International Journal of Advanced Biotechnology and Research (IJBR)
ISSN 0976-2612, Online ISSN 2278–599X,
Vol-7, Issue-3, 2016, pp961-967
http://www.bipublication.com

Research Article

Economic Perspectives of Sugarcane Crop in Pakistan: A Time Series Analysis (1970-2015) (Part 4)

Abdul Rehman[1*], Abbas Ali Chandio [2], Luan Jingdong[1*] and Imran Hussain[3]
[1]College of Economics and Management,
Anhui Agricultural University, China
[2]College of Economics and Management,
Sichuan Agricultural University, China
[3]Allama Iqbal Open University, Pakistan
[*]Corresponding author**:** Email: abdulrehman@ahau.edu.cn,
luanjingdong@ahau.edu.cn Tel: +86-15256556123

ABSTRACT:
This study investigates the relationship between output of sugarcane crop, area under sugarcane crop, fertilizer consumption and agricultural GDP of Pakistan. The time series data used in this study were collected from the period of 1970-2015. Augmented Dickey Fuller (ADF) unit root test, Johansen Co-integration test and Ordinary Least Square an econometric technique have been used to analyze the data. The results of Johansen Co-integration test revealed that there exists a long-run relationship among output of sugarcane crop, area under sugarcane crop, fertilizer consumption and agricultural GDP of Pakistan. Regression results revealed that output of sugarcane crop and fertilizer consumption has significant and positive relationship with agricultural GDP while area under sugarcane crop has negative relationship. Therefore, this study recommended that Government of Pakistan should give high priority on the development of irrigation system and increase the cultivated area of sugarcane crop.

Keywords: Output of sugarcane, Fertilizer consumption, Agricultural GDP, Co-integration, OLS Methods and Pakistan

[1] INTRODUCTION

Sugarcane is widely grown in the tropical and subtropical regions of the world with high economic importance. According to an estimation in 2014, sugarcane was planted on an area of 27 million hectares in more than 100 countries of the world (FAOSTAT, 2015). Globally, Brazil ranked number 1 in terms of sugarcane production with 39% of total world sugarcane production and India ranked second with overall 19% followed by China, Thailand and Pakistan with production of 7, 5 and 4% respectively (FAOSTAT, 2015). So far, in the sugar industry, it is usually utilized for its sucrose contents which are further used in industry as sweetener and remaining biomass residue (bagasse) after extraction of sucrose is consumed as fuel to provide steam and electricity to run the sugar mills. However, increasing awareness about its co-products such as cane trash, molasses, bagasse and filter cake etc. are, nowadays, used in many industries and many refined products e.g., bioethanol and electricity as well as chemicals including a variety of polymers (Dias, et al., 2013).

India has secured its position as largest producers, consumers and trading of sugarcane products. Its production has been paid much attention by

society and government due to its abundance. Sugarcane (*Saccharum officinarum* L.) is termed as most important traditional and commercial crop of industrial importance in the world due to its strategic and commercial application in almost all the industries. Importance of sugarcane industry is increased in recent years due to its economic impact on sustainable energy production. Sugarcane industry provides raw material for the second agro-based industry next to textile and is base for all major sweeteners produced in the country. Furthermore, unprocessed sugarcane is consumed as human food and animal feed in Brazil, India and Cuba and these are world leading sugarcane producers which are more than half of the total sugarcane production in the world (Girei & Giroh, 2012).

In rural areas, sugarcane cultivation remains as an important segment of socioeconomic development by producing higher income and provide employment opportunities to more than half a million people globally. Sugarcane production and prediction both have direct and indirect impacts on national and international economies and it plays an important role in the management of food (Hayes & Decker, 1996). Assessment of its reduced production which is caused by any natural disaster such as insect-pest infestation or drought could be critical for those countries where economy is completely dependent on sugarcane production. Similarly, early detection and management of problems associated with crop harvest can help to boost the yield and subsequent profit.

Early predictions about crop yield can be useful globally and regionally that offers useful information for policy makers. It can also help the farmers at the field level to make quick decision on upcoming circumstances, for instance, choice of alternative crops or whether to stop a crop to further grow at any or early stage. (Barnett & Thompson, 1982) used some meteorological data which was based on precipitation and temperature for forecasting wheat yield. Similarly, Parthasarathy, Munot, and Kothawale (1988) have developed some equations to forecast the yield using regression models. Meanwhile, (Deressa, Hassan, & Poonyth, 2005) applied a Richardian crass section using regression model and proved that climate change has serious connection with sugarcane productivity. In that study, climatic variables like minimum and maximum temperature were not considered. In another study, it was reported that high fertilizer application has greater impact on climatic variation and on environmental damage (Ranuzzi & Srivastava, 2012). In precision agriculture, principles of artificial intelligence and soft computing techniques have been utilized for spatial analysis and crop management (Drummond, Sudduth, Joshi, Birrel, & Kitchen, 2003; Y. Huang, et al., 2010) particularly, ANN analysis has been utilized in precision agriculture to compute the data against spatial analysis and crop management (Drummond, et al., 2003; Irmak, et al., 2006).

In another study, yield of sugarcane alone and in rotation with potato (*Solanum tuberosum* cv. Kufri Bahar) were increased and net income was also significant in that intercropping system (Imam, Hossain, Sikka, & Midmore, 1990). Insect pest control such as diseases, insects and weeds in sugarcane rotation were also studied (Berry, Dana, Spaull, & Cadet, 2009; B. Chen, Wang, Zhang, Li, & Xiao, 2011; C. Y. Li, et al., 2009) however, there was lack of information to assess the interspecific competition in sugarcane intercropping system so far. One of important factor in intercropping systems is competition that have direct role in determining the yield of crop (Caballero, Goicoechea, & Hernaiz, 1995; Q. Z. Li, et al., 2011). Vandermeer (1990) confirmed that when intra-species competition in an intercropping system is greater than inter-species competition, an increase in yield could be seen in that cropping system.

Several major advantages can be achieved in cereal-legume intercropping system that increase yield and land use efficiency (Ghosh, 2004), efficiency in utilization of natural resources like water, light and nutrient (Harris, Natarajan, &

Willey, 1987; B. C. Xu, Li, & Shan, 2008). It can also add up in controlling insect pest and diseases (B. Chen, et al., 2011). Furthermore, cereal-legume intercropping system has emerged as a popular cropping system in the world (Eskanddari, 2012; Jensen, 1996).

[2] PRODUCTION AND AREA USED FOR SUGARCANE CROP

Area under cotton crop in 1000 hectares and area yield in kg/ hectares of Pakistan are showed in Fig. 1 and Fig. 2.

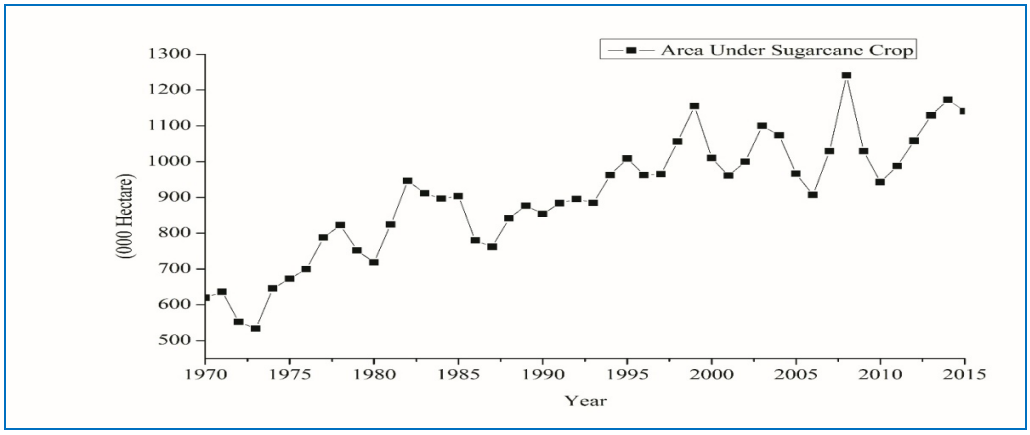

Fig. 1: Area under sugarcane crop 1970-2015

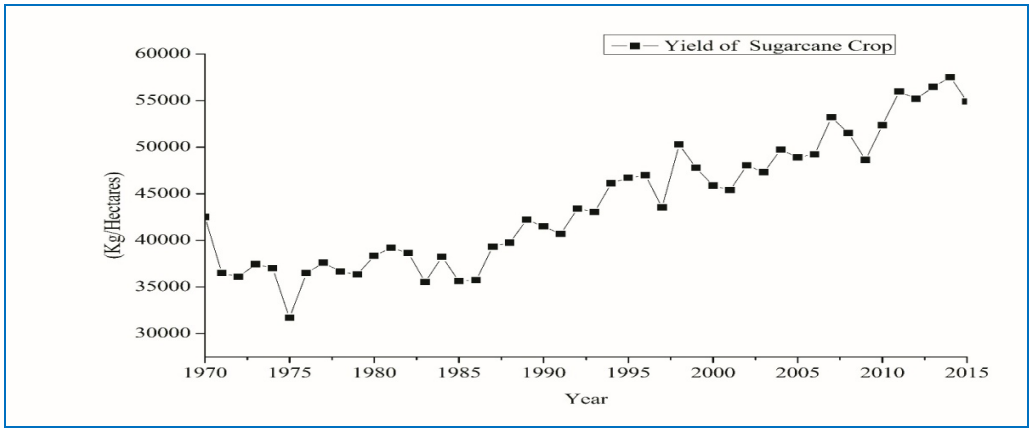

Fig. 2: Yield of sugarcane crop in kg/hectares 1970-2015

[3] MATERIALS AND METHODS

This paper studies the relationship among output of sugarcane crop, area under sugarcane crop, fertilizer consumption and agricultural GDP of Pakistan. It uses time series data ranging from 1970 to 2015, collected from the Economic Survey of Pakistan (various issues). The ADF (1981) unit root test has been applied to check the stationarity of the data. Variables which are non-stationary at their level form, we have to again check stationary of each variable after taking first difference. Moreover, the Johansen Co-integration (1990) test has been applied to examine the long-run relationship between the study variables.

To show the relationship between output of sugarcane crop, area under sugarcane, fertilizer consumption and agricultural GDP of Pakistan. The following model is estimated:

$$ln\ (AGRGDP) = \beta_0 + \beta_1\ ln\ (OPSUGARCANE) + \beta_2\ ln\ (ARSUGARCANE) + \beta_3\ ln\ (FC) + \mu \ldots\ (1)$$

Where

Ln *(AGRGDP)* = natural log of Agricultural Gross Domestic Product per year in (million rupees)

Ln (OPSUGARCANE) = natural log of output of sugarcane crop in (000, tones)

Ln (ARSUGARCANE) = natural log of area under sugarcane crop (000, hectare)
Ln (FC) = natural log of fertilizer consumption in (000, nutrient tones)
μ = error term

[4] RESULTS AND DISCUSSION

The results of ADF unit root test are presented in Table 1. In (Table 1) the stationarity of the data has been checked including intercept and trend. According to Table 1, lnAGRGDP, lnOPSUGARCANE and LnARSUGARCANE are not stationary at their level while LnFC is made stationary at their level. Furthomre, lnAGRGDP, lnOPSUGARCANE and LnARSUGARCANE are made stationary after taking the first difference.

Table 1: Results of ADF unit root test including (trend and intercept)

Variables	At level		First Difference	
	t-Statistic	Critical values	t-Statistic	Critical values
LnAGRGDP	-2.123963 (0.5189)	1% -4.175640 5% -3.513075 10% -3.186854	-6.967641* (0.0000)	1% -4.180911 5% -3.515523 10% -3.188259
LnOPSUGARCANE	-2.934896 (0.1622)	1% -4.186481 5% -3.518090 10% -3.189732	-8.405917* (0.0000)	1% -4.186481 5% -3.518090 10% -3.189732
LnARSUGARCANE	-2.758528 (0.2198)	1% -4.186481 5% -3.518090 10% -3.189732	-9.245570* (0.0000)	1% -4.186481 5% -3.518090 10% -3.189732
LnFC	-4.326839* (0.0080)	1% -4.234972 5% -3.540328 10% -3.202445	-7.161089* (0.0000)	1% -4.186481 5% -3.518090 10% -3.189732

Note: *, **, *** shows 1%, 5%, 10% of significance level

To check a long run relationship between the study variables, the Johansen Co-integration method including Trace statistic and Max-Eigen Statistic tests have been used. The values of trace statistic and Max-Eigen statistic are presented in Table 2 and 3, which shows the long run relationship among output of sugarcane crop, area under sugarcane crop, fertilizer consumption and agricultural GDP of Pakistan over the period of 1970-2015 and rejects the null hypothesis of non-co-integration. Because the values of trace statistic test and Max-Eigen statistic test are larger than their relevant critical values which shows the existence of two co-integrating equation at 5 percent.

Table 3: Johasan Co-integration test using Trace Statistic

Series: Ln(AGRGDP) LN(OPSUGARCANE) Ln(ARSUGARCANE) Ln(FC)				
Lags interval (in first differences): 1 to 1				
Eigenvalue	Trace Statistic	5 Percent Critical Value	Prob**	Hypothesized No.of CE(s)
0.571061	71.82877	47.85613	0.0001	None *
0.419422	34.58534	29.79707	0.0130	At most 1 *
0.183737	10.66116	15.49471	0.2332	At most 2
0.038519	1.728345	3.841466	0.1886	At most 3

Trace test shows 2 co-integrating equation at the 0.05 level,*denotes rejection of the hypothesis is at the 0.05 level.

Table 3: Johasan Co-integration test using Max-Eigen Statistic

Series: Ln(AGRGDP) LN(OPSUGARCANE) Ln(ARSUGARCANE) Ln(FC)				
Lags interval (in first differences): 1 to 1				
Eigenvalue	Max-Eigen Statistic	5 Percent Critical Value	Prob**	Hypothesized No.of CE(s)
0.571061	37.24342	27.58434	0.0021	None *
0.419422	23.92418	21.13162	0.0197	At most 1 *
0.183737	8.932815	14.26460	0.2918	At most 2
0.038519	1.728345	3.841466	0.1886	At most 3

Max-eigenvalue test shows 2 co-integrating equation at the 0.05 level,*denotes rejection of the hypothesis is at the 0.05 level.

The results of regression analysis including the three independent variables (OPSUGARCANE, ARSUGARCANE, and FC) are reported in (Table 4). The results indicate that the coefficient of output of sugarcane crop was highly significant at both 1% and 5% of significance level, which sowed that there was a positive and significant relationship among agricultural GDP and output of sugarcane crop. This implies that a 1 percent increase in output of sugarcane crop agricultural GDP increased by 6.16%. Moreover, the results showed that there was a negative relationship between area under sugarcane crop and agricultural GDP. Furthermore, the results revealed that the coefficient of fertilizer consumption was significant at 5% of significance level, which showed that there was a positive and significant relationship among fertilizer consumption and agricultural GDP of Pakistan. This implies that a 1 percent increase in fertilizer consumption agricultural GDP increased by 0.58%. The high value of R^2 was (0.79). This indicates that about 0.79 % of total variation in agricultural GDP have been explained by three explanatory variables (Output of sugarcane crop and area under sugarcane crop and fertilizer consumption). The calculated value of F-statistic was 55.97476 with the probability values of 0.000000 which shows that the overall model fitting was good.

Table 4: Regression Results

Explanatory Variables	Coefficient	Std. Error	t-Statistic	Prob.
C	-10.47976	6.024099	-1.739640	0.0892
Ln(OPSUGARCANE)	6.164378	1.121440	5.496840	0.0000
Ln(ARSUGARCANE)	-6.862998	1.660374	-4.133406	0.0002
Ln(FC)	0.588717	0.302461	1.946425	0.0583
R-squared	0.799928	Adjusted R-squared		0.785637
F-statistic	55.97476	Prob(F-statistic)		0.000000
Durbin-Watson stat	0.583628			

[5] CONCLUSION AND POLICY RECOMMENDATIONS

This present study was investigated the relationship between output of sugarcane crop, area under sugarcane crop, fertilizer consumption and agricultural GDP in Pakistan over the period 1970-2015. Time series data was collected from Pakistan Statistical Year Book (various issues). The Phillips Perron (PP) unit root test, Johansen Co-integration test and OLS method were used to analyze the data. The results of Johansen Co-integration test revealed that; there exists a long-run relationship between output of sugarcane crop, area under sugarcane crop, fertilizer consumption and agricultural GDP of Pakistan. The results of regression analysis showed that output of rice and

fertilizer consumption has positive and significant relationship with agricultural GDP of Pakistan while area under sugarcane crop has a negative relationship with agricultural GDP of Pakistan. Estimation indicates that at 1 percent increase in output of sugarcane crop brings 6.16% increase in agricultural GDP. Furthermore, at 1 percent increase in fertilizer consumption agricultural GDP increased by 0.58%. Based on the findings, the study recommended that Government of Pakistan should give high priority on the development of irrigation system and increase the cultivated area of sugarcane crop.

ACKNOWLEDGEMENT

In this paper Abdul Rehman and Abbas Ali Chandio have equal contribution. The authors are grateful to the School of Economics & Management, Anhui Agricultural University Hefei, China for its financial and moral support. Moreover, the authors are also indebted to the reviewers for their positive suggestion that helped to improve the content of this study.

REFERENCES

1. Barnett, T., & Thompson, D. R. (1982). The use of large-area spectral data in wheat yield estimation. Remote Sensing of Environment, 12, 509-518.
2. Berry, S., Dana, P., Spaull, V., & Cadet, P. (2009). Effect of intercropping on nematodes in two small-scale sugarcane farming systems in South Africa. Nematropica, 39, 11-34.
3. Caballero, R., Goicoechea, E., & Hernaiz, P. (1995). Forage yields and quality of common vetch and oat sown at varying seeding ratios and seeding rates of vetch. Field Crops Res., 41, 135-140.
4. Chen, B., Wang, J. J., Zhang, L. M., Li, Z. Y., & Xiao, G. L. (2011). Effect of intercropping pepper with sugarcane on populations of Liriomyza huidobrensis (Diptera: Agromyzidae) and its parasitoids. Crop Protection, 30, 253-258.
5. Chen, R., Huang, J., & Qiao, F. (2013). Farmers' knowledge on pest management and pesticide use in Bt cotton production in China. China Econ. Rev., 27, 15-24.
6. Deressa, T., Hassan, R., & Poonyth, D. (2005). Measuring the impact of climate change on South African Agriculture: the case of sugarcane growing regions. Agrekon., 44, 524-542.
7. Dias, M. O. S., Junqueira, T. L., Cavalett, O., Pavaanello, L. G., Cunha, M. P., Jesus, C. D. F., & et al. (2013). Biorefineries for the production of first and second generation ethanol and electricity from sugarcane. Appl. Energy, 109, 72-78.
8. Drummond, S. T., Sudduth, K. A., Joshi, A., Birrel, S. J., & Kitchen, N. R. (2003). Statistical and neural methods for site-specific yield prediction. Transactions of the ASAE, 46, 5-14.
9. Eskanddari, H. (2012). Yield and quality of forage produced in intercropping of maize (Zea mays) with cowpea (Vigna sinensis) and mungbean (Vingna radiate) as double cropped. J. Basic Appl. Sci. Res., 2, 93-97.
10. FAOSTAT. (2015). Food and Agriculture Organization of the United Nations: Statistics Division. In FAOSTAT (Ed.).
11. Ghosh, P. K. (2004). Growth, yield, competition and economics of groundnut/cereal fodder intercropping systems in the semi-arid tropics of India. Field Crops Res., 88, 227-237.
12. Girei, A. A., & Giroh, D. (2012). Analysis of the factors affecting sugarcane (Saccharum officinarum) production under the out grower's scheme in Numan Local Government Area Adamawa State, Nigeria. Adv. Agric. Sci. Eng. Res., 2, 195-200.
13. Harris, D., Natarajan, M., & Willey, R. (1987). Physiological basis for yield advantage in a sorghum/groundnut intercrop exposed to drought. 1. Dry-matter production, yield, and light interception. Field Crops Res., 17, 259-272.

14. Hayes, M. J., & Decker, W. L. (1996). Using NOAA AVHRR data to estimate maize production in the United States Corn Belt. International Journal of Remote Sensing, 17, 3189-3200.
15. Huang, Y., Lan, Y., Thomson, S. J., Fang, A., Hoffmann, W. C., & Lacey, R. E. (2010). Development of soft computing and applications in agricultural and biological engineering. Computers and Electronics in Agriculture, 71, 107-127.
16. Imam, S., Hossain, A. D., Sikka, L., & Midmore, D. (1990). Agronomic management of potato/sugarcane intercropping and its economic implications. Field Crops Res., 25, 111-122.
17. Irmak, A., Jones, J. W., Batchelor, W. D., Irmak, S., Boote, K. J., & Paz, J. O. (2006). Artificial neural network model as a data analysis tool in precision farming. Amer. Soc. Agric. Biol. Eng., 49, 2027-2037.
18. Jensen, E. S. (1996). Grain yield, symbiotic N2 fixation and interspecific competition for inorganic N in pea-barley intercrops. Plant Soil, 182, 25-38.
19. Li, C. Y., He, X. H., Zhu, S. S., H.P.Zhu, Wang, Y. Y., Li, Y., Yang, J., Fan, J. X., Yang, J. C., Wang, G. B., Long, Y. F., Xu, J. Y., Tang, Y. S., Zhao, G. H., Yang, J. R., Liu, L., Sun, Y., Xie, Y., Wang, H. N., & Zhu, Y. Y. (2009). Crop diversity for yield increase. PLOS One, 4, 1-6.
20. Li, Q. Z., Sun, J. H., Wei, X. J., Christie, P., Zhang, F. S., & Li, L. (2011). Over yielding and interspecific interactions mediated by nitrogen fertilization in strip intercropping of maize with faba bean, wheat and barley. Plant Soil, 339, 147-161.
21. Parthasarathy, B., Munot, A. A., & Kothawale, D. R. (1988). Regression model for estimation of Indian food grain production from summer monsoon rainfall. Agricultural and Forest Meteorology, 42, 167-182.
22. Ranuzzi, A., & Srivastava, R. (2012). Impact of climate change on agriculture and food security. ICRIER Policy Ser., 16.
23. Vandermeer, J. H. (1990). Intercropping. In C. R. Carroll, J. H. Vandermeer & P. M. Rosset (Eds.), Agroecology (pp. 481-516). New York: McGraw-Hill Inc.
24. Xu, B. C., Li, F. M., & Shan, L. (2008). Switchgrass and milkvetch intercropping under 2:1 row replacement in semiarid region, northwest China: aboveground biomass and water use efficiency. Eur. J. Agron., 28, 485-492.