PLAUSIBLE IMPACTS OF CLIMATE CHANGE ON POTATO IN SOME IMPORTANT POTATO GROWING POCKETS IN INDIA BASED ON INFERENCE FROM THEIR CLIMATE ANALOGUES

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Scientific evidence gathered over the last couple of decades suggests that climatic conditions are changing rapidly. This trend is likely to continue, and even accelerate in future (IPCC 2007; Moss et al., 2010). These anticipated changes in climate baseline, variability, and extremes will have far-reaching consequences on agricultural production, posing additional challenges to meeting the food security for a growing world population (Lobell et al., 2008; Roudier et al., 2011). It is therefore pertinent to work out the impact of climate change on agricultural production, and develop, both mitigation and adaptation strategies. Although various methods have been proposed for the purpose but climate analogues offer a simple alternative. Reason being that relying on “analogue locations” that have today the climatic characteristics that are expected tomorrow in a target production zone can help predict the effect of changing climate on crops (Haussmann et al., 2012). Moreover, such studies are more realistic, since, in addition to crop growth and development the pests and diseases complex can also be studied. This study was therefore undertaken to determine the climate analogues of important potato growing regions to assess the possible impact of climate change in future.

Six distinct potato growing regions having more than 3000 ha under potato and distributed across the Indo-Gangetic plains viz., Jalandhar, Agra, Gwalior, Patna, Kannauj and Bardhaman were selected. The geographical co-ordinates of these locations were input into the spatial analogue tool (Darwin et al., 1995). For each site the inputs used were the ensemble of climate models for the Global Climate Model (GCM) and A1B, SRES for the emission scenario. In the analysis settings, Grid-analysis was selected to compare one single location with the whole geographic domain and output generated for any geographic region at any resolution was equal to or above one km. Further, spatial analogue of the selected site were determined using the backward analysis i.e. sites whose current climate is analogous to the future expected climate of the chosen site. Regarding similarity index the Climate Change, Agriculture and Food Security (CCAFS) model which calculates dissimilarity as a weighted Euclidean distance between the variables vectors for the reference (f). Based on this, target (p) scenarios were selected, and finally the optimum growing period of different regions were also input into the tool.

The spatial analogues were determined on the basis of both, mean temperature and

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precipitation in case of climatic variables while, all 19 bioclimatic variables (Busby, 1991) were used in the case of bioclimatic model. The weighting factor for temperature was taken as DTR while in the case of precipitation it was taken as an integer value of one. Regions with high similarity were selected from the output grids produced by the tool and their geographical coordinates were derived.

Climate analogues indicate the locations where the likely situation of the reference location in 2020 under A1B SRES situation exists currently. This concept of climate analogue can help in knowing the likely phenology as well as the pests and diseases scenario of the reference location under the climate change scenario. The reference stations and their climate analogues common in both the methods *i.e.*, climatic variables and bioclimatic model are given in (Table 1). The preliminary indications based on the analogues of the reference locations are discussed below.

**Jalandhar**

It is an important seed producing region in Punjab that lies in the North-West of the country. Two of its analogues, Moga and Patiala are in Punjab itself but as of now both are not major potato growing regions. Out of the other three analogues Palamu in Jharkhand and Kawardha in Chhattisgarh are also non-potato producing regions whereas Baghpat in UP is an important potato growing region. Based on the current situation in the analogue sites it can be inferred that the vector dynamics which is highly temperature dependent would change under climate change and that would have serious implications on the seed production in Punjab. It is therefore, important to study the occurrence of different virus vectors and their dynamics in the analogue station to understand its implications on quality seed production. On the basis of the current status of potato cultivation in Baghpat and nearby areas, it appears that white flies would become a serious vector in the region under climate change scenario and aphid build-up would sharply increase thereby shortening the available seed growing window.

**Agra, Gwalior and Patna**

These are important seed and ware potato growing regions of the country. The study shows that the analogue locations of these places falls on the northern boundary of MP and southern boundary of UP. These

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Location (decimal degree)</th>
<th>Analogues (decimal degree)</th>
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<tbody>
<tr>
<td>1</td>
<td>Agra 27.167, 78.033</td>
<td>Etah 27.739, 78.729; Morena 26.271, 77.740; Satna 24.285, 80.772; Korba 22.327, 82.75; Garhwa 23.843, 83.673; Betul 21.777, 77.740; Ratlam 23.279, 75.169; Koriya 23.803, 81.739; Tikamgarh 24.744, 79.234</td>
</tr>
<tr>
<td>2</td>
<td>Patna 25.617, 85.167</td>
<td>Dholpur 26.831, 77.674; Gadchiroli 19.027, 80.179; Parbhani 19.07, 76.795; Aurangabad 24.814, 84.178.</td>
</tr>
<tr>
<td>3</td>
<td>Gwalior 26.233, 78.25</td>
<td>Alwar 27.769, 76.685; Lalitpur 24.734, 78.729; Dindori 22.814, 81.234; Jabalpur 23.34, 80.223; Rewa 24.784, 81.717; Sidhi 24.305, 82.200; Ratlam 23.299, 75.213</td>
</tr>
<tr>
<td>4</td>
<td>Jalandhar 31.326, 75.579</td>
<td>Moga 30.683, 75.213; Patiala 30.266, 76.224; Palamu 23.813, 84.222; Kawardha 22.236, 81.234; Baghpat 29.274, 77.191</td>
</tr>
<tr>
<td>5</td>
<td>Bardhaman 23.233, 87.85</td>
<td>Kawardha 22.276, 81.19; Kanker 20.27, 80.75; Yavatmal 20.27, 78.685; Dumka 24.375, 87.210; Kandhamal 20.311, 84.266; Bastar 19.227, 81.673; Paschimi Singhbhum 22.317, 85.189; Narsimhapur 22.845, 79.212; Korba 22.804, 82.20; Ratlam 23.289, 75.213</td>
</tr>
<tr>
<td>6</td>
<td>Kannauj 27.055, 79.918</td>
<td>Surguja 23.249, 83.738; Gadchiroli 18.779, 80.223; Bolangir 20.805, 83.255; Hugli 22.804, 87.738; Paschimi Singhbhum 22.358, 85.716; Madhubani 26.32, 86.243</td>
</tr>
</tbody>
</table>
areas have high yield potential due to mild winters, but are constrained by high water deficit, especially in Agra and Gwalior. Based on the analogue locations it is expected that stem necrosis, thrips and mites are likely to become important pests and vectors of the region in future due to climate change. Development of water use efficient varieties would become the priority to increase/sustain potato production in these regions.

Kannauj

It represents a situation in central UP where large areas are under early potato due to the adoption of potato-wheat sequence. The study shows that its analogue stations are scattered across various states comprising of UP, Bihar, Jharkhand, Odisha and West Bengal. The distribution of the analogue sites suggest that it is likely that due to increased vector pressure, these areas may no longer be suitable for seed production. Besides, hitherto unknown diseases and pests of the region like early blight and mites may become endemic impacting the overall potato productivity in the region and steps to prevent it needs to be initiated.

Bardhmaan

It represents another unique potato growing region in West Bengal in eastern Indo-Gangetic plains characterized by mild winters and short growing season but high yield potential due to near optimum temperature regime and mostly clear days. The study indicates that its analogue stations are located in central and southern Madhya Pradesh, Odisha, Jharkhand and eastern Maharashtra. It appears that late blight would become less severe and the processing quality of the produce may improve due to climate change in Bardhmaan and nearby areas on the basis of the situation of the analogue sites. The pest and disease severity is likely to aggravate further. Bacterial wilt may become more severe, seed degeneration is likely be faster and pests like mites may become endemic and needs to be carefully monitored and steps taken to prevent it.

Spatial analogues have been used to improve adaptation strategies in many ways. Peacock and Worner (2006) identified analogue regions for the city of Auckland, New Zealand, in order to assess the risks of the long-term establishment of insect pests introduced through imports. Williams et al. (2007) developed maps showing regions with climate conditions that are likely to disappear from the surface of the earth due to global warming, and regions that will gain climates that currently do not exist. Hallegatte et al. (2007) on the other hand used the range of uncertainty for the identification of analogs to illustrate the difficulties of developing adaptation plans that optimize both the risks and the costs. Ramirez-Villegas et al. (2011) used analogs to assist in crop selection in some parts of Africa in future climates. Climate change impact on bio-physical reactions of different crops have been widely studied using plant physiology models that includes, CERES-Maize (Ritchie et al., 1989), CERES-Wheat (Godwin et al., 1989), SOYGRO (Jones et al., 1988) for major grains and SIM-POTATO (Hodges et al., 1992) for potatoes. These models can simulate how crops’ varieties change their rate of growth in response to climate. Only few studies have used climate analogue approach for climate change impact assessment (Adams et al., 1995; Adams et al., 1999). However, the use of spatial analogues is often criticized, especially because paired regions may differ in aspects other than climate. For example, day length (photoperiod) depends on latitude, and this aspect is rarely equivalent in the reference region and its analogues. Thus, a similar climate alone may not necessarily provide all the conditions required for the establishment
of a species. However, Grenier reported that although all possible inferences are not necessarily appropriate due to climate and non-climatic differences, the exercise can still result in valuable information, and therefore spatial analogues as a heuristic tool is useful for exploring ideas and strategies.

About eighty percent of the potato crop in India is grown in the Indo Gangetic plains under irrigated conditions. Hence, the use of climate analogues for assessing the possible impacts of climate change would be relevant since temperature is the major determinant of crop development, pest occurrence and also potato quality to a large extent. Yield may not be properly reflected since incident radiation is affected by the latitude. Therefore, only the plausible changes in pests and diseases as well as tuber quality have been discussed in this study. The results show that, by and large, the seed production in Punjab as well as ware crop in Agra, Gwalior, Patna and Kanauj is likely to face threats due to increased pest and disease pressure while the ware crop in Bardhaman may benefit due to less severity of late blight and improved processing quality. Seed degeneration may be faster and pests like mites and whitefly may become endemic. These inferences can serve as pointers to further studies.

LITERATURE CITED


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