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Bajo, Wangduephodrang
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ROYAL GOVERNMENT OF BHUTAN

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FOREWORD

It is an immense pleasure to publish the 38th Annual Technical Report of Agriculture Research and Development Centre (ARDC) Bajo, coinciding with for the financial year (FY) 2023-24 This report synthesizes the research and development activities conducted in the areas of field crops, horticulture, technical support services, and project-supported initiatives by the Centre and its Sub-Centre at Menchhuna, Tsirang in the last financial year (FY) 2023-24.

ARDC-Bajo implements activities focused on its national mandate for coordinating field crops research and development, a regional mandate for horticulture research and development, and specific commodity mandates for rice, wheat, and citrus. These activities are carried out in close collaboration and consultation with the Ministry of Agriculture and Livestock, the Department of Agriculture and its central agencies, projects, local government agencies, and, most importantly, the farmers and other beneficiaries.

The Centre initiated and implemented numerous activities, including Rice Varietal Evaluations, Evolutionary Plant Breeding, Legume Crop Evaluations, and the establishment of horticulture germplasm blocks. It also established an Irwin mango evaluation trial and conducted various vegetable evaluation trials. During this FY, the Centre tested and promoted durum wheat through the Seed Without Borders Program. The Centre successfully implemented the Million-Fruit Tree Program (MFTP). As of June 30, 2024, the National Citrus Repository (NCR) collected 120 citrus germplasm cultivars through budwood and seed. Additionally, the Centre supported farmers by providing improved seeds and seedlings and by developing the capacity of farmers and extension workers in new innovations and climate-resilient technologies.

ARDC-Bajo successfully completed all planned activities for the financial year 2023-24, as outlined in the Annual Work Plan and 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 and ARDSC-Menchhuna. Their significant efforts contributed to 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 Centre's achievements in 2023-24. I would like to request all seniors, colleagues, supporters, and stakeholders to continue providing their full cooperation, support, and best wishes for our future endeavours.

This report is intended not only to serve as an account of activities implemented over the past year but also as a technical reference and guideline for all stakeholders involved in agricultural research and rural development. It aims to contribute to achieving national food and nutrition self-sufficiency, economic self-reliance, and ultimately, the overarching national goal of Gross National Happiness in Bhutan.

Tashi Delek!

Passang Tshering
Program Director

GLOSSARY OF ACRONYMS

AET	Advance Evaluation Trial
AFACI	Asian Food and Agriculture Cooperation Initiative
ARCM	Agriculture Research Coordination Meeting
ARDC	Agriculture Research and Development Centre
ARDSC	Agriculture Research and Development Sub-Centre
BAMS	Bhutan Agri-microbial Solution
BFDA	Bhutan Agricultural and Food Regulatory Authority
CIMMYT	International Center for Wheat and Maize
CRP	Chimipang Royal Project
CV	Coefficient of variation
DoA	Department of Agriculture
EPB	Evolutionary Plant Breeding
ESP	Elementary Service Personnel
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
GSP	General Service Personnel
HLB	Huanglongbing
HYV	High Yielding Varieties
IET	Initial Evaluation Trial
IPM	Integrated Pest Management
IWP	Individual Work Plan
LSD	Least Significant Difference
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
NFT	Nutrient Film Technique
NPK	Nitrogen Phosphorus Potassium
NPPC	National Plant Protection Centre
NSC	National Seed Centre
NSSC	National Soil Services Centre
ORP	Outreach Programme
PST	Project Support Team
RCBD	Randomized Complete Block Design
RDTC	Rural Development Training Centre
RNR	Renewable Natural Resources
TSS	Total Soluble Sugar
VRC	Variety Release Committee
VET	Varietal Evaluation Trial

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FIELD CROP RESEARCH AND DEVELOPMENT PROGRAM

1. Rice Research and Development Program

1.1. Performance evaluation of Nepal rice varieties

Eight varieties of Nepal rice namely, IR98846-20/-4-3, NR2169-10-4-1-1-1-1-1, IR14L362, Sukha Dhan 5, Sukha Dhan 4, Sukha Dhan 3, Hardinath1, and Hardinath 3 were assessed to evaluate their performance and identify the most suitable variety under Bhutanese conditions. Days to physiological maturity, ranged from 140 to 150 days among the accessions. Sukha Dhan 4 demonstrated highest yield at 3362 kg/acre, followed by Sukha dhan 5 at 2830.44 kg/acre. PR1256 exhibited the lowest yield at 497 kg /acre as shown in the table 1.

Table 1: Agronomic performance of Nepal Lines

Variety	No. Tillers/hill	Plant height(cm)	Panicle length (cm)	Maturity days	Presence of Awn	Yield kg/acre
Sukha Dhan 3	13.20	90.50	23.90	140.00	No	2079.00
Sukha Dhan 4	15.60	95.00	22.30	150.00	No	3362.00
Sukha Dhan 5	18.50	102.00	21.70	143.00	No	2830.44
Hardinath 1	15.90	89.50	23.19	1480.00	No	2242.77
Hardinath 3	16.80	94.90	22.90	142.00	No	2421.55
IR98846-2-1-4-3	16.90	94.00	23.40	148.00	No	2145.86
IR14L362	14.90	93.00	20.60	140.00	No	1872.40
PR 126	12.50	90.00	22.50	143.00	No	497.00
NR2169-10-4-1-1-1-1-1	10.80	101.00	21.70	146.00	No	2140.00

1.2. Demonstration of released rice varieties

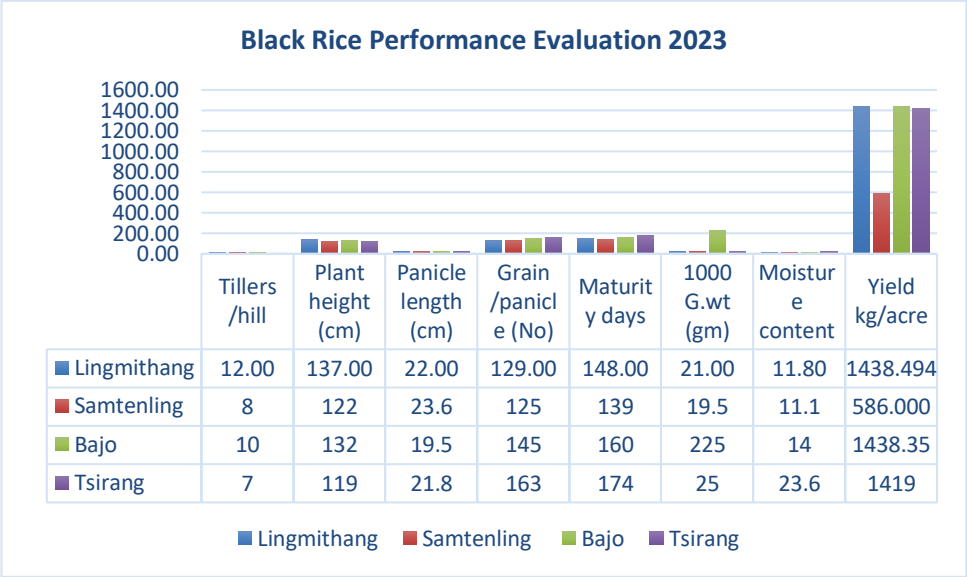
The Centre receives different groups of visitors with different learning objectives. Farmers showed interest in seeing new crop varieties that yield high; extension personnel were keen on new technologies; and trainees, guests and visitors had specific objectives to visit the Centre. In general, many 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 eight 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 2:Yields of released rice varieties at demonstration plots

Designation	Plant height (cm)	Tillers/hill	Maturity days	Grain yield (kg/ac)
Bajo Kaap1	105	13	145	2350
Bajo Kaap 2	110	6	150	2320
IR 20913	120	14	125	1510
Bajo Maap 2	110	13	153	1982
IR 64	108	21	143	1990
Bajo Maap 1	115	16	140	1598
Black rice (local)	130	10	160	989
Vietnam rice	125	11	160	898
Bajo Kaap 3	110	13	155	2360

1.3. Black Rice Performance Evaluation

The multi-location evaluation of black rice was conducted at four locations: ARDC Bajo, Samtenling, ARDSC Lingmithang, and Tsirang, using single plots. The data reveals variations in agronomic traits, including tillers per hill, plant height, panicle length, grain count per panicle, maturity days, 1000 grain weight, moisture content, and yield. Yields are highest in Lingmithang and Bajo (around 1438 kg/acre), slightly lower in Tsirang (1419 kg/acre), and significantly lower in Samtenling (586 kg/acre). These differences highlight the varying performance and adaptability of black rice across different local conditions.



	Tillers /hill	Plant height (cm)	Panicle length (cm)	Grain /panicle (No)	Maturity days	1000 G.wt (gm)	Moisture content	Yield kg/acre
Lingmithang	12.00	137.00	22.00	129.00	148.00	21.00	11.80	1438.494
Samtenling	8	122	23.6	125	139	19.5	11.1	586.000
Bajo	10	132	19.5	145	160	225	14	1438.35
Tsirang	7	119	21.8	163	174	25	23.6	1419

Figure 1: Black Rice Performance 2023 at different locations

1.4. Evolutionary Plant Breeding at ARDC Bajo

The Research Centre, in collaboration with the National Biodiversity Centre (NBC) and the Dzongkhag Agriculture Sector, has been conducting "Participatory Technical Assessment of Evolutionary Plant Breeding (EPB)" trials on mid-altitude rice in Punakha and Tsirang. These trials, introduced in Bhutan for the first time through the EPB project, are funded by the 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.

The EPB trials in Bhutan have been initiated on rice and beans, with ongoing trials in Punakha and Tsirang representing mid-altitude rice-growing areas. Evolutionary populations for these crops were prepared by mixing the most popular traditional and improved varieties collected and contributed by farmers and ARDCs from specific locations.

The primary objective of these trials is to identify a new variety from the EPB population and develop evolutionary populations that are climate-resilient and adaptive to specific regions. Evolutionary Plant Breeding is based on the concept of natural selection, where crop populations with a high level of genetic diversity are subjected to natural selection forces. Through cycles of sowing and re-sowing seeds, plants favoured under prevailing growing conditions contribute more seeds to the next generation, resulting in evolving crop populations that can adapt to their growing conditions. EPB involves mixing as many different types of a particular crop as possible and allowing them to cross freely with each other. The different rice varieties include IR64, BM1,

Dawa (Local), Nabja (local), Tan Tshering (local), Bonday and a of mixture having six traditional varieties namely IR64, BM1, Dawa (Local), Nabja (local), Tan Tshering (local), Bonday. The trial is aimed at producing a rice variety that is adapted to a particular microclimate and resilient to the changing climate and agrarian practices.

Table 3:ANOVA for yields of Evolutionary Plant Breeding trial

Source		DF	SS	MS	F-value	P
Replication		2	1237600	618800		
Treatment		6	1027737	171290	1.16	0.3896
Error		12	1777977	148165		
Total		20	4043313			
	CV (%) = 20.94		Mean = 1838.3 Kg/acre			

1.5. Evolutionary Plant Breeding Trial ARDSC

In the quest of sustainable agriculture practices, Evolutionary Plant Breeding has emerged as a promising avenue in many developed countries, offering solutions tailored to the dynamic challenges faced by farmers. Amidst the backdrop of climate change and evolving pest and diseases pressure, traditional breeding techniques often struggle for further improvement. In response, strategies like Evolutionary Plant Breeding tactics have gained traction, offering a bridge between scientific innovation and practical implementation.

Accordingly, Evolutionary Plant Breeding activities on paddy were conducted in the farmer's field since 2019 for the duration of five years, as a part of the Evolutionary Plant Breeding Project in collaborative with National Biodiversity Centre, Serbithang, Thimphu. The main objectives of the trial is to develop rice varieties that are well adapted to their specific growing condition and can thrive in diverse environment with minimal human intervention. This approach aims to harness the natural process of plant breeding and selection to create resilience, high-yielding and sustainable rice cultivars that can withstand various biotic and a biotic stress such as pest, diseases, drought and soil condition.

Ultimately the goal is to enhance food security and agriculture sustainability in rice production area by leveraging the inherent genetic diversity of the crop and allowing it to evolve over time to ensure sustainable quality seed supply in the community. However, in the course of earlier trial nothing much evolution was happened and couldn't get the concrete result, owing to limitation in project tenure. Actually, it needs to be continued for at least few more years in order to obtain precise outcome. In regard to this the Program Director of Agriculture Research Development Center has instructed to continue the evolutionary plant breeding trial in our on-station for another two years to acquire reliable outcome.

Consequently, with the available sample seeds of project areas, consisting six varieties including mixture seed (Attey, Chottey, Gaurey Masino,Wangkhar Ray kaap-2,IR-64 and mixture) the trial was continued in our station in a large single block design, maintaining the same plant to plant and row to row distances emphasizing more for mixture. In addition, mixture seed was tested at different agro-ecological zone in the farmer's field as some on-farm activities, usually to observe its performances and ultimately to perceive farmer's preference for the evolving variety.

On farm trial with EPB materials of mixture was established at Patala of Drujigang to represent the higher altitude, Barshong and Mendrelgang for mid altitude and Sunkosh village for lower

elevation. The detail agronomic traits were collected as per the data recording sheet provided by the project counterpart. The results are detailed in table number 4 and 5.

Table 4: On-station EPB yields assessment result

Treatment	Tillers Numbers /hill	Plant Height (cm)	Blast Score (1-9)	1000 g.w (gm)	Panicle length (cm)	Mc %	YLD (kg $6m^{2)}$	YLD (kg/acre)
Attey	12	97.8	2	21	21.5	29.4	2.425	1343
Chottey Masino	10	105	2	16	23.6	29	2.03	1130
Gawri Masino	10	103	3	14	22.5	21.6	1.7	1033
WRK-II	13	97	1	22	23.8	24.8	2.795	1648
IR-64	12	92	1	22	22	23	2.005	1211
Mixture	11	103	2	20	22.4	26.1	2.1	1217

Table 5: On-farm EPB yields assessment result

Varieties	Tillers No. /hills	Plant Height	Blast Score	No of grain/ panicle	Panicle length (cm)	Mc %	YLD ($kg/4m^{2)}$	YLD (kg/acre)
Chotey(EPB)	10	121	2	156	24.2	23	1.9	1721
EPB mixture	8	102.6	2	132	21.2	22.7	1.2	1091
EPB mixture	7	121	2	113	22.4	28.5	1.24	1043
EPB mixture	9	146	2	126	24.2	24	1.5	1341
EPB mixture	8	118	2	122	22.3	27.3	1.24	1061
Chotey(EPB)	8	117	2	142	23.7	25.2	1.22	1074

The evolved variety (Mixture seed) was observed with better performance only in the early crop stages with vigorous vegetative growth and without much sign and symptoms of pest and diseases. However, as the crop progressed, massive logging issues emerged, negatively impacting grain development resulting chaffy grains formation and deteriorating the rice quality as well as productivity. Water management seems very crucial for the evolved varieties.

1.6. Rice seed production and maintenance of varieties

The Centre produce and maintain paddy seeds of promising varieties every year basically to maintain the seed for research and meet unforeseen requirements and support the Dzongkhags. The seeds are from demonstration and trial borders.

Table 6: Paddy seed produced from released and potential varieties FY 2023-24

SN	Variety	Qty (kg)	Centre	Remarks
1	IR 64	900.00	ARDC Bajo	Released variety
2	IR20913	150.00	ARDC Bajo	Released variety
3	Bajo Kaap 1	720.00	ARDC Bajo	Released variety
4	Bajo Kaap2	550.00	ARDC Bajo	Released variety
5	Bajo Maap 1	340.00	ARDC Bajo	Released variety
6	Bajo Maap 2	580.00	ARDC Bajo	Released variety
7	Bajo Maap 3	700.00	ARDC Bajo	Released variety
13	Mixture	420.00	ARDC Bajo	
	Total	**4360.00**		

1.7. Promotion of improved high-yielding rice seeds

Rice has been an indispensable commodity to the Bhutanese food system and livelihood. The entire Bhutanese population depends on rice either as producers or consumers. Rice is the most preferred staple food of all the Bhutanese with an estimated per capita consumption of 144 Kg for 2022. From the standard dietary requirement of 2100 Kcal, 1470 Kcal (70%) accounts for carbohydrates. Therefore, despite formidable challenges to rice farming, it will continue to remain crucial to the Bhutanese food system, tradition, culture, and livelihood. In the common Bhutanese diet, 80% of 1470 Kcal is estimated to be met from rice while the rest is accounted to other sources of carbohydrates. This exemplifies the role of rice in the Bhutanese food system. The Centre has supported 1275 kg of rice seed to the rice-growing farmers. The support was through procurement of improved high-yielding rice seeds and from the stock maintained at the Centre.

Table 7: Promotion of rice seeds 2023-2024

Dzongkhag	Gewog	No. of HHs	Qty (kg)	Area (ac)	Rice Varieties
Tsirang	Sergithang	13	660.00	26.40	Khamtay
Wangdue	Adthang	21	615.00	24.60	Bajo Kaap 3
Total		**34**	**1275.00**	**51.0 0**	

2. Legume (soya bean and ground nut) Research

Soya bean and groundnut are the two leguminous crops evaluated at the Agricultural Research and Development Centre Bajo (ARDC). The performance assessment of different varieties was conducted during the 2023-2024.

2.1. Evaluation of Soya Varieties in a Randomized Complete Block Design (RCBD)

Objective: The objective of this experiment is to evaluate the performance of three soya varieties (Japanese large, Japanese small and Local) in terms of growth and yield characteristics.
Experimental Design: The experiment is laid out in a Randomized Complete Block Design (RCBD) with three replications.

Table 8: ANOVA for yields of soyabean trial

Source	DF	SS	MS	F-value	P
Replication	2	129415	64707		
Treatment	2	3113687	1556844	18.92	0.0091
Error	4	329221	82305		
Total	8	3572323			
CV (%) = 32.31%		Mean yield = 887.87 kg/ac			

The ANOVA results indicate a significant effect of the treatment on yield, with an F-value of 18.92 and a p-value of 0.0091 ($p < 0.05$). This suggests that the differences observed between treatment groups are statistically significant. The coefficient of variation (CV) is 32.31%, and the mean yield is 887.87 kg/ac.

Table 9: Least Significant Difference (LSD) Test summary

Treatment	Days to 50% Germination	Days to 50% flowering	Plant height at maturity (cm)	Days to maturity (No)	Pod yield/ plot (Kg)	Yield/ acre
Japanese Large	21[a]	71[a]	164[a]	27.40[b]	1.60[b]	323.70[b]
Japanese Small	14[b]	62.67[b]	96.33[b]	14.10[c]	3.17[b]	640.60[b]
Local	15[ab]	70.33[a]	170[a]	49.20[a]	8.40[a]	1699.60[a]
CV (%)	18.33	4.25	2.43	18.01	32.31	32.31

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

Table 10: Proximate analysis of soya

Samples ID	**Ash (%)**	**Protein (%)**	**Moisture (%)**	**Fat (%)**	**Carb (%)**
Japanese small	5	34.72	10.9	2	47.38
Japanese large	5	33.67	10.5	2	48.83
Khangma labi I	4.66	35.33	11.9	15	33.11

The table 10 presents the proximate analysis results for three peanut samples identified as Japanese small, Japanese large, and Khangma labi I. The analysis includes measurements of ash, protein, moisture, fat, and carbohydrate content. Both Japanese small and Japanese large samples have similar ash (5%) and fat (2%) content, with protein content slightly higher in the Japanese small (34.72%) compared to Japanese large (33.67%). The Khangma labi I sample shows a lower ash content (4.66%) but significantly higher fat content (15%) and protein content (35.33%) compared to the Japanese samples. The moisture and carbohydrate contents vary among the samples, with Khangma labi I having the highest moisture (11.9%) and lowest carbohydrate (33.11%) content.

2.2. Evaluation of Peanut Varieties

Objective: The objective of this experiment is to evaluate the performance of three peanut varieties (Japanese large, Japanese small, and Bartsham (local)) in terms of growth and yield characteristics. Experimental Design: The experiment is laid out in a Randomized Complete Block Design (RCBD) with three replications.

Table 11:Agronomic performance of peanut varieties

Treatment	**Days to 50% Germination**	**Days to 50% flowering**	**Plant height at maturity (cm)**	**Pod yield/ plot (Kg)**	**Yield/acre (Kg)**
Japanese Large	35.00	75.67	25.60	1.40	566.44
Japanese Small	37.00	74.00	23.41	2.50	1011.50
Bartsham	37.67	72.33	26.10	1.80	728.28

Table 12: Proximate analysis of peanut varieties

Samples ID	**Ash (%)**	**Protein (%)**	**Moisture (%)**	**Fat (%)**	**Carb (%)**
Japanese large	2.33	25.31	7.40	32.00	32.96
Japanese small	2.33	24.98	6.20	41.50	24.99
Bartsam	2.33	23.78	6.30	4.00	63.59

The table 12 presents the proximate analysis results for three different samples: Japanese large, Japanese small, and Bartsam. The ash content is consistent across all samples at 2.33%. The protein content ranges from 23.78% to 25.31%, with the Japanese large sample having the highest protein percentage. Moisture content is relatively low, between 6.2% and 7.4%. Fat content varies significantly, with the Japanese small peanuts containing the highest fat percentage at 41.5%, while the Bartsam sample has only 4%. Carbohydrate content is highest in the Bartsam sample at 63.59%, and lowest in the Japanese small sample at 24.99%.

3. Wheat Research and Development Program

3.1. Introduction, observation and selection of 54th International Durum Wheat Yield Nursery (IDYN), 14th Elite Zinc Advanced Nursery (HZAN) and 30th Semi-arid Wheat Yield Trial (SAWYT)

In the FY 2023-2024 wheat seasons, Agriculture Research and Development Center (ARDC), Bajo, received three sets of breeding lines with trial IDs 35721, 49395, and 49368 from CIMMYT Mexico. These sets consisted of 50 durum wheat nursery lines, 234 Elite Zinc Advance nursery, and 50 semi-arid wheat lines. Among these, 16 durum wheat lines, 17 lines from the biofortified wheat trial, and 20 lines from the semi-arid wheat trial were selected for further evaluation.

The sowing of these lines took place in December 2023, alongside the local check variety, bumthangkaadrukchu. The establishment of the nursery followed the prescribed protocol and trial design provided by CIMMYT Mexico. The selection of breeding lines was primarily based on grain yield, along with considerations for plot uniformity, lodging incidence, agronomic score, and spike observation.

These chosen lines will undergo further evaluation in an initial evaluation trial (IET) during the 2024-2025 seasons to determine their performance.

3.2. Introduction and evaluation of Durum Wheat Semolina and progress

Overview and seed sourcing and distribution

During the FY 2023-2024, significant strides were made to address the absence of durum wheat varieties in our domestic agricultural landscape. At the request of the CEO of Gen-sum Pasta in Genekha, Thimphu, Agriculture Research and Development Centre (ARDC), Bajo proactively sourced high-quality durum wheat seeds from India through cross-border seed agreements. This initiative underscores our commitment to creating opportunities for Bhutanese farmers and positioning durum wheat as a potentially lucrative field crop. Our primary objective was to evaluate the performance of durum wheat semolina within Bhutan's unique agro-ecosystem, highlighting our dedication to agricultural innovation and sustainable economic growth.

ARDC, Bajo imported durum wheat semolina twice from India via the National Seed Centre (NSC) in Paro. The initial procurement was 1,675 kgs. Then conducted milling and processing operations in collaboration with Agriculture Machinery and Training Centre (AMTC) Paro and Gen-sum Pasta to determine if the imported durum seeds could be processed into pasta, as required by Gen-sum Pasta. After thorough testing, a second order was placed for 6,000 kgs from NSC. Paro.

The second import of 6000kg was intended for widespread distribution to assess the feasibility and performance of durum wheat across various regions and altitudes. This initiative aimed to collect

substantial data on its adaptability during the first year. Seeds were allocated to the following entities for research (both on-station and on-farm) and some for commercial purposes.

This strategic distribution was designed to ensure a comprehensive evaluation and maximize the potential for successful integration of durum wheat into Bhutan's agricultural landscape. In total, 7,175 kg were distributed, with a portion retained for trial and seed production at the Centre and an additional 300 kgs reserved for the next season in the cold chamber at ARDC, Bajo. The table13 display the seed distribution to farmers and individual entities.

Table 13: Trial Location and Seed Distribution in FY 2023-24

SN	Dzongkhag	On-station	On-Farm trial	Seed distribution (kg)
1	Thimphu		Geney Gewog (68 HHs)	1895
2	Sarpang	ARDC Samteyling, ARDSC Pangpang	Samteyling gewog	500
3	Mongar	ARDC Wengkhar	Mongar & Trashigang	1080
4	Thimphu	NCOA, Yusipang	Paro	500
5	Tsirang	ARDSC Menchhuna	Tsirang and Dagana	560
6	Punakha		CRP	120
7	Wangdue	NSC Bajo		120
8			FMCL, Dechenphu farm	920
9	Punakha		Barp gewog Private farm	400
10	Lhuntse	Minjey	Minjey	80
11	Wangdue		All gewogs	1000
Total				**7175**

Durum Wheat Introductory Trials and Evaluation

An introductory trial was launched in the 2023-2024 wheat seasons at regional research stations (ARDC-Bajo, ARDC-Wengkhar, ARDC-Samtenling, and NCOA-Yusipang) and in farmers' fields to evaluate the performance of durum wheat across different agro-ecological zones. The results of the trial carried out at ARDCs; Bajo, Wengkhar, Samtenling, & NCOA-Yusipang and ARDSCs; Menchunna, Khangma, & Pangbang from the initial assessment are provided in the table (14 to 20).

Table 14: Agronomic traits of yield analysis of Durum wheat at ARDC, Bajo

Treatments	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 $6m^2$ (kg)	Agronomic score (5=best)
12/01/2023	75	85	73	7	14	152	52	1.2	2
12/06/2023	79	89	68	6	12	151	51	1.1	2
12/11/2023	76	86	66	7	12	148	53	1.07	2
12/16/2023	80	90	64	7	14	149	51	1.07	2
12/21/2023	82	90	63	7	13	145	52	1.1	2

Table 15: Agronomic traits of yield analysis of Durum wheat at ARDSC, Menchunna

Treatments	Days to 50% to Heading	Days to 50% to Flowering	Plant Height (cm)	Spike Length (cm)	No. of Spikelet	Days to Maturity	1000 Grain (gm)	Yield/plot 6m^2 (kg)	Agronomic score (5=best)
10/17/2023	95	110	75	8.6	13	173	61	0.26	2
10/22/2023	98	106	76	9	13	172	57	0.33	2
10/27/2023	95	104	74	8.5	14	169	63	0.37	2
11/01/2023	98	110	76	9	14	167	57	0.3	2
11/07/2023	99	112	75	9.5	14	164	62	0.42	2

Table 16: Agronomic traits yield analysis of Durum wheat at ARDC, Wengkhar

Treatments	Days to 50% Heading	Days to 50% Flowering	Plant height (cm)	Spike length (cm)	No of spikelet's	Days to Maturity	1000 Grain weight (gm)	Yield/plot 6m^2 (kg)
11/24/2023	104	111	62.73	16.93	40	172	73	0.86
11/29/2023	106	112	56.50	16.10	38	167	73	0.49
12/4/2023	106	114	60.67	18.63	48	179	70	0.63
12/9/2023	110	119	59.87	18.57	35	174	62	0.55
1/19/2024	106	85	63.77	17.90	32	133	65	0.28

Table 17: Agronomic traits of Yield analysis of Durum wheat at ARDSC, Khangma

Treatments	Days to 50% Heading	Days to 50% Flowering	Plant height (cm)	Spike length (cm)	No of spikelet's	Days to Maturity	1000 Grain weight (gm)	Yield/plot 6m^2 (kg)
12/01/2023	72	81	40	3	28	130	65	0.25
12/06/2023	72	82	45	2.8	23	130	65	0.2
12/11/2023	74	83	50	3	28	130	60	0.18
12/16/2023	76	84	48	3.2	28	130	60	0.17
12/21/2023	72	84	48	3	25	130	65	0.15

Table 18: Agronomic traits of yield analysis of Durum wheat at ARDC, Samtenling

Treatments	Days to 50% Heading	Days to 50% Flowering	Plant height (cm)	Spike length (cm)	No of spikelet's	Days to Maturity	1000 Grain weight (gm)	Yield/plot 6m^2 (kg)
12/6/2023	127	130	77.37	6.93	44	203	63	1.40
12/11/2023	127	132	74.37	6.50	42	198	58	1.47
12/16/2023	133	138	71.43	7.23	38	195	57	1.63
12/21/2023	133	136	74.40	7.73	41	190	61	1.70
12/26/2023	128	131	78.90	6.87	44	185	57	1.97

Table 19: Agronomic traits of yield analysis of Durum wheat at ARDSC, Panbang

Treatments	Days to 50% Heading	Days to 50% Flowering	Plant height (cm)	Spike length (cm)	No of spikelet's	Days to Maturity	1000 Grain weight (gm)	Yield/plot 6m^2 (kg)
12/6/2023	149	164	85	6.8	8	206	63	1.40
12/11/2023	144	159	86	7.6	8	201	58	1.47
12/16/2023	139	154	85	7.3	7	196	57	1.63
12/21/2023	134	149	87	6.9	8	191	61	1.70
12/26/2023	129	144	83	8.6	8	186	57	1.97

Table 20: Agronomic traits of yield analysis of Durum wheat at NCOA, Yusipang

Treatments	Days to 50% Heading	Days to 50% Flowering	Plant height (cm)	Spike length (cm)	No of spikelet's	Days to Maturity	1000 Grain weight (gm)	Yield/plot 6m^2 (kg)
12/01/2023	72	81	80	7	15	116	57	0.43
12/06/2023	72	82	70	7	27	118	67	0.46
12/11/2023	74	83	72	8	23	116	65	0.5
12/16/2023	76	84	70	8	24	121	66	0.42
12/21/2023	72	84	64	6	18	122	60	0.31

Durum Wheat On farm: Geney Gewog, Thimphu

A total of 1,895 kg of durum wheat seeds were distributed exclusively to the farmers of Geney Gewog, Thimphu. This gewog was specifically targeted because the pasta manufacturing facility, Gen-sum Pasta, is located there, enabling local farmers to fully benefit from its proximity. Constant monitoring and technical support were provided as needed throughout the cropping seasons followed by Filed Day during the harvesting time.

Table 21: Agronomic traits of Durum wheat at Geney gewog.

Site/Location	No. of HH	Altitude (masl)	Plant Height (cm)	Panicle Length (cm)	Yield kg/plot	Yield (kg ac^{-1})
Chigoen	1	2473	80	8.3	2.9	1627.30
	2	2540	74	9.2	2.75	1555.29
Zangleykha	1	2936	73	7	3.2	1945.10
	2	2829	69	9	3.4	1737.10
	3	2928	75	7	2.65	1359.95
	4	2606	76	7	3.45	1723.56
	5	2830	83	10	4.7	2356.03
Genekha	1	3008	85	9	2.9	1549.39
	2	3014	66	8	2.5	1218.35
	3	2988	74	9	3.15	1673.32
	4	3032	71	9	1.95	1017.96
Tshocheykha	1	2985	75	9	2.55	1319.03
	2	3126	78	8	2.75	1386.01
	3	3128	76	8	2.75	1357.96

Crop cuts were conducted in durum wheat fields starting the week after the field day. Two to three samples were collected from each selected field. Geney Gewog consists of four chiwogs: Chigoen, Zangleykha, Genekha, and Tshocheykha. In Chigoen chiwog, crop cuts were performed in two households; in Zangleykha, five households; in Genekha, four households; and in Tshocheykha chiwog, three households. The plot yield from 6m² plots varied from 1.95 kg to 4.7 kg per plot.

Durum Wheat On-farm: Wangdue Dzongkhag

On farm evaluation of Durum wheat was carried out in all the gewogs under Wangdue Dzongkhag. The plot yield ranged from 0.9kg to 2.03 kg. Kazhi gewog yielded the highest with 1137.29 kg ac^{-1} and Bjena the lowest at 512.98 kg ac^{-1}. Field data could not be obtained from two gewogs; Sephu and Phobjikha, since it was completely destroyed by frost, snow, and low temperatures. Table shows the agronomic traits of Durum wheat under Wangdue Dzongkhag. There are mixed opinions among farmers regarding the Durum Wheat variety. Some farmers appreciate its larger grain size and consistent plant growth in their areas, while others reject it due to smaller grain size, late maturity, and threshing difficulties. Despite expectations of pest and disease resistance and identical cultural practices; management, and planting dates of durum and the local variety, the local variety was observed to be healthier with taller plants. This, however did not deter the interest of some other farmers.

Table 22: Agronomic traits of Durum wheat at Wangdue Dzongkhag.

Site/Location	Altitude (masl)	Plant Height (cm)	Panicle Length (cm)	Yield kg/plot	Yield (kg ac^{-1})
Kazhi	1950	99	12	2.03	1137.29
Rubesa	1100	79	8	1.73	984.43
Bjena	1712	77	7	0.9	512.98
Dangchu	2323	77	6	12	801.90
Nyisho	1577	72	7	2	1110.03
Phagyuel	1882	71	7	1.5	871.29
Daga	1400	74	8	1.33	745.16
Nahi	1611	46	7	1.53	854.97
Athang	4072	74	7	0.96	647.52
Gasetshowom	1300	72	6	1.12	730.42
Thedtsho	1190	73	7	0.93	614.65

Durum Wheat On-farm in different Dzongkhags

On-farm data from the six Dzongkhags as shown in the figure below showed that yields ranged from 169 kg per acre to 930 kg per acre. Radhi in Trashigang Dzongkhag recorded the highest yield as computed to 930 kg per acre followed by Lhuntse (648 kg per acre). In Tsirang and Dagana Dzongkhags, Durum wheat was grown under dryland conditions, relying entirely on rainfall. In contrast, in Sarpang, Durum wheat was sown immediately after the paddy harvest when the soil was moist and received irrigation twice: once after germination at the tillering stage and again during the flowering stage.

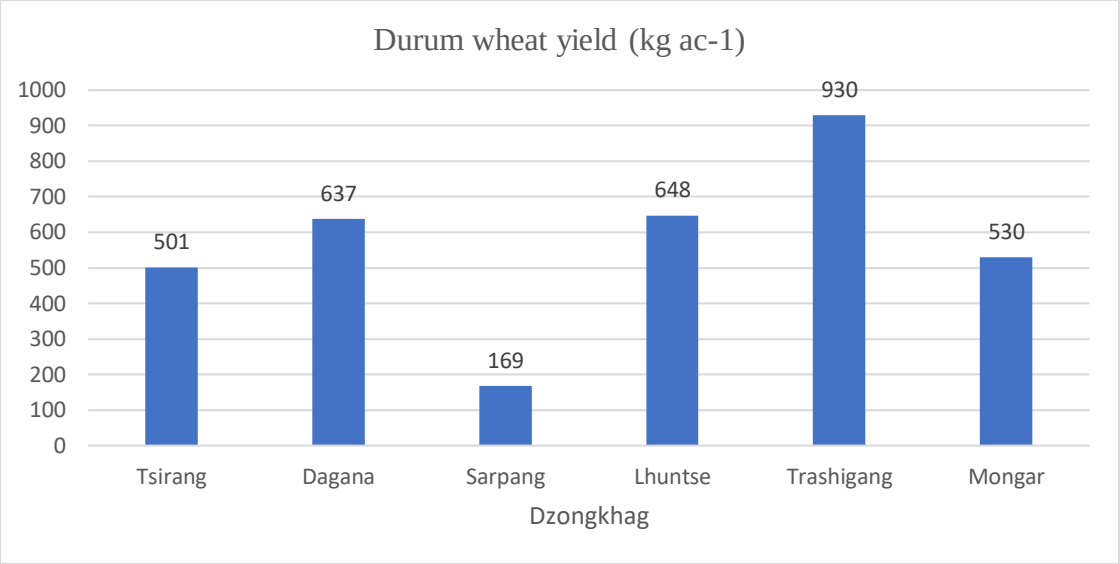


Figure 2: Durum wheat yield (kg/ac) in different Dzongkhag

Among the locations where Durum wheat was cultivated, both on-station and on-farm, it performed best in Geney Gewog, Thimphu. This area had a very low incidence of pests and diseases and a relatively high yield, ranging from 1.95 kg to 4.7 kg per plot. In contrast, the maximum yield from other locations was 2.03 kg per plot in Kazhi Gewog, Wangdue.

The on-station trial yield of Durum wheat yielded better at NCOA Yusipang, ARDC Bajo, and ARDSC Khangma, with yields ranging from 1.1 to 1.97 kg per plot across all treatments, compared to other ARDCs and ARDSCs, as shown in the tables above. However, it matured earlier at ARDSC Panbang (116-122 days) and late at NCOA Yusipang (186-206 days).

At ARDSC Menchunna, 70% of the wheat grain was shattered to the ground by a hailstorm during the crop maturing stages, making the yield data unreliable.

At ARDC Samtenling the first treatment, sown on December 1, 2023, produced the best yield (0.25 kg/6m^2) among the five treatments. Therefore, Durum wheat should be sown in the last week of November or the first week of December, as later sowing did not perform well in the foothill zones.

NCOA Yusipang established an on-farm trial on December 18, 2023, at Dawakha Village in Dogar Gewog, Paro Dzongkhag. However, during the vegetative stage, a prolonged lack of rainfall caused the seedlings to dry up and eventually died.

3.3. Advanced Evaluation of 11th Harvest Plus Yield Trial (HPYT) CIMMYT lines

From the IET that was carried out in the previous season, nine lines were selected out of eighteen. Out of nine, only three lines were selected this season. The experiment followed a Randomized Complete Block (RCB) design with three replications. Each treatment occupied a plot size of 6m^2. To allow for effective weeding and intercultural operations, spacing was maintained at 20 cm x 20 cm. An inorganic fertilizer was applied at a rate of 80:40:40 (NPK) kg ha^{-1}, supplemented with sufficient farmyard manure (FYM) as a basal dose. Intercultural activities were performed whenever necessary. The selected lines will further be evaluated under Participatory Evaluation Trial (PET) in 2024-2025 seasons. The result of the selected lines is presented in table.

Table 23: Agronomic traits of 11th HPYT of bread wheat lines in 2023-2024.

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)	Agronomic score (5=best)
443	54	74	90	10.6	10	139	51	2.2	3
430	52	72	88	9	10	150	44	2	3
433	53	74	89	10.6	9.5	145	44	1.7	3

3.4. Participatory Evaluation Trial (PET) on Biofortified Wheat lines

Amongst the tested bio fortified wheat lines at ARDC, Bajo, and ARDSC, Menchunna. BF450 and BF447 were selected for further evaluation in the farmers' fields next season. The results of the trial are presented below in Table.

Table 24: Agronomic traits of Biofortified wheat lines at ARDC, Bajo ARDSC, Menchunna

Centre	Entry	Days to Heading	Days to Maturity	Plant height (cm)	Spike length (cm)	1000grain weight (gm)	Yield/plot (kg)
ARDC,Bajo	BF450	77	162	90.6	8.8	47	1.6
	BF447	75	153	87	8.6	41	1.2
	Check Bumthangkaadrukchu	81	145	76	8.5	52	1.6
ARDSC, Menchunna	BF450	87.3	168	72.8	8.6	44	0.8
	BF447	85	169	69.5	9	42	0.9
	Check Bumthangkaadrukchu	78	158	76.1	8.1	43	0.6

3.5. 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 25: Wheat seed produced at ARDC,Bajo, & ARDSC, Menchunna in FY 2023-24

Sl.no	Varieties	Quantity produced (Kg)	Centre	Remarks
1	Bajosokha kaa	150	ARDC,Bajo	Released varieties
2	Gumasokha kaa	220	ARDC,Bajo	
3	Bumthangkaadrukchu	250	ARDC, Bajo	
4	Bajokaa 3	180	ARDC,Bajo	
5	Durum	140	ARDC,Bajo	
6	Mixture (trial borders)	250	ARDC, Bajo	
7	Bajokaa 3	100	ARDSC,Menchunna	Released varieties
8	Durum	150	ARDSC,Menchunna	
	Total	**1440**		

4. Maize Research and Development

4.1. Maize Performance Evaluation Trial

As usual, ARDSC-Menchunna conducted maize research and development activities annually. In the FY 2023-2024, the sub-center conducted an on-station maize performance trial of three promising varieties. Timely data were collected, and no pests or diseases were observed during the growth stages. Crop cut samples from the three varieties were taken with a sample size of 7 m² each and then computed to kg per acre, as reflected in Table 26.

Table 26: Agronomic traits of the maize varieties

Phenological characters	**Yangtsipa**	**Ganesh II**	**Chaskharpa Ashom**	**Sweet corn**	**Baby corn**
Plant height	169	193	203	180	188
Ear length	71	91	97	91	103.20
Cob length	9.7	17	18	15	19.20
Cob No	19	22	20	12	14
Yield t/ac	1.42	2.34	2.5	1.8	1.2

In terms of yield, the maize variety Chaskharpa Ashom outperforms other maize varieties. However, farming communities are reluctant to grow this variety due to its open cob, which is susceptible to rot during the rainy season.

4.2. Response of Maize to Different Doses of Organic Fertilizer Applications

The study aimed to evaluate the response of the maize variety Yangtsipa to different doses and combinations of organic fertilizers. This research was conducted at ARDSC-Menchunna to identify the most effective organic fertilizer treatment for maize growth and yield.The experiment was designed using a Randomized Complete Block Design (RCBD) with 10 treatments and 3 replications. The treatments included various organic fertilizers applied individually and in combination. The maize variety used was Yangtsipa, with a seed rate of 12kg per acre. The treatments were as follows:

T1: Leaf mould 5t/ha (3kg)
T2: Farm Yard Manure 5t/ha (3kg)
T3: Biochar (3kg)
T4: Bokashi (3kg)
T5: Chicken Manure 5t/ha (3kg)
T6: Vermicompost (3kg)
T7: T1 + T2 + T3
T8: Control (no treatment)
T9: T1 to T6
T10: T5 + T6

Timely data were collected on the yield of maize (kg per plot) for each treatment across three replications.

Table 27: ANOVA for yields of maize (Yangtsipa)

Source	DF	SS	MS	F-value	P
Replication	2	5.5590	2.77951		
Treatment	9	7.1627	0.79586	2.13	0.0822
Error	18	6.7242	0.37357		
Total	29	19.4459			
CV (%) = 21.49%		Mean yield = 2.8440			

The ANOVA suggests that there is no statistically significant difference among the treatment means at the 5% significance level (P = 0.0822). However, the P-value is close to 0.05, indicating

that there may be some evidence of differences among treatments that could be explored further with additional experiments or a more powerful test. The coefficient of variation (21.49%) indicates that there is moderate variability in maize yields, which could affect the precision of the results.

4.3. Improved maize varieties seed production and promotion

The ARDSC Tsirang produces and maintains seeds of various released maize varieties. These seeds are used exclusively for on-farm demonstrations, supporting client Dzongkhags upon request, and other ad-hoc needs from both the Department and Commodity Programs. In the 2023-2024 period, 623 kg of maize seed was distributed to farmers in Tsirang Dzongkhag on a promotional basis, covering over 50 acres of dryland.

HORTICULTURE RESEARCH AND DEVELOPMENT PROGRAM

5. Fruits, Nuts, Spices, Flowers

5.1. Evaluation of temperate and sub -tropical fruits and nuts germplasm

ARDC Bajo has established both warm temperate and sub-tropical fruit and nut orchards (Table 28) germplasm blocks. The germplasm blocks serve as technology hub and demonstration sites for providing hands-on training for researchers, extension agents and farmers in the long run. The technology driven demonstration orchards provides an opportunity for the agri-business minded youth to learn practically from internship program with the Centre. It is also to evaluate and identify superior cultivars for diversification of fruit cultivation.

Table 28: Fruit crop varieties established in the germplasm block

Crops	Varieties
Peach	Kurataki, Nonomewase, Floridasan, Beauty cream
Apricot	Khasha, New Castle
Pear	Yakumo, Niitaka, Hosui, Kosui, Shinko, Chojuro
Kiwi	Hayward, Wengkhar Yellow, Wengkhar Green, Enza Red, Male
Grape	Steubin, Perlette, Campbell, Kyoho, Risamate, Nsehelena
Dragon fruit	Gewai ringa
Pomelo	R3P4, R4P5, R3P9, Banpeiyu
Lime	Seedless lime
Lemon	Frost Eureka
Loquat	Mogi, Tanaka
Avocado	Brogdown, Hass, Bacon, Zutano, T1, T2, T3, M1, M2, M3
Persimmon	Jiro, Fuyu, Yubeni, Zinjimaru, Taishu
Plum	Honey Rosa, Santa Rosa, Soldum, Kiyo, Oishi wase
Kumquat	Marumi
Pecan nut	Wichita, Western Schley
Wine grape	Cabernet Sauvignon 337, Syrah 470, Cot 598, Sauvignon Blanc 906, Chardonnay 96, Pinot Noir 72, Merlot 181, Petit Manseng 573
Guava	Pink Flesh, Thai Giant, Allahabad Safeda, Local
Pomegranate	Chaula, Bedana, K5, K3
Grape fruit	Star ruby

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. farmer's fields.

5.2. Varietal evaluation of wine grapes

Department of Agriculture in collaboration Bhutan Wine Company have established vineyard at ARDC Bajo in the year 2020 with nine varieties. First harvest done in the year 2023 and collected required data for the analysis as mentioned in the table 3. In production point of view Sauvignon

Blanc (4.5 kg per vine) variety found to be best performing variety followed by Syrah (2.7 kg) and Malbec (2.3 kg). Chardoney (0.6 kg) seems less adaptable for the elevation of 1200 masl. Installed bird net all over the vineyard to protect from birds. In the year 2022, all grapes lost to birds.

Table 29: Wine grapes production

Variety	**Berry color**	**Avg seed/berry**	**Avg. Wgt/ cluster (g)**	**Avg. no. of cluster**	**Avg. Yield/ Vine (g)**	**Avg. Berry Wgt (g)**	**Avg. Brix (%)**
Pinot noir	red	2	134.70	15.67	2110.75	1.85	20.71
Chardoney	white	3	82.94	7.33	607.95	1.79	22.32
Sauvignon Blanc	white	2	155.32	29	4504.28	1.59	21.73
Petit Menseng	white	2	89.43	24.33	2175.83	1.31	27.35
Merlot	red	2	133.01	17.33	2305.06	1.7	22.4
Malbec/Cot	red	2	156.90	15	2353.50	2.41	21.5
Cab Franc	red	2	190.86	12.33	2353.30	1.79	19.2
Syrah	red	2	142.22	19	2702.18	1.37	21.6
Cabernet Sauvignon	red	2	142.85	17	2428.45	1.2	21.6

5.3. Performance evaluation trial of passion fruit

Passion fruit performance evaluation trial has been established in the year 2023 with coordinating center ARDC Wengkhar. There are two varieties Summer Queen (Fig 1) and local variety as a check variety. Vines are planted using CRD with 5 replications with spacing of 3m x 2m. randomly selected 10 fruits from each replication for data collections (Table 30).

Table 30: Fruit quality analysis of summer queen passion fruit variety at Bajo 2023-24

Area	Mean fruit weight (g)	Mean fruit height (cm)	Mean fruit diameter (cm)	Mean TSS (%)	Mean Pulp weight (g)	Mean juice content (ml)	Color of fruit	Fragrance	No of fruits per plant (no)
Bajo	54.3	8.9	5.4	15.1	30.4	19.3	Purple	Yes	5

5.4. Evaluation of pure germplasm of Langra (Malda) and Himsagar varieties of mango

Mango cultivars currently available in the world have several drawbacks, such as alternate bearing, low yield, narrow ripening window and low fruit quality. Hence, it is very important to trace and exploit the genetic diversity in mango and ultimately preserve the vital germplasm of promising and threatened mango varieties/cultivars to broaden the genetic resource repository. Langra (also called Malda in some parts of India) and Himsagar are popular mango varieties originated from India which are known for their taste and aroma around the world. In Bhutan, these mango cultivars are currently available in some parts of the country but their genetic purity is questionable. Thus, the Department of Agriculture, Bhutan introduced the pure germplasm (grafted seedlings) of mango varieties Langra and Himsagar from the ICAR-Central Institute of Subtropical Horticulture, Lucknow, India in July 2023.

Therefore, ARDC Samtenling has initiated to evaluate yield performance and fruit quality of Langra and Himsagar mango varieties in different regions of Bhutan through multi-locational trials. Orchard established with used of RCBD with three replications consist of three plants for each replication using Samtenling Amchukuli 4 (Tommy Atkin) as a check variety (Fig 1). All cultural practices are followed as the protocol. Pit dug with 1m x 1m. Re-filled pit with biochar in bottom layer and charged with water. Then topped with mixture of compost and soil.

5.5. Establishment of Irwin mango evolution trial under protected environment

Miyazaki mangos are grown in Miyazaki Prefecture, Kyushu, Japan. They are commonly referred to as "Taiyo no Tamago" or "Egg of the Sun" due to its dazzling golden hue and juicy, rich flavor. Miyazaki mangoes are a premium fruit that is highly valued in Japan and considered a symbol of luxury. They are often grown utilizing advanced agricultural techniques and stringent quality control standards, yielding fruit that is both visually attractive and delicious. They are also commonly recognized as the world's most costly mango. Miyazaki mangoes are a form of Irwin mango that developed in Florida in the US and is also known to as 'apple mango' because of their red apple-like look.

Therefore, six grafted Irwin mango collected from ARDC Samtenling and planted inside double fabricated greenhouse to evaluate adaptability and quality of fruit production with proper irrigation, manuring and temperature. Pit dug with 1m x 1m. Re-filled pit with biochar in bottom layer and charged with water. Then topped with mixture of compost and soil.

5.6. Pomelo Evaluation varietal trial

Consisting of three varieties (R3-P4, R4P5, Banpeiyu). Tagged five plants for every variety for sampling. Will collect data for fruit parameters for this fruiting season like fruit weight, fruit size, TSS, citric acid content, rind thickness, total weight per plant.

5.7. Citrus phenology study

The center has established citrus varietal evaluation trial consisting of six varieties; Taracco Ippolito/Trifoliate, MC.Mahan/Rangpur lime, Cant Star Rubby/P.Rubidoux, Caffin Climentine/ Bigamate, Afloureer/C35 and Dorokha local/Volcameriena as a check variety. Citrus phenology cycle for the year 2023 completed with the required data collection as per citrus phenology monitoring template. Data were collected from first stage bud break till 9th stage harvest of fruits. Details mentioned Table …

Table 31: Phenological study of Citrus in different stages

Phenological Stage	**Phenological stage details**	**Varieties**					
		V1	**V2**	**V3**	**V4**	**V5**	**V6**
Bud Break	When 50% of buds are 3mm in length	80%	70%	50%	20%	30%	20%
Start of Bloom	When 5% of flowers are open across block	5%	2%	1%	10%	1%	0%
Full Bloom	when 50% of flowers open across block	80%	75%	70%	55%	60%	50%
End of Petal Fall	More than 80% of petals have dropped from trees in block	90%	90%	80%	75%	75%	60%

Cell Division	Fruits sink in water	100%	100%	100%	100%	100%	100%
Final Fruit Drop	When large number of fruitlets fallen from tree	85%	70%	40%	50%	55%	50%
Cell Expansion	Fruit float in water	100%	100%	100%	80%	100%	100%
Color Break	When 50% of fruit are light green to light yellow	50%	70%	70%	100%	70%	50%
Fruit Maturity	When desired colour and flour achieved	97%	80%	80%	90%	100%	85%
Harvest	Start of harvest	7.17 kg	29.72 kg	5.7 kg	1.8 kg	0.56 kg	0.98 kg

V1= Afloureer/C35; V2= Caffin Climentine/Bigamate; V3= Cant Star Rubby/ P.Rubidoux; V4= Dorokha Local/Volkame riena; V5= Taracco Ippolito/Trifoliate; V6 = MC.Mahan/Rangpur lime

Furthermore, collected data on fruit parameter like fruit weight, fruit size, TSS, Rind thickness, nos. of seeds, juice content, and no. of segments (Table 32). The data will be collected for next two years and analysis will be done.

Table 32: Citrus fruit parameters

Variety	Av. Fruit Wgt (gm)	Av. Fruit Diameter (mm)	Av. Fruit Length (mm)	TSS (%)	Nos of seeds	Juice content (ml)	Rind thickness (mm)	No. of segments
Afloureer	101.35	64.03	47.93	11.7	11	50	2.67	10
Climentine	44.9	47.15	39.09	11.7	8	19.2	2.66	11
Star Ruby	315.37	90.28	78.44	12.9	2	130.29	3.65	12
Dorokha local	123.86	66.18	52.93	11.2	16	51.2	2.55	10
Taracco	195.43	70.65	70.36	8.5	2	78.67	2.92	10
Rangpur lime	94.54	55.89	52.67	11.7	1	40	2.69	10

5.8. Citrus Repository Germplasm Maintenance and Evaluation

Progress in citrus research on production management is advancing, but a complete system from nursery to marketing through production must be further explored and institutionalized. This is crucial to sustaining increased production and yield, especially as the global citrus industry faces threats from deadly graft-transmissible diseases such as Huanglongbing (HLB), Citrus Tristeza Virus, Citrus Exocortis Viroid, and Phytoplasmas. The citrus repository is a cornerstone for initiating and institutionalizing the citrus planting materials clonal system to supply 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 2024, the National Citrus Repository (NCR) has collected 120 citrus germplasm cultivars through budwood and seed. These cultivars, sourced from Australia, Japan, Nepal, India, and Bhutan, are maintained as foundation plants in the NCR. The NCR has successfully achieved its annual target of 120 citrus germplasm collections, with 74 germplasms collected locally and 46 globally. However, 22 collections are in a quarantine house for future HLB testing. Seven

accessions are in a biological indexing house for HLB disease screening through biological indexing and TR PCR by NPPC. The 8th batch of TR PCR tests detected 10 samples as HLB positive, which are recommended for destruction by NPPC scientists. Negatively tested plants will move to the foundation house as germplasm through propagation.

A total of 28 varieties are being evaluated for varietal performance in different agro-ecological zones (500, 1000, 1500, and 2000 masl) as a collaborative activity.

Current Status and Future Plans

Foundation Plants: A total of 490 foundation plants are well maintained in an insect-proof screen house as germplasm.

Characterization: 13 varieties are being developed for characterization in the repository for research and development purposes.

Protected Cultivation Trials: Five new varieties are undergoing protected cultivation trials with high density in farmer's fields in collaboration with the Dagana Dzongkhag Agriculture sector.

Laboratory Facilities: One plant growth chamber with a capacity of 165 liters and one refrigerator have been procured to initiate Micrografting (STG) in the NCR laboratory. This is the only technique to convert HLB positive to negative.

Management Protocol: A standard protocol is well maintained in managing the citrus repository. The NCR's efforts in collecting, maintaining, and distributing citrus germplasm are essential for the sustainable development of the citrus industry in Bhutan. As of 30th June, 2024, the NCR has distributed disease free seedling ad detailed in the table 33.

Table 33: Distribution of disease-free seedlings

SN	Recipient	Number of Varieties	Remarks
1	ARDC, Samtenling	8	Sarpang
2	NCOA, Yusipang	9	Thimphu
3	Chimipang Royal Project (CRP)	16	Punakha
4	NSC, Tashi Yangtse	20	Tashi Yangtse
5	Dechencholing Royal Project	15	Thimphu
6	ARDC, Bajo	11	Wangdue Phodrang
7	ARDSC Menchhuna	26	Tsirang
8	RDTC, Zhemgang	7	Zhemgang
9	ARDSC, Panbang	5	Zhemgang
10	Research Outreach Programs	22	Dagana & Tsirang
	Total	**139**	

5.9. Grafting of soft-shell walnut and almond under MFTP Program

The Million-Fruit Tree Plantation Project (MFTP) in Bhutan, initiated by His Majesty the Fifth Druk Gyalpo, aims to boost rural livelihoods, improve food security, and connect youth with rural areas. The project began on March 15, 2022, with the first phase planting over 1 million fruit trees across 205 Gewogs. However, 30% of the trees did not survive, leading to a replacement effort in the second phase starting February 5, 2023. This phase focused on high-value fruits. The third phase, launched February 5, 2024, seeks to plant over 1.2 million high-value fruit trees, including kiwi, avocado, and agarwood, further enhancing Bhutan's fruit industry and rural development.

During the third phase of the Million Fruit Tree Plantation (MFTP). Program, the grafting of almond and walnut, two high-value nuts, was carried out in the FY 2023-24. The main purpose of

the grafting was to provide the farming communities with true-to-type fruit plants. ARDC-Bajo covered five dzongkhags under its jurisdiction: Gasa, Punakha, Wangdue, Tsirang, and Dagana.

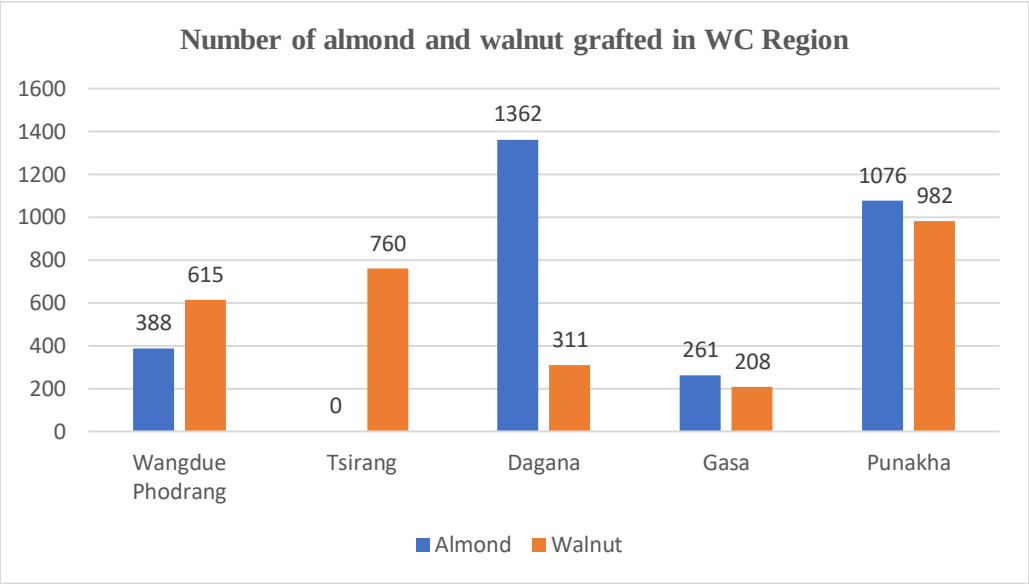


Figure 3: Grafting of almond and walnut in 2023-24

As part of the MFTP Program, 5,963 trees have been grafted with improved varieties, including 2,876 walnut trees and 3,087 almond trees during the FY 2023-24. The highest number of almond grafts was in Dagana (1,362) and Punakha (1,076). For walnut trees, Punakha led with 982 grafts, followed by Tsirang with 760.

5.10. Production of quality fruits and nuts seedlings

The fruit nursery block serves as a site for generating and demonstrating management technologies, offering hands-on training for researchers, extension agents, and farmers. It is also dedicated to developing nursery management techniques for producing high-quality seeds and seedlings. At the Centre, both grafted and non-grafted seedlings of released and promising fruit and nut cultivars are produced and maintained annually. Scion wood for these varieties is collected from November to January. Grafting is carried out in greenhouses towards the end of February and in open fields from February to March. These seedlings are used at research station and some are issued to farmers. Institutions as promotional.

Table 34: Details of fruit seedlings produced

SN	Crop	Variety	No. of seedling produced	No. of seedling issued	Remarks
On-station, ARDC Bajo					
1	Citrus	Rootsctock	300		seedlings
2	Avocado	Assorted	100		seedlings
3	Dragon fruit	mixed	1000		cuttings
4	Loquat	Tanaka	100		seedlings
5	Guava		50		seedlings
6	Persimmon	Fuyu & Jiro	500		Seedlings
7	Walnut		130		Grafted
8	Persimmon	Fuyu &Jiro	370		Grafted

On-station, ARDSC Menchhuna					
9	Persimmon	Fuyu &Jiro	115		Grafted
10	Pear	Kosui & Hosui	167	27	Grafted
11	Peach	Assorted	426	92	Grafted
12	Plum	Assorted	333	74	Grafted
13	Apricot	Assorted	250		Grafted
14	Cherry	Pink Cherry	110		Grafted
15	Avocado	Assorted	124	41	Seed
16	Loquat	Tanaka	146	104	Seed
17	Kiwi	Hayward	440	106	Seed
18	Citrus rootstock	Trifoliate	4000	175	Seed
19	Kiwi	Assorted	623	106	Seed
Total			**9654**	**725**	

During the fiscal year 2023-2024, ARDC Bajo produced 2,550 seedlings through grafting and seeds, while ARDSC Menchhuna produced 6,734 using the same methods. In total, 9,654 seedlings were produced through grafting and seed propagation. Of the seedlings raised, 725 have been distributed to farmers by ARDSC Menchhuna.

5.11. Floriculture maintained at the Centre

The floriculture unit at ARDC-Bajo specializes in the cultivation and management of flowering and ornamental plants. It focuses on producing flowers and ornamental plants for gardens, floristry, and landscape design. Additionally, the unit maintains germplasm and seeds of flowers and herbs, with a strong emphasis on multiplying varieties and making them available to recipients. Key activities in floriculture include:

I. Propagation: This involves sowing seeds of seasonal flowers, producing cuttings of vegetative flowers, and performing grafting and budding for specific plant traits.

II. Planting and Transplanting: A mixture of leaf mold and biochar is used for potting flowers. Daily tasks include transplanting nursery plants and ensuring proper spacing and growth conditions.

III. Maintenance: Regular tasks include irrigation, weeding, pruning excess foliage, and fertilization to ensure plant health.

The unit also maintains and produces herbs such as rosemary, oregano, chocolate mint, thyme, basil, and parsley. In the fiscal year 2023-2024, the floriculture unit distributed 13,881 potted flowers and herbs to institutions, farmers, officials, thromdes, dzongkhags, monasteries, schools, and interested individuals.

5.12. Termination of NCT trials

During the FY 2023-24 two NCT trials were terminated

1. Sacha Inchi (*Plukenetia volubilis*): With the seedling support from ARDC, Wengkher, an observation trial was set up on-station on 10/8/2020 with a planting distance of 2m/ 3 m. In total 19 plants were planted for the trial. The production was observed from 13 plants only due to the frost damage during the month of January and February. It was observed that the plant is susceptible to frost and snow. After observing continuously for three years or more, the seriousness of the frost and snow damage, it was confirmed that the plant adaptability at this altitude is difficult. So, in consultation and prior approval from the national coordinator the trial is terminated.

2. Small cardamom,ARDSC,Maenchuna, Tsirang: Evaluation of six varieties of small cardamomum (*Elettaria cardamomum*) for its adaptability and performance at different agroecological zones of Bhutan trial was set up at ARDSC, Menchhuna, Tsirang. However, the entire plantation has dried and withered after one year of plantation.

Since these NCT trials did not perform as expected, the coordinating centers have been informed of the termination of the trials.

6. Vegetable Research and Development

During the FY 2023-24, the Vegetable unit under Horticulture Sector conducted 10 different vegetables trials including hydroponic and sunken garden.

Eggplant varietal evaluation trial

To diversify eggplant varieties four varieties of Japanese eggplant were evaluated at ARDC-Bajo for their yield potential. The experiment was conducted in Randomized Complete Block Design (RCBD) with three replications.

Table 35: Agronomic performance of eggplant varieties FY 2023-24

Variety	Yield per plot kg(2m2)	Yield (kg/Acre)	Fruit Length(cm)	Fruit Size(cm)	Fruit weight (gm)
Nagoaka	1.20	2400	11.50	4.71	77.04
Manryo	1.40	2800	11.90	4.11	80.78
Senryo	2.10	4200	10.40	5.14	112.00
Sinkowase	2.00	4000	14.10	4.87	107.18
Pusa purple long (check)	0.80	1600	11.50	3.37	63.80

It was observed that the Senryo variety demonstrated the highest yield potential, followed by the Sinkowase variety. Among all the varieties evaluated, Pusa Purple Long, used as the check, had the lowest yield. The best-performing varieties will be further evaluated for potential release as new varieties.

6.1. Evaluation of yellow flesh watermelon variety

Yellow-flesh watermelons have recently grown in popularity due to their unique color and increased sweetness compared to red varieties. An evaluation of yellow-flesh watermelon was conducted using the Sugar Baby variety as a check. The trial was set up using a Randomized Complete Block Design (RCBD) with two treatments and three replications. The plants were spaced 1 x 3 meters apart. From each replication, three plants were randomly tagged. Data were collected from at least two fruits per tagged plant.

Table 36: Agronomic performance of watermelon varieties FY 2023-24

Variety	Avg. Weight (kg)	Avg. Height(cm)	Avg. Diameter (cm)	Flesh colour
Yellow flesh	2.91	17.78	17.86	Yellow
Sugar baby (check)	2.88	18.2	17.78	Red

The results indicate that the average weight of the yellow-flesh watermelon is slightly higher compared to the check variety, Sugar Baby. Additionally, the distinct yellow flesh color is an advantage in the market, as most available varieties are red.

6.2. Evaluation of on station trial for coloured Cabbage and Golden Cross (NCT)

The trial was set up at ARDC-Bajo using randomized complete block design with 2 treatment and 4 replications. Each experimental plot consisted of 20 plants in a bed size of 5m x 1m. The distance between rows to row and plant to plant of 50cm and spacing between beds of 50 cm. Data collected from 5 randomly selected plants from each treatment plot. The main objective is to evaluate the performance and adaptability of hybrid coloured cabbage in four agro-ecological climatic condition of Bhutan.

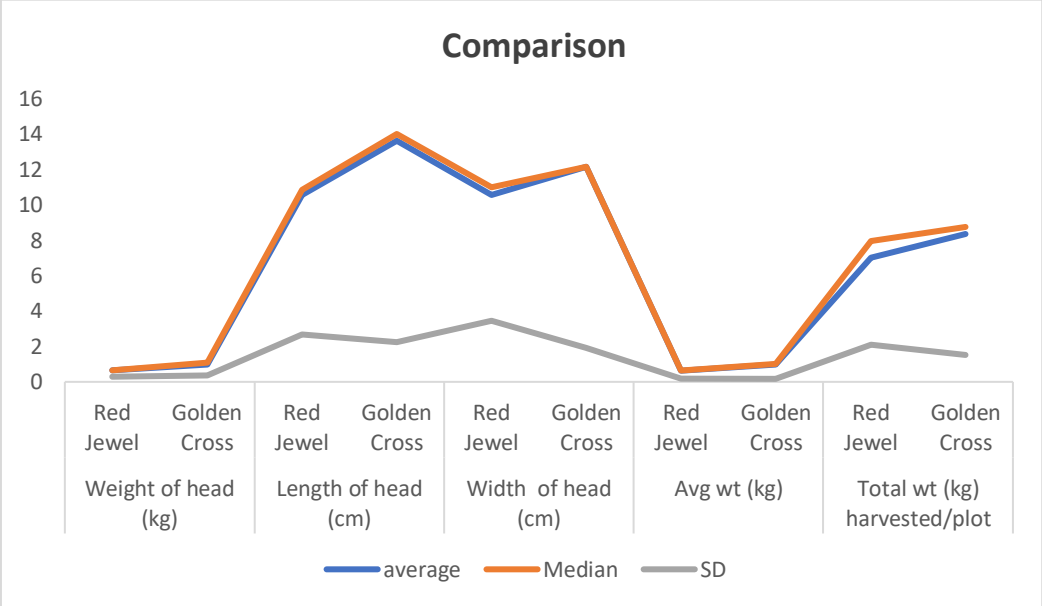


Figure 4: Agronomic performance of Red Jewel and Golden Cross

The graph indicates that the Golden Cross surpassed Red Jewel in all the parameters for average such as weight of head, length, width, average weight and total production. The Red Jewel has higher SD comparing to Golden cross in all the parameters except weight of head (*SD=0.29*).

6.3. Performance evaluation of Korean Vegetables (cabbage and tomato)

The Korean Cabbage trial was set up on-station at ARDSC, Tsirang at an elevation of 1448 masl.15 seedlings were planted for the trial.

Table 37: Agronomic performance of Korean Cabbage

Treatment	Cabbage height whole part(mm)	Cabbage weight (gram)	whole plant width(mm)	Cabbage head width half cut (mm)	Cabbage head height half cut(mm)
Korean Lines	111.00	577.17	120.17	155.00	107.50
Control	107.80	383.67	95.33	95.33	107.80

The average head weight of Korean lines was better than control. The head weight of Korean cabbage was 577.17 gm, compared to 383.67 gm of control variety. The height of the Korean line was 111.00m compared to 107.80 mm, which was similar. However; the width of Korean was bigger measuring 120.17m compared to the control variety with 95.33mm.

The Korean tomato trial was also set up on-station at ARDSC, Tsirang at an elevation of 1448 masl.The beds size of 12m x5.m was used with a spacing of 50cmx 50 cm. On each bed 26 plants each for variety New Hera and Cosmic (check) was planted. Cosmic is a Korean hybrid variety of Takii seed company notified in Bhutan for commercial production.

Table 38: Agronomic performance of Korean Tomato

Varitey	Yield (MT MT/Hectare)	Mean fruit weight (gm)	Mean fruit length(cm)	mean fruit width(cm)	Total Brix
Cosmic hybrid (Control)	11	65.6	54	45.9	4.5
New Hera 130	6	45	38	44.6	4.9

The results of the trial in Bhutan indicated that the available variety cosmic performed better than New Hera. The yield of Cosmic was 11 MT/ hectare compared to yield of New Hera which yielded 6MT/hectare. Fruit weight and fruit length was higher in cosmic however.

6.4. Varietal performance evaluation trial on sweet potato

Evaluation of Japanese sweet potato varieties on station to see the adaptability and yield performance. Orange flesh which was released in 2021 as check, purple flesh and gorojima varieties are being evaluated using a randomized complete block design. The vegetative propagation method is being used. Vine cuttings are used where it forms roots. These varieties have completely different features of their own. The management practices are followed as per the vegetable cultivation guidebook. The trial will be taken for NCT and try growing in different agro-ecological zones and also in few farmers' field.

6.5. Strawberry varietal evaluation on station

There are four different varieties of strawberry grown in the Centre. Camerosa and sweet Charlie are released by NCOA, Yusipang. Thai variety and red flesh are the two varieties being evaluated. Thai variety strawberries are grown tropical climate of Thailand. These varieties were developed and selected for their ability to withstand high temperature and humidity. It can produce high quality fruit and good taste. The fruit has generally conical or heart-shaped shape and larger in size. They often have higher sugar content compared to other varieties making them sweeter with mild tanginess. Thai variety won the organoleptic test amongst the four varieties.
Red flesh strawberries are a distinctive and increasing its popularity due to its unique appearance and flavour profile. They are known for their deep uniform color, sweet, and aromatic taste. Red flesh strawberry plants are low growing perennials. The fruit shape is perfectly in triangular oval. Red flesh strawberries provide a delightful variation on the classy strawberry, offering enhanced visual appeal and richer flavor making them popular for both culinary and fresh consumption. It is also ranked higher during the organoleptic test on station.
there was not much differences in the fruit width, total brix contains and fruit thickness.

6.6. Performance evaluation of Chill (SHP 4884)

The chili NCT trial for SHP4884 was conducted in March 2023, with the final harvest taking place in August 2023. The trial aimed to compare the performance of chili plants under protected cultivation versus open field conditions, covering an area of 6m² per replication. Three treatments per replication were applied using a Randomized Complete Block (RCB) design. Consistent management practices were followed for all treatments to ensure unbiased results.

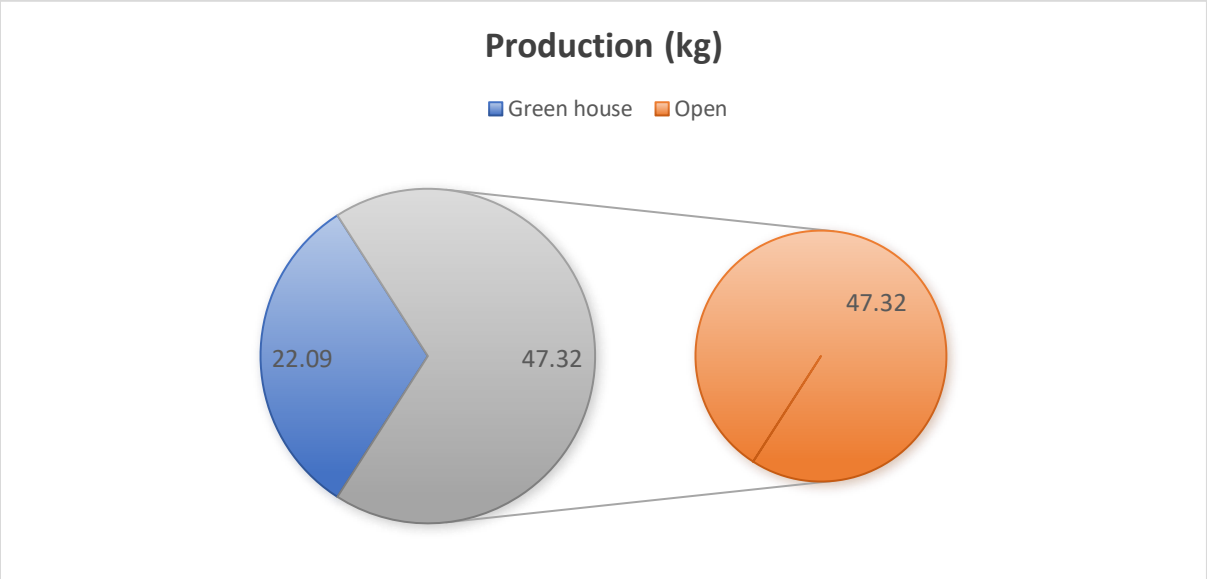


Figure 5: Yield comparison of chili SHP4884 production in green house and in open field

The production in the open field was comparatively higher than inside the green house. The sooty mold infestation damaged the crop almost to 50% of the total production.

6.7. Okra Varietal Evaluation Trial.

An on-station trial evaluating the okra variety Japanese Long was conducted at ARDC-Bajo along with local check. The trial was set up using a randomized complete block design. This variety will be tested in farmers' fields in the coming season for evaluation to put up the variety for release in Variety Release Committee (VRC).

Table 39: ANOVA for yields of okra

Source	DF	SS	Mean Square	F-value	*Sig.*
Variety	1	0.163746	0.163746	1.177	0.339
Residual	4	0.556447	0.139112		
CV (%) = 11.51%%		Mean yield = 3.2963 kg/ac			

Variety: The F-value for the variety is 1.177 with a p-value of 0.339. This indicates that there is no statistically significant difference between the yields of the two varieties of okra at the 0.05 significance level. These results suggest that the difference in yield between the "Japanese long" and "Local (check)" varieties is not statistically significant.

6.8. Evaluation of chili Lines

The National Centre for Organic Agriculture, the coordinating center for vegetables, dispatched twenty-eight lines of chili for a trial. These chili lines are high-yielding and tolerant to major pests

and diseases. Three local varieties were used as checks. The trial was set up using a randomized complete block design. The data is not yet available, as the trial is ongoing and harvesting not completed.

6.9. 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. During the FY 2023-24 the Centre could produce more than 117 kg of assorted vegetable seeds.

Table 40: Breeder seeds produced, issued and maintained in stock in the FY 2023-24

Crop	Variety	Seed Quantity Produced (kg)	Remarks
Mustard green	Red rio	3	
Beans	Dwarf beans	2.31	
	Chaskarpa orey	3.4	
	Muka orey	0.30	
	White Pole beans	7.01	
Radish	Shoigon	18	
Spring onion	Nobgang	25	
	Gaselo	28	
Pumpkin	AVPU 1394 and Kuri	4.8	
Zucchin	Zucchini (Yellow and Green)	2.22	
Strawberry	Sweet charlie, chandler, camarosa, thai	1200 (nos.)	360 runners issued to Dagana and 60 to NCOA, Yusipang
Broccoli	Dessico	1.8	
Chilli	Dewitt	0.5	
Carrot	Pure red	6	
Carrot	Kuroda	15	
	Total	**117.34**	

6.10. Production and supply of spawn for mushroom cultivation

Mushroom cultivation in Bhutan has created employment opportunities due to its high market value. However, the lack of quality spawn supply has hindered commercial-scale production. To address this, the Department of Agriculture (DoA) entrusted all regional ARDCs with the task of producing spawns and providing technical support for mushroom cultivation in their respective regions, with technical assistance from the National Mushroom Centre. In the fiscal year 2023-24, a total of 6,022 oyster spawns and 354 second-generation oyster mother spawns were produced and supplied to farmers to support mushroom cultivation. The spawns were distributed to interested farmers in the West-Central Region, as detailed in the table below.

Table 41: Quantity of spawn supported in the Region in the FY 2023-2024

SN	Dzongkhag	No. of spawn poches supplied	No. of HHs
1	Wangdue Phodrang	779	13
2		5	1 school
3		4573	Khotokha Dessung
4	Punakha	275	5
5		100	CNR
6	Dagana	260	30

7	Trongsa	15	1
8	Pemagytshel	15	1
Total		**6022**	**53**

7. Hydroponic Farming Research

The hydroponics research focused on implementing and monitoring a hydroponic system for growing spring onion, lettuce, komatsuna, and various herbs. Using the Nutrient Film Technique (NFT) system, crops like spring onion, garlic, lettuce, and coriander were cultivated. The study also included planting herbs such as basil, chocolate mint, and parsley, with the latter being harvested five times. While spring onion and garlic grew well, coriander had poor growth. Lettuce showed a high growth rate and excellent quality, reaching maturity in 5-6 weeks. The deep-water culture system was used to grow red jewel cabbage, a new crop for the center, which successfully formed heads. Overall, the hydroponic system demonstrated high efficiency, yielding crops with rapid growth rates, high yields, and excellent quality, with minimal pest and disease issues.

8. Walipini Farming Research

The Walipini structure at the Centre serves as a demonstration for farmers, visitors, and youth interested in farming. A Walipini is a sunken greenhouse that uses geothermal energy from the soil to maintain warmer temperatures, making it suitable for year-round cultivation, especially in high-altitude areas with challenging winter and summer conditions. The structure's design helps protect crops from snow, rain, and cold weather, allowing for faster growth and higher yields than conventional greenhouses.

The first crop planted in the Walipini was the tomato variety 'Roma,' which yielded 53.37 kg over seven harvests in four months and 11 days. The temperature inside the Walipini was consistently warmer than outside, with a difference of 4.8°C in January 2023. Watermelons were planted in June, benefiting from the controlled environment for extended cultivation. After the watermelon harvest, soil solarization was conducted to prepare the soil for planting hybrid onion NO.1358. The onions were planted in December 2023, with a harvest of 31 kg of wet weight.

8.1. Temperature and Humidity data in Walipini for 24 hours

Daily temperature and humidity inside the Walipini have been recorded using a battery-based data logger. Data loggers are devices that record environmental data over time, either through built-in instruments or sensors. The error in the data recorded by the data logger is minimal, making it a reliable tool for various applications such as scientific research, industrial monitoring, or personal and environmental data tracking. The battery-based data logger installed in the Walipini recorded the analyzed average temperature and humidity over 24 hours during the week from April 3rd, 2024, to April 9th, 2024.

The implementation of sunken greenhouse, gives a myriad of benefits for agricultural production, particularly in challenging climates. The Walipini allows for year-round cultivation by maintaining warmer temperatures during colder months and protecting crops from frost. This extended growing season enhances productivity and enables the production of off-season crops, providing fresh produce even in winter. The adoption of sunken greenhouse technology holds significant promise for the future of agriculture, ensuring food security and resilience against climate change.

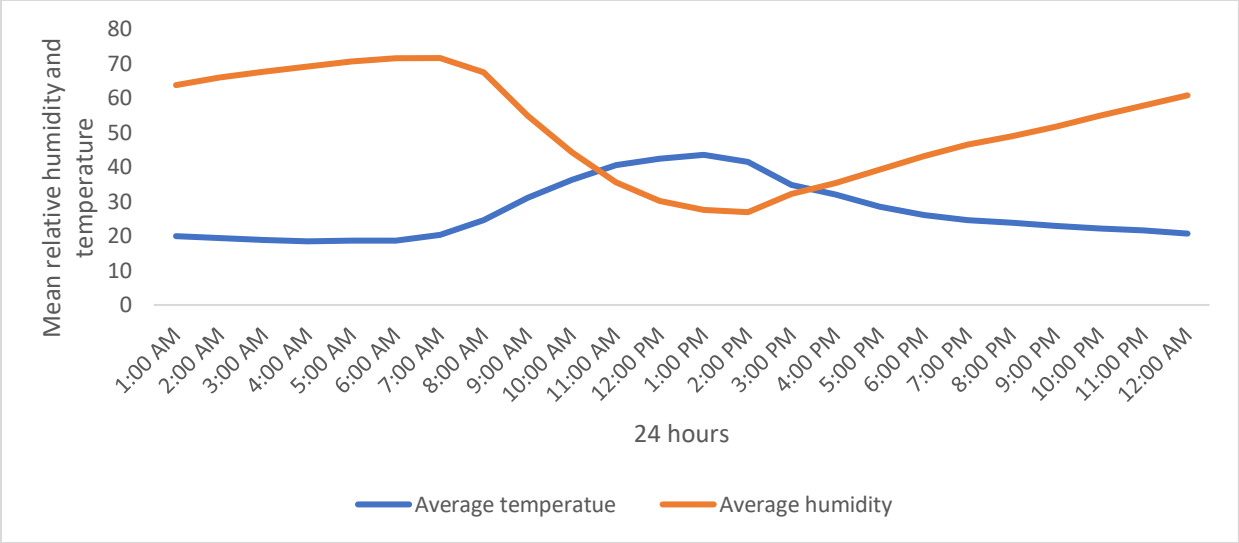


Figure 6: Temperature and Relative Humidity recording inside Walipini greenhouse in 24 hours

SUPPORT SERVICES RESEARCH AND DEVELOPMENT PROGRAM

9. Seed samples tested for various parameters

National Seed Testing and Referral Laboratory at ARDC-Bajo is responsible to carry out basic tests such as germination percent, physical purity percent, and moisture percent of seeds. The clients include ARDCs, BAFRA, NSC, farmers and private seed companies. The seed parameters to be tested depend on the interests of clients and the capacity of the laboratory to perform tests. The seed samples submitted through BAFRA are tested for germination percent, purity percent and moisture percent whereas seed samples from farmers are usually tested for germination and purity percent only. The results and recommendations are then provided to the beneficiaries. The seed samples collected are usually from vegetables and cereals crops.

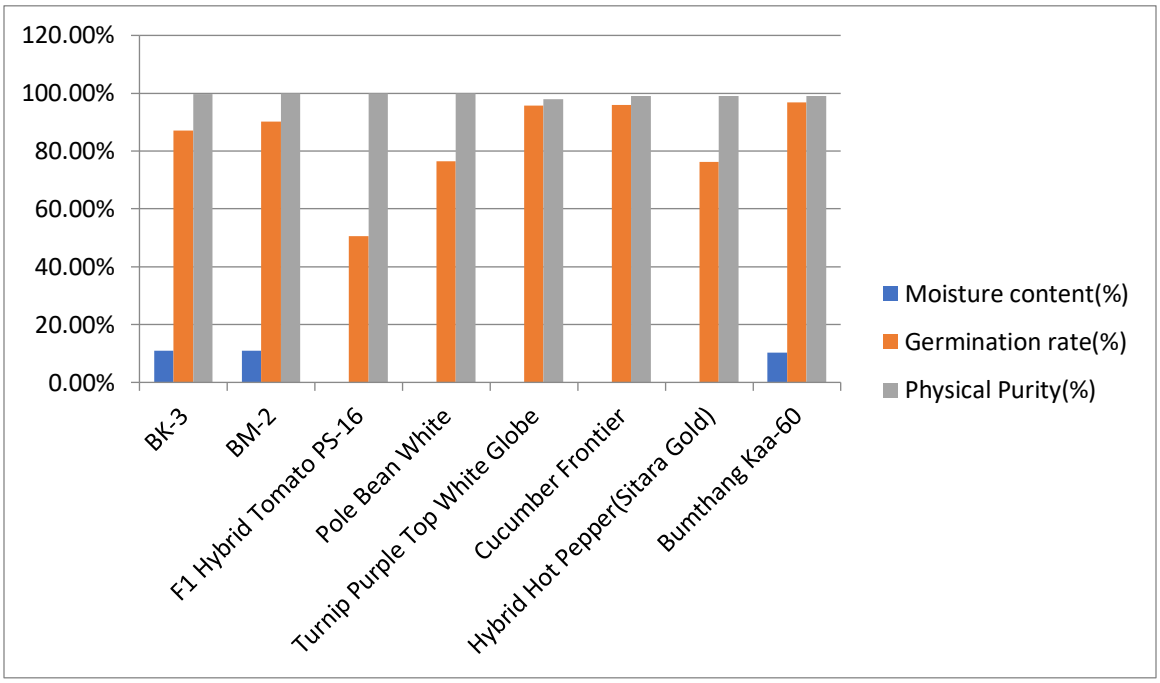


Figure 7: Germination and purity mean of crop seed sample tested

10. Coordinating National Trial on Wood Vinegar in Four ARDC Centres

Bhutan prioritizes promoting organic farming practices. This approach emphasizes finding alternatives that are safe for animals and the environment. To achieve this goal, ARDC Bajo in collaboration with three other research centres, is conducting a trial on using wood vinegar as a fungicide and weedicide on tomato plants. The trial utilizes Ratan variety for fungicidal purposes and GARV variety for weed control. While Bajo and other centres, has yet to collect data, the ARDC Samtenling is nearing the final data collection stage.

11. Farmer's training and distribution of Super Grain Bags

As part of the deposit activity with the National Plant Protection Centre (NPPC) and funded by Bhutan for Life, the plant protection team gave training and demonstration on the use of Super

grain bags to 209 farmers of Tsirang and Dagana Dzongkhags. For centuries, farming has been the cornerstone of Bhutanese society. Since the dawn of agriculture, Bhutanese farmers have skilfully navigated both biological challenges (biotic factors) and environmental challenges (abiotic factors) to ensure a successful harvest. However, traditional methods of storing crops are no longer sufficient to protect them.

Previously, farmers relied on storing seeds in sacks or bottles, hanging them from rooftops. Unfortunately, these methods do not guarantee long-term storage. Seeds are susceptible to pest damage, and proper grain storage facilities are often lacking.

To address this issue, the National Centre for Plant Protection introduced "super grain bags" for storing agricultural seeds. These innovative bags not only extend the shelf life of seeds but also preserve their taste and aroma, and promote better germination. Most importantly, super grain bags offer superior pest control, safeguarding crops after harvest. They are suitable for storing all types of dried seeds, including those of dru-na-gu, coffee, and sorghum. The bags were distributed in Patshaling, Kana and Nichula gewogs.

12. Monitoring of Fall Armyworm using sex pheromone in Gasa Dzongkhag

With fund support from AFACI through NPPC, monitoring of Fall armyworm using the sex pheromone trap was carried out in Gasa Dzongkhag. The main objective is to detect the presence and monitor FAW in Gasa Dzongkhag. Two types lure supplied by NPPC (PCI from India and SF 2113-manufactured by Pherobank BV, The Netherlands) was used to evaluate the FAW presence. Monitoring of Fall armyworm was carried out in Potato, Potato intercrop with maize, Paddy nursery, Potato & Paddy intercrop with maize in Khamey and Khatoed Chiwog, Gasa Dzongkhag. Traps were deployed from the seedling stage and vegetative stage of the crops. Each trap was hung approximately 1.2 meters above the ground and was placed inside the field. The pheromone lures were replaced after 2 weeks. Data was collected at a fortnightly interval. The pheromone lure trapped non-target moths as well which is a setback. The moths trapped inside the traps were segregated and recorded and samples were collected from the field and brought to the laboratory for confirmatory identification in NPPC. Updates on the results will be shared after the completion of data collection.

Table 42: Monitoring of Fall Armyworm in Gasa Dzongkhags

Sites	Crop	Location	Village, Gewog	Lure Used
1	Potato Intercrop with maize	27.5335N 89.448E	Dongchana, Khatoed	PCI
2	Potato		Omchugang, Khatoed	Netherland
3	Paddy Nursery	27.491N, 89.4347E	Potogang, Khamey	PCI
4	Paddy Nursery, Potato & maize intercrop	27.4857N 89.4354E	Damji, Khamey	Netherland

13. Maize-legume intercropping for Fall armyworm management

Maize, an important source of food and nutritional security widely grown as a staple crop closely associated with household food security in Bhutan. Starting in 2019, the Fall Armyworm (FAW), *Spodoptera frugiperda* (G.E. Smith) was detected in Bhutan which now has become a major pest in the region. Intercropping, especially with leguminous crops, has proven effective in managing the fall armyworm (*Spodoptera frugiperda*) (Jalloh et al. 2023; Tanyi et al. 2020; Udayakumar, Shivalingaswamy, and Bakthavatsalam 2021). Jalloh et al., (2023) found maize-legume intercropping systems improve soil health, maize growth and reduce FAW larval feeding and development. Udayakumar et al., (2021) reported that intercropping maize with various leguminous crops (such as groundnut, broad bean, *Desmodium* sp, and soybean) reduced fall armyworm damage and larval populations compared to monocropped maize. For its management, ARDC Bajo (PP Unit) in collaboration with National Plant Protection Center (NPPC) with fund from AFACI are evaluating the effectiveness of maize-legumes intercropping at two different locations viz., ARDC, Bajo (Wangdue) & Dzomilithang (Punakha).

The trial was laid in a randomized block design comprising five treatments. The treatments were i) Maize - Rajma Beans, ii) Maize - White Pole Beans, iii) Maize – Borloti, iv) Maize -Top crop Beans and v) Maize mono-crop. Each treatment has three replications. Yangtsepa maize was used for this trial. Data collection was carried out fortnightly using the eppicollect5 application in mobile devices. Twelve plants were tagged from each plot for data collection. The data was collected using the Toepfex & Fallet 0.0-4.0 Leaf damage Index, on the first three fresh leaves. Presence of beneficial insects and other pests were also recorded as per the protocol. The result on this evaluation will be updated at the end of the experiment.

14. Sentinel Plots for Wheat Rust

With support from CIMMYT through NPPC, ARDC Bajo 24 lines of wheat seeds to establish sentinel plots for monitoring stripe rust, stem rust, or both. The seeds were sown in lines, each in two rows spaced 70 cm apart. The local variety, Bumthang Ka Druchu, was used as a check. Any diseases observed in the plots were collected and the samples were sent to international laboratories for pathotyping and genotyping. Data was collected using ODK application in mobile devices.

15. Soil and Land Management Services

1. Rice Husk Biochar

This technology is prepared from a rice husk as a raw material and rice straw is used as a feedstock. It is produced under a controlled air environment called “pyrolysis”. It is a soil amendment that retains and conserves soil moisture and nutrients in the soil. Most importantly, it helps to fix soil carbon in the soil. The Unit produced about 3,800 kg of biochar. It was used at the Centre in various horticultural crops. The Centre also distributes it to the farmers, youths, and college students for studies and promotion.

2. Fermented Rice Bran Bokashi

It is an organic fertilizer prepared from rice bran produced in an anaerobic fermentation. It acts as a substitute for chemical fertilizers. The Unit produced about 4,550 kg of bokashi. It was used at

the Centre in various horticultural crops. The Centre also distributes to the farmers, youths, and students for studies and promotion.

3. Bhutan Agri-Microbial Solutions (BAMS)

Similar to Effective Microorganism (EM), the Centre developed another organic technology called BAMS. It is mainly used as a substitute for microorganism source in preparing bokashi. It also helps in accelerating the rate of decomposition in composting. The Unit produced about 1,000 liters of BAMS for a use in bokashi preparations as well as supplies it to college students for studies.

4. Vermi Composting

It is an organic input produced at the Centre for a use in potting mix as well as in flowers and horticultural crops. The unit produced about 850 kg this year. It is one of the highly nutritive soil nutrient sources produced by the Center.

5. Capacity building on Climate Smart Agriculture (CSA) Technologies

Hands-on-trainings, demonstrations and practicum was performed for farmers, trainees, students, Dessups, staff and agriculture extension officials under Wangdue, Punakha, Dagana, Tsirang and Gasa. The CSA technologies that were catered for up-scaling includes biochar, bokashi, BAMS, wood vinegar, smart irrigation, land development and hydroponics cultivation. About 500 people were trained this year alone.

6. Consortium for Scaling-up Climate Smart Agriculture in South Asia (C-SUCSeS) Project

Funded by this project, the farmers of Khamoe gewog under Gasa were trained on CSA technologies such as biochar, bokashi, BAMS and wood vinegar. The training covered its preparations, usage and benefits linking to agriculture and climate as a whole.

16. Visitors' information

During the fiscal year 2023-24, ARDC-Bajo welcomed 41 diverse groups of visitors, including farmers, students, youths, trainees, high-level delegates, and foreign representatives from various organizations and agencies. These visits, conducted for study tours and exposure trips, had varied learning objectives. Farmers were interested in observing high-yield crop varieties, extension personnel focused on new technologies, and trainees, guests, and other visitors had specific reasons for their visits. Overall, there was a broad interest in the technologies available or adopted at the Centre. (Annexure I)

FOOD SECURITY AND AGRICULTURE PRODUCTIVITY PROJECT (FSAPP)

ARDC Bajo received a total budget of BTN 17.30 million during FY 2023-24 from FSAPP for implementing project activities, along with an additional BTN 3.50 million for the construction of a farmers' hostel. This brought the total funding to BTN 20.80 million for FY 2023-24. The Centre successfully utilized 100% of the allocated funds.

Table 43: FSAPP Annual Workplan & Budget: July 2023 to June 2024

SN	Component	Annual Workplan & Budget: July 2023 to June 2024	BTN (M)	Remarks
1	Component 2: Enhancing Farmer Productivity: Sub-component 2.2: Providing technical and institutional capacity building to farmers, extension services, and selected agricultural institutions to improve farm management and sustain Project activities	(a) Construct farmers hostel at ARDC Bajo	12.5	100% expenditure
2		(b) Integrated Management (Nutrient, water efficiency, pest, & diseases, Canopy management) of Citrus	3.80	100% expenditure
3		(c) Establish and demonstrate raised bed nursery raising in protected cultivation to showcase technology	0.80	100% expenditure
4		(d) Set up Hydroponics at ARDSC Menchuna as a demonstration	1.00	100% expenditure
5		(e) Demonstration of climate-smart agriculture technologies	0.50	100% expenditure
6		(f) Promote cultivation of black pepper as an intercrop with arecanut trees	1.5	1.00M reappropriated to Farmers' hostel wall construction
7	Component 4: Project Management	(a)Conduct quarterly Project Support Team Meetings to enhance planning and implementation of the project's activities	0.20	100% expenditure
8		(b) Monitoring of project's activities under ARDC Bajo region	0.20	100% expenditure
9		(c)Maintenance of property-vehicle	0.30	100% expenditure
		Total	**20.80**	

17. Construct farmers hostel at ARDC Bajo

A sum of BTN 9.00 million, along with an additional BTN 3.50 million (totaling to BTN 12.5 million), was allocated for the construction of a two-story farmers' hostel at ARDC Bajo. The construction of the hostel has been completed and handed over to ARDC Bajo. The facility can accommodate 32 farmers on the ground floor and includes five staff rooms and two executive rooms upstairs.

18. Citrus Integrated Management (Nutrient, pest, & diseases, Canopy management)

During FY 2023-24, ARDC Bajo was allocated NU 3.8M from the Food Security and Agriculture Productivity Project (FSAPP) to carry out integrated management of citrus. The ARDC Bajo team

conducted consultation meetings with citrus-growing farmers from FSAPP gewogs (Kana, Drujegang, Lajab, and Karmaling) under Dagana Dzongkhag. During these meetings, a citrus fruit drop management campaign was carried out in each gewog, demonstrating to farmers how to pick and dispose of fruit drops. Farmers were also trained on preparing bio-enzyme and detergent using citrus fruit drops to control citrus fruit fly infestation. A total of 330 households participated in the campaign. The Centre procured and distributed 200-liter plastic barrels to citrus-growing farmers in groups in each chiwog for collective collection and disposal of fruit drops the coming season (Kana 25 nos, Drujegang 25 and Lajab 15 nos).

The Centre has carried out mass citrus canopy and soil nutrient management including plant protection measures in the project gewogs under Dagana Dzongkhag with involvement of Gewog Extensions and Dzongkhag officials along with the beneficiaries. Canopy management is carried out to control tree height and width for ease of management practices and reduce water and nutrient requirements, rejuvenate fruit earing woods on regular basis, improve light and air penetration into canopy which manipulate fruit size and improve fruit quality. It also manipulates crop load and reduce alternate bearing habit of the tree. Total of 4,829 citrus trees covering 43.12 acres of land under four FSAPP supported gewogs are properly canopy managed.

Table 44: Details of Citrus canopy managed under Dagana Dzongkhag

SN	Gewog	Total HHs covered	Citrus canopy management		Total
			Bearing	Non-bearing	
1	Karmaling	9	70	454	524
2	Laja	11	507	225	732
3	Drujaygang	3	405	153	558
4	Kana	16	2335	680	3015
Total		**39**	**3317**	**1512**	**4829**

The beneficiaries were demonstrated and made aware of how to prepare trenches for irrigation and fertilizer application. The trench should be prepared along the direction of the natural flow of surface runoff water, down the trunk, with a size of 45 cm width and 45 cm depth, and it should be one meter away from the tree trunk. Biochar, bokashi, NPK, and cattle manure were added and then filled with water. Additionally, hands-on training was provided on Bordeaux (Bodo) paste and spray preparation. Bodo paste should be prepared with a ratio of 1:1:10 (copper sulfate (kg): lime (kg): water (liters), and the spray with a ratio of 1:1:100 (copper sulfate: lime: water). Bodo paste is used as a pesticide, fungicide, bactericide, and algaecide, controlling pests like trunk borers and reducing the infestation of parasites like lichens and mosses on the trees. To continue the task, the following materials were supplied to the gewog extension so that they can continue the canopy management.

Table 45: Materials procured and issued to gewogs for citrus canopy management

Gewog	Metal trunk (no)	Copper sulphate (kg)	Lime (kg)	Secateurs (no)	Pruning saw (no)	Power chain saw (no)	Power sprayer (no)	Top pruner (no)	Suphula (kg)
Karmaling	1	50	50	11	11	1	1	1	0
Lajab	1	50	50	11	11	1	1	1	1000
Kana	1	50	50	11	11	1	1	1	1800
Drujaygang	1	50	50	11	11	1	1	1	2000
Total	**4**	**200**	**200**	**44**	**44**	**4**	**4**	**4**	**4800**

During FY 2023-24, more than 100 acres of citrus orchards were covered under the Integrated Management of Citrus program, which includes nutrient, pest, disease, and canopy management.

19. Establishing Demonstration of Raised Bed Nurseries in Protected Cultivation

The establishment and demonstration of raised bed nursery raising in protected cultivation is a vital initiative to showcase advanced agricultural technology. This technique is designed to enhance plant growth conditions, facilitate easy irrigation using drip irrigation with automation, improve yields, ensure efficient water use, and promote sustainable agricultural practices.

The objective is to introduce and promote the concept of raised bed nursery raising and drip irrigation among visitors, especially farmers visiting the Centre, providing them with the knowledge and skills needed to implement these technologies effectively.

During FY 2023-24, a sum of BTN 0.80 million was allocated to establish a raised bed nursery in greenhouses at the Centre. The Centre successfully constructed 10 raised nursery beds inside the greenhouses on-station. Each bed measures 25 meters in length, 1 meter in breadth, and 60 cm in height.

20. Set up Hydroponics at ARDSC Menchuna as a demonstration

During FY 2023-24, through FSAPP, a hydroponic system was constructed at ARDSC Menchhuna, Tsirang to showcase this innovative technology. This system will serve as a demonstration site for the many youths who visit the Sub-Centre seeking appropriate and attractive farming technologies. The hydroponic setup measures 20 meters in length and 5 meters in breadth, with 1,500 planters installed inside. The greenhouse structure has been raised by an additional 1.6 meters using iron posts to ensure better ventilation and temperature regulation.

21. Demonstration and promotion of climate smart technologies

During FY 2023-24, the Centre demonstrated several recently released climate-smart agriculture technologies, including bio-char, bokashi, improved potting media methods, composting and mulching, rice husk biochar, fermented rice bran fertilizer, Bhutan Agri-microbial solution and wood and bamboo vinegar. These technologies were promoted through hands-on demonstrations and farmer training sessions in project gewogs. For interested youths and school dropouts, the Centre conducted a week-long, tailor-made skilling program, providing practical training on these climate-smart technologies. Additionally, hands-on training programs were organized for farmers in the field. The objective of these initiatives is to promote climate-smart technologies that will assist farmers, youth, and agricultural entrepreneurs in practicing organic agriculture.

The demonstration training was divided into two parts. For those who were interested to take intensive course at the Centre they were invited at the Centre and a weeklong tailor-made training program was developed to them. 23 participants from Lajab, Kana and Drujegang gewogs attended the week-long training at ARDC Bajo. Similar training was provided at Gewog level for those interested participants who could not come to attend at the Centre.

The training covered various sustainable agricultural practices, including the preparation and benefits of rice husk biochar, fermented rice bran bokashi, and Bhutan Agri-Microbial Solution (BAMS) for organic farming. Participants received hands-on training in bio-digester technology, wood vinegar production, open-air biochar, integrated pest management (IPM), vermicomposting,

improved potting media, and mushroom cultivation. Each session emphasized practical applications, enhancing participants' skills in organic farming techniques and contributing to rural livelihood improvement.

Table 46: List of participants for CSA training

SN	Gewog	Number of Participants			Remarks
		Male	Female	Total	
1	Drujegang	04	05	09	Week long skilling program on climate smart technologies at ARDC Bajo
2	Kana	04	00	04	
3	Lajab	09	02	11	
4	Lhamoizingkha	26	12	38	Farmers' hands-on training on Open air biochar production and uses; orchard development
5	Karmaling	10	05	15	
6	Nichula	25	11	36	
Total		**78**	**35**	**113**	**40% female participation**

22. Promote cultivation of black pepper as an intercrop with arecanut trees

The primary objective of this activity is to diversify the cropping system in monoculture arecanut plantations and increase farmers' income during uncertain climate change impacts. Farmers can benefit from different crop harvests through these diversified cropping systems. ARDC Bajo, with support from FSAPP, initiated this intercropping at Karmaling Gewog in FY 2022-23. The Centre aims to expand the cultivation to Karmaling, Lhamoizingkha, and Nichula Gewogs. This is achieved through skilling programs, encouraging private nursery growers to raise black pepper seedlings, and increasing arecanut plantation and intercropping. The seedlings were procured from private nurseries and promoted to farmers along with hand-on training.

In FY 2023-24, the activity successfully established 14.46 acres of arecanut plantation intercropped with black pepper, benefiting 74 households and involving the planting of 13,000 black pepper seedlings.

Table 47: Black pepper distribution details

Gewog	No of HHs	No. of seedlings	Area (Ac)	Remarks
Karmaling	16	4000	4.45	Plantation completed
Lhamoizingkha	25	5400	6.00	Planting demo conducted, seedling procured and plantation will be carried out July-Aug, 2024 (on onset of rainfall)
Nichula	33	3600	4.00	
Total	**74**	**13000**	**14.46**	

23. Project Management Unit

During FY 2023-24, the Centre coordinated and conducted four Project Support Team (PST) meetings. These meetings were held to review progress, provide updates on ongoing project activities, present future plans, discuss implementation issues, and identify areas where technical support is needed in project sites under Dagana Dzongkhag. Additionally, the meetings addressed relevant field-related problems and constraints. Attendees included PMU officials, representatives from FAO-TA, and PST members from ARDC Bajo and Dagana. The meetings resulted in important resolutions aimed at improving the working environment.

The PST members of ARDC Bajo made several visits to monitor project activities. ARDC Bajo also conducted a technology adoption study on some of the project activities. In collaboration with the Dzongkhag, ARDC Bajo collected five success stories, some of which have already been published, with the rest to be published through various media channels.

The site engineer from the Regional Cluster Engineering, Punakha, who was involved in the construction of the farmer's hostel, made several monitoring and site visits to the construction site. His travel expenses were covered by the budget allocated for monitoring project activities.

As per the requirement of the project ARDC Bajo conducted adoption survey was conducted using purposive random sampling method by randomly selecting the beneficiaries of each promoted technologies. For this survey, semi structured questionnaire was designed, and data was collected through interviews and Google Form from a random sample of beneficiary farmers from project gewogs under Dagana dzongkhag. The collected data was then analyzed using excel and SPSS.

Table 48: Summary table of technology adoption rate of different technology promoted

SN	Technology Promoted	Adoption rate from survey %	Total HHs beneficiary	Share percentage of beneficiary
1	Promotion of Climate smart technologies	100	47	7%
2	Promotion of Low-cost water harvesting technology	89	250	38%
3	Promotion of Electric fencing using HDPE poles	100	12	2%
4	Promotion of Citrus Canopy Management	78	306	46%
5	Promotion of Mushroom Cultivation	46	46	7%
Overall Technology adoption percent (%)		**82.6 %**	**Weighted Adoption rate (%)**	**81.90 %**

FINANCIAL REPORT FOR THE FY 2023-24

Table 49: Financial report as of June 30 2024

Title source	Approved budget (Nu. M)	Expenditure (Nu. M)	Balance (Nu. M)	Remarks
RGoB	67.21	67.182	0.028	As block grant
Green Climate Fund (GCF)	1	1	0	Skilling of field on climate smart technologies
FASP Project	20.8	20.8	0	Implement project activities
C-SUCSeS	0.053	0.053	0	Deposit work
NSB	0.2	0.2	0	Deposit work
NMC	0.25	0.25	0	Deposit work
NPPC/AFACI	0.457	0.457	0	
MFTP	0.943	0.943	0	Deposit work
Total	**90.913**	**90.885**	**0.028**	

ANNEXURE

Annexure I: Visitors details 2023-24

SN	Date	Organization	No. of Heads	Purpose
1	27/06/2024	FSAPP	15	FSAPP PST meeting, site visits for FSAPP implemented activities
2	25/06/2024	ESS Expert, FAO	1	Monitoring of Farmers' hostel construction for ESG and OHS
3	15/06/2024	CRP, TA- FSAPP	22	Exposure Visit of BCC Champions of FSAPP Gewogs to ARDC Bajo
4	14/06/2024	Dessung	30	30 Dessups on the third phase of planting subtropical fruit plants
5	14/06/2024	ICIMOD Delegates, Nepal	15	Exposure Visit of ICIMOD Delegates to ARDC Bajo for in climate-resilient technologies
6	13/06/2024	JICA HQ Thimphu	7	JICA officials, led by the JICA-iNTE Crop Coordinator to review the status of project activities implemented both at the station and in the farmer's fields
7	06/06/2024	B.SC student	28	Horticulture nurseries, floriculture and ROP
8	05/06/2024	JICA HQ Thimphu	7	Conduct preparation for pipeline project on HWC management
9	05/06/2024	FSAPP	18	AOS workshop
10	27/05/2024	CNR, Lobesa	30	BSc OAG students practical/demo on organic fertilizers
11	19/05/2024	BATIF Delegates		Exposure visit
12	15/05/2024	FSAPP ISM Delegates	5	FSAPP ISM Delegates Visit on ESS on Farmer's hostel
13	12/05/2024	FSAPP Farmers, Dagana	23	Hand-on training on climate smart and improved agriculture technologies (9 day)
14	26/04/2024	CNR, Lobesa	30	B.Sc Agriculture students on climate resilient technologies hand-on demonstration
15	20/04/2024	College of Language and Culture Studies, Trongsa	17	Exposure visits to develop entrepreneur ship
16	09/04/2024	DoA	2	Chief ARID for Research Review Meeting
17	06/04/2024	MoAL	7	Visit of honourable Dasho Secretary, MoAL along with important delegates DAMC DG, DoL Director, DoA Director, Health Director and Chief marketing officer, DAMC to monitor Mayazaki mango trail & Durum wheat program
18	04/04/2024	Co-TLL FAO & team	7	Official visit
19	20/03/2024	ESS FASPP	1	collect information for the quarterly ESS report for Bajo Farmer's hostel.
20	07/03/2024	FSAPP	21	PST meeting, field visit

21	06/03/2024	MoAL	7	Honorable Minister of the Ministry of Agriculture and Livestock visited the Agriculture Research and Development Centre (ARDC) Bajo as a familiarization visit.
22	29/02/2024	Dasho MP Nisho-Sephu demkhong	1	Feminization visit
23	28/02/2024	Exchange student from America, Bhutan Ecological Society	27	The purpose of their visit was to gain insights into the Research Centre and to familiarize themselves with the various activities conducted by ARDC Bajo.
24	19/02/2024	DoA	10	Joined for Tashi Khader to new Program Director
25	31/01/2024	Dessung	19	Visit of Permaculture experts along with Dessung trainees, visit to horticulture nurseries and discuss about Permaculture with relevant staff
26	31/01/2024	Lingkana Place	2	Fruit plant balling discussion with horticulture sector
27	18/01/2024	Royal Project, Lingkana	2	Horticulture technologies
28	17/01/2024	ARDSC Menchuna		Technologies transfer
29	28/12/2023	FAO Nepal	2	Familiarization on Climate smart technologies
30	27/12/2023	NCOA (JICA)	14	Visit with JICA expert to learn about Climate Smart Technologies
31	26/12/2023	Director, DoA	2	Monitoring visit
32	09/12/2023	ESS expert, FAO	3	Farmers hostel construction site, discussion regarding ESS issues and OHS requirement
33	29/11/203	FSAPP	22	PST meeting, field visit
34	28/11/2023	FSAPP	22	PST meeting, field visit
36	29/09/2023	CEO, FMCL	10	Bio fertilizer
37	09/08/2023	FSAPP Aduit	4	FSAPP Audit field visit
38	07/08/2023	FSAPP	23	PST meeting, field visit
39	02/08/2023	Dzongkhag Administration Wangdue Phodrang	12	Familiarization visit by Dzongda and new recruits
40	27/07/2023		28	Demonstration on climate smart and improved agriculture technologies (ESPs and GSPs)
41	05/07/2023		8	Visit of honourable Dasho Secretary, MoAL along with Director and other officicals from DoA and Agri Sector, Dzongkhag Administration Wangdue Phodrang
Total			**504**	

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 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**.**

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