

# Climate Smart Agriculture in the context of smallholder farmers in Himalayas



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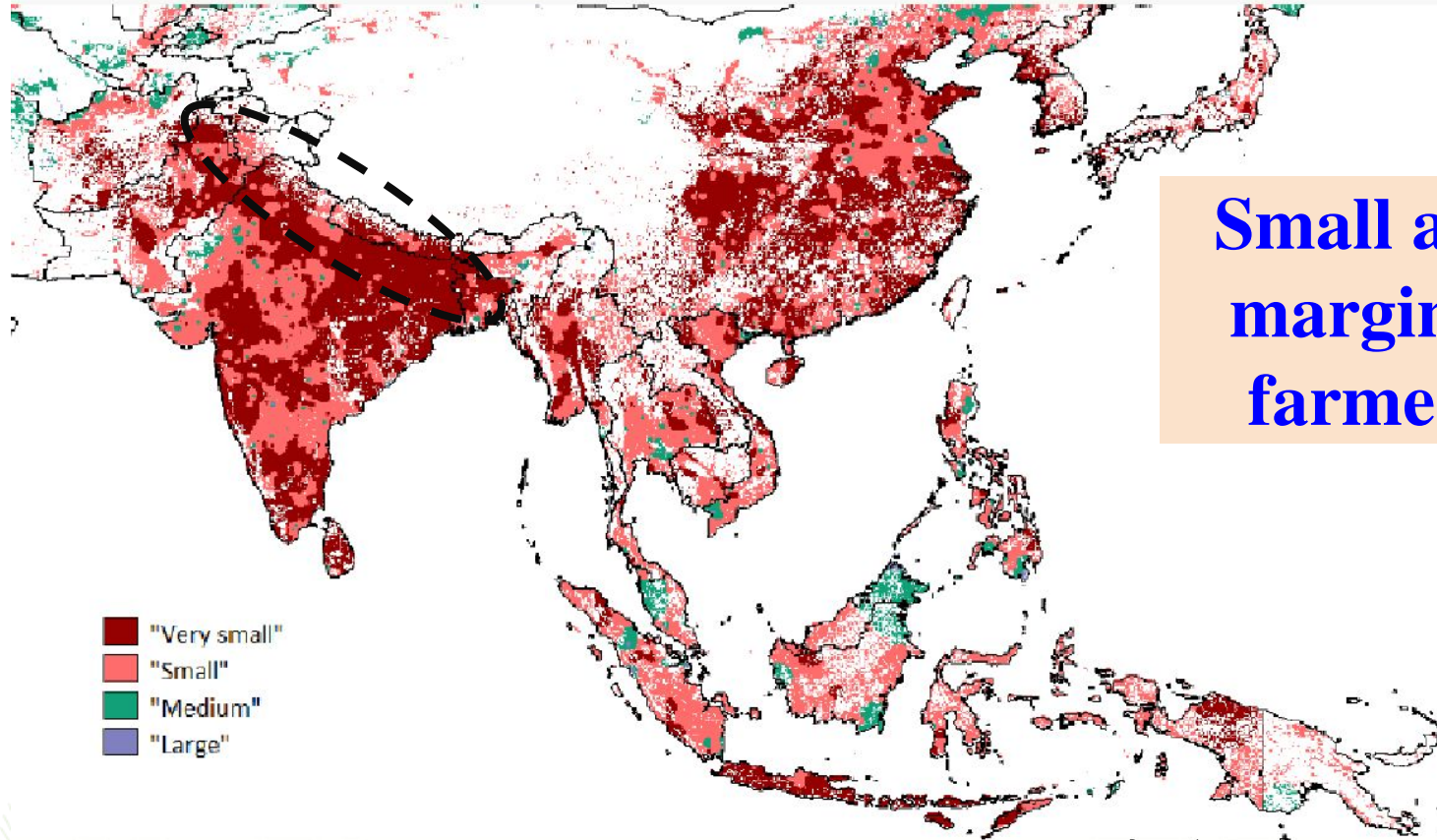
# Systems change: Plot sizes in Asia

Very small < 0.5 ha

small 0.5-2 ha

medium 2-100 ha

large > 100 ha



**Small and marginal farmers**

- "Very small"
- "Small"
- "Medium"
- "Large"



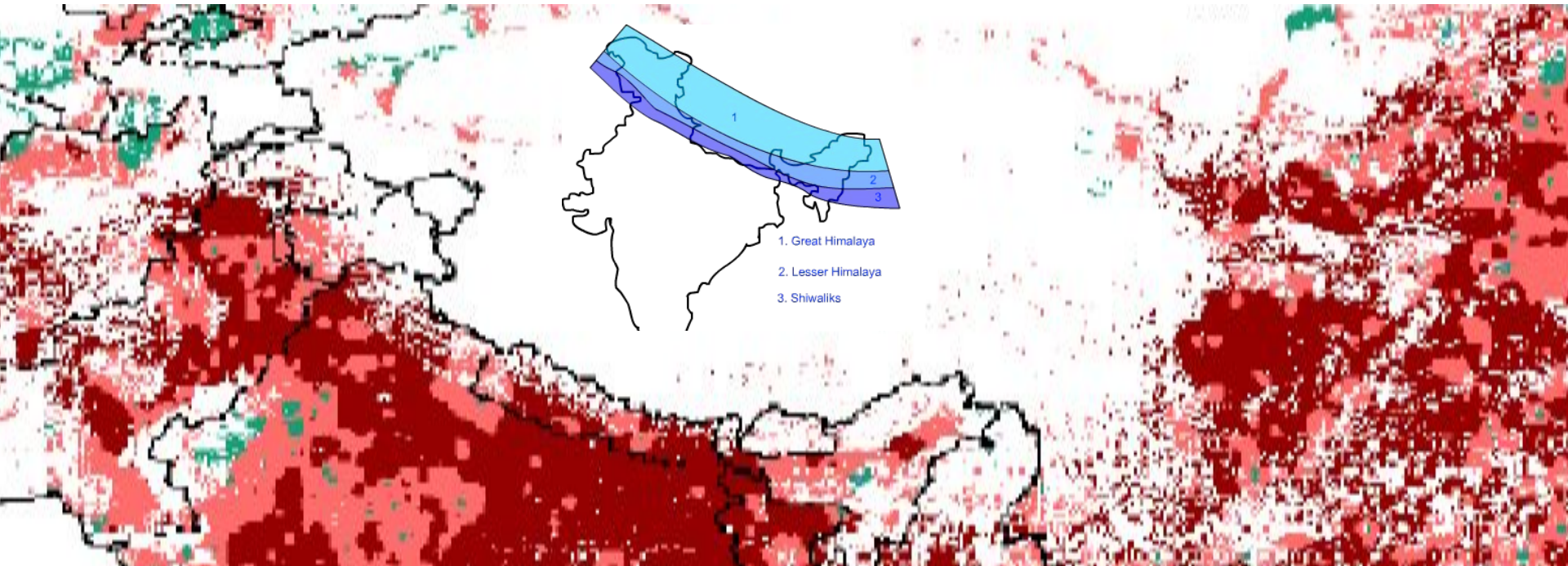
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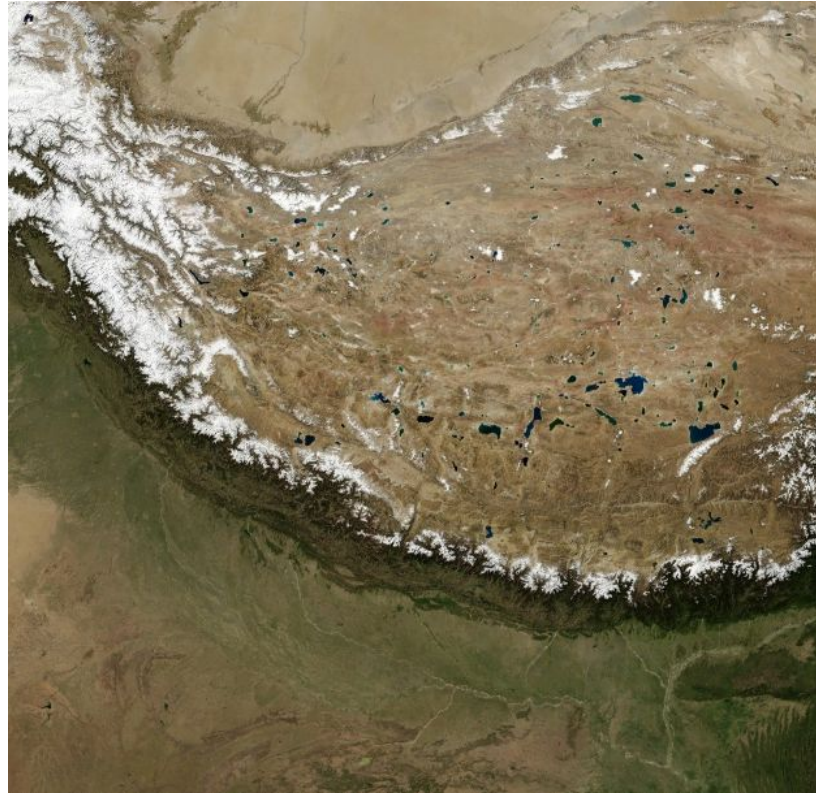
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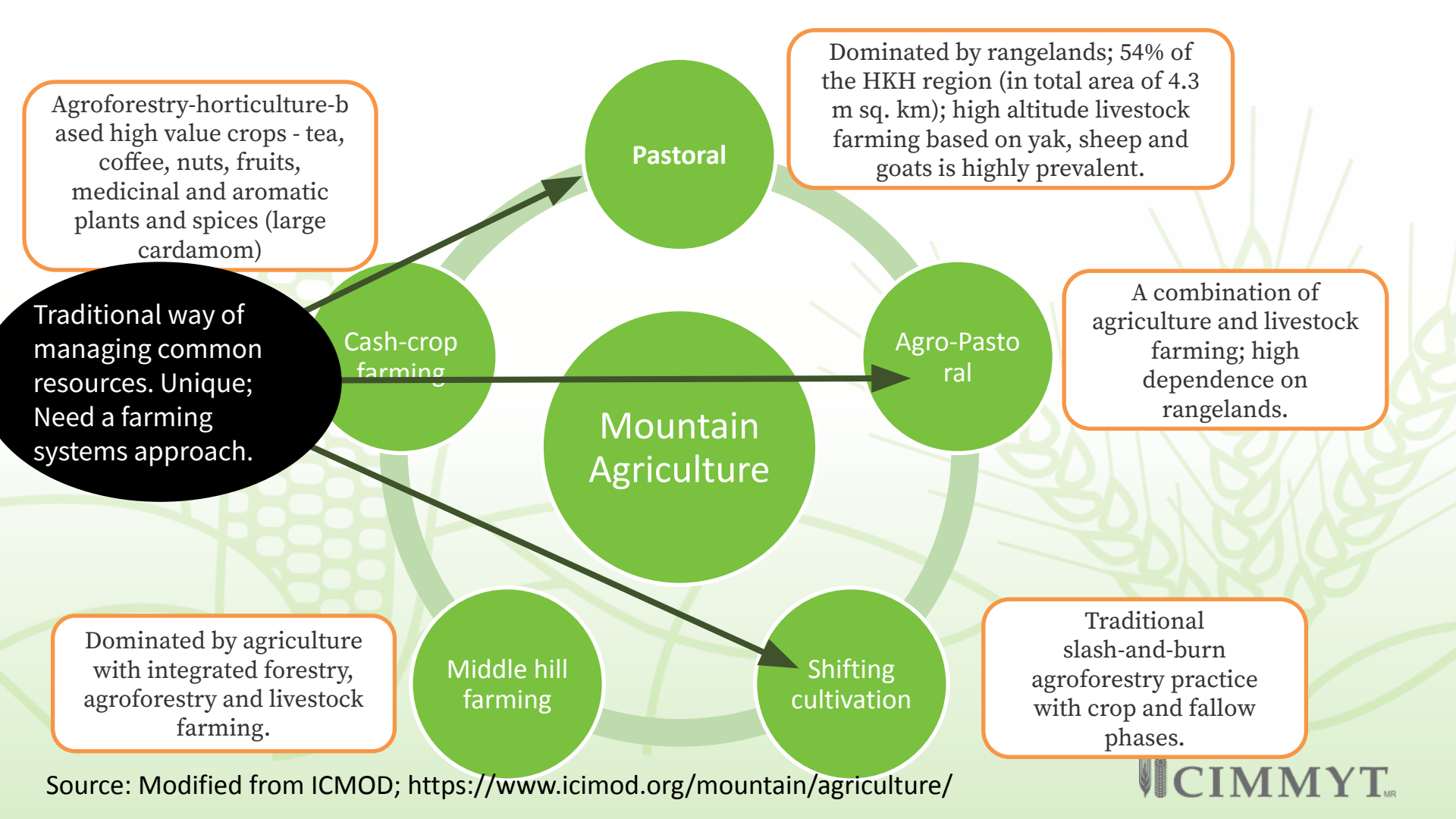


Small holders map: Fritz et al., 2015; Himalayan map: Source: <https://www.excellup.com>

# Himalayas as pictured by NASA Landsat 7 Satellite.



Source: [https://en.wikipedia.org/wiki/Himalayas#/media/File:Himalayas\\_landsat\\_7.png](https://en.wikipedia.org/wiki/Himalayas#/media/File:Himalayas_landsat_7.png)



Source: Modified from ICMOD; <https://www.icimod.org/mountain/agriculture/>

# Mountain agriculture is different?

Largely family farming; for centuries has contributed to sustainable development.

Low carbon footprint, mostly organic, evolved in an often harsh and difficult environment.

Trends in global development have significantly reduced the resilience of mountain ecosystems.

Small-scale, diversified with integration of forests and husbandry activities.

Too many challenges; Climate Change; Soico-economic dynamic is also changing.

Multidisciplinary and holistic approaches needed to improve livelihoods.





**Forest**



**Agriculture**



**Animal husbandry**



**Domestic system**

**Livestock-the-  
engine-and-insp  
iration-of-mou  
ntain-economy**

Source: <https://www.google.com/url?sa=i&url=https%3A%2F%2Fleisaindia.org%2>

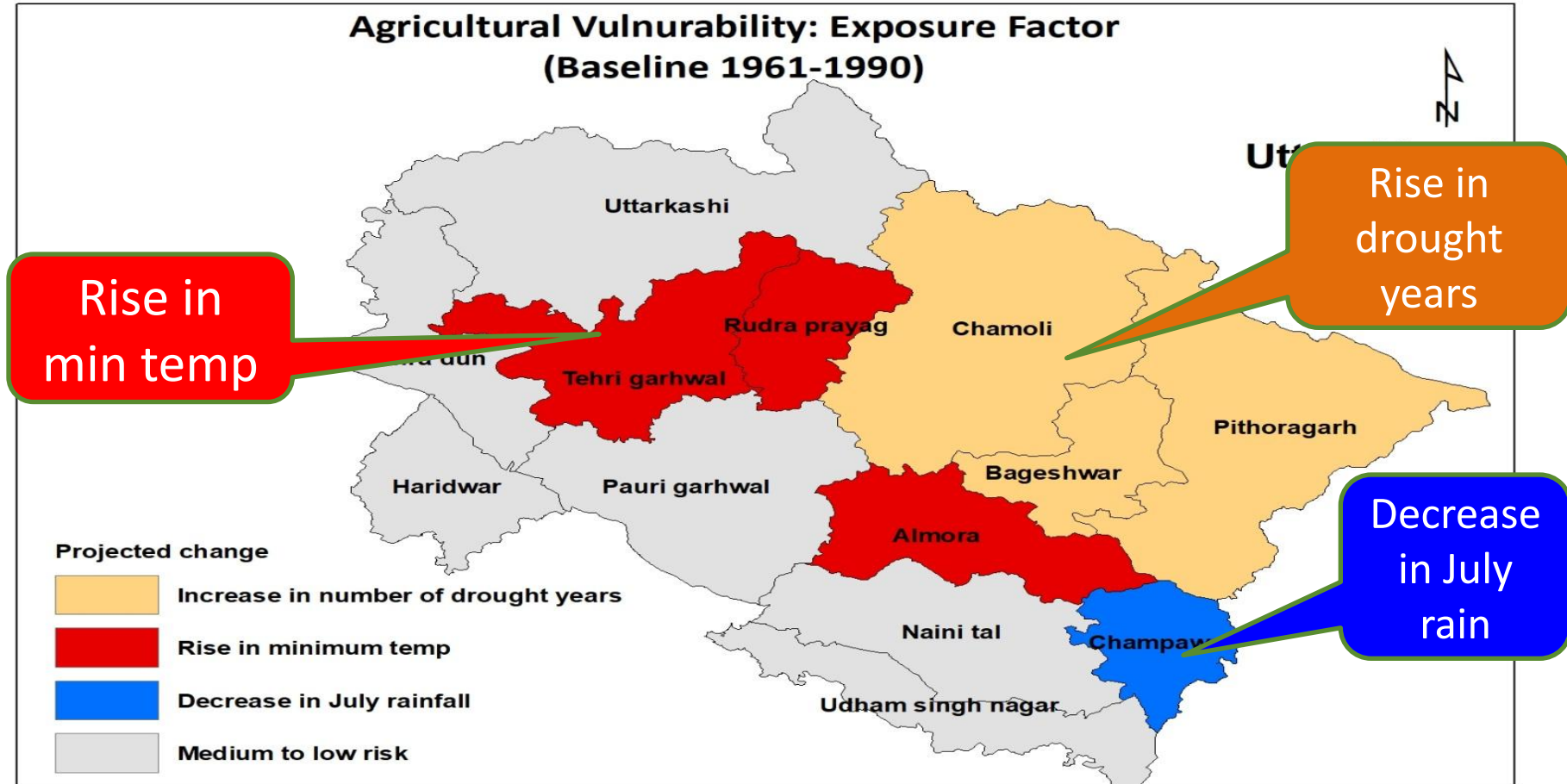


# **An example of the state of Uttarakhand**



# Agriculture vulnerability

## Agricultural Vulnerability: Exposure Factor (Baseline 1961-1990)



# Uttarakhand

Barren



About 86% of the state is hilly, but >80% of the crop land is in Terai

Crop lands;  
all crops

Crop lands;  
all crops

## Landuse/Landcover 2012 (MODIS)

- Evergreen forest (N)
- Evergreen forest (B)
- Deciduous forest (N)
- Deciduous forest (B)
- Mixed forest
- Closed shrublands
- Open shrublands

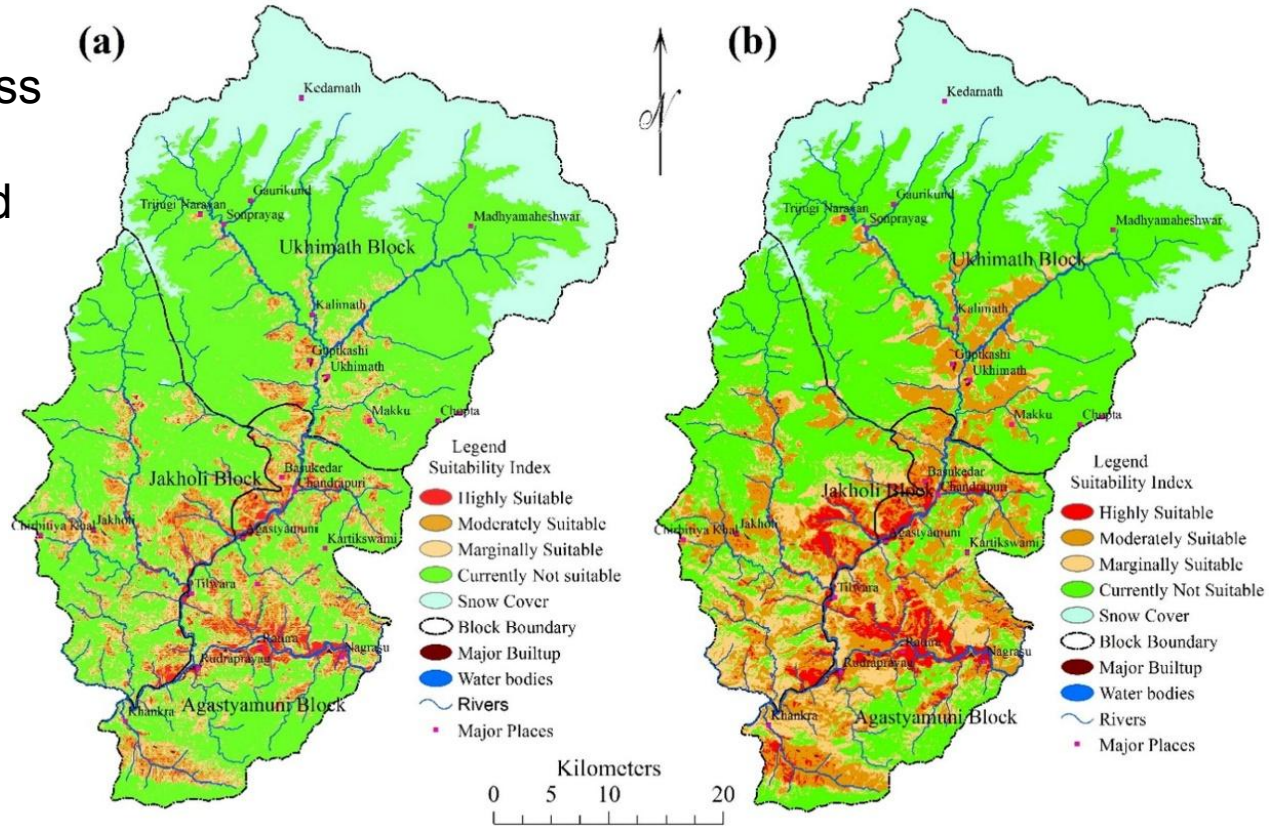
- Woody savannas
- Savannas
- Grasslands
- Water/Wetlands
- Croplands
- Urban and built-up
- Cropland/Natural vegetation mixed
- Snow and ice
- Barren or sparsely vegetated



**Land suitability classes**  
for agriculture based on  
analytical hierarchy process  
- AHP (a), frequency ratio  
(b) derived using weighted  
overlay analysis in Rudra  
Prayag district of  
Uttarakhand.

Integrated with remote  
sensing (RS) and  
geographic information  
system (GIS)

Atul Kumar et al., 2021  
J Saudi Society of Agric Sci



# Issues and challenges

**The world has  
been changing;  
so is agriculture.**

**Continuing out-migration  
from mountain areas has  
further reinforced a  
'plains bias' in  
development strategies**

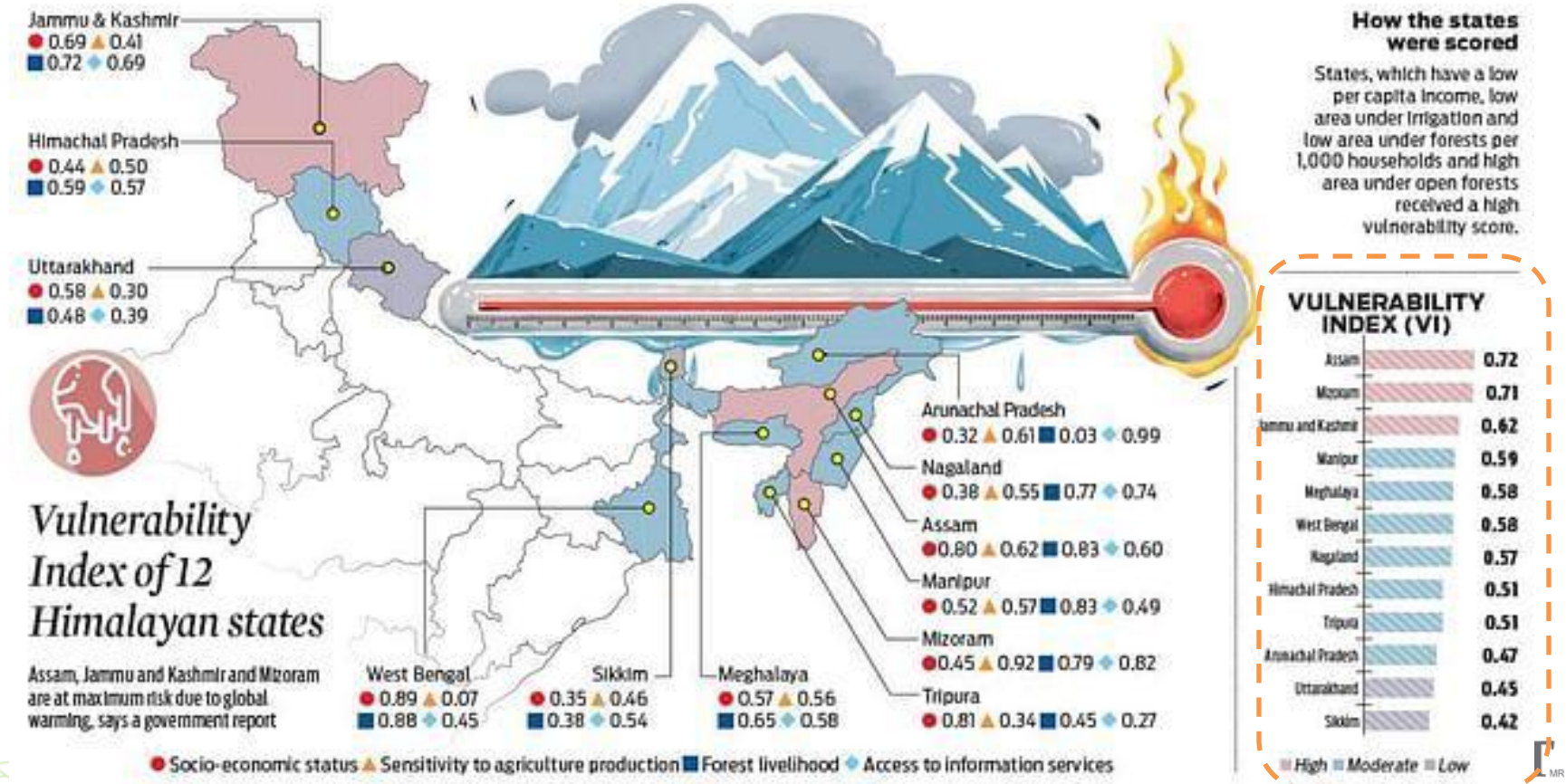
**(<https://www.mountaininitiative.in>).**

Source:  
<https://news.mongabay.com/2020/06/divesting-from-deforestation-theres-now-an-investors-guide-for-that/>

MONGABAY.COM



# Assam, Mizoram, Jammu and Kashmir and other Himalayan states stare at climate risk



Jammu & Kashmir  
 ● 0.69 ▲ 0.41  
 ■ 0.72 ◆ 0.69

Himachal Pradesh  
 ● 0.44 ▲ 0.50  
 ■ 0.59 ◆ 0.57

Uttarakhand  
 ● 0.58 ▲ 0.30  
 ■ 0.48 ◆ 0.39



**Vulnerability Index of 12 Himalayan states**

Assam, Jammu and Kashmir and Mizoram are at maximum risk due to global warming, says a government report

West Bengal  
 ● 0.89 ▲ 0.07  
 ■ 0.88 ◆ 0.45

Sikkim  
 ● 0.35 ▲ 0.46  
 ■ 0.38 ◆ 0.54

Meghalaya  
 ● 0.57 ▲ 0.56  
 ■ 0.65 ◆ 0.58

Arunachal Pradesh  
 ● 0.32 ▲ 0.61 ■ 0.03 ◆ 0.99

Nagaland  
 ● 0.38 ▲ 0.55 ■ 0.77 ◆ 0.74

Assam  
 ● 0.80 ▲ 0.62 ■ 0.83 ◆ 0.60

Manipur  
 ● 0.52 ▲ 0.57 ■ 0.83 ◆ 0.49

Mizoram  
 ● 0.45 ▲ 0.92 ■ 0.79 ◆ 0.82

Tripura  
 ● 0.81 ▲ 0.34 ■ 0.45 ◆ 0.27



# **Solutions and approaches**

# What is 'Climate-Smart Agriculture' (CSA)?

**SUSTAINABLY  
INCREASE  
AGRICULTURAL  
PRODUCTIVITY  
& INCOMES**

1

**ADAPT  
& BUILD  
RESILIENCE TO  
CLIMATE  
CHANGE**

2

Practices



Programs

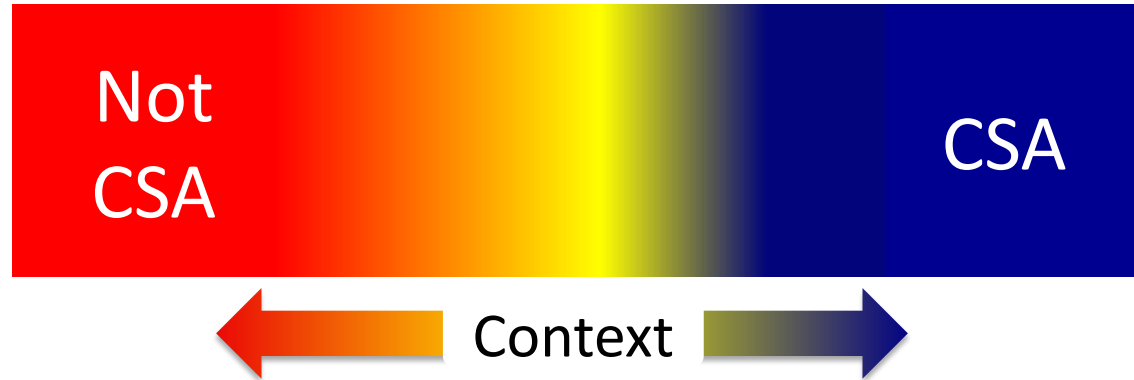


**In this definition, the principal goal of CSA is identified as food security and development (FAO 2013)**





# CSA is important but No blanket recommendations

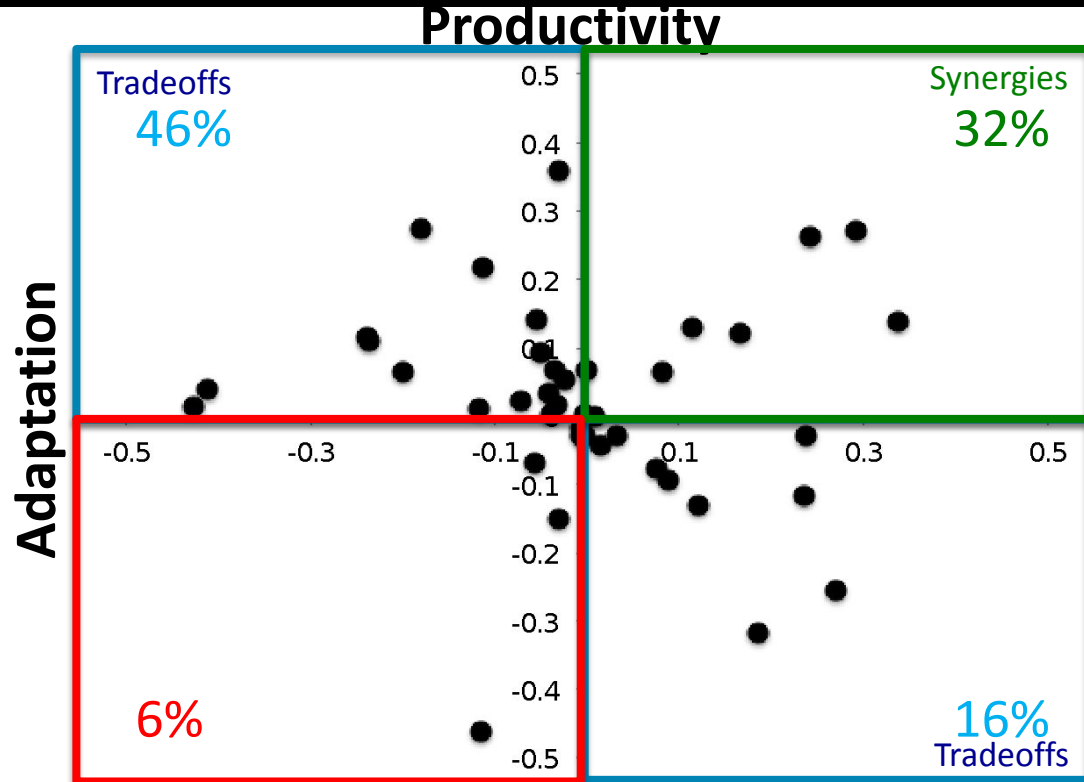


Many practices/programs/policies can  
be CSA **somewhere**

But **none** are likely CSA everywhere



# Synergies and tradeoffs between food security and adaptation



Mean effect from random sample of  
130 studies (55 comparisons)

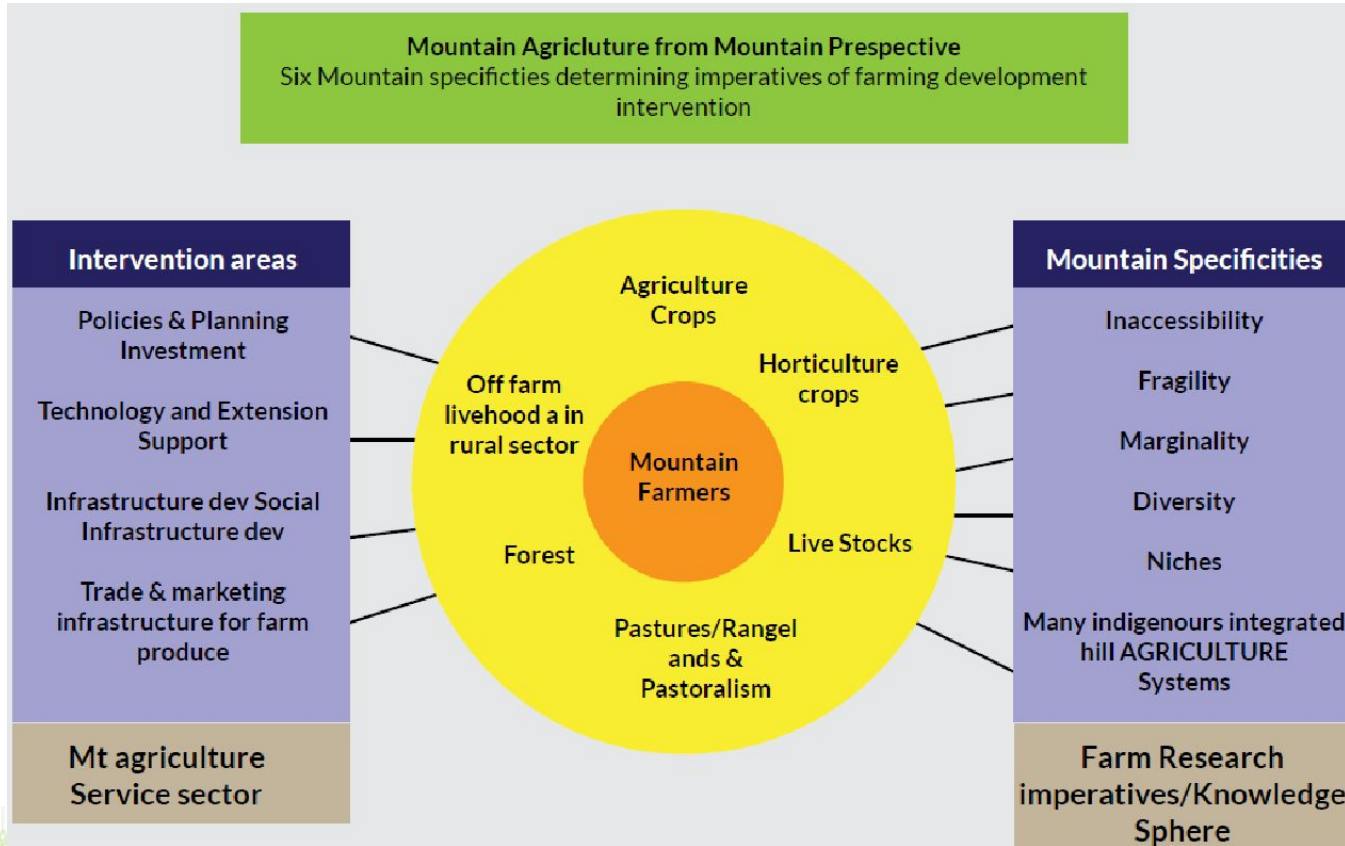
Rosenstock et al. 2016



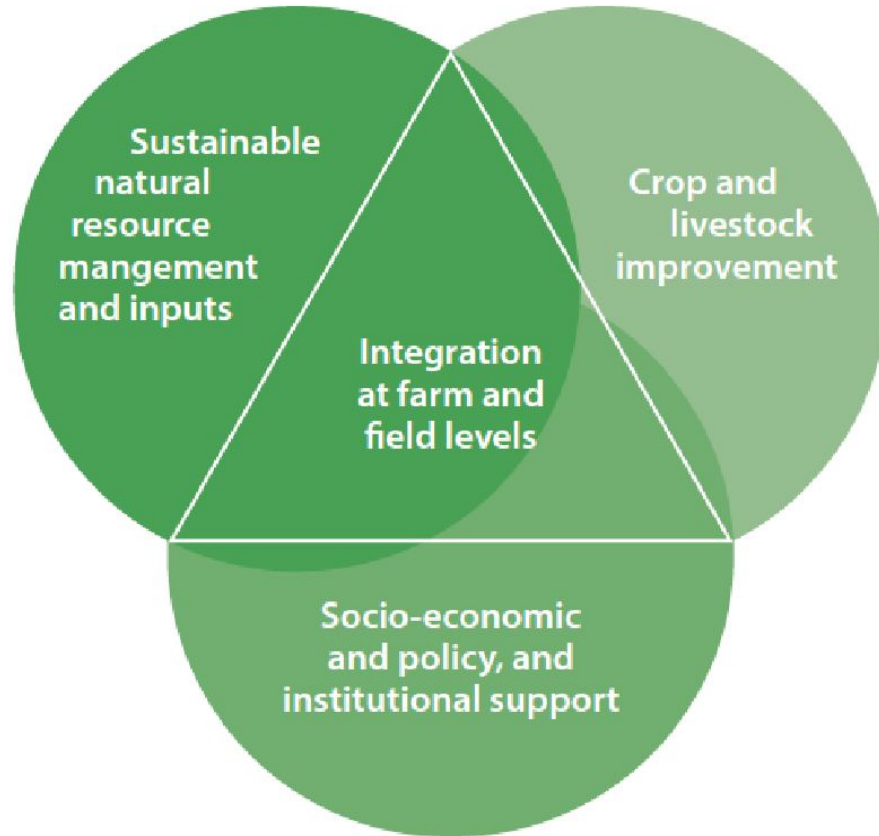
**So, what to be done that a farmer  
will understand and follow?**

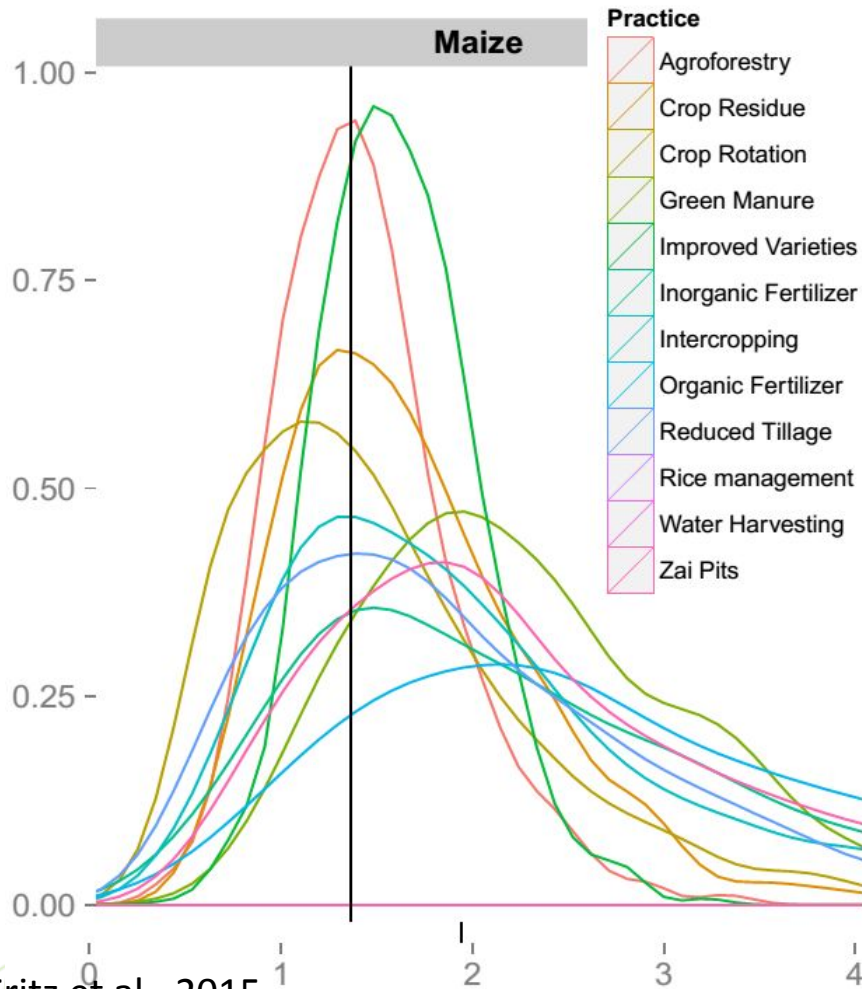
**Anything which reduces risk and  
enhances livelihood security –  
farmer friendly**

# Developing the Himalayan farming niches is the only way forward for evolving promising and sustainable agriculture systems in the Himalayas



# Integrated approach for the sustainable development of mountain agriculture

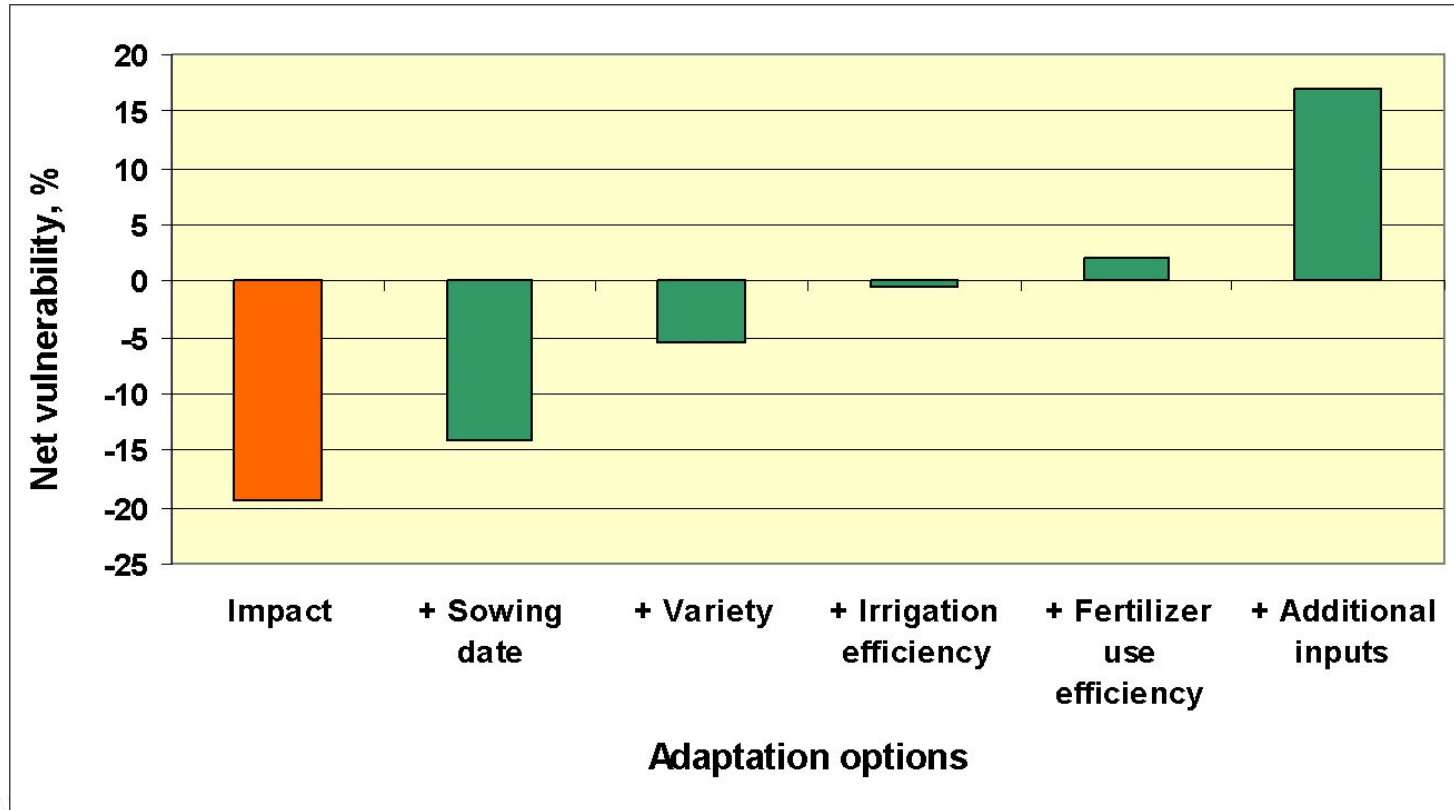




**One  
technology  
will not help;  
but a package**

**Example of  
CSA in Maize  
in Tanzania**

## Simple agronomic options can increase adaptation and meet food demands in short-term (all crops)



# Example from Earthquake Recovery Support Program in Nepal, 2016 (USAID funded)

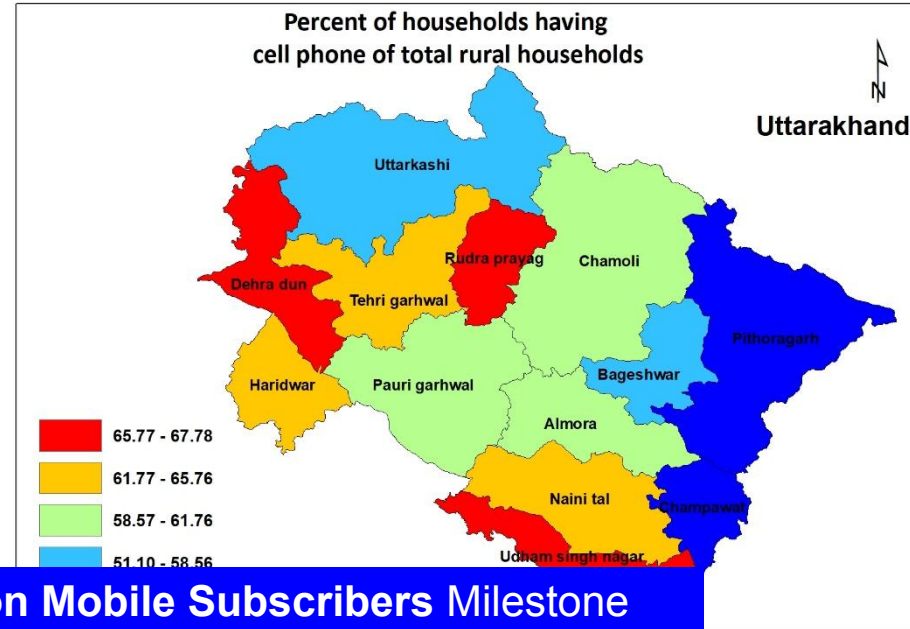
- 8 earthquake-affected districts
- Support items:
  - Improved seed
  - Hermetic bags and storage cocoons for grain storage
  - Mini-tillers and attachments
  - Hand tools
  - Advice on better-bet agronomy





# Deploy Integrated ICT services

- Weather forecasts and agro-advisories
- Early warning systems of food shortage, other shortages
- Marketing connections
- Crowd-sourcing for stakeholder participation
- Mobile phone can be a game changer



India crossed **1 Billion Mobile Subscribers Milestone** on June 6, 2016, as per data released by the country's telecom regulator

As of 30 June 2021, there are **1180.83 million wireless subscribers** including inactive users in India according to Telecom Regulatory Authority of India (TRAI).

2005

Preliminary data shows that successful ICT-enabled RAS could drive...



**>50%**

Greater adoption rates



**30-40%**

Increase in yields



**20-25%**

Increase in farmer income



**30-45x**

Return in farmer income / dollar invested



**10x**

Cost savings for public systems

SOURCE: Yield, income, ROI and cost targets are aspirational targets estimated for RAS investments based on evidence from existing models and dimensions of BMGF proposed investment. Dalberg study provides detailed data and methodology on impact and cost-effectiveness of RAS models.

# Value addition

**Value-added agriculture** entails changing a raw **agricultural** product into something new through packaging, processing, cooling, drying, extracting or any other type of process that differentiates the product from the original raw commodity.

# Marketing strategy?



**Where is packaging industry?**

## Import:

New Zealand – 1500 t

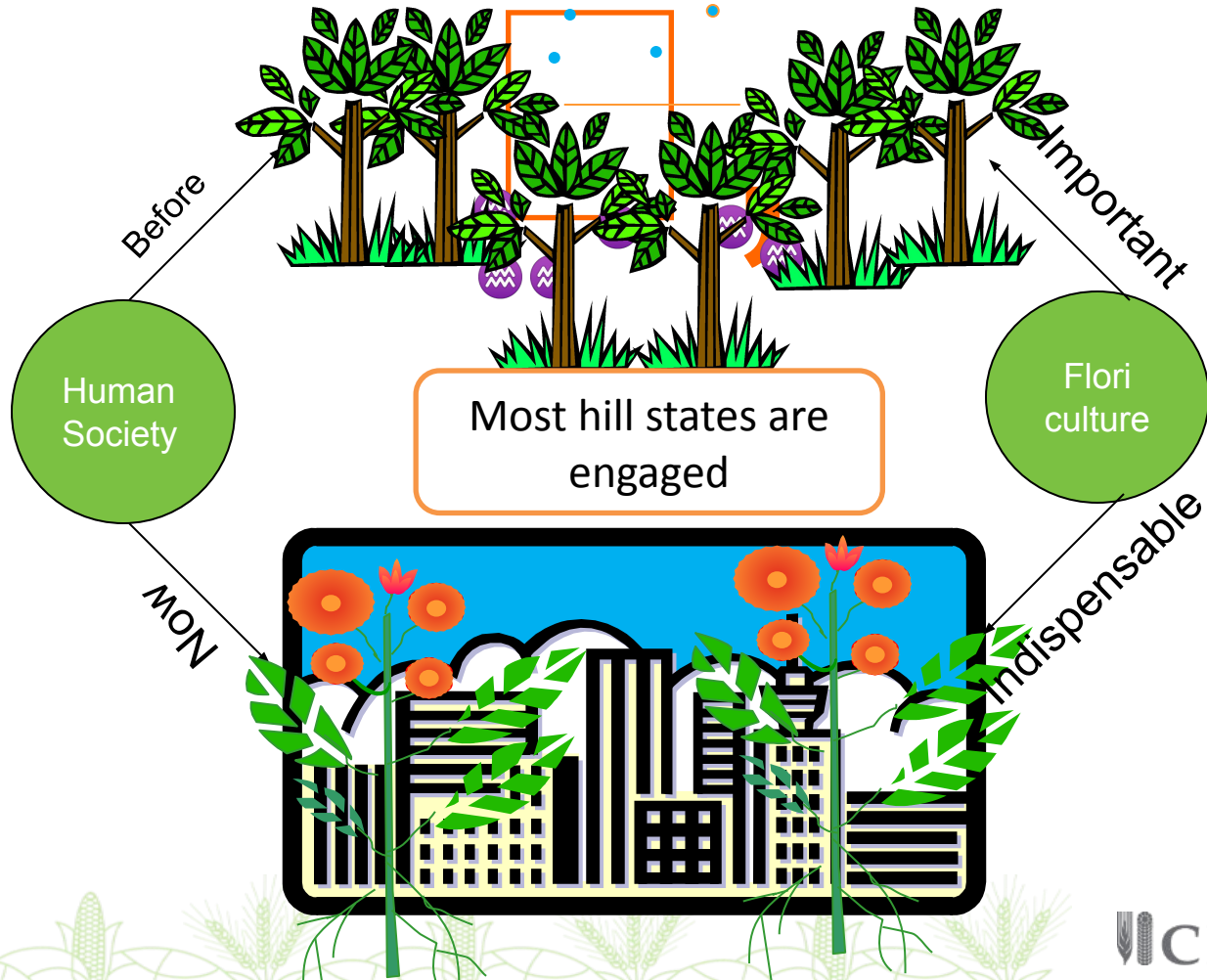
Chile – 250 t

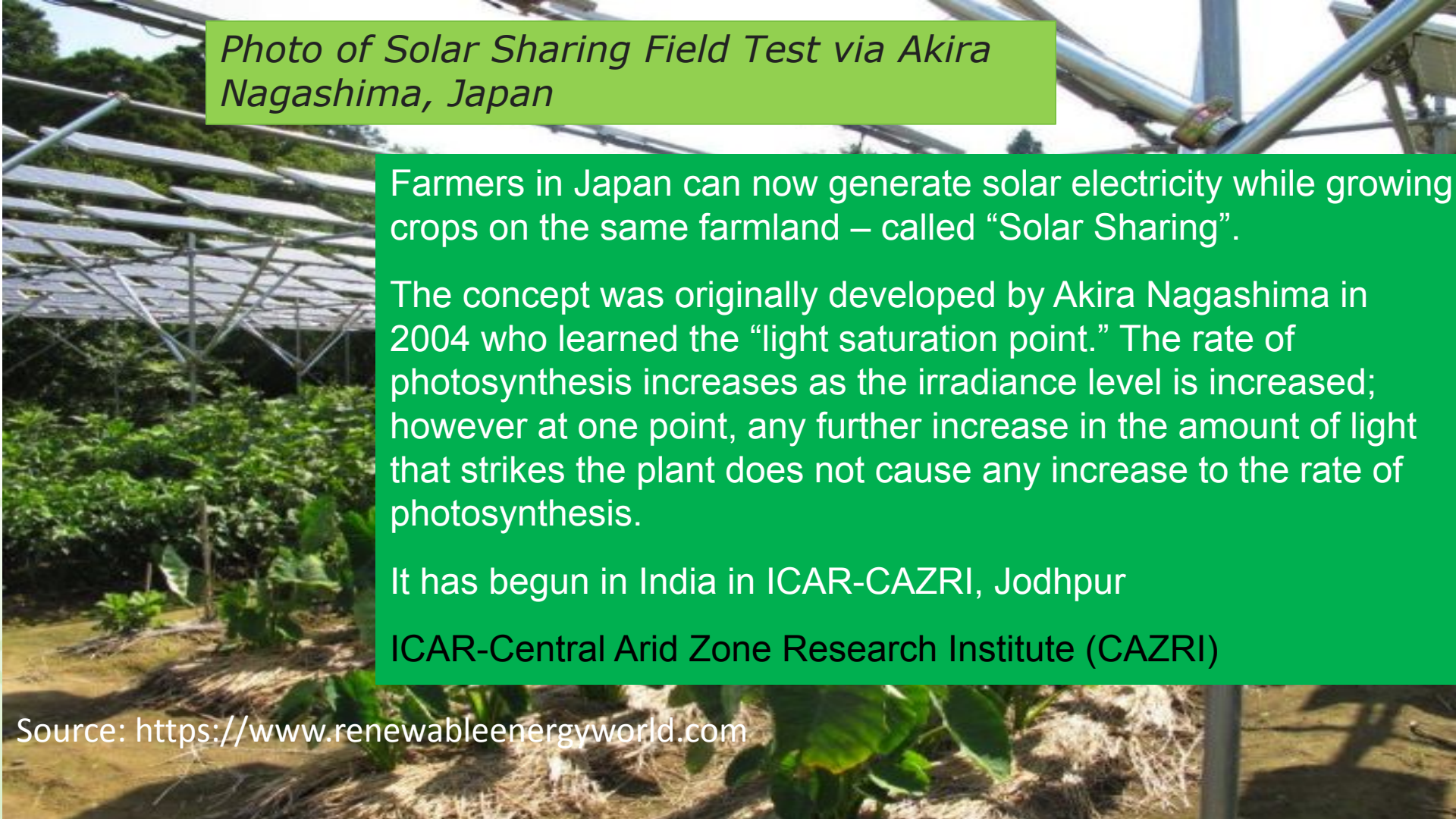
Italy – 300 t



## India:

Arunachal Pradesh – 300 t





*Photo of Solar Sharing Field Test via Akira Nagashima, Japan*

Farmers in Japan can now generate solar electricity while growing crops on the same farmland – called “Solar Sharing”.

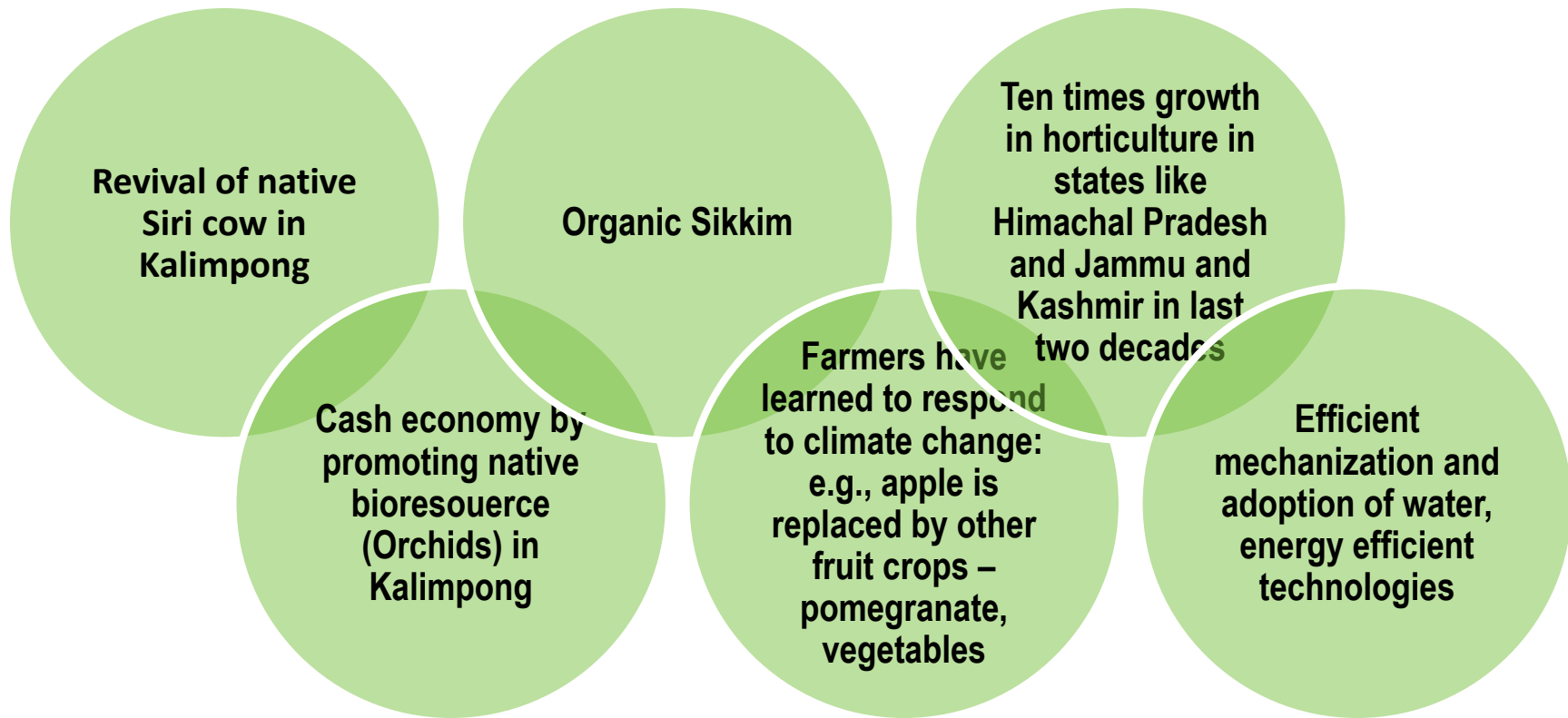
The concept was originally developed by Akira Nagashima in 2004 who learned the “light saturation point.” The rate of photosynthesis increases as the irradiance level is increased; however at one point, any further increase in the amount of light that strikes the plant does not cause any increase to the rate of photosynthesis.

It has begun in India in ICAR-CAZRI, Jodhpur

ICAR-Central Arid Zone Research Institute (CAZRI)



# **Success stories? Future?**



Source: [https://www.mountaininitiative.in/images/IMI\\_FAO\\_Report\\_on\\_SOMA.pdf](https://www.mountaininitiative.in/images/IMI_FAO_Report_on_SOMA.pdf)



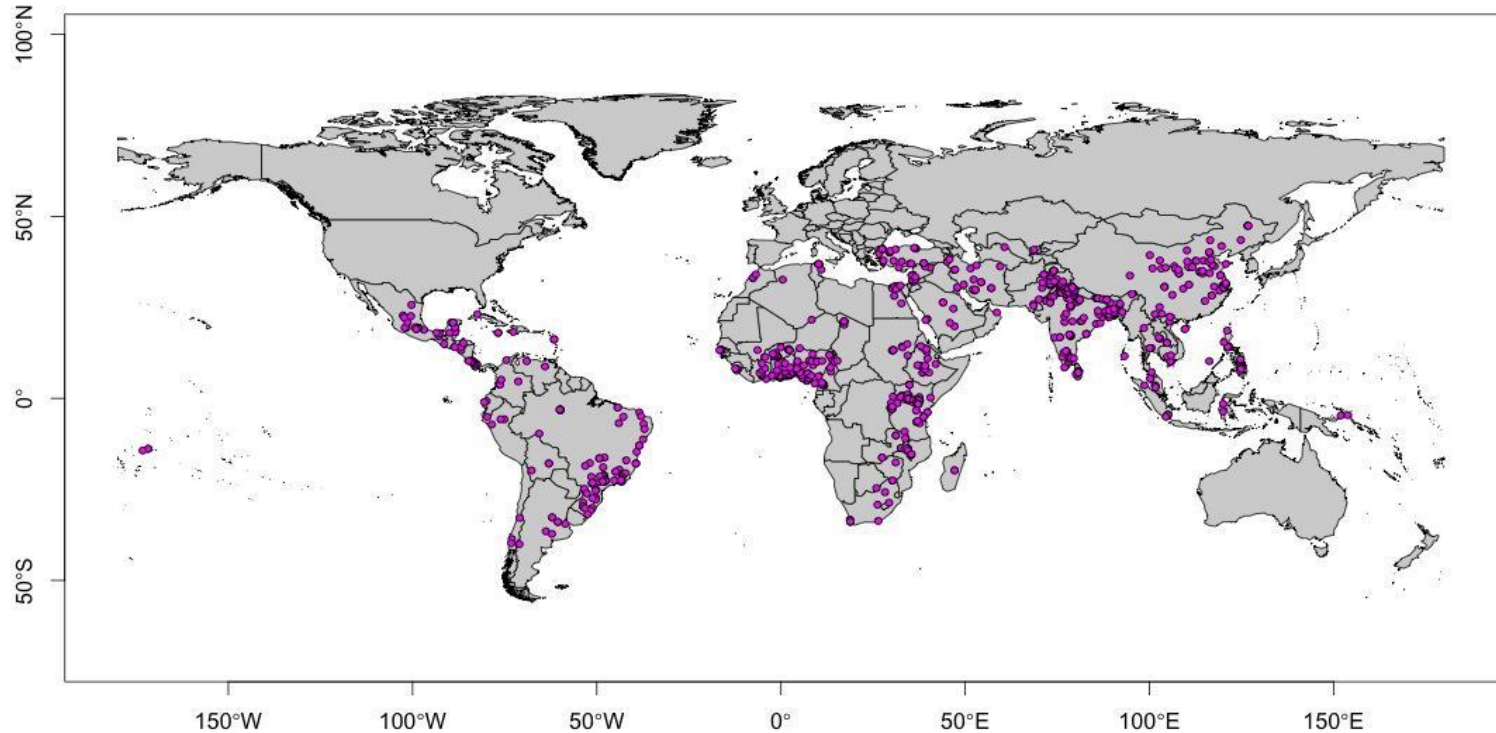




**School Education**



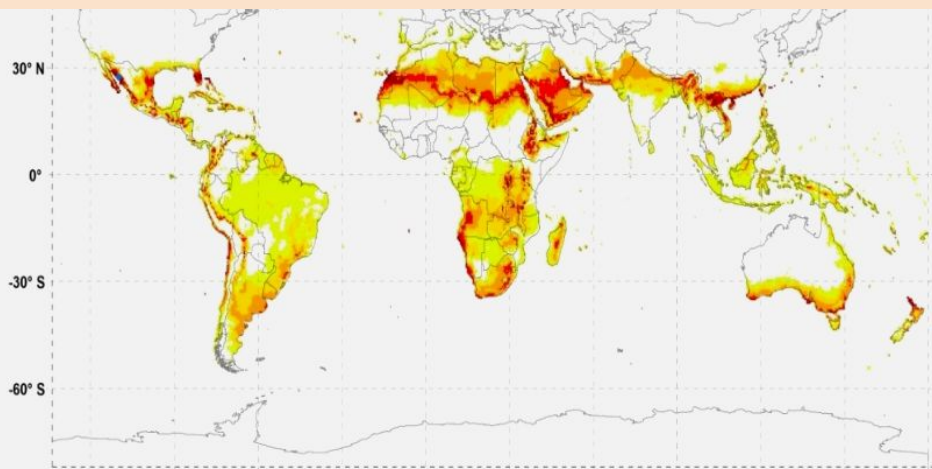
# Studies with indicators for at least **one** component of CSA



Rosenstock et al. 2016; Random sample of 815 studies

- Tomorrow's climate exists today at some other place
- Identification of such spots using databases and models
- Identification of homologues socio-economic locations
- Farmer-to-farmer exchange to facilitate co-learning of adaptation strategies/ risk management

**Farmer-to-farmer learning is helpful, but it is not necessary to repeat a success story without a major effort**



Slide source: PK Agarwal, BISA

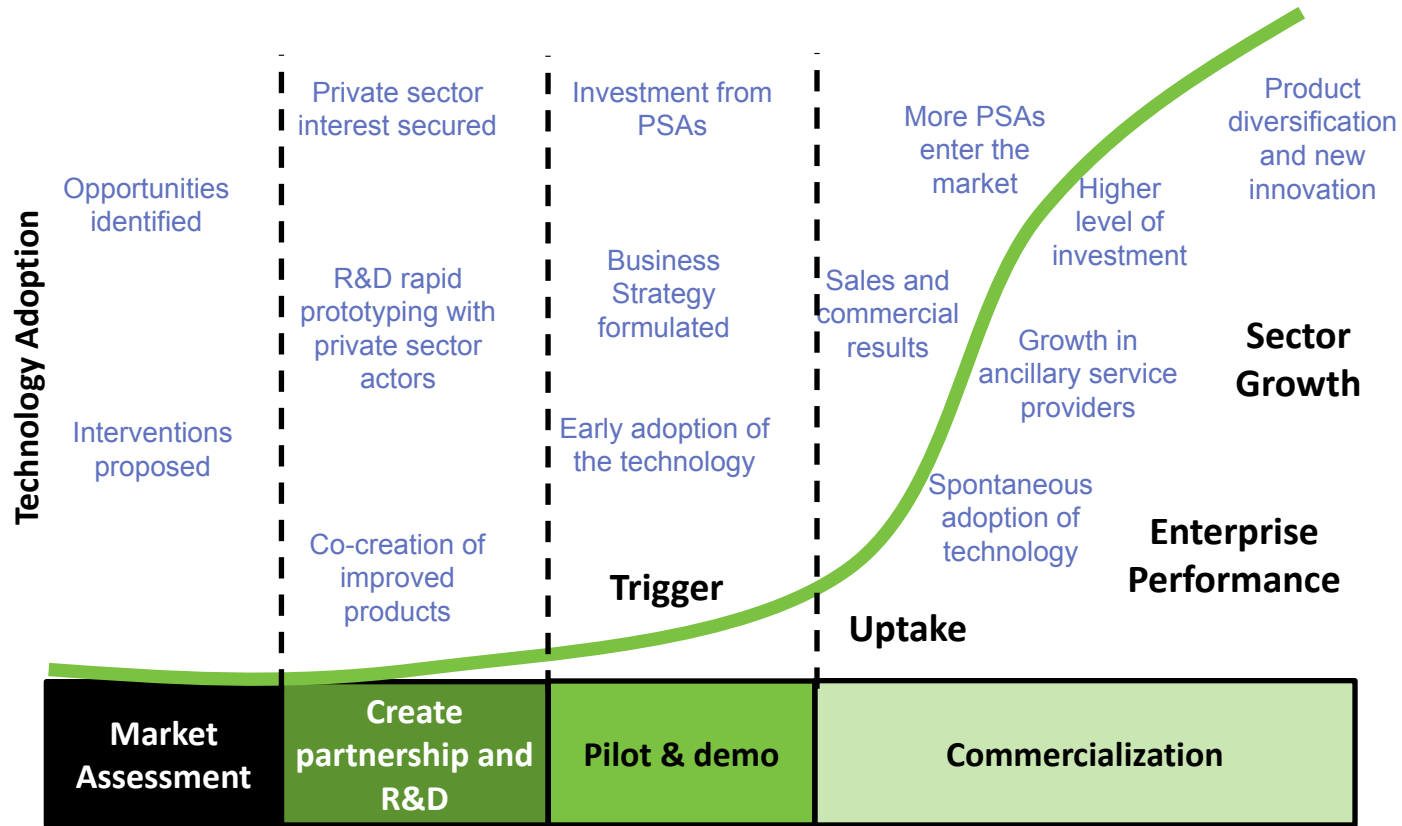
# Appropriate mechanization

- Emerged in the 1950s and 1960s following concerns over possible undesirable consequences of the spread of large-scale mechanization in developing countries
- Mechanization with minimum negative social and environmental consequences (e.g., consolidation, labor displacement, soil degradation)
- Argues that machines should adapt to farm size, and not the opposite. Consolidation should be driven by economic development, not by mechanization



Source: Bruno Gerard, former Director of SIP, CIMMYT

# Innovation and Scaling Sequence



Source: Adapted from iDE and World Bank

Time



Countries exporting apples to India, namely, USA, Australia, New Zealand, Europe and China all have modernized apple farming as agri-enterprises - varieties, root stock, plant husbandry, and post-harvest management and state of art marketing means.

<https://www.mountaininitiative.in>



# THE FUTURE OF AGRICULTURE


*A technological revolution*

Drones with precision sprayers (insert) apply agrochemicals only



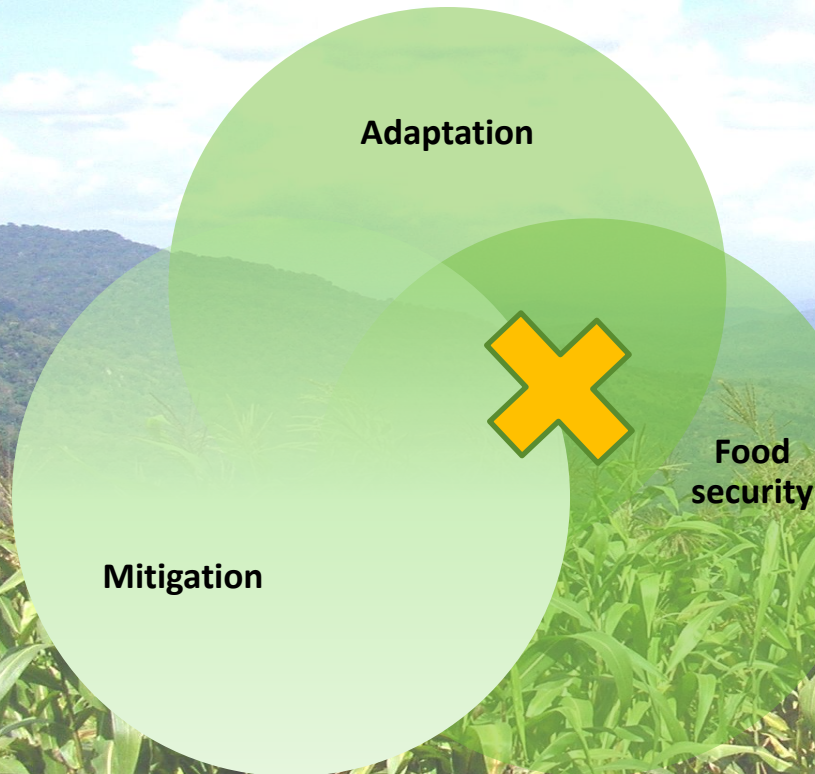


One day you might be able to buy a spray that changes the colour of their flowers by silencing certain genes. Farmers may use similar gene-silencing sprays to boost yields, make their crops more nutritious, protect them from droughts and trigger ripening. The technique could let us change plant traits without altering their DNA.  
<https://www.newscientist.com>



Monsanto hopes to have an RNA spray ready by 2020 that will tackle potato beetles resistant to many pesticide.

# Adaptation to Climate Change and Declining Resources: Four Key action points



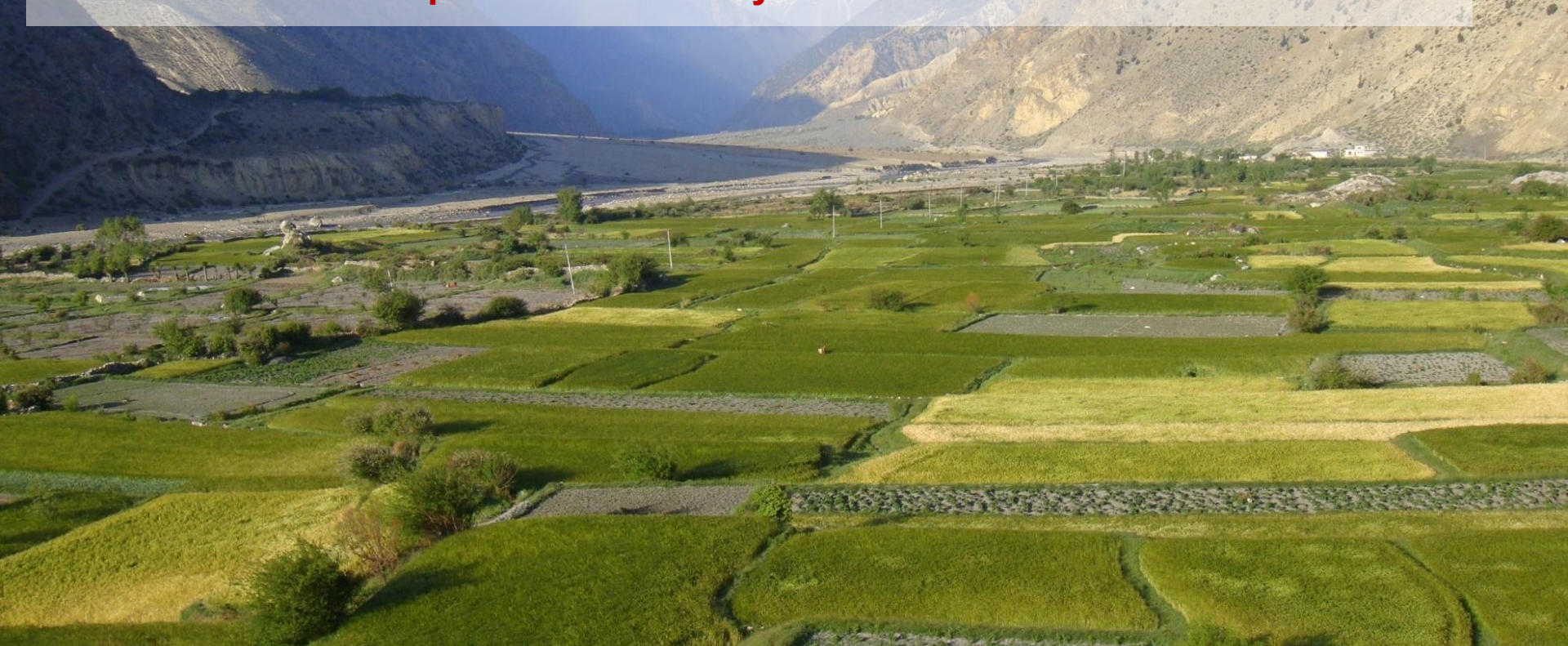
1. Invest in management of land and water resources, and input delivery and market linkage mechanisms, to fully exploit the benefits of available technologies.
2. Manage current climatic risks for poverty alleviation and for equitable development
3. Exploit large mitigation co-benefits of adaptation options
4. Address issues of poverty, governance, institutions and human capital which limit agriculture growth even today.



**Farmers should be central to all approaches**



**On addressing agriculture is not enough; we must address generic vulnerability issues simultaneously – poverty, literacy, governance, etc., which limit adaptation even today and will do so in future as well**



# Thanks for your understanding

