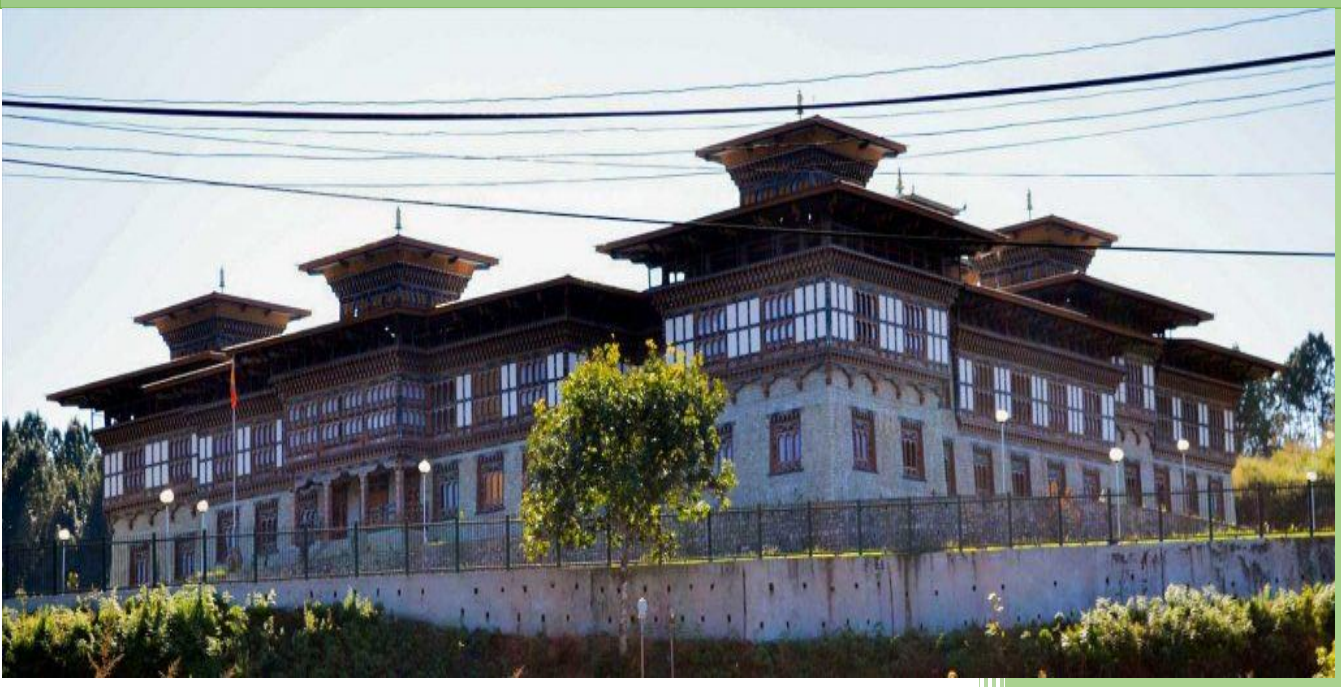
BUILDING RESILIENT COMMERCIAL SMALLHOLDER AGRICULTURE (BRECSA)

AGRICULTURE RESILIENCE PLAN (ARP) FOR TSIRANG 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 TSIRANG DZONGKHAG

(VERSION 1.0)

March 2024

Project Management Unit

Samtenling, Sarpang

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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 (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 Tsirang 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 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 poses a substantial threat to livelihood activities in Tsirang 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 vegetables, Cattle (dairy), paddy, maize, orange, piggery, poultry, green gram, cardamom, and ginger.

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. Vegetable and paddy cultivation relies 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 Barzhong, Tsholingkhar, Kilkhorthang, Dunglegang, and Gosarling struggle with reduced fruit quality and yields due to insufficient rainfall and inadequate irrigation infrastructure. Similarly, maize grown in Gewogs like Shemjong,

Tsirang Toed and Pungtenchhu, 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. Farmers from Gewogs like Sergithang, Shemjong, and Patshaling also reported incidents of heat stress in poultry and pigs, sometimes resulting in animal deaths.

3.4 Wildlife Conflicts: Maize and paddy fields face severe crop predation by wildlife, mainly the wild boar, as animals move to new areas in search of food amid changing climate conditions. All the Gewogs growing these crops reported increased crop destruction by these animals, threatening food security and requiring 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 mitigate climate-related risks and build long-term resilience in Tsirang'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).

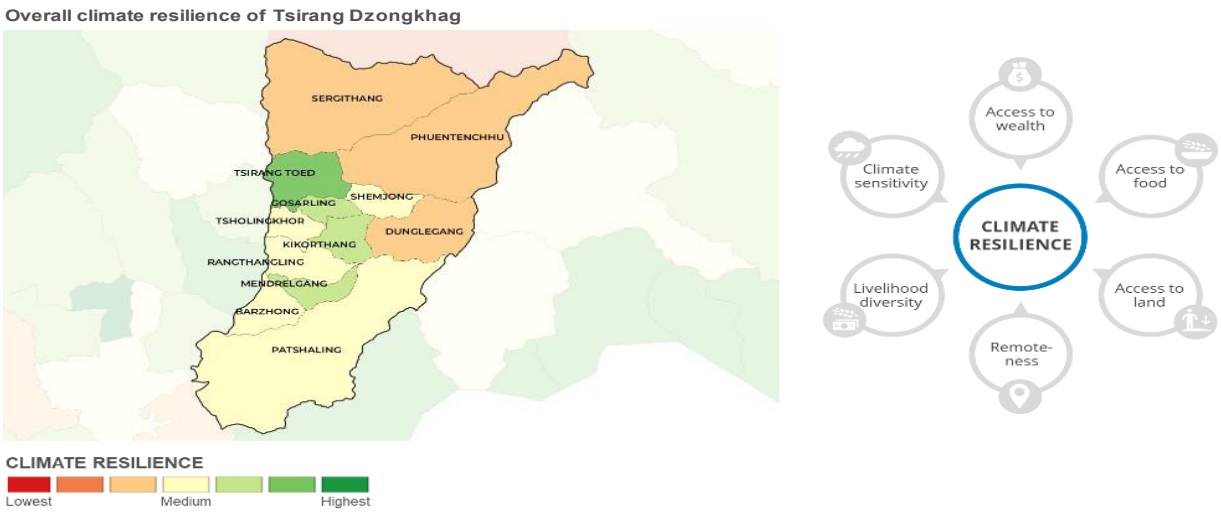

Figure 1. Overall climate resilience of Tsirang Dzongkhag

Table 1 provides an analysis of the resilience level of each Gewog within Tsirang Dzongkhag, highlighting the district's vulnerability due to economic, climate sensitivity, and geographical constraints. A score of 1 indicates high resilience, while a score of 4 signifies the lowest resilience in each category. The access to land and livelihood diversity in Tsirang provides some resilience against climate shocks. Farmers engage in various activities, from vegetable, fruit, and paddy cultivation to livestock rearing, which supports both food security and income diversification. This diversity enhances resilience by providing multiple income sources and spreading risk across various agricultural activities. All the Gewogs within the Dzongkhags score relatively high in resilience, especially in terms of access to land and

climate sensitivity. Overall, Sergithang and Phuentenchhu Gewogs exhibit low resilience in wealth and food access, suggesting higher economic and food insecurity and greater vulnerability to climate 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 level of Tsirang Dzongkhag

Gewog	Access to wealth	Access to food	Access to land	Remote-ness	Climate sensitivity
Barzhong	**3**	**1**	**2.5**	**4**	**2.25**
Patshaling	**3**	**2**	**2**	**3**	**2.25**
Kikorthang	**2**	**2**	**2.5**	**2**	**1.25**
Mendrelgang	**2**	**2**	**2**	**2**	**2.25**
Rangthangling	**3**	**2**	**2**	**4**	**2.25**
Dunglegang	**4**	**3**	**1.5**	**3**	**2.5**
Gosarling	**2**	**3**	**2**	**2**	**2**
Sergithang	**4**	**4**	**2**	**4**	**2.5**
Phuentenchhu	**4**	**4**	**2**	**3**	**3**
Shemjong	**3**	**4**	**2**	**2**	**2**
Tsirang Toed	**3**	**1**	**2**	**2**	**2.5**
Tsholingkhar	**3**	**4**	**2.5**	**1**	**2.5**

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

5. DZONGKHAG PROFILE

The Dzongkhag profile provides a comprehensive overview of key information and salient features for Twelve Gewogs under Tsirang Dzongkhag. Each Gewog is described in terms of area, number of households, population distribution by gender, irrigation schemes, total irrigation length, and agricultural land (wetland and dryland). Overall, it highlights the

diversity in the size, population, and agricultural infrastructure across the twelve Gewogs, providing valuable insights for planning and development initiatives. Tsirang's unique agroecological zones and cultural acceptance, influence both the agricultural practices and the livelihoods of its residents.

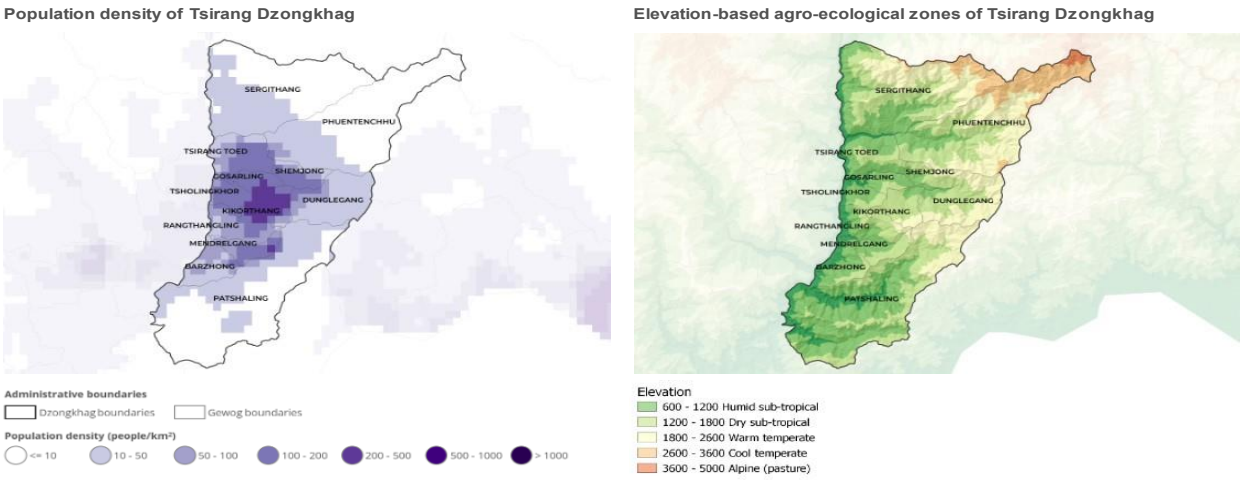

Figure 2. Population density map and agro-ecological zones of Tsirang Dzongkhag

The size and demographic characteristics of the Gewogs in the Dzongkhag vary significantly. Patshaling is the largest Gewog, covering 170.90 sq. km, while Kilkhorthaang is one of the smallest, at 17.80 sq. km. In terms of household numbers, Kilkhorthaang has the highest, with 549 households whereas Tsirang Toed has the fewest, at 262.

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 Kilkhorthang and Tsholingkhar, for instance, have larger wetland areas, essential for paddy cultivation, while Gewogs such as Doonglagang rely more on dryland agriculture. Because of terrain limitations, all the Gewogs rely more on dryland agriculture, producing vegetable, fruit, and livestock farming. 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. Gewog profile

SL. No	Gewog	Area (Sq. Km)	Number of Households	Population		Irrigation schemes (Nos.)	Total length (km)	Wet land (Acre)	Dryland (Acre)
				Male	Female				
1	Barshong	21.20	327	1239	1144	49	24.55	241.71	568.21
2	Doonglagang	45.90	373	1649	1531	19	31.95	225.66	799.60
3	Gosarling		305	2301(T		14	46.00	378.58	484.37
4	Kilkhorthaang	17.80	549	1582	1612	32	62.78	625.53	734.56
5	Mendrelgang	15.50	389	2995 (T)		13	25.01	358.11	688.36
6	Patshaling	170.90	302	1249	1256	16	22.20	118.40	617.08
7	Pungtenchhu	132.32	315	2693 (T)		52	69.25	364.33	609.90
8	Rangthangling	24.50	362	1592 (T)		20	27.60	308.50	429.00
9	Semjong	14.50	315			33	37.45	314.16	532.81
10	Tsholingkhar		303	3840 (T)		28	88.70	575.50	906.00
11	Tsirang Toed	30.30	262	2152 (T)		52	35.15	362.98	763.93
12	Sergithang	45.93	314	2906		16	28.5	285.1	743.92

Data source: NSB (2019). Gewog data and 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 southwest 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.

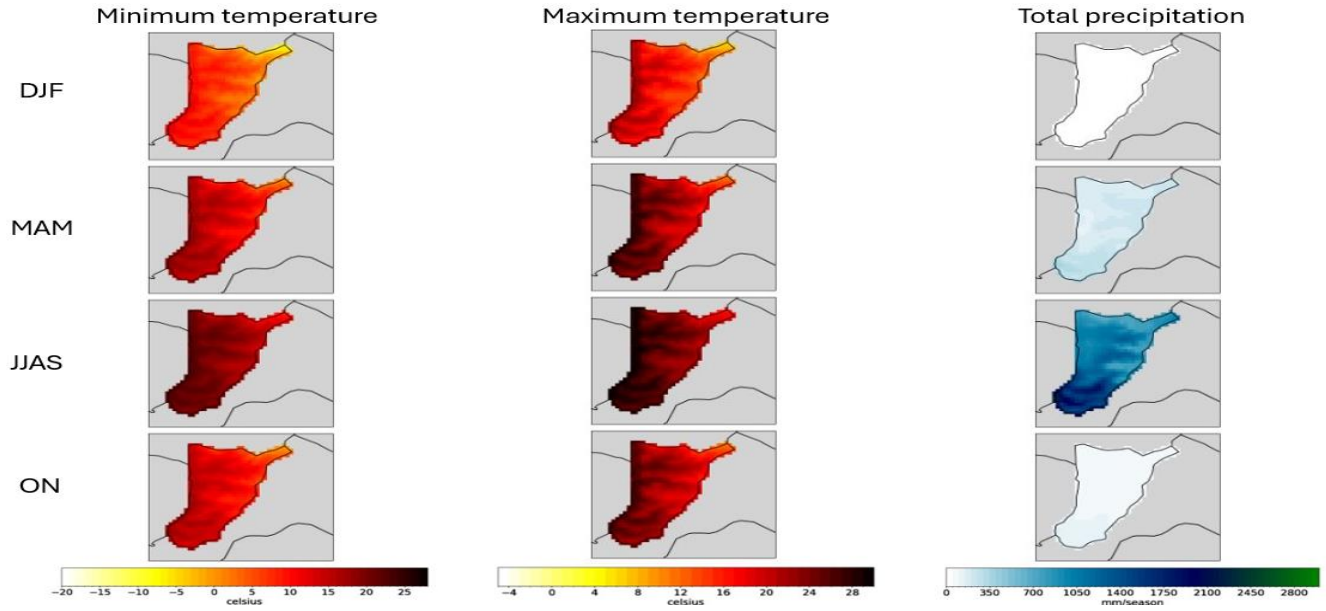

Figure 3. Seasonally averaged minimum temperature (left), maximum temperature (centre), and total precipitation (right) for Tsirang Dzongkhag over the baseline period (1996-2019)

Seasonally averaged minimum and average maximum temperatures (Fig.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 Tsirang Dzongkhag across all seasons, with temperatures reaching above 20 °C during summer and only dropping to 5-10 °C during winter. Tsirang 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. Although Tsirang Dzongkhag is positioned north of the highest rainfall totals (along the southern edge of the country), it still receives a large amount of precipitation, with a total of >1000mm for the monsoon season, and a larger amount in southern parts. 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 Tsirang Dzongkhag (Figure 3). The main increases occur during the monsoon season June to 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 Tsirang Dzongkhag. There is warming in all seasons, with the largest changes occurring in the autumn months 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 15-30 days per year for Tsirang Dzongkhag, with the largest changes occurring in the south. 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 Tsirang Dzongkhag, the baseline wettest values of RX1Day are approximately 300 mm/day, which is projected to increase to up to 420 mm/day by 2050 – an increase of 40 %. Again, the increases are the largest in the south. 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 Tsirang 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.

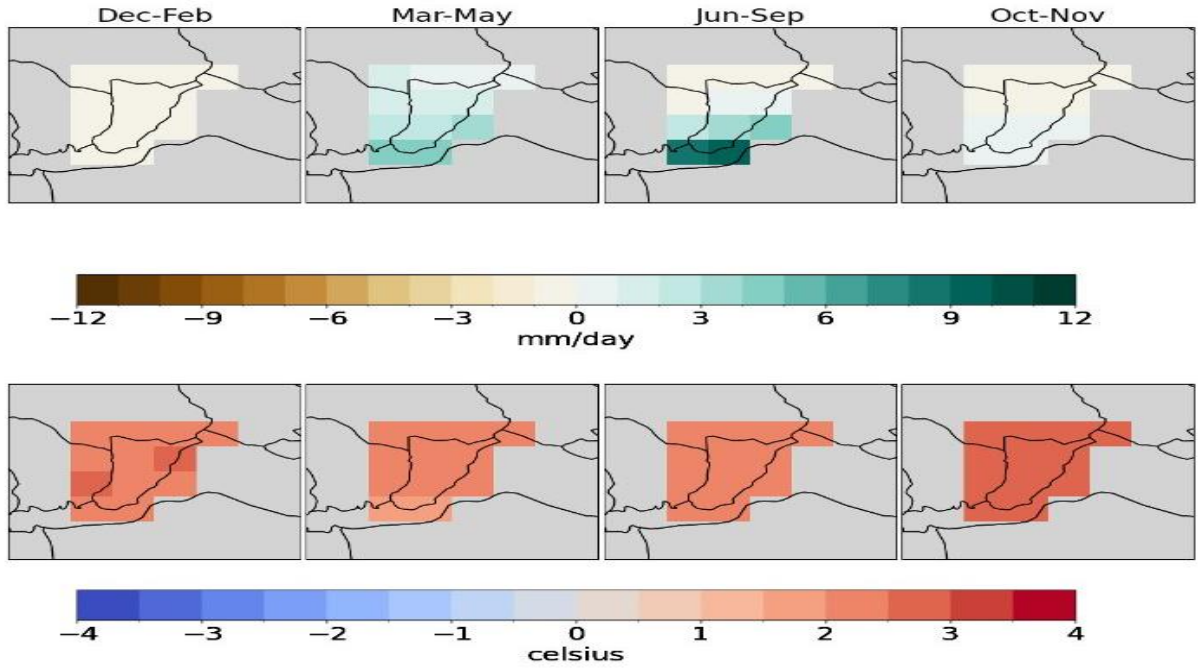

Figure 4. Projected changes in seasonal total precipitation (top panels) and seasonal average daily mean temperature (bottom panels) for 2050 (2036–2065) relative to the baseline (1981–2010).

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. 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 favor these warmer temperatures, including Chili Pod Borer and Cut Worm (chilli), Grey Leaf Spot and Armyworm (maize), and Brown Plant Hopper (paddy).

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.

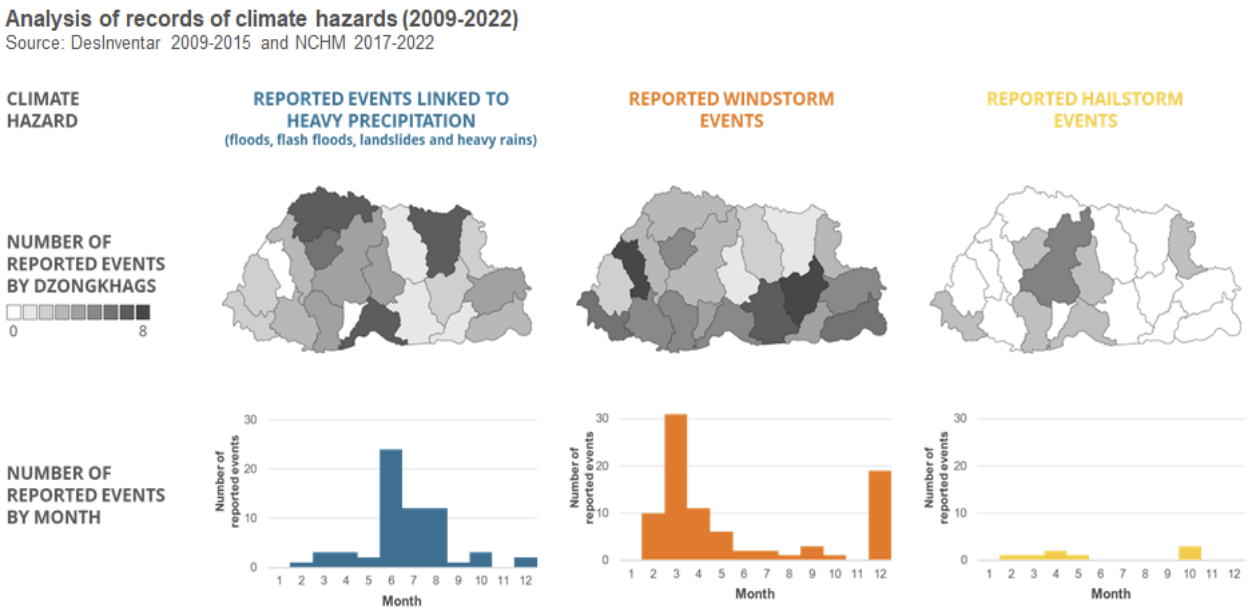

Figure 5. Analysis of records of climate hazards (2009-2022)

Tsirang Dzongkhag has experienced significant climate changes, notably a decrease in rainfall during critical periods like February and March, essential for maize and vegetable cultivation, a delay in monsoon rains in June and July, affecting paddy transplanting, and increased rainfall from August to September, particularly affecting vegetable cultivation and paddy maturation and harvesting. This shift has led to water shortages during critical agricultural periods, causing maize, paddy, and cardamom yields to decline, sometimes by up to 50%, and has also resulted in the drying up of water sources, further exacerbating the challenges for local farmers. Furthermore, the increased temperatures have led to the decline of mandarin orange trees in lower elevations while thriving in higher areas. Prolonged hotter and drier periods from February to June have also impacted cattle, poultry, and pig rearing, resulting in reduced production due to heat stress, shortages of fodder, and exacerbated disease instances. In addition, communities have also noted more frequent and severe windstorms and hailstorms damaging crops such as maize, vegetables, and oranges. The most vulnerable groups in Tsirang include elderly individuals who cannot cope when their crops are destroyed, women who bear the brunt of household chores, paddy cultivators who require substantial water for their crops, and orange farmers at lower elevations.

Communities in higher elevations are particularly affected by water scarcity, while those in lower altitudes are more impacted by increasing temperatures.

To cope with these impacts, the communities have adopted several strategies. Farmers have resorted to alternative cropping, such as growing maize, pulses (such as green gram), or vegetables instead of paddy, utilizing small-scale water storage systems, and/or using polyhouse to shield vegetables from heavy rain during the monsoon season. Efforts have been made to protect water sources by fencing and planting trees. Some farmers have implemented irrigation methods using pipelines and sprinkler systems for vegetable cultivation; however, when irrigation water is scarce due to the drying up of water sources, they resort to spraying water manually. Rainwater harvesting has been attempted, though with mixed success due to issues with evaporation and stagnation. Some of those rearing poultry and/or pigs are also using climate-smart sheds to help cope with the excessive heat. Finally, to cope with the climate challenges some farmers also abandoned agriculture altogether, left land fallow, and/or migrated to other areas for alternative livelihoods.

7. ADAPTATION AND MITIGATION MEASURES

Farmers in Tsirang 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. Water-saving devices, technologies, and practices should be actively promoted and supported for crops like vegetables and mandarin. Drip irrigation systems, for instance, deliver water directly to the root zone, reducing evaporation and runoff while rainwater harvesting systems can be used to capture rainwater which can be utilized during the dry spell. 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 such as Bulbul 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 Tsirang, severely affecting most citrus orchards and causing fruit drop rates of up to 90% in some cases. 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, particularly those engaged in vegetable cultivation or producing dairy, piggery, and poultry products, struggle with distant or underdeveloped markets. They also contend with intense competition from

cheaper imports from India. Strengthening market linkages through cooperative models, cold storage facilities, and improved market information can help overcome these issues.

Livestock management: Dairy farmers face challenges like fodder shortages during the earlier parts of the year. To ensure year-round fodder availability, the promotion of silage production and pasture development needs to be taken up. Breed improvement programs, with a focus on introducing breeds suited to local climatic conditions, will enhance dairy productivity. Farmers raising pigs and poultry also face challenges, as rising temperatures lead to heat stress in animals. Furthermore, various livestock diseases, including African Swine Fever (ASF) in pigs, Newcastle disease in poultry, and Foot-and-mouth disease (FMD) in cattle, are known to occur frequently. Strengthening veterinary services and implementing robust animal health programs are crucial to mitigate climate-related risks and improve livestock resilience.

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 the 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 community consultations for the CLEAR+ exercise, community representatives defined the four main livelihood activities in each Gewog based on the contributions to households' food and income. For Tsirang, the following livelihood activities were highlighted (listed in the order of importance - i.e., the number of Gewogs that highlighted the activity): Vegetables, Cattle (dairy), Paddy, Maize, Orange, Piggery, Poultry, Green gram, Cardamom, Ginger. Additionally, farmers in Tsirang Dzongkhag cultivate a variety of other crops on a small scale, including buckwheat, millet, and fruit trees.

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 Tsirang Dzongkhag

Semjong	Dunglagang	Goserling	Patshaling	Tsholingkhar	Tsirangtoe	Phentenchu	Rangthangling	Sergithang	Barshong	Kilkhorthang	Mendrelgang
Piggery	Vegetables	Vegetables	Vegetables	Dairy	Diary	Vegetables	Dairy	Chili	Piggery	Vegetables	Vegetables
Vegetables	Dairy	Dairy	Dairy	Vegetables	Vegetables	Poultry	Vegetables	Piggery	Cardamom	Paddy	Dairy
Dairy	Avacado	Paddy	Piggery	Orange	Ginger	Piggery	Ginger	Vegetables	Vegetables	Dairy	Paddy
Oranges	Oranges	Orange	Egg	Maize	Orange	Orange	Piggery	Paddy	Cattle	Maize	Maize
Avacado	Goat	Piggery	Cardamom	Goat	Poultry	Cardamom	Orange	Quinoa	Roots and Tubers	Orange	Ginger
Poultry	Honey	Poultry	Legumes	Paddy	Quinoa	Paddy	Paddy	Maize	Ginger	Poultry	Green gram
Green gram	Kiwi	Goat	Orange	Piggery	Goat	Dairy	Goat	Banana	Orange	Cardamom	Orange
Ginger	Quinoa	Maize	Broilers	Cardamom	Piggery	Goat	Maize	Dairy	Paddy	Piggery	Broilers
Paddy	cardamom	Green Gram	Maize	Avocado	Mushroom	Quinoa	Poultry	Cardamom	Goat	Turmeric	Egg
Cardamom	Poultry	Honey	Cucumber	Ginger	Green Gram	Ginger	Cardamom	Orange	Broilers	Green gram	Goat

Table 4. Prioritized list of commodities for Tsirang Dzongkhag

Commodity	Rank
Vegetables	1
Dairy	2
Piggery	3
Oranges	4
Paddy	5
Poultry	6
Goat	7
Cardamom	8
Ginger	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 and value chain activities. These adaptations are tailored to mitigate the environmental, economic, and logistical difficulties that impact sustainability and resilience 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

Tsirang Dzongkhag's value chain is evolving, with some commodities already having established systems while others show potential for further development. In Tsirang

Dzongkhag, 22 different crops are cultivated, with maize being the most widely grown, involving 69% of households. Among these crops, those with established value chains, such as mandarin, cardamom, ginger, and vegetables, are also widely grown.

The value chain analysis performed during the CLEAR+ analysis recommended **meat and eggs** (**Table 5**) for the Dzongkhag. In this analysis, these commodities were selected based on their potential to offer households a steady income year-round, without being dependent on seasonal factors. Bhutan imports livestock products worth billions, with only about 25% produced domestically. Since many farmers in Tsirang are involved in livestock production, particularly meat and eggs, strengthening these two value chains would help reduce the country's reliance on imports.

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)
Meat	Lack of cold storage and processing facilities	Establishment of meat processing unit and cold storage facilities	Year-round production during the lean demand seasons	Every farm households, semi or commercial farms	Enablers required to establish the value chain
Eggs	Lack of access to market for small holder producers	Formation of egg marketing cooperative targeting the marginal household producers	Consistent year-round access to market for marginal household producers	Ever households that produce on a very marginal 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 locations for the establishment of Gender and Youth Inclusive Hubs in Tsirang

The strategic locations for the establishment of gender and youth-inclusive hubs were identified during the validation workshop 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 participants were taken into account. The prioritized commodities, based on local production strengths and future potential, were then grouped and ranked. All twelve Gewogs proposed at least two potential commodities based on these criteria. Among the commodities listed, **meat** (pork including chicken) and **vegetables** were selected as the focus commodities for the Agri-food Hub in Tsirang. Consequently, the workshop recommended a reorientation of value chain priorities towards meat and vegetables, aligning investment and development efforts more closely with local preferences and market opportunities.

Table 6. Location and commodities for Agri-food Hub for Tsirang Dzongkhag

Gewog	Location	Commodity	Factor of site and crop selection
Semjong	Changchey	Meat, 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

During the workshop, two commodities were identified as niche products for Tsirang Dzongkhag**: mushrooms and honey**. These products were selected based on specific

criteria and considerations that align with the region's environment, current production, existing knowledge, and future potential.

Mushroom: The decision to select mushrooms as a niche product stems from the favorable environmental conditions in the Dzongkhag and the strong interest expressed by local residents. In 2023, Tsirang Dzongkhag produced 11.55 metric tons of mushrooms. Although this quantity may seem modest, participants noted the enthusiasm among farmers and the availability of raw materials for mushroom cultivation. The region's climate and natural resources are conducive to mushroom farming. By promoting mushrooms as a niche product, the Dzongkhag can capitalize on these advantages, encouraging more farmers to participate in cultivation and thereby enhancing local production. Furthermore, mushrooms are highly nutritious and can command premium prices in both local and regional markets, making them a compelling choice for diversifying income sources.

Honey: Honey has been recognized as a promising niche product due to the current production activities already undertaken by farmers in the Dzongkhag. Evidence of honey production in the region highlights its significance, as Tsirang Dzongkhag ranks third in honey production across Bhutan. This established presence not only showcases the capability of local farmers to produce honey but also reflects a growing awareness of its economic potential. The existing knowledge and experience among local beekeepers can be leveraged to expand production and improve practices. By focusing on honey as a niche product, the Dzongkhag can capitalize on its ranking and existing production base, encouraging more farmers to engage in beekeeping. This shift can lead to increased local production and the establishment of a more robust honey market.

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.

Ginger, Tumeric, 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 Tsirang Dzongkhag was conducted using a **multi-criteria assessment approach**. This method allowed 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. Below is an elaboration on the approach and the factors considered:

Road Infrastructure: Given the poor roads, especially those connecting the Gewogs, 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 assessment for production and marketing in Tsirang Dzongkhag is given 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.

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, 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 handling, processing, and marketing of agricultural and dairy products after harvest. Unlike production infrastructures, the needs in this category are set to be further evaluated during the **Multi-Stakeholder Platform** (**MSP**) meeting.

1. **Milk Collection Centers**: Establishing milk collection centers to streamline the dairy supply chain and reduce losses during transportation.
2. **Processing Plants:** for commodities such as pork, 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 and livestock products, the construction of cold storage units is crucial for preserving quality and extending market access.

Table 7. Infrastructure requirement of Tsirang Dzongkhag

Infrastructure	Unit	Total target	Semjong	Doonglagang	Goserling	Patshaling	Tsholingkhar	Tsirangtoe	Phuntenchu	Rangthanglin	Sergithang	Barshong	Kilkhorthang	Mendralgang	Commodity
Production infrastructure															
Construction of new irrigation	KM	**58**	1	0	0	0	0	0	40	10	0	0	0	7	Paddy
Dryland irrigation/pipe irrigation	Sets	**3099**	1	0	150	390	3.5	1402	315	140	186	210	1	300	Ginger/vegetables orange, Kiwi
Rehabilitation/renovation of existing irrigation	KM	**22**	0				6				0		16	0	Paddy
Chain link fencing	KM	**371**	135	7	70	6	0	90	32	4		4	10	13	Paddy, Bio-security and vegetable
Land development	Acre	**544**	0	0	0	17	0	100	7	200	20	0	0	200	Orange, paddy
Electric fancing	Km	**9**	0			2								7	
Greenhouses/Hydroponic /high-tech mushroom shed	Nos..	**225**	100				0	125	0						Vegetables, Mushrooms

Construction of farm road	KM	**1**		1											
Cattle shed construction	Nos..	**700**	0	350	0	100	0	70	0	10	50	50	70	0	Dairy
Poultry shed construction	Nos..	**594**	320	35	100	35		7	15	2	30		50	0	Piggery
Piggery shed	Nos..	**634**	320	50	0	40	2	50	40	7	70	20	30	5	Poultry
Goat shed	Nos..	**480**	0	320	0	0	0	0	0	0	30	100	0	30	Goat
Post-harvest, processing and value additional infrastructure															
Milk collection center/MPU	Nos..	**30**	5	1	1	6	1	2	0	1	5	6	1	1	Dairy
Collection shed/pack house/storage center	Nos..	**12**	5	0	0	0	4	0	0		2	0	1	0	Ginger/vegetable
Pocessing plant	Nos..	**12**	1			1				1	8	1	0	0	Ginger
Meat processing unit	Nos..	**11**	1	2	2	1		1			1	1		2	Pork/chicken
Construction of cold stores	Nos..	**8**	1	2			2				1	1		1	Vegetables, meat

Bio-gas installation	Nos..	**480**	320			140								20	Dairy
Market infrastructure/equipment															
Procurement of milk freezer van	Nos..	1			1										
Construction of sales outlet	Nos..	5				3				1				1	Dairy/vegetables

10. AGRICULTURE RESILIENCE PLAN

10.1. Agriculture Resilience Plan for Barshong Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected target	Budget (M)
Piggery	Diseases, Shortage of Piglets, Expensive Piglets and Feed, Expensive Construction of Shed, Lack of Proper Infrastructures and clean processing units)	Enhance pork production	Construction of climate smart Shed in all Chiwogs (200 HH)	Nos.	20	11.50
			Construction of Processing unit at Barshong Toed	Nos.	1	
			Construction of small storage unit (for chevon and pork) at Barshong Toed	Nos.	1	
			Capacity building for farmers	Nos.	200	
Cardamom	Labour Shortage, Drought, Weed, Vertebrate Pests and Lack of Improved infrastructures.	Enhance quality cardamom production	Promotion of Dyer(Electric or fuel/firewood) Gangtokha and Barshong Toed (62 HH)	Nos.	10	6.00
			Supply of Grass Cutter (62 HH)	Nos.	30	
			Promotion of Integrated Pest, nutrient and soil management practices	KG	1000	
			Procurement of traps	Nos.	1000	
			Procurement of Spray Machines	Nos.	62	

Vegetable(Cole crop, dally Chilli, early Bhutanese Chilli and winter Chilli, beans)	Labour Shortage, Drought, Weed, Vertebrates Pests and Lack of Improved infrastructures, shortage of irrigation.	Enhance Chilli Production in the Gewog	Supply of Mini Power Tiller for all 5 Chiwogs of Barshong	Nos.	10	7.00
			Supply of Bed making Machines	Nos.	10	
			Procurement of Mulching Plastics	Rolls	1000	
			Construction of pipe Irrigation system in dry land	Nos.	10	
			Promotion of Drip irrigation facilities and Implementation of smart irrigation facilities(Water pump/1-5HP,syntax sprinkler)	Sets	200	
			Supply of Harvesting Crates(For orange, vegetables, roots and tubers)	Nos.	1000	
			Capacity building for farmers	Nos.	142	
			Supply of hybrid seeds	Pkts	5000	
Dairy	Unavailability of improved and Productive cattle, lack of adequate fodders, lack of climate smart shed, lack of milk collection	Enhance dairy products in the Gewog	Inputs supply (Sexsorted semen) 5 Chiwogs of Barshong (200 HH)	Nos.	100	10.00
			Construction of climate smart shed for 5 Chiwogs of Barshong	Nos.	50	
			Construction of Small Milk Collection center and processing unit Collection center at every chiwog and	Nos.	6	

	and processing infrastructure.		processing unit at Barshong Toed			
			Supply of Milk Chiller Barshong Toed	Nos.	1	
			Supply of Grass Chopper for all 5 Chiwogs of Barshong	Sets	50	
			Supply of Freezer at MPU at Barshong Toed	Nos.	4	
			Supply of Churner at MPU at Barshong Toed	Nos.	2	
			Supply of Milk Can for Barshong Toed	Nos.	20	
			Supply of weighing Balannce	Nos.	2	
Roots and Tubers	Human- Wildlife Conflicts, Lack of Processing units, Labour shortage	Enhance value addition of the products	Construction of Chain link fencing in the Gewog Chunyikhang	Km	4	11.50
			Supply of Machineries and equipment for 5 Chiwogs of Barshong	Nos.	50	
			Construction of small Processing Unit(To be also used for ginger) Barshong Toed	Nos.	1	
			Promotion of Packaging and Labeling equipments Barshong Toed	Nos.	2	
Ginger	Labour shortage, lack of storage facilities	Enhance production of ginger	Procurement of farm machineries 5 Chiwogs of Barshong	Nos.	10	3.00

Orange	Pest infestation, lack of capacity for citrus management, lack of irrgational and nutrients management.	Enhance quality Production	Capacity building of farmer 5 Chiwogs of Barshong	Nos.	114	2.00
			Promotion of integrated pest and nutrient management for 5 Chiwogs of Barshong	Kg	1500	
Paddy	HWC, labour shortage, Pest out breaks, storage pest,	Enhance paddy production	Supply of Thrashing Machine) Barshongtoed,B/Maed, Chunyikhang	Nos.	40	1.00
			Supply of Super grain bags	Nos.	400	
			Promote high yielding variety of paddy	Kg	1000	
Goat	Diseases, policy level challenges (Unable to free graze due to environmental regulations), Lack of infrastructures such as climate smart sheds, processing units	Enhance Chevon Production	Construction of climate smart shed for 5 Chiwogs of Barshong	Nos.	100	6.00

10.2 Agriculture Resilience Plan for for Doonglagang Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected Target	Budget (M)
Vegetables	Pest and diseases, Bad quality seeds, Not easily available and expensive seeds, Infrastructure (green house) not affordable, Irrigation problem, low production, erratic rainfall, wildlife predation, labour shortage, lack of modern agriculture skills.	Land Development of all chiwogs for 150 HH	Terracing	Acre	200	14.00
		Irrigation	Supply drip irrigation system	Sets	200	15.00
			Maintenance of existing irrigation channel for all chiwogs (180 HH)	Km	35	20.00
		Fencing	Maintenance of chain link fence at Dangreyboog Toed (17 HH)	Km	2	3.00
		Farm mechanization	Power tiller all chiwogs (350 HH)	Sets	35	16.00
			Bed-making machine (1 for 10 hh)	Nos.	35	10.50
			bush cutter (1 for 10 hh)	Nos.	35	9.00
			planter (1 for 10 hh)	Nos.	35	2.28
		Capacity building on modern agriculture	Capacity on climate smart agriculture and green house management	Nos.	350	0.50
		Soil nutrient Management	Soil testing and application of fertilizer		All chiwog	
	Weed pressure	Mulching	Procurement plastic mulching all chiwogs	Nos.	2100	7.35

Dairy	Labor shortage, Fodder shortage during lean seasons, Diseases, collection and storage, breed improvement, heat wave	Farm mechanization, pasture development, bio security, enhanced milk collection center, introduction of improved breed, climate smart dairy shed.	Electric chaff cutters	Nos.	350	28.00
			Construction of climate smart shed (fan, sprinkler, water system, roof insulation)	Nos.	35	70.00
			Construction/ of straw silage pit	Nos.	350	7.60
			Construction of milk collection center	Nos.	1	40.00
			Milk collection can	Nos.	350	1.75
			Cream separator	Nos.	350	24.50
			Automatic milking machine	Nos.	350	50.00
			Butter chunner	Nos.	350	7.00
			Sex sorted semen of improved breeds	Nos.	400	1.00
Cardamom	Pest and diseases, irrigation, lack of healthy seedlings, lack of post-harvest facilities, market linkage, wild life conflict	Supply of healthy seedlings, introduction of modern drying facilities, overhead sprinkler.	Supply disease free seedling	Nos.	300000	3.00
			Supply of electric dryer	Nos.	70	8.40
			Overhead sprinkler	Nos.	1500	1.50
Oranges	Wild life conflict, pest and disease, poor orchard management, post-harvest management	Pest and disease management, orchard management	IPM, soil fertility, tree canopy management, rejuvenation, replantation, power tiller accessibility	Nos.	300	3.00

Goat	Diseases, breed improvement, lack of labor, lack of fodder, heat wave	Bio security enhanced, breed improvement, farm mechanization, pasture development, climate smart shed	Supply of wire mesh	Km	2	3.00
			Supply of buck and ewes	Nos.	10	2.00
			Silo pit construction	Nos.	230	5.00
			Climate smart shed (fan, sprinkler, water system, roof insulation)	Nos.	230	10.00
Honey	Pest and diseases, post-harvest management, apiary management	Clean production of honey, introduction of modern hives	Supply of modern hives	Nos.	350	1.40
			Supply of beekeeping equipment	Nos.	200	6.00
			Supply of packaging materials	Nos.	20000	0.50
			Capacity building on modern beekeeping	Nos.	200	0.415
Poultry	Lack of labor, diseases, lack of improved infrastructure, post-harvest facilities, lack of hygienic product, heat wave	Farm mechanization. climate smart poultry shed, cold and chilling storage, bio security enhanced, clean chicken and egg production	Supply of automatic feeder and drinker	Nos.	35	1.00
			Fencing	Km	5	2.00
			Construction of cold storage and chill structure	Nos.	35	4.00
			Construction of climate smart shed (fan, insulation) in all chiwogs	Nos.	35	20.00
			Construction of egg and chicken products	Nos.	1	80.00
Avocado	Wild life conflict, pest and disease, poor orchard management, post-harvest management	Pest and disease management, orchard management	IPM, soil fertility, tree canopy management, rejuvenation, replantation, power tiller accessibility	Nos.	80	1.00

Quinoa	Management, lack of labor, post-harvest	Capacity building	Training on production and post-harvest	Nos.	50	1.00
		Farm mechanization	Supply of power tiller	Nos.	50	4.00
Piggery	Diseases, input supply, lack of improved infrastructure, post-harvest, market linkage, storage, labor shortage, road network	Bio security enhanced, climate smart shed, establishment of breeding farm, cold and chilling storage facilities, farm mechanization, approach road construction	Fencing	Km	2	3.00
			Climate smart shed (insulation, fan, water system and sprinklers)	Nos.	50	50.00
			Establishment of breeding farm	Nos.	5	30.00
			Construction of cold and chilling storage house	Nos.	1	30.00
			Processing plant	Nos.	1	30.00
			Approach road Norjangsa	Km	1	1.00
Kiwi	Wild life conflict, pest and disease, poor orchard management, post-harvest management	Pest and disease management, orchard management	IPM, soil fertility, tree canopy management, rejuvenation, replantation, power tiller accessibility	Nos.	70	1.00

10.3 Agriculture Resilience Plan for Gosarling Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected Target	Budget (M)
Vegetables	Insufficiency use of water, Inferior quality of seeds	Provision of climate smart Irrigation technology, Hybrid Seeds and polytunnels houses	Drip Irrigation, Mulching plastics, Protective house, Water Sprinkler, Protected cultivation in all chiwogs (250HH)	Acres	350	85.00
Dairy	Shortage of Feed and fodder, deterioration of milk quality	Leasing of land for Pasture development, milk chilling facilities for 250 HH	Pasture development	Acres	500	30.00
			Build milk collection center	Nos.	1	
			Purchase of milk chilling machine	Nos.	1	
			Purchase of milking machine	Nos.	60	
			Milk can	Nos.	50	
			Construction of Silo pits	Nos.	100	
			CAIT training	Nos.	25	
Paddy	Small terrace of wet land, Insufficiency of Irrigation water, Human wildlife conflict, Inferior quality of seeds, labor shortages	Land development, Renovation of Channel, Chain link fencing, High yielding and climate resilient seeds	Agri.land consolidation and Development	Acres	45	40.00
			Renovation of Channel	Km	45	
			Chain-link fencing	Km	45	
			High yielding and climate resilient seeds			
Orange	Decline of Citrus orchard (Citrus greening/Fruit drops)	Orchard management technology	Orchard management Practices	Acres	30	2.00

Piggery	Expensive feeds, Lack of market linkages	Processing Plant	Pork processing plant at Pelrithang	Mt	700	14.00
			Development of market linkages			
Poultry	Saturated marked, high feed cost, High mortality rate	Construction of Climate resilient shed	Control temperature shed	Nos.	100	10.00
Goat	Unavailability of climate resilient shed	Processing plant	Chevon drying	Mt	100	1.00
Maize	Drought, Army worm/ Pest and diseases, Poor quality seeds, Wild life conflict, Labor shortages	Make farmers awareness on Army worm, Support Fencing facilities, Farm mechanization	Support Chain-link Fencing	Acres	210	30.00
			Farmers training on pest management	Nos.	200	
			supply of drought tolerant variety maize seed	Mt	5	
Honey	Lack of honey hives	Multiplication of bee hives, Cultivation of Mustard and Buckwheat	Honey Processors, capacity building, branding and marketing, Protective gears for Pelrithang and Pemathang chiwogs	Nos.	100	7.00

10.4 Agriculture Resilience Plan for Kilkhorthang Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected target	Budget (M)
Vegetables	Pest/diseases	Control of pests and diseases	Training on pest/diseases control at Menchuna,Tashiyangjong, Neyzergang,Dekiling & Sa-tsangma (531 HH)	Nos.	300	0.09
	Shortage of water	Development of irrigation facility	Supply of Sintex and install drip irrigation set (100 HH)	Nos.	100	1.00
	Lack of Seeds	Enhance vegetable production	Supply of different variety seeds (531 HH)	Pkt	21480	1.62
Dairy	Low milk production, Improper dairy sheds, lack of fodder and feeds, lack of farmer's capacity in modern dairy management	Enhance milk production	Breed improvement program (CAIT training)	Nos.	10	0.415
			Purchase of AI gears	Nos.	5	0.122
			Purchase of sex sorted semen	Nos.	120	6.00
			Construction of climate smart dairy shed construction	Nos.	70	5.00
			Fodder development	Acre	70	4.00
			Purchase of milking machine	Nos.	70	1.40
			Purchase of chaff cutter	Nos.	70	1.40
			Capacity building in smart dairy farm management	Nos.	70	5.00
	Poor milk hygiene	Investment in cold Infrastructure and value addition facilities to preserve surplus product	Support milk van with cold chain facility	Nos	2	6.00
			Support milk collection center with chilling facilities			
			Milk testing equipment and gears			

			Milk collection containers Menchuna, Satsangma, Lower Dekiling		3 Nos.	1.50
	Insufficient MPU space, Lack of milk testing equipment and gears, Lack of equipment's at MPU, Lack of packaging materials at MPU, Lack of product display refrigerator	Expansion of MPU to Central MPU (CMPU)	Addition of processing and milk collection unit MPU at Dekiling chiwog (	Nos.	1	3.00
			Purchase of equipment & machines for CMPU (Milk testing machines, packaging materials, milk chillier machine, milk storage tank, cheese vat, pasteurizer, vacuum packing machines, butter churner, product display refrigerator)		1 set	20.00
	Disease outbreak	comprehensive herd health management	Purchase of veterinary gears.	Sets	4	0.40
			Capacity building on animal health for 300 HH	Nos.	6	1.00
Maize	Lack of Suitable varieties	Suitable Varieties	Supply of suitable varieties seeds to control from wind storm.		531	0.071
Paddy	Crop damage by wild animals	Crop protection	Fencing for its control measure Menchuna & Tashiyangjong	Km	10	20.00
	Shortage of labour	Farm mechanized	Procurement of paddy transplanter & paddy harvester	Nos.	5	1.00
Orange	Irrigation shortage	Development of irrigation facility	Renovation/maintenance of existing irrigation (HDPE pipe) (531 HH)	Km	16	13.40

	Poor Orchard management	Management training	Training, pruning and Canopy management of Orchard.	Nos.	155	0.10
Poultry (broiler)	Disease outbreak	Comprehensive herd health management	Construction/expansion of climate smart shed with climate related farm equipment	Nos.	30	150
			Awareness on health and management	Nos.	30	1.00
			Farm biosecurity	Nos.	30	1.50
	Lack of post-harvest facilities	Production of clean meat	Purchase of stun gun, bio-pit, deep freeze	Nos.	30	0.70
	Lack of meat mobility van	Provision of mobility van with chilling facilities	Purchase of mobility van with chilling facilities	Nos.	1	22.00
Poultry (Layer)	Disease outbreak	Comprehensive herd health management	Construction/expansion of climate smart shed with climate related farm equipment	Nos.	20	10.00
			Awareness on health and management	Nos.	20	1.00
			Farm biosecurity	Nos.	20	1.00
Cardamom	Lack of Dryer	Provide Dryer	Procurement of dryer	Nos.	15	1.27
Piggery	Disease outbreak	Comprehensive herd health management	construction/expansion of climate smart shed with climate related farm equipment	Nos.	30	15.00
			Awareness on health and management	Nos.	30	1.00
			Farm biosecurity	Nos.	30	1.50
	Lack of post-harvest facilities	Production of clean meat	4. Purchase of stun gun, bio pit, chilling store	Nos.	30	0.70
	Lack of meat mobility van	Provision of mobility van	Purchase of mobility van with chilling facilities	Nos.	1	22.00

		with chilling facilities				
Turmeric	Lack of inputs like electric dryer, Slicers, Grinder Machine and Packaging machine.	Improvement of Turmeric market.	Supply of inputs like electric dryer, Slicers, Grinder Machine and Packaging machine. Menchuna	Nos.	1	0.98
			Construction of turmeric processing shed at Menchuna	Nos.	1	1.50

10.5 Agriculture Resilience Plan for Mendrelgang Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected Target	Budget (M)
Vegetable	Irrigation	Water harvesting, drip irrigation, sintext	Provide High tech irrigation system (drip set, water harvesting tank/plastic/syntex tank for Reserbo, Mendrelgang, Pemashoing , Dzomlingzor (100 HH)	Nos.	70	3.00
	Seed & seedling	Make seeds/seedlings available	Supply of vegetable seeds (hybrid/OP) (200 HH)	Pkts	3000	2.00
	Pest & Diseases	Make (pesticide/insecticide/Bio-control) available	Procurement of PP chemical/Oranic	liters	100	1.00
	Human wildlife conflict	Fencing system	Provide effective fencing system			
	Distant market	Develop community storage /packaging facilities	Construction of cold storage facilities	Nos.	1	1.00
		Improvise existing sale outlet	Renovation & maintenance of existing sale outlet at road head Reserbo	Nos.	1	4.00
	Post harvest	Support post-harvest equipment/storage facilities	Vegetable crates, Dryer	Nos.	100	1.00
	Lack of knowhow	Capacity development	Provide capacity development, training	HH	100	2.00

Cattle (dairy)	Disease out break	Timely vaccination /management /climate resilient shed	Provide vaccination	HH	150	0.70
			Provide Awareness	HH	150	0.70
	Market	Chiller van for safe transportation	Electric freezer van for 150 HH	Nos.	1	2.00
	Infrastructure	Construction of MCC/Chiller	Construct MCC at Pemashong	Nos.	1	2.00
	Waste management	Climate smart waste management	Construction of biogas	Nos.	20	0.50
	Fodder shortage	Support fodder development	Supply of food seed/seedlings	Kg	1050	0.70
		Support chaffcutter machine	Supply of chaffcutter machine	Nos.	50	1.00
	Lack of CAIT /sexsorted semen	Capacity development of CAIT	Provide training to CAIT	Nos.	5	0.20
	Chilling /Transportation	Provide chilling facilities	Provide chiller van	Nos.	1	2.00
	Testing equipment	Advanced Milk testing equipment	Provide advanced milk testing equipment for Pemashong	Nos.	1	0.50
Paddy	Labor shortage	Farm mechanization	Provide Farm machineries (mini-Power tiller)	Nos.	140	1.00
	Human wildlife conflict	Fencing system	Provide fencing system /chain-link Dzomlingzor	km	12	18.00
	Irrigation	Irrigation development	Construction of HDPE irrigation system Dzomlingzor	Km	7	5.00
	Small terrace	Land Development	Terrace consolidation at Mendrelgang, Reserbo, Pemashong, Tashipang	Ac	100	10.00

Maize	Labor shortage	Farm mechanization	Provide power tiller	Nos.	50	5.00
	Human wildlife conflict	Fencing system	Provide effective fencing system at Tashipang	Km	7	10.50
	Erratic rain fall	Rain water harvest	Provide rain water harvesting equipment in all chiwogs	Nos.	50	1.00
	Slopy Terrance	Agriculture Land development (ALD)	Bench terracing Dzomlingzor , Tashipang , pemashong,	Ac	100	10.00
Ginger	Pest & Disease	Plant protection measures	Support plant protection materials/chemicals Dzomlingzor , Tashipang , pemashong,	HH	150	0.20
	Seeds/rhizomes	Seed replacement	Supply of Ginger Rhizomes Dzomlingzor , Tashipang , pemashong,	MT	10	1.00
	Labor shortage	Farm mechanization	Farm machineries (Power tiller/grass cutter)	Nos.	150	1.00
Green gram	Irrigation	Pipe /sprinkler Irrigation system	Provide smart irrigation system	Nos.	150	1.00
	Post harvest equipment	Post-harvest equipment	Provide post-harvest equipment (Packing, Sealing)	Nos.	150	0.50
Orange	Citrus fruit fly	Citrus fruit fly management program	Provide citrus fruit fly management	HH	200	1.00
		Orchard management program	Provide citrus orchard management	HH	200	1.00
		Irrigation	Climate Smart irrigation	Nos.	50	2.00
			Water harvesting tanks	Nos.	50	1.00
	Nutrient	Nutrient Management	Provide package of practices	HH	200	2.00

	Lack of orchard management skill	Awareness/ capacity building	Provide awareness/capacity development for citrus growers	HH	200	2.00
Poultry (Chicken)	Opportunist	Provide establishing large farms	Support larger farm at Reserbo, Tashipang , Pemashong	Nos.	5	1.00
	Substandard meat production	Support mini processing and packaging	construction of processing and packaging with some facilities Reserbo, Tashipang , Pemashong,	Nos.	1	2.00
			Meat processing equipment Reserbo, Tashipang , Pemashong	set	1	1.00
			Defesthering machines Reserbo, Tashipang , Pemashong,	Nos.	1	0.10
	Disease problem	Awareness to the farm holder on importance of emerging disease.	Give training to farm holder Reserbo, , Tashipang , Pemashong,	times	2	0.10
		Strong biosecurity measures	Fencing/ Foot bath Reserbo, Tashipang, Pemashong,	HH	5	1.00
	Distant marketing	Cold storage	Construct mini processing unit at Reserbo, Tashipang , pemashong,	Nos.	1	2.00
		Chiller van	Support freezer van Reserbo, Tashipang , Pemashong	Nos.	1	2.00

Poultry (Egg)	Disease outbreak	Promote advocacy Bio security Foot deep	Public awareness on diseases	Times	10	0.10
			Fencing			
	Marketing problem	Product diversification	Diversification			1.00
	High feed price	Market linkage				
	Opportunist	Provide establishing mega /large farm	Support establishment of shed	Nos.	4	2.00
	shortage of packaging material	Provide establishing egg tray factory	Support establishment of shed	Nos.	1	4.00
Goat	Poor management	Climate resilient housing	Provide climate smart shed Riserbu/Dzomlingzor	Nos.	30	1.50
	Inbreeding	Breeding improvement	Hybrid Input supply	Nos.	5	0.10
	Marketing	Market linking	Electric freezer van	Nos.	1	1.50

10.6 Agriculture Resilience Plan for Patshaling Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected Area	Budget (M)
Vegetables Production	Lack of Irrigation Facilities	Irrigation development	Construction of pipe irrigation system Chuzoma, Patshaling Toed, Maed Thakhoring and Pangthang (25mm)	Bundles	4000	1.40
			Supply of drip irrigation set	Nos.	100	1.40
			Farmers capacity development and operation and maintenance of drip system	Nos	319	0.35
			Supply of automatic irrigation drip system	Nos.	5	1.00
			Supply of Sintax(1000l) and water pump(1HP)	Nos	50	0.80
			Supply of high-quality US made sprinklers head	Nos	1500	1.00
	Unavailability of bio-pesticides and insect trap	Promotion of bio-pesticides	Supply of Neem oil	bottles	3000	0.795
			Supply of tree spray oil	litres	2500	0.455
			Funnel Trap	Nos	6000	0.504
			Fall army worm lure	Nos	6000	0.54
	Market challenges	Strengthening market outlet	Construction of market outlet for organic and local produce inThakhorling	Nos	3	6.00
			Development of organic hub for agri-tourism	Nos	1	9.00

	Quality control and Post harvest management	Procurement of post-harvest handling equipment	Procurement of packaging materials	NA		3.00
		Promotion of Organic Produce	Capacity building on quality produce	Nos.	300	0.35
			Supply of high yielding seed varieties	Packets	3500	1.50
			Supply of high value crops seedling (Asparagus and Strawberry)	Nos	35000	1.50
	Pest and disease	Procurement of pesticides	Supply of insecticides	Litres	10000	0.90
			Capacity building of IPM	Nos	200	0.25
	Issues with nutrient management	Agriculture Land Development	Bench terracing of sloppy dry land	NA		8.00
			Plantation of sugarcane on terraces	NA		0.50
	Soil degradation	Improvement of soil profile	Construction of vermi-compost	Nos	30	5.00
			Construction of bio-digester	Nos	30	4.50
			Construction of compost shed	Nos	30	7.00
Dairy	Heat/cold stress	Climate smart shed	Construction of climate smart dairy sheds (5 cow level)	Nos.	100	15.00
			Construction of biogas plant	Nos.	100	3.00
	Clean milk production	Hygienic milk production	Supply milking machine	Nos.	100	3.00
			Supply cow mat	Nos.	500	2.50
	Fodder shortage	Fodder conservation	Supply TMR formulation machine (Five cow level)	Nos.	100	10.00

			Supply Grass chopper (shaft cutter)	Nos.	100	3.00
			Training farmers on fodder conservation techniques	Nos.	500	0.30
			Support to improved pasture development	Acre	50	1.50
			Support fencing materials	Km	50	1.50
	Product diversification	Post production equipment	Supply automatic butter churner	Nos.	2	1.00
			Supply Cheese vat	Nos.	1	1.00
			Supply vacuum packing machine	Nos.	1	0.50
			Supply packaging materials	NA		0.50
			Farmers capacity building on dairy product diversification (post Production)	Nos.	500	0.30
			Supply Cool boxes	Nos.	10	0.10
	Disease outbreak	Strengthen biosecurity	Chain link Fencing support for farm area	Nos.	100	5.00
			Support for foot/tyre dip facility	Nos.	100	0.20
			Farmers training on emerging animal health issues	Nos.	100	0.30
	Inadequate infrastructure	Upscale MPU	Expansion of existing MPU	Nos.	1	1.00
			Construction of MCC with chilling facilities at strategic locations	Nos.	5	5.00
			Procurement of chiller van	Nos	1	5.00
			Supply of milk analyser	Nos.	5	0.50
			Milk storage tank (SS)	Nos.	6	0.60

			Display refrigerator/Deep Freezer	Nos.	5	0.40
	Breeding	Enhance/Strengthen breeding services	Train CAIT	Nos.	10	0.25
			Procurement of climate smart (transportation) mobility facility for mobile AI services	Nos.	1	0.50
			Procurement of Sex sorted semen	Nos.	500	1.30
			Farmers training on dairy reproductive managemt/AI/breed improvement	Nos	500	0.30
Piggery	Heat/cold stress	climate smart shed	Construction of climate smart piggery sheds	Nos	40	6.00
			construction of biogas plant	Nos.	40	1.20
			Supply of high-pressure cleaning material	Nos.	40	0.20
	Product diversification	Post production equipment	Supply of butcher knife	Nos.	2	0.15
			Supply vacuum packing machine	Nos.	1	0.10
			Supply packaging materials	Nos		0.50
		Pork Processing Equipment	Hand held electric stunner	Nos.	40	1.25
			Pork Portioning equipment	Nos.	2	1.00
	Disease outbreak	strengthen biosecurity	Chain link Fencing support for farm area	Nos	40	1.50
			support for foot/tyre dip facility	Nos.	40	0.15
			Farmers training on emerging animal health issues	Nos.	500	0.30
	Breeding		Train CAIT	Nos.	10	0.50

		Enhance/Strengthen breeding services	Farmers training on pig farm management/book keeping	Nos.	500	0.30
			Supply Quality Parent stock for breeding purpose	Nos.	200	1.00
Poultry Layer	Heat/cold stress	Climate smart shed	Construction of climate smart poultry sheds	Nos.	20	3.00
	Product diversification	Post production equipment	Farmers training on egg grading	Nos.	500	0.30
			Supply of egg grading equipment	Nos.	1	0.50
	Disease outbreak	Strengthen biosecurity	Chain link Fencing support for farm area	Km	20	1.00
			Support for foot/tyre dip facility	NA		0.10
			Farmers training on emerging animal health issues	Nos.	150	0.10
Cardamom	Inadequate Infrastructure	Procurement of Equipment	Supply and procurement of electric dryer	Nos	5	4.00
			Supply of Packaging materials and equipment	NA		2.00
Legumes	Inadequate supply of seeds	Procurement of hybrid seeds	Supply of hybrid seeds	Packets	2500	1.00
Orange	Management of Orchard	Capacity development and Demonstration	Farmers training and demonstration on Orchard management	Nos.	200	0.45
			Training and Pruning	Nos.	200	0.50
			Orchard basin making	Nos.	200	0.50
Poultry Broiler	Heat/cold stress	Climate smart shed	Construction of climate smart poultry sheds	Nos	15	2.25
		Post production equipment	Supply chicken defeathering machine	Nos.	15	0.50

	Product diversification		Chicken Portioning equipment	Nos.	8	0.40
	Disease outbreak	Strengthen biosecurity	Chain link Fencing support for farm area	Km	15	1.00
			Support for foot/tyre dip facility	Nos.	15	0.05
			Farmers training on emerging animal health issues	Nos.	100	0.10
	Market issue	Meat Processing center	Establishment of Meat Processing center	Nos.	1	2.00
Maize	Pest and Diseases	Promotion of IPM	Advocacy on IPM techniques	Nos.	2	0.265
	Value Addition	Procurement of Packaging and Milling machine	Supply of Milling machine for Tengma	Nos.	10	3.00
			Supply of Packaging materials and equipment for tengma and kharang	NA		4.00
Cucumber	Value Addition	Procurement of Equipment	Supply of Packaging and labelling equipment	NA		0.54
Sugarcane	Inadequate infrastructure	Procurement of equipment	Installation of sugarcane (Guar) processing unit and equipment at Thakhorling	Nos	1	7.00

10.7 Agriculture Resilience Plan for Pungtenchhu Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected target	Budget (M)
Vegetables	Irrigation shortages	Vegetable production enhanced	Construction of dryland irrigation in Tashicholing, Norbuthang, Sershong, Tongshingang (benefiting)117	Nos.	4	10.00
	Lack of reliable market		Supply of Drip irrigation sets in all Chiwogs for 120 HH	sets	120	3.60
			Supply of Water sprinkler all chiwogs	sets	120	0.12
			Supply of packaging materials	sets	120	0.60
			Supply of polyhouse in all chiwogs	sets	50	5.00
Poultry	Low production due to heat stress	Poultry production enhanced	Construction of Climate resilient shed in all chiwogs	Nos.	15	22.50
			Supply of improved DOC (Broiler & Layer) 15 HH	Nos.	30000	1.50
			Supply of improved pullets (Layer) 15 HH in all chiwogs	Nos.	15000	4.50
			Supply of feeder for all chiwogs	Nos..	2250	1.125
			Supply of drinker	Nos..	2250	1.125
Piggery	Shortages of Piglets	Pork production enhanced	Piggery shed construction (Breeding/Fattener farm) Tashicholing, Norbuthang & Peljorling	Nos..	3	3.10
	Lack of storage & market facilities		Supply of pigllets(Improved breed) in all chiwogs	Nos..	120	1.20

Mandarin (Orange)	Pest & diseases problem	Mandarin orchard management	Fruit drop management program in all chiwogs	Nos.	5	0.10
	Difficult land terrains		Orchard terracing in all chiwogs	acres	25	2.00
			Supply of improved seedling in all chiwogs	Nos..	2500	0.625
Cardamom	Low production	Cardamom Production enhanced	Supply of improved seedlings Peljorling, Sershong, Tongshingang	Nos..	120000	3.60
	Pests and diseases		Improved dryer Peljorling, Sershong, Tongshingang	Nos.	5	1.00
Paddy	Insufficient of irrigation water	Paddy production enhanced	Construction of irrigation channel for all chiwogs, 214 HH	scheme	2	100.00
	Labour shortage		Maintenance of irrigation channel	schemes	5	12.50
			Supply of mini-tellers	Nos..	25	2.50
			Chain-linked fencing in all chiwogs	Kms.	50	50.00
Dairy	Low milk production	Dairy production enhanced	Supply of Improved cattle	Nos..	55	5.50
	Shortages of fodders		Construction of improved shed	Nos..	55	8.25
			AI service delivery through sex sorted	dose	200	0.74
			Capacity building	Nos..	55	0.50
			Feed & fodder development	acres	100	1.00
Goat	Low Chevon production	Chevon production enhanced	Supply of improved goat	Nos.	10	1.00
			Capacity building	heads	315	0.20
Quinoa	Low adoption	Quinoa production enhanced	Capacity building	heads	200	0.10
			Supply of seeds	kgs	200	0.02

			Dehusking machine	Nos..	10	1.00
Mushroom	Low adoption	Mushroom production enhanced	Capacity building	Heads	100	0.50
			Supply spawn	Pkts	1000	0.25
			Supply quipements	Nos.	100	2.00

10.8 Agriculture Resilience Plan for Rangthangling Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected target	Budget (M)
Dairy Development	Poor quality of milk (high microbial content because of unhygienic practices)	Farmer Capacity Development	Training and awareness Darchagang, Neymeds and Rangthangling Charingma	HH	250	0.20
		Develop facilities	Construction of Milk Collection Centre with Solar operated milk chilling machine of 1000 litre capacity Neymedsa for 250 HH	Nos.	1	4.00
			Milk collection and storage containers (40-50 lts)	Nos.	30	1.50
			Milk Quality Testing	sets	2	0.20
			Automatic milking machines	sets	50	2.50
	Low milk production	Cattle Breed Improvement Program	Initiate Sex Sorted Semen Scheme	doses	500	0.10
	Heat Stress to dairy cows	Climate smart dairy shed	Construct climate smart large scale model dairy shed	HH	10	2.50
Piggery Development	Inadequate piglets supply	Initiate breeding farm	Construct piggery breeding farm	HH	5	2.50
	Piggery Management	Capacity building	Training/awareness program	HH	120	0.20
	Limited pork supply	Establishment of farms	Establishment of large-scale farm (500 level) Nemazor/Sunkosh	farms	2	3.00
Poultry Development	Limited farms	Establishment of farms	Establishment of large-scale layer farm (5000 level) Rangthangling/Charingma	farms	2	3.00
	Disease outbreak	Biosecurity	Strengthen biosecurity measures (chain-link fencing and foot dip facilities)	HH	300	5.00

Chevon Production	Low chevon production	Establishment of farms	Establishment of large-scale layer farm (100 level) Rangthangling/Charingma/Sunkosh	2 farms		1.00
Vegetable production	Scarcity of water	Climate smart irrigation technology	Establishment of drip irrigation, sprinkler	Acres	150	7.00
	Labor shortage	Farm mechanization	Supply of power teller, mini teller,	Acres	150	20.00
	market linkages	Market fluctuation	Construction of outlets Neymesa	No.	1	2.00
	Soil Degradation	Soil Fertility management	Set up Vermi compost, bio digester, Compost	Nos..	5	2.50
			Agriculture Land Development all Chiwogs for 150 HH	Acres	50	8.25
Ginger	Pest and diseases	Pest and disease management	Awareness and sensitization	HH	150	0.2.0
	Post harvest and quality control	Processing and packaging	Construction of processing unit with all the machineries and equipment at Rangthangling Charingma	Nos.	1	5.00
	Limited resource and technology	Seed	Supply of high yielding disease free rhizoms Rangthangling Charingma, Nimazor, Sunkosh	MT	10	1.00
Orange	Poor fruit quality	Orchard Management	Capacity development on cirtus management Rangthangling Charingma, Nimazor	HH	100	0.3
	Land degradation	Sustainable Land Management	Orchard terracing	Acres	50	3
	Pest and diseases	Integrated Pest Management	Farmers training on pest management with the supply of Pheromon trap	HH	150	0.5

Paddy	Limited irrigation water	Water Management	Construction or Maintatinace of irrigation channal Rangthangling Charingma, Nimazor , Sunkosh	km	10	5.00
	Labour shortages	Farm mechanization	Supply of women friendly harvesting machine	Nos.	10	1.50
Maize	Poor Maize production	Enhance production	Supply of improved seeds for all chiwogs	Kg	10000	0.40
	Land degradation	Sustainable Land Management	Agriculture Land Development	Acres	100	6.00
Cardamom	Poor management	Cardamom management	Sensitization and awareness on cultivation practices and management	HH	50	0.50

10. 9 Agriculture Resilience Plan for Semjong Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected Target	Budget (M)
Piggery	Disease outbreak	Mitigation and proper facilities	Strengthen biosecurity measures (chain-link fencing) Dekiling, Dzomling, Dangreygang, Tashling Toed and Tashiling Maed	km	100	20.00
			Awareness and disease control program	Nos.	1	0.10
	Water shortage		Rain water harvest technology	Nos.	320	1.00
	Improper pig shed and unmechanized		Improved shed and procurement of machines	Nos.	320	5.00
	Lack of processing plant		Construction of pork processing plant	Nos	1	30.00
	Boar management problem		Introduction of AI, capacity building and procurement of AI equipment	Nos.	10	1.00
	Low shelf life		Construction of blast freezer and cold storage	1 no		50.00
	Insufficient piglet		Establishment of Contract Pig Breeding farms	Nos.	10	5.00
	Improper waste management		Capacity building and Construction of compost pit	Nos.	320	2.00
			Construction of biogas plant	Nos.	320	5.00
			Introduction of EMT solution	Nos.	320	0.50
Vegetables	Irrigation shortages	Improved technologies, and facilities	Construction of dryland irrigation Dzomling and Tashiling Maed	No.	1	2.00
	Seed nursery raising		Construction of fabricated poly house	Nos.	100	4.00

	Limited hybrid seeds		Procurement of hybrid seeds	pkts	10000	5.00
Dairy	Disease outbreak	Mitigation and proper facilities	Awareness and disease control program	HH	320	0.10
	Fodder shortage		Development of pasture land, silage and hay making, and construction of silo pit	HH	320	5.00
	Lack of high yielding dairy cattle		Improvement of breed through AI	HH	320	1.00
			Training of CAIT and procurement of AI equipment	Nos.	10	2.00
	Low shelf life		Capacity building for product diversification and, construction of MPU and procurement of dairy equipment	Nos.	320	30.00
	Improper cow shed and unmechanized		Improved shed and procurement of machines (Chaff cutter)	Nos.	320	10.00
Oranges	Poor fruit Quality	Orchard management, and increase production	Farmers training on Citrus fruit fly management, pruning and training	Nos.	300	0.10
	Limited seedling		Supply of orange seedlings	Nos.	10000	0.40
Avocado	Marketing	Improve marketing strategy	Construction of avocado cream processing unit	Nos.	1	5.00
Poultry (Layer, Broiler and native)	Disease outbreak	Mitigation and proper facilities	Strengthen biosecurity measures (chain-link fencing)	km	20	2.00
			Awareness and disease control program	Nos.	1	0.10
	Improper poultry shed, high labour requirement		Improved shed and procurement of poultry equipment	Nos.	320	10.00
	Low shelf life		Construction of cold storage and ice processing plant	Nos.	320	30.00

	Marketing problem		Development of marketing strategy or market linkages (Consultation meeting with Mult stakeholders)	Nos.	320	1.00
			Procurement of freezer van	Nos.	1	2.00
Beans	No quality products	Value addition	Support packaging	Nos.	300	0.50
Ginger	Limited seedling, incidence of ginger rot	Increase production	Supply of disease-free planting materials	Kg	10000	1.00
Paddy	Irrigation shortages	Technologies, practices, and facilities	Maintenance and construction of irrigation channel	Nos.	5	1.00
	Labour shortages		Supply of mini tiller	Nos.	50	3.00
			Supply of Women friendly paddy harvester	Nos.	150	5.00
	Human wild life conflict		Construction of chain link fencing for paddy and maize	km	15	15.00
Cardamom	High time consumption and improper drying of cardamom	Increase production	Procurement of electric cardamom dryer	Nos.	50	15.00
Maize	Low yield and production	Increase production	Supply of Yangtsepa maize seeds	kg	15000	5.00

10.10 Agriculture Resilience Plan for Sergithang Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected targets	Budget (M)
Production of Early Bhutanese Chilli	High investment	Promotion of high value agriculture products.	Support bed makers and transplanter Tashithang, Sergithangmae and Semdenjong	HH	130	1.00
	Pest and diseases outbreak		Support bio fertilizer and pesticides	HH	130	0.70
	Lack of labour		Support mulching	HH	130	1.40
			Support of micro irrigation system	HH	130	1.00
Piggery production	Unavailability of piglets	Pork production through smart farming technology.	Supports piglet breeding farm	Nos.	10	1.00
	Diseases outbreak		Strengthened farm bio security and diseases control program at Sergithangmae and Semdenjong	Nos.	30	1.00
	Lack of management practices		Capacity building	HH	100	0.15
	Heat and cold stress		Support climate smart shed with boi gas plants.	Nos.	70	2.00
Vegetable production	Unavailability of quality seeds.	Climate smart technology.	Supports high yielding seeds at Tashithang & Sergithangmae	HH	100	1.00
			Supports and promote community seed producer.	HH	100	1.00
	Pest and diseases outbreak		Supports PP chemical	HH	100	0.50

	Lack of premium price for organic vegetable and market.		Capacity building	HH	100	0.20
	Insufficient of irrigation facilities		Bio fertilizer and bio pesticide	HH	100	0.50
	Farm Labour shortage		Support farm machinery	Nos.	50	5.00
			support of Micro irrigation system	Nos.	50	1.00
	Terrain topography		Agriculture land development	Ac	50	5.00
	Insufficient land holdings		Provide individual land leasing	Ac	30	0.50
	Improper handling of fresh vegetable		Purchasing of harvesting crate.	Nos.	100	1.00
Paddy production	Insufficient Irrigation facilities	Self-food sufficiency	Climate smart irrigation supports Tashithang,Norbugan and sergithangtoe	Nos	102	5.00
	Human wild life conflict		Support chainlink fencing Tashithang	Km	92	8.00
	Low adaptation of improved variety		Awareness and on farm trial	Nos.	20	0.30
	Farm Labour shortage		Supports farm machineries	Nos.	30	1.00
	Narrow terraces		Terraces consolidation	Acres	30	5.00
Quinoa production	Market accessibility	Promotion of climate resilient super crop.	Value addition supports (packaging & branding) Sergithanmae	HH	200	10.00
	Low soil fertility		Supports bio fertilizer Sergithangmae	HH	100	0.70
	Lack of product development materials		Supports processing machines (dehusking,	Nos.	57	5.00

			processing plant). Sergithangmae			
	Lack of processing machines		Capacity building (product development) Sergithangmae	HH	57	0.15
Maize	Wild like conflict	Promotion of food security	Support Chainlink fencing at Semdenjong	Km	47	8.00
	Terrain topography		Land development supports (Land bencing) at Semdenjong and sergithangtoe	Ac	72	5.00
	Lack of improved seeds		Support improved seeds	HH	72	0.50
	Lack of processing machines		Supports cornflake and kaharang processing machines	Nos.	10	1.00
Banana	Pest and diseases	Increase income generation	Support improved variety Sergithangmae	HH	10	0.3
	Lack of post-harvest technology		Chips processing unit at Sergithangmae	HH	57	3.00
Dairy Production	Diseases outbreak	Promote smart Dairy development.	Awareness and diseases control program Tashithang and Sergithangmae	HH	100	0.15
	Poor of management practices		Capacity building (Management)	HH	100	0.15
	Inferior breeds		Intensify AI technology sex sorted semen and capacity building of CAIT.	HH	150	1.00
			Procurement of AI equipment	HH	285	0.80
	Lack of proper equipment		Supports Dairy equipment (Milk Can, Butter churner)	Nos.	50	1.00

	Improper shed		Support smart dairy shed.	Nos.	50	1.50
	Inadequate infrastructure		Establishment of MCC with chilling facilities.	Nos.	150	10.00
	Fodder shortage		Fodder development, winter fodder conservation.	Nos.	50	0.80
Cadmon Production	Low production	Promotion of high value Spices	Supply of improved seedlings Semdenjong	HH	20	0.70
	Pest and diseases outbreak		Capacity building Semdenjong	HH	20	0.05
	Insufficient Land Holding		Supports individual land leasing. all Chiwog			
	Lack of dryer		Support dryer machines. Semdenong	Nos.	10	1.00
Orange	Recycling of existing orange orchard	Promotion of high value Fruits	Shifting of orange orchard in suitable area.	Ac	20	1.00
	Fruit drop problem		Capacity building (Orchard management)	HH	20	0.05
	Pest (Monkey)		Support bagging and netting	HH	20	0.70
Poultry (egg production)	Erratic market	Income generation through poultry farming.	Facilitate Market Linkage	Nos	2	1.00
	Diseases outbreak		Strengthened bio security and diseases control program.	Nos.	15	1.00
	Heat and cold stress		Support smart poultry shed and equipment. all Chiwog	Nos.	20	2.00
Goat Development	Diseases outbreak	Increase income generation	Awareness and diseases control program Tashithang and Nobugang	HH	50	0.10

	Heat and cold stress		Support shed construction	Nos.	30	1.00
Apiculture development	Lack of processing unit	Promotion of high value products.	Establishment of processing units	Nos.	1	1.00
	Lack of knowledge and skills		Capacity building	HH	50	0.30
	Limited equipment		Supports supply of equipment. (modern bee hive, foundation machine, honey harvester) Semdenjong and Tashithang	Nos.	50	1.00
Avocado	Market accessibility	Promote high Nutritional fruit.	Value addition supports (packaging & branding) all Chiwog	HH	285	2.00
	Lack of storage facilities		Support storage facilities	Nos.	285	5.00
	Lack of quality variety		Support improved quality seedlings	Nos.	285	1.00
	Lack of knowledge		Capacity building	Nos.	285	0.30
Fish	Low production	Promote nutritional food	Promote trout farming Tashithang	Nos.	1	0.50
	Unavailability of commercial feed		Support feed formulation with local materials Tashithang		35	0.50
	Lack of knowledge and skills		Capacity building		35	0.20
Broiler farming	Erratic market		Facilitate market linkage with BLDC Sergithangmae	Nos.	10	
	Diseases outbreak		Awareness and diseases control program	HH	10	0.50

	Lack of cold storage facilities		Establish mini blast freezer and support deep freezer	Nos.	10	2.00
	Heat stress		Support smart broiler shed.	Nos.	10	1.00

10.11 Agriculture Resilience Plan for Tsholingkhar Gewog

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected target	Budget (M)
Dairy	High feed cost	Enhanced milk production	Provide 50% cost on existing feed price for Tsholingkhartoed, Tsholingkagrmaed, Drubchugang and Kapazhing			2.50
	Disease prevalence		Awareness and Capacity building for disease management, quality milking for 72 HH	Nos.	7	0.18
	Poor market		Supply of equipment (milking cane), product diversification, quality assurance testing kits, cold storage facilities (CSF=3), facilitate ghee production equipment & packaging materials, butter and cheese packaging materials at Damphu	Nos.	1	5.00
	Poor market infrastructure		Collection centers with cold storage facilities at Tsholingkharmaed and Drubchugang	Nos.	2	4.00
	Low milk production		Breed improvement, Community Artificial Insemination Technician training, Sexsorted semen at Drubchugang, Tsholingkhartoed	Nos.	2	0.10
	Fodder shortage		Winter fodder development and fodder conservation, Chaff cutter machines for Tsholingkhartoed, Tsholingkagrmaed, Drubchugang and Kapazhing	Acres	50	0.50

Vegetables	Hybrid seeds expensive	Improve production and quality	Hybrid seeds vegetable seeds for 247 HH	Acres	500	2.50
	Water shortage		Construction of dryland irrigation with HDP and tanks (source Tshokhonakhola) Tsholingkhartoed	km	3.8	4.50
	Water shortage		Smart irrigation materials/equipment for Tsholingkhartoed, Tsholingkagrmaed, Drubchugang and Kapazhing	Nos.	500	1.50
	Collection shed and cold Storage facility,		construction of Collection shed and cold Storage facility for Tsholingkhartoed, Tsholingkagrmaed, Drubchugang and Kapazhing,	Nos..	4	1.50
	Pest and diseases,		Capacity building Organanic pest control methods and introduction of IPM,	Nos.	1	0.50
	Vegetable Quality deterioration		Harvesting tray and Packaging materials and handling training for Tsholingkhartoed, Tsholingkagrmaed, Drubchugang and Kapazhing (170 HH)	Nos.	1000	0.45
	Labor shortage		Mini power tiller (Cost sharing)	Nos.	100	5.00
	Erratic rainfall		Protected agriculture (Poly-houses) for Tsholingkhartoed, Tsholingkagrmaed, Drubchugang	Sets	100	5.00
Orange	Irrigation shortage	Increase production and quality of fruits	Smart irrigation and installatio training (smart irrigation) materials/equipment.	Nos..	250	2.50
	Pest and diseases,		Pest and diseases management through Integrated pest management, Nutrient management and equipment	times	5	0.50

Maize	Pest and diseases	Increase production	Supply of Pest and diseases resistant variety for Tsholingkhartoed, Tsholingkagrmaed, Drubchugang and Kapazhing	times	2	0.50
			Awareness on pest surveillance (Integrated pest management and equipment)	time	1	0.15
Goat	Limited numbers to rare by rule of forest and expensive meat price	Increase production	Improve management	Nos.	100	0.10
Paddy	Pest and diseases	Yield improvement	Awareness training, Introduction of IPM methods and equipment	times	2	0.45
	Irrigation shortage		Maintenance of Irrigation channels (Replacing earthen drain with HDP pipe	Nos.	5	7.50
Piggery	High feed cost	Increase production	provide 50% cost on existing feed price all chiwogs	50%		0.10
	Disease prevalence		Farm Bio-security, awareness, capacity development	time	1	1.50
	Heat stress		Climate smart shed for Tsholingkhar maed and Toed	Nos.	2	0.30
Cardamom	Diseases, Irrigation shortage	Yield and quality improvement	Replacement with disease resistant and high yielding varieties for Tsholingkhartoed, Tsholingkagrmaed and Drubchugang	Acres	100	0.20
	Irrigation shortage		Smart irrigation materials/equipment	Nos.	200	1.50
	Local dryer (Bati)		Improve dryer	Nos.	40	0.50

Avocado	Irrigation shortage and poor management	Improve quality and production	Smart irrigation materials/equipment and management training all chiwogs	Nos.	200	1.80

10.12 Agriculture Resilience Plan for Tsirang Toed

Livelihood Activity	Challenges	Key Investment area	Strategic Action	Unit	Projected Target	Budget (M)
Diary	Lack of Marketing infrastructure	Development Climate smart dairy and marketing structure	Procurement of cool van and collecting cane all chiwogs (250 HH)	Nos.	1	1.20
	Lack of Cooling facilities for diary product		Construction collection shed Soentabsa chiwogs	Nos.	2	3.50
	Improper animal shed leading to animal stress	Climate smart dairy farming	Climate smart diary shed construction in all chiwogs	Nos.	70	1.40
	Outbreak of pest and disease	Improve Animal health	Awareness, mass vaccination, training in all chiwogs	times	7	0.70
	Shortage of feed and fodder	Fodder conservation technique	Supply of improve feed and fodder seeds and seedling	Acres	20	0.70
			Making of silage	HH	250	0.21
			Straw treatment.	HH	250	0.07
	Labor shortage	Supply of Drudgery reduction equipment	Supply of chaff cuter	Nos.	20	1.00
			Milk churner in all chiwogs	Nos.	70	0.21
			Milking machine	Nos.	5	0.075
Vegetable	Lack of proper irrigation facilities	Irrigation development	Construction pipe dry land irrigation at Wangphu and Kabelzhing	scheme	2	5.00

			Roof Rain water harvesting	HH	200	5.00
			Supply of drip irrigation system	sets	1400	8.40
			Supply of sprinkler	Nos.	700	0.21
			Water pump 1HP	Nos.	20	0.40
			Supply of HDPE Pipe and flexible pipe	Nos.	280	1.40
	Labor shortage	Supply of Drudgery reduction machinery	Mini power tiller	No	7	1.00
			Auto weeder	Nos.	50	1.00
			Bed making machine	Nos.	7	0.90
	Pest and Disease	IPM intervention	Training, awareness on IPM	Times	7	0.70
			Pesticide application equipment supply	No	35	0.50
	Soil degradation	Soil health improvement	organic fertilizer production	HH	50	0.25
	Extreme weather patterns	Protected agriculture	Supply Greenhouse	Nos.	100	10.00
			Supply of Mulching plastic for retention of moisture in the soil	Rolls	1000	2.00
	Lack of proper post-harvest/processing unit	Promotion food processing	Dalley chili processing machine packaging materials (pickle, chatney and chili paste) Tsirangtoed, Soentabsa	set	2	2.00

	Low of vegetable diversity, Low employment for PWD	Improve model nutrition kitchen garden	Supply of Greenhouse Wangphu and Kabelzhing	Nos.	20	2.00
Ginger	Lack of proper irrigation facilities	Irrigation development	Roof Rain water harvesting Tsirangtoed, Soentabsa, Wangphu,	HH	200	5.00
			Supply of drip irrigation system	sets	1400	8.40
			Supply of sprinkler	Nos.	700	0.21
	Outbreak of pest and disease	IPM intervention	Training, awareness,	Times	7	0.70
			Bio- chemicals and equipment,	No	35	0.50
	Labor shortage	Supply of Drudgery reduction machinery	Bed making machine	Nos.	7	0.35
Orange	Lack of proper irrigation facilities	Developed irrigation facilities	Roof Rain water harvesting at Tsirangtoed, Soentabsa, Wangphu	HH	150	5.00
			Supply of HDPE Pipe and flexible pipe	Nos.	280	1.40
	Outbreak of pest and disease	IPM intervention	Training and awareness on IPM	Times	7	0.70
			Bio- chemicals and equipment supply	Nos.	35	0.50

	Soil nutrients degradation	Soil health improvement	orchard Basin making and fertilizer support	HH	200	1.50
Poultry	Improper animal shed leading to animal stress	Climate smart dairy farming	Climate smart poultry shed construction Soentabsa, Wangphu	Nos.	7	7.00
	Outbreak of pest and disease	Improve Animal health	Awareness, mass vaccination, training	times	7	0.70
	Labor shortage	Supply of labor-saving equipment	Auto feeder, auto sprinkler, debeaking machine, De feathering machine	sets	7	2.00
Quinoa	Lack of processing unit	Supply of labor-saving equipment	Supply of dehusking machine	Nos.	5	0.35
			Supply of packaging machine	Nos.	5	0.35
	Pest and disease	IPM intervention	Training on IPM, materials and equipment supply	times	7	0.50
	lack of farm mechanization	Agriculture land development	dryland bench terracing and wetland consolidation	Acres	100	15.00
	Human wild life conflict	Improve crop defence structure	Instillation of Chain link fencing in all chiwogs	KM	20	6.00
Goat	Lack of good breed	Improvement of breed	Supply of superior breeding bucks	Nos.	10	0.30

Piggery	Lack of Marketing infrastructure	Clean pork production	Procurement of cool van All chiwogs	Nos.	1	1.20
	Lack of storage and cooling facilities		Construction of processing unit and cooling storage Soentabsa chiwogs	Nos.	1	3.50
	Improper animal shed leading to animal stress		Climate smart piggery shed construction	Nos.	50	1.40
	Outbreak of disease		Awareness, mass vaccination, training	times	7	0.70
	shortage of piglet		Establish piglet breeding farm Kabelzhing, Wangphu	Nos.	2	2.00
Mushroom	Lack of proper production structure, automation machine and equipment	Improve quality production	Construction of mushroom production shed at Tsirangtoed, Soentabsa	Nos.	5	5.00
			Support auto fogger machine at Tsirangtoed, Wangphu	Nos.	5	0.50
			Support mushroom spawn Tsirangtoed, Wangphu	Pkts	7000	2.00
			Support Packaging materials	set	5	1.00

Green Gram	Pest and disease	IPM intervention	Training and awareness in bio pesticide	Times	7	0.70
	Human wild life conflict	Improve crop defense structure	Instillation of Chain link fencing	KM	70	21.00