Pak. J. Agri. Sci., Vol. 51(4), 1091-1094; 2014
ISSN (Print) 0552-9034, ISSN (Online) 2076-0906
http://www.pakjas.com.pk

THE ECONOMIC ROLE OF LIVESTOCK ASSETS IN COTTON PRODUCTIVITY IN PUNJAB, PAKISTAN

Khuda Bakhsh[1,*], Ayesha Maqsood[2], Sarfraz Hassan[2] and M. Asif Kamran[3]

[1]Department of Management Sciences, COMSATS Institute of Information Technology, Vehari, Pakistan; [2]Institute of Agricultural and Resource Economics, University of Agriculture, Faisalabad, Pakistan; [3]Nuclear Institute of Agriculture & Biology, Faisalabad, Pakistan.
[*]Corresponding author's e-mail: kbakhsh@ciitvehari.edu.pk

The present study was designed to determine the factors affecting cotton productivity in Punjab province of Pakistan. The factors considered in the study are livestock assets in addition to other conventional factors including farm inputs and socioeconomic characteristics. A Cobb Douglas production function was estimated. Impacts of livestock assets on various farm characteristics like share of Bt cotton, cotton area and dummy for good quality of land are considered. Findings of the study show that variables namely pesticide, irrigation, farming experience, cotton area, dummy for good quality land, dummy for off-farm income, dummy for livestock units, interaction terms of livestock units with pesticide and ratio of Bt cotton area to area under cotton are significantly related with cotton yield. Combined effect of livestock and pesticide use on cotton productivity is 0.38 percent whereas joint contribution of livestock and share of Bt cotton in cotton yield is 0.01 percent. Integrating livestock in farming system can have additional benefit of higher crop productivity and thereby improve farm income and livelihood of rural community.
Keywords: Livestock assets, cotton yield, Cobb Douglas, Bt cotton

INTRODUCTION

New technologies are assumed to increase crop productivity and farm income. However, this requires additional investment, being an important factor, to adopt new technologies. One such case is the use of Genetically Modified (GM) seeds in many parts of the world. The use of GM Bt cotton seed is common in Pakistan. Many studies show that it has resulted in less pesticide use and higher cotton productivity in the world (Thirtle *et al*., 2003, Qaim and Matuschke, 2005). Nevertheless, the use of Bt cotton seed demands financial resources availability to farmers for different operations from sowing to harvesting. The previous studies conducted in Pakistan have determined the factors relating to increasing cotton production and eventually benefiting the cotton growers (Bakhsh *et al.,* 2005, Mumtaz *et al.,* 2009). In addition to these evidences, it is also a fact that crop and livestock activities are, to a larger extent, interdependent upon one another for their performance. The latter provides with inputs like FYM and draught energy for the crop sector and, in turn makes use of fodder, crop products and residues for feeding animals (Herani *et al.,* 2008). Further, livestock serves as financial capital for farmers and a source of investment for different farming operations. Similarly, investment from crops to livestock rearing results in capital growth, by means of growth of herd through reproduction (Barret, 1991). Thus such type of interdependence calls for a detailed study to investigate impact of livestock on crop productivity in general and Bt cotton productivity in particular. The existing literature has not investigated econometric relationship between farmers' decision to diversify between crop and livestock resources. The present study has been designed to estimate the impact of livestock assets in addition to other factors on cotton productivity through comparing the means of various variable inputs and livestock. We also consider the role of livestock on the use of other inputs by taking interaction terms in the econometric analysis. The findings of the study have attempted to fill the information and literature gap relating to crop production and livestock interdependence.

MATERIALS AND METHODS

***Analytical model*:** Cotton yield depends on different factors. They include inputs, socio-economic factors, farm assets, etc. So the production function can be written as:

Error! Reference source not found. (1)

Where y is yield of cotton, X represents various farm inputs, Z includes socio-economic variables and A is farm assets. Here we consider livestock as asset contributing in purchasing various farm inputs so, having a direct impact on crop productivity. The livestock are considered as having an imperative role to buy various farm inputs as they serve as an alternative source of income to the farmers. Thus we introduce interaction terms of animal units (AU) and farm inputs. AU is estimated by method of Quraishi *et al.* (1993). The above function can be written in the following form

Table 1. Summary statistics of variables

Variables	Minimum	Maximum	Mean	Std. Dev.
Seed (Kg/ha.)	9.88	32.12	18.35	4.88
Fertilizer (Kg/ha.)	11.33	557.03	228.51	79.96
Pesticide (liters/ha.)	0.41	15.33	4.40	2.08
Irrigation (Rs/irrigation)	766.47	2602.31	1710.13	2569.39
Labor (Rs/ha.)	4363.19	15262.75	6133.37	1760.43
Farming experience (Years)	2.00	55.00	19.52	11.22
Cotton area (hectares)	1.00	185.00	22.60	27.88
Dummy for good land quality (Yes = 1)	0.00 (150)	1.00 (127)	0.46 (127)	0.50
Dummy for off-farm income (Yes = 1)	0.00 (249)	1.00 (28)	0.10 (28)	0.30
Dummy for AU (Yes = 1)	0.00 (25)	1.00 (252)	0.91 (252)	0.28
Ratio of Bt cotton to cotton area	4.00	100	73.68	31.228
Cotton yield (Kg/ha.)	494.20	4200.70	1842.38	783.63
Number of observations	277			

Figures in parentheses are frequencies

Error! Reference source not found. (2)

Where XA represents interaction terms of AU and various farm inputs, other identities are defined above.

***Empirical model*:** Cobb Douglas type production function is used to estimate the impact of livestock on cotton productivity. The log-linear form of production function is given in equation 3.

Error! Reference source not found. (3)

Where **Error! Reference source not found.** is cotton yield (kg/hectare), β_o is constant, β is coefficient of farm inputs, **Error! Reference source not found.**is farm inputs used in cotton production ranging from 1 to j, α is coefficient of socio-economic variables, **Error! Reference source not found.** indicates socio-economic variables ranging from 1 to j,**Error! Reference source not found.** is coefficient of farm assets, γ is coefficient of interaction terms of farm assets i.e. animal unit and farm inputs i.e. pesticide and Bt-share, **Error! Reference source not found.** are interaction terms from 1 to j and μ is error term. The farm inputs included in the model are irrigation, labor, fertilizer, seed and pesticide. Socioeconomic variables include land quality (good land), occupation of farmers (off-farm income) and farming experience of the respondents. The farm assets variables include dummy for animal unit and cotton area. The detailed summary statistics of the variables is given in Table 1.

***Source of data*:** The Southern Punjab was chosen for this study because cotton is commonly concentrated in this area. We have used a three stage sampling technique. The first stage involved randomly selection of three districts from the Southern Punjab. The second stage was concerned with the preparation of list of cotton growing farmers who purchased cotton seed from the registered private seed companies/input dealers during cotton growing season of 2008. We selected respondents from the list of cotton growers using a systematic simple random sampling technique. A total of 96 respondents from one selected district were interviewed. From all the selected districts, 288 respondents were interviewed in 2009. Some observations with missing information are excluded. Thus the final analysis of the present study is based on 277 observations.

RESULTS AND DISCUSSION

***Livestock and farm characteristics*:** Comparison of categories of AU and farm characteristics is given in Table 2. We consider three categories of AU i.e., farmers having up-to 10 animal units are included in category one, for 11-20 animal units the category is taken as two and for above 20 animal units, the category is taken as three. Results show that as the number of animal units increases from 1-3 categories, the share of Bt cotton also increases. This is because of the reason that farmers having higher number of animal units may be financially strong (Nell, 1998; Moorosi, 1999) and are able to purchase relatively expensive Bt cotton seed as compared to the farmers having lower animal units. This +in turn increases their cotton yield as Bt cotton seed is reported to give higher outputs (Morse *et al*., 2004; Traxler *et al.,* 2003; Qaim and de Janvry, 2005). Similarly, cotton

Table 2. Impact of livestock on various farm characteristics Mean (SD)

AU Categories	Ratio of Bt cotton to cotton area	Cotton area (ha)	Dummy for good land quality (1=good quality)
Up-to 10 AU	72.41 (31.54)	19.62 (28.18)	0.43 (0.50)
11-20 AU	74.57 (31.12)	23.73 (23.60)	0.47 (0.50)
> 20 AU	78.56 (30.11)	35.69 (29.70)	0.58 (0.50)

area also shows an increasing pattern with the increase in animal units. Farmers having more animal units possess an alternate source of income which they can use to boost the cotton yield by allocating more area to the cotton crop. The dummy for good quality land also shows a positive relation with animal units as the respondents keep higher number of AU, the possibility of good quality land also increases (Masikati, 2011). The reason lies in the fact that the higher number of animal units serves as a source to provide more farmyard manure to the land, thus, improving land quality. Further, farmers have to grow fodder to feed livestock and mostly they rotate land area allocated to fodder crop. Fodders are also considered to improve land quality as well. We have presented econometric results in Table 3.

Table 3. Estimates of Cobb Douglas production function

Variables	Coefficient	S. E.	t-value
Constant	5.959	0.971	6.137
Ln seed	0.436	0.309	1.413
Ln fertilizer	0.036	0.050	0.728
Ln pesticide	0.463*	0.179	2.589
Ln irrigation	- 0.032**	0.015	-2.142
Ln labour	-0.082	0.075	-1.099
Farming experience	0.004**	0.002	2.076
Cotton area	0.002*	0.001	2.882
Dummy good quality	0.107*	0.039	2.774
Dummy off-farm income	0.149**	0.066	2.258
Dummy for AU	2.552*	0.810	3.151
DAU X ln seed	- 0.437	0.318	-1.375
DAU X ln pesticide	0.378**	0.185	2.048
DAU X Bt cotton share	0.009*	0.001	11.892

R^2= 0.48, Adjusted R^2 = 0.45, F-value = 18.52, sig 0.00; *and ** shows level of significance at one and five percent, respectively.

Findings show that out of 13 variables, 9 variables are significant i.e. having impact on cotton yield. The significant variables at one and five percent level of significance include pesticide, irrigation, farm experience, cotton area, dummy for good land quality, dummy for off-farm income, dummy for animal units and interaction terms of AU with pesticide and Bt-ratio. We introduce interaction terms as animal units are considered financial capital and increase possibility of purchasing pesticide timely through either selling the animal products or part of herd to buy crop inputs including pesticides. The reason for including interaction term of animal units and Bt-ratio is that risk averse farmers making investment in new and expensive technologies want to diversify their investment portfolio. The pesticide is positively related with cotton yield, since cotton is highly susceptible to chewing and sucking pests so there is great need for pesticide application in cotton crop in order to protect crop from pests. It is also an indication that as the application of pesticide increases in cotton crop it will boost cotton yield. Mumtaz *et al*. (2009) and Bakhsh *et al.* (2005) also indicated in their study that pesticide use positively contributed in cotton productivity. However, our study involves the most commonly used pesticide against sucking pests. The reason is that due to adoption of Bt cotton seed, less pesticide is used against chewing pests but still it substantially increases cotton productivity through controlling sucking pests.

Irrigation variable is negatively related with cotton yield indicating that as the cost of irrigation increases cotton yield decreases. This is because of the reason that as per law of demand, with increased cost of irrigation, demand for irrigation may decrease and the farmers would apply less irrigation, consequently cotton yield may decline. Since the selected area farmers have to supplement their irrigation through pumping, their cost increases and has negative effect resulting in below optimum irrigation. Chanyalew *et al.* (1989) pointed out in their study that with an increase in pumping costs, either from increased fuel price or increased pumping lift, would cause a decline in the number of irrigation. Zilberman *et al.* (2008) argue that rising energy prices can result in groundwater extraction costly, altering water allocation and distribution.

Farming experience of the respondents is positively related with cotton yield, pointing towards higher experience of farming as a tool to elevate the yield of cotton crop. As highly experienced farmers are well aware of constraints in cotton production, so they are in a better position to cope with these hurdles. The area under cotton crop is also positively related with its yield showing that an increase in the area under cotton crop would lead to a bumper crop. The dummy for good land quality is also significant which shows that with the improvement of land quality the yield of cotton will increase. The significance of dummy for off-farm income shows that farmers having off-farm income sources receive higher cotton yield. This is because of the reason that farmers do not have to rely only on farm income for investment in cotton production but they have the opportunity to make use of the off-farm income in cotton production activities.

The significance of dummy for AU with cotton yield shows that farmers possessing AU have higher cotton yield compared to their counterparts. As AU is considered to be an alternate source of income for the farmers and higher AU is an indication of better financial position of the farmers as well (Nell, 1998; Moorosi, 1999) so, a farmer having livestock may be able to make investment with ease in cotton production whenever it is required. The interaction term of AU with pesticide is significant and positive, which is an indication that AU significantly affects the pesticide usage i.e. the higher number of animal units facilitates farmer to purchase pesticide used against cotton pests. Similarly, the interaction term of AU with share of Bt cotton is also positive and significant, depicting the reality that livestock farming helps farmers to increase cotton area under Bt cotton. Although Bt cotton has resistance against bollworms, it provides no resistance to sucking pests. Farmers have to apply pesticide against sucking pests at the time when they have little financial resources and livestock provides ready finances at this critical time. Ahmad *et al*. (2005) indicate that financial constraint is one of the most limiting constraints to purchase farm inputs at appropriate time. Availability of livestock with farmers increases financial viability of farmers growing cash crops such as cotton. Further, sustainable agricultural practices at farmers' fields can help to tackle issues of widespread poverty, low agricultural productivity and degradation of natural resources. Considering short-term available options, integration of livestock and crop production is the best choice as little investment is required.

***Conclusion*:** Livestock plays an important role in taking new initiatives by farmers. This is evident from the study that with increased livestock units, area allocated to Bt cotton also increases, pointing out that farmers are in a better position to take risk by adopting new technology. Similarly, farmers possessing higher livestock units are found to have better quality of land. It may be due to the fact that they apply higher quantity of farmyard manure. Moreover, we also find that farmers having livestock at their farms received higher cotton yield compared to their counterparts. Combined effects of livestock with Bt cotton area and pesticide use are positively related with cotton yield.

On the basis of the findings of the study, we conclude that livestock farming has two kinds of benefits-serving as secure financial tool to cope against production risk and contributing land productivity through incorporation of farmyard manure. Thus, the need is to increase livestock keeping in the rural economy. However, the poor farmers need to be provided financial aid by means of easy-terms credit to invest in livestock sector, since credit not only helps in expanding economies of size but also increases productivity of agricultural sector. Although the present study has made an attempt to determine the impact of livestock on cotton productivity, future studies should focus on other issues such as factors leading to livestock farming, environmental impacts, risk reducing strategies adopted by farming community and the resultant crop productivity.

***Acknowledgement*:** The authors are thankful to South Asian Network for Development and Environmental Economics (SANDEE), Nepal for financial support.

REFERENCES

Ahmad, B., S. Hassan, K. Bakhsh and W. Ahmad. 2005. Profitability and various constraints in potato production. Pak. J. Agri. Sci. 42:68-73.

Bakhsh, K., I. Hassan and A. Maqbool. 2005. Factors affecting cotton yield: a case study of Sargodha (Pakistan). J. Agri. Soc. Sci. 1-4:332-334.

Chanyalew, D., A.M. Featherstone and O.H. Buller. 1989. Groundwater allocation in irrigated crop production. J. Prod. Agric. 2:37-41.

Barret, J.C. 1991. The economic role of cattle in communal farming systems in Zimbabwe. Available online at http://www.odi.org/sites/odi.org.uk/files/odi-assets

Herani, G.M., M.W. Pervez, A.W. Rajar and R.A. Shaikh. 2008. Livestock: a reliable source of income generation and rehabilitation of environment at Tharparkar. MPRA Paper No. 8700, 15:39.

Masikati, P. 2011. Improving the water productivity of integrated crop-livestock systems in the semi-arid tropics of Zimbabwe: an ex-ante Analysis using simulation modeling. Available online at http://hss.ulb.unibonn.de/diss_onlineelektronischpublizi ert

Moorosi, L.E. 1999. Characterization of small-scale cattle farming in Botshabelo and ThabaNchu districts of the Free State. M.Sc. Thesis, University of the Orange Free State, South Africa.

Morse, S., R. Bennett and Y. Ismael. 2004. Why Bt cotton pays for small-scale farmers in South Africa. Nat. Biotech. 22:379–80.

Mumtaz, A., I.S. Chaudhry and M.B. Khan. 2009. Factors affecting cotton production in Pakistan: Empirical evidence from Multan district. MPRA Paper No. 22829, 09:57.

Nell, W.T. 1998. Transfer and adoption of technology: The case of sheep and goat farmers in Qwaqwa. Ph.D. Thesis, University of the Orange Free State, South Africa.

Qaim, M. and A. de Janvry. 2005. Bt cotton and pesticide use in Argentina: economic and environmental effects. Env. Dev. Econ. 10:179–200.

Qaim, M. and I. Matuschke. 2005. Impacts of genetically modified crops in developing countries: a survey. Q. J. Int. Agric. 44:207–27.

Quraishi, M.A.A., S.K. Ghulam and S.Y. Mian. 1993. Range management in Pakistan. Department of Forestry, Univ. Agri. Faisalabad, Pakistan.

Thirtle, C., L. Beyers, Y. Ismael and J. Piesse. 2003. Can GM technologies help the poor? The impact of Bt cotton in Makhathini Flats, KwaZulu-Natal. World. Dev. 31:717–32.

Traxler, G., S.G. Avila, J.F. Zepeda and J.E. Arellano. 2003. Transgenic cotton in Mexico: economic and environmental impacts of first generation biotechnologies. N. Kalaitzandonakes, Ed., pp. 183–202. New York: Kluwer Academic Publishers.

Zilberman, D., T. Sproul, D. Rajagopal, S. Sexton and P. Hellegers. 2008. Rising energy prices and the economics of water in agriculture. Water Pol. 10.1:11-21.