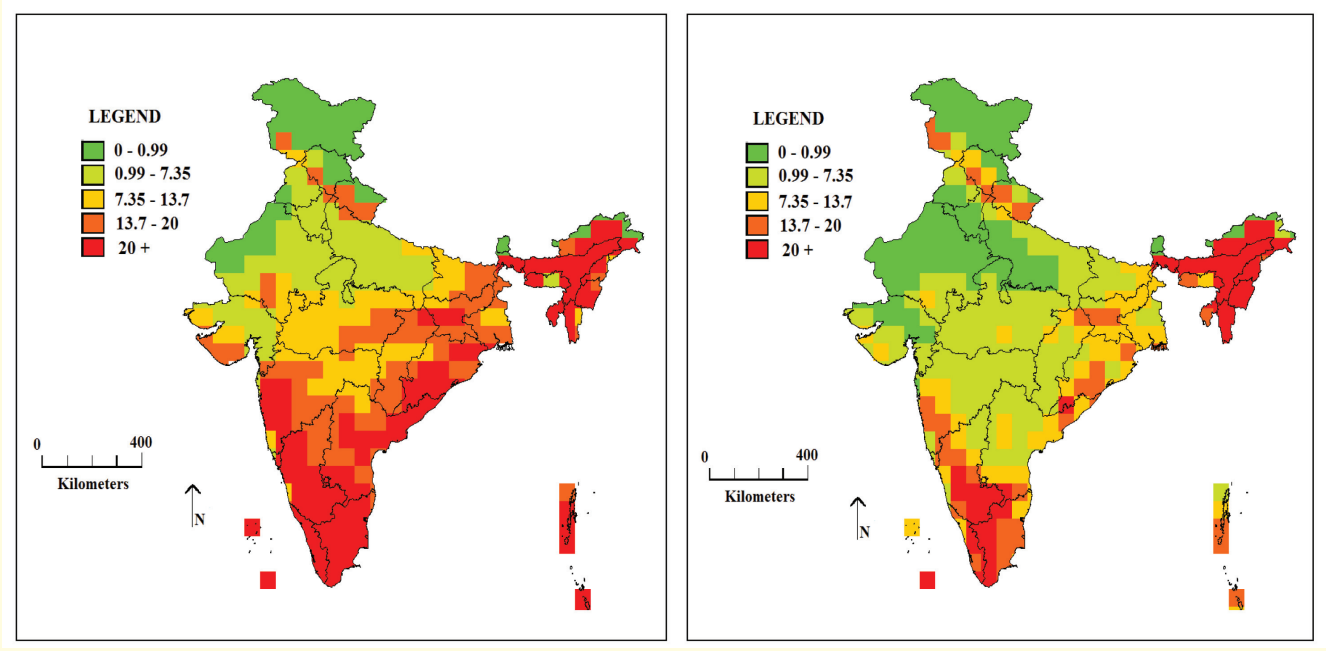
Technical Brochure

CLIMEX SIMULATIONS AS A TOOL FOR PREDICTING CLIMATE CHANGE MEDIATED DISTRIBUTION OF PESTS AND THEIR MANAGEMENT IN HORTICULTURAL ECOSYSTEMS

Potential distribution of *Bactrocera dorsalis* in India



Current climate **Future (2050)**

CLIMEX, a bioclimatic modeling software, enables the user to estimate the potential geographical distribution and seasonal abundance of a species in relation to climate using Ecoclimatic Index (EI), which is the combination of Growth and Stress Indices. EI value shows the overall favorableness of the location for the target species and ranges from 0-100. The model is based on the assumption that if we know where a species lives we can infer what climatic conditions it can tolerate. Similar observations under climate change scenarios can also be generated that will have high implications in pest management in horticultural ecosystems. We made first ever attempt using CLIMEX in India which could provide great insight into the response of pests to climate change warranting their future utilization in pest management initiatives. Various applications of CLIMEX are presented in this brochure.

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"Compare location" function

Prediction of number of generations of *Spodoptera litura* under climate change situation

S. litura is a polyphagous pest on agri-horticultural systems and reported to feed on more than 120 species of host plants. The lower and upper threshold temperatures of 10.5° and 37°C and thermal degree unit requirement for egg-egg development for *S. litura* (551.20 per generation) obtained from literature was used for modeling. Based on thermal requirements, risk maps indicating the potential number of generations of *S. litura* per year was calculated for different parts of India for current and 2030 (for A2 scenario obtained from CliMond) using CLIMEX. Subsequently, the maps were incorporated into DIVA-GIS software for suitable contrast colour codes corresponding to number of generations.

In the current climatic conditions, most of the northern and north eastern states are expected to have less than 9 generations/yr (Fig 1). Central India is projected to have 9-10 generations/yr and parts of Tamil Nadu, Andhra Pradesh and Kerala are predicted to have 11-12 generations/yr. Under climate change scenario (2030) an overall increase of 1-2 generations is expected. More than 12 generations are expected in parts of Andhra Pradesh and Tamil Nadu. Though in these regions extreme temperature will hinder its development, the pest is still expected to complete 12 generations during favourable months.

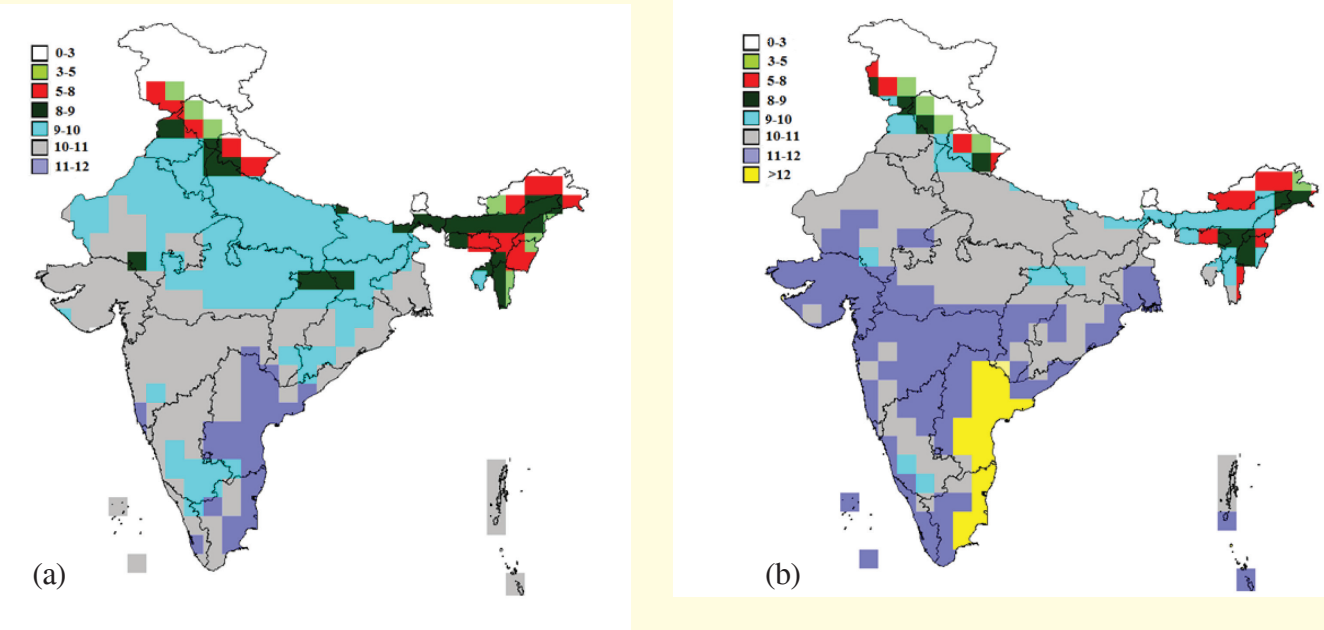

Figure 1. Expected number of *Spodoptera litura* generations in India under a) Current scenario b) 2030 (CSIRO A2 scenario)

Oriental fruit fly, *Bactrocera dorsalis* (Hendel) – Potential distribution

Potential distribution of *B. dorsalis*, a polyphagous pest on several horticultural crops was generated using CLIMEX simulations. Met data used was based on a Global Climate Model (GCM), CSIRO-Mk. The model was run with the A1B SRES (Special Report on Emission Scenarios of IPCC) for 2030, 2050 and 2070 in comparison with the current scenario (average base data of 1960-1990). A1B group of the A1 storyline of SRES was chosen with the assumption that a balance of fossil and non-fossil energy sources would exist in the future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and rapid introduction of new and more efficient technologies.

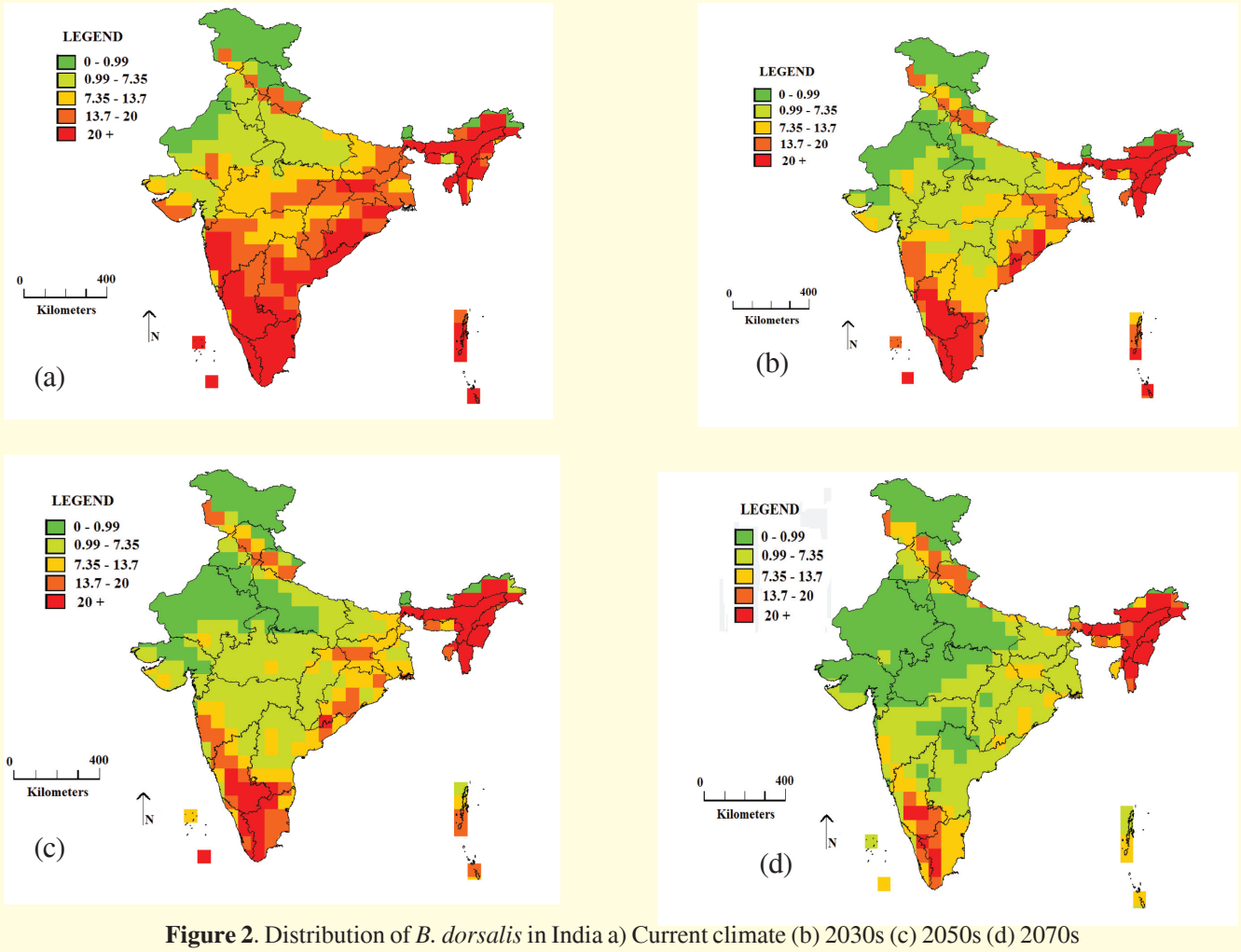

Figure 2. Distribution of *B. dorsalis* in India a) Current climate (b) 2030s (c) 2050s (d) 2070s

In future, *B. dorsalis* distribution is expected to increase (in terms of EI values) in few parts of North East region, J&K, Uttarakhand and Himachal Pradesh, decrease in other parts of India. An overall decrease is predicted under climate change situation as presented in various maps (Figure 2 a-d).

'Match Climate' application : Pest risk analysis for quarantine pests

Match Climate application of CLIMEX was used to compare the climate at one location (home) with other selected locations (away). This function allows user to identify regions climatically similar to the home location. A new development in the CLIMEX package is the 'region matching' algorithm which allows the user to use multiple home locations to be matched against set of away locations. The results are given as Composite Match Index (CMI) ranging from 0 – 1 and above 0.7 considered as a close match.

In the present modeling study, 33 home locations of known records with incidence of *Bactrocera papayae*, a quarantine pest for India were selected to run with match climate regional application choosing world as 'away'. Subsequently, from the away location, India map was filtered to locate regions within India having similar climatic conditions against the known distribution records (Figure 3).

The CLIMEX model predicted southern and eastern parts of India having similar climatic conditions. In specific, most parts of Karnataka, Tamil Nadu, Andhra Pradesh, Orissa, Bihar, Jharkhand, West Bengal and parts of Maharashtra, Kerala and Chhattisgarh have a similar climate with the home locations *i.e.,* above 0.7 (Fig 3). The aforesaid regions harbour numerous horticultural crops , most of which are known to be hosts of *B. papayae* in its native range (CABI, 2014). Parts of Andaman and Nicobar Islands are proximal to the South

East Asian countries having high incidence of *B. papayae*, hence strict quarantine measures to check intentional or accidental entry needs to be undertaken.

CLIMEX is dynamic software that suffices multi-purpose applications like conservation, resource management, invasion ecology, bio control *etc.*

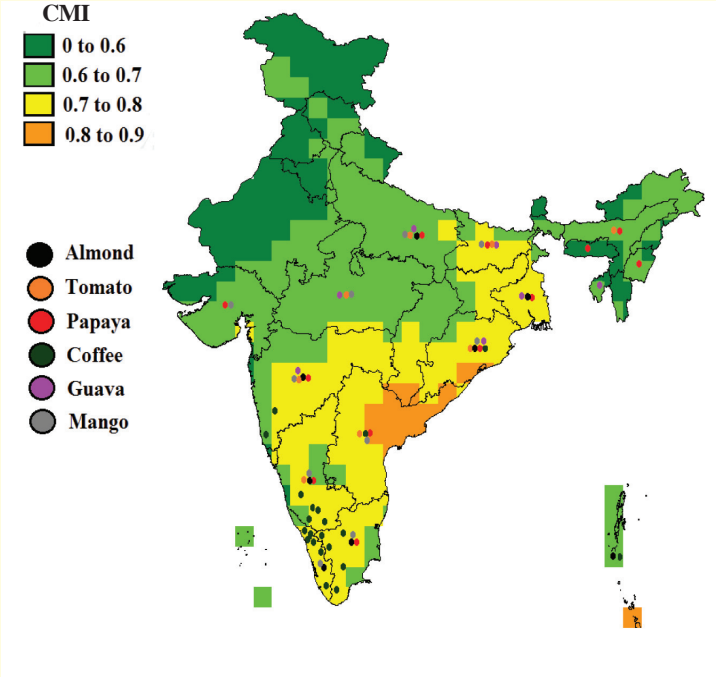

Fig 3: Climatic suitability for *Bactrocera papayae* in India based on Composite Match Index (CMI values)

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