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## Findings

At several places in the study area land transformation has been carried out by the farmers themselves in order to increase the earnings from their agricultural land. Sandy soil is converted into silty clay soil locally known as *naili* and c*hhachar dakar*. *Naile* and c*hhachar dakar* are suitable for paddy and wheat crops while sandy soil is useful for crops like *bajra, guar,* barley, pulses, mustard, *taramira* etc. land transformation through human efforts has directly affected the cropping pattern of the study area. The study area receives average annual rainfall less than 200mm which can sustain the cultivation of crops like *bajra, guar, jawar,* gram, mustard etc. While the crops like cotton, wheat and rice require more than 200 millimeter of rainfall. Relative humidity of December and January less than 16 percent negatively affect the mustard crop and other crops while high relative humidity also affect negatively some of the crops due to increasing disease incidences. The impact of gradually increasing temperature as observed on wheat crop reduces the ripening time field life of wheat crop. Now a days, wheat crop is sown till December $15^{th}$ while harvested before April $14^{th}$ in the study area. At the time of harvesting wheat crop require $27^0$ C temperatures while in the study area temperature around this limit is observed during the last fortnight of March and similar observations are for *kharif* season crops like pappy and cotton. In study area during the months of January and February after western disturbances prevailing high speed hot and dry wind adversely affect the winter crop like wheat and mustard. High speed cold and dry winds decrease the average production of wheat and mustard. In June the prevailing high speed hot and dry wind locally known as *loo* also adversely affect *bajra* crop. The plants of *bajra* from sandy soil of Western Haryana are blown away.

Western Haryana experiences the moderate duration of sunlight on annual basis. There is enough sunlight available from the germination to fructification stage of the crops. Excellent quality as well as quantity of ground water in Gagghar catchment area promotes the cultivation of crop like rice and wheat while in the area of poor ground water quality like Siwani, north-eastern part of Loharu cultivation of crops depends on rainfall where both tube well and canal irrigation facilities are not up to the mark.

Canal irrigation was decreased by 18.73 percent from 1984-85 to 2014-15. In Bawani Khera, Loharu, Fatehabad, Tohana, Sirsa, Dabwali, Rania and Ellenabad all other tehsils reveals negative change in canal irrigation while Loharu tehsil recorded a 240 percent increasing canal irrigation. Tubewell irrigation in the study was increased by 542.43 percent during the study period while maximum change was found in Bhiwani Tehsil and minimum in Narnand tehsil. All tehsils revealed the positive change in study area under tube well irrigation. Field observations show that pesticides useful for paddy are harmful for cotton and other crops. So paddy and cotton cannot be grown on adjacent fields because during the process of spraying in paddy fields, brings about losses of cotton crops in windy weather. This kind of process promotes the monoculture in adjacent field. The use of N, P and K is directly affected the cropping pattern in western Haryana, wheat, the dominant crop of the whole region during *rabi* seaon requires maximum nitrogen from soil. To fulfil this requirement of nitrogen farmers input 500 kg/hectare of urea for *rabi* crop. In order to get maximum gain from a parcel of land imbalanced ratio of N, P and K is applied affect the cropping pattern of the study area.

Analysis of the impact of irrigation on cropping patterns in the study area reveals that provision of irrigation replaced less profitable crops with high profitable crops. Results show that in dry land of semi-arid region of Western Haryana paddy became the dominant crop in highly irrigated tehsils due to increased irrigation facilities during *kharif* season while in less irrigated tehsils *bajra* and cotton were the dominant crop due to limited supply of water for irrigation and dependence on rainfall during the season. Economically more rewarded crops like wheat and mustard in *rabi* season and rice and cotton in *kharif* season have much encroached upon agricultural landscape and have replaced less profitable crops like *bajra*, maize, *moong, guar, moth* of *kharif* season and barley in *rabi* season.

At village level, it is observed that paddy in *kharif* season and wheat in *rabi* cropping season are the dominant crops in highly irrigated villages. Paddy is sown on the land adjacent to both the sides of canals and their distributaries as well as where the permanent availability of water through minor irrigation exists. Farmers of the highly irrigated villages has adopted paddy as the replacement of other less remunerative crops like cotton (A),cotton (D), *bajra, guar, moong , moth* etc.

During *rabi* season wheat is the primary crop and mustard secondary crop. Farmers prefer wheat because Haryana government has adopted the policy of MSP on both wheat and mustard crops, however, there is upper limit of 6 quintal/acre for mustard to be covered by MSP, which de-motivate the farmers from the cultivation of mustard.