

Designing DSS for Mountain Agro-ecosystems under Climate Change

Mountain farmers' as climate change observers and mitigation strategists : A case study

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Study objectives

1. Are mountain farmers aware of climate change ?
2. In what ways climate change is making an impact on their farming based livelihoods ?
3. Are the mountain farmers adapting to the climate change impact intelligently, making their economy and livelihoods even better
4. Can farmers innovations add value to DSS for mountain agro ecosystems ?

Study Area and Methodology

FRUIT AND VEGETABLE FARMERS OF KULLU VALLEY IN HIMACHAL PRADESH

- Two locations, South end and North end of the valley
100km apart,
- South end of the valley, 1100-1300m,
vegetable farmers of Hurla & Tharas villages
- North end of the valley, 2500-3000m,
Apple farmers of Burua, Vashishat, and Kothi villages

Methodology

It is a field survey based study with designed individual farmers questionnaires, group discussions, to document;

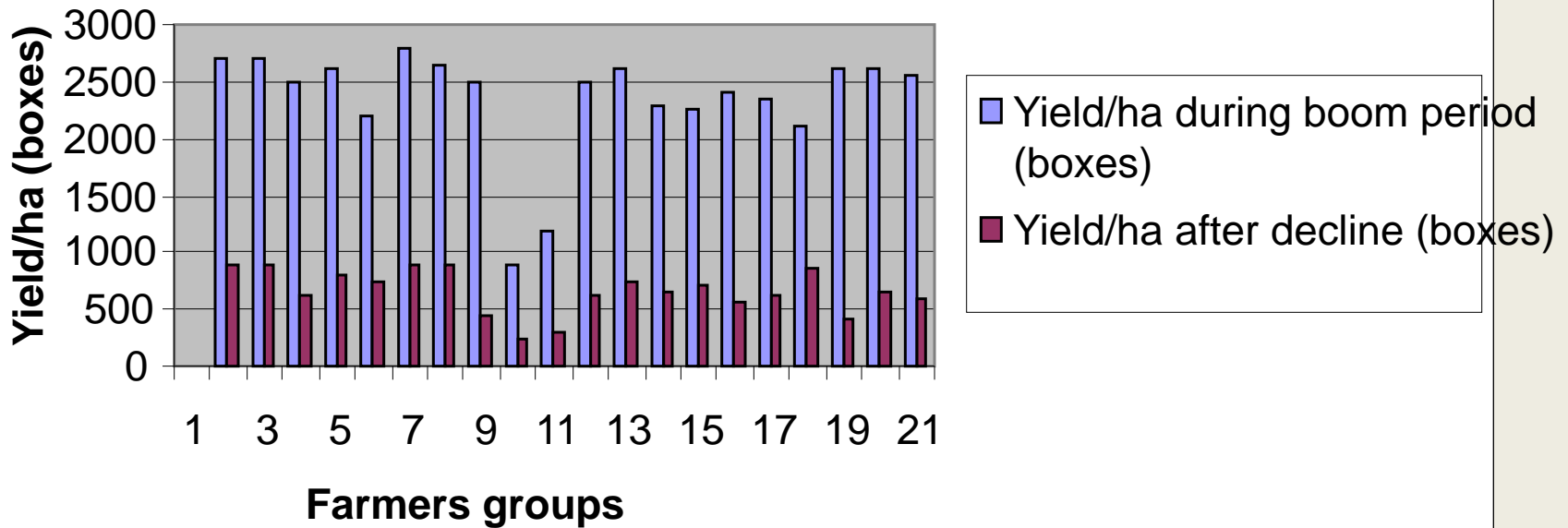
- i. the impact of climate change on mountain farmers livelihoods and economy
- ii. the mountain farmers innovative ways to adapt to climate change impact

STUDY FINDINGS

- Apples planted during 1955-1970
- Apples removed during 1980- 1995-2000
- Phase out period was 5-10 yrs
 - (production started declining in early 1980s)
- Gradual decline in the quality and productivity of the apples
- 60% reduction in fruit production observed compared to boom period
- Farmers income from apples declined to levels where costs equalled returns and even surpassed

THE YIELD FALL-APPLES

**Figure 1: A bar graph to show the contrast between the apple yield during the boom and decline period
(1 box = 10kg)**



Farmers observations about climate change impact on apple farming

Parameter	% of response
• Farmers observations of climate change (increase in temperature, low and erratic rainfall, occurrence of bad weather conditions such as frost, hailstorm and sudden low temperatures during apple flowering and fruit set period)	100
• Impact on fruit quality (size, weight, colour etc.) Small size, low weight, poor or no colour development	100
• Initial indicators of climate change impact on apples a..First decline in apple yield followed by poor fruit quality	60
b.. First decline in quality followed by yield decline	40

Apple Crop Disappearance from Lower Kullu Valley

Reasons

- Shorter and warmer winter season, 20yrs-1C rise in temp ,observatory records
- Winter snow and rainfall declined causing failure of chilling requirement , ca. 90 days
- Increasing temperature – declining fruit color
- Precipitation became irregular, hailstorms frequency increased
- It all happened during 1980 --- 2000

Apple Crop Disappearance from Lower Kullu Valley by 2000

Impact on crop

- Less color reduced value
- Fruit shape, size and weight not A grade
- Hailstorm damage- reduced value
- Less production- less income

Impact of climate change on apple marketing and income

(%, farmers' responses)

Parameter	% of responses
• Poor or no marketing; low price due to poor fruit quality and low production	100
• Rate of profit decline per year	
10-20%	45
20-25%	40
35-40%	15

Indicators of climate change impact on apple crop and orchard management practices (% farmers' responses)

<u>Parameter</u>	<u>% of response</u>
• Attack of pests and diseases;	
• Apple Scab disease incidence	100
• Other diseases (scale, root rot, canker, drying trees etc.)	80
• Use of a pesticide increased (sprays)	100
• Increase in the use of many types of pesticides	100
• Increased use of chemical fertilisers	100
• Increased cost of production and lower profits	100

Effects of excessive use of fertilisers and pesticides on the apples (% farmers' responses)

Fertilisers

Pesticides

Positive effects

Maintained crop yield and quality

Diseases controlled

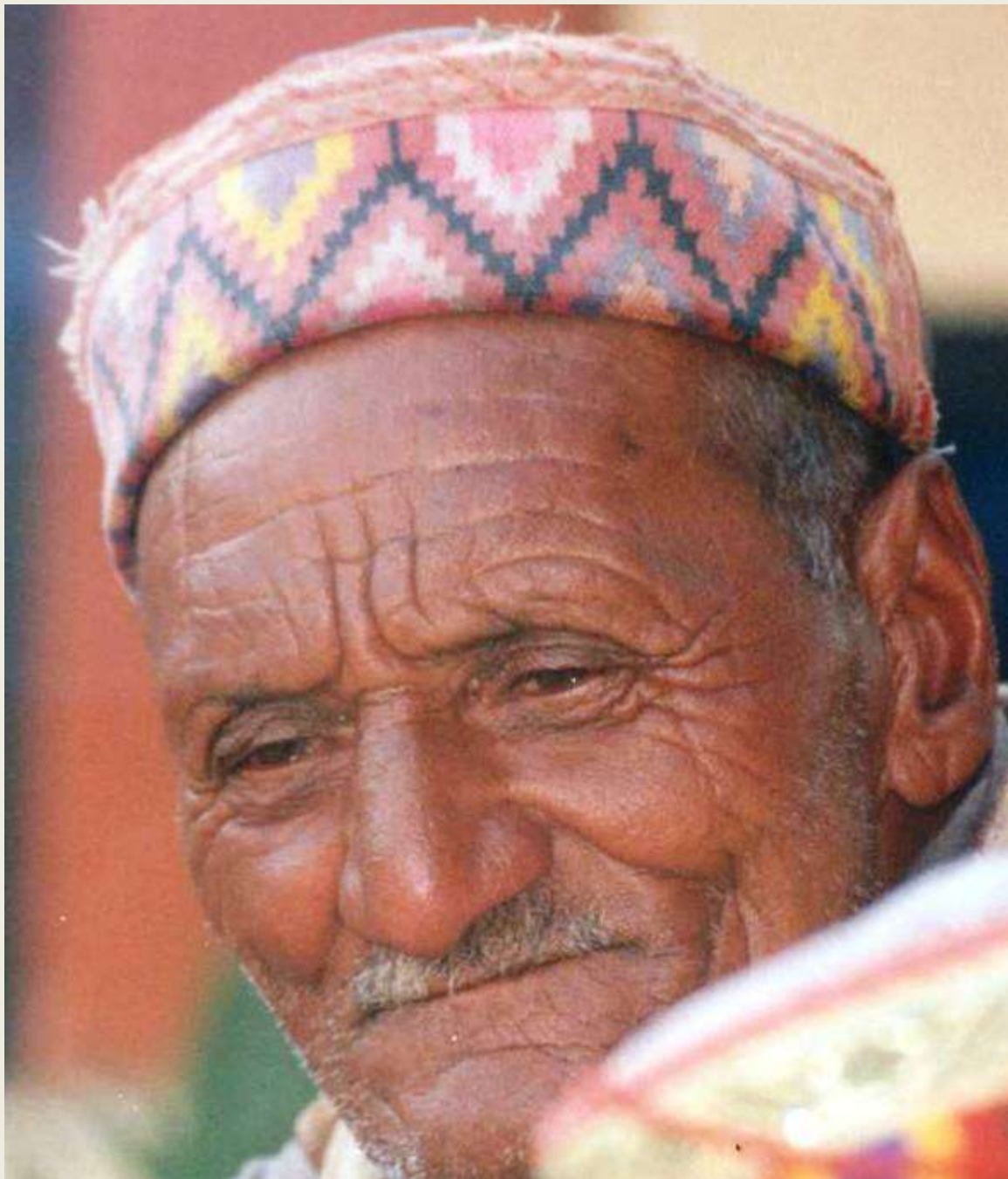
Negative effects

Long term soil quality and fertility
Soil deteriorated-hardened and
soil micro flora and fauna declined

Resistance of pests increased
Beneficial insect (pollinators
and natural pest enemies)
killed
Negative impact on soil (micro
fauna) and health
Pollination affected; pest
population increased ,
bad for human health

Farmers Replacing fruit orchards with vegetable farming :
A tomato crop in a degenerating plum orchard, Hurla village
Previously plums replaced an apple orchard





The
Respondent
farmer
who lost
his
apple orchard
to climate
change

Land use after the phasing out of apples

(% of farmers' responses)

- Crops replacing apples farmers
- a. Vegetables /wheat/maize 20%
- b. Fruits/veg/food grains 35%
- c. Veg and fruits 25%
- d. Fruits only 20%

For, 91% farmers options > a. - d. contribute 60 % of their farm income

New crops more beneficial than apples 40%

New crops less beneficial than apples 45%

New crops and apples, income same 15%

Time taken to change crops 2-3yrs (35%) and 4-5 yrs (65%)

Change affected ; process oriented by 40% and abrupt by 60%

Analysis of findings of South end of the Valley

- Apple farming failure was a result of climate change
- Apples were first replaced by other fruit crops like plums, then after 15-20 yrs plums being replaced by vegetables and food grains
- New cropping patterns are giving equal or better income for 50% farmers, others are still losers
- Climate change induced crop replacement was a painful experience for most of the farmers

The process of change in the apple economy in the South end of Kullu Valley

- **1950-0r 60s Apples planted in the valley**
- **70-80s apple production reaches highest, excellent marketing scopes; apple became major contributor to apple economy**
- **Mid 80s Climate change in the valley becomes prominent – longer summers, warmer winters with less snowfall; pests and new diseases start appearing due to increasingly hospitable climate and production starts decreasing**
- **Farmers start using pesticides and fertilisers to maintain production**
- **Production maintained but chemicals have adverse effects on soil and pollinators; increased costs of production**
- **Pests become resistant to pesticides so farmers use stronger pesticides**
- **This affects the quality and yield of the fruit**
- **Pesticides kill pollinators, leading to pollination problems- decrease in pollination and fruit set, giving low yield**
- **Cost of production continues to increase whereas yield, quality and the market value of the crop decreases**
- **Furthermore, the scab attack causes havoc in the valley, destroying crops**
- **Trees start drying up and thus, apple farming is no longer profitable or viable**
- **Major loss leaves farmers rebuilding their household economy which takes 4-5 years**
- **Land is used for other purposes- e.g. vegetable crops or alternate fruit crops**

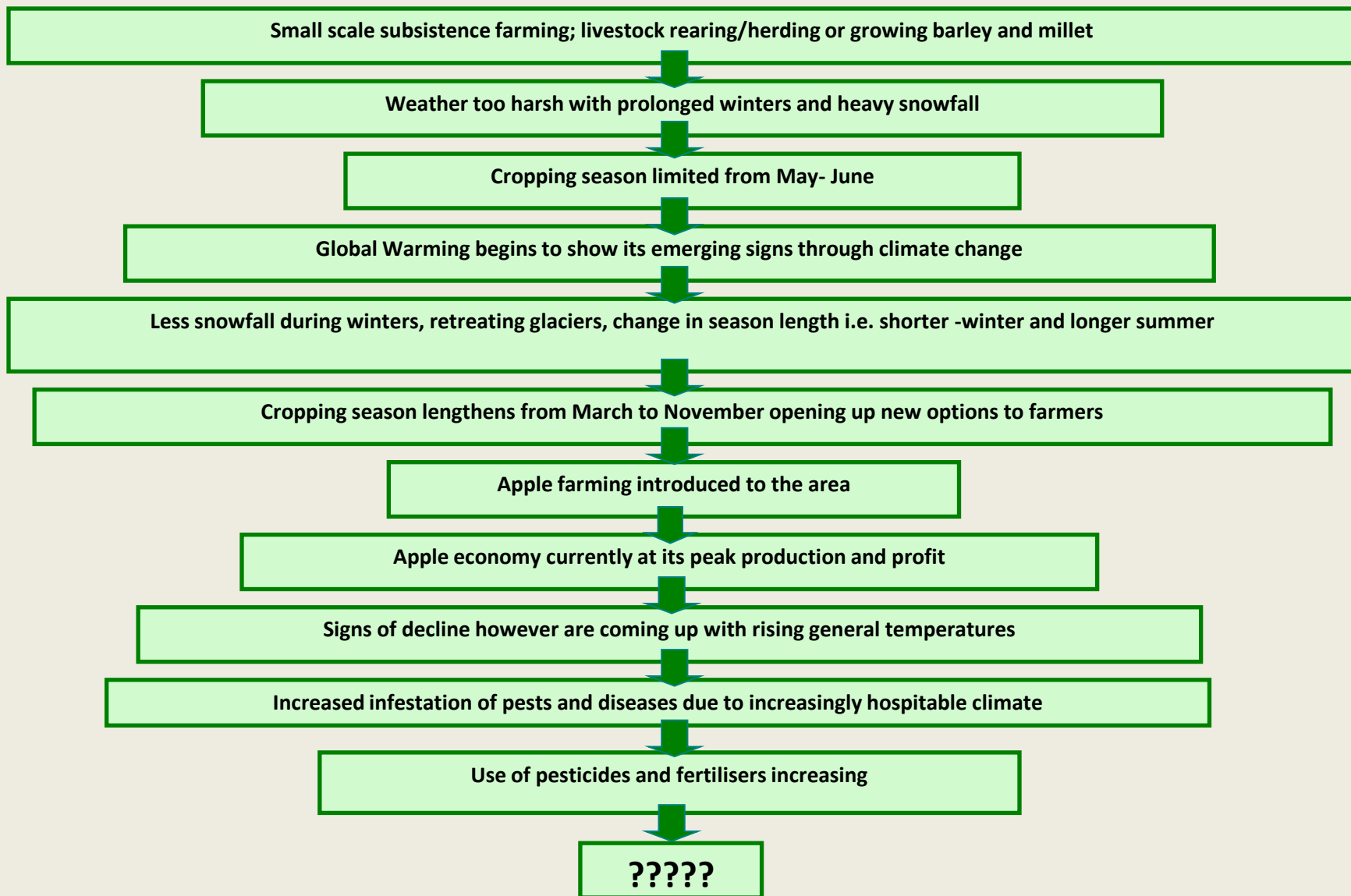
North end of the Kullu Valley- shift to apples

- **Major apple plantations - during and after 1980s**
- **Household income improved - 50 times, (Rs 2000 to 100,000/yr)**
and some households income crossed Rs one million/yr
- **For 90% farmers contribution of apples to household income 80% -- 100%**
- **Farmers still expanding apple orchards 80%**
- **Other crops grown for consumption :** rice,pulses,veg, oilseeds
- **Indicators of Improved living standards :**
“ better housing with piped water, bath rooms, phones, family vehicles, better clothing, increased expenses on education , health, and electricity for light, heating, cooking”

Why farmers shifted to apples

- **Farmers said apples were not planted earlier due to cold climate**
- **Climate suitability and awareness and Govt support services were factors, helping expansion of apple farming**
- **Type of farming replaced by the apple orchards ;**
 - a. Subsistent crop-livestock farming* 10%**
 - b. Semi-nomadic pastoral farming* 60%**
 - c. Partly both of the above* 30%**
- **Some farmers replaced their crops; barley, maize, millet, wheat by apples and others, abandoned their nomadic shepherds lives (goats and sheep replaced).**

A flow chart showing the process of change in the agricultural economy of farmers living at North end of the Valley



General observations of mountain farmers on climate change

- Climate change felt in jerks
- Increasing incidences of extreme weather conditions; cloud bursts, flash foods, prolonged droughts
- Increasing rainfall in trans Himalayan cold arid agro ecological zone
- Increasing rate of rainfall in winters

General observations on Climate change and mt agriculture-3

- Growing seasons becoming longer in high mountain zone and therefore
- Expanding farming into higher altitudes
- Greening of pasture lands in cold arid region of the Himalayas

Mountain farmers fears about climate change

Water scarcity is becoming a major concern

- *Drinking water for humans, quality and quantity*
- *Water for household use, washing clothes and bathrooms*
- *Drinking water for livestock*
- *Water for irrigation of crops; vegetables farming, fruit crops, others*
- These aspects are already determining quality of life and locations for human settlements

Conclusions -1

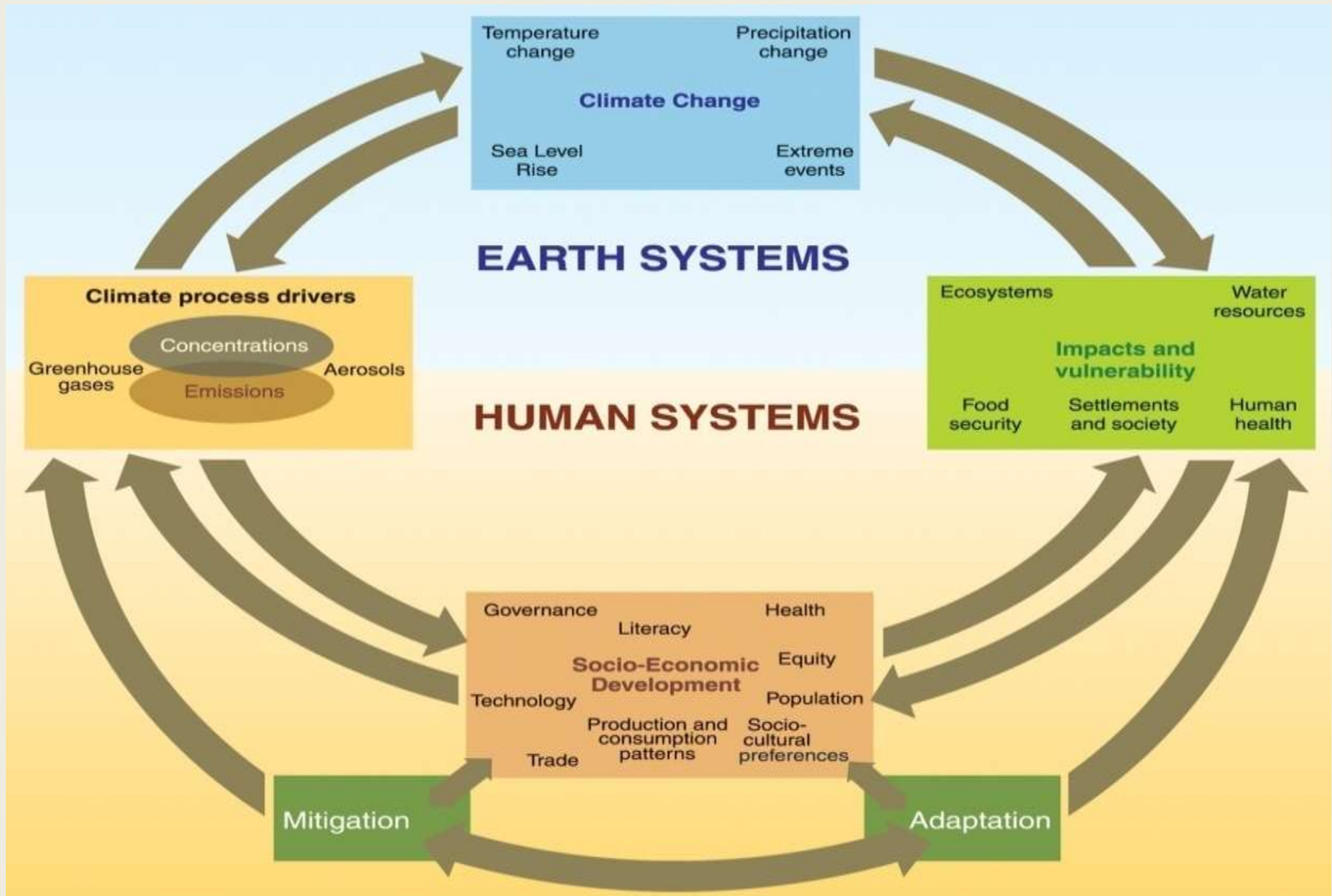
1. Farmers noticing climate change indicators and are aware of the climate change process
2. Climate change is already forcing replacement of cropping patterns and crops in the mountain areas
3. Farmers looking for new opportunities and trying new innovations w.r.t. to crops and cropping patterns
4. Farmers success in replacing crops depends on level of access to institutional support services and marketing opportunities for their new produce.
5. Crop replacements could be more remunerative, equal or less remunerative

Mountain Agro ecosystems and DSS

- Spatial information basic to designing DSS
- Non spatial information contains valuable human knowledge and information for managing agro ecosystems
- Conventional DEVELOPMENT PLANNING dependent on socioeconomic information (non spatial data)
- Integration of spatial and non spatial data in DSS, will enhance practical use value of DSS to policy making and development planning

Climate change based agro-ecosystem changes

(common to mountain agro ecosystems)



Thank you