CLIMATE RISKS AND ADAPTATION OPTIONS FOR OILSEED CROPS IN SOUTH ASIA

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INTRODUCTION

As South Asia's first commodity-specific climate adaptation Atlas, the *Atlas of Climate Adaptation in South Asian Agriculture (ACASA)* focuses on characterizing climatic risks at a granular level, assessing the likely impacts of climate change, and proposing plausible adaptation options while evaluating their land-climate suitability, gender benefits, yield benefits, economic viability, and overall adaptation benefits. ACASA analyses 21 major commodities, including cereals, pulses, oilseeds, fruits and vegetables, livestock, and other non-food crops.

The following brief will examine climatic hazards for oilseed crops (both current and future scenarios). Oilseed crops constitute a vital yet under-realised component of South Asia's agricultural economy, serving as key sources of edible oil, protein-rich meal, and smallholder income. Groundnut, soybean, and mustard are the key annual oilseed crops in the region. The productivity of these crops is relatively low, primarily due to climatic hazards, low inputs, and pest and disease infestations (Shekhawat et al., 2012). Exploring and deploying various adaptation options, strengthening oilseed research, seed systems, and value chains, remains crucial for enhancing self-sufficiency, improving farm incomes, and increasing climate resilience in South Asia (Rao et al., 2015).

OILSEED CROPS FOR SOUTH ASIA

Oilseed crops cover about ~34 million hectares (Mha) in South Asia. To understand their spatial distribution, we used the MapSPAM-2019[1] dataset, which provides spatially disaggregated crop statistics based on sub-national data. To improve the accuracy of this dataset for our study region, we corrected it using recent sub-national crop statistics, ensuring that the gridded values are consistent with district-level oilseed crops area reported by local governments. This adjustment enables a more accurate representation (see figure 01) of oilseeds cultivation patterns across the diverse agro-ecological zones of South Asia.

1 The Spatial Production Allocation Model (SPAM) moves the data from coarser units such as countries and subnational provinces, to finer units such as grid cells, reveals spatial patterns of crop performance, creating a global gridscape at the confluence between geography and agricultural production systems. Read more about SPAM and its methods.

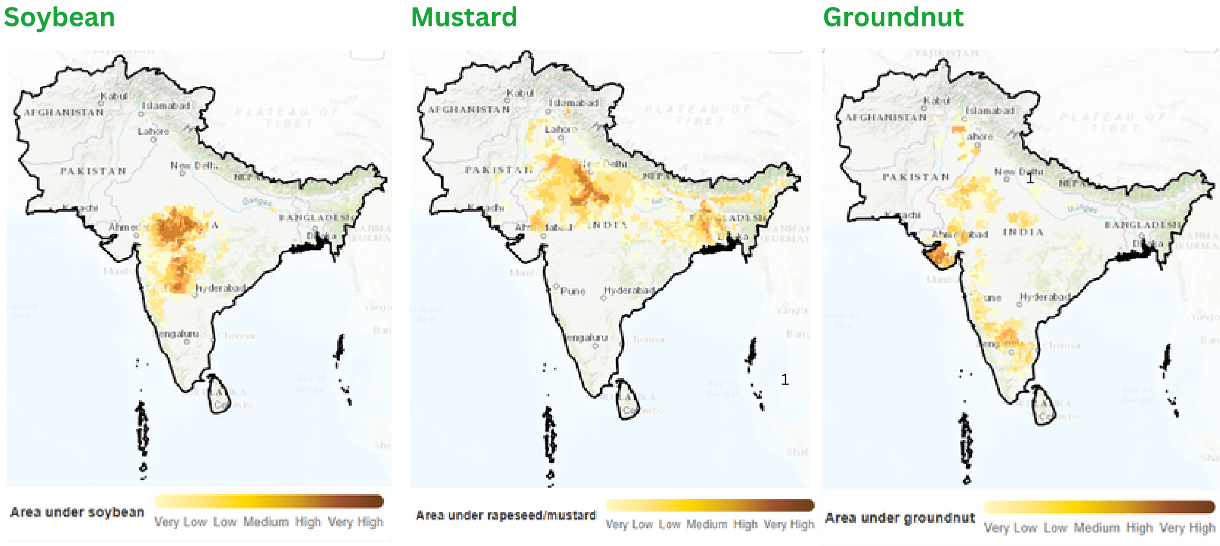

Figure 01: Baseline map showing the distribution of key oilseed crops' area (Mha) across South Asia

Source: ACASA-BISA

CLIMATE RISKS FOR OILSEED CROPS IN SOUTH ASIA

ACASA assesses the risks to oilseed crops by evaluating various factors contributing to climate hazards, exposure, and vulnerability. The methodology includes computing hazards based on climatic conditions, vulnerability based on socio-economic variables, and exposure based on the area cropped with oilseed crops. Combining these elements, an integrated risk framework tailored to crops was developed. The flow chart in Figure 02 shows the steps in risk assessment for oilseed crops.

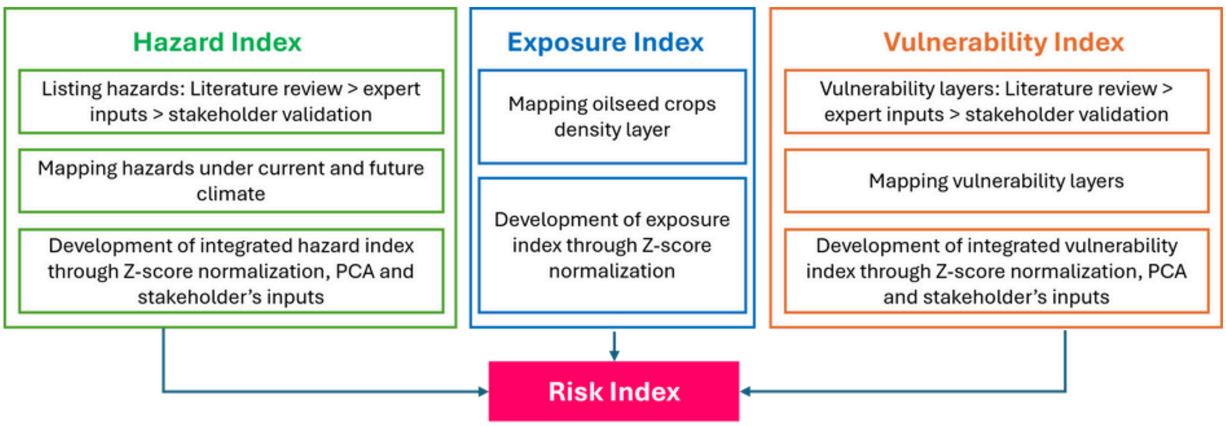

Figure 02: Climate risk assessment methodology in ACASA for oilseed crops

Key layers of risk analysis for oilseed crops include: (A) *Hazard* - crop-water deficit index, dry spell, delayed monsoon, heat stress, high temperature induced pollen sterility, excess rainfall, waterlogging, and flood events; (B) *Exposure* - includes oilseed cropped area as also depicted in Figure 01; (C) *Vulnerability* - through layers such as irrigation, income, socio-economic development indicator, volumetric soil water, and rural infrastructure.

An example of one of the hazards associated with mustard is depicted in Figure 03 for both the current and future climate. Heat stress is defined using both the intensity and frequency of extreme heat during the entire crop duration. Intensity refers to the number of days exceeding a threshold of maximum temperature (Tmax). At the same time, frequency refers to the number of years (out of 30) in which such extreme heat has occurred at a given location.

Heat stress for mustard in South Asia

Baseline *Future (2050s)* *Future (2080s)*

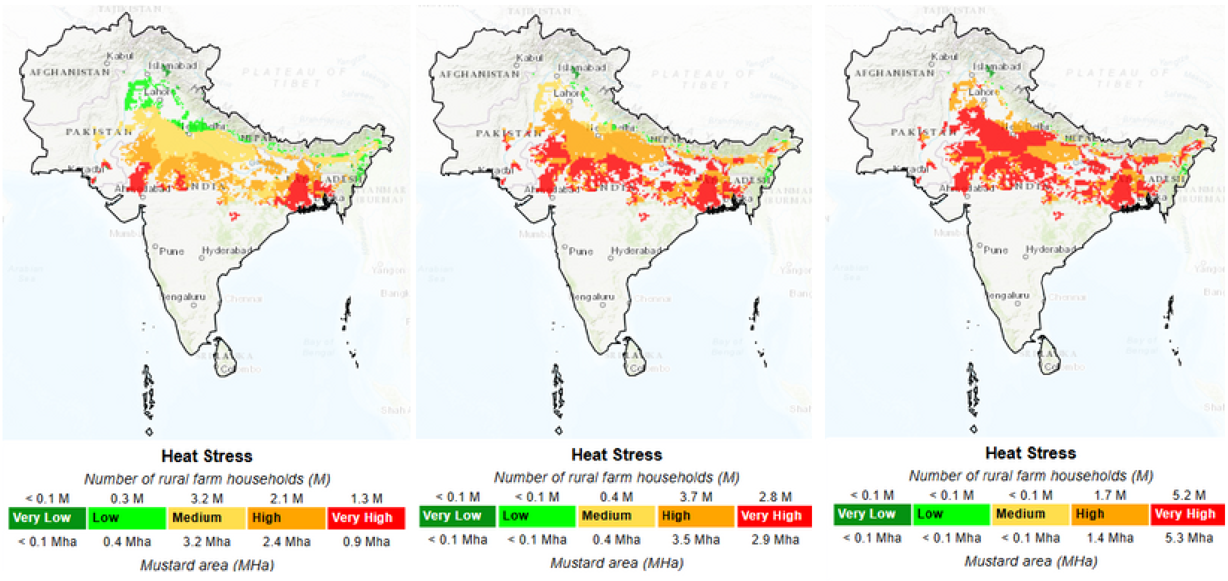

Figure 03: 'Heat stress' is one of the key hazards for mustard in South Asia. It is defined using both the intensity and frequency of extreme heat during the entire crop duration

Source: ACASA-BISA

Image: Reuters/Danish Ismail

Under future climatic conditions, the area of mustard in South Asia classified as facing “very high” heat stress is expected to expand across nearly the entire mustard-growing belt of the region. Projections indicate that heat stress in mustard will rise to the “very high” risk category over 4.4 million hectares by the 2080s, compared to baseline levels. Consequently, around 4 million rural farming households engaged in mustard cultivation and production are expected to be directly affected.

ADAPTATION OPTIONS FOR OILSEED CROPS IN SOUTH ASIA

As elaborated in Figure 04, adaptation options for all commodities in ACASA were identified through a multidimensional approach that incorporated land-climate suitability, gender benefits, yield benefits, economic viability, and overall adaptation benefits. This approach is the result of integrating a rigorous process that combines a literature review, field insights, heuristic modelling, crop growth simulation, cost-benefit analyses, and stakeholder consultations.

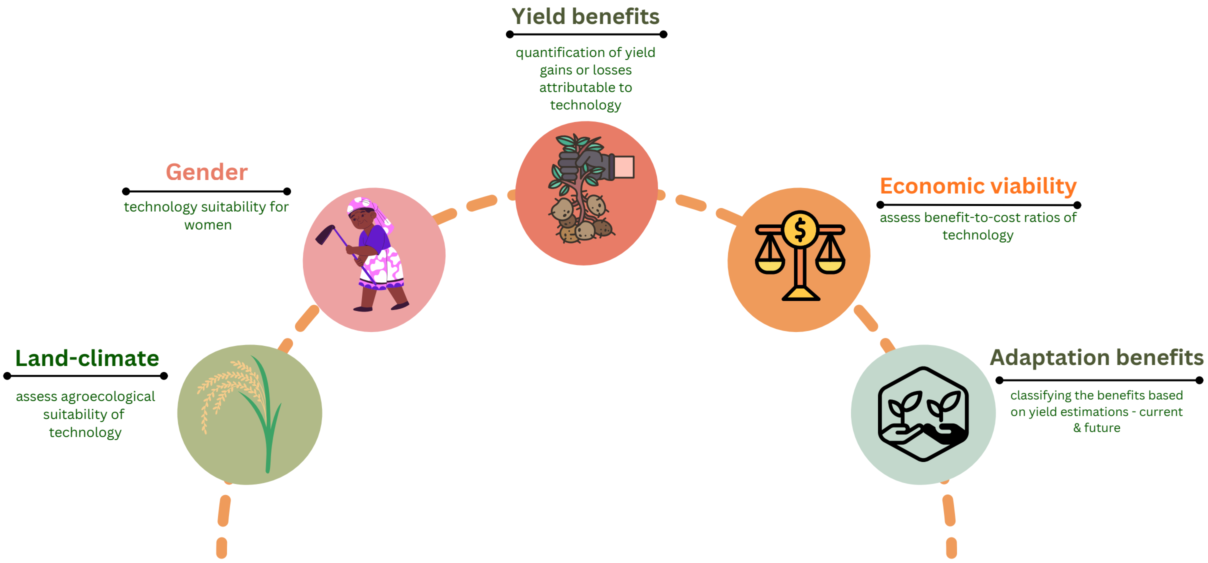

Figure 04: Adaptation Indicators considered in ACASA to arrive at the suitability and overall benefits of the proposed technology

Adaptation measures for oilseed crops are broadly classified into five categories: stress-tolerant varieties, planting technology, water management, fertiliser management, ICT-linked input management, and crop insurance.

Figure 05 illustrates the suitability of crop insurance in current and future climate scenarios for mustard into four classes, ranging from unsuitable to highly suitable areas. The insurance is most appropriate in areas experiencing a medium level of hazards. Under very low or very high hazards, insurance is less relevant and becomes more expensive.

Suitability of crop insurance for mustard in South Asia

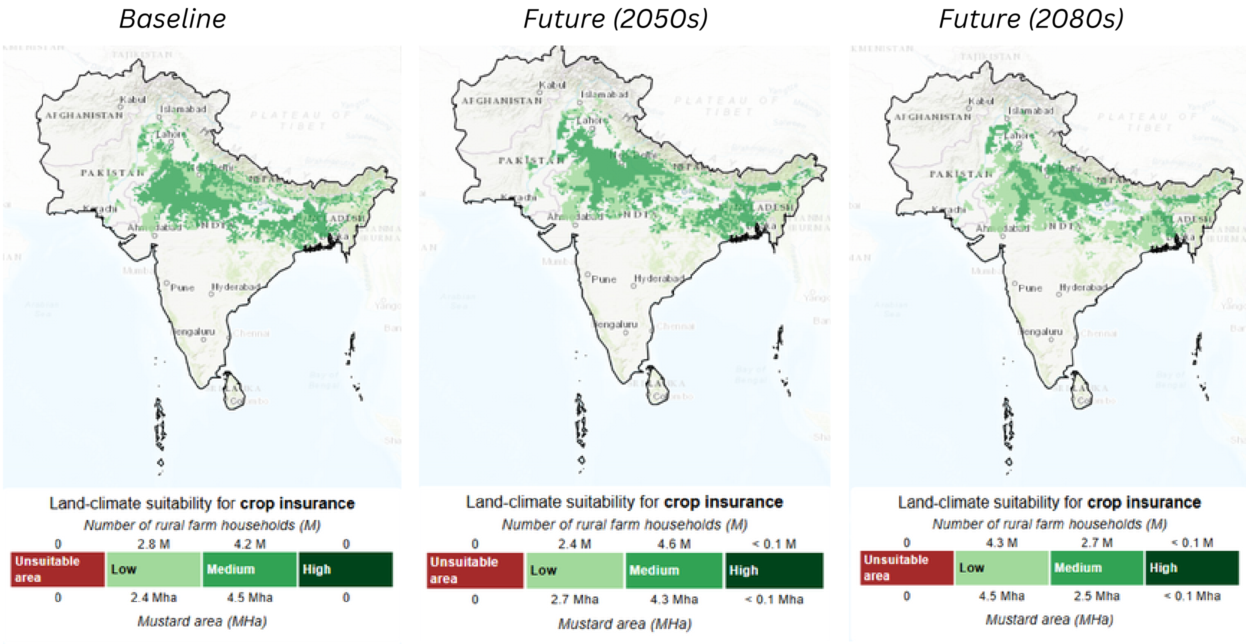

Figure 05: Crop insurance as an adaptation strategy for mustard in South Asia. Crop insurance is a formal risk management tool that provides financial protection to farmers against yield or income losses arising from biotic (pests, diseases) and abiotic (drought, floods, heat stress, etc.) stresses that adversely affect crop growth, productivity, and farm income. It is designed to stabilize farm livelihoods by transferring part of the production risk from the farmer to an insurer, thereby encouraging investment in improved seeds, inputs, and sustainable agricultural practices.

Source: ACASA-BISA

The current scenario (baseline) indicates that most mustard-growing regions in South Asia are moderately suitable (medium) for crop insurance catering to ~4.2 M rural farm households. This suitability increases by ~10% in the 2050s as more areas become suitable for crop insurance to mitigate heat stress for mustard. However, in the 2080s, the suitability decreases to 2.7 M rural farm households, indicating that insurance is becoming less suitable because of extreme heat stress in this future scenario.

Image: Agrifarming.in

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Image: Agrifarming.in

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About BISA
BISA is an international research institute established through a joint initiative between CIMMYT and ICAR, New Delhi, India, to implement the vision of the Nobel laureate Norman E. Borlaug. It aims to harness the latest genetic, digital, and resource management technologies and use research for development approaches to invigorate the region's agriculture and food systems to meet future demands.