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RESEARCH ARTICLE

Changing Rainfed Agriculture: An Empirical Analysis of Pothwar Region of Punjab, Pakistan

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ABSTRACT

Pakistan is largely an arid country. The performance of agriculture in the arid and semi-arid areas mainly depends on rainfall. The present study was conducted in the rainfed areas of Pothwar region of Punjab, the main purpose of this study was to see the overtime changes in rainfed agriculture. So keeping in view the objective of this study both anthropological and sociological data collection and analysis techniques have been applied. Overall 136 farmers having above 50 years of age were selected as respondents of this study. The results clearly indicated increase in rainfed cropping intensity in the area. The estimated increase in Rabi cropping intensity was about 15.36%, while in Kharif seasons increase in cropping intensity was about 87.16%.Further the use of chemical fertilizers was much popularized in the area. Presently, 83.71% farmers applied fertilizers on wheat crop and 87% used on groundnut crop. The trend of using high yielding seed was also improved over the years. The increase in productivity of almost all major crops (wheat, groundnut, maize and gram) and minor crops (sorghum, millet, mungbean and brassica) was highlighted by the respondents. Resultantly, their farm income was significantly increased as it was pointed out by 73% respondents. All these positive changes in rainfed agriculture reflected that previously launched rural development programs and interventions were well planned with significant contribution in improving the rainfed farming system of the Pothwar region in Punjab, Pakistan.

INTRODUCTION

The importance of Pakistan's rural sector is evident from the fact that it is the mainstay for food security and earns about 50% of foreign exchange. It employs 42.3% labor force and has a share of 19.8% in national GDP. It also provides raw material for industries and serve as the main market for a large proportion of industrial products (Anonymous, 2015-16). Out of the total geographical area of Pakistan, about 62% consists of rural landscape. The share of rural population is 67% that is living in about 50,000 villages scattered countrywide (Anonymous, 2005). Pakistan is largely an arid country with 80 percent falling in the arid and semi-arid regions (Shah et al., 2011). Today Pakistan stands amongst the most arid countries. Climatically it is characterized as desert or near desert and half of the country receives less than 250 mm rainfall per annum (Farooq et al., 2007). In the past, less importance was given to rainfed agriculture (low potential) due to its intrinsic risks (Zia et al., 1997). However, rainfed areas are rich in natural resources. It sustains 80 percent of the livestock population and contributes 12 percent of wheat, 27 percent of maize, 69 percent of sorghum, 21 percent of millet, 25 percent of rapeseed and mustard, 77 percent of gram, 90 percent of groundnut, 53 percent of barley and 85 percent of pulses (Zia et al., 1996).

In Pakistan, the terms rainfed and dry land are used interchangeably (Rashid et al., 2004). Dry lands are the areas receiving less than 500 mm annual rainfall, where in Pakistan, about 75% areas receives less than 250 mm annual rainfall. Generally land resources of rainfed areas are characterized as less productive and marginal areas (Rashid et al., 2004).

Recognizing the importance of rainfed areas and the limited opportunities for crop production, a number of alternative development schemes have been launched during last 30 years. Among these schemes, construction

of small dams, establishment of dug wells and introduction of drought resistant varieties and provision of agricultural loans to small and medium farmers are considered as important interventions. As a result of these schemes, considerable changes in rainfed agriculture took place. The impacts of these changes were mainly positive and multidimensional. The present study is an effort to analyze overtime changes, factors responsible of these changes and technological issues limiting rainfed agriculture. Further, the aspects that had motivated farmers to adopt modern farm management practices were also a key objective of this study. This kind of micro level information is important for policy makers, planning and development professionals to streamline and devise the future developmental programs in the right direction.

MATERIALS AND METHODS

Both anthropological and sociological research techniques were applied in this study. For qualitative analysis, information was collected by using anthropological technique and for quantitative investigation sociological data collection and analysis techniques have been used.

Sampling

The sample size of this study was decided on the basis of total population of the villagers having age above 50 years. The main reason to select above 50 years respondents was to collect last 30 years development related information. Initially, a total of 150 farmers were interviewed but after completing the survey, information of 14 farmers was rejected due to poor quality of the data in terms of un-answered questions and queries. Finally, a representative sample consisting of 136 farmers was selected for detailed analysis.

Data collection and analysis

The methods of empirical and ethnological field research (quantitative and qualitative) were applied and connected with calculation methods of social sciences. An encoded questionnaire was used during the field work, the information acquired through structured questionnaire was codified, edited and analyzed by using SPSS software. For the interpretation of statistical results, additional material from secondary sources such as census reports, publications, research reports, unpublished studies, statistical reports, etc. was also consulted.

Case studies

As this study was conducted in far flung areas of Pothwar region therefore case study method was also used to verify the field observations and make the results more reliable and authentic. Overall, twenty six individuals were selected for detailed studies on different aspects of rural life, agriculture and overtime changes. The following analytical tools for data analysis were applied:

Crop intensity: The cropping intensity refers to rising of a number of crops from the same field during one agricultural year and was calculated using the following formula:

Cropping Intensity = (Gross Cropped Area / Net Sown Area) × 100

Percent change: Percent increase and/or decrease are measures of percent change, which is the extent to which a variable gains or losses intensity, magnitude, extent, or value. The percent change was calculated by using the formula as follows:

Percent change = (change/original) ×100

The mean/averages: The mean values were calculated by using the statistical formula:

Mean = $\sum X/N$

Where:

$\sum X$ is the summation for the scores

N is the symbol for the number of scores

RESULTS AND DISCUSSION

Socioeconomic characteristics

In development studies, age of the respondents is considered as an important variable and therefore respondents with age ≥50 years were selected for this study. For analysis, farmers were divided into four groups. Analysis showed that 38.97% respondents were in 50-55 years age group and rest 27.94% belonged to the 56-60 years age groups. The proportion of farmers having age from 60-65 years and >65 were 22.06 and 11.03%, respectively. The share of above 65 was kept intentionally low due to their less knowledge about new developments. The similar age groups have also been used by CIMMYT, 1993 while conducting an adoption study.The educational status of the farmers was also taken as an important variable in this analytical study. The percentages of farmers having education up to primary and middle levels were 37.5% and 25.74%, respectively. The strength of these two groups was more than half of the total sample. The share of farmers having education up to matriculation and higher levels were 15.44% and 6.62%, respectively and remaining 14.7% were illiterate respondents. Overall education level of the sample farmers was low because the respondents selected for this study were above 50 years and in the past, trend and facilities of education were not common in the villages (Habib et al., 2013).

Family size and composition

The results revealed that the average household size in jointly living families was 10.34 persons, compared to 5.91persons under single family system. The average number of adult males in single and joint family systems was 2.36 and 3.19, respectively. On similar

lines average family size was identified by Habib etal. (2013).

Income sources

In the past, agriculture and livestock were their main sources of income. However,presently 40.13% households pointed out that they earned their income from off-farm sources like shop keeping, labor work in addition to private and government jobs. A quite similar proportion of farmers (41.63%) highlighted agriculture as their major source of income and similar results found by Zahra et al. (2014). Only 18.24% respondents indicated livestock farming as a sole source of their income.

Average farm size

The size of land holding is considered important socioeconomic variable. The farmers having large land holding usually enjoyed power, higher social status and prestige in the society. The analysis showed that majority of the famers had farmssizes rangingfrom 8 to 187 Kanals with an average of 27 kanals of land per farmer. On average, majority of the farmers had 7.58 kanals of irrigated land. Similar findings had also been reported by Zahra etal. (2014).

Overtime changes in rural economy

The economy of village Chinji was primarily based on agriculture. Rainfed farming was predominant in the area. Wheat and groundnut were their main crops. During the last 30 years, lots of development effects have been made by different organizations to improve their farming practices along with natural and human resources. About the contribution of these organizations, majority of the people applauded the positive role of Agency for Barani Area Development (ABAD), Department of Agriculture and Livestock, Government of Punjab, National Rural Support Program (NRSP) and Punjab Rural Support Program (PRSP). During the last 30 years, these institutions have introduced new cash crops, high yielding and drought resistance varieties, improved farm technologies, irrigation facilities and high yielding breeds of animals. Due to these interventions, the study village experienced many changes in their farming activities. Among these changes cultivation practices, production technologies and post-harvest techniques were identified as prominent changes. These type of changes had also described by Hasan (2001) in his findings he pointed out that extensive trainings and awareness activities had changed the community approaches towards better production techniques.

Change in cropping intensity

The term cropping intensity can be defined as a ratio between the area under crops and the area operated by the farmers. It is reported in percentage form (Iqbal, 1989). Cropping intensity is influenced by various factors including soil type, soil moisture, improved technologies, financial and physical resources of the people. Similarly in the studied village, various organizations had provided interventions to improve the cropping intensity of rainfed agriculture; mainly they had provided agricultural loan, knowledge, skills, irrigation facilities and resource conservation technologies. These interventions had benefited the farming communities and improved their livelihood. The empirical results clearly indicated a significant change in both irrigated and rainfed farming systems of the area. In the rainfed farming system, the estimated increase in Rabi cropping intensity was about 8.62%. While in Kharif increase in cropping intensity was about 24.78%. The drastic increase in Kharif cropping intensity was due to induction of groundnut crop in their farming system (Figure 1). The analysis showed that due to development of irrigation facility Rabi season cropping intensity was increased by 23.32%. The availability of irrigation facility also increased Kharif season cropping intensity and that increase was about 17.61%. Among the respondents, majority of them (73%) had pointed out a significant increase in their farm and household income. Their social life was also improved considerably.

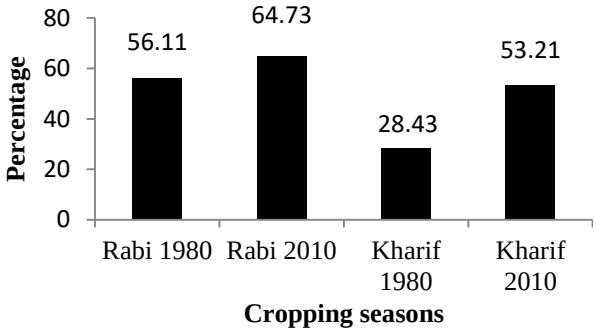


Fig. 1: Change in rainfed cropping intensity in sample farms

Use of improved seed

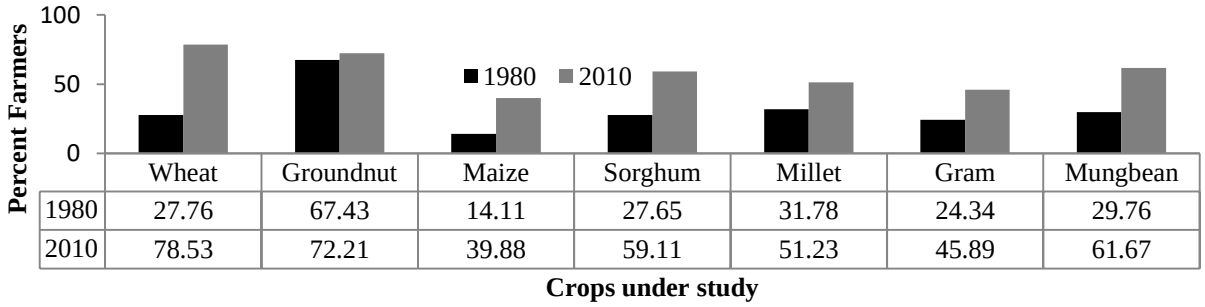
Traditionally, farmers planted only wheat crop in the Rabi seasons for which they used their traditional wheat varieties. The main reason behind the use of traditional varieties was non-availability of improved seed in the area. While over the years, increased population pressure and poor economic conditions had forced the farmers to replace their local seeds with improved high yielding varieties. Further, these varieties were also extensively promoted and demonstrated by the government and non-governmental organizations. Although change in seed had increased per acre productivity of almost all crops but comparatively increase in yield of wheat, groundnut and pulses was higher as compared to other crops (Figure 2). Furthermore, along with the improved seed varieties, farmers had also highlighted the use of recommended

quantity of seed. Change in this practice also improved the farm productivity. The importance of seed quantity in improving farm productivity was also analyzed and explained by Hagmann et al. (2003). Traditionally, 27.76% respondents used improved seed for wheat and 67.43% respondents used improved seed for groundnut crop which was quite less share in the year 1980. But over the years this trend was changed and presently 78.53% farmers are applying improved seed of wheat and 72.21% farmers applying improved seed for groundnut crop. The percentage share of farmers who were applying improved seed in the year 1980 for maize, sorghum, gram, millet and mungbean crops were reported as 14.11, 27.65, 24.34, 31.78 and 29.76% respectively. However, these trends were changed and now farmers used improved seed by 39.88, 59.11, 45.89, 51.23 and 61.67% for maize, sorghum, gram, millet and mungbean crops, respectively. During the last 30 years, this was a quite impressive development in the rainfed farming system, it had improved farm productivity and profitability in the rainfed areas (Figure 2).

Traditionally, farmers only used farm yard manure (FYM) in their fields. However, use of chemical fertilizers started in late 1970's and in the early years farmers were reluctant to use chemical fertilizers. Initially to promote the use of chemical fertilizer Agriculture Department established fertilizer demonstration plots in their villages. Subsequently, they have also organized farmer field days to discuss the performance and benefits of fertilizer application. Even in the beginning, department had provided these fertilizers free of cost to the farmers. Ultimately, due to the combined efforts of government institutions, input dealers and progressive farmers, use of chemical fertilizers was popularized in the villages and the mentioned development in the use of fertilizer was also identified by Ahmad et al. (2014). Hussain and Khan (1998) also noted that chemical fertilizer application had significant effects production of crops. Over the years, use of chemical fertilizers was much increased in the area and at present 83.71% farmers applied fertilizers on wheat crop and 87.23% farmers used chemical fertilizers in the groundnut field. The overtime changes in fertilizer application trends by crops are shown in Figure 3.

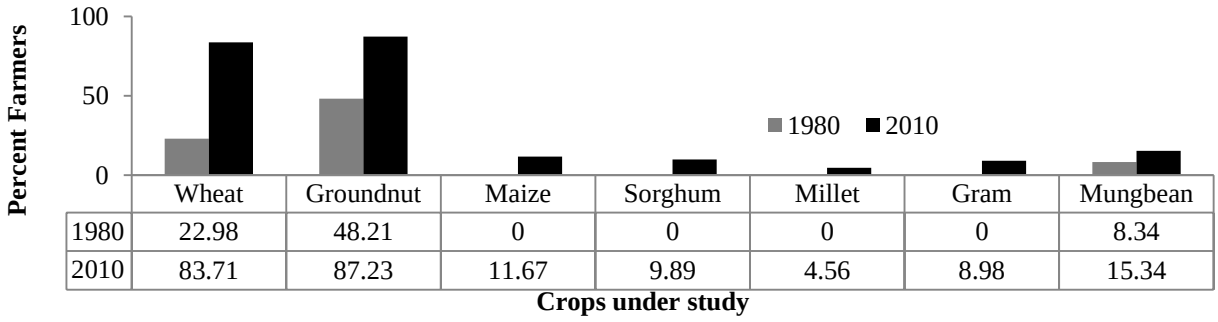
Productivity of major crops

In the study area, governmental and non-governmental organizations had introduced various agricultural development interventions. Among the given interventions, improved seeds, farm mechanization, rehabilitation of agricultural land, use of chemical fertilizers, development of irrigation facilities and new knowledge about production and marketing of agricultural commodities was common. Basically, these interventions had increased per acre yields of almost all major and minor crops of the area. The above mentioned agricultural developments were also identified by Zuberi (1989). Improvements in per acre productivity of major and minor crops had found their positive impact on crop productivity.



	Wheat	Groundnut	Maize	Sorghum	Millet	Gram	Mungbean
1980	27.76	67.43	14.11	27.65	31.78	24.34	29.76
2010	78.53	72.21	39.88	59.11	51.23	45.89	61.67

Fig. 2: Status of improved seed use in selected villages



	Wheat	Groundnut	Maize	Sorghum	Millet	Gram	Mungbean
1980	22.98	48.21	0	0	0	0	8.34
2010	83.71	87.23	11.67	9.89	4.56	8.98	15.34

Fig. 3: Fertilizer application trend in selected villages

Table 1: Overtime changes in the productivity of major crops

Crops	1980	2010	Percent change
	Avg. Yield (Mds/acre)		
Wheat	12.00	25.00	108
Groundnut	8.00	19.00	137
Maize	7.00	16.00	128
Gram	9.00	15.00	67

Source: Survey data

Table 2: Overtime changes in the productivity of minor crops

Crops	1980	2010	Percent change
	Av. Yield (Mds/acre)		
Sorghum	6.00	10.00	67
Millet	5.00	8.00	60
Mungbean	3.00	6.00	100
Taramera (Brassica)	3.00	5.00	67

Source: Survey data

Wheat: It was commonly grown crop and used as staple food in the area. There was considerable variation in grain yield due to land type and erratic rainfall in the area. The reported wheat yield during 1980 was about 12 monds per acre which was much less than the potential yield. These results are quite comparable with the findings of Badar et al. (2002). Since last three decades, Agriculture department had introduced and disseminated various high yielding wheat varieties in the area and farmers were motivated to adopt new cultivars and planting techniques. As a result of these efforts, wheat yield was significantly increased. The estimated per acre increase in wheat yield was about 108 % approximately.

Groundnut: The groundnut crop was cultivated as a cash crop. It's per acre yield was also varied due to biotic and abiotic factors. In the initial years, groundnut yield was between 8monds per acre but gradually high yielding varieties, better management practices and technical knowledge had improved groundnut yield. It is evident from the data that presently farmers are getting 19monds per acre which is significantly higher than the previous groundnut yield to a greater extent. The previous studies conducted byHussain and Prescott (2006) similar per acre yield of groundnut in the rainfed areas of Punjab, Pakistan.

Maize: The Maize is another important traditional crop of the Punjab area. It is dual purpose crop, important for human and animal consumption. Traditionally its yield was very low and gradually improved. Comparing the past and present situation of maize productivity, most of the respondents told that under conventional production methods their average maize yield was 7 monds per acre, but gradually maize yield was increased and goes up to the level of 16 monds per acre.

Gram: Gram is also important crop of the area and it is commonly grown in the rainfed area of Punjab. The Gram crop was mainly cultivated on marginal lands (piece of land away from the village) and its reported average yield was 9 monds per acre as indicated in the Table 1. The subsequent increase in gram yield was 67 % which is very encouraging (Table 1).

Productivity of minor crops

Generally, minor crops are cultivated on marginal lands and are not given due attention by the farmers. The main reason behind their negligence was the relative importance of major crops in the household economy. This neglect was also reported by Habib et al. (2013). The identification and information regarding overtime productivity trends of minor crops was analyzed and results are discussed as follows:

Sorghum: It was an important fodder crop used by both farming and non-farming household for their livestock population. Usually farmers allocated area to sorghum on the basis of their animal population. Mostly farmer preserved sorghum dry stalk to be used during the fodder scarcity months. The overtime data on sorghum productivity is presented in Table 2 showing an increasing trend in sorghum yield. The reported average increased yields of sorghum were 10 monds per acre. This improvement showed 67% increase in sorghum per acre yield.

Millet: Traditionally local people used millet flour for their own consumption. But over the years' the trend of using millet flour was reduced and it was replaced with wheat flour. Comparing the past and present yield trends, farmers reported that during 1980's average production of millet was 5 monds per acre, whereas; in the present years average yield of millet was reported 8 monds per acre. Overall, this analysis showed 60% increase in yield over the last 30 years.

Mungbean: The mungbean was generally grown for domestic consumption. Over the years, farmers replaced their indigenous varieties with high yielding ones. The findings clearly indicated overtime increase in mungbean productivity in the area. The average mungbean yield during 1980 was 3 monds per acre and presently it was improved considerably and gone up to 6 monds per acre. The estimated increase in mungbean yield was 100% as compared to the previous years. Discussing the overtime changes in mungbean productivity, some progressive farmers indicated that it could be further improved by adopting complete technological package associated with new varieties. The similar suggestions were also given by Suppleetal. (1985).

Brassica: The Brassica (Taramera) was mainly cultivated for both human and animal consumption. Over the last 3 decades, importance of brassica was due to decreasing trend of its consumption. Consequently, area and production of this crop also decreased. However, yield wise analysis of showed increasing trend in yield. Traditionally its yield was about 3mounds/acre that has been increased considerably up to 5mounds/acre (Table 2). Overall, it showed 67% increase in Taramera yield which was also encouraging

for the farmers. However, for the promotion of this crop, majority of the respondents suggested value addition and establishment of market outlets as important steps.

Conclusions and Recommendations

Conclusions of the study are based on empirical analysis and field discussions. Over the years, government and non-government organizations had made significant efforts to improve productivity of rainfed farming system. For this purpose they launched various agriculture development projects and also introduced many new agricultural technologies. The technology dissemination processes adopted by these organizations were effective and productive in term of improving farming activities. Majority of the respondents were in view that technologies and innovations introduced by these institutions had produced positive change in their farming system and livelihood levels. The directions and patterns of these changes were also encouraging. These changes had also transformed rural economy and improved socioeconomic parameters of the local communities. Over the years, cropping intensity and productivity of almost all major and minor crops was also improved. It is clear from the results that changes in rural economy was due to introduction of high yielding varieties, modern machinery and introduction of new crop management techniques. This technological shift has provided them an opportunity to diversify their income sources. Keeping in view, it is suggested that in future rural development activities and economic aspects must be taken into account while designing and implementing the developmental projects.

Authors' contributions

All authors contributed equally in designing the research, conducting the surveys and writing this manuscript.

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