BUILDING RESILIENT COMMERCIAL SMALLHOLDER AGRICULTURE (BRECSA)

AGRICULTURE RESILIENCE PLAN (ARP) FOR TRONGSA DZONGKHAG (VERSION 1.0)

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ROYAL GOVERNMENT OF BHUTAN

MINISTRY OF AGRICULTURE AND LIVESTOCK

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Building Resilient Commercial Smallholder Agriculture

(BRECSA)

AGRICULTURE RESILIENCE PLAN FOR TRONGSA DZONGKHAG

(VERSION 1.0)

March 2024

Project Management Unit

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1. INTRODUCTION AND BACKGROUND.

The Agriculture Resilience Plan (ARP) is a strategic framework designed to enhance the capacity of agricultural systems to withstand and recover from adverse conditions such as climate change, extreme weather events, pest outbreaks, and economic shocks. Its primary purpose is to suggest recommendations that would ensure food security, maintain agricultural productivity, and support farmers' livelihoods through adaptive practices, technological innovations, and sustainable resource management. The ARP is a document that includes measures like identifying agroecological practices (Crop diversification, IPM), suitable post-harvest management techniques, climate-resilient infrastructure (protected production technologies, rain harvesting, temperature-controlled storage structures, water-efficient technologies, climate-smart animal sheds), and value-addition facilities. It also encompasses other climate change adaptation measures such as water-saving technologies and water harvesting and storage facilities, which must be tailored to each local needs.

2. PURPOSE AND SCOPE OF ARP

The Agriculture Resilience Plan (ARP) for Trongsa Dzongkhag serves as a comprehensive strategic framework to enhance the resilience of agricultural systems amidst the challenges posed by climate variability, limited resources, and socio-economic vulnerabilities. Developed through an inclusive and participatory process, the ARP incorporates findings from the CLEAR+ exercise and ARPR validation workshops, ensuring that it reflects the realities faced by communities across the Dzongkhag.

It envisions building agricultural and livestock systems that can adapt to shifting climate patterns, withstand shocks such as erratic rainfall, droughts, and pest outbreaks, and continue to support farmers' livelihoods. It focuses on promoting sustainable farming practices enhancing the productivity of climate-sensitive crops such as paddy and oranges, and integrating climate-smart technologies, such as rainwater harvesting systems, climate-smart sheds, and polytunnels.

The ARP adopts a **Gewog-specific approach**, emphasizing localized strategies rather than a single Dzongkhag-wide framework. This ensures interventions remain **r**elevant to local contexts and address their specific climate challenges, resource availability, and livelihood priorities. It also targets the critical commodities for each Gewog, addressing challenges like pest outbreaks, irrigation needs, wildlife conflicts, and market constraints. For instance, Gewogs, where paddy or dairy cattle are primary livelihood sources can focus their effort more intensively on water access, pasture development, and market linkages, while others with more emphasis on crops like cardamom may prioritize wildlife conflict management or post-harvest facilities.

3. CONTEXT

The climate plays a pivotal role in Bhutan's agriculture, shaping the productivity and sustainability of this predominantly agrarian economy. Bhutan's diverse topography, ranging from subtropical lowlands to alpine highlands, creates varied microclimates that support various crops. However, Bhutan's agricultural sector faces climate-related challenges, including unpredictable rainfall, increasing temperatures, and more frequent extreme weather events, threatening crop yields and food security.

Climate change threatens livelihood activities in Trongsa Dzongkhag, with wide-reaching impacts across various crops and livestock systems. During community consultations, Gewog residents shared their experiences of shifting climate patterns—particularly erratic rainfall and rising temperatures—increasingly affecting their main livelihood commodities, including paddy, maize, dairy cattle, cardamom, oranges, potatoes, and wheat.

3.1 Erratic Rainfall: One of the most critical challenges reported was the irregular and insufficient rainfall, leading to water scarcity across various agricultural and livestock activities, particularly during the early months of the year. Crops like paddy rely heavily on water availability during transplanting, while maize, oranges, and cardamom are also impacted, as they need consistent moisture for optimal growth. In the absence of irrigation facilities for these dryland crops, farmers rely entirely on natural rainfall. Paddy growers in

Gewogs like Drakteng and Langthil frequently face water shortages that hinder the completion of paddy cultivation. Likewise, cardamom and orange growers in Korphu and Langthil struggle with prolonged dry spells in March and April, resulting in plant mortality and reduced yields. Investing in water management systems and drought mitigation strategies could help farmers address these challenges effectively.

3.2 Rising Temperatures: Rising temperatures were also a significant concern, with residents observing changes in growth patterns and an increase in pest and disease outbreaks across crops and livestock. Oranges, for instance, have become increasingly vulnerable to pests like citrus greening and fruit flies, resulting in yield losses and plant mortality. Meanwhile, crops like paddy and maize are experiencing more frequent pest issues, such as armyworm infestations.

3.3 Livestock Impacts: In dairy cattle farming, water scarcity affects fodder growth, and many farmers reported struggling to find sufficient fodder, impacting cattle health and milk production, especially during the winter months. Additionally, participants in community consultations linked last year's outbreak of Lumpy Skin Disease in cattle to climate change.

3.4 Wildlife Conflicts: Maize and paddy fields face intensified wildlife conflict as animals move to new areas in search of food amid changing climate conditions. All the Gewogs reported increased crop predation, which threatens food security and requires effective wildlife conflict management strategies.

To address these challenges, the district's residents emphasize the need for a comprehensive climate adaptation strategy that includes water conservation techniques, pest and disease management, improved irrigation systems, cooperative marketing to overcome market access issues, and training programs for farmers on climate-smart agriculture. These measures could not only mitigate climate-related risks but also build long-term resilience in

Trongsa's agricultural sector, helping the community navigate the evolving impacts of climate change.

4. CLIMATE RESILIENCE

Climate resilience is the ability of rural communities to withstand and quickly recover from climate-related shocks and stressors, such as changes in rainfall patterns, higher temperatures, or extreme weather events like wind storms, without suffering long-term negative effects on food security. In other words, communities with high resilience can recover and improve more rapidly after a climate-related shock than those with low resilience.

The resilience level In Bhutan assessed by CLEAR+ analysis was based on six factors identified during community consultations: access to wealth, food, and land; livelihood diversity; remoteness; access to irrigation and availability of non-climate-sensitive livelihood options (Figure 1).

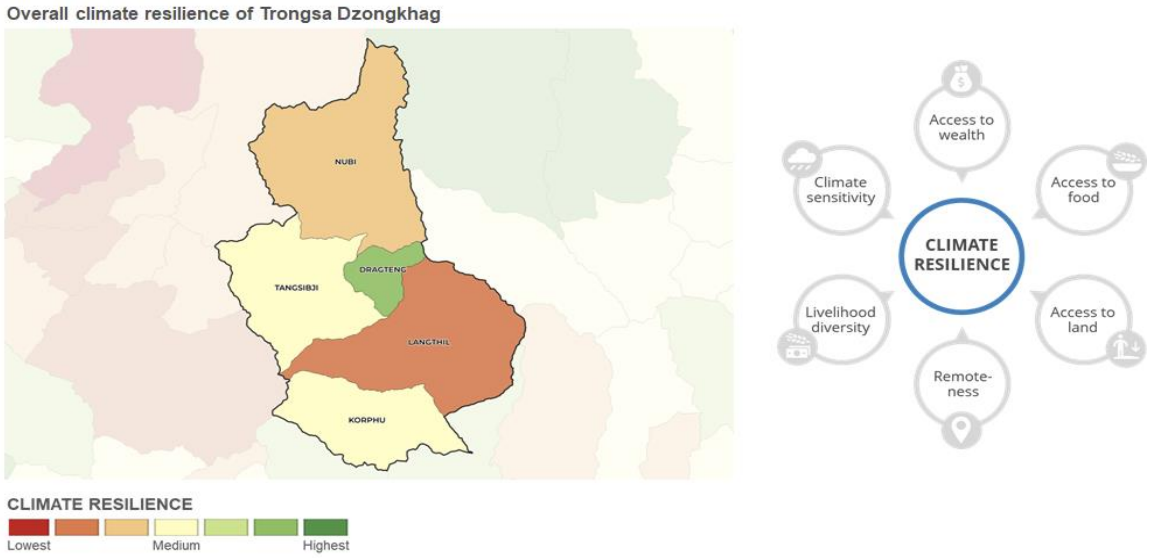

Figure 1: Overall climate resilience of Trongsa Dzongkhag

Table 1 provides an analysis of the resilience levels of each Gewog in Trongsa Dzongkhag, highlighting the district's vulnerability due to economic, climate sensitivity, and geographical constraints. A score of 1 indicates high resilience, while 4 signifies the lowest

resilience in each category. Trongsa, one of Bhutan's relatively remote regions, experiences multiple challenges that impact its resilience to climate-related shocks. Each dimension—wealth, remoteness, access to food, land access, and livelihood diversity—is integral to understanding the district's resilience framework and identifying areas where intervention may strengthen local livelihoods and enhance adaptability.

Table 1. Resilience table of Trongsa

Gewog	Access to wealth	Access to food	Access to land	Remoteness	Climate sensitivity
Dragteng	3	1	3	2	1.5
Korphu	4	1	2.5	1	3.75
Langthil	4	3	3.5	3	2
Nubi	4	3	2.5	3	2.75
Tangsibji	3	1	2.5	2	2.5

*Scores 1-4 were assigned to each category, with 1 being the most resilient and 4 being the least resilient.

Gewogs such as Draagteng and Tangsibji show relatively high resilience due to better access to wealth, food and land, scoring 1 in food access and moderate ratings in other categories. In contrast, Korphu and Langthil are among the least resilient due to their limited access to wealth, land, and higher climate sensitivity. The table suggests that Gewogs with limited wealth and access to land, like Langthil, may need focused development interventions to enhance resilience and improve living conditions.

5. DZONGKHAG PROFILE

The Dzongkhag profile provides a comprehensive overview of key information and salient features for five Gewogs under Trongsa Dzongkhag. Each Gewog is described in terms of area, number of households, population distribution by gender, irrigation schemes, total irrigation channel length, and agricultural land (wetland and dryland). Overall, it highlights the diversity in the size, population, and agricultural infrastructure across the five Gewogs, providing valuable insights for planning and development initiatives. Trongsa's extensive forest cover plays a vital role in shaping its agroecological zones and influencing the agricultural practices and livelihoods of its residents. Forests serve as a resource base for many households for products such as orchids and Sichuan pepper while the proximity of agricultural lands to forests increases interactions between humans and wildlife. Wild animals, such as deer and wild boars, often raid crops, leading to significant losses, and farmers must invest time and resources in guarding fields or building deterrents. These challenges can intensify, impacting both food security and the overall well-being of the community. Population densities vary significantly, with some Gewogs, such as Draagteng and Langthil, having relatively higher populations, while other Gewogs, like Tangsibji, have smaller populations.

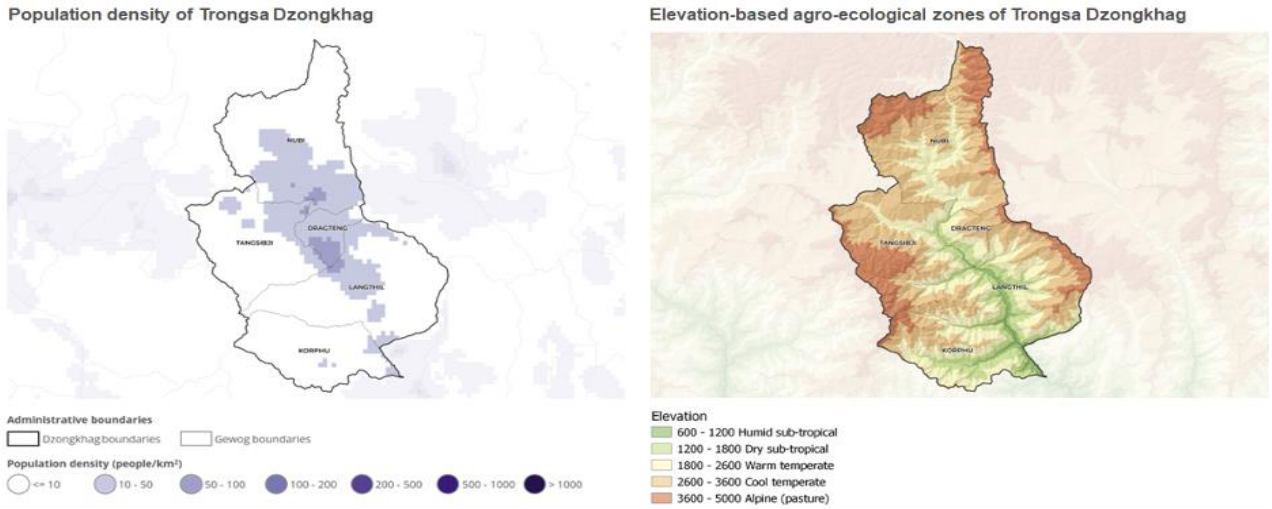

Figure 2. Population density map and agro-ecological zones of Trongsa Dzongkhag

Table 2 showcases the distribution of agricultural land in each Gewog, distinguishing between wetland and dryland. This agricultural land data highlights the district's

dependence on both irrigated wetland and more prevalent dryland farming. Gewogs like Draagteng and Langthil, for instance, have larger areas of wetland, essential for paddy cultivation, while Gewogs such as Nubi rely more on dryland agriculture because of terrain limitations. This detailed profile will aid in strategic planning, identifying where improvements in irrigation and infrastructure could bolster agricultural resilience and enhance food security for the Dzongkhag's scattered communities.

Table 2 Dzongkhag profile

Gewog	Area (Sq. Km)	Forest cover	Number of Households	Population		Irrigation Schemes (Nos)	Total Length (km)	Wet Land (Acre)	Dry Land (Acre)
				Male	Female				
Draagteng	84.59	67%	994	2258	2620	8	22.10	913.676	1695.83
Korphu	288.10	56%	203	1028	1070	12	25.40	320.808	1291.19
Langthil	508.40	78%	748	1495	1401	27	101.00	704.780	1714.87
Nubi	554.40	56%	481	1028	1070	32	106.85	586.753	2146.29
Tangsibji	371.60	75%	429	1045	928	11	24.50	433.268	908.005

Data source: 12FYP personal communication with the District Agriculture Officer.

6. OVERVIEW OF BASELINE CLIMATE, FUTURE SCENARIOS, AND CLIMATE-INDUCED IMPACTS

6.1. Overview of Baseline Climate

Bhutan experiences daily mean temperatures typically ranging from 12°C to 28°C through the year, with daily maximum temperatures sometimes exceeding 30°C during the hottest months (April to June). Temperature varies with topography across Bhutan with colder temperatures at high elevations. The warmest time of year is pre-monsoon (March to May), when the southernmost areas of the country can be affected by severe thunderstorms. The precipitation patterns in South Asia, including over Bhutan, are controlled mainly by the Southwest Monsoon circulation. The Southwest Monsoon is a seasonal pattern of winds from

the south west which brings heavy rain in the months of June to September over most of the country, with southern and eastern parts experiencing the highest rainfall totals due to their proximity to the Bay of Bengal. The variability of monsoon rainfall can lead to dry spells and drought over much of the country.

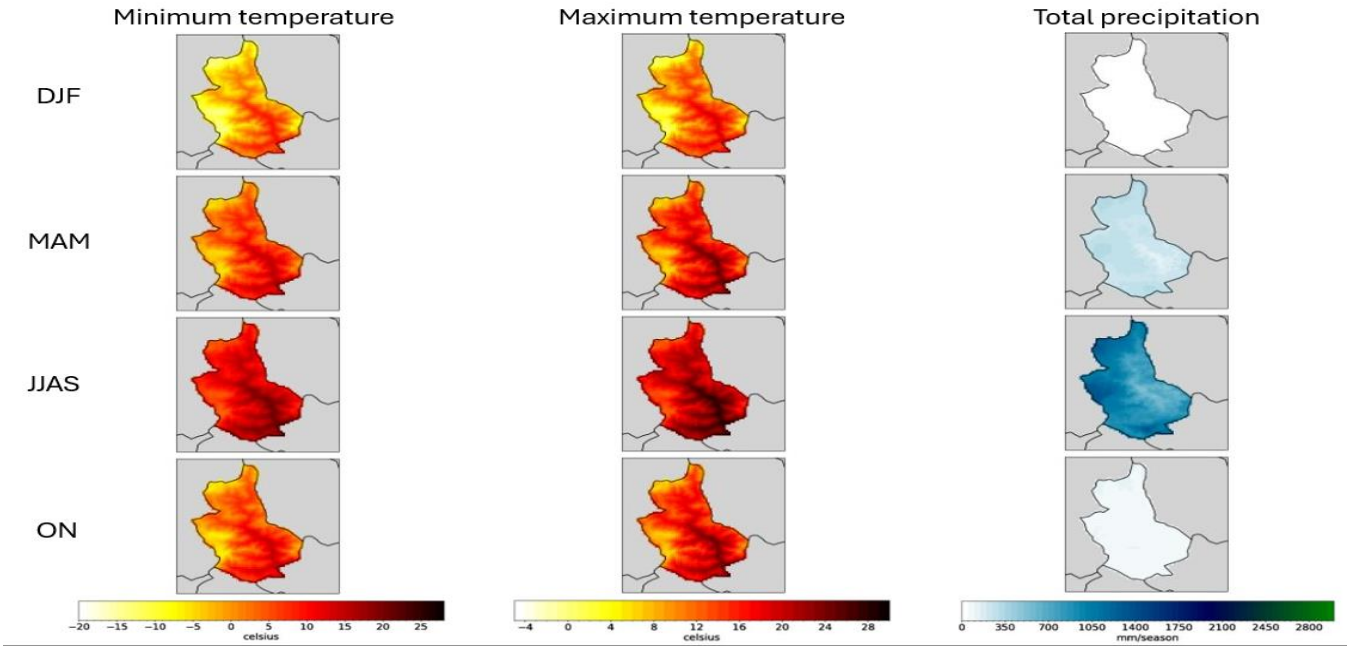

Figure 3 Seasonally averaged minimum temperature (left), maximum temperature (centre), and total precipitation (right) for TYrongsa Dzongkhag over the baseline period (1996-2019)

Seasonally averaged minimum and average maximum temperatures vary with latitude over the country, across all seasons, with the south being the warmest and the north the coldest. The summer months from June to September show the highest temperatures whilst the winter months from December to February show the lowest. The warmest time of year is during the monsoon season, with the highest mean temperatures of 24 °C, and maximum temperatures of 29 °C, occurring in June, July, and August. Seasonally averaged minimum temperatures in Trongsa Dzongkhag reach above 20 °C during summer but can drop below freezing on higher ground during winter. Trongsa Dzongkhag reaches 28 °C in the central valley during summer, with spring and autumn also reaching 24-28 °C. Winter is cooler but

still warm at 5-20 °C, again warmer in the valleys and cooler on higher ground. The Southwest Monsoon from June to September contributes about 72% to the total annual rainfall of Bhutan with the highest amount received in the month of July, followed by August. The highest totals are along the southern edge of the country, which does not usually include Trongsa Dzongkhag. However, seasonal rainfall totals in the monsoon months of June-September reach 1000 mm/season, with larger totals on higher ground and lower amounts in the valleys. The spring months from March to May and autumn months of October and November contribute about 22% to the total annual rainfall, and precipitation is low in the winter months of December to February.

6.2 Overview of Projected Climate

Most climate models project a warmer and wetter climate for Bhutan in 2050. Annual mean temperatures are projected to be 2.5 °C higher on average and the annual average precipitation is projected to be 12.5 percent higher compared to the baseline values, when averaged across the whole of Bhutan. There is a large variation latitudinally in the projected changes in precipitation, with a large increase in the far south of the country, and little change elsewhere (including Trongsa Dzongkhag). There is a small signal for increases during the pre-monsoon season, March-May. Projected changes in temperature vary latitudinally across the country, with increases of around 2.5 °C projected for Trongsa Dzongkhag. There is warming in all seasons, with the largest changes occurring in the autumn months of October-November.

There are also projected changes in future occurrence of extreme events, for both rainfall and temperature. The number of Frost Days (FD), which here is defined as the number of days in which the minimum daily temperature is below 0 °C over one year, is projected to decrease by 10-45 days per year for Trongsa Dzongkhag. Changes in Consecutive Dry Days (CDD), which is a count of the longest number of days without any precipitation per season, show that for Trongsa Dzongkhag, the CDD will increase by 5-10 days in both the winter and

autumn, meaning that there will be less precipitation in these seasons, despite the projection of a generally wetter future.

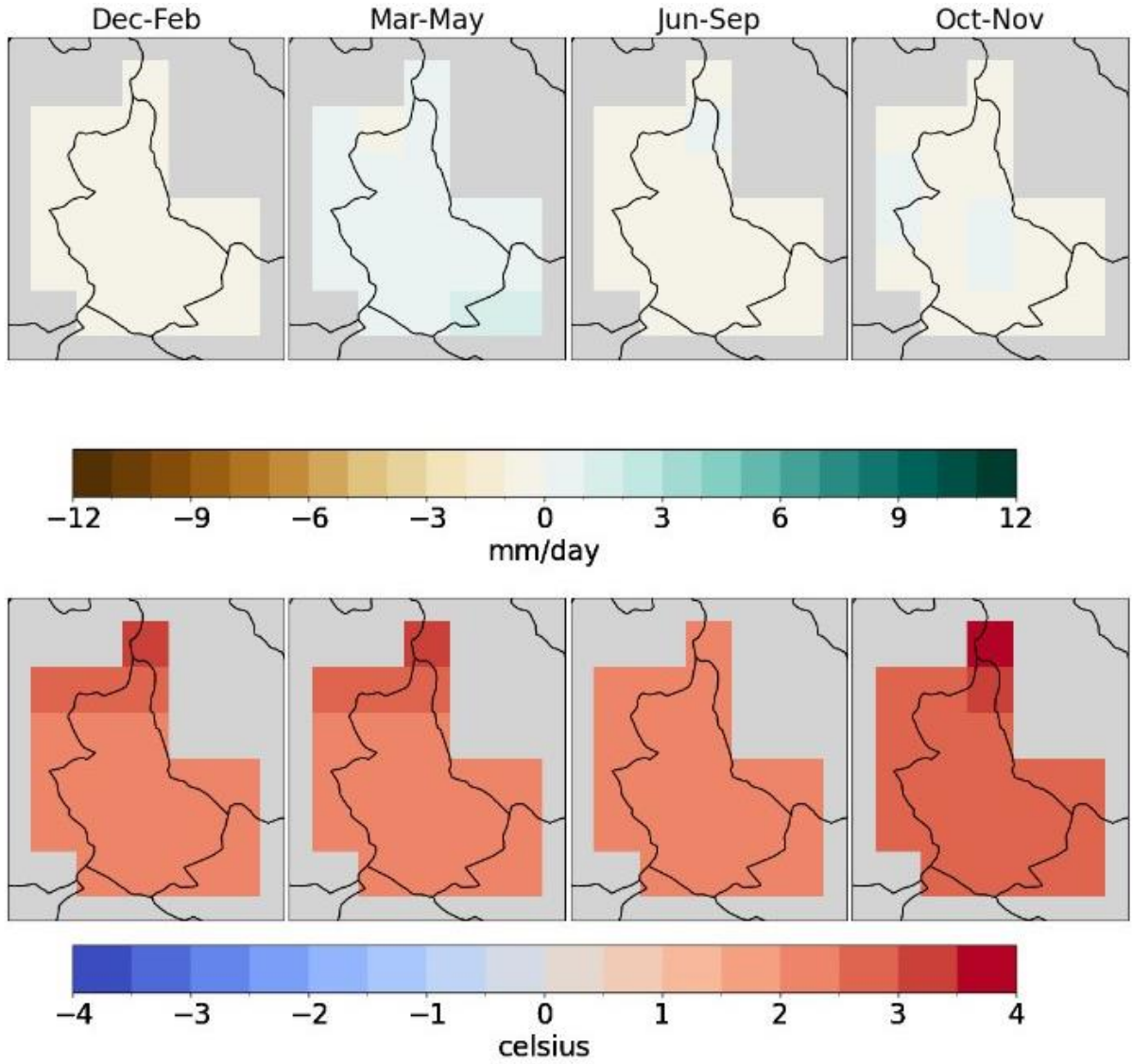

Figure 4. Projected changes in seasonal total precipitation (top panels) and seasonal average daily mean temperature (bottom panels) for 2050 (2036–2065) relative to the baseline (1981–2010).

The projected increase in temperature will result in much higher temperatures on average across the country. This will mean that current peak temperatures will be exceeded earlier in the year and for longer through the year. As such, heatwave conditions will increase in

frequency and intensity compared with the baseline climate. This will increase heat stress impacts on crop production where optimum temperatures may be exceeded (e.g., for paddy rice) and health impacts on livestock, particularly in the hottest regions. However, warmer temperatures will also reduce the impacts of frost damage on certain crops, such as vegetables and mandarin oranges, and may also increase the areas in which these can grow. Evaporation rates will increase with rising temperatures, and with larger increases in temperature, the evaporation rates will also be larger.

While there is little change in precipitation projected for Trongsa Dzongkhag, the intensity of heavy precipitation events is projected to increase due to the changing nature of precipitation in a warmer climate, further exacerbating the risk of flash flooding events and the associated damage to crops, infrastructure and access to markets and supply chains.

The projected reduction in number of Frost Days will result in more precipitation falling as rain rather than snow at higher altitudes, and a higher rate of snow and glacial melt, which will affect the seasonality of river flows and water availability downstream.

Other impacts on crops and livestock are shifts in cropping seasons linked with precipitation variability, increases in heat stress in years when the monsoon rains are delayed, and the incidence and habitable areas of pests and diseases.

6.3 Climate-Induced Hazards and Impacts

This section analyzes historical occurrences of extreme climate events, including heavy precipitation, windstorms, and hailstones, as illustrated in Figure 4. It examines the frequency and distribution of these events across Bhutan over time, with a specific focus on those linked to heavy precipitation, such as flash floods and landslides, as well as windstorms. The maps use darker shades to indicate Dzongkhags with a higher frequency of reported incidents, while the accompanying charts depict the months when these events are most common.

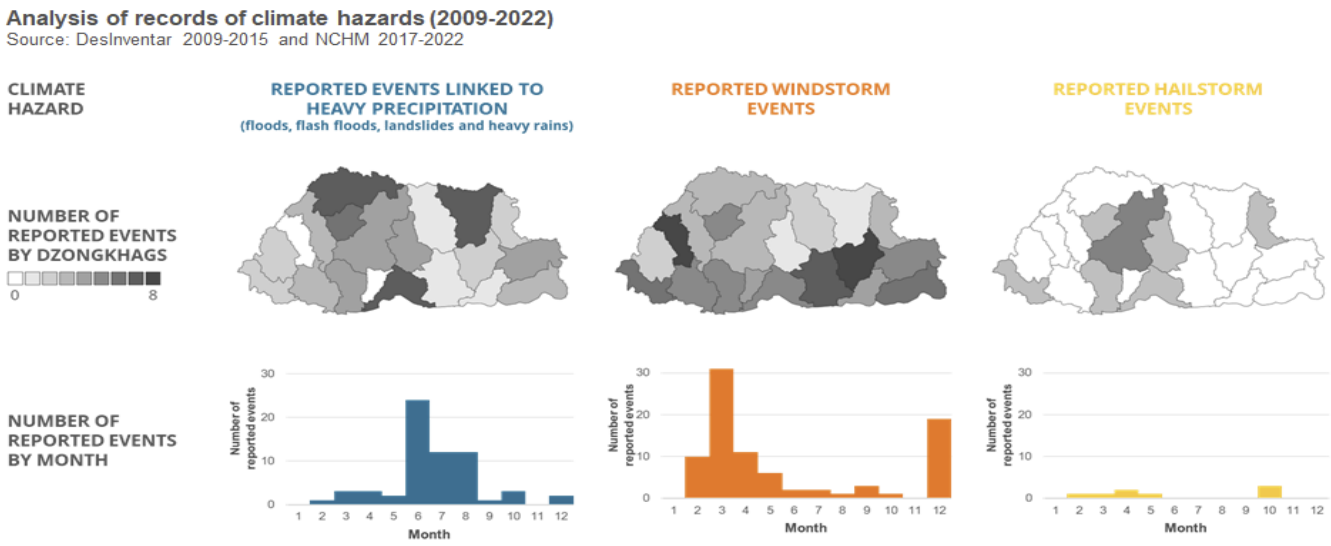

Figure 5: Analysis of records of climate hazards (2009-2022)

Trongsa Dzongkhag has experienced significant changes in climate, including shifts in rainfall patterns and increased temperatures. Rainfall, which traditionally began in March and April, now starts later, causing water shortages during critical periods like sowing maize and establishing paddy nurseries. This delay in rainfall, along with the more frequent occurrence of windstorms and hailstorms in April and May, has led to reduced crop yields and frequent crop damage. Heavy rains late in the monsoon season (August to September) further complicate paddy harvesting, often resulting in grain shattering. Additionally, prolonged dry spells and increased temperatures have caused water sources to dry up, affecting irrigation, drinking water supplies and cattle fodder. The most vulnerable groups in Trongsa are those who rely solely on income from agriculture, have fewer manpower, and have less land, including households with elderly members or persons with disabilities, and those who lease land.

Current coping strategies in Trongsa include making offerings and prayers to local deities for favorable weather conditions. Some farmers have adapted by building irrigation channels and soaking seeds before transplanting. There has also been a shift towards using improved breed and seeds, such as Indian chili seeds, which are better suited to warmer conditions. Additionally, farmers are diversifying their crops and growing less water-intensive crops,

such as maize and vegetables like cabbage, cauliflower, onion, ginger and broccoli, and planting trees around water sources to protect against climate impacts.

7. ADAPTATION AND MITIGATION MEASURES

Farmers in Trongsa Dzongkhag face a variety of challenges linked to climate change, wildlife conflicts, pest outbreaks, and market inefficiencies. Based on these challenges, the recommended adaptation and mitigation measures focus on enhancing resilience and promoting sustainable practices across the agricultural and livestock sectors.

Water Management: Erratic rainfall and water scarcity have severely affected crop yields, especially paddy cultivation. Strategic interventions in irrigation infrastructure, such as the construction and maintenance of irrigation channels, are critical.

Improving land use efficiency through land development practices will ensure optimal productivity. For maize and other crops, drought-resistant varieties and efficient water management techniques are essential to cope with water shortages.

Human-Wildlife Conflict Mitigation: Crop predation by wild animals is a major challenge across multiple Gewogs in the Dzongkhag, affecting paddy, maize, buckwheat, and cardamom. Boar and Deer are the primary wild animals damaging crops during the vegetative phase, while many bird species, such as Bulbul and Kalij Pheasants, are known to dig up seeds immediately after sowing. Although preventing crop damage from birds and rodents such as squirrels can be challenging, establishing a community-based robust fencing system remains the only viable means to protect crops from animals such as wild boar.

Pest and Disease Management: Outbreaks of pests and diseases threaten both crops and livestock productivity. As in other mandarin-growing regions of Bhutan, citrus fruit fly infestations are a major concern in Korphu and Langthil gewogs, causing severe fruit drop rates, while late blight is a major concern on potatoes in Tangsibji Gewog. Such challenges highlight the urgent need to strengthen pest and disease management systems to safeguard

agricultural yields. Strengthening pest and disease management systems through Integrated Pest Management (IPM) and timely alerts of outbreaks will empower farmers to protect their crops and livestock, reduce losses, and adapt to the challenges posed by climate change. Improved access to climate services and agricultural extension support is crucial to deliver real-time information on pest and disease risks.

Farm Mechanization and Labor Shortages: Labor shortages, particularly in paddy cultivation, can be alleviated through farm mechanization. Providing access to affordable machinery and training farmers on its use will reduce dependency on manual labor while improving efficiency and productivity.

Market Linkages and Infrastructure Development: Many farmers, especially those cultivating oranges, potatoes, cardamom, and dairy products, struggle with distant or underdeveloped markets. Strengthening market linkages through cooperative models, cold storage facilities, and improved market information will address these issues.

Livestock and Fodder Management: Livestock farming, particularly dairy, faces challenges like fodder shortages and poor adaptability of cow breeds to local conditions. Promoting silage production and pasture development will ensure year-round fodder availability. Breed improvement programs, with a focus on introducing breeds suited to local climatic conditions, will enhance livestock productivity. Improved veterinary services and animal health programs are also vital to mitigate climate-related risks.

8. CLIMATE RESILIENT LIVELIHOODS

Empowering communities to sustain and enhance their livelihoods amidst changing climatic conditions is crucial. This involves supporting and promoting agricultural practices that are resilient to climate variability. Such practices ensure that households can maintain food security and achieve stable incomes despite unpredictable weather patterns.

To effectively support these efforts, this section outlines key livelihood activities that serve as a foundation for resilience in various Gewogs in the Dzongkhag. It identifies potential value chain commodities that can be developed to enhance local economies and promote sustainable practices. Additionally, it explores niche products that leverage existing knowledge and resources within the Dzongkhag. By focusing on current production capabilities, existing expertise, and future opportunities, this section seeks to provide a comprehensive framework for promoting agricultural resilience and enhancing the livelihoods of community members.

8.1 Prioritization of commodities for livelihood

The livelihood prioritization serves as a detailed summary of the main livelihood activities that sustain households within the Dzongkhag, focusing on the contributions to food and income. It serves as a critical tool in understanding the economic landscape of a particular Dzongkhag, guiding decision-making processes, and designing targeted interventions that can enhance resilience and improve livelihoods. The profile helps pinpoint the main sources of food and income for households, which is crucial for understanding the community's economic priorities.

During the consultations, community representatives defined the four main livelihood activities in each Gewog based on the contributions to households' food and income. For Trongsa, the following livelihood activities were highlighted (listed in the order of importance - i.e. the number of Gewogs that highlighted the activity): Paddy, Maize, Cattle (dairy), Cardamom, Orange, Potato, Buckwheat, Wheat, Sichuan pepper.

A similar exercise was conducted during the ARPR validation workshop, utilizing a broader set of selection criteria. The participants prioritized the potential commodities based on their significance for livelihood and income generation, which helped identify the most valuable commodities for each Gewog, as outlined in Table 3. This was further integrated to produce a Dzongkhag commodity list (Table 4).

Table 3. Prioritized list of commodities for all Gewogs of Trongsa Dzongkhag

Nubi	**Tangsibji**	**Draagteng**	**Langthil**	**Khorphu**
Dairy	Dairy	Green Tea	Quinoa	Vegetables
Paddy	Wheat/Barley	Soya Bean	Dairy	Cardamom
Sichum pepper	Mushroom	Dairy	vegetables	Orange
Chilli	Potato	vegetables	Poultry/Egg	potato
Potatoes	Vegetable	Poultry	MAize	Maize
Vegetables	Maize	Potato	Cardamom	Dairy
Mushroom	Paddy	Wheat	Orange	Poultry(Egg)
Wheat	Poultry	Maize	Paddy	
Buckwheat	Cardamom	Buckwheat		
Maize	Buckwheat	Barley		

Table 4. Prioritized list of commodities for Trongsa Dzongkhag

Commodity	**Rank**
Dairy	1
Vegetables	2
Potatoes	3
Maize	4
Poultry	5
Paddy	6
Cardamom	7
Wheat/Barley	8
Mushroom	9

Based on insights from community consultations and the validation workshops with local government officials, several adaptation strategies are proposed by the workshop participants to address the specific challenges encountered in various livelihood activities.

These adaptations are tailored to mitigate the environmental, economic, and logistical difficulties that impact the sustainability and resilience of agricultural livelihoods and serve as the foundation for the **Agriculture Resilience Plan** (ARP). The priority adaptation measures can be broadly categorized into thematic areas**: technology and practices** and **capacity development**. These cover agricultural land and water management, addressing human-wildlife conflict, enhancing pest and disease management, strengthening market linkages, and promoting farm mechanization in crop farming. In livestock production, adaptation measures encompass fodder management, pest and disease control, product processing, and market enhancement.

8.2. Value chain interventions and Agri-entrepreneurship development

In Trongsa Dzongkhag, CLEAR+ chain analysis has highlighted **vegetables and dairy** as vital commodities for improving local agriculture. The choice of vegetables and dairy value chains (table 5) was influenced by their ability to ensure market access for the producing households. Key entry points for these value chain commodities include implementing a school feeding program and establishing connections between producers and local milk processing units. Dairy is a key quick income source for households compared to other cash crops such as vegetables, cardamom, potatoes, and mandarin. In the Dzongkhag, many households rear cattle for milk production and for producing cheese and butter for personal use and sale. Given the widespread involvement in livestock rearing, there is a clear need for a reliable market system to ensure farmers have access to a consistent and assured market for their milk. Such a mechanism would provide farmers with a stable and regular source of income, significantly improving their livelihoods.

Table 5. Potential commodities for value chain development

Value chain commodities	Value chain inefficiencies	Adaptation options / Recommendations	Expect results (outputs)	Target groups *	Remarks (e.g., seasons, specific Gewog, need for additional study/research)
Vegetables	Lack of access to market	Establishment of school feeding program	Access to assured market	Household producers within the community	Enablers required to establish the value chain
Dairy	Limited milk absorption capacity of the existing MPUs	Expanding the MPUs	Consistent assured market for the households	Ever households that produce milk on varying scale	Enablers required to facilitate the establishment of the value chain

* Subsistence, Semi-Commercial, and/or Commercial, Policy makers, Women, Youth

8.3 Identification of strategic location for establishment of Gender and Youth Inclusive Hubs in Trongsa

The identification of strategic locations for the establishment of gender and youth-inclusive hubs was identified through stakeholder consultation using the multi-criteria specified in Table 6. The selection of hub commodities was primarily based on the recommendations from the value chain analysis in the CLEAR+ report and the priority commodity list from the BRECSA project. Additionally, inputs from the ARPR validation workshop were taken into account, even if they differed from the CLEAR+ recommendations. The prioritized

commodities, based on local production strengths and economic potential identified by participants from each Gewog, were then grouped and ranked. All five Gewogs proposed at least two potential commodities based on these criteria. Among the commodities listed, Dairy, which had the highest frequency, was selected as the focus commodity for the Agri-food Hub in Trongsa.

Additionally, insights were drawn from an entrepreneur's analysis of milk production in nearby Gewogs, which also included an assessment of the market demand for milk and milk products. The entrepreneur's proposal was submitted to the Dzongkhag, and the site approval and allocation have already been completed. This provided a strong rationale for selecting dairy as a key commodity for the agri-food hubs. The study indicated high milk production levels, suggesting a sufficient supply to support a dairy hub and value-added processing.

The selected site is at Bji Zam in Nubi Gewog. The site has been strategically identified for its suitability to meet current and future needs. This location not only caters to immediate project requirements but also offers an extensive area of government-owned land, providing significant potential for future expansion. The availability of this land ensures scalability for infrastructure development, enabling the integration of additional facilities as demands grow. Furthermore, the location's accessibility and proximity to key resources make it an ideal choice for establishing a robust and sustainable dairy hub.

Table 6. Location and commodities for Agri-food hubs for Trongsa Dzongkhag

Gewog	**Location**	**Commodity**	**Factor of site and crop selection**
Nubi	Bji-Zam	Dairy	1. Production scale
			2. Potential for upscaling
			3. Central location
			4. Market Assurance
			5. Possibility of value addition
			6. Land & other infrastructure availability

8.5 Identification of Niche Commodities

During the ARPR validation workshop, two commodities were identified as niche products for Trongsa Dzongkhag: Green Tea and Sichuan Pepper. These products were selected based on specific criteria and considerations that align with the region's environment, current production, existing knowledge, and future potential.

Green Tea: Green tea cultivation in Trongsa has been growing steadily, emerging as a promising niche commodity thanks to the region's favorable agro-climatic conditions. The cool climate and high altitudes of Trongsa provide an ideal setting for producing high-quality green tea with unique flavors. Farmers are inclined to adopt tea cultivation since it is wildlife-friendly and does not require labor-intensive night guarding, making it an appealing crop choice for the area.

Sichuan pepper: This unique product from Trongsa Dzongkhag, particularly renowned in Nubi Gewog, originally began as a wild harvest and was sold with minimal value addition. It has been an important source of income for farmers in the area. Elevating it to the status of a niche commodity can significantly boost economic benefits for the local farmers. Additionally, some farmers have already started cultivating the plants in their fields, which now requires support through proper management techniques to enhance productivity and quality.

8.6 Identification of Commercial crops:

Although value chain commodities and commercial commodities are quite similar, the team decided to define them clearly to ensure a shared understanding and avoid future confusion. The distinction between the two lies in the funding strategy: for commercial commodities, funding is focused solely on enhancing or scaling up production. In contrast, Hub commodities will receive end-to-end funding, covering all stages of the value chain, from production to processing and marketing. It is expected that the differentiation will help in the planning and allocation of resources effectively.

Mushroom and Quinoa have been identified as two commodities with strong potential for commercial production within the Dzongkhag. Each of these commodities has unique advantages that make them well-suited for expansion in both local and regional markets, supporting economic development and income generation for local farmers.

Mushroom: The selection of mushrooms as a niche product was based on the favorable environmental conditions within Trongsa and successful examples from local farmers already engaged in mushroom cultivation. The region's climate and natural resources support mushroom farming, which has shown promising results for those currently involved. By promoting mushrooms as a niche product, the Dzongkhag can leverage these advantages, encouraging more farmers to engage in cultivation and thus strengthening local production. Additionally, mushrooms have high nutritional value and can fetch premium prices in local and regional markets, making them an attractive option for diversifying income sources and supporting food security. It was reported that a few enterprising individuals had been exporting dried shiitake mushrooms to the USA for the Bhutanese market. However, these exports were conducted without any formal certification. Therefore, by recognizing mushrooms as a niche commodity, there is a need to support farmers in obtaining certification by improving both the quality and quantity of their produce.

Quinoa: Quinoa has been identified as a key niche product due to its strategic importance at both the national and Dzongkhag levels. It has been designated as the "One Country One Priority Product" (OCOPP) for Bhutan, highlighting its significance in the national agricultural agenda. At the local level, Langthil Gewog has recognized quinoa as part of its "One-Gewog-One Product" (OGOP) initiative. This dual recognition underlines quinoa's potential to boost agricultural development and contribute to regional food security. Farmers in Langthil Gewog are already actively engaged in quinoa production and possess sufficient skills and knowledge, which can be harnessed to expand cultivation and enhance farming practices. By positioning quinoa as a niche product, the Dzongkhag can leverage its existing production base by encouraging more farmers to participate in quinoa cultivation.

9. PRIORITIZATION OF INFRASTRUCTURE NEEDS TO ADDRESS THE PRODUCTION AND MARKETING CONSTRAINTS

The infrastructure assessment for production and marketing in Trongsa Dzongkhag was conducted using a **multi-criteria assessment approach**. This method allows for a comprehensive evaluation of the current infrastructure, identifying gaps and prioritizing key areas for intervention and investment. The criteria were carefully selected to reflect the unique challenges and opportunities of the region. Below is an elaboration on the approach and the factors considered:

Road Infrastructure: Given the very poor roads in the region, accessibility is a major challenge, especially during the rainy season. This factor assesses the quality and availability of roads connecting villages to markets and main highways. The focus is on identifying bottlenecks that hinder the transportation of goods, particularly during the summer when the farm roads get blocked due to landslides.

Production infrastructures: Based on the prioritization of key agricultural and livestock commodities, an evaluation of relevant production infrastructures was conducted. This included an assessment of the need for facilities such as dairy sheds and chain-link fencing, which are critical or supporting the production needs of both sectors. Additionally, criteria related to climate conditions and soil suitability were incorporated to determine the feasibility and potential of each prioritized commodity based on local knowledge and insights.

Storage and Processing Facilities: The lack of proper storage facilities often leads to post-harvest losses, particularly for perishable commodities. This criterion evaluates the existing warehousing capacity, cold storage options, and the need for new facilities to reduce wastage and extend the shelf life of produce. Assessing the presence of value addition facilities, such as milling, drying, and packaging units, is crucial. The focus is on the availability and adequacy of processing units for key commodities, which can enhance market value and provide better returns for farmers.

Market Infrastructure: The proximity and condition of marketplaces, including weekly markets and trading centers, are vital for producers to sell their goods. This assessment looks at the availability of local markets to understand how well-connected the farmers are.

Irrigation infrastructure: Given the issue of erratic rainfall and water scarcity reported by the community, assessing irrigation infrastructure is critical. This includes evaluating existing irrigation channels, and storage structures, and their effectiveness in supplying water to agricultural fields.

9.1. Categorization of infrastructures

The infrastructure is broadly classified into two categories, as specified in the subsequent sections below and in Table 7.

A. Production infrastructures: This category focuses on the facilities and structures needed to enhance the primary production of agricultural and livestock commodities. The assessment of these infrastructures was initiated during the validation workshop, where stakeholders identified key requirements to support efficient production. Examples include:

1. **Irrigation Systems**: Both the construction of new irrigation systems and the rehabilitation of existing ones were identified as priorities. This includes irrigation systems for both wetland and dryland crops such as paddy, maize, cardamom and vegetables.
2. **Fencing**: Chain link fencing is essential for protecting crops like paddy, maize, and vegetables from wildlife damage.
3. **Greenhouses**: The provision of greenhouses is critical for extending the growing season and improving yields, especially for vegetables.
4. **Livestock Facilities**: The construction of cattle, poultry, and piggery sheds was proposed to enhance the productivity of dairy and meat products by providing adequate shelter and promoting better management practices.

B. Post-harvest processing and market infrastructures: This category includes facilities and equipment that support the post-harvest handling, processing, packaging, and marketing of agricultural and dairy products after harvest. Unlike production infrastructures, the needs in this category are set to be further evaluated during an upcoming **Multi-Stakeholder Platform** (MSP) meeting. The aim is to refine and prioritize these requirements based on broader community and market insights. Key examples include:

1. **Milk Collection Centers**: Establishing milk collection centers to streamline the dairy supply chain and reduce losses during transportation.
2. **Processing Plants:** such as milk processing plants are essential to increase the shelf life and add value to raw produce.
3. **Packhouses and Cold Storage Facilities**: Given the perishability of certain products like potatoes and vegetables, the construction of cold storage units is crucial for preserving quality and extending market access.

Table 7. Infrastructure requirement of Trongsa Dzongkhag

Infrastructure	Unit	Total target	Nubi	Tangsibji	Langthel	Draagteng	Khorphu	Total budget (Nu.M)	Commodity
Production infrastructure									
Construction of new irrigation	KM	**92**	30	20	30	8	4	**38.5**	Paddy
Dryland irrigation/pipe irrigation	Sets	**780**			300		480	**2.7**	Ginger/vegetables /gram/orange
Rehabilitation/ renovation of existing irrigation	KM	**30**			30			**10**	Paddy

Chain link fencing	KM	**511**	245	49	2	202	13	**116.25**	Paddy, Bio-security and vegetable
Land development	Acre	**970**	210	150	250	350	10	**50.5**	Orange, paddy, vegetable, maize
Electric fancing	Km	**110**		50		60		**30**	
Greenhouses/Hydroponic/high-tech mushroom shed	Nos.	**712**	200	150	212		150	**36.2**	Vegetables
Construction of farm road	KM	**1**			20		30	**8**	
Cattle shed construction	Nos.	**1070**	630	100	150	140	50	**19**	Dairy
Poultry shed construction	Nos.	**60**		50			10	**5**	Piggery
Piggery shed	Nos.	**0**						**0**	Poultry
Goat shed	Nos.	**0**						**0**	
Post-harvest, processing and value additional infrastructure									
Milk collection center/MPU	Nos.	**8**		8				**6**	Dairy
Collection shed/pack house/storage center	Nos.	**1**				1		**3**	Ginger/vegetable
Pocessing plant	Nos.	**2**		2				**30**	Ginger/quinoa
Meat processing unit	Nos.	**0**							
Construction of cold stores	Nos.	**0**							
Bio-gas Installation	Nos.	**0**							
Market infrastructure/equipment									
Procurement of milk freezer van	Nos.	1							
Construction of sales outlet	Nos.	5				3	1	**2.5**	Dairy/veg

10. AGRICULTURE RESILIENCE PLAN

10.1 Agriculture Resilience Plan for Draagteng Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected Target	Budget (M)
Green Tea	Limited market channels	Market accessibility	Promote linkages with high end hotels and retailers	No.(linkage)	20	1.00
	Poor packaging	Improved packaging	Provide advanced machines to improve packaging	Nos.	2	2.00
	Competition from other products	Product diversification	Support product standardization and diversification (green tea blends, green tea scented candles, soap and candies)	Nos.	5	2.00
	Poor group management	Strengthen Groups	Facilitate the conduct of leadership training, team work and individual responsibilities and management	Nos.	210	0.500
	Limited product promotion and exhibition	Promote product exhibition	Initiate and propose platform for product exhibition like Black Mountain Festival)	Nos.	3	1.50
Soya Bean	Limited arable land	Land Development	Land development and leasing government land	Acres	300	5.00
	Labour shortage	Farm mechanization	Supply of farm machineries	Set	5	5.00

			(harvesters, oil extractors, miller)			
		Youth engagement	Youth group formation and capacity building	Nos.	200	1.00
	Limited market and lack of market information	Market assurance and sharing market information	Conduct B2B meetings and develop market linkages	HH	500	1.00
Dairy	Frequent outbreak of diseases	Animal health management intervention	Animal health awareness and advocacy to farmers of all chiwogs	HH	500	1.00
			Conduct timely preventive vaccination and medication	Nos.	1800 (cattle population)	1.00
	Feed and fodder shortage	Feed and fodder development	Revamp of existing fodder development in 5 Chiwogs	Acre	30	5.00
			Supply of fencing materials of pasture land (barbed wire with eco-pole)	Acres	30	5.00
			Silage conservation for winter feeding in all chiwogs	HH	280	2.00
	Lack of proper packaging of dairy products	Product promotion and standardization	Support packaging materials	Nos.	1	1.00

	Limited machineries in MPU	Machinery and equipment support	Milk canes, cold storage canes, milk churner, milk heater set	Set	1 each in MPU	5.00
	Low breed cattle	Intensify Artificial insemination program	Training of two CAIT from chiwog and conduct training	Nos. (CAIT)	10	1.00
			Introduction of Sex sorted semen for breed improvement	Nos	2500	10.00
			Supply of jersey heifers/cows to 5 chiwogs	Nos.	70	3.00
	Poor dairy management	Improved dairy housing	Dairy shed construction	HH	140	7.00
		Capacity development	Provide training on management and clean milk production and improved housing	HH	280	1.00
	Domestic animal depredation by wild animals	Intensive farming	Pasture land development through lease and dairy smart technologies	HH	50	5.00
	Ineffective dairy group management	Strengthen the Group	Capacity building and group strengthening of Draagteng Dairy Development Group	Nos.	1	0.50

Vegetables	Limited market during peak season	Post harvest management and value addition	Provide storage facilities to improve shelf life	Nos.	1	3.00
			Invest in value addition and post-harvest training	HH	150	1.00
	Crop damage by wild predators	Crop protection	Provide robust fencing and alarm facility	HH	150	1.00
	Outbreak of pest and diseases	Integrated plant protection	Provide pesticides and insecticides	HH	150	1.00
	Low yield	Quality seed supply and improve crop management	High yielding seed supply to all chiwogs	HH	150	0.50
			Farmers training on crop management	HH	150	0.50
	Limited access to market shed	Develop market linkage and infrastructures	Support construction of market at strategic location at Kuengarabten	Nos.	3	1.50
Poultry	Poor poultry management	Poultry management improvement interventions	Provide trainings on poultry management and production to poultry group members	HH	50	1.00
	Outbreak of diseases	Improve of bio-security and diseases prevention strategy	Fencing of poultry farm area (chain-link fencing)	HH	15	2.00
			Timely vaccination and supply of medicine to those who owns poultry	HH	50	0.50

Maize	Lack of product processing and value addition	Product promotion and diversification	Provide value addition trainings	HH	200	5.00
	Pest and disease outbreak	Integrated plant protection	Supply of Pesticides /Insecticides	HH	200	1.00
	Crop damage by wild animals	Crop protection mechanisms	Provide robust fencing and alarm facility	HH	200	1.50
	Low yield	High yielding enhancement through seeding selection	Supply of seeds that are high quality and climate resilient	Packets	400	1.00
Wheat	Limited product processing and value addition	Product diversification and value addition interventions	Establishment of wheat flour processing plant at center	No.	1	3.00
	Pest and disease	Integrated plant protection	Supply of Pesticides /Insecticides	HH	150	1.00
	Crop damage by wild animals	Crop protection mechanisms	Provide robust fencing and alarm facility	HH	150	0.50
	Low yield	High yielding enhancement through seeding selection	Supply of seeds that are high quality and climate resilient	Packets	150	0.50

Paddy	Water shortage	Construction of Irrigation channel	Supply of HDPE pipe to isolated areas like Tashidingkha/ Samcholing	Km	8	1.00
	Post-Harvest loss	Awareness programs on weather patterns	To provide sensitization and education program on weather patterns to farmers	HH	500	1.00
	Human Wild-Life Conflict	Crop protection	Provide Chain-link fencing	KM	200	5.00
	Low yield	Improve yields interventions	Supply of improved seeds	kg	5000	1.50
			Capacity building on soil nutrient management to farmers	HHs	500	1.00

10.2 Agriculture Resilience Plan for Korphu Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Proposed Target	Budget (M)
Vegetable	Shortage of irrigation water	Irrigation and water harvesting interventions	Pipe and drip irrigation equipment supply in all chiwogs	HH	210	1.00
			Rain water harvesting equipment supply and demonstration to all chiwogs	Nos.	100	1.00
	Climate impact on vegetable production	Climate resilient technologies application	High-tech and normal greenhouse supply and installation in Nabji, Nimshong and khorphu	Nos.	150	3.00
	No assured market for vegetables	Product processing and market linkage interventions	Supply household level dryers	Nos.	50	1.00
			Construction of small sales outlet at Korphu Nakoshar	Nos.	1	1.00
	shortage of seeds	Enhanced yield through high-quality seed supply	Procurement and supply of seeds in all chiwogs	HH	100	0.50
Cardamom	Poor quality seed	Improve yield through quality seedling supply	Supply of Hariwa in all chiwog	Nos	210000	4.00
			supply of cardamom variety bearing twice bearing	Nos.	210000	

	Poor post-harvest management (dring)	Improve post-harvest management	Supply of dryer machine in all chiwog	HH	5	0.60
	Shortage of irrigation water	Improvement of irrigation	Supply of Pipe and sprinkle in all chiwog	HH	200	0.50
	Limited access to market	Road network to assure access to market	Farm road construction in all chiwog	KM	30	5.00
	Pest and diseases outbreak	Crop protection and management intervention	Timely indent and supply of pesticides and fungicides			
Paddy	Water source shortage	Identification of new water source, construction and renovation irrigation channels	Source name (lekpagangchhu) for 3 chiwog Nabji, Korphu toed and moed	KM	5	10.00
			New construction and renovation of irrigation channel in 3 chiwogs	KM	4	3.00
	Unproductive land	Land and soil management interventions	Land Development for all chiwog	Acres	300	10.00
	Lack of post-harvest and value addition facilities	Post harvest and product processing interventions	Supply of Dehusking (Thresher) in all chiwog	HH	100	2.00
			Supply of paddy harvester in all chiwog	Nos	10	0.50

	Crop depredation by wild animals	Crop protection and management intervention	Repaving and renovation existing chain-link fence in Nabji Korphu paddy field	KM	6	5.00
Orange	Pest and diseases outbreak	Integrated pest management interventions	Timely indent and supply of pesticides and fungicides to all chiwogs	Nos	300	0.09
	Inadequate water supply	Pipe irrigation improvement	Supply of pipe irrigation to HH level	HH	20	0.20
	Poor seed quality	High quality seed intervention	Supply of High yielding quality seeds in all chiwog	Nos.	210000	6.00
Potato	Poor seed quality	High quality seed intervention	Supply of High yielding variety quality seeds in all chiwog (Yusi maap)	KG	210000	4.00
	Pest and diseases outbreak	Integrated pest management interventions	Timely indent and supply of pesticides and fungicides	Nos	400	0.10
	Labour shortage	Labour saving technology intervention	Supply of Mini power tiller in all chiwog	Nos.	50	5.00
	Unproductive land	Soil nutrient management intervention	Supply of suphala and urea in all chiwog	Packet	200	2.00
Maize	Poor seed quality	Procurement of High yielding seed	Supply to Nimshong Chiwog teod and moed	MT	2	0.10
	Crop depredation	Crop protection	Installation of Chain-link fence at Nimshong	Km	5	10.00

	by wild animals	and management intervention				
	Limited post-harvest and processing facilities	Procurement of Maize grinder	Supply of Maize grinder in Nimshong chiwog	Nos	20	0.90
Mushroom	shortage of seeds or spawn	procurement of mushroom spawn (Oyster and Shitake)	Supply of Oyster and shitake mushroom spawn in all chiwog	packets	28000	0.70
	Inadequate mushroom production technologies	Capacity building and introduction of new technologies	Farmers capacity building on mushroom production in all chiwog	HH	210	0.15
Dairy	Frequent outbreak of notifiable diseases	Animal health management intervention	Animal health awareness and advocacy program to farmers in all chiwogs	HH	100	0.50
			CoAHW(Community animal health worker) advocacy program	Nos.	10	0.50
			Procurement of medicine and vaccines	Nos.	14	1.00
	Feed and Fodder shortage	Feed and Fodder development	Mass fodder plantation	Acre	50	1.00
			Hay and silage production for winter feeding in all Chiwogs	MT	3	2.00
			fodder land development	Acre	80	1.00

			(Government land lease) along with barbed wire Fencing			
			Procurement and supply of fodder seeds	MT	3	2.00
	Poor quality cattle breed	Cattle breed improvement program	Intensification of AI programs (sex sorted semen, AI equipment's, AI Crate) in all Chiwogs	Nos	6	1.00
			Procurement and supply of improved cattle breeds (Jersey) in all Chiwogs	Nos.	300	4.00
	Low milk production	Enhance milk production	Construction of improved Dairy sheds in all chiwogs	Nos.	50	1.00
			Procurement of dairy equipment	Nos.	7	1.00
	Wildlife depredation	Reduced wildlife Conflict	Construction of chain link fence around Dairy sheds	HH	50	2.00
			Stall feeding	MT	3	2.00
Poultry	Frequent outbreaks of notifiable diseases	Animal health management intervention	Animal health awareness and advocacy program	HH	100	0.50
			Procurement of medicine and vaccines	Nos.	14	1.00
	Low egg production	Enhance egg production	Procurement and supply of DOCs and pullets	Nos.	5000	1.00
			Procurement of poultry equipment	Nos.	7	2.00
			Improved Poultry Sheds	nos	10	3.00

10.3. Agriculture Resilience Plan for Langthil Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Proposed Target	Budget (M)
Dairy	Frequent outbreaks of diseases	Animal health management intervention	Animal health awareness and advocacy to farmers of all chiwogs	HH	250	2.00
			Supply of medicine to all chiwogs	Set	200	1.00
	Feed and fodder shortage	Feed and fodder development	Pasture land development in Baling, Koshella, Dangdung and Langthil Chiwog	Acre	150	150
			Supply of GM seed and winter fodder seeds	kgs	3000	0.80
			Develop hydroponic fodder	HH	200	12.00
			Silage production for winter feeding in all chiwogs	HH	200	1.00
	Poor housing system in dairy management	Dairy shed development	Supply of dairy shed construction materials in all chiwogs	HH	150	4.50
	Poor quality cattle breed	Cattle breed improvement	Supply of jersey heifers to 100 HHs of Baling, Koshella, Langthil and Dangdung	Nos	200	6.00
		Intensification of AI services	Giving training to CAIT in all chiwogs	Nos.	5	0.50

			Supply of sex sorted semen	Nos.	100	0.15
	Lack of post-harvest and processing facilities	Equip existing MPU with processing facilities	Supply of facilities such as water supply, cold chain, homogenizer, packaging materials, storage can, cream separator, peculator, yogurt culture,	Nos.	20	2.00
Paddy	Low yield	Quality seed supply	High yield and climate resilient seed supply to all chiwogs	Kg	1000	0.300
		Soil nutrient management	Farmers training on FYM and bio-compost making in all chiwogs	HH	250	0.500
	Lack of irrigation water	Investment in renovation and construction irrigation	Renovation of existing irrigation channel att chiwogs	Km	30	10.00
			Construction of new irrigation channel in all chiwogs	Km	30	10.00
	Labour shortage	Farm mechanization	Supply of thrashers and harvesters all chiwogs	Set	100	10.00
Poultry (indigenous free ranging	Outbreak of disease	Poultry health management intervention	Supply multivitamin medicines	HH	5	0.50
	Wildlife depredation/farm biosecurity	Chain-link fencing around the farm	Supply of chain link fencing materials	bundles	75	1.125

	availability of DoC birds	Procurement of birds	Supply of indigenous birds in all chiwog	Nos.	2500	1.25
Mushroom (shitake)	Shortage of machineries, spawn and shed	Machineries, temperature and humidity control equipment	Supply of machines, temperature, spawn and humidity control equipment	HH	10	3.00
Poultry Layer	Outbreak of diseases	Animal health management intervention	Animal health awareness and advocacy to farmers of all chiwogs	HH	10	0.50
	Unable to purchase pullets and high cost of feed	Procurement of pullet's layers in subsidy rate	Supply of Pullets or DOC at subsidy rate in order to minimize the cost burden	Nos.	4000	0.80
	Farm biosecurity	Installation of Chain-link fencing around farm	Supply of chain-link fencing materials	bundles	75	1.125
Quinoa	Unproductive of land	Land development	Development of land in Yuling and Baling	Acres	100	10.00
	Insufficient seed	Procurement of seed	Supply of seeds in 100 HH	Kgs	5000	0.90
	Lack of processing facilities	Procurement of dehusking machine	Supply of dehusking machine in Yuling and Baling chiwog	Nos.	2	0.05
Maize	Pest and diseases outbreak	Plant protection management	Supply of fungicides in all chiwog	Nos.	2000	0.10
	Labour shortage	New technologies intervention	Supply of mini power tiller	Nos.	200	2.00

	Low yield	Introduction of high yielding seed	Supply of high yielding and climate resilient seeds in all chiwogs	MT	10	3.00
Cardamom	Pest and diseases outbreak	Plant protection management	Supply of fungicides in all chiwog	Nos.	200	0.20
	Poor quality seedling	Procurement of high yilding seeds	Supply of high yielding seedling (HARIWA)	Nos.	200000	2.00
	Labour shortage	Transportation intervention	Construction of farm road Janbee and Baling	KM	20	3.00
	Irrigation problem	Procurement of irrigation equipment intervention	Supply of irrigation pipe in all chiwog	Nos.	100	0.40
			Supply of Sprinkle in all chiwog	Nos.	500	0.10
Orange	Pest and diseases outbreak	Orchard health Management intervention	Supply of pesticides and fungicides in all chiwog	Nos.	200	0.20
	Poor quality	Procurement of High Yeilding Varieties	Supply of high yielding sapling in all chiwog	Nos.	10000	0.30
	Irrigation problem	Procurement of irrigation equipment	Supply of irrigation pipe in all chiwog	Nos.	200	0.60
Vegetables	Pest and diseases outbreak	Procurement of pesticides and fungicides	supply of pesticides and fungicides in all chiwog	Nos.	500	0.20
		Procurement of sprayer	Supply of sprayer in all chiwog level	Nos.	50	0.10
	Water shortage in the field	Procurement of irrigation equipment	Supply of drip irrigation in all chiwog	Nos.	300	3.00
			Supply of Sprinkle in all chiwog	Nos.	300	0.20

			Supply of rain water harvest materials Jangbee and Baling	Nos.	150	0.08
			Farmers demonstration on spring shed management in Jangbee chiwog	HH	60	0.15
	Climate impact on the vegetable production	Application of climate resilient technologies	Supply of green house in all chiwog	Nos.	200	10.00
			Supply hydroponics in Dangdung and baling	Nos.	2	1.20
			Supply of shed net in all chiwog	Nos.	200	0.50
	Seed quality	Procurement of high-quality seed	Supply of high-quality seeds in all chiwogs	Packets	15000	0.50
	Poor knowledge on Vegetable production	Capacity building program	Provide capacity building program in all chiwog	HH	200	0.30

10.4. Agriculture Resilience Plan for Nubi Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Proposed Target	Budget (M)
Dairy	Frequent outbreak of diseases	Animal health management intervention	Animal health awareness, disease prevention program and advocacy to farmers of all chiwogs	HH	380	2.10
			Supply of medicines for all chiwogs	Bottle/ tube	1050	1.50
	Feed and fodder shortage	Feed and fodder development	Improved pastureland development, (Temperate region). Supply of fencing materials, fodder seed supply, process of land leasing activities for all chiwogs	Acre	210	2.50
			To mitigate animal nutrition improvement during fodder lean season, silage preparation hands on training, paddy straw treatment, supply of chaff cutters, fodder seed supply,	HH	380	4.50
	Poor quality cattle breed	Cattle breed inprovement	Cattle sourcing, (improved breeds), expansion of CHBPP areas, supply of sex sorted semen, capacity building on CAIT, and CoAHW, supply of LN2 cans and A.I. equipment's, LN2	Nos.	160	6.50

			processing plant and A.I. crates for all chiwogs			
	Lack of climate smart cattle shed	Improved cattle shed design	Construction of climate resilient cattle sheds, supply of cattle mats for all chiwogs	Nos.	630	4.50
	Insufficient land for pasture development	Land leasing program	Process of government land leasing for pasture development, land management program for Bji-S and Dorgoen Chiwogs	Acre	30	2.50
	Inadequate knowledge and practices on clean milk production & Biosecurity measures	Improvement of the milk quality	Training on clean milk production practices and Bio-security measures for all chiwogs	HH	380	2.00
	Poor dairy products handling & storage facilities	To mitigate the milk quality deterioration	Supply of the bulk cooler tanks, stain steel milking buckets, milk cans,	Nos.	4 bulk coolers, 350 buckets & 200 cans	2.50
	Poor management of highland animals, (Yaks & sheep's)	Animals nutrition & health improvement	Supply of MoC, molasses and mineral supplement feed, (UMMB), supply fodder beat seed, turnip & radish seed supply and supply of highland equipment's/gears, vaccination, gid surveillance, rangeland development, transit camp	Nos.	60 bags, 50 pkts. 150 kgs. 30 sets	5.00

			& A.I for yaks for Sinphu chiwog			
	Lack of packaging and processing knowledge/ideas	Awareness creation	Hands on training on products packaging technics and skill	HH	200	1.00
	Low seed quality	Improvement of seed quality	Supply of hybrid seeds	pkts.	9000	1.80
	Pests and diseases	Protected cultivation technology	Supply of green house, deep irrigation, mulching plastics	Nos.	250	250
Paddy	Low yield	Improvement of the seed quality	Supply of the improved seeds	Kgs.	24000	1.30
	Inadequate irrigation	Improvement of the irrigation channels	Supply of HDP pipe for all chiwogs	km	30	4.50
	Wild animals damage	Protection of the crop	Installment of the chain-link fencing	Km	120	15.00
	Pests and diseases	Protection of the crop	Supply of the chemicals	Bottle	2500	1.25
Wheat	Low yield	Improvement of the seed quality	Supply of the improved seeds	Kgs.	12000	0.72
	Wild animals damage	Protection of the crop	Installment of the chain-link fencing	Km	100	12.00
	Product processing	Enhancement of product quality	Supply of flour mills, packaging equipment	Nos.	20	3.00

	Lack of packaging and processing knowledge/ideas	Awareness creation	Hands on training on products packaging technics and skill	HH	200	1.50
Mushroom	Non availability of equipment	Sourcing of the equipment	Supply of the of the equipment	Sets	10	1.50
	Low quality spawn	Improvement of spawn quality	Supply of the improved spawn	HH	50	0.50
	Lack of proper sheds	Establishment of proper sheds	Inputs supply, shed net, cement, plastics	HH	50	0.25
Vegetable	Lack of protected cultivation technology	Improvement of protected cultivation technics	Supply of climate resilience green house, deep irrigation sets, mulching sheets for all chiwogs	HH	150	1.50
	Wild animals damage	Protection of the crop	Installment of the chain-link fencing	Km	25	3.75
Sichuan pepper	Lack of packaging technology	Improvement of packaging technics	Supply of packaging equipments for three chiwogs, (Gager-Karshong, Bemji-Chela & Daba-Simphu)	HH	200	2.50
	Lack of pepper trees management	Improvement of trees management	Supply of pruning equipment, awareness training on tree management for three chiwogs, (Gager-Karshong, Bemji-Chela & Daba-Simphu)	HH	200	2.75

10.5. Agriculture Resilience Plan for Tangsibji Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Proposed Target	Budget (M)
Dairy	Low milk production	To enhance clean milk production	Supply of dairy shed materials	Nos.	100	2.00
			Training and awareness program in clean milk production	HH	100	1.00
	Lack of product diversification and access to market	Value addition to dairy products	Milk products diversification and value addition (processing, leveling, packaging, and marketing)	Nos.	7	1.00
			Construction of Milk Collection Centre (MCC) (1 Chenibji, 2 Nyela-Drangla, 2 Tangsibji and 1 Tshangkha)	Nos.	6	5.00
			Revamp and expansion of existing dairy farmers group	Nos.	5	1.00
			Supply of MPU equipment (Percolator, cream separator, and Chilling machine)	Nos.	1	2.00
	Frequent outbreak of notifiable diseases	Animal health management intervention	Animal health awareness and advocacy to farmers in all chiwogs	HH	200	0.70
			Conduct training to CoAHW (Community Animal Health Worker)	Nos.	10	0.50
			Procurement and Supply of medicine	Nos.	14	0.50

	Feed and fodder shortage	Feed and fodder development	Mass pasture development (land development, seed supply)	Acre	150	2.00
			Capacity development of TMR (Total Mixed Ration) formulation and purchase of ingredients for TMR	HH	100	1.00
			Supply of barbed wire	HH	80	1.00
			Hay and Silage production for winter feeding in all chiwogs	HH	100	1.00
	Poor quality cattle breed	Cattle breed improvement program	Supply of improved breeds	Nos.	100	2.00
			Intensification of AI program (AI equipment, sex sorted semen, AI shed, AI crate)	Nos.	2	1.00
			Group formation of ELITE heifer	HH	100	1.00
			Capacity development of CAIT (community AI Technician) and purchasing of LN2 equipment)	Nos.	20	1.00
Poultry	Outbreak of frequent diseases	Animal health management intervention	Animal health awareness and advocacy to farmers of all chiwogs	HH	50	0.50
			Installation of farm Biosecurity (chain link fence) to all chiwogs	Nos.	2	5.00
			Procurement and Supply of medicine and vaccines to all chiwogs	Set	20	0.5.0

	Low egg production	To enhance egg production	Supply of poultry shed to all chiwogs	Nos.	50	2.00
			Supply of DoC and pullets to all chiwogs	Nos.	5000	1.00
			Supply of packaging materials to all chiwogs	HH	50	1.00
			Supply of debeaking and defeathering machine to all chiwogs	Nos.	50	1.00
Wheat	Low yield	Quality seed supply	Improved wheat variety seed supply to all chiwogs	Kg	2000	1.20
		Soil nutrient management	Farmers training on FYM and bio-compost making in all chiwogs	HH	210	0.50
	Lack of product processing and value addition	Product processing and market linkage interventions	Supply of threshing and processing plant at Chendebji	Nos.	2	30.00
			B2B meeting with FCBL and traders	Nos.	2	0.01
		Crop depredation by wild animals	Chain-link fencing to all chiwogs	Km	30	4.00
Potato	Poor quality seeds	Improvement of seeds	Procurement and distribution to all chiwogs	MT	1400	2.00
	Pest and diseases	Availability of chemicals on time	Procurement and distribution to all chiwogs	Ltrs	3500	2.00
	Labour shortage	Farm Mechanization	Supply of mini-power tillers to all chiwogs	Nos.	250	25.00
	No assured market	Improvement of transport network	B2B meeting and market linkages with FCBL,traders to all chiwogs	Nos	20	20.00

Paddy	Inadequate Irrigation facilities	Improvement of irrigation facilities	Supply of HDPE Pipes to Tangsibji & Kela	Km	20	20.00
	Crop damage by wild animals	Crop Protection	Chainlink fencing to all chiwogs to Tangsibji & Kela	km	15	50.00
	Frequent outbreak of pest and diseases	Crop Protection	Supply of chemicals to all chiwogs to Tangsibji & Kela	Ltrs	1000	0.80
Maize	Low yield	Quality seed supply	Improved maize variety seed supply to all chiwogs	Kg	5000	2.50
		Soil nutrient management	Farmers training on FYM and bio-compost making in all chiwogs	HH	80	0.70
	Lack of product processing and value addition	Product processing and market linkage interventions	Supply of corn flake machine at Kela and Tshangkha chiwogs	Nos.	10	12.00
			Supply of shelling machine	Nos.	80	0.50
			B2B meeting with FCBL and traders	Nos.	10	0.30
Vegetables	Non availability of hybrid seeds.	Quality seed supply	Supply of hybrid seeds to all chiwogs	Pkts	5000	0.80
	Pest and diseases	Protected Cultivation Technology	Purchasing and supply of materials (Green house, drip irrigation, mulching plastic)	Nos.	150	15.00
Cardamom	Non availability of improved seedlings	Quality seedling supply	Improved seedling supply to Kela Chiwog.	Nos.	500000	50.00
	Wild animal damages	Crop Protection	Barbed wire fencing to Kela Chiwog	Km	50	25.00

	Lack of post-harvest facilities	Enhance quality and reduce post-harvest	Procurement and supply of electric dryers to Kela Chiwog	Nos	5	10.00	