	F	10302000064	Ga-2-138	Dagana	Drujegang
46	Tshering Dema	F	10302001335	Ga-2-16	Dagana	Drujegang
47	Passang Om	F	10302001241	Ga-2-13	Dagana	Drujegang
48	Jigme Lhamo	F	10302001337	Ga-2-17	Dagana	Drujegang
49	Zam	F	10302001031	Ga-2-444	Dagana	Drujegang
50	Jiten Dorji	M	11201000983	Ga-2-200	Dagana	Drujegang
51	Sonam Zangmo	F	10302001150	Ga-2-104	Dagana	Drujegang

Annexure 9. FSAPP Youth skilling and engagement programs in Climate Smart Technologies (31/10/2022 to 10/11/2022, ARDC Bajo)

SN	Name	Gender	CID #	House #	Dzongkhag	Gewog
1	Samgan Sherpa	M	11304001087	Ga-8-100	Dagana	Samachu
2	Pema Rinzin Waiba	M	10304002487	Ga-3-353	Dagana	Tsandagang
3	Roshan Khatiwara	M	11310000652	Ga-8-nil44	Dagana	Lower Tsandagang
4	Tenzin Lhamo	F	10309002023	Ga-8-51	Dagana	Tsendagang
5	Bimal Subba	M	10309003749	Ga-8-417	Dagana	Samachu
6	Arjun Mongar	M	10311002437	Ga-10-26	Dagana	Goongpasumchu
7	Sonam Lham	F	10311001108	Ga-10-161	Dagana	Tsangkha
8	Karma Wangmo	F	10311001076	Ga-10-155	Dagana	Tsangkha
9	Nim Dem	F	10311001266	Ga-10-592	Dagana	Tsangkha
10	Tandin Wangchuk	M	13011001495	Ga-10-224	Dagana	Zinchila
11	Rajash Powrel	M	10305000648	Ga-5-34	Dagana	Delaythang
12	Lux Man Waiba	M	10305002767	Ga-10-97	Dagana	Pungshi
13	Bud Man Lepcha	M	10305002444	Ga-5-106	Dagana	Pungshi
14	Tak Bdr Gurung	M	31302000060	Ga-5-Nil/27	Dagana	Pungshi
15	Kinley Namgay	M	10305003134	Ga-5-137	Dagana	Delaythang
16	Dawa Penjor	M	10305001579	Ga-5-nil30	Dagana	Delaythang
17	Mon Bdr Bhattarai	M	10304000315	Ga-4-65	Dagana	Balleygang
18	Kesar Bdr Subedi	M	10304000742	Ga-4-12	Dagana	Dogak
19	Tak Bdr Gurung	M	10304000904	Ga-4-26	Dagana	Dogak
20	Arjun Chuwan	M	10314002849	Ga-4-21	Dagana	Dogak
21	Chungku	F	12004004944	Ga-4-54	Dagana	Dogak
22	Dawa Lhakpa Waiba	Male	10304002491	Ga-4-214	Dagana	Upper Goshi

23	Passang Sherpa	Male	10304003557	Ga-4-186	Dagana	Upper Goshi
24	Prem Bdr Bhattrai	Male	10304000323	Ga-4-67	Dagana	Balleygang
25	Leki Drakten	Male	10304000941	Ga-4-280	Dagana	Dogak
26	Dawa Tshering	Male	10304000866	Ga-4-166	Dagana	Middle Goshi
27	Naresh Gurung	Male	10304001302	Ga-4-356	Dagana	Lower Goshi
28	Mon Bdr Shingdhan	Male	10305000483	Ga-5-18	Dagana	Lhaling-Nindukha
29	Phual Maya Katwal	Female	10305000728	Ga-5-230	Dagana	Lhaling-Nindukha
30	Subash Chandra Mongar	Male	10303000616	Ga-5-409	Dagana	Batsha
31	Budha Bir Subba	Male	0011579(RP)	Ga-3-96	Dagana	Batsha
32	Chimi Dema	Female	10311001065	Ga-10-153	Dagana	Tsangkha
33	Pemba Lhamo	Female	11302002301	Ga-10-159	Dagana	Tsangkha
34	Dawa Dem	Female	10311001302	Ga-10-337	Dagana	Tsangkha
35	Namgay Dorji	Male	10606000628	Ga-10-150	Dagana	Tsangkha
36	Moni Kumar Darjee	Male	10311001894	Ga-10-72	Dagana	Petaykha
37	Semon Kumar Darjee	Male	10308000737	Ga-9-102	Dagana	Tashiding
38	Bir Bdr Rai	Male	10306001435	Ga-6-144	Dagana	Pogto

Annexure 10. Black Pepper distribution list, Karmaling gewog FY 2022-23

SN	Name	Chiwog	CID Number	HH #	No. of seedling
1	San Bdr. Tamang	Karmaling	11304000103	Ga-12-237	100
2	Binu Gurung	Karmaling	11304001663	Ga-12-107	50
3	Sancha Maya Geshing	Karmaling	11304001454	Ga-12-ni131	100
4	Passang Wangmo Sherpa	Karmaling	11304001695	Ga-12-112	100
5	Birkha Bdr. Gurung	Karmaling	11304001743	Ga-12-117	50
6	Pema Tara Sherpa	Karmaling	11304001601	Ga-12-102	30
7	Thak Bdr. Gurung	Karmaling	11304001916	Ga-12-187	50
8	Bhim Bdr. Basnath	Karmaling	11304001672	Ga-12-109	30
9	Nim Tempa	Karmaling	11304001600	Ga-12-205	50
10	Datti Maya Chettri	Karmaling	11304002141	Ga-12-297	20
11	Nima Wangdi Sherpa	Karmaling		Ga-12-300	20
12	Dilli Ram Basnath	Karmaling	11304002096	Ga-12-3-30	30
13	Narath Chettri	Karmaling	11304001682	Ga-12-110	50
14	Bal Bir Thapa	Karmaling	10304002694	Ga-12-nil 65	50
15	Kumar Sherpa	Karmaling	10312000410	Ga-12-236	30
16	Nar Bdr. Gurung	Karmaling	11304002079	Ga-12-306	5
17	Dilli Ram Gurung	Karmaling	11304001835	Ga-12-293	30
18	Phurba Rinzin Sherpa	Karmaling	11304002019	Ga-12-298	20
19	Som Yang Sherpa	Karmaling	11304001614	Ga-12-198	100
20	Dawa Namgay Sherpa	Karmaling	11304002063	Ga-12-245	30
21	Dawa Tenzin Sherp	Karmaling	11304002062	Ga-12-329	20
22	Dawa Tshering Sha	Karmaling	11304001810	Ga-12-125	30
23	Prem Maya Waiba	Karmaling	10312000563	Ga-12-337	50
24	Devi Gurung	Karmaling	11304001837	Ga-12-170	10
25	Kiran Gurung	Karmaling	11304002037	Ga-12-301	50
26	Man Bir Gurung	Karmaling	11304001766	Ga-12-119	30

27	Dilli Ram Pradhan	Karmaling	11309001384	Ga-12-264	50
28	Thir Bdr. Gurung	Karmaling	11304001934	Ga-12-89	50
29	Mon Bdr. Pradhan	Karmaling	10313001128	Ga-12-91	50
30	Lhakpa Sherpa	Karmaling	11304001267	Ga-12-Ni117	20
31	Dhan Kumari Sherpa	Karmaling	11304001645	Ga-12-106	20
32	Suk Bir Rai	Karmaling	11304001823	Ga-12-199	30
33	Purni Maya i	Karmaling	11030100175	Ga-12-327	10
34	Ti Bdr Sherpa	Karmaling	11304001690	Ga-12-111	100
35	Phur Tenzin Sherpa	Karmaling	11304001901	Ga-12-185	30
36	Phurba Dendup	Karmaling	11304002095	Ga-12-310	30
37	Pasang Sherpa	Karmaling	11304002061	Ga-12-51	30
38	Durga Maya Gurung	Karmaling	11304001845	Ga-12-88	30
39	Dil Bdr.Subba	Labtshakha	11304000626	Ga-12-14	30
40	Tanka Bdr. Limboo	Labtshakha	11304000497	Ga-12-01	30
41	Harka Dhoj Subba	Labtshakha	11304000556	Ga-12-08	30
42	Sancha Bir Subba	Labtshakha	11304000540	Ga-12-06	30
43	Buhda Raj Subba	Labtshakha	11304000340	Ga-12-626	30
44	Bagi Maya Subba	Labtshakha	11304000601	Ga-12-12	30
45	Sam Kumar Subba	Labtshakha	21304000045	Ga-12-19	30
46	Sancha Raj Subba	Labtshakha	11304000608	Ga-12-13	30
47	Purna Bdr. Subba	Labtshakha	11304000660	Ga	30
48	Jash Raj Subba	Labtshakha	11304000710	ni1150	30
49	Dhan Bdr. Subba	Labtshakha	11031200044	Ga-12-16	30
50	Chobilal Subba	Labtshakha	11304000744	Ga-12-nilO	30
51	Ganga Maya Rai	Labtshakha	10303000719	Ga-12-154	30
52	Jith Bdr. Subba	Labtshakha	11304000112	Ga-12-175	30
53	Aita Singh Subba	Labtshakha	11304000753	Ga-12-ni102	30
54	Rathna Bdr. Subba	Labtshakha	11304000708	Ga-12-21	30
55	Bom Bdr. Subba	Labtshakha	11304000532	Ga-12-05	30
56	Krishna Bdr. Gurung	Labtshakha	10312000508	Ga-12-ni108	30
57	K.B Gurung	Labtshakha	11304000763	Ga-12-ni105	30
58	Sancha Kumar Gurung	Labtshakha	11304000678	Ga-12-18	30
59	Tek Bdr. Rai	Labtshakha	11304000509	Ga-12-03	30
60	Dambar Singh Rai	Labtshakha	11304000564	Ga-12-09	30
61	Durga Man Rai	Labtshakha	11304000510	Ga-12-165	30
62	Nirpa Raj Gurung	Labtshakha	11304000726	Ga-12-23	30
63	Dil Br. Gurung	Labtshakha	11304000768	Ga-12-ni107	30
Total					**2335**

CENTRE AT A GLANCE

The Centre was founded as Agricultural Demonstration Station in 1965. In 1982 it was re-established as the Centre for Agricultural Research and Development (CARD) basically to undertake research in rice and rice-based crops. Research and farming systems was also started in the late 1980s. In 1994, the Centre was renamed as RNR Research Centre to incorporate research in livestock and forest that are inseparable components of Bhutanese farming systems. Subsequent to realignment exercise by the Ministry of Agriculture and Forest to enhance the efficiency of the service delivery to farmers, development mandate was added to Research Centres in July 2008. Following the organizational development exercise undertaken by RCSC in 2016 the Research Centres is now renamed as Agriculture Research and Development Centre (ARDC).

The Centre is located at Bajo (1100masl) in Wangdue Phodrang which is 70km west of the capital city Thimphu.

At the national level ARDC Bajo is mandated to coordinate field crops research and citrus program, while at the regional level it undertakes relevant research and development for West-Central Region (Gasa, Punakha, Dagana, Tsirang and Wangdue. Phodrang). The Centre has 50.90 acres of research farm, furnished office space, modest laboratory and library facilities.

Sub-centre at Mithun, Tsirang was opened in 2006 to cater to the humid sub-tropical Dzongkhags of Tsirang and Dagana. It has about 36 acres of research area, office space and the National Citrus Repository is being developed**.** The Centre also cater the Chimipang Royal Project, Chimipang which was established in 2014 on Royal Command to demonstrate agricultural technologies and training of extension personnel and farmers.

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