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PROJECTED ANALYSIS OF CROPPED AREA CHANGES IN AGRO-CLIMATIC GUJRANWALA ZONE OF PUNJAB, PAKISTAN

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ABSTRACT

The present research study was planned during FY 2021-22 for projected analysis of the major cropped area changes in agro-climatic Gujranwala zone of Punjab, Pakistan. Projections were worked out with time series analysis "Auto Regressive Integrated Moving Average" (ARIMA (2, 1, 4) model) on the secondary data set of past 32 years (1990-2022). The projected percent change area of crops i.e. wheat, rice, sugarcane and maize were estimated at -0.58%, 1.5%, -1.66% and -0.21 for Gujranwala zone while same of crops estimated at 0.44%, 1.38%, 1.55%, -1.24% and -0.94 for Punjab respectively up to 2030. The yield of only cotton and maize is projected to decline over years from 2023 to 2030 with values of -0.78% and -0.21% respectively. While yield trends of wheat, rice and sugarcane is projected to increase (0.29% to 1.92%) over the same period at both levels i.e. Gujranwala zone as well as Punjab province against the Pakistan's population growth rate of 2.40 percent. Overall more than 82% cropped area lies under rice-wheat cropping pattern in Gujranwala zone. The remaining cropped area was recorded as rice-berseem (10%), sugarcane-wheat (3.5%) and maize-berseem/wheat (1%). Based on field survey crops data the descending order of net returns (PKR/acre) with BCR were estimated as Garlic, Potato, Sugarcane, Rice, Wheat and Maize (hybrid) respectively. The economic analysis depicted that there is a need to shift from production of low-value crops to high-value crops in order to make agriculture sector more profitable and competitive. With employed 'multiple linear regression analysis' the slope coefficients of independent variables i.e. support price and yield for dependent variable (wheat area) were calculated as 0.044 and 0.161 for Gujranwala zone while same of values 0.153 and 0.688 estimated for Punjab respectively. Similarly, the slope coefficients of described independent variables for sugarcane area were calculated as -0.132 and 0.00 for Gujranwala zone while same of values 0.028 and 0.006 estimated for Punjab. The reasons for comparatively declining area trends under major crops particularly in Gujranwala zone might be rapid urbanization, sudden climatic changes, labor shortage, lower support price, lack of farm mechanization and uneconomic land holding size etc.

Keywords
ARIMA model, Cropped area, Gujranwala; Net returns, Projected, Rice-wheat

INTRODUCTION

In Pakistan agriculture sector contributes 22.7 percent to the GDP and provides employment to around 37.4 percent. During 2021-22, the cropped area of cotton and wheat declined by 6.8% and 2.1% respectively. Self-sufficiency in wheat has been an objective of every Government and thus always challenges for the agriculture experts and policy makers; the production of wheat declined by 3.9%. Wheat production declined due to decline in area sown, shortfall in irrigation water and drought conditions at sowing (November-December

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month with zero rainfall), less fertilizers off take due to short supply as well as price hike and heat wave in March/April, though the government has increased minimum support price to Rs 2200/40 kg for 2022. While the cropped area of sugarcane, rice and maize increased by 8.2%, 6.1% and 16.6% respectively. Rice's production comprises of 34 percent of basmati (fine) types and 66 percent of coarse types (Govt. of Pakistan, 2022).

Pakistan's population growth rate of 2.40 percent is the highest in South Asia and stands in sharp contrast to the 1.0–1.5 percent growth rate of other South Asian countries (UNDP, 2019). Patterns of land use in Pakistan have developed through centuries and that may be attributed to different environmental and physical factors (Landform, soil, climate, water availability) as well as human factors (Population size, growth, economic demands, and cultural practices or customs). Agricultural land use is mainly determined by the distance to market (Von Thunen, 1960) and soil fertility pattern (Ricardo, 2002). It is the crop sector that serves as the last means for providing wheat, rice, sugarcane, cotton, vegetables, pluses and edible oils for the population. The crop sector also provides the necessary raw materials for the industrial sector to increase value added, which largely contributed to the growth of the industrial sector. Land use change (LUC) plays an important role in the study and analysis of globally changed scenario today (Shirazi, 2013). The growing socio-economic requirements of rising population is alarming and to overcome the increased demands, the pressure on available land resources will be high (Seto *et al*., 2002). The study of such variations in agricultural land can offer a better option for making a policy decision for future resource management and planning (Fan *et al*., 2007).

When Pakistan came into being in 1947, only 17 percent of the country could be called urban. As of 2020, 37 percent of the total population lives in urban cities, with a growth rate of 2.5 percent per annum (Mangi et al., 2020). With this massive expansion, industries have also expanded on to agricultural lands and have resulted in the subsequent pollution of water bodies required for farming. As rapid urbanisation has led to growth in the timber industry due to construction and housing needs, deforestation is also spoiling the natural habitat on the outskirts of cities like Lahore and Karachi. This also depletes the air quality and causes environmental damage affecting the future crops which require specific environmental conditions. There is a lack of vertical housing in Pakistan, which is causing encroachments on agricultural land and pastures and ultimately the demand for products and food items which cannot be locally produced has soared, leading to an increase in imports of such items.

The area and yield projections of agricultural commodities prove helpful for formulating government policies with regard to production, consumption, prices, procurement, marketing, storage and domestic and foreign trade. Like wheat is Pakistan's main staple crop and therefore essential for the food security of the country. Wheat is cultivated in various cropping systems such as rice-wheat, maize-wheat, cotton-wheat and sugarcane-wheat in Punjab, Pakistan. Rice-wheat and cotton-wheat contributed about 60% of the wheat area in the country (Latif et al. 2022). Over the past few years, Pakistan's wheat production has not increased at a rate to suffice local demand shifting the country from a wheat exporter to a wheat importer. This change may be due to climate change, lack of high yielding varieties, insufficient increase in support prices and declining agricultural land due to urbanization etc. The cultivated area under different crops is changing in agro-climatic zone of Adaptive Research Farm Gujranwala with the passage of time. There was a need to diversify and add more valuable crops to existing cropping systems to achieve sustainability and diversification.

The present study aimed at assessing the trends in acreage and yield in the studied area of Gujranwala zone and Punjab during the last 32 years and estimating the production potential up to 2030 by using suitable time series model. Therefore the present study has been planned for projected analysis of the cropped area changes over time in agro-climatic Gujranwala zone of Punjab; Pakistan so that any policy recommendation related to allocation of agriculture and natural resources may be given.

MATERIAL AND METHODS

Time-series data on Punjab's agriculture system of Pakistan (area and yield of major crops) for the period 1990-2022 was employed which was collected from Statistical Yearbook of Punjab Bureau of Statistics Lahore and

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Crop reporting service of Agriculture department. It was not an easy task to forecast the future production potential of agricultural crops because a large number of unpredictable exogenous and institutional factors are always involved. There are two main types of quantitative techniques that can be used in the forecast analysis: the causal or regression method and the time-series method. Time-series analysis is divided into four main forecasting models, namely the deterministic models, the smoothing models, the analytical models and the stochastic models. In this study, we use the type of stochastic models which is the Autoregressive Integrated Moving Average (ARIMA) model. The ARIMA model has chosen for analysis due to its suitability to our dataset and non-stationary nature of time series to be forecasted. The equation form of the model is as:

$$\mathbf{y'(t) = c + \phi 1^* y'(t-1) + \cdots + \phi p^* y'(t-p) + \theta 1^* \varepsilon(t-1) + \cdots + \theta q^* \varepsilon(t-q) + \varepsilon t.}$$

Where p and q refer to the orders of the auto regression and of the moving averaging, respectively, and Φ and θ denote the coefficients. This model has great statistical power for reliable forecasting from small datasets and requires data for only time series being forecasted but not for its determinants. In order to make the series stationary for production differenced series was obtained by putting the value of 'p' equal to 2, the difference or 'd' value equal to 1 and finally the order of moving average value 'q' was set to be 4. Therefore, the analytical software Statistix 16 was used for time series analysis by adopting ARIMA (2, 1, 4) model. AIC (Akaike Information Criterion) and BIC (Bayesian Information Criterion) values are estimators to compare ARIMA models. The lower these values, the better are the model. This confirms with the finding of a similar study by Najeeb et al. (2005).

Linear regression is a basic and commonly used type of predictive analysis. The regression analysis has uses like to determine the strength of predictors, forecast an effect and trend forecasting. Multiple linear regression is a regression model that estimates the relationship between more than one independent variables and one dependent variable using a straight line. A multiple regression line has an equation of the following form

$$\mathbf{Y = a + b_1X_1 + b_2X_2}$$

Where X_1 and X_2 are the explanatory variables and Y is the dependent variable. The slope of the lines are b_1, b_2 and a is the intercept (the value of y when x = 0).

Field survey was also conducted for primary data collection during FY 2021-22 for estimating cost and net returns of growing crops in studies zone. Six districts namely Hafizabad, Gujrat, M.B.Din, Narowal, Gujranwala and Sialkot being in the agro-climatic Gujranwala zone were considered for study area. The sample size of 120 respondents farmers having farming experience with more than ten years were selected with convenience and snow-ball non-probability sampling method keeping in view the time and cost constraints. The ratios employed for economic analysis according to CIMMYT, (1988) are given below as:

Net returns = Gross income – Total operational cost

Benefit cost ratio (BCR) = Gross income/Total operational cost

RESULTS AND DISCUSSION

As per latest available data the cultivated area (000 ha) of province Punjab and Gujranwala division was reported as 12531.62 and 1367 respectively. While district wise area (000 ha) in studied Gujranwala zone's districts Gujrat, M.B.Din, Gujranwala, Hafizabad, Narowal and Sialkot respectively were recorded as 236 (17.26%), 222 (16.24%), 292 (21.36%), 189 (13.83%), 177 (12.95%) and 251 (18.36%) (Govt. of Punjab, 2021).

As per data published by Govt. of Punjab (2022) total cultivated under major crops, i.e., rice, wheat, maize, cotton and sugarcane during 1996 to 2020 in Punjab, Gujranwala zone and districts of zone/division showed significant variations. The data was analyzed and arranged by calculating % change area (000 ha) difference over 5-years interval period. Regarding rice crop the maximum increase was recorded during 2016-2020 with values of 4.94% for Gujranwala division and 6.32 % for Punjab province. Similarly, the minimum decrease was recorded during 2011-2015 with values of -2.36% for Gujranwala division and 0.23% for Punjab province. Regarding rice wheat the maximum increase was recorded during 2006-2010 with values of 2.01% for Gujranwala division and 0.69% for Punjab province. Similarly, the minimum decrease was recorded during 2016-2020 with values of -1.41%

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for Gujranwala division and -0.46% for Punjab province. Regarding rice sugarcane the maximum increase was recorded during 2016-2020 with values of 3.95% for Gujranwala division and 2.93% for Punjab province. Similarly, the minimum decrease was recorded during 2016-2020 with values of -5.44% for Gujranwala division and 0.96% for Punjab province. Regarding maize the maximum increase was recorded during 2006-2010 with 4.31% for Gujranwala division while during 2001-2005 with 6.48% for Punjab province. Similarly, the minimum decrease was recorded during 2016-2020 with values of -6.89% for Gujranwala division and -3.4% for Punjab province. Regarding cotton crop it is work mentioning here that although it is a cash crop of Pakistan and our economy is agro-based industry due to textile sector mainly but in agro-climatic Gujranwala zone this crop is not grown in general due to infeasible agro-climatic conditions for cotton cultivation. Only some areas of district M.B.Din lying in this zone was prominent for cotton cultivation earlier to 1990s (Table 1).

Table 1: Land use change (%) of different major crops

Crop	Year/district	Gujarat	M.B.Din	Sialkot	Narowal	Gujranwala	Hafizabad	Grw.div.	Punjab
Rice	1996-2000	-0.39	5.75	1.31	2.3	2	4.4	2.56	4.19
	2001-2005	2.1	3.6	0.43	-0.89	1.62	1.93	1.47	1.83
	2006-2010	0.78	0.19	-2.4	2.93	-0.52	0.91	0.32	0.34
	2011-2015	-0.99	-4	-3.09	-5.86	-1.33	1.13	-2.36	0.23
	2016-2020	5.14	10.36	6.11	2.32	3.39	2.3	4.94	6.32
Wheat	1996-2000	2.78	0.63	1.39	2.56	1.29	2.01	1.78	0.95
	2001-2005	1.63	1.38	0.05	1.15	1.11	1.42	1.12	0.73
	2006-2010	1.56	2.24	2.22	3.5	0.52	2.02	2.01	0.69
	2011-2015	0.08	1.55	-0.88	-1.86	-0.65	0.45	-0.22	0.7
	2016-2020	0.02	-2.32	-1.63	-3.46	0.12	-1.21	-1.41	-0.46
Sugarcane	1996-2000	-1.85	-0.08	-11.17	-6.82	-10.63	-2.08	-5.44	0.96
	2001-2005	-6.77	0.19	2.89	-8.37	-4.35	-1.05	-2.91	0.61
	2006-2010	2.7	2.17	-1.67	-7.33	1.81	-2.1	-0.74	2.45
	2011-2015	-3.33	-6.98	-5	0	-3.33	1.65	-2.83	1.19
	2016-2020	8.67	1.45	13.33	3.33	-2	-1.07	3.95	2.93
Maize	1996-2000	2.63	13.56	0.82	-13.13	-15.46	9.52	-0.34	0.37
	2001-2005	-3.49	1.11	9.22	-2.99	-6.83	1.46	-0.25	6.48
	2006-2010	2.34	-0.04	14.26	-9.81	18.34	0.74	4.31	0.35
	2011-2015	7.81	-3.31	-12.78	-16.33	1.26	1.2	-3.69	5.96
	2016-2020	-32.98	-19.52	6.33	33.78	-7.09	-21.85	-6.89	-3.4
Cotton	1996-2000		-6.06					-6.06	-0.55
	2001-2005		-3.37					-3.37	0.74
	2006-2010		-3.96					-3.96	-6.44
	2011-2015		-8.01					-8.01	5.96
	2016-2020		0					0	-3.4

Cotton crop is mostly grown in certain districts in Punjab and Sindh province due to favorable growing climate. This includes especially the southern Punjab (Rahim Yar Khan, Bahawalpur, Multan, Bahawalnagar, Khanewal, Vehari, Lodhran and Muzaffargarh) and Northern/Central Sindh (Ghotki, Sukkur, Khairpur, Sanghar, Nawabshah, Matiari) (Bussay et al., (2009). Hence, during 2011-2015 the maximum area change (5.96%) was recorded for Punjab. On the contrary during 2006-2010 the minimum area change (-6.44%) was recorded for Punjab (Table 1).

The reasons for comparatively decreasing area under wheat, sugarcane, maize and cotton crops particularly in Gujranwala zone might be due to rapid urbanization, higher cost of production, sudden climatic changes, labor shortage, lack of farm mechanization and uneconomic land holding size etc. Wheat support price also remained lower as compared to market price during 2016-2022 which may depict the reason for declining area trends to some extent. However a slight increasing area trend was projected in rice crop with the possible reason of better national as well as international market price due to higher demand/population pressure and declining area as well as yield of substitute wheat staple crop at the same time.

As for as yield parameter for studied Gujranwala zone/division is concerned; among the major crops the yield of only cotton and maize is projected to decline over years from year 2023 to 2030 with projected yield change values of -0.78% and -0.21% respectively. While yield trends of wheat, rice and sugarcane is projected to increase over the

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same period at both levels i.e. Gujranwala zone as well as Punjab province with projected values of 0.29% to 1.92% as a whole (Table 2, Figure 1Figure 2). However, all these increase in yield change values are much lower than the Pakistan's population growth rate of 2.40 percent (UNDP, 2019). In this regard proper planning and execution should be framed by Govt. like restriction and ban to build residential colonies on fertile agriculture lands and promote town planning in barren lands, promoting vertical housing schemes overall, boosting vertical yield performance of crop sector through research and development, establish value addition industry and promote high value crops to earn more foreign exchange through trade.

Table 2: Model Statistics by using ARIMA time series model

Model	Model Fit statistics						Ljung-Box Q(18)			Projected values (weighted) up to 2030
	R-squared	RMSE	MAPE	MaxAPE	MaxAE	Normalized BIC	Statistics	DF	Sig.	
Wheat_area_Grw_div-Model_1	0.861	37.002	2.669	12.406	107.685	7.997	5.835	12	0.924	-0.58
Wheat_area_Punjab-Model_2	0.84	166.258	1.838	4.945	338.187	11.002	10.514	12	0.571	0.44
Rice_area_Grw_div-Model_3	0.768	33.822	3.289	11.948	94.388	7.818	7.455	12	0.826	1.5
Rice_area_Punjab-Model_4	0.923	93.183	3.276	11.032	261.132	9.845	12.45	12	0.41	1.38
Sugarcane_area_Grw_div-Model_5	0.886	3.756	5.114	16.328	7.559	3.422	9.42	12	0.667	-1.66
Sugarcane_area_Punjab-Model_6	0.755	46.57	4.55	13.337	88.957	8.457	6.97	12	0.86	1.55
Maize_area_Grw_div-Model_7	0.681	1.56	9.807	36.312	2.865	1.665	11.851	12	0.458	-3.57
Maize_area_Punjab-Model_8	0.836	79.573	7.837	61.563	298.581	9.547	6.664	12	0.879	-1.24
Cotton_area_Grw_div-Model_9	0.934	0.338	12.748	61.325	0.95	-1.412	15.103	12	0.236	-23.56
Cotton_area_Punjab-Model_10	0.711	174.793	5.873	25.163	358.892	11.103	8.386	12	0.754	-0.94
Wheat_Yield_Grw_div-Model_1	0.69	189.315	4.837	17.151	420.166	11.262	15.49	12	0.216	1.02
Wheat_yield_Punjab-Model_2	0.852	151.274	3.771	13.497	390.061	10.814	8.273	12	0.763	0.42
Rice_Yield_Grw_div-Model_3	0.9	107.034	4.674	10.406	197.506	10.104	9.924	12	0.623	1.33
Rice_yield_Punjab-Model_4	0.973	61.213	2.411	6.449	119.245	9.004	11.827	12	0.46	1.34
Sugarcane_Yield_Grw_div-Model_5	0.809	2.97E+03	4.378	10.743	6.07E+03	16.749	3.498	12	0.991	0.29
Sugarcane_yield_Punjab-Model_6	0.943	2.77E+03	3.931	11.762	5.51E+03	16.611	9.179	12	0.688	1.38
Maize_Yield_Grw_div-Model_7	0.87	658.011	13.256	41.037	2.79E+03	13.754	6.889	12	0.865	-0.21
Maize_yield_Punjab-Model_8	0.976	404.544	8.641	30.401	1.34E+03	12.799	9.689	12	0.643	1.92
Cotton_Yield_Grw_div-Model_9	0.341	130.089	14.867	37.327	309.221	10.495	9.196	12	0.686	-0.78
Cotton_yield_Punjab-Model_10	-0.081	330.792	11.606	40.224	751.79	12.378	11.306	12	0.503	0.81

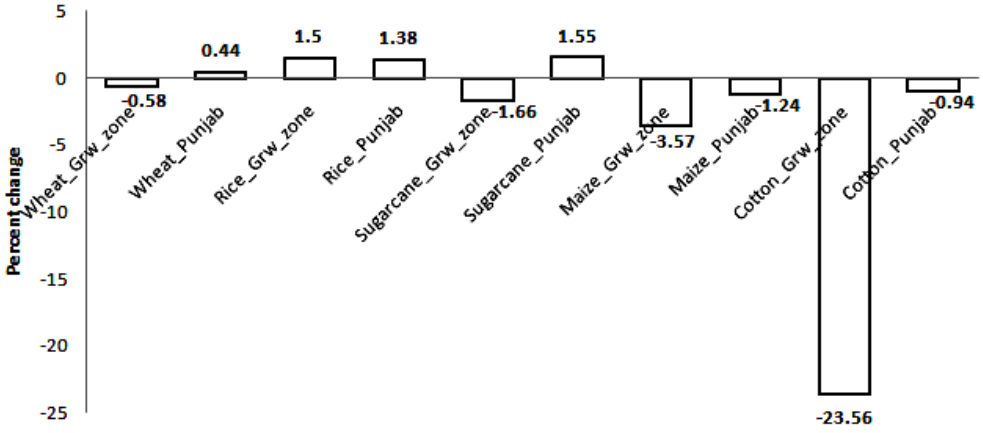

Figure 1: Projected cultivated area changes of major crops up to 2030

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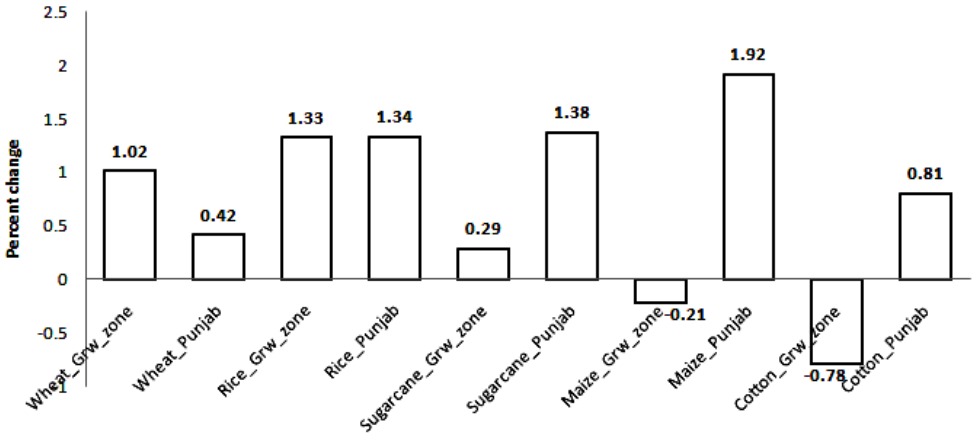

Figure 2: Projected yield changes of major crops up to 2030

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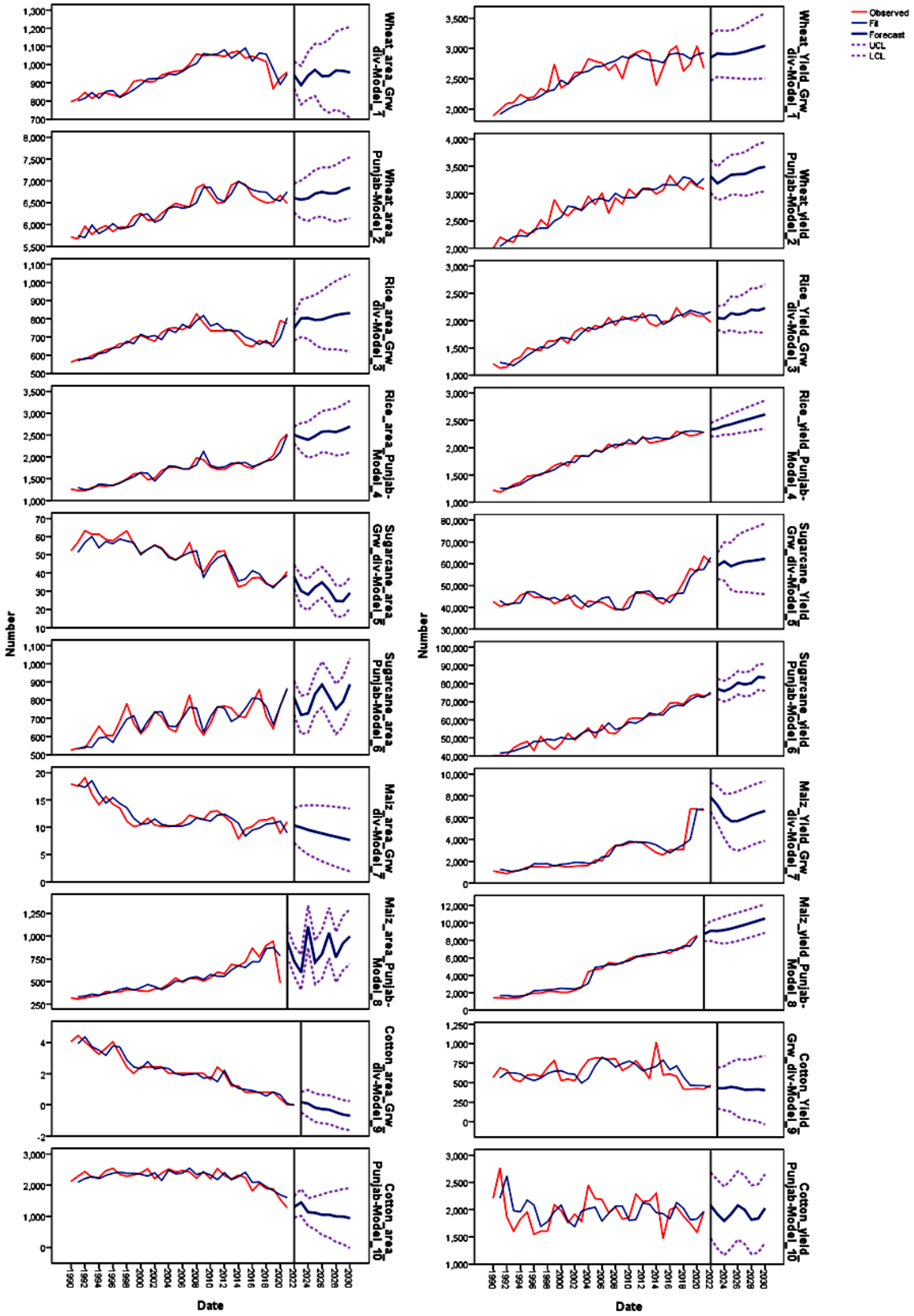

Figure 3: Projected values of area (000 ha) and yield (kg/ha) up to 2030

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Factors like machinery, irrigation, improved varieties, pesticide-use and other management techniques also caused an increase in yield but commercial fertilizer use seemed to be the leading reason causing an increase in yield. It is becoming difficult to maintain self sufficiency in feeding the increasing population as an increase in yield with increasing fertilizer ratio seems to be stagnant. Rapid urbanization and industrialization caused a major loss of agricultural land. In early 1990s, several different industrial regions had been developed largely on agricultural land decreasing the cropping area. Also cities have been expanded by building new housing colonies to accommodate an ever increasing population while sacrificing good agricultural land (Khan *et al*., 2012) explained that the natural disasters, like severe droughts of 1998- 2002 and 2004-2005 and severe flood of 2010, influenced strongly land use pattern in Pakistan. Soil erosion remains to be a severe problem in Pakistan. Improper land use has led to heavy soil erosion in barani lands. Water and wind erosion has affected 11 and 3-5 million hectares, respectively. Zia *et al*., (2004) concluded that about 11 million hectares are waterlogged with 5-10 feet water table depth in Pakistan. The soils affected by salinity and sodicity comprise 5.3 million hectares. Drainage capacity of the soils has been reduced by salinity, sodicity and water logging, resulting in less soil fertility, lower crop yield and biodiversity loss.

Field survey data collected during FY 2021-22 for estimating cost and net returns of growing crops as well as existing cropping patterns in studied Gujranwala zone also explained the projected trends of area and yield for major crops. Overall more than 82% cropped area lies under rice-wheat cropping pattern in Gujranwala zone. Percent share of cropped area under rice-berseem (10%), sugarcane-wheat (3.5%), sugarcane as ratoon (1%), maize-berseem/wheat (1%) recorded. While cropped area below 01% each were highlighted for fodder (pearl millet/sorgum)-wheat, rice-peas-wheat, maize/rice-potato, bajra/lentil/moong-wheat, maize-bitter gourd/cucumber/beans, mash-wheat and seasum-berseem/wheat. The prominent areas for highlighted specific cropping patterns are also mentioned in Table 3. The economic ratios like net returns and benefit cost ratio (BCR) were also computed. The crop wise information having highest to lowest net returns (PKR/acre) with respective calculated BCR were recorded as Garlic (PKR 204535/acre with BCR 2.47), Potato (PKR 168492/acre with BCR 2.69), vegetable items (range of PKR 43445-153553/acre with range of BCR 1.47-3.77), Sugarcane (PKR 70929/acre with BCR 1.92), Rice (non-basmati) (PKR 48741/acre with BCR 2.21), Rice (basmati) (PKR 40122/acre with BCR 1.86), Wheat (PKR 38970 with BCR 2.42), Maize (hybrid)(PKR 38187/acre with BCR 1.77), Onion (PKR 37950/acre with BCR 1.98), Moong (PKR 26509/acre with BCR 2.38), Seasum (PKR 20621/acre with BCR 2.07), Mash (PKR 12320/acre with BCR 1.8) and Masoor (PKR 9575/acre with 1.86). The detail is given in Table 3 and 4 as well as Figure 2 and 3. The analysis depicted that there is a need for shifting from production of low-valued crops to high-value crops in order to make agriculture sector more profitable and competitive.

Table 3: Cropping patterns with prominent areas of Gujranwala zone during FY 2021-22

Main cropping patterns	Percent share of cropped area	Prominent areas
Rice-Wheat	82	*Division Gujranwala*
Rice-Berseem	10	*Badomalhi, Kamoki*
Sugarcane-Wheat	3.5	*M.B.Din, Gujrat*
Sugarcane (Ratoon)	1	*M.B.Din*
Maize-Berseem/Wheat	1	*Noshehra Virkan, Badomalhi, Kamoki, Daska*
Others (fruits, vegetables etc.)	< 2.5	*Division Gujranwala*
Fodder (pearl millet/sorghum)-Wheat	< 2	*Division Gujranwala*
Rice-Peas-Wheat	< 0.5	*Daska, Wazirabad, Shakargharh*
Maize/Rice-Potato	< 0.5	*Noshehra Virkan, Daska*
Bajra/Lentil/Moog-Wheat	< 0.05	*Jalal pur Jattan, Shakargharh*
Maize-Bitter goud/Cucumber/Beans	< 0.05	*Noshehra Virkan*
Mash-Wheat	< 0.05	*Zafarwal, Pasrur, Jalal Pur Jattan*
Seasum-Berseem/Wheat	< 0.05	*M.B.Din, Badomalhi, Kamoki*

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Table 4: Economic values of growing crops in Gujranwala zone during FY 2021-22

Crop	Net returns (Rs/acre)	BCR
Bitter gourd	122532	2.72
Bottle gourd	72448	2.13
Brinjal	64957	1.7
Canola	49011	2.89
Carrot	43445	1.77
Cauliflower	87363	2.39
Cucumber	152360	2.43
Garlic	204535	2.47
Lady finger	56833	1.47
Maize (hybrid)	38187	1.77
Mash	12320	1.8
Masoor	9575	1.86
Moong	26509	2.38
Onion	37950	1.98
Potato	168492	2.69
Raddish	38292	1.93
Rape seed & mustard	42596	2.89
Red chilli	63888	1.87
Rice (basmati)	40122	1.86
Rice (non-basmati)	48741	2.21
Seasum	20621	2.07
Spinach	56952	2.46
Sugarcane	70929	1.92
Sunflower	45416	2.19
Tenda	153553	3.77
Tomato	61601	1.82
Wheat	38970	2.42

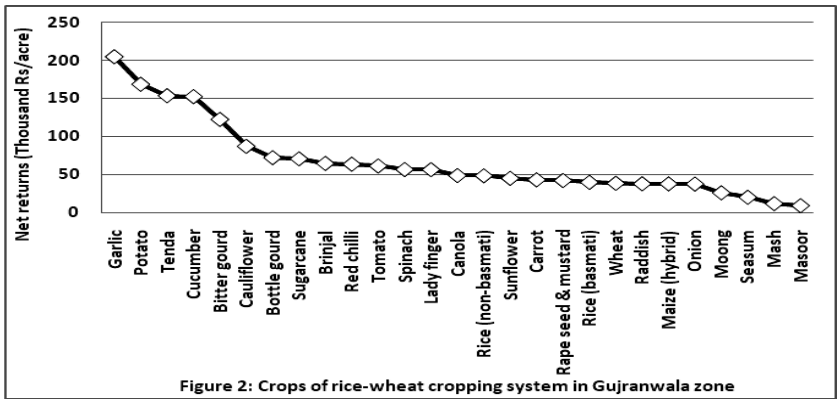

Figure 2: Crops of rice-wheat cropping system in Gujranwala zone

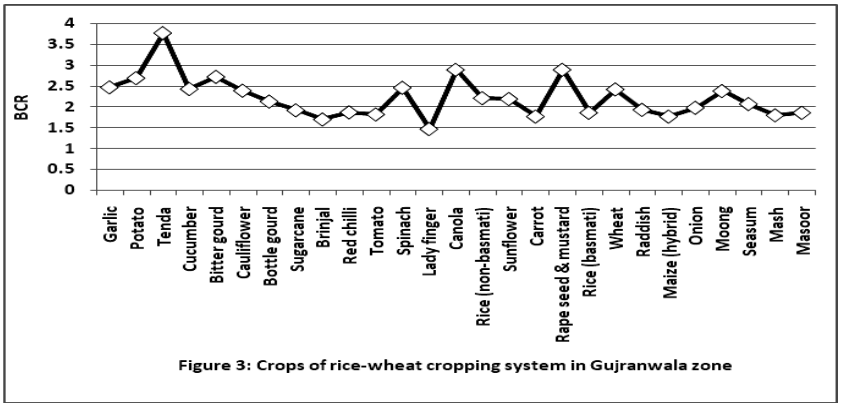

Figure 3: Crops of rice-wheat cropping system in Gujranwala zone

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The cultivated area under wheat crop is significantly changing among the major crops which further need to be investigated. The support price of produce and yield potential are always the important factors and variables to change the cultivated area trends of any crop. In Pakistan Govt. announced the support price of only wheat and sugarcane. Therefore by considering the support price of wheat as well as sugarcane the important the Linear regression analysis was also performed for the projected area of wheat and sugarcane crops as these crop's area are declining over time due to different factors described above earlier. The calculated statistical analysis is given in table 5, 6 and 7 regarding the following estimated regression equations:

Wheat Area (000 ha) of Gujranwala zone = 498.44+ 0.044 (wheat support price) + 0.161 (wheat yield kg/ha)

Wheat Area (000 ha) of Punjab province = 4334.2+ 0.153 (wheat support price) + 0.688 (wheat yield kg/ha)

Sugarcane Area (000 ha) of Gujranwala zone = 46.468 - 0.132 (sugarcane support price) + 0 (sugarcane yield kg/ha)

Sugarcane Area (000 ha) of Punjab province = 378.53 + 0.028 (sugarcane support price) + 0.006 (sugarcane yield kg/ha)

In this study R^2 ranges between 45% to 74%. In agriculture data set above of 40% is considered acceptable. The value of R^2 = 60% indicated that there is strong relationship between variables i.e. yield and support price to area of crop. R^2 denotes goodness of fit for the applied model (Table 5).

Regarding projected analysis of wheat area changes in Gujranwala zone the slope of independent variables (i.e. support price and yield) was calculated as 0.044 and 0.161 respectively to regress the dependent variable (i.e. area under wheat crop). The interpretation of 0.044 is that one unit increase in support price resulted in 0.04 unit increase in area. Similarly, for Punjab province the estimated slope of independent variables (i.e. support price and yield) was calculated as 0.153 and 0.688 respectively to regress the dependent variable (i.e. area under wheat crop). Regarding projected analysis of sugarcane area changes in Gujranwala zone the slope of independent variables (i.e. support price and yield) was calculated as -0.132 and 0.00 respectively to regress the dependent variable (i.e. area under wheat crop). Similarly, for Punjab province the estimated slope of independent variables (i.e. support price and yield) was calculated as 0.028 and 0.006 respectively to regress the dependent variable (i.e. area under wheat crop). The analysis showed that there was no significant effect of yield parameter to change in projected area. But support price effects were positively estimated only for Punjab province with negative effects for Gujranwala zone which further needed to be investigated (Table 7).

Table 5: Model Summary

Crop	Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
						R Square Change	F Change	df1	df2	Sig. F Change	
Wheat	Gujranwala zone	0.78	0.608	0.581	59.125	0.608	22.534	2	29	0	0.748
	Punjab province	0.862	0.742	0.724	200.994	0.742	41.745	2	29	0	0.993
Sugarcane	Gujranwala zone	0.863	0.744	0.727	5.12127	0.744	42.19	2	29	0	1.031
	Punjab province	0.671	0.45	0.412	67.4495	0.45	11.844	2	29	0	1.391

Table 6: ANOVA table

Crop	Model		Sum of Squares	df	Mean Square	F	Sig.
Wheat	Gujranwala zone	Regression	157545	2	78772.5	22.534	0.000
		Residual	101377	29	3495.76		
		Total	258922	31			
	Punjab province	Regression	3372912	2	1686456	41.745	0.000
		Residual	1171564	29	40398.8		
		Total	4544476	31			
Sugarcane	Gujranwala zone	Regression	2213.08	2	1106.54	42.19	0.000
		Residual	760.594	29	26.227		
		Total	2973.68	31			
	Punjab province	Regression	107764	2	53882.2	11.844	0.000
		Residual	131934	29	4549.43		
		Total	239698	31			

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Table 7: Coefficient values of used model

Crop	Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	95% Confidence Interval for B	
			B	Std. Error	Beta			Lower Bound	Upper Bound
Wheat	Gujranwala zone	(Constant)	498.44	102.35		4.87	0	289.11	707.76
		VAR(support price)	0.044	0.025	0.272	1.743	0.092	-0.008	0.095
		VAR(yield)	0.161	0.044	0.572	3.668	0.001	0.071	0.252
	Punjab province	(Constant)	4334.2	390.54		11.098	0	3535.4	5132.9
		VAR(support price)	0.153	0.106	0.227	1.441	0.16	-0.064	0.37
		VAR(yield)	0.688	0.162	0.669	4.239	0	0.356	1.019
Sugarcane	Gujranwala zone	(Constant)	46.468	8.934		5.201	0	28.196	64.74
		VAR(support price)	-0.132	0.017	-0.965	-7.974	0	-0.166	-0.098
		VAR(yield)	0	0	0.181	1.493	0.146	0	0.001
	Punjab province	(Constant)	378.53	155.23		2.438	0.021	61.047	696.01
		VAR(support price)	0.028	0.515	0.023	0.054	0.957	-1.026	1.081
		VAR(yield)	0.006	0.004	0.649	1.545	0.133	-0.002	0.013

CONCLUSION

The projected percent change area of crops i.e. wheat, rice, sugarcane and maize were estimated at -0.58%, 1.5%, -1.66% and -0.21 for Gujranwala zone while same of crops estimated at 0.44%, 1.38%, 1.55%, -1.24% and -0.94 for Punjab respectively up to 2030. Overall more than 82% cropped area lies under rice-wheat cropping pattern in Gujranwala zone. The economic analysis depicted that there is a need to shift from production of low-value crops to high-value crops in order to make agriculture sector more profitable and competitive. The reasons for comparatively declining area trends under major crops particularly in Gujranwala zone might be rapid urbanization, sudden climatic changes, labor shortage, lower support price, lack of farm mechanization and uneconomic land holding size etc.

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