

Climate Change Impacts on Agriculture Value Chains

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Climate Context

- Nepal ranks 4th in climate risk (Global Climate Risk Index)
- Max. temperature increase per year on average is 0.056 degrees Celsius between 1971 and 2014
- Annual precipitation increase with an average of 87 mm/year
- Increase in total rainfall with decline in winter/pre-monsoon rainfall
- Climate Change has adversely affected agriculture, food, water resources, forests, biodiversity, human health, tourism, energy, irrigation, settlements, and infrastructure.

Objective of the Study

Fulfill the knowledge gap by identifying climate impacts on selected agriculture value chain and propose appropriate adaptation measures to de-risk investments in value chain development.

This will further contribute to:

- Increase production, farmers income and food security
- Minimize trade deficit in food products
- Minimize climate change impacts on food production, farm income and export value
- Promote gender, youth and social inclusion in agriculture development

Study Rationale

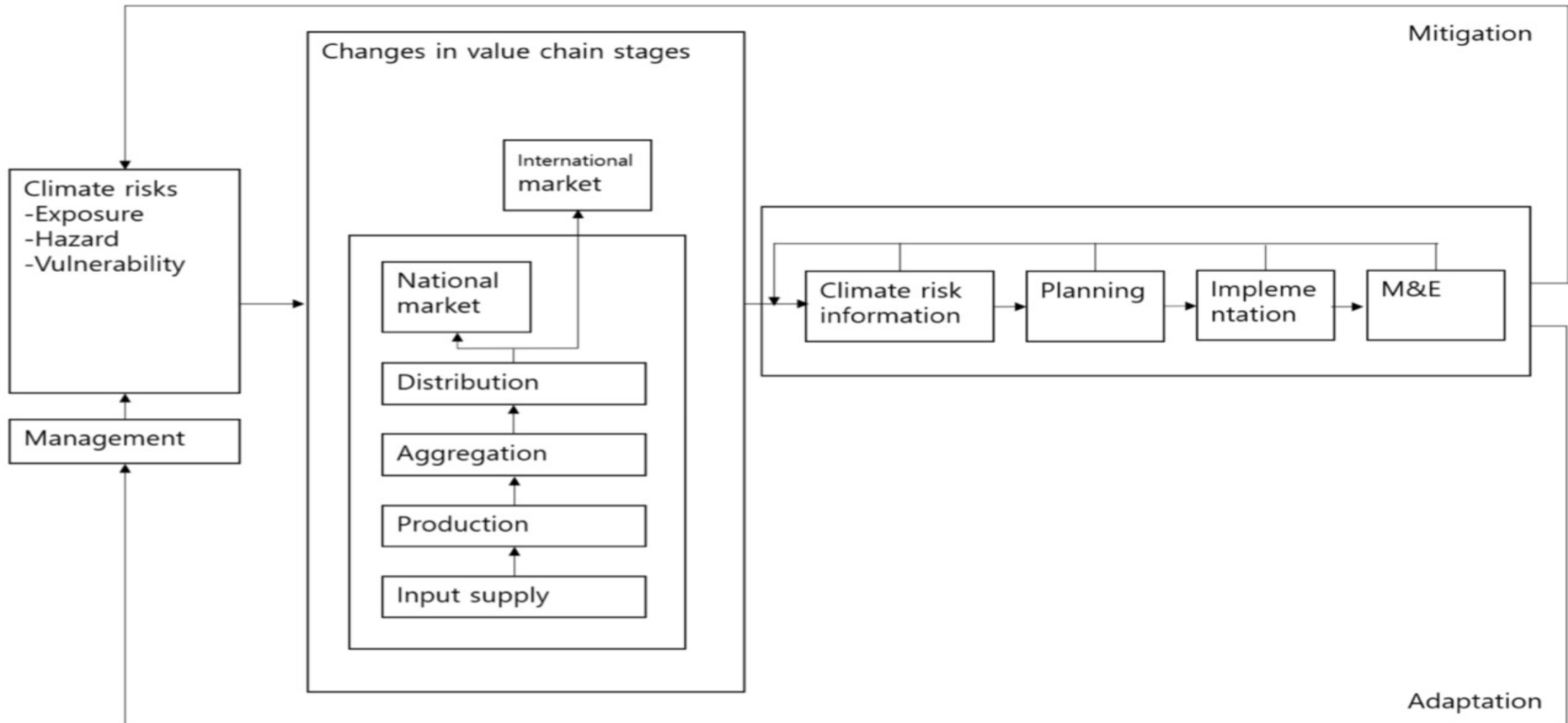
▪ **Agriculture in Nepal:**

Major contributor to GDP and employment, smallholder dominant, high women's involvement, increasing fallow land degradation

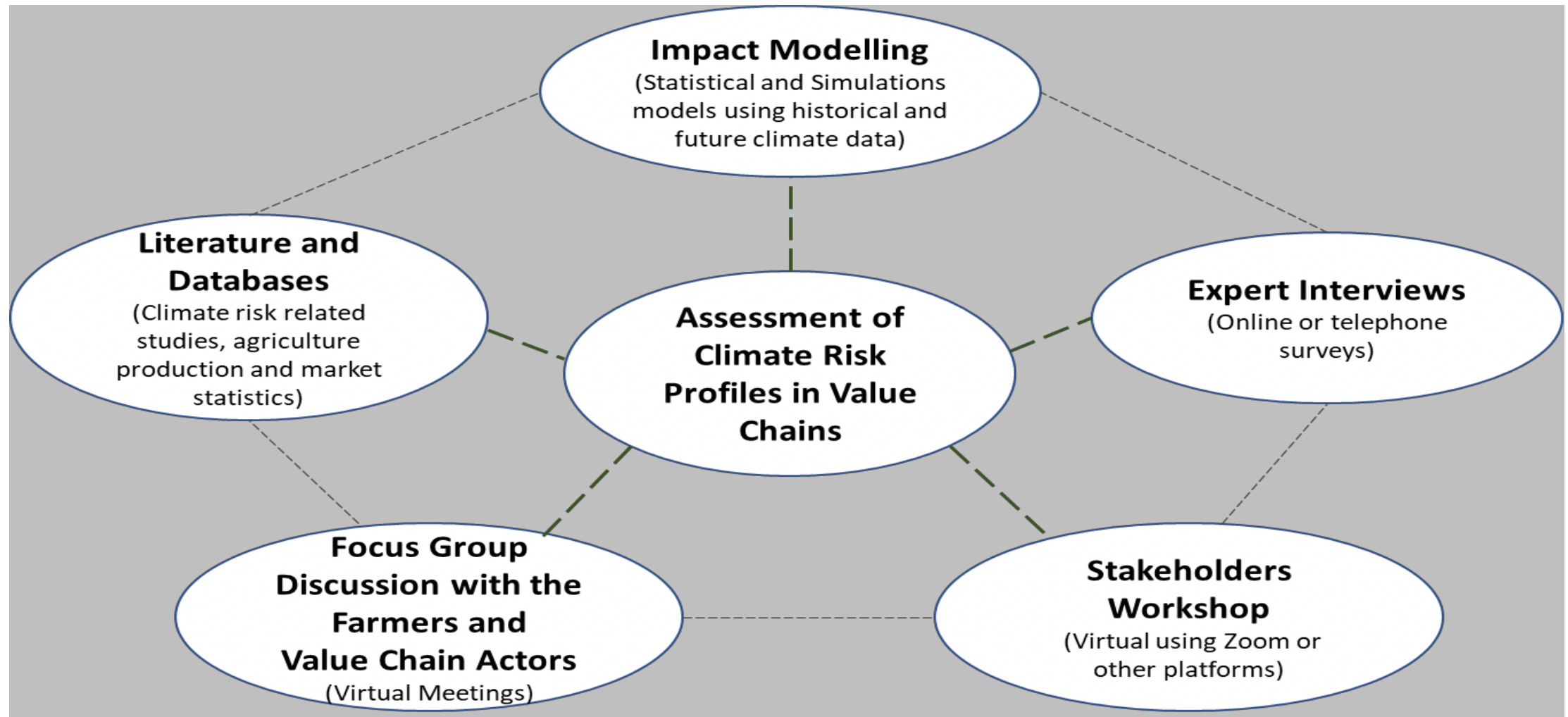
▪ **Climate Change Impact:**

- **In Production**: change in crop calendar, growing season, heat budget, chilling requirement; land use pattern and crop/livestock production suitability, water availability and incidence of insect/pests, etc.
- **In Value Chain**: change in input availability, cost of inputs, on-farm production (yield), harvesting-storage-processing, product marketing (wholesale and retailing) and consumption (price)

Conceptual framework



Summary of Methodology



Selection of Value Chain

- Selection of VCs informed by agriculture VC development priorities of the 15th National Development Plan (2019/20 - 2023/24) and Agricultural Development Strategy (ADS) 2015-2035.
- Some niche commodities considered as emerging crops of Nepal
- Initial desk review and consultation with advisory group:
 - Boston matrix for business strategy of growth and planning- Increased farmer income and market demand
 - Innovative-strategic-and-emerging products- consumption patterns and import volume trend
 - Scope for CC mitigations and adaptation- crop vulnerability in different VC functions (production and post harvest impact, transport, processing etc.)

Selected VCs: Apple, Avocado, Banana, Large Cardamom and Timur

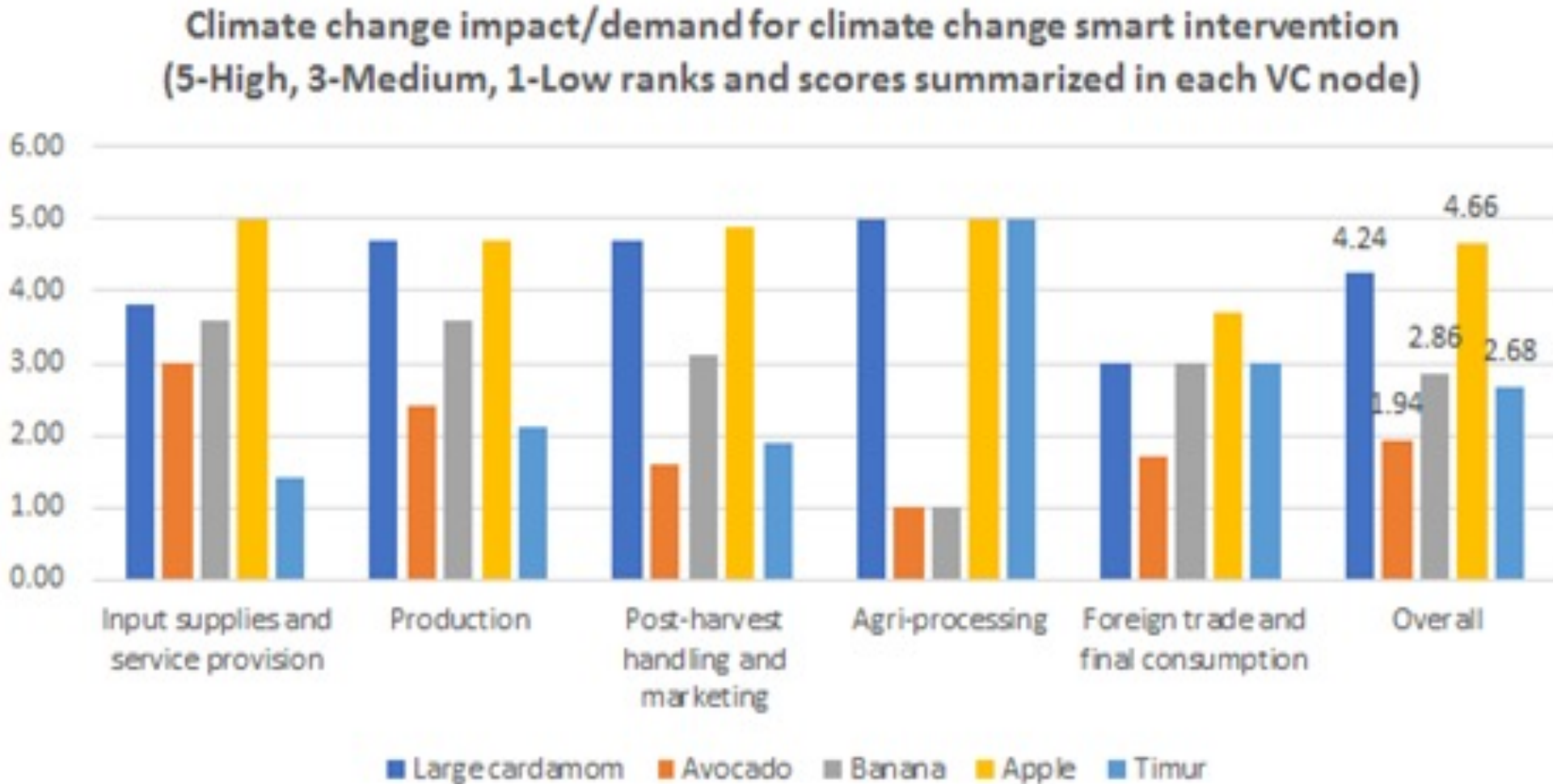
Assessment of Climate Change Trends

- Spatial interpolation of seasonal precipitation and temperature, and extreme events (length of dry spells, rainy days, pre-monsoon, and monsoon drought) were estimated at a 1x1 km grid.
- Average temperature and precipitation of several Global Circulation Models (GCMs) used for climate projections..
- These model-forecasts were corroborated by ground-check through field surveys.

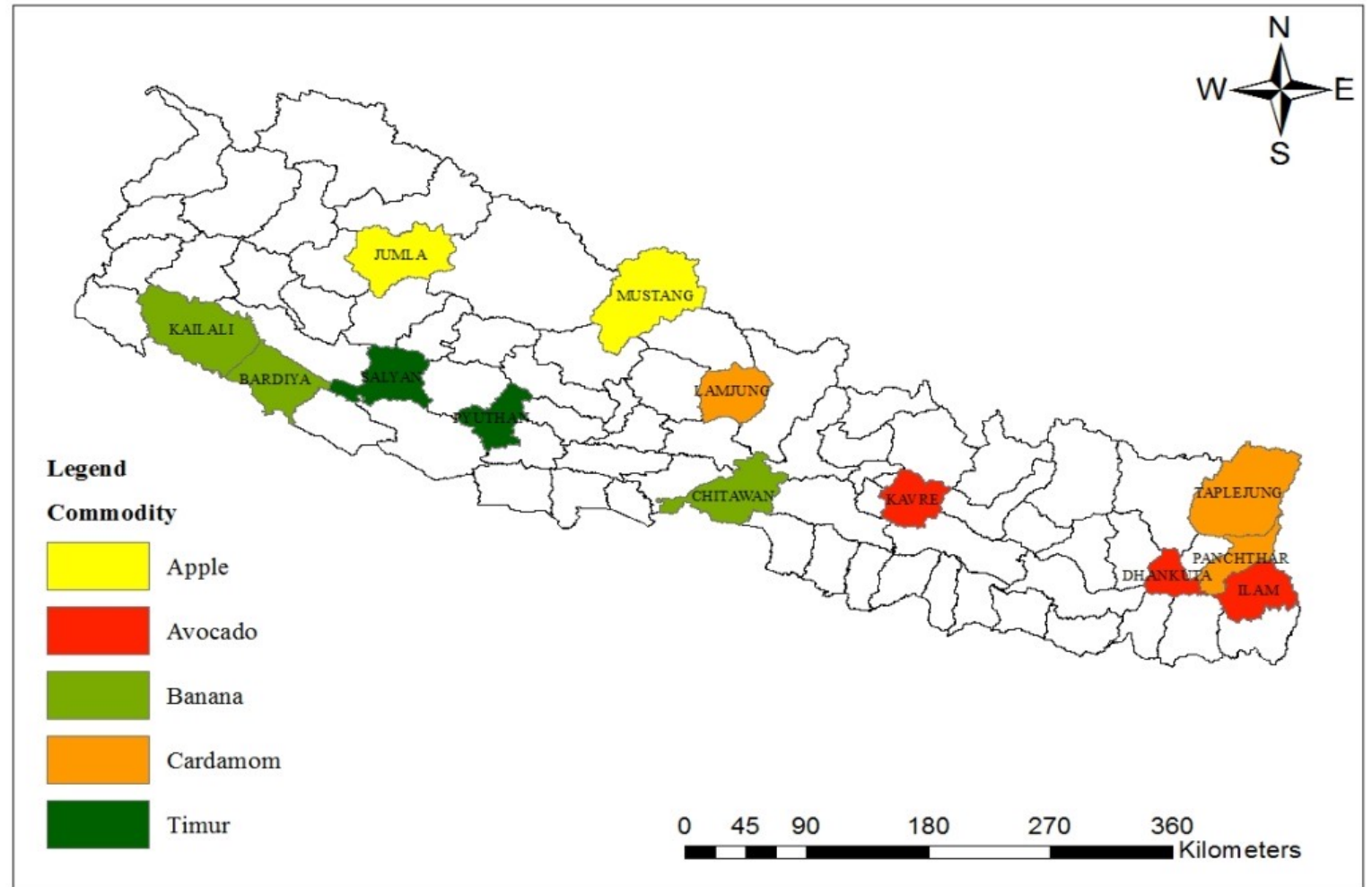
Assessment of CC impacts in VCs

- Initially intended to use IMPACT-II model for estimation. But data unavailability for selected crops results in adopting alternate methods
- Regression models based on historical climate and crop production (yield) data were used to estimate the impact of climate variables in crop yields.
- Multivariate regression models were run using historical and cross-sectoral data (climate and crop production) combined for the major crop production areas/districts at the rate of about 9-10 districts per farm product
- Partial market model used for estimation on the supply and demand functions
- Financial analysis [benefit-cost ratio (BCR), internal rate of return (IRR), net present value (NPV) and payback period] s carried out for a project period of 15 years

Assessment of CC impacts in VCs - Through surveys



Survey area



Apple

	Input	Production	Collect/Grading/Packaging	Wholesale	Retail
Suitable condition	- 20-25°C - 46-63 days chilling below 7°C during winter to break dormitory		2-10°C	2-10°C	2-10°C
CC impact	<ol style="list-style-type: none"> 1. Drought effects on apple nurseries during winter and fungus infection during rainy season due to high and erratic rainfall. 2. Orchard and plants drying due to low rainfall, decrease snowfall 3. Aphid and Milly's bug insects heavy damage the apple plants due to low rainfall 4. Increase soil acidity due to high-temperature ad CC impact and decrease yield and production. 		<ol style="list-style-type: none"> 1. Transportation roadblocks at the time of marketing due to flood and landslide by heavy rainfall. 2. Quality loss and storage damage in storage due to high humidity and temperature (5-10% weight lost within 1 month). 		

Impact

- Yield loss up to 22% due to climate change
- Profit loss due to CC up to 50.5%
- Overall BCR would fall from 1.59 to 1.40 due to CC

Measure

- NPR 350,000 per ha as compensating finance required for these CC adaptation technologies for high density plantation (like Fuji), pest, irrigation and orchard management.
- New variety development
- water conservation, rain harvesting, snow-harvesting, ground water recharge, and piped irrigation
- Cold chain

Banana

	Input	Production	Collect/Grading/Packaging	Wholesale	Retail
Suitable condition	<ul style="list-style-type: none"> - 26-30°C - 2,000mm or higher for production 		14-20°C		<ul style="list-style-type: none"> - 13-16°C (ripen), 16-20°C (green)
CC impact	<ol style="list-style-type: none"> 1. Bananas fruit scraping—if day and night temperature vary by more than 15 degrees in winter. 2. Beetle and banana weevils' cause damage the Banana plants due to low rainfall. 3. Soil acidity due to high temperature 4. Plant leaves drying due to low temperature and cold wave 5. Hailstones during late winter and early summer damage orchard and low yield (flowers and leaves damage). 		<ol style="list-style-type: none"> 1. Transportation roadblocks due to flood and landslide by heavy rainfall. 		

Impact

- Yield loss up to 16% due to climate change
- Profit loss due to CC up to 20.5%
- Overall BCR would fall from 2.45 to 1.92 due to CC

Measure

- NPR 200,000 per hectare required for tissue culture saplings plantation, irrigation, pest and soil management
- promote plant-genetic diversity of banana seeds to resist cold injuries, winds and storms
- New variety development such as fragrant and golden yellow bananas
- Tenure arrangement for a period of 10 years for commercialization
- Govt support for access to electricity, irrigation
- Attention to landslide and floods blocking roads 2-4 times a month
- Attention to agro tourism and Banana processing (i.e. alcoholic beverages)

Large Cardamom

	Input	Production	Collect/Grading/Packaging	Wholesale	Retail
Suitable condition	<ul style="list-style-type: none"> - 10-20°C - 2,000-3,500mm - Moisture content critical in minimizing postharvest losses 		Moisture content 10-12%	Moisture content 10-12%	
CC impact	<ol style="list-style-type: none"> 1. fungus infection during rainy season 2. Caterpillar larva and aphid insects heavily damage by low rainfall. 3. Increased soil acidity due to high temperature 4. Orchard and plants drying due to low rainfall and decreased snowfall and high temperature in winter and summer 5. White colouring of capsules/seeds due to no/low rainfall in early winter 6. Hailstones during late winter and early summer damage orchard resulting in low yield (damage caused to flowers and leaves). 		<ol style="list-style-type: none"> 1. If rainfall continues during the harvesting period, the cardamom gets damaged resulting in low-quality produce. 2. Transportation roadblocks due to flood and landslide 3. Weight loss in storage due to high humidity and temperature (5–10% weight loss within three months) 4. Fungus attraction in large cardamom capsules and discolouring due to high humidity in storage. 		



Impact

- Yield loss up to 25% due to climate change
- Profit loss due to CC up to 35%
- Overall BCR would fall from 1.61 to 1.40 due to CC

Measure

- NPR 300,000 per hectare required for irrigation, pest and soil management
- Develop plant-genetic diversity and types of shade trees, and nursery business
- Research location-specific and wider adaptable varieties and gene bank for documentation
- Product diversification such as elaichi tea, powder, essential oils, candy, etc. Attention to agro tourism and Banana processing (i.e. alcoholic beverages)

Timur

	Input	Production	Collect/Grading/Packaging	Wholesale	Retail
Suitable condition	<ul style="list-style-type: none"> - 10-20°C - 2,000-3,500mm - Moisture content critical in minimizing postharvest losses 		Moisture content 10-12%	Moisture content 10-12%	
CC impact	<ol style="list-style-type: none"> 1. fungus infection during rainy season 2. Caterpillar larva and aphid insects heavily damage by low rainfall. 3. Increased soil acidity due to high temperature 4. Orchard and plants drying due to low rainfall and decreased snowfall and high temperature in winter and summer 5. White colouring of capsules/seeds due to no/low rainfall in early winter 6. Hailstones during late winter and early summer damage orchard resulting in low yield (damage caused to flowers and leaves). 		<ol style="list-style-type: none"> 1. If rainfall continues during the harvesting period, the cardamom gets damaged resulting in low-quality produce. 2. Transportation roadblocks due to flood and landslide 3. Weight loss in storage due to high humidity and temperature (5–10% weight loss within three months) 4. Fungus attraction in large cardamom capsules and discolouring due to high humidity in storage. 		

Impact

- Yield loss up to 13% due to climate change
- Profit loss due to CC up to 9%
- Overall BCR would fall from 1.88 to 1.75 due to CC

Measure

- NPR 100,000 per hectare required for saplings plantation, pest and irrigation management
- Facilitate Community Forestry User Groups for rapid multiplication of timur seeds, nursery or saplings
- Dig water ponds for rain harvesting
- Land development such as land slope terracing, landslide stabilisations, gully and river bank protection and prevent wild fire
- Enhanced cleaning and packaging for commodity quality, considering 90% of timur grains exported to India

Avocado

	Input	Production	Collect/Grading/Packaging	Wholesale	Retail
Suitable condition	<ul style="list-style-type: none"> - 10-20°C - 2,000-3,500mm - Moisture content critical in minimizing postharvest losses 		Moisture content 10-12%		Moisture content 10-12%
CC impact	<ol style="list-style-type: none"> 1. Early blooming/flowering due to high temperature and erratic rainfall 2. Fungus damage and white colouring due to high/erratic rainfall 3. Orchard and leaves drying due to low rainfall 4. No fruiting/low fruiting due to the mismatch between male and female flowers pollinating in the same tree due to high temperature, drought and cross-pollination behaviour 		<ol style="list-style-type: none"> 1. Weight loss in storage due to high humidity and temperature (2–5% weight loss within a month). 		



Impact

- **Profit loss due to CC up to 13.4%**
- **Overall BCR would fall from 2.37 to 2.15 due to CC**

Measure

- NPR 200,000 per hectare required for grafted sapling plantation and irrigation
- Reduce knowledge gap on flowering, pollination and fruiting
- Appropriate postharvest measures and increased investment in avocado processing
- Commodity promotion for increased consumption

Climate Change Impacts on Consumption, Production and Trade

Year	Consumption (Metric Ton)	Production (Metric Ton)		Net Trade(Metric Ton)	
		Without CC	With CC	Without CC	With CC
Apples					
2020	121,543	34,691	33,755	-86,852	-87,788
2030	217,665	42,288	32,031	-175,377	-185,634
Banana					
2020	355,666	276,893	282,236	-53,508	-78,773
2030	699,649	268,631	321,467	-378,182	-431,018
Timur					
2020		901	816	580	525
2030		1,098	902	707	580

Note- Consumption data of Large Cardamom and Avocado not available

Adaptation options

Weather Smart



- ❖ Weather forecasts
- ❖ ICT-based agro-advisories
- ❖ Index-based insurance
- ❖ Climate analogues

Water Smart



- ❖ Aquifer recharge
- ❖ Rainwater harvesting
- ❖ Community management of water
- ❖ Laser-levelling
- ❖ On-farm water management

Carbon Smart



- ❖ Agroforestry
- ❖ Conservation tillage
- ❖ Land-use systems
- ❖ Livestock management

Nitrogen Smart



- ❖ Site-specific nutrient management
- ❖ Precision fertilizers use
- ❖ Catch-cropping and legumes integration

Energy Smart



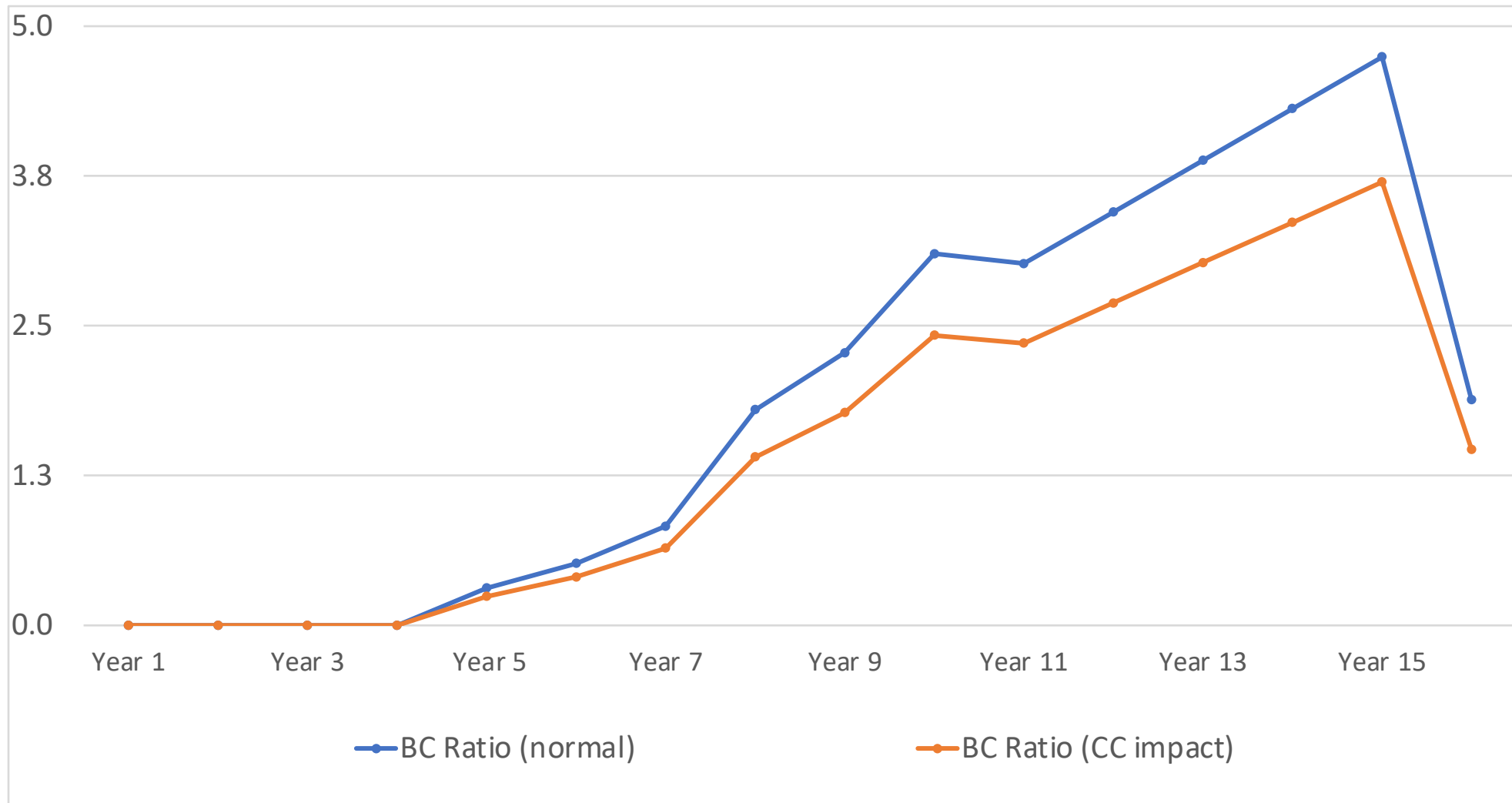
- ❖ Biofuels
- ❖ Fuel-efficient engines
- ❖ Residue management
- ❖ Minimum tillage

Knowledge Smart



- ❖ Farmer-to-farmer learning
- ❖ Community seed and fodder banks
- ❖ Market information
- ❖ Off-farm risk management
- ❖ Local institutions

Sensitivity test (BC Ratio for Apple)



Conclusion

- Average Benefit Cost Ratio (BCR) of five VCs would fall from 1.92 to 1.72 due to climate change
- The compensating finance required for 5 VCs for technology and inputs to offset the adverse effects of CC is US\$ 2,000 per hectare on average.
- Temperature, precipitation, humidity are factors contributing outputs along the value chains
- Adaption option include climate resilient varieties; input management; postharvest loss minimization through transport management and maintaining temperature/moisture condition agro-processing
- Fruit plantation and value-chain development program provide other benefits such as building resilience to risks and emission reduction.

Thank you