



BUILDING
RESILIENT
COMMERCIAL
SMALLHOLDER
AGRICULTURE
(BRECSA)

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



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MINISTRY OF AGRICULTURE AND LIVESTOCK

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Building Resilient Commercial Smallholder Agriculture
(BRECSA)

AGRICULTURE RESILIENCE PLAN FOR ZHEMGANG DZONGKHAG
(VERSION 1.0)

March 2024

Project Management Unit

Samtenling, Sarpang

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1. INTRODUCTION 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 (polytunnel house, 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 AGRICULTURE RESILIENCE PLAN (ARP)

The Agriculture Resilience Plan (ARP) for Zhemgang 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 **relevant 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 efforts 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 poses a substantial threat to livelihood activities in Zhemgang 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 oranges, dairy cattle, maize, cardamom, ginger, paddy, areca nuts, and wheat.

3.1 Erratic Rainfall: One of the most pressing issues reported was the irregularity and insufficiency of rainfall, which has led to water scarcity across multiple agricultural activities. Crops like paddy rely heavily on water availability during transplanting, while maize, oranges, and cardamom have been particularly impacted, as they need consistent moisture for optimal growth. However, lacking irrigation facilities, they rely solely on natural rainfall. Orange growers in Gewogs like Ngangla, Phangkhar, and Bardo struggle with reduced fruit quality and yields due to insufficient water, exacerbated by inadequate irrigation infrastructure. Similarly, cardamom and ginger, grown in Gewogs like Goshing and Phangkhar, face similar challenges, with dry spells resulting in plant mortality and reduced

productivity. Investments in water management and drought mitigation measures could help producers mitigate water shortage impacts.

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. 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 conflicts, as animals move to new areas in search of food amid changing climate conditions. Gewogs like Shingkar and Bjoka 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 Zhemgang'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 (Fig. 1).

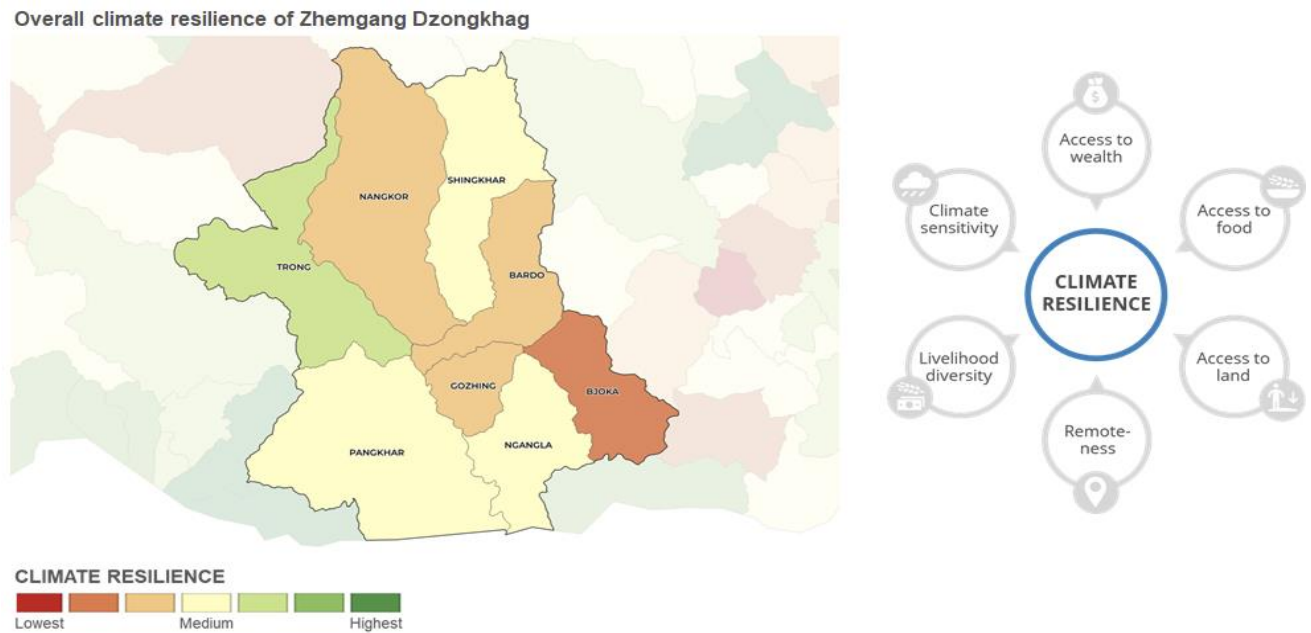


Figure 1: Overall climate resilience of Zhemgang Dzongkhag

Table 1 provides an analysis of the resilience levels of each Gewog in Zhemgang 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. Zhemgang, one of Bhutan's most 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 Zhemgang

Gewog	Access to wealth	Access to food	Access to land	Remoteness	Climate sensitivity
Ngangla	4	2	2	3	2
Pangkhar	4	1	2.5	4	2.75
Trong	3	2	2	1	2.5
Bjoka	4	3	2.5	4	3.5
Gozhing	4	3	1.5	3	3.5
Bardo	4	2	2.5	4	3
Nangkor	4	1	2.5	3	2.5
Shingkhar	4	1	2.5	4	3.25
*Scores 1-4 were assigned to each category, with 1 being the most resilient and 4 being the least resilient.					

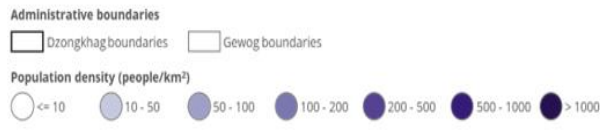
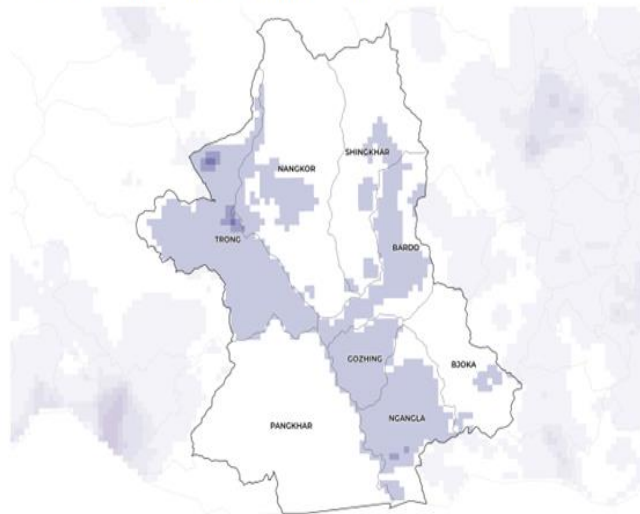
Gewogs such as Trong show relatively high resilience due to better access to resources and connectivity, scoring 1 in remoteness and moderate ratings in other categories. In contrast, Pangkhar, Bjoka, Bardo, and Shingkhar are among the least resilient due to their limited access to wealth, high remoteness, and higher climate sensitivity. The table suggests that Gewogs with limited wealth and connectivity, like Bjoka and Shingkhar, 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 eight Gewogs under Zhemgang 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 eight Gewogs, providing valuable insights for planning and development initiatives. Zhemgang's

substantial forest cover, at 94%, contributes to its unique agroecological zones, influencing both the agricultural practices and the livelihoods of its residents. Population densities vary significantly, with some Gewogs, such as Nangkor and Ngangla, having relatively higher populations and more extensive irrigation schemes, while others, like Bjoka and Bardo, have smaller populations and limited irrigation infrastructure.

Population density of Zhemgang Dzongkhag



Elevation-based agro-ecological zones of Zhemgang Dzongkhag

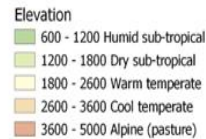
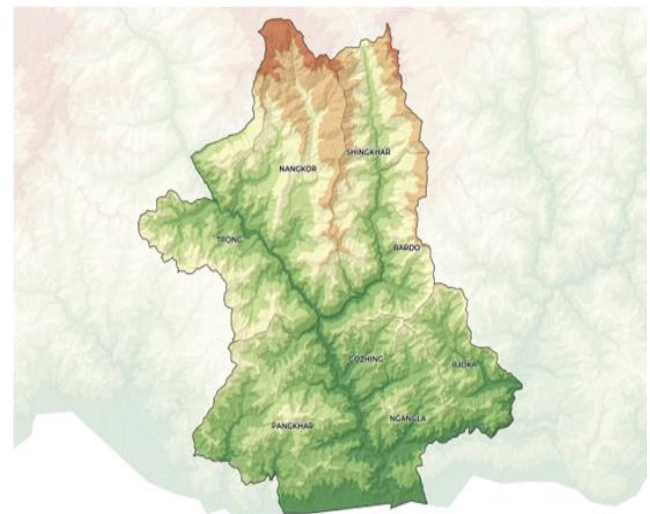


Figure 2: Population density map and agro-ecological zones of Zhemgang Dzongkhag

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 Nangkor and Trong, for instance, have larger areas of wetland, essential for paddy cultivation, while Gewogs such as Bardo and Bjoka 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)	Number of Households	Population		Irrigation schemes (Nos)	Total length (km)	Wet land (Acre)	Dryland (Acre)
			Male	Female				
Bardo	210.48	343	598	454	7	22.50	353.433	3474.47
Bjoka	196.00	191	403	495	3	3.70	65.056	1481.164
Goshing	99.11	248	508	697	2	3.00	89.762	2238.54
Nangkor	543.00	400	497	994	26	81.40	734.687	3707.583
Ngangla	315.00	437	2320	2400	8	11.00	252.866	3040.588
Pangkhar	542.74	211	2400	1920	4	3.90	187.602	2433.382
Shingkhar	309.00	244	1897	1812	9	22.50	478.37	2447.370
Trong	358.00	380	1627	1920	1	5.00	533.283	2709.792

Data source: <http://www.zhemgang.gov.bt/downloads/gewog-glance> and Dzongkhag Statistics

Unit

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 southwest which brings heavy rain from 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.

Seasonally averaged minimum and average maximum temperatures (Figure 2) 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 remain high in Zhemgang Dzongkhag across all seasons, with temperatures reaching above 20 °C during summer and only dropping to 5-10 °C during winter. Zhemgang Dzongkhag reaches 28 °C during summer, with spring and autumn also reaching 24-28 °C. Winter is cooler but still warm at 10-20 °C. The Southwest Monsoon from June to September contributes about 72% to the total annual rainfall of Bhutan with the highest amount received in July, followed by August.

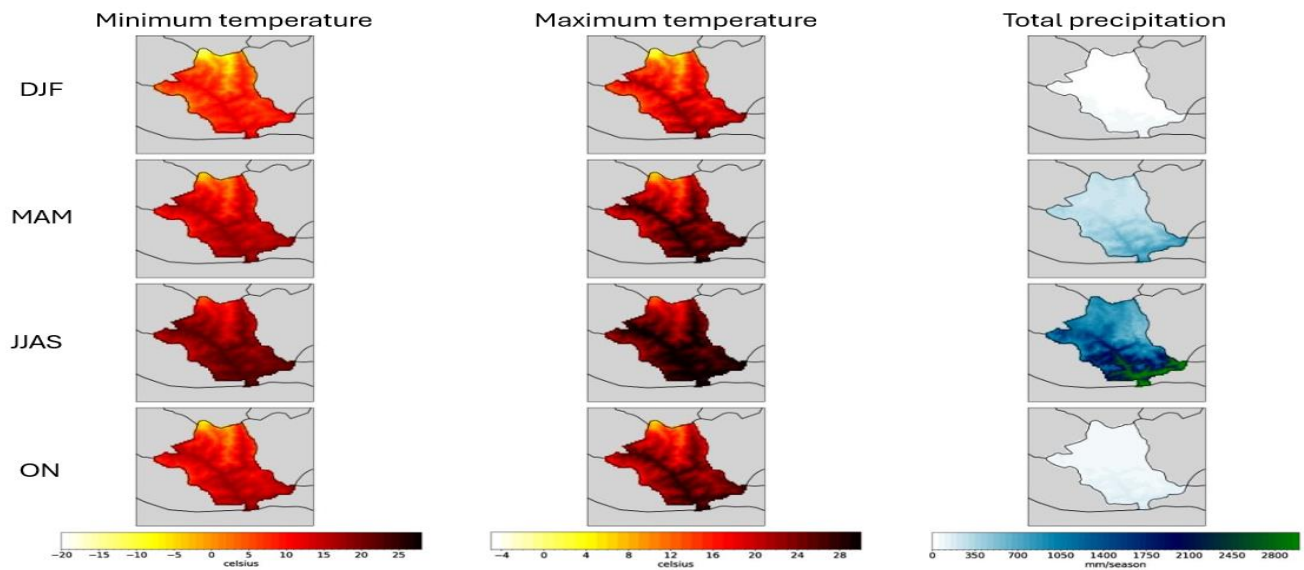


Figure 3: Seasonally averaged minimum temperature (left), maximum temperature (centre), and total precipitation (right) for Zhemgang Dzongkhag over the baseline period (1996-2019)

The highest totals are along the southern edge of the country, including the far south of Zhemgang Dzongkhag. Precipitation is also higher in the valleys and lower on higher ground. The spring months from March to May and the 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, including Zhemgang Dzongkhag (Figure 3). The main increases occur during the monsoon season, June-September, implying that the monsoon will become stronger in the future. Increases are also projected to occur in the pre-monsoon season, March-May, suggesting a potential earlier start and lengthening of the monsoon season. There is little future change projected for precipitation in the autumn (October-November) and winter (December-February) seasons. Projected changes in temperature vary latitudinally across the country with increases of around 2.5 °C projected for Zhemgang Dzongkhag. There is warming in all seasons, with the largest changes (up to 3.5 °C) occurring in the autumn months of October-November.

There are also projected changes in the future occurrence of extreme events, for both rainfall and temperature. The Count of Hot Days (CHD), which here is defined as the number of days in which the maximum daily temperature exceeds 30 °C over one year, is projected to increase by up to 36 days per year for Zhemgang Dzongkhag. The occurrence of extreme rainfall events can be quantified by the changes in RX1Day. This is a measure of the maximum total daily rainfall over one day (i.e. the total rainfall on the wettest day of the year). For Zhemgang Dzongkhag, the baseline wettest values of RX1Day are approximately 350 mm/day, which is projected to increase to up to 480 mm/day by 2050 – an increase of 37 %. Conversely, changes in Consecutive Dry Days (CDD), which is a count of the longest number of days without any precipitation per season, show that for Zhemgang Dzongkhag, the CDD will increase by 8-10 days in the winter and 5 days in the autumn, meaning that there will be less precipitation in these seasons, despite the projection of a generally wetter future.

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. The increase in the CHD will impact a range of crops (including potatoes and tomatoes), as these suffer yield reduction at temperatures above 30 °C. Many crop pests and diseases favour these warmer temperatures, including Chili Pod Borer and Cut Worm (chilli), Grey Leaf Spot and Armyworm (maize), and Brown Plant Hopper (paddy).

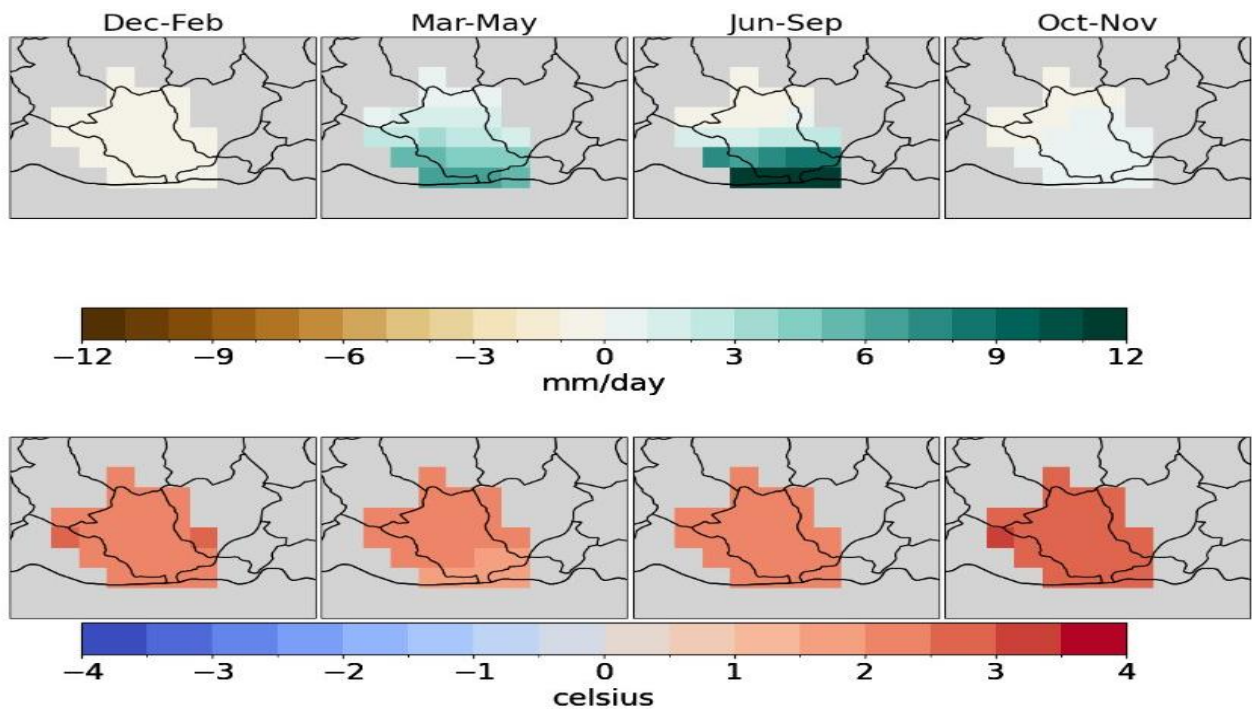


Figure 4: Projected changes in seasonal total precipitation (top panels) and seasonal average daily mean temperature (bottom panels) for 2050 (2036–2065) relative to the baseline (1981–2010).

Evaporation rates will increase with rising temperatures, and with larger increases in temperature the evaporation rates will also be larger. The projected increase in precipitation

during the pre-monsoon and monsoon seasons will result in overall increases in water availability during these seasons.

As well as the projected increase in mean precipitation, the intensity of heavy precipitation events is also 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.

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.

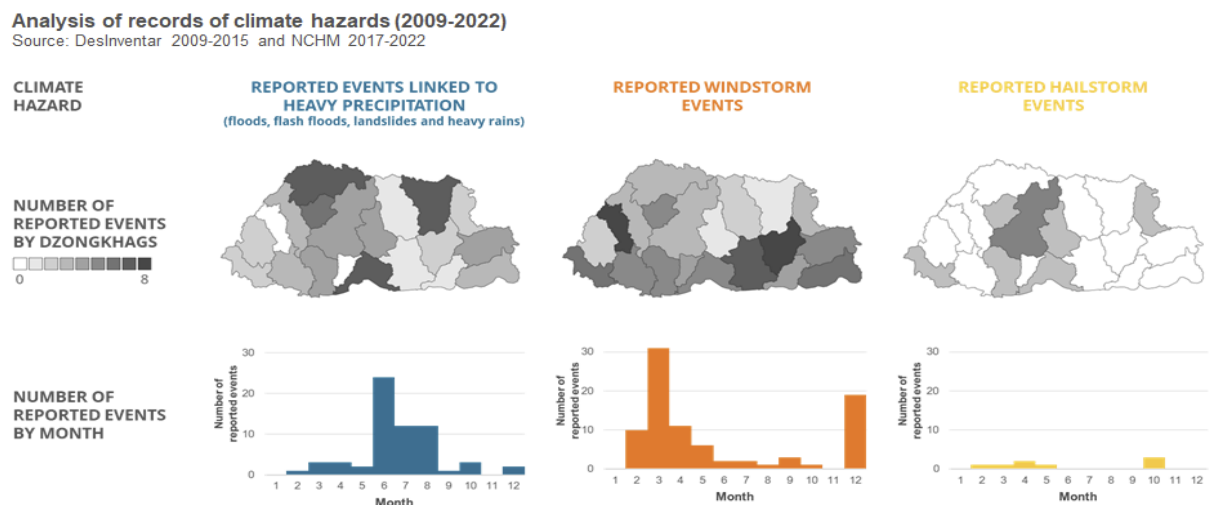


Figure 5: Analysis of records of climate hazards (2009-2022)

Zhemgang Dzongkhag has been experiencing notable climate changes, including increased

temperatures and erratic rainfall patterns. Communities reported a decrease in rainfall during February and March, essential for maize cultivation and land preparation (plowing), a delay in monsoon rains in June and July, affecting paddy planting, and increased rainfall (heavy downpours) from August to September, resulting in landslides, roadblocks, soil erosion, waterlogging and destruction of irrigation structures, particularly affecting paddy maturation and harvesting. Windstorms have also become more frequent and intense, particularly from February to June, causing significant damage, especially to maize, and occasionally to residential structures. For example, on two separate occasions in April 2021, strong winds damaged more than 100 buildings and destroyed crops and greenhouses. Furthermore, the increased temperatures have led to the decline of once thriving orange trees and chili cultivation; however, higher temperatures also led to the cultivation of areca nut in the previously unsuitable areas. Extended dry periods and increased temperatures in the early part of the year also impacted water sources crucial for drinking, irrigation, and livestock rearing, resulting in reduced dairy production due to heat stress, shortages of fodder, and exacerbated disease instances. Communities also believe that these climate changes increased human-wildlife conflict as animals more often venture into croplands in search of food. The most vulnerable groups in Zhemgang include the elderly, persons with disabilities, those solely reliant on agriculture, particularly paddy cultivators, and those without resources to invest in technologies such as farm machinery and greenhouses. These groups are less equipped to adapt to the adverse effects of climate change, facing greater challenges in maintaining their livelihoods.

To cope with these impacts, villagers have implemented several strategies. These include fencing and planting banana trees near water sources to protect them, although this practice has not been widely adopted. Collaborative efforts have been made to bring water from new water sources to ensure continued access to irrigation and drinking. The use of greenhouses has proven effective in protecting crops such as vegetables from adverse weather. Additionally, some farmers have begun water harvesting and storage during the rainy season to mitigate shortages during dry periods, and there is a shift from maize to cardamom and ginger farming due to its better adaptability to the changing climate. Some farmers also resort to religious ceremonies and carrying holy scripts around the villages to invoke rain.

7. ADAPTATION AND MITIGATION MEASURE

Farmers in Zhemgang 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 and maize cultivation. Strategic interventions in irrigation infrastructure, such as the construction and maintenance of irrigation channels, are critical. Water-saving devices, technologies, and practices should be actively promoted and supported for crops like vegetables and mandarin. Drip irrigation systems, which deliver water directly to the root zone and minimize evaporation and runoff, should be promoted in Mandarin orchards. In Gewogs facing acute water shortages, even for drinking, rainwater harvesting systems should be introduced to enhance water availability. Adopting these water-saving solutions can help farmers address water scarcity, enhance productivity, and build resilience to climate change. In addition, improving land use efficiency through land development practices will ensure optimal productivity.

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 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. Strengthening pest and disease management systems through integrated pest management (IPM) and timely alerts of outbreaks will help farmers adapt. 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, 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 in the early part of the year and low productivity among cows. 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 a Gewog, focusing on the contributions to food and income. It serves as a critical tool in understanding the economic landscape of a particular Gewog,

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 community consultations, community representatives defined the main four livelihood activities in each Gewog based on the contributions to households' food and income. For Zhemgang, the following livelihood activities were highlighted (listed in the order of importance - i.e., the number of Gewogs that highlighted the activity): Orange, Cattle (dairy), Maize, Cardamom, Ginger, Paddy, Areca nut, Cane and bamboo craft, Wheat. Additionally, farmers in Zhemgang Dzongkhag cultivate a variety of other crops on a small scale, including vegetables, buckwheat, millet, and fruit trees.

A similar exercise was conducted during the ARPR validation workshop, utilizing a broader set of selection criteria. Participants evaluated the 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 Zhemgang Dzongkhag

Bardo	Bjoka	Goshing	Nangkor	Ngangla	Phangkhar	Shingkhar	Trong
Dairy	Cane and Bamboo Craft	Ginger	paddy	Dairy	Orange	Paddy	Dairy
Poultry	Maize	Orange	orange	Paddy	Ginger	Dairy	Poultry
Piggery	Turmeric	Dairy farming	Diary	Piggery	Dairy cattle	Poultr (Layer)	Piggery
Cadamom	Cardamom	Cardomom	vegetable	Coffee	maize	Cardamom	Paddy

Turmeric	Ginger	Native-Poultry	Maize	Turmeric	Cardamom	Ginger	Orange
Orange	Mustard	Maize	Potato	Ginger	Poultry	Turmeric	Spices
Maize	Orange	Lemon	cardamom	Orange	Coffee	Buckwheat	Vegetables
Paddy	Coffee	Cassava	Tuemric	Poultry	piggery	Orange	Mushrooms
Coffee	Vegetables	Quinoa	Ginger	Mushroom	turmeric	Orange	Coffee
Vegetables	Paddy	coffee	Poultry	Vegetables	Banana		

Table 4. Prioritized list of commodities for Zhemgang Dzongkhag

Commodity	Rank
Dairy	1
Orange	2
Ginger	3
Cardamom	4
Paddy	4
Maize	5
Turmeric	6
Coffee	7
Poultry (layer)	8
Vegetables	9
Piggery	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, dairy farming is practiced across all Gewogs, while pig farming and egg-focused poultry are prioritized in select Gewogs.

8.2 Value chain interventions and Agri-entrepreneurship development

In Zhemgang Dzongkhag, CLEAR+ value chain analysis has highlighted **vegetables and turmeric** as vital crops for improving local agriculture. Among the 18 crops cultivated, those with established value chains, such as mandarin, cardamom, and ginger, are also widely grown. Notably, 62% of households cultivate mandarins, which are exported or sold domestically. The choice of vegetables and turmeric 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 the implementation of a **school feeding program** and establishing connections between producers and local turmeric processing units to facilitate the export of finished products.

Table 5. Potential commodities for value chain development

Value chain commodities	Value chain inefficiencies	Adaptation options / Recommendations	Expected 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

Turmeric	Lack of linkages with the turmeric processing units in the Dzongkhags	Linking the household producers with the turmeric processing units	Consistent annual assured market for the products produced by the households	Every household that produce on a very marginal scale	Enablers required to facilitate the establishment of the value chain
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* Subsistence, Semi-commercial, and/or Commercial, Policy makers, Women, Youth)

8.3 Identification of strategic locations for establishment of Gender and Youth

Inclusive Hubs in Zhemgang

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. The prioritized commodities, based on local production strengths and economic potential, were then grouped and ranked. All eight Gewogs proposed at least two potential commodities based on these criteria. Among the commodities listed, **Dairy, turmeric, vegetables and coffee** were selected as the focus commodities for the Agri-food Hub in Zhemgang. Consequently, the workshop recommended a reorientation of value chain priorities towards Dairy and Turmeric, aligning investment and development efforts more closely with local preferences and market opportunities.

Table 6: Location and commodities for Agri-food Hub for Zhemgang Dzongkhag

Gewog	Location	Commodity	Factor of site and crop selection
Trong	Buelsa (Jevan Golay)	Turmeric, Dairy	1. Production scale
			2. Potential for upscaling
			3. Central location
			4. Market Assurance
			5. Possibility of value addition
			6. Land & other infrastructure availability
Ngangla	Marangdut, Panbang	Coffee and vegetables	1. Production scale
			2. Potential for upscaling
			3. Central location
			4. Market Assurance
			5. Possibility of value addition
			6. Land & other infrastructure availability

8.4. Identification of Niche Commodities

The stakeholder consultation prioritized and identified **mushrooms** as potential niche commodities for Zhemgang Dzongkhag.

Mushrooms: were selected based on specific criteria and considerations that align with the region’s environment, existing knowledge, and future potential, supported by successful examples from local farmers already engaged in mushroom cultivation. The Dzongkhag has suitable agro-climatic conditions and abundant natural resources to provide a strong foundation for mushroom farming. The Dzongkhag can leverage the comparative advantage, encouraging more farmers to take up mushroom cultivation, thus strengthening local production and branding mushrooms as a niche commodity. The diverse natural resource base and suitable agro-climatic condition of the Dzongkhag are ideal for cultivating both oyster and shiitake mushrooms.

8.5 Identification of commercial crops:

Although value chain commodities and commercial commodities are quite similar, the ARPR validation workshop 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.

Tumeric, Ginger, Vegetable and Dairy have been identified as 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.

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

The infrastructure assessment for production and marketing in Zhemgang 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 Dzongkhag, as outlined below:

Road Infrastructure: Given the very poor roads in the region, accessibility is a major challenge, especially during adverse weather conditions. 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 become blocked due to landslides and flash floods.

Production Infrastructures: Based on the prioritization of key agricultural and livestock commodities, an evaluation of relevant production infrastructures was conducted. This included a detailed assessment of the need of facilities such as dairy sheds and chain-link

fencing, which are critical for 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 centres, are vital for producers to sell their goods. This assessment looks at the availability, accessibility, and infrastructure of local markets, and identifies areas where new markets may be needed. This also considers how well-connected farmers.

Irrigation: 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 tanks, and their effectiveness in supplying water to agricultural fields.

9.1 Categorization of infrastructures

The infrastructures are 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 large-scale irrigation for paddy and maize as well as dryland irrigation specifically tailored for crops like coffee, turmeric, ginger 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 climate-smart 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:** Commodities such as coffee, ginger, and turmeric processing plants are essential to increase the shelf life and add value to raw produce.
3. **Cold Storage Facilities:** Given the perishability of certain products like vegetables, the construction of cold storage units is crucial for preserving quality and extending market access.

Table 7: Infrastructure requirement of Zhemgang Dzongkhag

Infrastructure	Unit	Goshing	Ngangla	Phangkhar	Bardo	Nangkhor	Trong	Bjoka	Shingkhar	Total	Total budget (Nu.M)	Commodity
Production infrastructure												
Construction of new irrigation	KM	0	5	0	3	8	18	0	0	34	110	Paddy, Maize,
Dryland irrigation	Acre	2	15	5	10	5	5	6	9	57	30	Coffee/turmeric vegetable
Rehabilitation/renovation of existing irrigation	KM	0	0	0	0	0	24	0	24	48	87	Paddy, Maize,
Chain link fencing	KM	0	6	100	40	15	20	10	30	221	249.5	Paddy, maize and vegetable
Land development	Acre	0	320	150	100	0	0	50	100	720	49	Orange, paddy, vegetable, maize
Greenhouses	Nos	0	100	0	20	100	0	0	0	220	16.7	Vegetables
Farm road maintenance and construction	KM	0	0	0	0	20	0	7	0	27	15	Orange
Cattle shed construction	Nos	205	50	100	250	100	100	0	50	855	206	Dairy
Poultry shed construction	Nos	5	0	6	0	0	5	0	10	26	15	Piggery

Piggery shed	Nos	0	3	10	2	0	4	0	0	19	11	Poultry
Post-harvest, processing and value additional infrastructure												
Milk collection center	Nos	0	0	0	0	0	2	0	1	3	11	Dairy
Collection shed	Nos	0	20	0	0	1	2	0	0	23	26	Coffee/turmeric vegetable
Ginger processing plant	Nos	5	0	0	0	0	0	0	0	5	5	Turmeric & ginger
Construction of bamboo craft work shed	Nos	0	0	0	0	0	0	1	0	1	28	Bamboo craft
Construction of cold stores	Nos	0	5	0	0	0	0	0	0	5	5	Coffee
Market infrastructure/equipment												
Procurement of milk freezer van	Nos	0	0	0	0	0	0	0	1	1	10	Dairy

10. AGRICULTURE RESILIENCE PLAN

10.1 Agriculture Resilience Plan for Bardo Gewog

Commodities	Challenges	Key investment area	Strategic action	Unit	Proposed Target	Budget (In million)
Dairy	Lack of knowledge and exposure	Dairy improvement and production	Dairy improvement and production in all chiwogs	HH	400	1.00
	Lack of dairy equipment and cold chain facilities		Supply of dairy equipment	sets	300	6.00
	Shortage of fodder		Supply of fodder seeds and seedling for 200 acres and 70 chaff cutters	Nos.	70	5.00
	Lack of proper Infrastructure		Supply of shed construction materials	HH	250	5.00
	Dilution of indigenous cattle		Supply of breeding bull -Methune and Nublang	Nos.	20	0.40
	Insufficient nutrients		Feed block/UMMB	MT	10	3.00
	Lack of high breed cattle		Supply of high producing breeds and breeding bull for all chiwogs	Nos.	300	24.00
	Lack of value addition and safety standards		Product diversification and brand development	Nos.	All chiwog	2.00
	Human wildlife conflict		Cattle insurance	Nos.	All chiwog	3.00

Cardamom	Lack of Irrigation channel	Improve water and soil management	Supply of water sprinklers and pipe (2500 Nos sprinkler) and 5000 meter of pipe for all chiwogs	Nos	340	11.75
	Lack management practices (Pest& disease)		Training in cardamom management	Nos		
	lack of improved drying equipment		Supply of 50 numbers electric dryer	Nos		
	Lack of proper fence		Supply of barbed wire fencing materials 20,000	Kg		
	Lack of quality seedling		Supply of 200,000 quality seedling	Nos		
Mazie	Human wildlife conflict	Improve soil management	Construction of chain link fencing along periphery of dryland for 353 HH	Km	25	37.50
	Lack of quality seed		Supply of quality seeds for 500 acres of land	Kg	17500	0.44
	Soil degradation and lack of fertile soil		Dryland terracing of 100 acres of land at Digala and langdurbi	Acres	100	9.00
Turmeric	Pest & disease	Improve crop production and management	Training in production management	HH	200	2.11
	Lack of healthy rhizome seed		Supply of quality rhizome seed	Kg		
Oranges	Lack of management	Improve management	Training in management	HH	340	0.22

	practices	practices	practices for 340 HH			
	Pest and diseases		Procurement of chemicals		All chiwog	0.01
	Lack of fencing materials		Supply of Fencing materials for 340 HH	Kg	50,000	5.25
	Tools and Equipment		Supply of tools and equipment 300 nos of Pruning Saw and 300 secateurs	Nos	600	2.40
Poultry	Lack of training	Poultry development	Training in Farm Management	HH	250	0.70
	Insufficient resources	and bio-security measures	Supply of pullets, and provide other resources	Nos.	17500	4.00
	Lack of Biosecurity		Chain-link fencing and proper signboard	Nos.	All chiwog	3.00
Paddy	Lack of irrigation	Improve crop production and other management	Construction of climate resilience irrigation system at Digala and Kalamti for 23 HH	Km	3	9.00
	Lack of improved seed		Supply of high yielding seed for Bardo,Khomshar and Digala	Kg	3000	0.10
	Human wildlife conflict		Construction of chain link fencing at Bardo,Khomshar and Digala for 260 HH	km	12	18.00
Piggery	Insufficient resources	Piggery development	Construction of modern sheds and supply of piglets	Nos.	2	2.00

			Langdhurbi and Digala			
	Limited training		Training in Farm Management Langdhurbi and Digala	HHs	120	0.50
Vegetables	Low production due to lack of seeds	Enhance vegetable production	Supply of hybrid seed for higher production for 80 acres of land	HH	All chiwog	0.50
	Lack of technologies		Enhanced vegetable production through green house and provide training	sets	20	2.20
Coffee	Lack of coffee management skills	Improved management and production	Training in coffee management practices	HH	120	0.10
	Small scale production		Enhance production through supply of seedlings for all chiwogs	Nos.	67,500	3.30
Ginger	Poor management practices in ginger cultivation Poor water management practices	Improve crop production	Training in management and production Improve water management by using drips	HH	200	1.34
	Lack of healthy rhizome		Replacement old stock rhizomes with disease free rhizome.	Kg	50,000	
Mushroom	unavailability of mushroom spawns	Improve crop production	Provide Oyster and Shitake mushroom	Nos	2000	2.00

10.2 Agriculture Resilience Plan for Bjoka Gewog

Commodity	Challenges	Key Investment Area	Strategic Action	Unit	Project ed targets	Budget (m)
Cane and Bamboo	Scarcity of Yula (Neomicro calamus Andropogonifolius).	Strengthenin g Cane and bamboo initiatives	Cane and Bamboo Plantation for 180 HH	Nos.	5	0.10
	Labour Shortage		Capacity Building for all chiwogs	Nos.	5 for 50% of all the chiwogs	0.50
			Development of Yula nursery for 180 HH	Nos.	5	0.10
			Unavailability of Raw Materials	Construction of workshop for 180 HH	Nos.	1
	Procurement of Equipment (Splitting machines and other necessary machines) for 180 HH			Nos.	1	0.20
	Ginger		1. Incidence of Pests and Diseases. 2. Low yield/loss of yield	Integrated disease management	1. supply of disease-free ginger rhizome for 180 HH	Mt.
Procurement of sprayer and chemicals		Nos.			20	0.15
Labour Shortage			Procurement of mini-Power-Tiller	Nos.	50	0.80
Maize	Human Wild-life conflict.	Climate Resilient maize Production	Supply of improved maize seeds	MT	7	0.28
	Pests and Diseases.		Chain Link Fencing for 80HH	Km	10	15.00
			Land Management	Acre	50	5.00

Cardamom	Pests and Diseases.	Climate Resilient cardamom Production	Supply of improved cardamom seedlings	20Ac	25	0.50
Turmeric	Marketing	Climate Resilient turmeric Production	Supply of Turmeric rhizome	100	50	1.00
Orange	Pest and disease Management	Increases orange production through improved cultural practices and control of pest and diseases	Capacity building on management practices and pest and diseases 100 HH in all chiwogs	Nos	5	0.20
	Market		Construction of Farm Road to Zarkabla	Km	7	25.00
	Irrigation		Construction of irrigation channel for Chapdenpa	Km	2	2.00
Vegetables	Market	Improve Vegetable Production	Supply of Seeds to 180 HH and 20 Acres	Acres	20	0.50
	Pest and Diseases		Procurement of sprayer and chemicals 180 HH	Nos.	20	0.50
Coffee	Market	Climate Resilient Coffee Production	Procurement of coffee Seedling for 100 acres of land (180HH)	Nos	200000	2.00
Cattle (Dairy)	Fodder Shortage	Fodder development	Supply of seed and seedlings	Acres	100	2.50
			Support chaff cutter and feed blocking machine	Sets	50	2.50

	Lack of improved cattle breed	Breed improvement	Procurement of Jersey Cow	Nos	100	3.00
			Breeding bull supply for all chiwogs	Nos	15	0.50
		Improve milk quality	Supply dairy equipment (butter churner and milk canes) for 150 HH	Sets	150	3.50

10.3 Agriculture Resilience Plan for Goshing Gewog

Commodity	Challenges	Key Investment area	Strategic action	Unit	Proposed Target	Budget (m)		
Ginger	Lack of proper post-harvest facility	Provision of grading and packing facilities	Construction of ginger cleaning and processing, facility	Nos.	5	5.00		
			Provision of washing, surface drying, grading, weighing and packaging equipment and machines					
			Provision for ginger storage structure					
Regular incidences of Pest and diseases (soft rot)	Control of pest and diseases	Capacity development on integrated disease management of ginger rot disease		Nos	5	1.30		
			Provision of chemicals for soil & rhizome treatment				Kg	1500
			Provision of disease-free stock rhizomes				Kg	100,000
Orange	Outbreak of pest and disease low production	Control of pest and diseases (Citrus greening, fruit flies)	Provision of pruning equipment	Nos	480 Acres	3.00		
			Supply of sprayer machines and PP Products					
	Poor orchard management	Capacity development on modern orchard management (Canopy management, soil fertility management, pest management, water shortage mitigation with drips)		Nos	200	1.00		
Dairy farming	Low milk production Inferior breeds	Enhance dairy production	Supply of jersey cows	Nos	700	33.00		
			Supply of breeding bull	Nos	12	0.20		

	Shortage of fodder Improper sheds		Promotion of and enhancement of Fodder cultivation through provision of fodder seed, seedlings & fencing materials	acres	700	42.00
			Fodder conservation and nourishment (Silo-pits)	nos	255	12.00
			Construction of climate smart cattle shed	nos	205	20.00
			Supply of equipment (butter churner, Cans and Chaff cutter)			1.00
			Dairy group formations and Establishment of Milk Processing/collection Unit (MPU)	nos.	3	2.00
			Exposure visits for farmers	Nos	100	1.00
			Promote Hydroponic fodder	Nos	200	2.00
			Training and supply of Feed blocks (Minerals)/UMMB production equipment	Nos	200	2.50
			Collection centre with equipped with refrigerator and deep freezer	Nos.	5	2.00
Cardamom	Pest and diseases	Buy hybrid saplings	Supply Hybrid saplings	Nos	60000	0.50
Native-Poultry	Degradation of native birds	Enhance native egg productions (cage free)	Support Shed constructions	Nos.	5	2.00
			Provide Equipment (feeders/drinker)/Laying box	Sets	50	0.50
			Supply of native birds	Nos	5000	1.00

Maize	Marketing and Pest and diseases	Hybrid seeds	Supply PPs and hybrid seeds	Nos.	255	0.30
Lemon	Lack of market and hybrid seeds	Hybrid seeds	Supply of hybrid seeds	Kg	2500	0.20
		Market linkage	Link market	Nos.	50	0.10

10.4 Agriculture Resilience Plan for Ngangla Gewog

Commodity	Challenges	Key Investment Area	Strategic Action	Unit	Proposed Target	Budget (M)
Dairy	Disease outbreak	Animal health management	Awareness and supply of medicines	HH	400	2.50
	Shortage of labor	Labour saving technologies interventions	Supply of churning machine, chaff cutter, milking machine.	Nos.	100	3.50
	Shortage of fodder during lean season	Feed and fodder development	Promotion of silage, TMR, feed block and plantation of winter fodders.	MT	5	3.50
	Poor quality of the milk	Enhancing clean milk production	Awareness and supply of milk quality test kits	Nos.	250	2.00
	Lack of milk collection & cold chain facilities	Establish milk post-harvest infrastructures	Establishment of milk collection and chilling centers at Sonamthang and Ngangla Trong Chiwogs	Nos.	10	2.50
	Poor dairy cattle breed	Breed improvement	Supply breeding bull and establishment of AI services	Nos.	100	11.00
	Heat and cold stress.	Climate smart dairy management	Construction of climate smart dairy shed.	Nos.	50	4.00
Paddy	Irrigation water shortage	Invest in different types of irrigation	Construction and maintenance of irrigation channels.	Nos.	5	20.00

			Installation of Solar water pumping system at Marangdut	Nos.	1	2.00
Vertebrate, Pest and diseases outbreak	Construction of fencing	Chain link Fencing in Marangdut and Yumdang	No.	6	40.00	
	Purchase of PP chemicals	PP Chemicals	Bottle	500	0.20	
Labour shortage	Farm mechanization	Supply of paddy transplanter, harvester, threshers and rice hullers	Set	6	3.00	
Low yield due to climate change	Adopt climate resilient technologies	Supply of quality seeds	Kg	500	0.20	
		Diversify cropping systems	Acre	300		
Land fragmentation & soil degradation	Land development	Terracing and land consolidation	Acre	20	4.00	
Piggery	Disease outbreak	Animal health management	Animal health management (Awareness and supply of medicines)	HH	400	1.00
	Shortage of labor	Labour saving technologies interventions	Procurement of Stunned guns	Nos.	5	0.40
	Poor quality breed	Breed improvement	AI and introduction of improved breeds	Nos.	50	1.50
	High cost and low-quality feed	Feed development	Low-cost feed development and establishment of feed outlets in Sonamthang	Nos.	1	1.80

	Heat and cold stress.	Climate smart piggery management	Construction of climate smart piggery shed in Sonamthang chiwog	Nos.	3	3.00
Coffee	Limited technical knowledge	Capacity building and introduction of new technologies	Provide training and exposure visits	HH	400	0.30
	Climate variability	Supply of quality coffee seedlings,	Provide quality seedlings,	Nos.	100,000	1.50
		Dryland irrigation	Dryland irrigation facilities,	Set	5	10.00
	Pest and diseases outbreak	Pest and diseases control and management	Provide pest and diseases awareness and provide PP chemicals and sprayers	HH	400	1.00
	Lack of post-harvest infrastructure and accessibility	Maintenance of existing farm roads	Farm roads maintenance	Nos.	5	5.00
		Establish post-harvest facilities	Construction of cherry aggregation shed	Nos.	5	10.00
			Construct Solar and greenhouse dryers	Nos.	5	5.00
	Shortages of irrigation water	Irrigation water management	Procurement of irrigation equipment and water pumps and solar electricity, construction of water tanks,	Set	7	20.00

	Lack of access to market	Improve access to market through MSP	Capacity building on FEBL and conduct B2B meetings	HH	400	1.00
	Labour shortage	Labour saving technologies interventions	Supply pulping machines, harvesting tools and equipment	Set	5	5.00
	Limited awareness and consumption	Product promotion intervention	Awareness meeting and workshops.	HH	500	0.50
Turmeric	Limited technical knowledge	Capacity building and introduction of new technologies	Provide training and exposure visits	HH	200	0.50
	Disease and pest outbreak	Purchase of PP chemicals	Supply PP chemicals	Bottle	300	0.20
		Pest and diseases management	Provide awareness workshops	HH	400	
	Lack of quality rhizomes (seed)	Purchase of quality rhizomes	Supply quality rhizomes	Kg	5000	0.50
	Huge post-harvest loss	Provide post-harvest facilities	Construction of collection shed	Nos	5	5.00
Ginger	Limited technical knowledge	Capacity building and introduction of new technologies	Provide training and exposure visits for Kaktong, Ngangla Trong and Rebati Chiwogs	HH	200	0.50

	Disease and pest outbreak	Pest and diseases management	Supply PP chemicals for Kaktong, Ngangla Trong and Rebati Chiwogs	Bottle	500	0.20
			Awareness meeting and workshops for Kaktong, Ngangla Trong and Rebati Chiwogs	HH	200	0.10
	Lack of quality rhizomes	Purchase of disease-free rhizomes	Supply quality rhizomes for Kaktong, Ngangla Trong and Rebati Chiwogs	Kg	3000	0.60
	Post Harvest lost	Provide post-harvest facilities	Construction of aggregation, cleaning and packing house for Kaktong, Ngangla Trong and Rebati Chiwogs	No.	5	5.00
Orange	Pest and diseases outbreak	Pest and diseases management	Supply PP chemicals for Kaktong, Ngangla Trong and Rebati Chiwogs	Bottle	5000	2.00
			supply PP equipments for Kaktong, Ngangla Trong and Rebati Chiwogs	HH	100	3.00
			awareness training and workshops for Kaktong, Ngangla Trong and Rebati Chiwogs	HH	200	2.00

	Irrigation water shortage	Irrigation water management	Purchase of dryland irrigation materials and rain water harvesting (Kaktong, Ngangla Trong, Rebati & Marangdut)	No.	5	5.00
	Soil degradation and erosion	Soil management	Land development and basin making (Kaktong, Ngangla Trong, Rebati & Marangdut)	Acre	300	8.00
Poultry	Disease outbreak	Animal health management	Creating awareness and procurement of medicine and vaccines (Sonamthang, Kagtong, Marangduth).	No.	200	0.50
	Shortage of labor	Labour saving technologies interventions	Procurement of De beaking machine, automatic feeder and drinker machine (Sonamthang, Kagtong, Marangduth)	No.	20	3.00
	Lack of Biosecurity	Strengthening bio-security	Procurement of fencing materials and proper signage (Sonamthang, Kagtong, Marangduth)	No.	4	2.50
	Heat and cold stress.	Climate smart dairy management	Construction of climate smart poultry shed (Sonamthang, Kagtong, Marangduth)	No.	3	3.50

	Price fluctuations	Market assurance and pricing strategy	SHFP linking Program and other B2B meetings	HH	200	0.05
	Product quality and hygiene	Investment quality improvement and packaging	Training on packaging, grading, sorting and cleanliness & exposure visit (Sonamthang, Kagtong, Marangduth)	HH	200	2.50
	High cost and low-quality feed	Feed development	Low-cost feed development and establishment of feed outlets in Sonamthang Chiwog	Nos.	1	1.20
	Lack of poultry chicks availability	Poultry input supply enhancement	Construction of brooding farm in Sonamthang Chiwog	Nos.	1	0.80
Mushroom	Limited Spawn Availability	Mushroom input supply enhancement	supply spawn and establish mushroom spawn production centers (RNR enterprise)	Pack et	20,000	5.00
	Pest and diseases outbreak	integrated pest management	Purchase materials for IPM (thermometers, hygrometers, water spraying equipment)	Nos.	100	2.00
	Climate sensitivity	Investment in protect mushroom farming	support shed materials (Youth)	Nos	7	10.00

Vegetables	Pest and diseases outbreak	Pest and diseases management	Supply pp chemicals	Bottle	2000	3.00
			Support equipment	Set	50	2.00
	Climate and Weather impacts	Investment in high-tech and protected vegetable farming	Supply hybrid seeds	Pack	1000	3.00
			Support greenhouses	Nos.	100	7.00
			Support mulching plastics	Roll	500	1.30
			Support dryland irrigation system	Set	5	15.00
	Labour shortage	Labour saving technologies interventions	Procurement of Tractors and its parts (bed making, rotary, plough)	Nos.	2	5.00

10.5 Agriculture Resilience Plan for Nangkor Gewog

Commodity	Current Challenges	Key investment area	Strategic action	unit	Proposed target	Budget (m)
Orange	Poor management	Capacity development	Orchard Management training (Canopy, nutrient, pest, water management) for 150 acres of orchard in 5 chiwogs	HH	200	3.00
	Insufficient water for irrigation needs	Improve irrigation system	Installation of irrigation pipelines. Installation of drip irrigation system Installation of water harvesting for 150 acres of orchards	HH	90	3.00
	Challenges in transportation due to poor farm road conditions	Farm road rehabilitation	Farm road restoration-20km Tshaidang to Dunmang 20km, benefiting 60 HH	Km	20	15.00
	Lack of appropriate tools and equipment	Enhancement of tools and equipment resources	Tools and equipment (pruning secatuer-2000, pruning saw 800 and top prunner 5000)	Nos	200	2.00

	Regular outbreak of pest and diseases	Integrated Pest Management	plant protection (chemicals and sprayers) 3000 for all chiwogs (150 Acres)	HH	200	3.00
	Low soil nutrient levels	Support subsidized fertilizer	Procurement and supply of fertilizers for 200 HH	Mt	10	3.00
Diary	Labor Shortage	Mechanization	Supply of chaff cutter for all chiwogs	Nos.	100	12.00
	Short shelf life of milk	Machines and equipment	Milk Chilling machines	Nos.	5	10.00
			butter churner	Nos.	250	
	Human wild life conflict	Insurance	Insurance for 300 cattle	Nos.	300	4.00
	shortage of fodder	Securing reliable fodder security	Pasture and fodder development in 150 acres in all chiwogs	Acres	150	6.00
	Inferior cattle breed	Advancing improved cattle breeding program	Supply of improved cattle breeds in all chiwogs	Nos	200	20.00
	Sub-standard dairy shed	Dairy shed development	Climate smart dairy shed construction in all Chiwogs	Nos.	100	50.00
	Inferior cattle breeds	enhancement of cattle breeds	Supply of breeding bulls benefitting all chiwogs	Nos.	15	15.00

	Limited knowledge on modern dairy farming techniques	Capacity development	Clean milk production, TMR, Feed and Fodder, Milk processing	HH	200	5.00
	Lack of infrastructure	Maintenance or construction of approach road	Connect farms to markets	Nos	All chiwogs	10.00
Poultry	Poor knowledge and skill in poultry farming	Capacity development	Egg handling, management and feeding practices in all chiwogs	Nos.	3000	8.00
	Poor poultry housing		Construction of climate smart sheds	Nos.	50	
Vegetables	Limited knowledge on vegetable production	capacity building	Management training (30hh per chiwog)	HH	150	0.50
	labour shortage affecting production Drudgery for women	Farm mechanization	Mechanization- mini tillers (10 each in chiwog), brush-cutters (10 each in chiwogs)	HH	10	15.00
	Lack of quality seeds	Input supply	Support of vegetables seeds	HH	All chiwog	1.50

	Challenges due to lack of poly-tunnel houses (Seedling production, rain protection)		Supply of green house (20x5 m)	Nos	100	7.50
	Shortage of Irrigation water Low yield	Improvement of irrigation facilities	Supply of water tanks Syntex 2000lit capacity @ 15000	Nos.	100	1.50
	Weed competition	Material supply (Mulching plastic)	Supply of Mulching plastic	Nos.	500	5.00
Cardamom	Poor cardamom due to inappropriate drying techniques	Crop management and post-harvest intervention	Supply of improved portable dryer machines	Nos.	30	1.50
	Outbreak of diseases affecting yield		Chemicals and fertilizers Supply of disease resistant slips	HH	200	1.00
Paddy	irrigation constraint	Improve irrigation system (Pipe irrigation)	buli-8km-Rumbrnag to Chubaar for 120 HH with 300 acres of land	Km	8	24.00
	Low yield due to		Improved quality seeds for	HH	150	0.5

	degenerated seeds/Poor quality seeds		Buli/Golleng/Tali/Nyakhar			
	Crop predation by wild animals Need for crop guarding		Chain link fencing 15km Buli/Nyakhar for 170 HH	km	15	30.00
Maize	Shortage of farm labor High dependency on manual labour Less efficient	Farm mechanization	Power tiller/mini tiller Nyakhar-Dunmang	HH	50	3.50
	Poor quality seed with less yield and high disease incidence	Enhance availability of improved seeds	supply improved seeds buli/Tali/Kikhar	HH	150	0.50
Potato	Lack of proper storage facilities Storage pest infestation	Cold storage	Establish cold storage/collection stage Goleng/Kikhar/Dakphai	HH	120	2.00
	Degenerated potato tubers	Support disease free potato tubers	Improved seed supply/distribution Goleng/Kikhar/Dakphai	HH	150	1.00
Turmeric	Diseased rhizome	support disease free	Improved seed supply/distribut-	HH	150	1.00

		planting materials	ion Goleng/Kikhar/Dakphai			
Ginger	Disease planting. Materials Regular outbreak of disease	support disease free planting materials	Supply of disease-free planting materials	HH	150	1.00
		Disease management through proper irrigation methods	Promotion of drip irrigation systems in ginger plantations	HH	150	

10.6 Agriculture Resilience Plan for Phangkhar Gewog

Commodity	Challenges	Key Investment area	Strategic Action	Units	Proposed target	Budget (m)
Orange	Citrus greening 2. irrigation, management strategy,	Control of pest and diseases, land development,	1.Machines for Management (Pruning and sprayer machines) 2. Spraying PP Products, support disease free seedling, lack of water irrigation storage tank for 200 acres of orange in all chiwogs	HH	250	15.00
Ginger	Pest and diseases (soft rot)	Control of pest and diseases	Soil & rhizome treatment (use of chemicals) for 80 Acres of ginger	Kg	1500	7.00
			Replacement of rhizome for 74 acres of land	Kg	100000	
Dairy	Shelf life of milk	Supply of dairy Equipment	Set up Agri-Dairy aggregation centre, supply of 200 Churning machine, 1 Chilling Van to benefit all the five chiwogs	Nos.	1	25.00
	Shortage of fodder	Availability of fodder	Pasture Development and	Acres	100	5.00

			fencing in 100 acers of land (all chiwogs)			
		Availability of fodder	Hydroponic fodder for all chiwogs	Mt	5	1.50
	Lack of Improved cattle	Procurement of improved cattle	Supply of hybrid cattle for households in 5 chiwogs	Nos.	250	16.00
	Lack of quality dairy shed	Dairy shed development	Construction of 100 climate smart dairy shed in all chiwogs	Nos.	100	75.00
	Labor shortage	Mechanization	Supply of chaft cutter/dairy smart equipment	Nos.	50	2.00
	Lack of awareness	Brand development	Value addition of dairy products	Nos.	50	1.00
		knowledge enhancement	Exposure visits to other Dzongkhags for 100 farmers from all chiwogs	Nos.	100	1.00
	Lack of employment opportunities	Employment opportunity	Youth group enterprise	Nos.	25	5.00
Maize	Marketing and Pest and diseases/human wildlife conflict	Hybrid seeds, formation of marketing group	Replacement of Hybrid seed, Land development, Post harvest machine, chain-link fencing All Chiwog	HH	200	15.00
Cardamom	Pest and diseases	Buy hybrid saplings	Supply Hybrid saplings, Fencing support All Chiwog	Nos	100000	5.00

Poultry	Insufficient egg	increase egg production	Construction of 6 Nos of sheds in 2 chiwogs	Nos	6	3.00
			Pullet supply for farmers from all chiwogs	Nos	20000	3.00
			Hydroponic feed for selected farmers from 3 chiwogs	HH	4	2.00
			Equipment support/wire mesh	Sets	200	2.00
	Degradation of native birds	Enhance native egg productions	Shed constructions/ wire mesh	Nos.	5	3.00
native birds supply			Nos.	20000	3.00	
Coffee	Lack of know-how on management, processing, marketing.	Skill development on production and processing strategies, market linkage.	Support seedling supply, training on management, post-harvest/processing machine for 125 acres of coffee plantation	HH	250	7.00
Piggery	Insufficient pork	Increase pork production	Construction of 10 sheds in 3 chiwogs	HH	10	3.00
			supply of piglet	Nos.	500	3.00
			wire mesh fencing bio security	Nos.	2	3.00
			Hydroponic feed	HH	20	2.00
Turmeric	Poor Management and lack of seedlings	Quality seedlings and processing	Supply quality seeds and management trainings (21 acres)	HH	70	1.00

Vegetables	Enhance vegetable production	support to smart climate resilient vegetable production	protected agriculture, smart irrigation, land development, post production equipment for 125 acres of vegetable land	HH	250	15.00
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10. 7 Agriculture Resilience Plan for Shingkar Gewog

Commodity	Challenges	Key Investment area	Strategic Action	Unit	Projected Target	Budget (in M)
Paddy/Maize	Water shortage	Major maintenance of IC and water source protection	Renovation of irrigation channel, Plantation and fencing of Water source Nimshong, Thrisa, Wamling, Shingkar (170HH)	KM)	24	72.00 (IC), 3M for chain link fencing at water source
	Defunct irrigation Channel					
	Drying up of water at source					
	Land degradation	Improved soil fertility resulting in higher crop yield	Land Terracing, Sustainable Land development (244 HH)	Acres	100	8.00
	Human-wildlife conflict	Protection of crop	Chain link fencing at Shinkar, Nimshong (120 HH)	Km	30	45.00
Cardamom	Inferior quality	Processing	Dryer machine for all Chiwog (244 HH)	Nos.	5	6.00
Dairy (cattle)	Shelf life of milk	Supply of dairy Equipment	Agri-Dairy aggregation center, Churning machine, Chilling Van (1 aggregation center, 200 churning machine, 1 Chilling van)	Nos.	1	25.00

	Human-wildlife conflict	Insurance	Costing for cattle	Nos.	120	1.50
	Shortage of fodder	Availability of fodder	Pasture Development	Acres	100	5.00
		Availability of fodder during dry season	Introduction of Hydroponic fodder plantation	Nos.	50	2.00
		Nutrient enhancement	Production of Feed block/UMMB	Tonnes	10	3.00
	Lack of hybrid cattle	Hybrid cattle enhancement	Supply of hybrid cattle	Nos.	200	16.00
	Lack of quality dairy shed	Dairy shed development	Construction of climate smart dairy shed	Nos.	50	75.00
	Labor shortage	Mechanization	Supply of chaff cutter	Nos.	60	4.00
	Lack of awareness	Brand development	Value addition of dairy products	Nos.	20	1.00
	Lack of employment opportunities	Employment opportunity	Youth group enterprise	Nos.	50	5.00
	Lack of Indigenous Breed	Enhancement of indigenous breeds	Supply of Mithun and Nublang	Nos.	20	1.00
	Lack of knowledge and exposure	Dairy development	Capacity development in dairy production and exposure tour to groups, farmers	Nos.	244	1.00

Free Range Egg Production	Lack of awareness	Market Linkages and awareness	Buyer Seller meet B2B linkage	HHs	244	5.00
	Lack of climate resilient poultry housing	Climate resilient Poultry farming	Construction of climate smart poultry housing	Nos.	10	5.00
	Low egg production	Enhance egg production	Supply of pullets (Improved and Native)	Nos.	2500	1.00
Ginger and Turmeric	Lack of market	Market Linkages and awareness	Buyer Seller meet, B2B linkages	Acres	100	12.00
Vegetables	Lack of market	Market Linkages and awareness	Buyer Seller meet, B2B linkages	Acres	50	4.00
	Lack of irrigation facilities	Climate resilient production system	Supply of irrigation system and protected infrastructure development			
	Lack of seedlings	Improved vegetable production	Supply of vegetable seeds on cost sharing basis	Nos	5000	2.00
Mushrooms	Lack of technology know-how	Technology development	Shitake and Oyster mushroom production	Nos	50	8.00
Orange	Lack of technology know-how	Technology development	Capacity strengthening on Grafting, Plucking, harvesting, orchard	Nos.	366	1.50

			management, packaging and marketing			
Buckwheat	Lack of technology know-how	Technology development	Support of postharvest equipment and machines All Chiwog	Nos.	10	1.00

10.8 Agriculture Resilience Plan for Trong Gewog

Commodity	Challenges	Key investment Area	Strategic action	Unit	Project ed target	Budget (Million)
Dairy	Low production Inferior breeds of dairy cows	Dairy improvement and production	Supply of improve breeds for all Chiwo	Nos.	200	2.00
			Supply of improved breeding bulls, Mithun and Nublang	Nos.	15	0.70
	Shortage of fodder		Supply of fodder seeds and seedling for all Chiwo	Acre	300	3.50
	Lack of pasture fencing		Supply of Barbed wire	Acre	300	6.00
	Poor Shortage of Infrastructures		Supply of shed construction materials All chiwo	HHs	100	12.00
	Spoilage of milk, Lack of dairy equipment and cold chain facilities.		Supply of dairy equipment All chiwo	HHs	100	3.00
			Supply of cold storage (Cellfrost, coolbox) for 2 MPUs at Tshanglajong &Trong-Dangkhar	Nos.	2	0.60
	Lack of knowledge and exposure		Capacity development and exposure visits	Nos.	100	1.00
Poultry	Low production, Heat and Cold stress, lack of Free-range eggs production	Poultry Development	Supply of Poultry birds	Nos	35000	6.50
			Construction of shed with all the amenities for all Chiwo	Nos.	5	5.00
			Market linked, Capacity development	Nos.	100	0.50

	Inadequate chicken production		Supply of DoC broiler	Nos.	25000	35.00
	Disease outbreak		Procurement of poultry medicine and training	as per the requirement	All chiwog	2.50
	Lack of Bio-Security		chain linked fencing for Tama-Berti, Gomphu and Tshanglajong-Zurphel.	Km	5	7.500
	Lack of awareness & Exposure		Capacity development and exposure tour	Nos	100	1.00
Piggery	Low Pork production, inferior Breed, Decline in pig farming, social stigma/religious stigmatization	Piggery Development	Supply piglets, Gilt and Boars Trong-Dangkhar, Berti and Gomphu	Nos.	500	2.50
	Lack of pig sty		Construction of shed	Nos	4	3.00
	Disease outbreak		Live input supply, Trong-Dangkhar	Nos	100	0.20
			Awareness program Berti and Gomphu	Nos.	100	
	Lack of Bio-Security		Chain-linked Fencing with Sinage Trong-Dangkhar, Berti and Gomphu	Nos.	4	2.00
	Lack of knowledge and exposure		Capacity development and exposure tour Trong-Dangkhar, Berti	Nos.	50	1.00

			and Gomphu			
Paddy	Human Wildlife Conflict	Chain-liked Fence	Chain linked fencing/Barbed wire	Km	20	40.00
	shortage of irrigation canal	construction of irrigation canal	New construction Changchangmay channel	Km	6	19.00
			Construction of new channel Pinsiling-Boksar	Km	12	38.00
		Renovation of Irrigation canal	Renovation of irrigation & maintenance in all Five Chiwogs	Km	24	15.00
Orange	Lack of Irrigation system, Pest & disease, wild life conflict, Accessibility	Construction of Water lines & Construction of access road	Construction of access road & Irrigation water supply	Km	40	30.00
		Capacity building on orchard management	Hands on Training on canopy management, awareness & pest management, Orchard development, Exposer tour; Input supply	HH	300	3.00
Spices - Cardamom, Ginger and Turmeric	Lack of market, Inappropriate dryers, Washer, Slice cutter	Market Linkages and awareness	Maintenance of existing house and procurement of equipment, Capacity All Chiwog	HHs	350	12.00
Vegetables	Lack of market	Market Linkages and awareness	Buyer Seller meet, B2B linkages	Acres	50	4.00
	Lack of irrigation facilities	Climate resilient production	Supply of irrigation system and protected infrastructure	Nos	50	4.00

		system	development, Supply of high yielding seeds			
Mushrooms	Lack of technology know-how	Technology development	Shitake and Oyster mushroom production, procurement equipment, Capacity building	HHs	50	5.00
Coffee	Lack of technology know-how	Technology development	Construction of collection centre, Capacity building	HHs	150	4.00