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Dynamic impacts of environmental degradation on the production of agricultural crops and land rent: a disaggregates analysis of Pakistan

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Abstract

It is very common that less developed countries concentrate on agriculture to fulfill their basic needs of living. The maximum proportion of employment is entirely dependent on agriculture and other sectors that have least contribution to gross domestic product of the respective countries. Similarly the dependence on agriculture is significant in Pakistan which is sometimes exploited by the climatic changes. The climatic changes create impacts on all kind of stakeholders of the society, particularly agricultural sector. The objective of this study is to investigate the impact of climatic changes on agricultural crops (rice and maize) and land rent that is the form of farmer's income. The data of agricultural crops, land rent, and variable included in agricultural index and climatic index is collected from agricultural and metrological departments of Pakistan from 1993 to 2015. The data is regressed with Panel data analysis for four provinces of Pakistan. It is found that climatic variables are negative and significant with the dependent variables that are rice, maize and land rent, whereas variable included in agricultural index like tube wells consumption of fertilizers have positive and significant relationship with the dependent variables. The concerned departments may take the outcome of this study into consideration while making policies for said scenarios.

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Introduction

More or less every country, particularly less developed countries has an agricultural sector in the world which is considered as back by of the society. This sector fulfills food needs of the economy and provides employment opportunities to the maximum of its work force. It is necessary for every country to be efficient in securing and exploring the production of said sector. Less developed countries provide evidence that agricultural sector contributes more and an attempt towards development in these countries. The role of agricultural sector is ambiguous due to climatic changes showing positive impact on production of crops in the world. Schlenker, W., Roberts, M. J. (2008) made an attempt to capture impact of changes in climate for the yield of crops in United State of America. He discovered that temperature beyond the threshold levels harms the yield of crops. The destruction of climatic changes are not only affect agricultural sector but also pressurize to other integral sectors of the economy. This leads to create further pressure on regional and world economies. Climatic changes drastically create impact over land rent which badly affects production and put pressure over farmer's income. According to profit maximization principal, the land rent must be equal to the net revenue from the land.

The production function estimates the consequence of climate on the yields of precise crops that depends upon exogenous factors, like water resources, energy consumption etc. Its drawback is that it does not report the complete alternative ways to overcome changes in climate, adopted by profit concerned farmers. Efficient crop production system encourages economic development throughout effective market mechanism, as well as fertilizer, seeds, pesticide, agricultural machinery, and labor. Environmental quality may be effective through toxic waste emissions, directly or inversely, and polluted the environmental system may be a threat for crop yield. Therefore, an efficient association between agricultural inputs and output keeps the pollution emissions within the environmental competence. Here we developed a link for the following factors to describe the relationships between these systems. The Fig.1 shows the crop production process in general prospects.

Literature review

Many empirical studies have proved that different pollutants have different relationship with production level, and concentrate on few pollutants, such as sulfur dioxide (SO_2), nitrogen oxides (NO), carbon monoxide (CO), energy consumption, etc. The outcome of experimental work may vary from different research tools, time of studies, samples, and cross country or time series data.

The source of economic growth is integrally important to know the impacts of pollution on economic growth. Fischer, G., Tubiello, F. N., Van Velthuizen, H., Wiberg, D. A. (2007). Predicted long-run weather transform and that climatic change will lead to 3.4 % increase in annual agricultural sector profits. Arrhenius, (1896) and Nordhaus, W. 1982) speculate the impact of greenhouse effect due to emission of carbon dioxide in the atmosphere. The climatic changes have an impact on social and economics lives of individuals up to a great extent (Seo, S. N. N., Mendelsohn, R., Munasinghe, M. (2005). Initially, the impact of climatic change on agriculture was investigated by Adams R.M. *et al.* (1992) and Reilly j.*et al.* (1995) among others. Environmental degradation through emission of CO2 may also influence the crop production (Bloom 2006). The negative effects of CO2 emission can be minimized through introduction of technology innovation to increase crop yields (Brunke, M. A. *et al.* 2004). Sometime production patterns help to minimize the net Carbon emission (Smith *et al.* 2007). Rainfall patterns and socio-economic conditions are closely affected by climatic changes (Crawford, E. 1997).). The climatic change has adverse effect on mostly grain food availability, livelihood and socio-economic lives of individuals and is badly affected by the climatic changes. Downes, S. M., Bindoff, N. L., Rintoul, S. R. (2009). Describes that world needs to enhance crop production to feed projected nine million people by 2050.

The livelihoods of farmers get great deal of influence through climatic change, because it creates impacts on agricultural production and crop prices, production, demand, trade, regional comparative advantage, and producer and consumer welfare (Parry, M., Rosenzweig, C., Iglesias, A., Fischer, G., Livermore, M. (1999);Mendelsohn, R., &Dinar, A. (2003);Kurukulasuriya, P., Mendelsohn, R. (2008). The study by Gbetibouo, G. A., Hassan, R. M., Ringler, C. (2010) provides evidence of economic and physical vulnerability of farm land due to climatic changes. Different studies conducted to provide economic impact on farmer's livelihood (Schlenker, W. *et al.* (2006), accommodated three approaches, for agro-economic analysis; Computable General Equilibrium (CGE) Models, Ricardian cross-sectional and Hedonic Models. Land rent is an alternative contained by lease agreement and awards the lease right to expand the period, and typically land rent is necessary to pay the premium, such as an amount of money against the use of land for every year. Farmers can enhance economic benefits by using available information to absorb climatic shocks in any economy at any equilibrium. Farmers tend to substitute crop with suitable crops in prevailing climate shock to enhance their land revenues and rent (Polsky, C. (2004).Krishna Kumar, K. *et al.* (2004), investigated in their study that any odd changes in rainfall cycle affect the food grain yield, which in turn badly affects the livelihood of farmers. The mechanism of rainfall can be seen in the following Fig.2.

The availability of water resources, more or less is not continuous and smooth throughout the world Different researcher examined this phenomenon and found similar results. Qin, D. *et al.* (2009) examined the deficiency of water availability under climatic change and it's the result indicates that it is vital to review its impacts on socio-economic and environmental aspects.

Methodology

This study is subject to quantify the impact of climatic change on land rentandmajor agriculture crops. The data of climatic and crops variable is gathered from Meteorological Departments, Intergovernmental Panel on Climatic changes (IPCC), and Agricultural censes of Pakistan. Regression analysis is made for production level of each crop, land rent with different agricultural, environmental and dummy variables. For Models of each crop and land rent is incorporated for both OLS and Fixed Effects. Huseman test is applied to decide between Fixed Effect and Random Effect. The result suggests incorporating Fixed Effect approach in each Model and data set is consideredfrom 1993 to 2015.

Models

The following Models are incorporated to capture the impact of independent variable on production of maize,

$$[MAIZE_{it}] = \begin{bmatrix}\alpha_1\\ \alpha_2\\ \alpha_3\\ \alpha_4\end{bmatrix} + \begin{bmatrix}\alpha_{11} & \alpha_{12} & \alpha_{13} & \alpha_{14} & \alpha_{17} & \alpha_{18} & - & - & -\\ \alpha_{21} & \alpha_{22} & \alpha_{23} & \alpha_{25} & \alpha_{26} & \alpha_{27} & \alpha_{28} & - & -\\ \alpha_{31} & \alpha_{32} & \alpha_{33} & \alpha_{35} & \alpha_{36} & \alpha_{37} & \alpha_{38} & \alpha_{311} & -\\ \alpha_{41} & \alpha_{42} & \alpha_{43} & \alpha_{45} & \alpha_{47} & \alpha_{48} & \alpha_{49} & \alpha_{410} & \alpha_{412}\end{bmatrix} \begin{bmatrix}TUBW_{i1t}\\ MNMAXT_{i2t}\\ MNMINT_{i3t}\\ MNRFAPRIL_{i4t}\\ MNRFJULY_{i5t}\\ MZAR_{i6t}\\ AGRCRD_{i7t}\\ LENC_{i8t}\\ DBAL_9\\ DKPK_{10}\\ DPUNJ_{11}\\ DSINDH_{12}\end{bmatrix} + \begin{bmatrix}\mu_{i1t}\\ \mu_{i2t}\\ \mu_{i3t}\\ \mu_{i4t}\end{bmatrix}$$

$$\Longrightarrow A = \alpha + B * C + \mu$$

Where production level of maize is represented by matrix A which is the dependent variable, α is represented by intercepts matrix, B is a matrix of coefficient, C matrix represent the independent variables and μ represent matrix of stochastic error terms. In matrix C, $TUBW_{i1t}$ describe total number of tube wells installed for irrigation,$MNMAXT_{i2t}$ is the Mean of maximum temperature in a Year$MNMINT_{i3t}$, Mean of minimum temperature in a Year,$MNRFAPRIL_{i4t}$ is Mean of rainfall In April$MNRFJULY_{i5t}$is Mean of rainfall In July$MZAR_{i6t}$, maize area cultivated in hector, $AGRCRD_{i7t}$,Agricultural Credit given per hector$LENC_{i8t}$, logarithm form of energy consumption as used for a proxy of environmental degradation, $DBAL_9$, Provincial Dummy for Baluchistan,$DKPK_{10}$, Provincial Dummy used for Kheber Pakhtun Khawa,$DPUNJ_{11}$, Provincial Dummy for Punjab and $DSINDH_{12}$ is a Provincial Dummy for Sindh.

The following Models are incorporated to capture the impact of independent variable on production of rice,

$$[RICE_{it}] = \begin{bmatrix}\beta_1\\ \beta_2\\ \beta_3\\ \beta_4\end{bmatrix} + \begin{bmatrix}\beta_{11} & \beta_{12} & \beta_{13} & \beta_{14} & \beta_{15} & - & - & -\\ \beta_{21} & \beta_{22} & \beta_{23} & \beta_{24} & \beta_{25} & \beta_{26} & - & -\\ \beta_{31} & \beta_{32} & \beta_{33} & \beta_{34} & \beta_{35} & \beta_{36} & \beta_{37} & \beta_{38}\\ \beta_{41} & \beta_{43} & \beta_{44} & \beta_{45} & \beta_{47} & \beta_{49} & \beta_{410} & \beta_{411}\end{bmatrix} \begin{bmatrix}FCONSMP_{i1t}\\ MNMAXT_{i2t}\\ MNMINT_{i3t}\\ MNRFJAN_{i4t}\\ RICYLD_{i5t}\\ AGRCRD_{i6t}\\ LENC_{i7t}\\ DBAL_8\\ DKPK_9\\ DPUNJ_{10}\\ DSINDH_{11}\end{bmatrix} + \begin{bmatrix}\upsilon_{i1t}\\ \upsilon_{i2t}\\ \upsilon_{i3t}\\ \upsilon_{i4t}\end{bmatrix}$$

$$\Longrightarrow D = \beta + E * F + \nu$$

Where production level of rice is represented by D shows that which is the dependent variable, β is represented by intercepts matrix, E is a matrix of coefficient, F matrix represent the independent variables and ν represent matrix of stochastic error terms. In matrix F, $FCONSMP_{i1t}$ describe the consumption of fertilizer per hector,$MNMAXT_{i2t}$ is the Mean of maximum temperature in a Year$MNMINT_{i3t}$, Mean of minimum temperature in a Year,$MNRFJAN_{i4t}$ is Mean of rain fall In January,$RICYLD_{i5t,}$ rice yield per hector, $AGRCRD_{i6t}$,Agricultural Credit given Per Hector$LENC_{i7t}$, logarithm form of energy consumption as used for a proxy of environmental degradation, $DBAL_8$, Provincial Dummy for Baluchistan,$DKPK_9$, Provincial Dummy used for Kheber Pakhtun Khawa,$DPUNJ_{10}$, Provincial Dummy for Punjab and $DSINDH_{11}$ is a Provincial Dummy for Sindh.

The following Models are incorporated to capture the impact of independent variable on production of wheat, The following Models are incorporated to capture the impact of independent variable on Land Rent,

$$[LRENT_{it}] = \begin{bmatrix}\eta_1\\ \eta_2\\ \eta_3\\ \eta_4\end{bmatrix} + \begin{bmatrix}\eta_{12} & \eta_{13} & \eta_{14} & \eta_{15} & \eta_{16} & \eta_{17} & \eta_{18} & \eta_{19}\\ \eta_{21} & \eta_{23} & \eta_{24} & \eta_{25} & \eta_{27} & \eta_{28} & - & -\\ \eta_{31} & \eta_{33} & \eta_{34} & \eta_{35} & \eta_{37} & \eta_{38} & \eta_{311} & \eta_{312}\\ \eta_{41} & \eta_{43} & \eta_{44} & \eta_{45} & \eta_{47} & \eta_{48} & \eta_{410} & \eta_{413}\end{bmatrix} \begin{bmatrix}MNMAXT_{i1t}\\ MNMINT_{i2t}\\ MNRFSEP_{i3t}\\ WHTYLD_{i4t}\\ SUGYLD_{i5t}\\ MZYLD_{i6t}\\ WHTP_{i7t}\\ MZP_{i8t}\\ SUGP_{i9t}\\ DBAL_{10}\\ DKPK_{11}\\ DPUNJ_{12}\\ DSINDH_{13}\end{bmatrix} + \begin{bmatrix}\phi_{i1t}\\ \phi_{i2t}\\ \phi_{i3t}\\ \phi_{i4t}\end{bmatrix}$$

$$\Longrightarrow M = \eta + N * O + \phi$$

Where Land Rent is represented by M, which is the dependent variable, η is represented by intercepts matrix, N is a matrix of coefficient, O matrix represent the independent variables and ϕ represent matrix of stochastic error terms. In matrix O, ,$MNMAXT_{i1t}$ is the Mean of maximum temperature in a Year$MNMINT_{i2t}$, Mean of minimum temperature in a Year,$MNRFSEP_{i3t}$ is Mean of rain fall in September$WHTYLD_{i4t}$is wheat yield per hector,$SUGYLD_{i5t}$is sugarcane yield per hector,$MZYLD_{i6t}$is maize yield per hector,$WHTP_{i7t}$ is market price of wheat, MZP_{i8t} is market price of maize, ,$SUGP_{i7t}$ is market price of sugarcane,$DBAL_{10}$, Provincial Dummy for Baluchistan,$DKPK_{11}$, Provincial Dummy used for Kheber Pakhtun Khawa,$DPUNJ_{12}$, Provincial Dummy for Punjab and $DSINDH_{13}$ is a Provincial Dummy for Sindh.

Results and discussion

Rank analysis

According to Table1, Sindh province stands at first place in maize and rice production, Sindh is self-sufficient in crops product and has no need to import crops from other provinces to meet domestic needs. It is a rice exporting province as well. Punjab province is at the second in maize and rice, whereas KPK and Baluchistan are at third and four respectively in rice and maize production. Khyber Pakhtun Khawa (KPK) province is standing at third place in production in these two crops. Although KPK has moderate canal system still then it is at third place in production and good quality of land fertility, which indicate managerial issue with agricultural sector.

The Baluchistan Province is at the least position in all kinds of crop production, because of poor structural and governance infrastructure.

The canal system is very poor and majority cultivation is dvariable under traditional water resources, called 'Careaz' (underground stream for rain water).

Hence so farmers have least opportunities to increase crop production, yield and cultivated area, and their need are fulfilled through imports from other provinces. But Baluchistan is very rich in fruit crops and export it within and outside the country.

Table 1. Rank analysis of agricultural crops production, cultivated area, crops yield, crops prices and land rent in Pakistan.

Provinces	Crops production		Cultivated area		Crops yield		Crops prices		Land rent
	Maiz	Rice	Maiz	Rice	Maiz	Rice	Maiz	Rice	Lrent
BALCH	4	4	4	2	3	4	1	3	4
KPK	3	3	1	4	2	2	2	4	1
PUNJAB	2	2	2	1	1	3	4	2	2
SINDH	1	1	3	2	4	1	3	1	3

More or less Punjab and Sindh are in first and second position in utilizing maximum areas in crop production, even though a significant area of Sindh is barren due to big landlords holding thousands of hectors and unable to fully utilize it with given budget constraint. Same situation prevails in Baluchistan but in KPK land is not concentrated in few hands but governance problem exist there. The only solution is land reforms, which Pakistan could not implement since its Independence due to political pressure, because landlords are mostly in politics and in Government bureaucracy.

Table 2. Empirical analysis of Maize production.

Variables	OLS				FE			
	Model-1	Model-2	Model-3	Model-4	Model-1	Model-2	Model-3	Model-4
TUBW	0.0038	0.0031	0.0042	0.0036	0.0011	0.00064	0.00057	0.00087
	(5.52)*	(4.60)*	(6.50)*	(4.760)*	(2.51)**	(1.510)*	(1.174)	(1.72)***
MNMAXT	-48.038	-16.863	22.8115	-18.9745	-65.66	-30.92	-33.29	-25.56
	(-1.15)	(-1.4)	(-1.33)	(-1.51)	(-1.49)	(-1.34)	(-1.41)	(-1.49)
MNMINT	15.885	32.692	22.811	39.030	7.164	31.10	34.476	38.70
	(1.77)***	(4.04)*	(2.35)*	(3.394)*	(0.581)	(2.45)**	(2.11)**	(2.39)*
MNRFAPRIL	1.6316				2.670			
	(1.52)				(1.97)**			
MNRFJULY		2.2905	1.7611	2.1691		2.135	2.01	2.24
		(2.48)**	(1.74)***	(2.33)**		(1.82)**	(1.37)	(1.97)**
MZAR		0.9500	1.11			1.166	1.14	
		(3.35)*	(2.25)**			(3.07)*	(2.92)*	
AGRCRD	0.0425	0.0442	0.0431	0.0420	0.044	0.042	0.043	0.045
	(10.78)*	(13.74)*	(11.49)*	(13.03)*	(7.751)*	(9.12)*	(8.94)*	(9.153)*
LENC	-294.35	-427.94	-340.120	-543.346	-1225.82	-1590.11	-1734.77	-1632.25
	(-0.84)	(-3.90)*	(-2.08)**	(-3.338)*	(-3.166)*	(-4.44)*	(-3.07)*	(-1.653)*
DPUNJ			148.97				138.08	
			(0.50)				(0.33)	
DSINDH				-465.89				-377.99
				(--1.667)				(-0.69)
DKPK				143.200				377.28
				(0.411)				(0.48)
DBAL				-455.90				-252.27
				(-1.02)				(-0.24)
Constant	1428.68	602.117	2066.99	1005.39	794.448	-1159.7	-1259.85	-1200.40
	(3.26)*	(1.39)	(8.62)*	(1.65)	(1.80)**	(-1.41)	(-1.431)*	(-1.64)
Ad.R^2	0.925	0.9394	0.929	0.942	0.903	0.914	0.91	
F-Stat	(140.20)*	(157.92)*	(151.66)*	(149.74)*	(153.45)*	(134.49)*	(132.87)*	()*
Obs.	92	92	92	92	92	92	92	92

Sindh province is at the first place in rice yield but least in maize yields even though Sindh stands well in maize production, which raise a question on utilization of quality seed, fertilizer, etc., which are linked with crop yields in case of maize only but Sindh is looking efficient in other crops. Punjab province is considered as rich in adopting modern techniques as compared to other provinces but the results here does not match with its reputation. It lacks in rice yield but good in maize yields.

Table 3. An Empirical Result of Rice Production.

Variables	OLS				FE			
	Model-1	Model-2	Model-3	Model-4	Model-1	Model-2	Model-3	Model-4
FCONSP	1.048	1.033	1.137	1.162	1.116	1.067	1.241	1.181
	(19.55)*	(13.22)*	(9.35)*	(11.62)*	(20.36)*	(11.34)*	(8.014)*	(10.49)*
MNMAXT	24.783	25.167	29.62		26.230	27.956	34.729	
	(3.86)*	(3.81)*	(4.15)*		(3.41)*	(3.41)*	(3.61)*	
MNMINT	35.6724	36.060	33.520	5.1504	30.464	32.012	23.8672	12.365
	(7.11)*	(6.88)*	(6.40)*	(0.492)	(5.10)*	(4.950)*	(1.70)***	(0.945)*
MNRFJULY	3.067	3.046	4.167	2.042	4.471	4.4856	4.450	2.8479
	(1.99)**	(2.47)*	(2.36)*	(1.95)**	(1.78)***	(1.87)**	(2.31)*	(2.34)*
RICYLD	0.422	0.418	0.329	0.309	0.418	0.404	0.320	0.230
	(7.08)*	(6.867)*	(4.16)*	(4.47)*	(5.51)*	(5.12)*	(3.35)*	(2.59)**
AGRCRD		0.0008	0.00045			0.0023	0.002	
		(0.27)	(0.152)			(0.64)	(0.53)	
LENC			-211.92	-445.67			-267.31	-1053.7
			(-0.61)	(-1.15)			(-0.529)	(-1.465)
DPUNJ			-181.37				-551.94	
			(-0.432)				(-1.69)	
DSINDH				269.04				146.49
				(1.15)				(0.39)
DKPK				-516.03				-771.86
				(-2.11)**				(-1.58)
DBAL				-466.84				-837.98
				(-1.27)				(-1.16)
Constant	-1950.7	-1955.9	-1936.87	-673.82	-1839.80	-1869.19	-1570.9	-933.69
	(-9.5)*	(-9.42)*	(-9.36)*	(-1.626)	(-8.91)*	(-8.80)*	(-2.890)*	(-2.02)**
Ad.R^2	0.955	0.955	0.955		0.955	0.9551	0.955	0.963
F-Stat	(395.91)*	(326.39)*	(281.81)*	()*	(72.63)*	(69.39)*	(66.10)*	(80.54)*
Obs.	92	92	92		92	92	92	92

This shows some governance issues being faced by Punjab Agricultural Department, linked with salinity and water logging, which is increasing day by day in Punjab. Baluchistan is at good position of said crop yields. This shows that Baluchistan needs to improve with more attention.

There is no set pattern visible in price context for each province. The provinces which have more production enjoying less prices and vice versa true for high prices. The market prices of crops are set through market forces of product market. The factor other than demand and supply of said crops are hardly effective, but hoarding provides artificial shocks to market prices of crops in Pakistan.

The land rent scenario in Sindh and Baluchistan is at third and fourth place respectively, due to price fluctuation and abundant of land available for tenants at rent. Therefore excess supply of land on rent decreases the worth of it, and land owner is bound to rent it out at lower price. The situation is quite different in Punjab and KPK provinces since small ownership of land, mostly farmers cultivate on their

own and least land is available on rent. Hence worth of land rent is high in these two provinces than other provinces.

Emperical analysis

Ordinary least square (ols) and fixed effect (fe) approach results

Table2 expresses the result of particular regression equations for said set of variables, consist of dependent and independent variables. The dependent variables include the production data of maize, whereas the set of independent variables, Agricultural (credit, maize cultivated area and tube wells). Environmental (log of energy consumption, mean of maximum temperature, mean of minimum temperature, mean of rainfall in April and mean of rainfall in July) and dummy (provincial dummies of Baluchistan, Khyber Pakhtun Khawa, Punjab and Sindh) variables. Hausman Test is incorporated to make sure the fitness of Fixed or Random Effect, which indicate that all four Models customize the appropriate results with Fixed Effect Model.

Table 4. Empirical analysis of land rent.

VARIABLES	OLS				FE			
	Model-1	Model-2	Model-3	Model-4	Model-1	Model-2	Model-3	Model-4
WHTYLD	8.25 (5.14)*	9.440 (6.52)*	8.33 (5.60)*	6.263 (3.47)*	4.55 (4.31)*	5.81 (5.91)*	4.02 (4.02)*	3.219 (2.88)*
MZYLD	2.53 (1.90)**	0.730 (0.73)*	1.12 (1.48)	1.23 (1.72)***	0.91 (1.146)	-0.84 (-1.31)*	0.52 (1.24)*	0.280 (0.71)*
SUGYLD	143.35 (1.71)***				167.88 (3.99)*			
MNMAXT		-294.34 (-2.34)**	-392.140 (-2.116)**	-275.78 (-1.29)		-141.95 (-1.81)**	-412.63 (-3.85)*	-5.740 (-0.04)*
MNMINT	248.06 (2.83)*				249.77 (4.83)*			
MNRFSEP	25.55 (1.26)	23.29 (1.47)	22.315 (1.430)	19.1603 (1.22)	-21.18 (-1.57)*	41.83 (4.09)*	40.11 (4.23)*	33.51 (3.45)*
MZP	9.073 (2.94)*	12.01 (3.87)*	10.62 (3.59)*	11.326 (3.98)*	3.94 (1.71)*	6.49 (1.88)**	2.01 (3.85)*	4.06 (1.97)*
WHTP	19.6 (8.033)*	18.37 (6.72)*	18.76 (7.64)*	19.05 (7.95)*	15.11 (4.17)*	16.76 (5.64)*	13.573 (2.93)*	13.90 (3.15)*
SUGP	14.279 (0.44)				15.78 (0.99)			
DPUNJ			-495.371 (-1.96)*				-1824.38 (-1.35)	
DSINDH				6141.05 (2.23)**				491.116 (3.39)*
DKPK			-3224.24 (-1.01)				-596.719 (-3.27)*	
DBAL				243.981 (0.869)				222.68 (0.125)
Constant	-2083.2 (-5.28)*	-1102.2 (-2.51)*	-3275.96 (-0.41)	-7221.9 (-1.54)*	4208.2 (0.787)	1621.53 (2.16)*	25031.3 (3.941)*	8256.94 (1.64)
Ad.R^2	0.848	0.85	0.854	0.856	0.95	0.954	0.960	0.961
F-Stat	(72.18)*	(73.56)*	(66.51)*	(67.48)*	(61.013)*	(64.65)*	(72.99)*	(74.56)*
Obs.	90	90	90	90	90	90	90	90

The results are customized with OLS and FE approaches and describe that tube well (TUBW) is considered in all four Models, which shows a positive relationship with the dependent variable, maize production (MZPROD), is significant for both OLS and FE approaches except the third Model for Fixed Effects, in which it is insignificant. This indicates that maize production increases up to a significant level as number of tube wells increases. Mean of maximum temperature (MNMAXT), Mean of minimum temperature (MNMINT), are incorporated in all four Models, MNMAXT is insignificant but have negative

relationship with the dependent variables for both OLS and Fixed Effect, except the third Model for OLS. On average, with the increase in MNMAXT, production of maize decreases. Mean of minimum temperature (MNMINT) has positive relationship with the dependent variables and significant for each OLS and Fixed Effect regression analysis. Challinor *et al.* (2012) primarily examined the temperature consequences on the crop yield.

The result indicates that the average and elevated temperature are not the leading indicators to make a decision of crop yield, but intense temperature creates negative impact on crop yield.

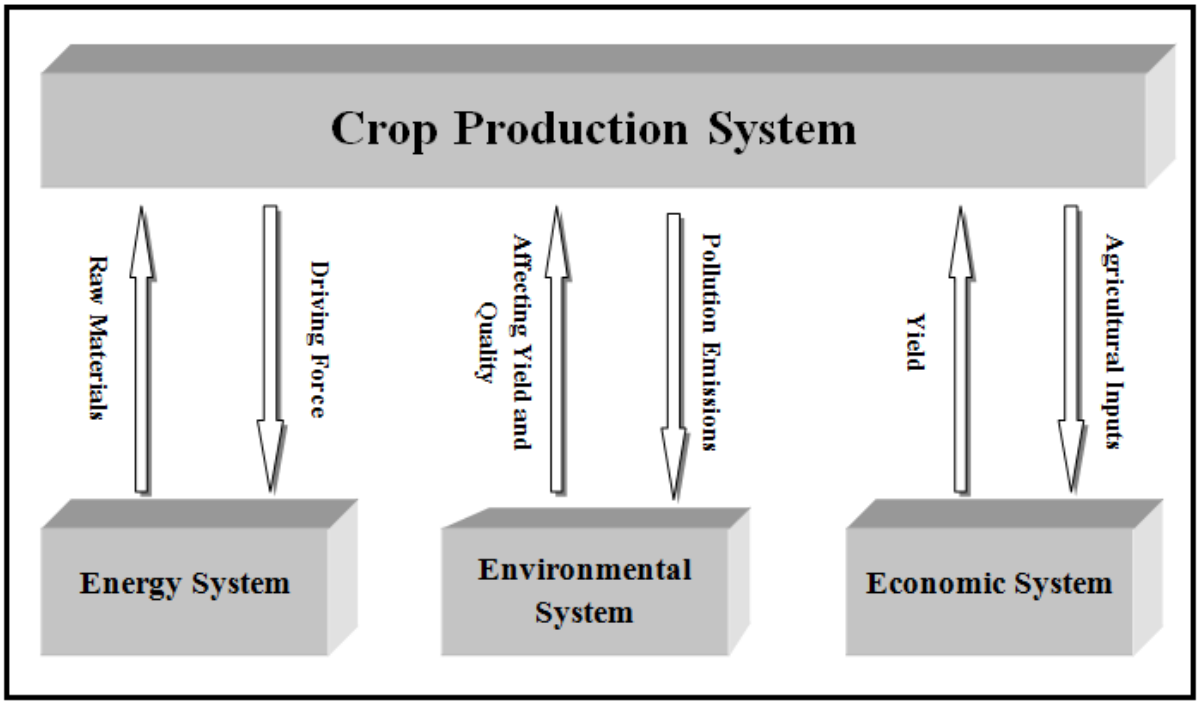

Fig. 1a. Crop production system in general Prospect.

This means that maize production increases with the increase in MNMINT. Mean of rainfall in April (MNRFAPRIL) is included only in the first Model, where it is positive and insignificant for OLS and positive and significant for FE approach, and mean of rainfall in July (MNRFJULY) is included in last three Models, where it is positive and significant for both OLS and FE, except for third Model in FE. The changing patterns of intense rainfall events are likely to have more production, transform farming production systems and able to diversify cropping patterns, processing, and off-farm activities to develop a smooth production system (Nelson *et al.*, 2009; Liverman and Kapadia, 2010). Cultivated areas for maize production (MAZAR) is incorporated in second and third Model where it is positive and significant for each OLS and FE analysis, clearly shows that with the increase in cultivated areas, maize production increases. Agricultural credit (AGRCRD) is included in all four Models, where it is positive and significant for each OLS and FE approaches. This means that farmers use the agricultural credit to buy modern agricultural technology, hybrid seeds, fertilizers, etc, the results shows that maize production increases, accordingly. Log of Energy Consumption (LENC) is included in all four Models, where it shows negative relationship with the dependent variable and significant, with the increase in energy consumption environment degraded and adversely affects the maize production. Chen *et al.* (2008) examined a study to check environmental impacts on agricultural phosphorus flow and found that surface water quality declines with the use of mineral fertilizer as a source of energy. Provincial dummies (DBAL, DKPK, DPUNJ, and DSINDH) are included in last two Models, where

these are insignificant, means the average of respective provinces are the same as average of respective variables of Pakistan.

Table 3 expresses the result of particular regression equations for the said set of variables. These variables are consisting of dependent and independent variables. The dependent variable include the production data of rice, whereas the set of independent variables, includes Agricultural (agricultural credit, maize yield and fertilizer consumption), Environmental (log of energy consumption, mean of maximum temperature, mean of minimum temperature, and mean of rainfall in July) and dummy (provincial dummies of Baluchistan, Khyber Pakhtun Khawa, Punjab and Sindh) variables. Hausman Test is incorporated to make sure the fitness of Fixed or Random Effect, which indicates that all four Models customized the appropriate results with Fixed Effect Model.

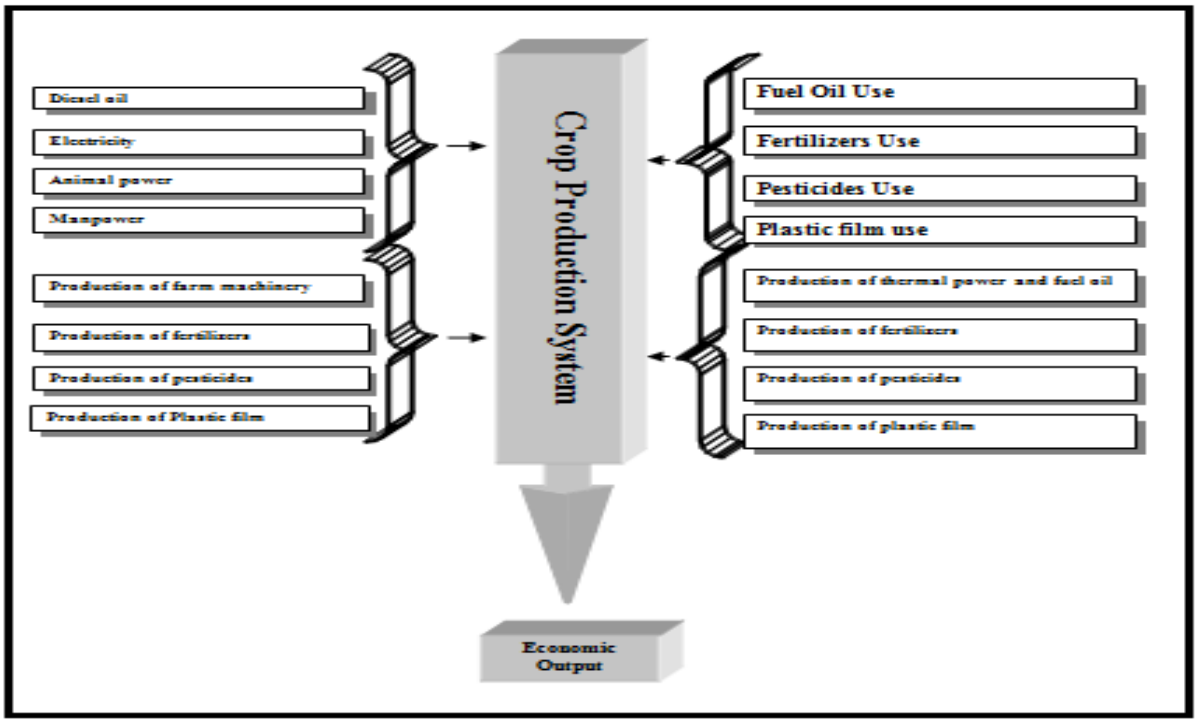

Fig. 1b. Crop production system in general Prospect.

Table 3 shows the results which are customized with OLS and FE approaches and describe that fertilizer consumption (FCONSP) is considered in all four Models, which shows a positive relationship with the dependent variable Rice production (RCPROD), which are significant for both OLS and FE approaches. This indicates that Rice production increases up to a significant level as fertilizer consumption increases. Spielman *et al.* (2010) explained that fertilizer can only be effective if it is used in time, otherwise it would remain ineffective. Fertilizers are normally purchased on credit. Small farmers are however advised not to take fertilizers on credit because it will be ineffective for them, (Feder*et al.*, 1985; Munshi, 2008; Duflo *et al.*, 2008).

Mean of maximum temperature (MNMAXT) is incorporated in first three Models, where it is positively affective and reported to be significant. Mean of minimum temperature (MNMINT), are incorporated in all four Models, it is positive and significant for each Model. In Pakistan, farmers get good results because of variation in temperature from province to province, due in specialization in certain crops and decide to grow temperature friendly crops. So, majority of farmers grow wheat at the end of December when the crop grows with the increase in temperature. This strategy create an impact on grain size, weight, and the number of grains per point (Koondhar *et al.*, 2016). Mean of rainfall in July (MNRFJULY) is included in all four Models, where it

is positive and significant for both OLS and FE approaches. The same result are supported by (Kurukulasuriya*et al.*, 2006; Guiteras, 2009; Schlenker and Lobell, 2010), and advocate the long term impact of rainfall on crop productions as a whole on agricultural sector.

Rice yield (RICYLD) is incorporated in all four Models, for which it is positive and significant. This means rice production increases with increase in Rice yield per hector. Krishnan *et al.* (2007) examined the effects of increasing CO_2 and temperature on rice yield and their results showed that rising temperature CO_2 absorption is capable of more rice yield, which is concerned with higher temperature. Yao *et al.* (2007) showed the impacts of CO_2 level on rice yield, showing that rice yield will increase with CO_2 effect, otherwise it will decrease. Agricultural credit (AGRCRD) is included in second and third Models, where it positive but insignificant for each OLS and FE approaches. This means that farmers are not using the agricultural credit efficiently to buy modern agricultural technology, hybrid seeds, fertilizers, etc., and outcome is not good as it was expected.

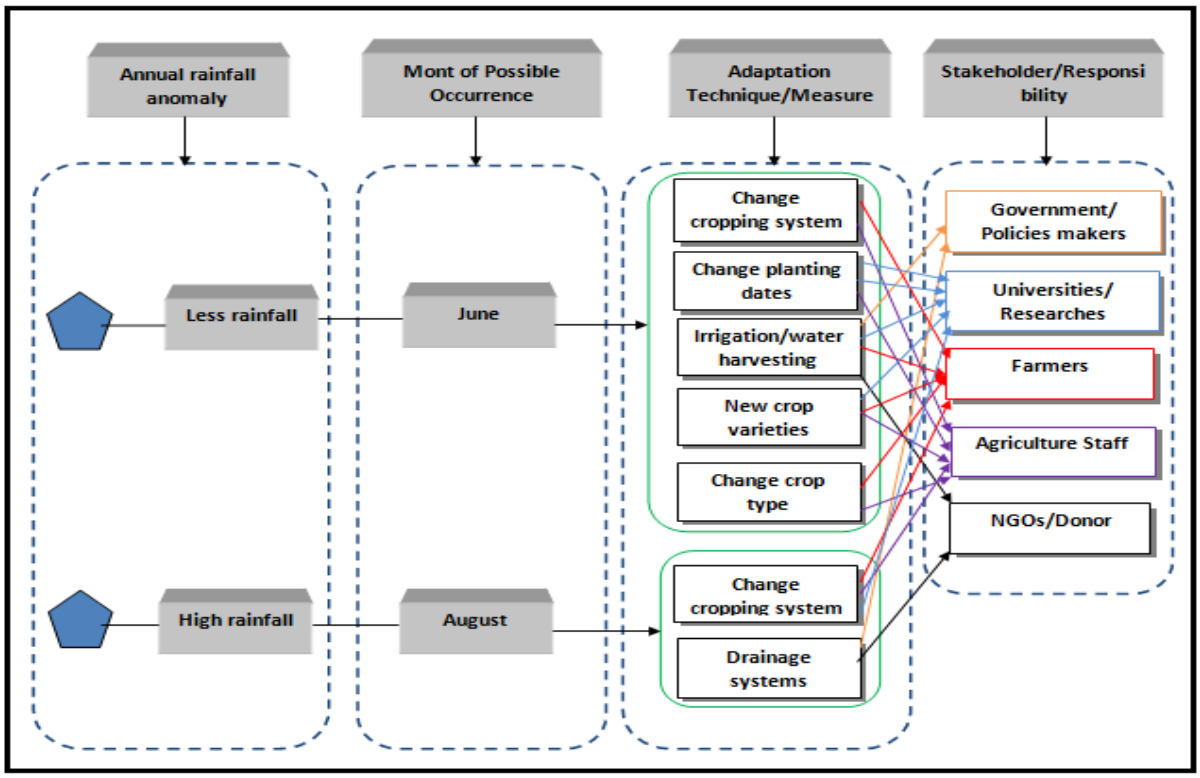

Fig. 2. Mechanism of rainfall and production process.

Log of Energy Consumption (LENC) is included in third and fourth Model, where it shows negative relationship with the dependent variable but is insignificant.

This means with the increase in energy consumption environment degrades and it adversely affects the maize production. Safa and Samarasinghe, (2012) analyzed the CO_2 emissions and noted that around 52% of the total CO_2 emissions were discharged from fertilizer use and around 20% came from fuel used in crop production. Provincial dummies (DBAL, DKPK, DPUNJ, and DSINDH) are included in last two Models, where DBAL, DKPK, and DSINDH are insignificant. This means that averages of respective provinces are the same as averages of respective variables for Pakistan. DPUNJ, is significant, and means that averages of respective provinces is different averages of respective variables of Pakistan.

Table 4 expresses the result of particular regression equations for said the set of variables, which consist

of both dependent and independent variables. The dependent variable includes the data of Land Rent, whereas the set of independent variables, includes Agricultural (Wheat Yield, Maize Yield, Sugarcane Yield, Wheat Price, Maize Price, and Sugarcane Price), Environmental (Mean of Maximum Temperature, Mean of Minimum Temperature, and Mean of rainfall in September) and dummy (Provincial Dummies of Baluchistan, Khyber Pakhtun Khawa, Punjab and Sindh) variables. Hausman Test is incorporated to make sure the fitness of Fixed or Random Effect, which indicates that all four Models customized the appropriate results with Fixed Effect Model.

The results are customized with OLS and FE approaches, and describe that wheat yield is included in all four Models where it is positive and significant. Maize yield is included in all four Models where it is positive and significant, but sugarcane yield is included in only the first model which shows positive and significant relationship with the dependent variable. It means that as crop yield increases and provides an initiative to farmers for more land rent from the tenant.

Prices of wheat, maize, and sugarcane are included in respective models, where these shows positive and significant relationship with the dependent variable. It means that increasing crop prices influences the farmer's decision to get more land rent from the tenant to increase their income level.

Mean of maximum temperature (MNMAXT) included in last three models, shows a negative and significant relationship with the dependent variable, it means when temperature crosses the threshold level then the tenant finds it infeasible for their working process, and in result land rent decreases.

Mean of minimum temperature (MNMINT), included in a model shows positive and significant results with the dependent indicator. Increasing temperature creates impacts on crop water productivity and provide shocks to other indicators like crop productivity, grain quality, etc. (Carter TR, and HulmeM, 1999). Mean of rainfall in September (MNRFSEP) is included in all four models, where it is positive but insignificant for OLS and positive and significant for FE approach. It means MNRFSEP is not helpful to increase the land rent because tenant don't think it feasible as much as it is expected. Provincial dummies (DBAL, DKPK, DPUNJ, and DSINDH) are included in last two Models, where DBAL, DKPK, which are insignificant, means the averages of respective provinces are the same as averages of respective variables of Pakistan. DPUNJ and DSINDH are significant, to show that averages of respective provinces are different from averages of respective variables of Pakistan.

Conclusion

This study find out that the places of each province in production of rice and maize, it can be concluded that Pakistan being an agricultural country needs to enhance the provision of agricultural accessories at a large canvas to provide economic stability to those who are engaged with primary sector, where 53 percent population of Pakistan engaged with this sector. Agricultural sector is still contributing high in gross domestic product of Pakistan. Funds are allocated in public books but do not show any physical contribution in said economy.

Pakistan has world largest canal infrastructure but from last fifty years could not construct a dam due to political conflicts and suffering worst energy crises because of this, majority of textile units have been shifted to Bangladesh to remain alive in economic circles. Similarly, Pakistan's ability to overcome climatic changes is questionable, since it has the least infrastructure, needs technical ability and resources to manage the ordinary climatic changes in every season.

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