Impact of Climate Change On Cash Crops in Balochistan:

By

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Abstract:

The thesis examines the impact of climate change on cash crops in district lasbella and sibbi. Further the climatic variables that affect is to be tested on production of cotton and sugarcane are temperature, i.e. minimum temperature & maximum temperature, rain and humidity. Data for the thesis analysis is of fifteen years from 2000 to 2014. Eveiws model of "OLS" is used for analysing data. Besides that, the estimation of the model shows the results that, in district lasbela on sugarcane productivity, 1°C change in maximum temperature decrease yield to 3.77%, but effect on cotton resulted fruitful and resulted 5.87% increase in yield, furthermore in district sibbi impact of maximum temperature on sugarcane; the yield increases to 5.75% but decreases the yield of cotton to 0.67%. Moreover, the impact of minimum temperature in district lasbella is that 1°C change in temperature decreases 1.68% sugarcane yield, and increases 4.4% cotton yield but in sibbi district sugarcane yield decreases to 5.68% and increases the production to 0.265% cotton yield. In district lasbela on sugarcane productivity the 1% change in humidity increase yield 0.40%, but on cotton impact of change in humidity is adverse, that is, 0.57% decrease in yield, furthermore in district sibbi the impact of humidity on sugarcane yield increases 0.48% and also increases the yield 0.35% cotton. Moreover, the impact of rain in both districts lasbella and sibbi resulted in same impacts, 1mm change in rain increases 0.005% sugarcane yield, but decreases 0.018% cotton yield. In sibbi district sugarcane yield increases 0.035% and no impact on cotton yield.

Keywords: climatic situations, humidity, ordinary least square, impact valuation, temperature variations, rainfall pattern, C4crops

Introduction:

Most policy documents continue preferring agricultural growth as part of an economic development strategy simply because the province is basically rural oriented society nearly 80 per cent of its population lives in rural areas. The review of macroeconomic indicators especially with reference to agriculture confirm its importance. Its tremendous potential is evident from the facts that it contributes 40% to GDP of Baluchistan and engages 67 per cent of the total labour force. Since twenty years Balochistan is affected worse than any other Province of Pakistan. Scarcity of water, drought, and due to decrease in snowfall and rain fall, underground water level downfall are the main issues of agriculture sector faced by province and masses. Due to drought in Balochistan 2.6%

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economic growth decreases and cost to twenty-five billion rupees to exchequer (PDMA, 2012). Unseasonal rainfalls also worst in shape of floods in province which destroyed crops and fields several years(UNHCR,2011). Nevertheless, climate change is a problem for our world too. Every country is in trap of it, either under developed country or developed one. Climate experts are too much worry about the current scenario going on. In fact, they are trying to cope with it and for this pressurizing industrialized nation to reduce the emission of green gas houses in atmosphere. Next because of climate change world is facing many other problems as the sea level rising, due to melting of glaciers. And also increase in precipitation levels. This shows the significance of this topic for agriculture sector of province and future income of the province and peoples. Changes in rainfall and temperature fall or increase is directly affecting the crops yield. It is more important than to cope with temperature changes scenarios with in time. Therefore, thesis significance is of too much for province. The main objective of the thesis is to find out the impact on production of cotton and sugarcane yield due to change in temperature, humidity percentage and change in rainfall. In many research works it is briefly explained with examples that Cotton and sugarcane are susceptible to weather changes. Increase in temperature or humidity or unseasonal rains directly affect the crops at different stages during germination, vegetative, tillering, reproductive and ripening phases. The impact either may be helpful or bad in case of output. Climatic variables as minimum temperature and maximum temperature, increase in or decrease in humidity, rain are the factors that affect the both crops phases. These factors due to climate change has been increasing or decreasing the sugarcane and cotton productivity influencing directly on crops productivity. Unseasonal rain falls usually destroy productivity and causes floods as in 2007 due to 'cyclone yemyin' occurred that influenced the crops and precious lives too in Makran division mostly. And also in 2010 the commission reported that due to floods irrigation infrastructure badly damaged by floods. Besides this due to floods in '2012', I million acre of cultivated land ravaged in Balochistan. As a result of this the significance of climate change study is of very important for Balochistan, to check the results how much cotton and sugarcane production would affected due to the climate change. The climatic effects are worsening our climate, that is, the ozone layer depletion. Due to these toxic gases is one amongst all. In this situation every country taking its part to curb this climate change effects, for our future generations and make a world a safer place for them and their future generations. In this situation the world biggest polluter China has taken a step to reduce its coal consumption which shows decline in 3.7% coal consumption in 2015 is a big turning point, and would shift to wind energy from coal which is friendly to our climate. Europe (Denmark, Spain, Portugal, Sweden, Germany, Ireland are top countries in the world) is the top continent in wind power energy. Obviously, this is a part of United Nations talk to agreement on climate deal known as intended nationally determined contribution (INDC's). On the whole this shows how much is the significance of climate change affects for the world and mostly underdeveloped countries like Pakistan. Evidently, Balochistan is the worst province that bearing the cost compare

to three other provinces because climate change in Pakistan, if we go through the past research work and the conditions. In brief its irrigation system went to dead point due to climate change ie, karaiz system. Besides extent of climate change is of very important for Balochistan for many reasons but the scope of this thesis just go through to check the impact of climate change on productivity of cotton and sugarcane in district sibbi and lasbella. Due to climate change the temperature is increasing. This increasing temperature in May, June and July and also in December, January and February is affecting the productivity of cotton and sugarcane. Whereas Scarcity of water as climate change in Baluchistan district is on worse, so its scope increases more as many sectors are affecting by climate change. The climatic variables, as maximum temperature and minimum temperature increase or decrease definitely impact on cotton and sugarcane productivity directly. And also, humidity is important factor for cash crops in both districts as change in humidity level impact both crops, which is taken consider in the thesis. Unseasonal rains are due to changes in climate and they also affect the crops productivity which is also an important factor here in this thesis. In Balochistan (sibbi & lasbela) little bit increase because the weather bit hotter and then its effects may occur on productivity of cotton and sugarcane and unseasonal rains may affect the crops too. Therefore, the varying temperature, humidity, rain is of very important factor for this thesis. So this thesis scope is too much for the cash crops productivity and future assessment of yield.

Literature Review:

The temperature affects the boll shedding in cotton at 35 ˚C and the number of fruiting sites with increase in temperature increased (Hodges et all, 1993). In 2000 a research conducted by ' Lewis ' showed that in a hot year the number of seeds per boll decreased 23.6 seeds per boll with mean maximum temperature of 36.6 ˚C in July whereas with a temperature decrease to 32.2 ˚C in same month was 28 seeds per boll. Frost incident may be lesser which produce low quality cane and this happens due to cold temperature. "Chandiposa" in a thesis showed with results that the climate change has a sever effect on sugarcane, I.e. the drought, rain, temperature Mathieson (2007). Study conducted by "Alexander" in 1973 proved that during the season of harvesting vary occurs in sucrose level, more sucrose collection occurs during the last stage of sugarcane cycle, when the sugarcane has contemptible development rate, that qualified by unfavourable conditions in weather. In the research thesis by "Scarpari and Beau Clair" in 2004 categorised two type of farmers that cultivate sooner and later. The sooner one farmers of sugarcane are more sensitive to weather conditions and ripening sooner. Opposite is the case with the farmers that cultivate late, they are less sensitive to weather conditions for ripening and reach the highest till the end of harvest season for sucrose level. Research thesis by "Keating" in 1999 summarized that weather changes has too much impact on productivity and quality of sugarcane. And also, temperate water shortages with lack of nitrogen and contemptible temperature are most efficient ripening agents. In 1962 a research conducted by "Clement" proved that due to dry weather and low

temperature sugarcane growth retard which may cause to reduce the sucrose levels. In “1983 Waggoner” showed that how crop yields may be affected by climate, i.e. by moisture and temperature. Future climate change affects may be severed as compare to past climate changes (Mendelsohn, 2007). Houghton et al. (2001) projected that temperatures may increase 1.5◦C to 5.8◦C and precipitation patterns to shift by 2100 due to extra releases of greenhouse gases in atmosphere. In "Pakistan general of meteorology" the projected changes in temperature and precipitation of 1931 to 1990 data scenarios were generated by "SCHENGEN" model, which resulted gradual increase in temperature and decrease in rainfall in western and soth-western coast line of Balochistan. And also, changes in humidity level which decreased to 5%. United nation development program, Quetta office with the help of Balochistan University of information technology and management sciences and Balochistan provincial disaster management authority in 15th of September, 2015 presented a thesis for formulation of drought mitigation policy. That in detail showed that in fact Balochistan is the most affected province of Pakistan directly and indirectly affected by climate changes because 60% to 70% affected by it. Meanwhile due to drought the water table affected which directly affected agriculture sector and also food shortages occurring. Finally, according to the finance ministry report Justin 2012 due to drought 25 billion cost to exchequer. 176millimeters of rain falls annually in Baluchistan whereas western part receives 50-millimeter annually which is very low to affect crops. Yet, water shortages which increased 60 % in Balochistan. According to "ICUN" report Rain fall pattern has also changes in Baluchistan, some time there is no rain for six to seven months and suddenly rain fall. Study conducted by "Jaynat Kumar Rotry and Mohammad Ashraf" that Balochistan is prone to drought and has been impacted severely during 1998–2002. Study conducted by Azmat Hayat khan, anjum Bari and Hazrat mir on climate change perspectives related with Pakistan. Following this in Balochistan about 5% decrease in humidity has observed and also increase in solar radiation observed in countries southern parts. Using "Schengen model" from period of 1931 to 1990 they get results of increase in temperature and decrease in rainfall in western parts of Balochistan and south-western coastline. Monsoon precipitation increased elsewhere except in coastal regions (where there was a significant drop) and the Western Baluchistan Plateau during 1951-2000 • during the above period, the winter rains decreased by 13-20% in western Baluchistan (GCISC).

According to PDMA report published in 22th of December in 2011, as a basically agricultural economy Pakistan may face food insecurity and decreased per yield productivity due to climate changes in future. Rosen Zweig in 1995 fined indication for significant threshold belongings. For example, their outcomes show largely positive crop yield responses to temperature rises of 2°C increase but yield declines at 4°C temperature rises. In the studies cited in "IPCC, 1996" showed that crop effects in lower spaces or latitudes lean towards to be more non-productive than crop impacts in higher latitudes, mostly with respect to maize and wheat yields. And also, the results of Smith in 1996 that rice yields are less variable than wheat and maize yield impacts. Relatively higher increase in

maximum winter temperatures was observed, whereas minimum temperatures during winter showed a slight decline. These results suggest that days have become warmer whereas nights have become cooler during the winter season in the high mountain areas. Monsoon temperatures (particularly maximum temperatures) have also increased in both the regions. More interestingly, maximum temperatures in the transitional periods "October-November" and "April-May" particularly in the high-mountain areas are at a rising trend. All these changes and seasonal variations have important implications for water resources and agriculture in the mountain areas in particular and for Pakistan in general. The results indicate that the maximum temperatures have increased all around the year particularly in the high mountain region during the last 30 years. Winter temperatures have increased in both sub-mountain and high-mountain regions during this period. Rainfall has also increased in both regions. Their thesis concludes that the increasing trends in temperature in the high mountain areas may have some positive impact on crop area and yields. However, these rising temperature trends may increase the melting of glaciers and snow, reduce snow accumulation during winter and enhance the overall de-glaciations process and therefore could well endanger the country's sustained sources of fresh water from glaciers and snow melting. Analysing the impact of water and agriculture in the mountain regions of Pakistan, that is the high mountain regions which are mostly winter areas and the monsoon or sub mountain regions. They evaluated the thirty years' data from "1971 to 2000" and find out that the winter temperature has increased in monsoon or sub mountain regions and high mountain regions. On the basis of results, they found that high mountain areas in winter's days' change bit warm whereas nights bit cold. These occurs relatively because of increase in day temperatures and decrease in night temperatures. Yet, monsoon temperature has also increased in both regions and in high mountain regions the temperature has increased which has non-productive impact on glaciers as increase occurs in melting and which may affect fresh water and agriculture. The thesis concluded that this may have some positive effects on crop productivity in high mountain areas further they said that due to this rain fall has also increased in both regions (Syed Sajidin Hussain et al., 2005). The study by GCISC (Global change impact studies centre), 2009 that in Pakistan change occurs in precipitation levels and temperature. Their assessment based on several global circulation models and the results showed that in Pakistan till 2020 temperature would increase 1.3 to 1.5 ^{0}C, by 2050 2.5 to 2.8 0C and 3.9 to 4.4 0C by 2080. Whereas, in the same study conducted they showed that increase in precipitation levels occurs in summer and decrease in winter in Pakistan. Their results were based on 2080 projections and showed that precipitation would decrease by 3.48 % which mean that 12.16% increase precipitation in summer and decrease could be 5.12%, which they further explained that no annual significant increase occurs in precipitation just increase in summer and decrease occur in winter which shows temporal temperature decrease. A thesis published by Metrological department of. Pakistan "climate change in Pakistan". Positively in Pakistan day and night temperatures are increasing or showing some other patterns, these changes mainly have several effects on crops and nature. Furthermore, in

thesis it expressed that these day and night temperature has effects on crops productivity and life too. In addition to this, thesis defined how change in photosynthesis (this is responsible in daylight to produce carbohydrates that results dry matter production) and respiration (the dry matter produced in day time is consumed) affecting crops. With higher night temperature more respiration occurs.

Research Methodology:

Data that was analysed all is secondary data that collected from Federal Bureau of Statistics, statistical wing of agriculture department Government of Balochistan, and Metrological Department Quetta. There are many problems for collecting data as complete data is not available of crops and other independent variables of many districts. Therefore, I limited my thesis to just two districts to lesser the difficulty of data and for good results.

Description of Study Area:

Two districts are selected for study purpose, sibbi and lasbella. Sibbi is one of the hottest place in Pakistan where temperature reaches to 50 degrees centigrade in june. Total geographical area of sibbi district is 0.552 million hectares in which reported area is 0.394 million hectares. Sibbi is situated in tropical zone. With low ratio of rain with diverse period. March and April which is early spring and monsoon season of July and August The famous Suleman range is situated north of the city and city is on adjacent point of indus plain. From north to east the well-known river nari is also positioned in sibbi. Crops are of two seasons Rabi and Kharif. Cotton and sugarcane are kharif crops. Vegetables and fruits of tropical zones also grown in the district. Main source of irrigation is through canal and tube wells.

Lasbella is bordered by Sind in the east and with khuzdar and Makran with north and west. Total geographical area of district is 1.515 million hectares, with reported area of 1.1513 million hectares. Climate of lasbela is desert dry hot type. But the sea breeze makes the climate less hot compare to other hot places of balochistan. From tropic of cancer lasbella is just a small number of degrees away. Lasbella is in tropical Ecological zone. Main source of irrigation in district are canal, wells and tube wells.

Data:

The data comprises of fourteen years, from 2000 to 2013, data chosen is of secondary data. And also interview was conducted of twenty farmers about in district sibbi and lasbella as shifting from sugarcane crop. Since the farmers blame the non-availability of water and dry season to this shifting. Sibi and Labella are the selected districts and the selected cash crops are cotton and sugarcane. Dependent variable is productivity (Y) in thousand tons for sugarcane and for cottons bales. Independent variables are temperature; mean yearly maximum and minimum temperature, i.e. Mxt and Mt respectively, humidity(H) shown in percentage, fertilizers(Fer) in kilo grams, number of tube wells(Tw), number of tractors (Trac), labour force(LF) used in cash crops and rain(R) in millimetres. Evidently the main focus of the thesis is on climatic

variables like rain, temperature and humidity on output of cotton and sugarcane. Here we have eight variables Y, TW, If, Trac, mxt, Mt, Fer.

H here, Yc is dependent variable and Tw If Trac, mxt Mt, Fer and H, are independent variables.

Regression Model:

Y= Bo+ B1tw+ B2lf+ B3trac + B4mxt + B5Mt + B6fer + B7h + u

Sample Regression Model:

Y= bo+ b1tw+ b2lf+ b3trac + b4mxt + b5Mt + b6fer + b7h + e

In this modelpopulation regression line is an estimator of sample regression line. the target is to estimate population regression line from sample regression line. Big "B's" are estimators of small "b's". Here we will know from "e" nature of "u". "U" is the residual for population regression line w hile for sample regression line residuals is "e". Our target is that from a sample regression line estimate the population regression line. Unit root test is applied to make stationary all those variables that are not stationary of both district. And then in lasbella district the results of dependent variable which is production of sugarcane the value of R^2 is 92.74% which shows that model is good fitted and well explained by independent variables and probability value of F-statistic is 4.5%. The model of cotton production shows that 92.53% variation can be explained by independent variables and the value of F-statistic is 4.7% less than 5%. And then in district sibbi the results of dependent variable which is production of sugarcane the value of R^2 is 96.26% which shows that model is good fitted and well explained by independent variables and probability value of F-statistic is 1.2%. The model of cotton production shows that 89.31% variation can be explained by independent variables and the value of F-statistic is 3.3% less than 5%. There is no serial correlation in all the four production models

Results and Discussion:

Table no.1 explains the results of the model of lasbella district.

TABLE NO.1

crop **lasbella**	**maximum temperature**		**Minimum temperature**		**humidity**		**rain**	
sugarcane	negative	3.773 %	negative	1.684 %	positive	0.402 %	positive	0.006
cotton	positive	5.869 %	positive	4.409 %	negative	0.573 %	negative	0.0573

The thesis results are summarised in detail here. Infect the results of maximum temperature in district lasbella for sugarcane are adverse and favourable for cotton production. Further the one degree change in temperature increases the productivity of cotton to 5.869 (%) percent and for sugarcane the change in maximum temperature decreases productivity to 3.773 (%) percent in district lasbela. Whereas for minimum temperature sugarcane production decreases to 1.684 percent due to change in 1 degree centigrade (Graceila et al, 2003). The change in one degree centigrade in minimum temperature on cotton increases the productivity to 4.409 percent (Afzaal, et al.2009) (Haneef, et al.2009) (European Commission.2007). Next the change in humidity percent has a favourable effect on sugarcane, that is, 0.402 percent increase, but unfavourable effect on cotton, that is, 0.573 percent decrease. Same results justified too by (Darren Dogs) (Margin, et al.2005). Again the impact of climate change on rainfall on sugarcane has positive, i.e. due to one mm of rainfall has favourable effect, which increases production of sugarcane 0.006 percent and on cotton production due to change in one mm of rainfall effect is negative which decreases the productivity 0.573 percent (Hulme, 1996) (Rosenzweig, 2005) (Hillel, 2005).

Table no. 2 shows the results of district sibbi

TABLE NO. 2

crop **sibbi**	**maximum temperature**		**minimum temperature**		**Humidity**		**Rain**	
sugarcane	positive	5.75%	negative	5.68%	positive	0.48 %	positive	0.035%
cotton	negative	0.67%	positive	0.259%	positive	0.35 %	positive	0.006%

Since the results of maximum temperature due to climate change on sugarcane are helpful, i.e. change in $1^{o}C$ in temperature increases production of sugarcane to 5.75% but the impact is damaging on cotton production, i.e. decreases the production to 0.67 %. Furthermore, the results of minimum temperature on sugarcane production are negative which decreases production to 5.68 percent due to change in 1 degree centigrade but on cotton increases the productivity to 0.259 percent. These

results also justified by many researchers as (Afzaal, et al.2009), (Haneef, et al.2009), (European Commission.2007), Next the change in humidity percent has a favourable effect on both sugarcane & on cotton, i.e. 0.48 percent and 0.35 percent increase in both sugarcane and cotton production respectively due to change in 1 percent humidity. Same results justified too by (Darren Dogs), (Margin, et al.2005) (lobell, et al.2005) (Schlenker, et al.2005). Again the impact of climate change on rainfall on sugarcane has fine results, i.e. one mm of rainfall variation has favourable which rises production of sugarcane 0.035 percent and on cotton production due to change in one mm of rainfall effect is 0.006%. These results justified too by (Hillel, 2005) (Downing, 1992) (Hulme, 1996) (Rosenzweig, 2005).

Conclusion and Policy Implications:

Summarizing the results of the thesis I conclude that the impact of climate change varies on both crops. The transformation in one degree centigrade in minimum temperature reduces the output of sugarcane in both districts (sibbi and lasbella). As sugarcane is highly vulnerable to weather changes. Thus the same are the results of sibbi and lasbella districts. Variation in maximum temperature has a damaging impact in district lasbella as production decreases but the case is opposite in district sibbi. In district sibbi due to change in maximum temperature productivity increased. Change in maximum temperature in lasbella district shows encouraging results in increase in output of cotton. But the results of sibbi district shows decrease in production. Minimum temperature change has a good result in output of cotton in both districts. Due to change in temperature the cotton production has increased than before. The change in one-degree centigrade production has augmented. Rainfall is the important factor for crops. It's Variation in mm due to climate changes have a thru affect in both districts (lasbella & sibbi) and on both crops (sugarcane and cotton). Sugarcane is a c4 crop, rain has a direct influence on sugarcane. Due to aberration in rainfall mm in district lasbella and sibbi the production of sugarcane has more than before which is beneficial. In Lasbella district the production of cotton is decreased due to change in mm of rain. District lasbella is humid compare to sibbi district. Increase in rainfall directly affect the output and production of cotton. Cotton crop is vulnerable to rain in stages of seeding, open to boll and final harvesting stage. In district lasbella change in one percent in humidity results in production growth. Due to climate change in both districts the humidity percentage also variates. Whereas the one percent variation in humidity in sibbi also rise in output of sugarcane. Thus when due to climate change if the humidity deviates one percent output of sugarcane escalates in both districts. Thus the results of the changes in humidity is helpful in output on sugarcane. Results of model on cotton crops in district lasbella are not beneficial to output. When change in humidity occurs due to climate change cotton output reduces. Thus the impact is undesirable. But the case on district sibbi is opposite. Due to change in humidity percent the production of cotton up according to model results. Thus the results of temperature rain fall and humidity results shows the severity of climate change in both districts. The results vary in both districts indeed.

Policy Implications:

1. To setup reliable and better wide-ranging data and information system, farmer to farmer interactions and utilize existing data by disaggregating and reintegrating them in more convenient way, and then using current baseline data, at least five years projected data be established for main sectors of the province.
2. Afterward climatic data and material should be systematized and used for planning. Moreover, farmers should be aware about causes of climate changes, for this purpose preparation should be provide to farmers through government interventions and trainings about impact of climate change and how to cope with climate change. Government response to climate change impacts are not fruitful, and no positive steps to cope this issue.
3. Water level is decreasing in all areas of Balochistan which shifted farmers to other crops, the results of this in district sibbi and lasbela sugarcane cropping has stopped and near to zero yield.
4. Again heat and drought resistance type of seeds should be deliver to farmers on subsidized rates and also motivation is recommended to use the provided seeds to cope with climate change affects.
5. Besides that, specific allocation of funds for forest department for reforestation should be kept in budget with facilitation of in time watering to cope with weather dryness. In fact, farmers should be well-versed about conservation of water, as day by day ground water level is dropping.
6. Construction of dams on immediate basis for conservation of water. Proper Timing should be adopted for watering of crops, usually evening timing and also useless discharge from tube wells should be reduced.
7. research on climate change should be promoted.

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