CROP AND LIVESTOCK DAMAGE AND LOSS ASSESSMENT METHODOLOGY 2021

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Disclaimer

This publication is aimed at providing a technical basis for assessing damage and loss in the crops and livestock sectors. It is expected to help our professionals estimate and draw up economic valuation of losses as a result of climate-driven impacts, and in no terms, carries or offers legal grounds for monetary compensations arising from different eventualities.

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Foreword

Climate change is inevitable and it affects every country without differentiating the boundaries. As we talk and deliberate on climate change it is important to consider either mitigation or adaptation to reduce the adverse impacts of climate change. However, it is important to note that some of the consequences of climate change can neither be mitigated nor be adapted to. These inevitable consequences of climate change result in economic loss which in general are referred to as damage and loss.

Bhutan is increasingly experiencing adverse impacts of climate change causing widespread damage and loss. However, such damage and loss are less quantified. Further, the data on crop and livestock loss are limited, which in turn affects policy decisions and climate-informed decision making. It is, therefore, critical to review the existing methodologies on crop and livestock loss assessment and this assignment was indeed timely. Further, this provides for a more detailed and precise evaluation that also helps us effectively quantify and put an economic value to such sector-specific climate-driven disaster impacts.

The Ministry of Agriculture and Forests is pleased to bring out the publication titled "Crop and Livestock Damage and Loss Assessment Methodology, 2021" funded by the Green Climate Fund (GCF).

We thank the task force members and the team for their contribution in coming up with crop and livestock damage and loss assessment methodology and commend the meticulous effort in completing this important assignment. We hope and expect that this SOP and methodology will provide the Department of Agriculture and Department of Livestock a technical reference base for a structured damage and loss analysis in crop and livestock sectors.

TASHI DELEK

(Thinley Namgyel)
SECRETARY

Abbreviations and Acronyms

ac	:	Acres
CoP	:	Cost of Production
DDM	:	Department of Disaster Management
DAO	:	Dzongkhag Agriculture Officer
DDMC	:	Dzongkhag Disaster Management Committee
DoA	:	Department of Agriculture
DoFPS	:	Department of Forest and Park Services
DoL	:	Department of Livestock
FAO	:	Food and Agriculture Organization
GCF	:	Green Climate Fund
GDMC	:	Gewog Disaster Management Committee
GDP	:	Gross Domestic Product
GHG	:	Greenhouse Gas
GLOF	:	Glacial Lake Outburst Flood
HWC	:	Human Wildlife Conflict
LD	:	Legal Division
MoAF	:	Ministry of Agriculture and Forests
NAP	:	National Adaptation Plan
NCHM	:	National Center for Hydrology and Meteorology
PPD	:	Policy and Planning Division
RCP	:	Representative Concentration Pathways
RNR	:	Renewable Natural Resource
RNR DMCP	:	RNR Disaster Management and Contingency Plan
SAPA	:	RNR Sectoral Adaptation Plan of Action
SOP	:	Standard Operating Procedure
USD	:	United States Dollar

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1.0 INTRODUCTION

The mountainous landscape, fragile ecosystem and diverse agro-climatic conditions make Bhutan vulnerable to several risks. The Renewable Natural Resources (RNR) sector encompassing agriculture, livestock and forestry is highly at risk from extreme weather events compounded by geographic locations and circumstances. Agriculture and food security, water resources, and forestry and biodiversity are core vulnerable sectors identified in the RNR Sectoral Adaptation Plan of Action (SAPA) and National Adaptation Plan (NAP) climate change risk assessments.

The agriculture and livestock sectors are highly vulnerable to climate change impacts with multiple effects on biodiversity, food sources, crop production, and water resources among others. These sectors are also vulnerable to climate change induced disasters such as flash floods, landslides, heavy rainfall, and windstorms resulting in the loss of agricultural land, crops, and livestock. Climate change impacts have been conspicuous in terms of reduced yields, loss of genetic resources, frequent occurrence of pests and diseases, and unpredictable weather patterns.

The frequency and intensity of climate-induced disasters have been increasingly experienced over the past year at the global as well as national and local levels. This has exposed countries to environmental, economic and social impacts. Bhutan is particularly vulnerable to the impacts of climate change given its geographic location and mountainous terrain. The vulnerability can be ascertained through frequent occurrence of various disasters in recent years that affect different sectors in the country. In particular, these climate-induced hazards impact the agriculture sector since it is one of the most climate-sensitive sectors. The production and supply including infrastructures is impacted putting more than 50% of the country's population who are predominantly older farmers at risk. Under these circumstances the livelihood options particularly that of rural communities are compromised.

According to Conforti, Markova, and Tochkov (2020), 70% of the economic loss in developing countries is as a result of climate related disasters and the economic loss from these disasters is valued at around USD 580 billion between 2005 to 2015. However, the information on economic loss in Bhutan resulting from climate change is quite limited.

Every year climate induced disasters affect the crop and livestock sectors but there is no proper mechanism to archive these crucial data. It is important to understand how this can be assessed, integrated and applied at the national, dzongkhag and gewog levels since climate-induced damage and loss information is critical in climate actions, climate negotiations, research and policy decisions. It is important to develop and integrate climate risk data into crop and livestock planning at the national and sub-national data to promote resilient agriculture practices in response to the reality of climate change. Natural disasters are expected to increase due to the continued increase in economic exposure and climate change (Botzen, Deschenes, & Sanders, 2019) Therefore, there is a need to review the existing framework and propose how it can be strengthened.

In order to enhance resilience towards climate change and help transform our agriculture system, the Royal Government of Bhutan is implementing a project titled "Supporting Climate Resilience and Transformational Change in the Agriculture Sector in Bhutan" funded by the Green Climate Fund (GCF). The project seeks to enhance the resilience of the smallholder farmers to climate change in eight districts, especially in the variation in rainfall and frequent occurrence of extreme events, through the promotion of resilient agricultural practices, water and land management approaches and reducing the risk and impact of climate change-induced extreme events.

The project under output 1 identified the review and enhancement of crop and livestock loss methodologies for consistent tracking and measurement of losses against climate change variability and impact, and integration into planning processes as one of the key activities of the GCF project. This is also a result of the project's acknowledgement of the critical intervention needed to make localized data available for crop and livestock planning and the need to eventually take actions that will minimize losses from climate impacts.

1.1 Objectives

The main objective of this project activity is mainly to review existing approaches and develop methodologies to calculate crop and livestock damage and losses due to climate change impacts. The activity is also expected to develop assessment tools and Standard Operating Procedure (SOP) for crop and livestock damage and loss reporting. With the development of the methodologies and SOP, the objective is also to institute a reporting system within the existing framework.

The study also examines the mandates and functions of the agencies under various departments working on climate change and disaster risk reduction in assessing crop and livestock damage and loss, and recommends the ideal line of reporting based on the existing framework. Finally, the study provides recommendations on key actions that needs to be taken in order to integrate damage and loss assessment in agriculture and livestock planning.

1.2 Scope

This methodological framework, tools and SOP shall guide the officials from the Department of Agriculture (DoA) and Department of Livestock (DoL) in carrying out crop and livestock damage and loss assessment due to the vagaries of climate change such as landslides, earthquake, heat and cold waves, erratic rain and snowfall, frost, hailstorm, flash flood and climate-induced events – Human Wildlife Conflict (HWC), fire and pest and diseases for planning and policy decisions.

The methodology and SOP shall serve as a uniform guide and reference for all the 20 dzongkhags.

2.0 OVERVIEW OF CLIMATE RISK PROFILE

The topography of Bhutan consists of rugged terrain, steep hills, and sharp gorges. Due to these variation in topography and altitude, the country experiences a wide range of climatic conditions. The country is broadly categorized into three climatic zones, which are subtropical in the southern foothills, temperate in the middle valleys and alpine in the northern mountains. The agricultural practices, land use and opportunities and challenges faced in our farming systems are predominantly affected by local climatic conditions, topography and altitude. Bhutan's climate is mostly dominated by the Southwest Monsoon Season or commonly called the Rainy Season which moves towards the North from the Bay of Bengal. The Southwest Monsoon Season starts its journey from June till September and the country receives most of its annual rainfall during this season. The Winter Monsoon Season from December till February is affected by the Western disturbance, bringing rain from the Mediterranean Sea.

2.1 Natural Disasters in Bhutan

Owing to the country's fragile geological conditions, steep terrain, endangered ecosystem, drastic elevation differences and changing climate, Bhutan is highly vulnerable to disasters particularly from hydro-meteorological and geological hazards. Most prominently, heavy rain, inconsistent rainfall, flood, flash floods, Glacial Lake Outburst Flood (GLOF), landslides, windstorms, cyclone induced storms, outbreak of new pests and diseases, drought, increasing human-wildlife conflicts and incidences of forest fire are observed in the country. These events pose a threat to livelihoods and properties affecting the environment as well as societal and economic development of the country.

The statistics of past extreme weather events and hydrological events in Bhutan are limited. The National Center for Hydrology and Meteorology (NCHM) has published a compendium of extreme weather events based on the news articles published by Kuensel from 1968 to mid of 2016, and subsequently, the center has been maintaining records of such events thereon [Refer Annexure IX for the historical events].

2.2 Climate Change and Variability

Climate is defined as the average weather conditions over a longer period. Climate variability is the changes in climate that occur within a smaller time scale such as a month, a season or a year however, climate change is the change that occur over a longer period, typically over decades or longer. In a wider view, climate change is displayed in the form of various natural disasters which raise widespread concerns over the globe which have potentially negative effects on human activities, ecological systems and economic perspective of the country.

There is a need to develop strategies for minimizing such climate risk and its immediate impacts on the nation. The production, monitoring and timely dissemination of reliable weather and climatic information to the users can assist in reducing the climate hazards. Thereby, the long-term, sound-quality and reliable climate data are essential precursors required in undertaking continued assessments to predict, develop, communicate, adapt and respond to

global climate variability and change. Climate data has a wide range of applications in planning and mostly it helps in risk management. Therefore, climate database is the driving force for evaluating human activities at various scales.

2.3 Climate Future: Key Trends

The NCHM completed climate projection studies for rainfall and temperature parameters which have been assessed for two future periods, viz. a short term (2021-2050) and a long term (2070-2099) for two socio-economic scenarios representing trends called Representative Concentration Pathways (RCP). RCP 4.5 and RCP 8.5 are used for the analysis where RCP 4.5 is the intermediate/stabilization scenario and RCP 8.5 is the high emissions scenario.

Temperature

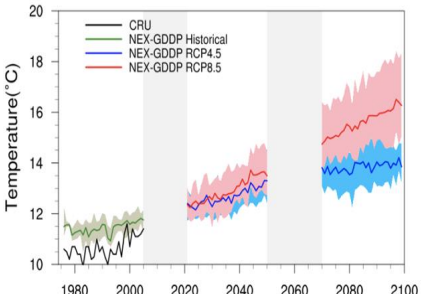

Figure 1: Historical climate projection for temperature (Source: NCHM, 2019)

The projection shows a consistent increase in temperature over the country under both the scenarios. Under the RCP 4.5 scenario, there is an increase in temperature of about 0.8°C - 1.6°C during 2021-2050 and about 1.6°C - 2.8°C towards the end of the century (2070-2099). Under RCP 8.5 scenario, the climate projection for surface temperature stipulated an increase of about 0.8°C - 2.0°C during 2021-2050 and an increase of about 3.2°C towards the end of the century (2070-2099).

Rainfall

The mean annual rainfall over Bhutan is likely to increase in the future for both the scenarios despite the variability within the model. Under the RCP 4.5 scenario, the annual rainfall indicates an increase of about 10% - 30%, with a 5% - 15% increase in summer rainfall (June - - September). The projection also shows an increase in winter rainfall (December - February) along with some parts of the northern region. The north-western regions are likely to experience a decreasing trend in rainfall. As a whole, Bhutan is likely to experience increasing trends in rainfall during 2021-2050 and a decreasing trend towards the end of 2070-2099.

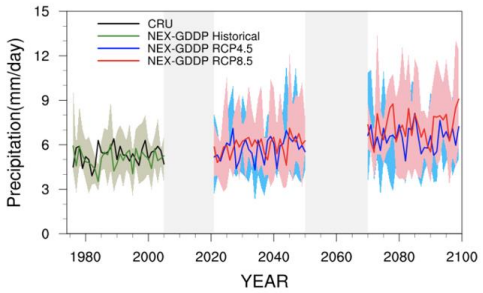

Figure 2: Historical climate projection for rainfall (Source: NCHM, 2019)

The mean annual rainfall specifically reflects an increase of about 10% - 20% during 2021-2050 and more than 30% increase in the course of 2070-2099. The interpretation suggests increasing rainfall in the summer season which is likely to decrease in the north-western region of the country during the winter season.

2.4 Climate Change and Agriculture

Bhutan's economy is dependent on the agriculture, livestock and forest sectors, which contributes to the country's Gross Domestic Product (GDP). Farming in Bhutan mostly comprises small-scale production and is dominated by the seasonal monsoon rain. The challenges faced by the farming communities include topology of the region, remoteness and inaccessibility, marketing, large-scale commercialization, minimal field equipment and labour shortage. Amongst these issues, the impact of climate change is apparently visible in the form of natural disasters.

Bhutan has been witnessing frequent extreme weather events which had socio-economic consequences and adversely affected people's livelihoods and well-being. Since agriculture continues to be dominated by agrometeorological variables, the changes in weather pattern significantly reduce agriculture output. Additionally, an increase in temperature and inconsistent rainfall patterns have led to decreasing crop yield, crop quality degradation and decreased water availability for farming and irrigation, and crop loss to other extreme events such as flash floods, windstorms, pests and disease outbreaks (MoAF, 2016).

The farming system in Bhutan is highly vulnerable to climate impacts due to farmers' small landholdings, adaptive capacity and subsistence level of productivity (NAP, 2021). Overall, the accelerating pace of climate change will result in reduced production affecting the livelihood and economy.

2.5 Climate Change and Livestock

Livestock production has a significant contribution to economic development, poverty alleviation, food security and improving rural livelihoods but in parallel it also contributes significantly to Greenhouse Gas (GHG) emissions of about 389 Gg CO_2 equivalent (NEC, 2020). Livestock is an integral part of the Bhutanese farming system and 77% of the farming households reared livestock which provides them with additional source of income (NAP, 2021). To engage in the livestock farming system, the Royal Government of Bhutan supports interested individual through investment in adopting modern technologies and practices such as crossbreeding, rearing improved breeds of cattle, animal health services and animal nutrition (MoAF, 2019).

Impact of climate change on livestock are increasing globally, despite animals having certain thermal comfort zones for adaptive capacity due to frequent extreme weather events heat/drought stress and change in rainfall pattern i.e., short annual rain falls all affecting the behaviour of the animals (Thornton et al., 2009; Zulfekar Ali et al., 2020; Aryal et al. 2021) directly or indirectly. The impacts of climate change on livestock reported are changes in quantity and quality of feeds; heat stress; changes in availability of water; emergence of livestock diseases; changes in biodiversity, systems and livelihoods (Thornton et al., 2009; Godde et al., 2021; Downing, 2017). It also results in a higher transaction costs and reduced farm profits; live weight losses and decline in productivity and production; negative implication on animal reproductive and breeding performance; reduction in livestock numbers

through higher mortality; food security threat with decrease in production levels and livestock product quality through decline in nutritional contents of the products (Escarcha et al., 2018). It is reported that the climate change could affect the whole livestock supply chain impacting on overall human, social, physical and financial capital (Godde et al. 2021).

While livestock sector in Bhutan did not encounter any major challenges from climate change, direct and indirect impact from climate change on livestock are observed and reported sporadically. As most of the livestock farming households are subsistence based rearing smaller number of livestock with low livestock diversity index, it demands for the preparedness plan to respond to the impact of climate change.

3.0 POLICIES AND LEGAL FRAMEWORK

The analysis of the policy and legal framework is carried out at three levels- international, national and agency level in the context of crop and livestock damage and loss.

3.1 International Level

The **Sustainable Development Goals** aim to end all forms of hunger and malnutrition by 2030, making sure all people- especially children- have sufficient and nutritious food all year. It also calls to take urgent action to combat climate and its impact by integrating disaster risk measures, sustainable natural resources management, and human security into national development strategies.

Sendai Framework for Disaster Risk Reduction 2015-2030 is a global blueprint for disaster risk management in conjunction with sustainable development goals. It has four broad priorities and seven targets geared toward a safe and resilient global community. It calls on member countries and partners to align their disaster risk reduction policies and strategies with set priorities and targets. Bhutan, being a signatory to this convention, has strategized its policies and programs accordingly. Bhutan has come a long way in driving these priorities/targets through integration and mainstreaming of it in various plans and projects initiated by different ministries and agencies.

3.2 National Level

The **Food and Nutrition Security Policy of the Kingdom of Bhutan, 2014** is the guiding policy of the Ministry of Agriculture and Forests and it acknowledges the risk of disaster. Consequently, it emphasises developing and implementing adaptation and mitigation measures for longer-term climate and environment changes and improving disaster preparedness capacity.

The **National Forest Policy of Bhutan, 2011** directs mainstreaming sustainable solutions to mitigate human-wildlife conflict through innovative mechanisms and instruments based on good science.

The Livestock Act of Bhutan, 2001 provides for ensuring the introduction and spread of diseases, particularly the notifiable and zoonotic diseases are prevented by regulating the import of animals, animal products and feed, and subjecting it to quarantine requirements. The Act also allows the compulsory destruction of animals, animal products or feed that is risky and pays compensation.

The Plant Quarantine Act of Bhutan, 1993 prohibits the import of plants, goods, plant products and soil which are likely to be a means of introducing or spreading plant pests into the country, and also endeavours to control those pests already in the country by restricting their spread and endeavouring to eradicate them.

The Seed Act of Bhutan, 2000 regulates the import and export of seeds to prevent the introduction of plants and diseases.

The Disaster Management Act of Bhutan, 2013 empowers the establishment and strengthening of the Disaster Management Authority at the national level and Disaster Management Committees at the dzongkhag, thromde, gewog and agency levels. The Act also mandates agencies and sectors to formulate and implement Disaster Management and Contingency Plan at national, dzongkhag and agency levels to prevent, mitigate and prepare for disasters and also to provide efficient response and relief during the time of disasters. It also stresses the importance of mainstreaming disaster risk reduction into development plans, policy, programmes and projects and calls for integrated and coordinated disaster management focusing on community participation and matters incidental thereto.

While the Act provides financial arrangements to support response and relief activities, immediate restoration of essential public infrastructure and services centres and recovery and reconstruction activities but does not support or guide payment of compensation to individuals and private entities for damages caused by the natural disaster.

3.3 Agency Level

RNR Disaster Management and Contingency Plan, 2017

As mandated by the Disaster Management Act of Bhutan, 2013, MoAF has formulated the **RNR Disaster Management and Contingency Plan (RNR-DMCP) 2017.** The RNR-DMCP mandates creation of the Disaster Management Institutions - Disaster Management Committee, Disaster Management Unit, Incident Management Team and Rapid Response Team. Additionally, it outlines contingency plans and procedures such as emergency response systems and standard operating procedures to handle identified disasters.

National Human-Wildlife Conflict Management Strategy of Bhutan (2018 – 2028)

The Department of Forest and Park Services (DoFPS) has adopted the National Human-Wildlife Conflict Management Strategy in 2019 which is expected to reduce the HWC incidences such as crop damage and livestock depredation by wildlife due to the large extent of human-wildlife interface. The strategy is intended to help create safe habitats for wildlife and save people and their properties in the human domain through the SAFE system approach.

4.0 APPROACH AND METHODOLOGY

In designing and developing this methodology, a task force was formed consisting of key member stakeholders from the Department of Agriculture, Department of Livestock, Department of Disaster Management, Policy and Planning Division, Legal Division and Dzongkhag Administration. The formal approval to carry out this assignment was obtained from the Ministry of Agriculture and Forests.

A field consultation and an online survey through structured questionnaires were carried out by the Department of Agriculture and Department of Livestock. The field consultation was held with about 37 participants represented by Dzongkhag Agriculture Officers (DAO) and extension agents of the Green Climate Fund (GCF) project site. The livestock consultation was mainly held with livestock officials working in the dzongkhag headquarters (24.7%), Livestock Extension Officers, Local Government Officials (71.9%) and officials working in central livestock agencies (3.4%). It was conducted mainly for the stakeholders to understand major agricultural and livestock risks to climate hazards, gaps and shortcomings in current government policy and future interventions required to strengthen agriculture and livestock resilience to natural and unexpected climate shocks.

4.1 Field Consultations and Survey Findings

The crop and livestock damage and loss in the country are mainly caused by the hazards mentioned below based on the findings from the survey, focus group discussions and the national documents such as the Agriculture Statistics and RNR Statistics.

- Wildlife
- Excessive rainfall
- Landslide/flash floods
- Windstorm/hailstorm
- Insect pest and diseases
- Drought

Stakeholder consultation both by DoA and DoL confirmed that almost 90 percent of field officials report crop and livestock damage to various agencies within the MoAF and DDM. The respondents also stated the need to establish a clear institutional line of reporting. Although reporting is done by the extension officials, the disaster information over the period is generally not available due to the limited understanding of changes in the institutional framework. It, therefore, necessitates establishing a SOP for reporting system and have a focal point for information repository. It was also established that most of the reporting was done with a hope to avail *Semso*/crop compensation but only about 10 percent of field officials use it for planning purposes.

Based on the field consultation and survey findings a need and gap analysis was carried out to establish SOP for damage and loss reporting.

4.2 Gap Analysis and Need Assessment:

What are the existing gaps – institutional, technical, policy/legislation, methodological etc

Table 1: Need and gap analysis for crop and livestock damage & loss assessment methodology

Thematic issues	Existing state	Needs	Gaps	Recommendation
Institutional	Lack of clarity in line of reporting, thus resulting in submission to various agencies on ad-hoc basis	A proper institutional coordination mechanism is needed. The technical departments should coordinate and submit it to PPD, MoAF	Lack of institutional coordination	**Uniform chain of reporting and response mechanism:** Propose uniform chain of reporting and response mechanism in place based on the Disaster Management Contingency Plan, 2017 and office order of the ministry (PPD/PMS/1/10/309)
Coordination	Legal Division (LD), Directorate Services of MoAF act as the coordinating agency for RNR disaster management	Coordination should be carried out by relevant departments	LD has lesser comparative advantage for Disaster data collection and compilation	Technical departments (DoA) and (DoL) to coordinate
Technical	Limited capacity in conducting field assessment	Capacity building initiatives and sensitization programs particularly on the damage and loss assessment in relation to crop and livestock	Limited budget	With the implementation of the damage and loss assessment in the field, sensitization and capacity building programs must be put in place.

Policy/ legislation	There are no insurance and compensation schemes in place	Need to institute crop insurance	High premium willingness to insure	The use of this methodology might be useful in terms of coming up with insurance and compensation schemes but the prerogative will depend on the government of the day
Implementation	Lack of crop and livestock loss data and evidence from climate-related hazards and disasters	Institutionalize RNR disaster database system	The existing reporting systems are inconsistent and sporadically implemented by different agencies	Develop a user-friendly assessment and reporting form Develop a standard disaster loss database management system for RNR sector
Methodology and approach	No methodology, SOP or guideline to calculate crop and livestock damage and loss	Develop an implementable methodology and SOP	Reports are collected and compiled on a need basis without any particular assessment methodology	Derive crop and livestock damage and loss assessment by incorporating international good practices and local experiences

4.3 Development Process of the Assessment Methodology and SOP

A series of field consultations, task force meetings and workshops were conducted before finalizing the document. The output of this task was presented to the GCF Project Board and finally endorsed by RNR-GNHC Committee of the MoAF.

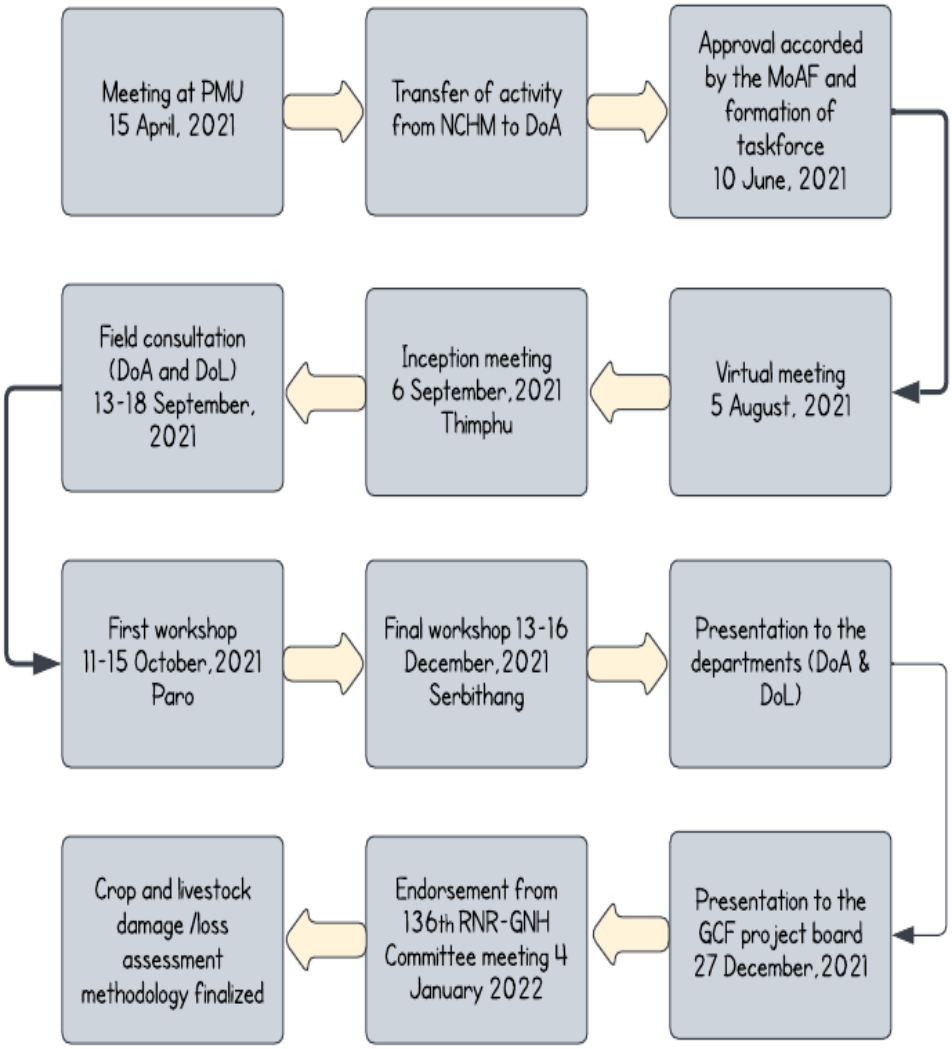

Figure 3: Development process of the crop and livestock damage/loss assessment methodology

5.0 KEY CONCEPTS AND TERMINOLOGIES

Hazard: A process or phenomenon that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation. While hazards may be natural, anthropogenic or socio-natural in origin, this report refers to climate-induced hazards only.

Disaster: a serious disruption of the functioning of a community or a society due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental loss and impacts.

Crop and Livestock damage: Damage is defined as the replacement or repair cost of totally or partially destroyed physical assets (crops and livestock) in the disaster-affected area.

Crop and livestock loss: Loss refers to changes in economic flows arising from the disaster that typically include production not obtained and sales not made in crops and livestock. Losses typically occur from the time of the disaster until full economic recovery from the crop and livestock products are achieved.

Cost of production (CoP): Cost of Production refers to the total cost incurred by a business to produce a specific quantity of a product or offer a service. In agriculture the total cost incurred in growing a particular commodity in a particular area divided by the total output produced in that particular area gives the Cost of Production per unit (i.e. Nu/kg)

$$Cost\ of\ Production(Nu/Kg) = Total\ Cost/Total\ Quantity\ Produced$$

Annual crop: Annual crops are crops that complete their life cycle in one planting season or one-year life span; e.g.,Vegetable

Perennial crop: Perennial crops are typically considered those that are more permanent, requiring several growth cycles before the fruit is produced; e.g., Fruit crops

Livestock: "Livestock" means cattle, sheep, goats, pigs, poultry, fish, horses and bees kept for use or profit

6.0 CROP AND LIVESTOCK DAMAGE / LOSS ASSESSMENT METHODOLOGY

6.1 Key Process for Crop and Livestock Damage/Loss assessment

Step 1: Preliminary information collection

The first step to estimating agricultural losses is to have basic farmer information such as household details, village, chiwog, gewog, dzongkhag, thram number, land types, land holding types (lease, institutions, groups and cooperatives, commercial farms) types of crops, livestock holdings, types of livestock and fisheries and key national publications such as Cost of Production (CoP) and Agriculture Statistics.

Step 2: Conduct field assessment

The next step is to conduct field assessment. For that, it is important to know the extent of crop and livestock damage caused by natural calamities.

Step 3: Estimation of crop and livestock damage and loss

The total crop and livestock losses will be calculated based on the damage and loss of crops (annual and perennial) and types of livestock including fishery. The estimation includes both the disaster year's replacement cost and the future economic loss caused by the disaster.

Crop damage and loss assessment methodology

6.2 SOP for Assessment of (CROP) Damage and Loss

1. The extension officials shall initiate and coordinate crop damage and loss (field and horticulture crops) assessment caused by climate hazards such as landslides, windstorms, floods, pests and diseases, etc.
2. The assessment team (GDMC) must visit the site and conduct a transect walk to carry out a visual inspection and ascertain the severity of the damage before officially confirming the crop damage/loss.
3. The extension officials must divide the field into convenient plots of rectangular, square or circular shapes depending on the case and calculate the area into appropriate units (m^2 converted into acres).
4. *Refer Annexure III for conversion methodology and formulae.*
5. The team should exercise judgement and appropriate scientific methodologies in demarcating the area of damaged crops/fields, and in assessing the degree of damage as a team in the presence of the landowner.
6. The crop loss assessment will be undertaken by a team composed of agriculture extension officials and the local government.
7. The following equipment forms an integral part of the assessment and should be carried to the damage site.
    - Measuring tape/rope/GPS
    - Camera
    - Recording book and pen

- Ground pegs

6.2.1 Computations of crop damage and loss

Computation

Crop damage and loss are computed as:

$$\textbf{Crop Damage} \ \& \ \textbf{Loss} = (\textbf{Crop damage}) + (\textbf{Crop loss})$$

Crop Damage

This is assessed as the pre-disaster value of destroyed crops, and is computed as:

Crop area damaged (ac) X crop yield (kg/ac) X CoP (Nu/kg)*

For annual crops, the damage is the replacement value that is assessed on the pre-disaster value of the destroyed crop by applying the CoP. It accounts for the production or investment cost of the crop.

For perennial crops, the damage is the replacement value that is assessed on the pre-disaster value of the destroyed crop by applying the CoP corresponding crop per tree or acre.

It is computed as:

Crop area (ac) or No. of trees damaged X yield per tree (kg) X CoP (Nu per kg)

Crop Loss

This is assessed as the loss of income or foregone output as a result of the disaster.

Loss is assessed to also compensate for the higher production costs that will potentially result when farmers replant or replace the crop, and to account for the income foregone until the crops become fully productive again.

Loss is mostly applied to perennial crops affected by a disaster as they require a certain period to mature before coming into regular production.

Loss is computed as:

Trees damaged (No.) X Crop Yield (kg/tree) x CoP (Nu/Kg) x Remaining Economic Life span (Years)

or

Crop area damaged (ac) X Crop Yield (kg/acre) x CoP (Nu/Kg) x Remaining Economic Life span (Years)

*Standard economic life span of fruit trees will apply for respective perennial crops (*Refer Annex iv*).

Assets Damage (Greenhouse structure)

Although personal farm assets in general include infrastructure like buildings, equipment, power and water supply installations, including machinery, irrigation facilities and raw materials, this methodology for now is limited to damage of greenhouse infrastructure only. This is specifically in view of the prevailing farm situation, and for ease of computation given that such an assessment is being approached for the first time.

Damage: Damage to Greenhouse structure will comprise two components:

a. Replacement Cost (for totally destroyed asset)

This will be assessed as the replacement cost of the destroyed greenhouse structure valued at the cost of the structure just before it was totally destroyed.

b. Repair Cost (for partially destroyed asset)

This will be assessed as the amount required to repair and put the asset back into its previous state just before its partial destruction.

Both the incidences of damage (replacement or repair cost) should be valued at pre-disaster price estimates.

6.2.2 General assumptions and pointers

- Crop yield will refer to the latest published and available agriculture statistics.
- Recommended seed or planting rates per acre shall be used to deduce the number of plants damaged in the case of plantation crops like sugar cane, cardamom, tea, etc., where individual plant counting is not convenient.
- For complete or permanent damage to non-bearing perennial crops like fruit plants and plantation crops, only “replacement” cost or "damage" shall be considered which will be computed as indicated in 6.2.1
- In case of complete damage to annual crops at the nursery stage, the damage cost incurred will be estimated as: the seedling rate of the crop (kg/ac) X approved seed rates (Nu/kg).

- For estimation of loss in the case of perennial crops, the approximate remaining economic life span for respective fruit crops shall apply (Refer Annexure IV)

6.2.3 Data Requirement

- Area damaged in acres (ac) for annuals and other crops as required.
- Number of plants damaged for perennial crops like fruit plants.
- Average yield (kg/acre) and (kg/tree) for perennial fruit crops as required using the latest published agriculture statistics.
- Type or stage of perennial fruit crops planted: bearing or non-bearing.
- Years to fruiting or average bearing age for perennial fruit plants.
- Cost of Production (CoP) for annual and perennial fruit crops.
- Pictorial evidences

6.3 SOP for Assessment of (LIVESTOCK) Damage and Loss

Livestock are lost to natural calamities and with climate change the incidence is expected to increase over the years. Different livestock - cattle, buffalo, yak, mithun, equine, goat, sheep and poultry are reared for different purposes (meat, milk, egg and draught power) and climate change will impact it differently based on their resilience, management and production system. Currently, the livestock loss from natural disasters are not accounted for nor attempts are made to gather such information with exception to wildlife depredation mainly for compensation purpose. Also, there is no standard assessment methodology to determine the livestock damage and loss either from the natural calamities or any other adverse climate induced events. For instance, livestock losses to wildlife depredation were compensated based on assumption of the average price determined for that particular livestock in the given time period. Since, FAO had already developed the methodology for damage and loss assessment in agriculture including livestock components, it is felt appropriate to attune and adopt it under Bhutanese context. FAO determines livestock damage and loss as the sum of livestock production damage, livestock production loss and livestock assets damage (complete and partial).

6.3.1 Standard Operating Procedure for assessment of livestock damage and loss

- The livestock extension officials shall initiate and coordinate to collect livestock damage and loss assessment from any climate hazards disaster.
- The assessment team (GDMC) must visit the site, inspect and assess the severity (deaths, injured, sick, partial or incomplete damage) and verify and record the damage affected by disasters using standard format.
- The livestock damage and loss assessment will be undertaken by a team composing livestock extension officials and the local government adopting the prescribed assessment methodology in Annexure VII (initial) & Annexure VIII (detail) guided by technical parameters provided in Annexure V & VI.

6.3.2 Computations of livestock damage and loss

FAO methodology attuned to the Bhutanese livestock farming context (guided by the general assumptions and pointers, technical parameters) will be adopted to assess the overall livestock damage and loss using the equation below:

Livestock damage and loss = Livestock Production Damage + Livestock Production loss + Livestock Assets Damage (complete and partial)

wherein, livestock production damage, livestock production loss and livestock assets damage will be computed as follows:

Livestock production damage = Nos. of animal/colony affected X unit COP (pre-disaster) - recovered value if any

Livestock production Loss = Nos. of animal/colony affected X Average annual production (Qty) X Unit cost (pre-disaster)

Livestock asset damage is calculated as the repair/replacement cost of partially/fully destroyed assets such as pond, dairy and poultry shed, equipment, machineries, feed, medicine, drugs, vaccine determined at pre-disaster unit cost.

6.3.3 General assumptions and pointers

- Livestock includes cattle, buffalo, yak, zo/zom, poultry, pig, goat, sheep, equine (horse, mule & donkey), aquaculture, fisheries and apiculture
- Cost of production (CoP) for different livestock types and categories (Annexure VI) determined by the Department of Livestock at the national level on a period basis will be used for the computation of livestock damage and loss
- Department of Livestock will update COP every two years
- Technical/production parameters developed or adopted from relevant sources by the Department of Livestock will be adopted (Annexure VI & VII) for the computation
- Livestock categories (young stock) not in production stage, and adult animals (i.e. bulls, equine, goat, sheep) used for meat and draught purposes will be accounted for livestock production damage only.
- In case of partial damage, the recovered value will be subtracted from the livestock production damage.
- Livestock production loss will be computed for 1 year (post disaster) for the damage of livestock during the production stage (layer, milch animals).
- Livestock production will be deduced from the latest annual Livestock Statistics or any relevant published documents.
- Pre-disaster unit cost of livestock products will be used for the computation of livestock damage and loss.

- In addition to infrastructure, machinery and equipment inputs such as feed, medicine, fertilizer, vaccines, pasture seeds will be accounted for livestock asset damage.
- Infrastructure, machinery and equipment must be depreciated based on useful life span (initial cost (Nu)/useful life span (year) annually)

6.3.4 Data requirement for livestock damage and loss assessment

- Numbers of animals affected by type, categories (Annexure VI), and severity of damage (partial, complete)
- Infrastructures, equipment, machineries and stored inputs (medicines, vaccine, feed, fertilizer, pasture seed) damaged along with quantity, cost and purchase date,
- Pictorial evidences if possible
- Maintain proper records of stock (in/out) and livestock products (milk, eggs, honey, meat etc) production or sale receipts to be adopted in times of production loss assessment.
- Pre-disaster unit market price for livestock products, stored inputs.
- Livestock Production systems (stall feeding, migratory, open grazing etc,)
- Production parameters (average body weight, average daily milk production, egg, wool and honey, dressing percentage) of livestock
- Cost of production of different livestock type and categories

7.0 SOP (REPORTING)

The institutional line of reporting has been developed based on the existing framework and as per the office order issued by the Ministry of Agriculture and Forests (PPD/PMS/1/10/309 dated 9 December 2021

7.1 Rapid Assessment Report

1. The affected farmer/communities inform the incidence immediately to the Gewog Disaster Management Committee (GDMC) through Tshogpa or directly to any members of GDMC in person, via telephone or any other means of communication.
2. The extension officials shall coordinate and conduct a preliminary/rapid field assessment within 36 hours of the receipt of the grievance and submit it to the GDMC as per the standard assessment format for validation and endorsement. The GDMC shall review and submit the rapid assessment report to the DDMC within 12 hours.
3. The DDMC shall compile, review, validate and endorse the report and submit it to DoA and DoL respectively within 12 hours.
4. The DoA or DoL shall compile, review, validate and endorse the report and submit it to the Policy and Planning Division (PPD) respectively within 12 hours.

7.2 Detailed Report

1. The extension officials shall coordinate and conduct a detailed field assessment within 4 days of the receipt of the grievance and submit it to the GDMC as per the standard assessment format for validation and endorsement. The GDMC shall review and submit the detailed field assessment report to the DDMC within 1 day.
2. The DDMC shall compile, review, validate and endorse the report and submit it to DoA and DoL respectively within 24 hours.
3. The DoA or DoL shall compile, review, validate and endorse the report and submit it to the PPD respectively within 24 hours.

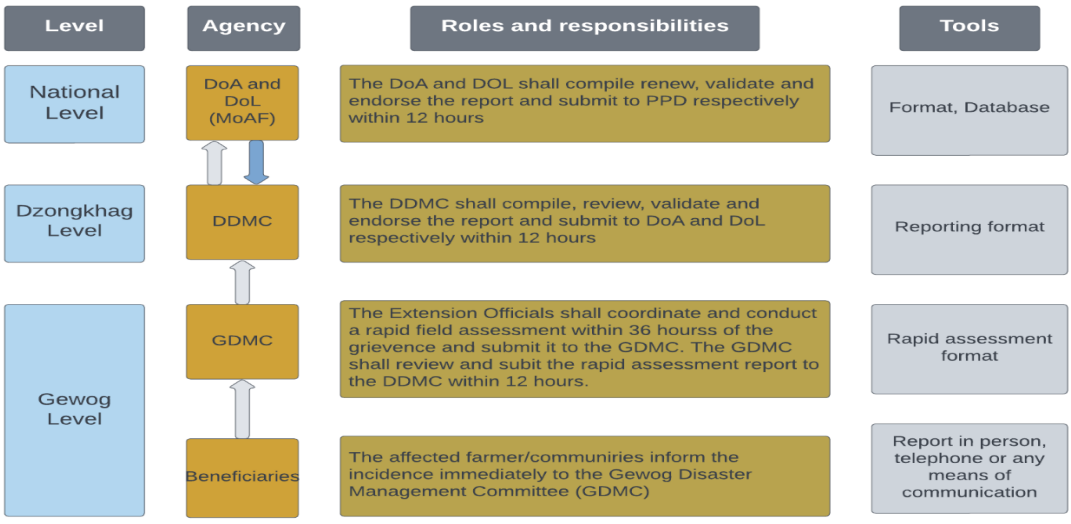

Figure 4: Institutional line of reporting (Crop and Livestock)

8.0 CONCLUSION AND RECOMMENDATION

Climate variability and associated extreme events as well as climate change affect the socio-economic conditions, particularly in developing countries. The frequency and intensity of climate-induced disasters in Bhutan are increasing annually causing widespread damage and losses to various sector. Moreover, the impact of the disasters is directly felt in the agriculture sector and therefore the departments (DoA & DoL) worked towards strengthening the knowledge base in the agriculture sector through the support of GCF project. This methodology, therefore attempts to provide an integrated, practical and technical basis for assessing damage and loss in agriculture as a result of climate-driven disasters. The methodology is based on the standard methodology developed by the FAO, and has been adapted to our context so as to suit the prevailing needs of the two sectors.

Recommendation and way forward:

Integration: It is recommended to integrate the proposed damage and loss methodologies at the national and subnational levels to maintain a repository of data to reinforce planning and also to monetize damage and loss. Similarly, stakeholders to continue identifying and addressing gaps and challenges in data collection.

Database: It is recommended to have a database for a complete crop and livestock damage/loss and to also consider future incorporation and enhancement. ICT/mobile app enabled data collection and reporting system must be adopted.

Application: ***This methodology will be primarily used for generating and maintaining data on crop and livestock damage/loss over a period of time*** **to be adopted for planning and policy decisions.**

Although the provision of compensation and insurance are the prerogative of the government and the insurance companies, this methodology can be a guiding tool in computing the payouts compensations in agriculture and livestock sector. To facilitate the process, it will be necessary to encourage intensification of agriculture and livestock farming and in parallel to institute and enforce farm and animal registration (e.g., registration of cattle under the National Cattle Identification System with the National Dairy Research and Development Centre) with relevant organizations for proper records, traceability, transparency and accountability.

Capacity building: Since the methodology has been adapted from the FAO and is relatively different from earlier assessment conducted in the country, the extension agents and relevant officials needs to be sensitized on the methodology for an efficient and reliable information system.

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Annexures

Annexure I: Rapid Assessment of Crop Damage/Loss Reporting Format (Form # Agri_1)

Reporting Period:……

Name of the Head of the household/Cooperatives/Institutions:			CID Number:
Village:	Chiwog:	Gewog:	Dzongkhag:
Thram Number:	Gung Number:	Contact Number:	
GPS Coordinates:			

Land holding as per Thram*

Land Use Type	Area cultivated		Total area (ac)
	Self (ac)	Leased (ac)	
Wetland			
Dryland			
Orchard			
Others (specify): …….			

**Fill in for only affected land types*

Crop Damage by Natural Calamities

Natural Calamities	Crops affected	Total area cultivated (acres)	Area Affected (Acres)	Pre disaster production from affected area (Kg)	Degree of damage (%)	Production loss (kg)	Crop Stages	Date of incidence
Wind Storm	**Paddy**	**1**	**0.4**	**1600**	**50**	**800**		
Rainfall								
Drought								
Hail Storm								
Others (Specify)								

Crop Damage by Wildlife

Natural Calamities	Crops affected	Total area cultivated (acres)	Area Affected (Acres)	Pre disaster production from affected area (Kg)	Degree of damage (%)	Production loss (kg)	Crop Stages	Date of incidence
Wild Boar		**1**	**0.4**	**1600**	**50**	**800**		
Monkey								
Elephant								
Others (Specify)								

Crop Damage by Pest and Diseases

Natural Calamities	Crops affected	Total area cultivated (acres)	Area Affected (Acres)	Pre disaster production from affected area (Kg)	Degree of damage (%)	Production loss (kg)	Crop Stages	Date of incidence
		1	**0.4**	**1600**	**50**	**800**		

Household signature:…….

Verified by:

Gewog Agriculture Extension: **Name: …….** **Signature: ……**

Tshogpa: **Name: ……** **Signature: ……**

Chairperson**:** **Name: …….** **Signature: …….**
(GDMC)

Annexure II: Detail field assessment form (Form# Agri_2)

Estimation of crop damage (for annual crops)

Crops affected	Total cultivated area (Acre)	Total Area affected (Ac)	Average crop yield (kg/Ac)	Pre disaster production from affected area (Kg) P	Degree of damage (%)	Production loss (kg)	Cost of Production (Nu/kg)	Estimated damage cost (Nu)
		(A)	(B)	P=(A*B)	C	PL= P*C	(D)	(Z=PL*D)
Paddy	10	5	1,200	6000	(50%)	3000	45	1,35,000

Crop Name	Crop age (years)	Total area cultivated (Ac) or No. of trees grown		Total affected (Ac or No)	Av yield (kg/tree) or (kg/ac)	Cost of production (Nu/kg)	Estimated total production loss (kg)	DAMAGE	LOSS		TOTAL CROP DAMAGE & LOSS (Nu)
								Replacement cost (Nu)	Remaining economic life span of crop (years)	Loss (returns foregone) (Nu)	
		Area (Ac)	Number	A	B	C	PL = (A * B)	X = (A*B*C)	D	Y = (A*B*C*D)	Z = X+Y
Apple	5		112	25	48	27	1,200	32,400	15	486,000	518,400
							0				

Verification Team:

Verified by:

Gewog Agriculture Extension: **Name: ……..** **Signature: ……**

Tshogpa: **Name: ……** **Signature: ……**

GDMC Chairperson: **Name: ……..** **Signature: ……**

Endorsed by:

DAO **DDMO**

Dzongkhag Disaster Management Committee
Chairperson

Annexure III: Units of Area and its conversion

- 1 hectare = 10,000 m^2 = 2.5 acres
- 1 acre = 100 decimal = 4000 m^2
- 1 langdo =approximately 1187 m^2 = 0.3 acre
- 1 decimal = 0.01 acre
- 1m^2 = 0.00025 m^2

Methods of area measurement

a. Circular field
   Area in m^2 = (3.14) x (radius in m)^2

b. Rectangular field
   Area in m^2 = length (m) x breadth (m)

c. Square field
   Area in m^2 = side (m)^2

d. The area can also be derived from a polygon using a GPS

Annexure IV: Fruiting year and lifespan of fruits and nuts

Crop	Year of bearing	Economic life span	Average yield per tree
Apple	4	25	40
Avocado	4	25	45
Banana	1	15	20
Hazelnut	4	20	3
Kiwi	4	20	35
Litchi	5	25	32
Mandarin	4	25	40
Mango	5	25	50
Passion fruit	1	15	14
Peach	4	20	35
Plum	4	20	40
Pear	4	25	45
Persimmon	4	25	45
Walnut	5	25	25
Pomegranate	4	25	20
Pineapple	1	10	1
Cardamom	3	10	
Areca nut	7	25	12
Coffee	3	20	3.2
Tea	6	35	0.05

Annexure V: Production parameters for computation of livestock production damage and loss

Type of Livestock	Production Parameter	Assumptions
Cattle/Yak/Buffalo	Live body weight (LW)	Dressing/crass weight: 63% of LW
Broiler	Live body weight (LW)	Dressing/crass weight: 70% of LW
Pig	Live body weight (LW)	Dressing/crass weight: 72 % of LW
Aquaculture & fishery	Live body weight (LW)	Dressing/crass weight: 82.4-84.5 % of LW
Goat/Sheep	Live body weight (LW)	Dressing/crass weight: 45 % of LW
Bees	Honey harvest per colony (improve & local)	20 kg/colony (improve) 8 kg/colony (local)
Poultry layer	Eggs per bird in a cycle (72 weeks)	270 eggs
Improved cattle	Milk production per cows and 305 days milking	6 litre per day
Local cattle	Milk production per cows and 305 days milking	2 litres per day
Sheep	Raw wool production per ewe & twice shearing	2 kgs

Annexure VI: Parameters for computation of Livestock damage and loss assessment

Category	Nos of animal/colony affected (A)	COP (B)	*Production damage(Nu) (C=AxB)- Recovered value	Average production(D)	Unit cost(E)	*Production loss(Nu)(F=AxDXF)	Damages to Asset(Nu)(G)	*Total Damage/loss(H=C+F+G)
Parent Stock								
Layer DoC		1,080.00		0.00	1,080.00		0.00	
Layer Pullet		1,159.00					0.00	
Layers		1,526.00		270 eggs/cycle(72 weeks)	16.5		0.00	
Broiler DoC		489.00		0.00	0.00		0.00	
Broiler Pullet		1,436.00		1kg live weight	1,681.00		0.00	
Broiler Layer	100.00	1,491.00		220 eggs/cycle(72 weeks)	16.00	352,000.00	0.00	
Commercial								
Commercial DoC Layer		61.00		0.00	61		0.00	
Commercial Pullet Layer		165.00			0.00		0.00	
Commercial Layers		310.00		270 eggs/ cycle(72 weeks)	8.5		0.00	
Commercial Broiler DoC		35.00		0.00	35.00		0.00	
Commercial Broiler		321.00		2.2 kgs live weight(42days)	860.00		0.00	
Piggery								
GGP/GP/PS								
Piglet		7,620.00		0				

Grower		7,120.00						
Gilt		15,600.00		75kgs live weight	650.00			
Boar		78,000.00		100 kgs live weight	650.00			
Sow		64,000.00		100 kgs live weight	650.00			
Commercial								
Piglet		3,682.00						
weaner		5,182.00		25 kgs live weight	650.00			
Grower		6,760.00		40 kgs live weight	650.00			
Gilt		10,920.00		70 kgs live weight	650.00			
young Boar		10,920.00		80 kgs live weight	650.00			
Boar		15,600.00		100 kgs live weight	650.00			
sow		15,600.00		100 kga live weight	650.00			
Dairy								
Crossbred								
Calf (1 year)		19,584.50						
Heifer		45,564.49						
Bull		45,564.49		400 kgs live weight				
Milking cow		70,577.99		350 kgs live weight				
Dry cow		61,481.99		350 kgs live weight				
Mithun								
Calf (1 year)								
Heifer								
Bull		47,702.00		500 kgs live weight				
Milking cow				465 kgs live weight				
Dry cow				465 kgs live weight				
Nublang								
Calf (1 year)								

Heifer		54,800.00						
Bull		54,800.00		400 kgs live weight				
Milking cow				350 kgs live weight				
Dry cow				350 kgs live weight				
Yak Component								
Yak calf		19,584.50						
Heifer		45,564.49						
Bull		45,564.49		350kgs live weight				
Adult yak		70,577.99		300kgs live weight				
Zow/Zom		61,481.99		300kgs live weight				
Aquaculture Component								
Aquaculture								
Fry		3.00						
Fingerling		7.00			11.02			
Table fish		88.25			265.11			
Broodfish		550.00						
Cold water Aquaculture (Rainbow trout)								
Eyed ova		2.00						
Fingerlings		25.00						
Table fish		112.50			450.00			
Equine Component								
suckling Foal		7,000.00						
weaning foal		10,000.00						
yearling(1-2yrs)		15,000.00						
colt/filly(younger than 4yrs		20,000.00						
stallion/mare(older than 4yrs)		50,000.00						
Mule		90,000.00						
Donkey		70,000.00						

Small Ruminant(sheep & goat)								
Lamb								
Ram		10,515.76						
Ewe		10,515.76						
Kid								
Doe		10,515.76			600.00			
Buck		10,515.76						
Apiculture Component								
Honey Bees								
A. mellifera nucleus colony		10,628.00						
Apis mellifera full fledged colony		13,895.47						
A. cerana nucleus colony		7,100.33						
Apis cerana full fledged colony		10,166.80						
A.mellifera queen		1769.68						
A. cerana queen		2571.52						

Reference:COP determined by respective commodities centres and farms under DoL.

Annexure VII: Initial Damage/loss Assessment Report Form (Form # Livestock form_1)

Name of the Head of the household/ Cooperatives/Groups:								CID Number:
Village:		Chiwog:		Gewog:		Dzongkhag:		
Thram Number:		Gung Number:		Contact Number:				
GPS Coordinates:								
Livestock Type*	Category **	Cause of Damage ***	Investment Cost (Nu)	Purchased/ Estd date	Nos affected	Severity of damage		Estimated damage cost (Nu)
						Partial	Complete	
Damages to Assets	Infrastructure							
	Equipment							
	machineries							
Total								

*Bovine, Equine, Avian, Swine, Pisces, Ovis, Caprine, Apiculture, Pasture, Fodder

**Calf, heifer, bull, cow, sow, boar, gilt, pullet, etc.)

***Landslide, windstorm, disease, rainfall, cold, heat, flood, earthquake

Verification Team:

Verified by:

Gewog Livestock Extension: **Name: …….** **Signature: ……**

Tshogpa: **Name: ……** **Signature: ……**

GDMC Chairperson: **Name: ……** **Signature: ……**

Annexure VIII: Detail Damage/Loss Assessment Report Form (Form # Livestock form_2)

Name of the Head of the household/cooperatives/groups:							CID Number:			
Village:		Chiwog:			Gewog:			Dzongkhag:		
Thram Number:		Gung Number:			Contact Number:					
GPS Coordinates:										
Livestock Type*	Category **	Cause of Damage ***	Initial cost (Nu)	Nos affected	Severity of damage		Estimated damage cost (Nu)	Estimated Production loss cost (Nu)	Damages to Assets (Nu)	Total Damage/ Loss (Nu)
					Partial	Complete				
Damages to Assets										
	Infrastructure									
	Equipment									
	Machineries									
	Inputs (medicine, vaccines)									
Grand Total										

*Bovine, Equine, Avian, Swine, Pisces, Ovis, Caprine, Apiculture, Pasture, Fodder

**Calf, heifer, bull, cow, sow, boar, gilt, pullet, etc.)

***Landslide, windstorm, disease, rainfall, cold, heat, flood, earthquake

Verification Team:

Verified by:

Gewog Livestock Extension: Name: ……. Signature: ……

Tshogpa: Name: ……. Signature: ……

GDMC Chairperson: Name: …….. Signature: ……

Endorsed by:

DLO **DDMO (Focal)**

Dzongkhag Disaster Management Committee
CHAIRPERSON

Annexure IX: Summary of the historical events (1968-2020)

Year	Date/month	Flood event	Dzongkhag	Village/gewog
1968	3-15 Oct	Punakha flood	Punakha	
1968	3-15 Oct	Thimphu flood	Thimphu	All gewogs
1968	4-Oct	Paro flood	Paro	Shaba, Wangthanka, Dopshari and Jukathang
1968	3-15 Oct	Phochu and mochu flood	Sarpang	Kalikhola
1968	3-15 Oct	Phochu and mochu flood	Tsirang	
1982	10-Aug	Thungti flood	Trashigang	Thungti
1987	10-Sep	Mochu flood	Punakha	Punakha market areas
1990	4-May	Mithidang flood	Trashigang	Trashigang
1990	2-Jun		Sarpang	Phuentsholing town
1991	May		Trashigang	Ramjar
1991	12-14 June	Haa chu flood	Haa	Lukha
1991	2,3,5 July	Duti khola flood	Sarpang	
1992	14-Jul	Flood	Samdrup Jongkhar	Samdrup jongkhar town
1993	5-May	Flash flood	Trashigang	Rangjung
1993		Flash flood	Chhukha	Genju
1993		Flash flood	Samtse	Pagli, Chengmari
1993	11-Aug	Flash flood	Paro	Damchna, Khenphu
1994	30-Jul	Flash flood	Trashigang	Trashigang town
1994	7-Oct	GLOF	Punakha	
1994	7-Oct	GLOF		Lunakha
1995		Obstruction of the stream caused flash flood	Lhuntse	Changzam
1996	July 12 and 13	Flash flood caused landslide	Sarpang	Sarpang town and Kharkhola village
1996	13-Jul	Flash flood	Trashigang	Bartsham
1996	13-Jul	Flash flood	Chukha	Pasakha
1999	August	Sethey kherey flood	Sarpang	Gelephu and Lodrai
1999	2-Sep	Stream catchment flood	Trashi Yangtse	
2000	August	Flash flood	Sarpang	Pasakha
2000	August	Flash flood	Sarpang	Phuentsholing
2000	3-Aug	Flash flood	Samtse	Noonpani
2000	3-Aug	Flash flood	Trashigang	Wamrong and Nanong
2000	3-Aug	Flash flood	Mongar	Kengkhar

2003	September	Bareykang river caused flash flood	Trashi Yangtse	Bumdeling
2004	9-Jul	Flash flood and landslides	Eastern dzongkhag	Melphey, Wamrong and Reserbo
2004	September	Flash flood	Trashigang	Phongmey
2005	May	Flooding	Sarpang	Phuentsholing
2005	23-Aug	Flooding	Trashi Yangtse	Bumdeling
2007	4-Jul	Flash flood	Trashi Yangtse	Toetso
2008	18-Jul	Flooding	Haa	Damthang
2008	September	Flooding	Sarpang	Phuentsholing
2008	September	Landslide and flooding	Samtse	Sukrutey
2009	25-26 May	Heavy rainfall and flood (cyclone Aila)	Thimphu	Semtokha and Hongtsho
2009	25-26 May	Flooding (cyclone Aila)	Haa	Haa town
2009	25-26 May	Heavy rainfall (cyclone Aila)	Dagana	
2009	25-26 May	Heavy rainfall (cyclone Aila)		Wangkha, Tanalum, Tshimasham and Taktikoth
2009	25-26 May	Heavy rainfall (cyclone Aila)	Samdrup Jongkhar	
2009	25-May	Landslide or snow avalanche (cyclone Aila)	Gasa	All gewogs
2009	June	Flooding	Thimphu	Zamtong and Tshochekha
2010	July	Flood water	Chukha	Pasakha
2010	28-Jul	Flash flood	Thimphu	Namseling and Mewang
2010	27-Aug	Flash flood	Sarpang	Sarpang town
2012	June	Flash flood	Gasa	Damji
2012	27-Jun	Flash flood	P/gatshel	Chengkari
2012	July	Heavy rain caused flash flood	Sarpang	Gelephu town and pelrithang
2012	July	Flooding	Sarpang	Near Gelephu
2013	June	Flash flood	Punakha	Kabjisa
2013	10-Aug	Flooding	Trashigang	Phongmey and Sakteng
2014	17-Jun	Flash flood	Trashi Yangtse	Toetsho
2015	28-Jun	Flood or GLOF	Gasa	Laya
2015	30-Jun	Flash flood	Chukha	Phuentsholing
2015	8-Aug	Flash flood	Dagana	
2015	8-Aug	Flash flood	Wangdue	Nahi
2015	18-Aug	Flash flood	Sarpang	Gelephu

2015	August	Flash flood	Samdrup Jongkhar	Samdrup Jongkhar
2016	20-Jun	Flash flood	Sarpang	Sarpang town
2016	23-Jul	Flash flood	Chukha	Phuentsholing
2016	24-Jul	Flash flood		Gelephu town and pelrithang
2016		Monsoon rainfall	Whole country	Whole country
2016	25-Jul	Flash flood	Punakha and Wangdue	
2016	26-Jul	Flash flood	Sarpang	Gelephu and Ghaden
2016	27-Jul	GLOF	Bumthang	Bumthang
2017	11-Mar	Heavy snowfall	Western, Northern and central	
2018	18-Dec	Snowfall	Thimphu, Paro, haa, gasa and Bumthang	
2019	9-Jan, 8,9,25,26,27,28 Feb	Snowfall	Haa and Gasa	
2019	29-Apr	Flash flood	Lhuentse	
2019	25-Jul	Landslides	Sarpang	Jigmecholing
2019	7-Aug	Flash flood	Wangdue Phodrang	Kamichu
2019	4-Dec	Windstorm	Thimphu and Gasa	Naro and Lunana
2020	21-May	Heavy rain	Tsirang	Rangthaling
2020	23-May	Heavy rain	Samdrup Jongkhar	Serthi, Lauri and Wangphu
2020	25-May	Windstorm	Zhemgang	Bardo
2020	25-May	Heavy rain caused flash flood and landslides	Pemagatshel	Threna under Udzorong gewog
2020	26-May	Heavy rain	Samtse	Tading
2020	26-May	Heavy rain	Pemagatshel	Dungmed
2020	11-Jul	Landslides	Samdrup Jongkhar	Gomdar
2020	22-Jul	Landslides	Tsirang	Patshaling
2020	26-Jul	Landslides	Trashigang	Peydung
2020	20-Sep	Windstorm	Punakha	Toepisa
2020	20-Sep	Windstorm	Pemagatshel	Dungmed
2020	1-Oct	Flash flood	Trongsa	Bjizam
2020	4-Oct	Flash flood	Wangdue	Ruebisa
2020	4-Oct	Windstorm	Trashiyangtse	
2020	22-23 Nov	Windstorm	Paro	Soe under Lamgong
2020	24-Dec	Windstorm	Paro	Doteng, Naja, Lamgong and Tsento

2021	5-Jan	Windstorm	Paro	Dokaa under Lamgong
2021	10-Mar	Windstorm	Sarpang	Phuentsholing
2021	4-Apr	Windstorm	Zhemgang	Nangkor, Bardo and Phangkhar
2021	4-Apr	Windstorm	Mongar	Balam, Drametse, Thangrong, Kengkhar, Shermuhoong and Ngatshang
2021	12-Apr	Landslides	Paro	Dobji dzong
2021	22-Apr	Windstorm	Samtse	Sipsu
2021	22-Apr	Windstorm	Mongar	Thangrong, Chaling, Drepoong and Shermuhoong
2021	22-Apr	Windstorm	Zhemgang	Nangkhor
2021	28-Apr	Windstorm	Zhemgang	Bardo, Bjoka, Goshing, Nangkor, Ngangla, Phangkhar, Trong and Shingkhar
2021	30-Apr	Windstorm	Mongar	Drepong, Chaling, Tsamang and Tsakaling
2021	30-Apr	Windstorm	Lhuentse	Tsenkhar
2021	15-Jun	Flash flood	Trongsa	Chendebji
2021	17-Jun	Landslides	Gasa	Laya
2021	29-30 Jun	Landslides	Sarpang	Pasakha