Unreaped Yield Potentials in Major Rainfed Crops and Scope for Bridging Yield Gaps - A Decision Support System

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In each crop there exists huge yield variation (farmers' average yield) between districts in the country. A part of this variation can be explained by various climatic and edaphic factors in combination with irrigated area under the crop and season (kharif/rabi) in which it is grown. It is quite possible that within a cluster of districts (not necessarily be contiguous) with similar climatic and edaphic factors and share of irrigated area and share of a particular season in area under the crop, significant variation exists between districts with respect yield of a crop. Yield of a district that tops in a cluster may be regarded as potential yield for the remaining districts in the cluster and the yield gaps for the districts in the cluster may be estimated as lag from the potential yield.

Major districts were identified for each crop with criteria like area sown to the crop is more than 10,000 ha. In case of rice, a district with more than 20,000 ha area is considered as major district. The technique of multivariate cluster analysis was used for clustering major districts of each crop. The clustering variables used were climate, available water holding capacity of soil and per cent irrigated area under the crop. Climate was assessed by moisture index computed from rainfall and potential evapo-transpiration data for the years 1971-2005 [Raju et. al., 2013, Current Science, 105(4): 492-495]. Edaphic factors like soil texture and soil depth were summarized by computing available water holding capacity of soil [Raju et. al., 2015, Journal of the Indian Society of Agricultural Statistics, 69(1): 83-93]. In case of crops viz., rice, sorghum and maize share of rabi season area was used as 4th clustering variable. Share of kharif season area was considered as 4th clustering variable in case of blackgram and greengram crops.

Study of variation in yield between districts within a cluster vis-à-vis crop management practices adopted in those districts may be found useful in targeting the yield gaps in districts having relatively low productivity despite similar resources. The variation in crop management such as consumption of nutrients like Nitrogen (N), Phosphorous (P) and Potassium (K) and extent of use of High Yielding Varieties (HYV), etc. explained between district variation in yield within a cluster to a large extent. The yield gaps in the districts having relatively low productivity within a cluster may be attempted to bridge with a consideration of economic feasibility.

A decision support system (DSS) has been developed based on the work carried out. The DSS accommodates 17 rainfed crops viz., rice, sorghum, pearlmillet, maize, fingermillet, chickpea, pigeonpea, blackgram, greengram, lentil, groundnut, soybean, sunflower, sesame, rapesedd & mustard, castor and cotton. User has to select a crop and a district cultivating the crop. The DSS provides climate and available water holding capacity (AWHC) of soil of the district and share of irrigated area and share of a particular season (in case of rice, sorghum, maize, blackgram and greengram) in area under the crop and yield of the district in the crop. The DSS identifies 3 model districts having climate, soil, share of irrigated area under the crop and share of a particular season (in case of rice, sorghum, maize, blackgram and greengram) in area under the crop similar to the district (target) selected. It further provides yield achieved by model districts. If the target district itself is the highest yielding district in the cluster, a remark to this effect is generated. If there are only 1 or 2 districts with yield more than that of target district in a cluster, only those districts will be listed as model districts. The highest yield among the model districts may be regarded potential yield. The difference between potential yield and yield of target district is regarded as unreaped yield potential. The DSS gives unreaped yield potential and its % to potential yield and nutrient use in terms of N, P, and K and extent of adoption of HYVs in target district. Nutrient use in terms of N, P, and K and extent of adoption of HYVs were furnished for model districts also to explore scope for bridging the yield gap in those lines.

Sources of data used for the study: District-wise statistics of area sown under a crop, share of a particular season in area under the crop and crop-wise yield and area under irrigation were congregated from the websites of Directorate of Economics & Statistics (DES), Department of Agriculture, Cooperation and Farmers Welfare (DACFW), Government of India (http://eands.dacnet.nic.in) and Agricultural Census, DACFW, Government of India (http://agcensus.nic.in) and respective state government web sites. Year to year statistics greatly vary due to fluctuations in climate. Hence the statistics of 3 consecutive years were averaged (mostly data of 2008-09 to 2010-11) and used for the study. The three years average is expected to reflect the things that normally occur in the district and be close to normal estimates. The data of crop-wise nutrient use and use of HYV were drawn from Input Survey-2011 of Agricultural Census, DACFW, Government of India (http://agcensus.nic.in). Daily rainfall data (for years 1971-2005) published by India Meteorological Department (IMD), Govt. of India in 2008 at 0.5^0x 0.5^0 grid level was brought to district level. Potential evapo-transpiration (PET) data at district level was computed from average PET data for the years 1971-2005 published by IMD in 2008 for fairly distributed 144 locations in India. These data sets were used in computation of moisture index used for assessing climate of a district. Soil maps of NBSS&LUP and Dunne and Wilmott (2000) available at https://doi.org/10.3334/ORNLDAAC/545 were used in computation of available water holding capacity (AWHC) of soil at district level.

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