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Characterization of the Groundnut Production Systems in India to guide the crop improvement efforts

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Introduction

Groundnut is an important source of income for farming communities in many developing countries like China, India, Nigeria and Myanmar. The groundnut production improvement is expected to have a significant impact on food and income security especially in these countries where food supplies are in deficit (Anderson et al., 2016). Currently, China produces ~35% while India produces about a 15% of global groundnut produce (FAO, 2016). Despite, India has much larger area under groundnut cultivation compared to China and this sole fact points out to large yield gaps in groundnut production on this sub-continent. In the presented work we will build up on the methodology for yield gap analysis using the mechanistic crop-growth modelling tools (Hajjarpoor et al., 2018) and try to map and dissect the groundnut yield variability and its causes in India.

Methods

Information on bio-geo-physical properties (weather, soil, crop, management) of these regions was collated and the SSM model used to reproduce seasonal variability and potential yield for the major groundnut producing districts. The difference between potential yield and water-limited potential yield mimicked the effect of drought in that district. Further, we estimated the difference between the weighted yield potential (according to the irrigation portion) and the currently achieved yields; i.e. yield-gap. Observed geo-bio-physical properties of the districts and simulation results of yield gap analysis were used to cluster groundnut-growing districts into units with higher degrees of similarities; i.e. homogeneous system units (HSU).

Results and Discussion

The results showed that India has the capacity of doubling the groundnut production -just by reaching 70% of the achievable yield- compared to the current production status (yield gap ~65%). Actual yields vastly fluctuate between the seasons and regions (~450-2000 kg ha^{-1}). Even though groundnut grows mostly in the rainy season (82% in Kharif season) but crop production in rainfed systems is largely limited by water availability during the season (~40%) with large variability in the drought stress effect on yields between the investigated districts.

Groundnut growing areas in India are divided into five agro-climatic zones according to some old map (Witcombe et al., 1998; Rathnakumar et al., 2013). However according to the results, the border between the old zone I and II is shifting to the Gujarat because of more water scarcely in the north than in the past. Now, Rajasthan is in the separate HSU #1 (Figure 1), characteristics with high drought effect (73%). Gujarat is in HSU #2, where low radiation is limiting yield potentials, although it shows low yield gaps, indicative of proper management practices. Old Zone III is expanded now in the center of India (HSU #3). HSU #3 is also under radiation-limitation production but has high yield gap, which indicates mismanagement and likely effect of diseases. Old zone V is now divided across three HSUs with different constraints, e.g. drought effects, rainfall amount, radiation and definitely different yield gaps. HSU #4 characteristics with high rainfall amount and the highest yield gap could be mostly constrained by diseases. HSU #5 has the lowest actual yield and the most groundnut area among the rest which could be a good target for breeders. The identified HSUs are proposed as authentic breeding units in crop improvement programs (target population of environments) in India.

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