
The Assessment of Implementing Conventional Cotton: A Regression Analysis of Meta-Data

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Abstract: This paper investigated the effects of implementing conventional cotton using meta data as the global scope from developed countries (America and Australia) and developing countries (India and China). The data base collected individual studies from more than one decade of field trials and survey. More specifically, the global effects of conventional cotton on crop yields, seed costs, pesticide costs, management and labor costs, and finally net returns were analyzed. Regression analysis was conducted to investigate and estimate the relationship between response variable and explanatory variables on these parameters. The results indicated that yield gain is the high expectation of cotton growers to optimize the net return and a strong positive correlation between yield and net return indicates that increased yield of using conventional cotton leads to higher revenue of cotton grower.

Keywords: Dependent, Economics, Independent, Indicators, Revenue

1. Introduction

Cotton is the cash crop among the farmers in the developing countries such as India, Pakistan, Indonesia, and China as well. Due to the development of Genetically Modified (GM) cotton around the world, nowadays mostly cotton growers choose GM seed for planting cotton. However, despite the higher seed cost and the uncertainty conditions such climatic conditions, conventional cotton is still needed by the farmers.

The aim of any agricultural enterprise is to maximize the profit, given limited resources or amount of inputs. The expenditure of using fertilizer, chemical matter, labor, management system and yield gain impact the net revenue of the cotton enterprise. Therefore, net income is a key measure for determining how successful a cotton grower operation has been historically, as well as an indicator of how the financial success of the farm might be in the future. What causes net returns to vary from year to year at the farm level, and more importantly, returns to vary between operations is important information for cotton producers to identify, so they can make good management decision. For instance, do

agronomic aspect (yield) has a greater effect on net return variability or do economic factors such as seed cost, pesticide cost, management and labor cost have a greater effect on net income variability? In economic analysis, inputs are the essential factors influencing yield. As a result, yield can affect net return.

At this point, more specifically, it is important to point out that the objective of this paper is to employ regression analysis to test factors influencing net return in cotton enterprise worldwide over time [1, 2, 3, 4, 5]. To determine which factors have a greater impact on net returns for cotton producers over time, historical returns were analyzed based on refereed journals, book chapters or non peer-reviewed conference proceedings through online searches from long-term studies in developed countries (USA and Australia) and developing countries (India and China). In this study, historical returns were identified from each individual study to look at variability in net returns across producers based on the input and output in economic analysis. A potential weakness of this study is that there are non-economic data

evaluated in this data set (for example, variety, soil type, irrigation or non irrigation facility, rainfall data, etc.) which would help to better identify specific management styles of individual producers. Nonetheless, it is believed that results from this study can be useful for operations of all sizes as they think about what they need to focus on for long-term business survival.

2. Materials and Methods

2.1. Data Source

The data for this study were obtained from literature searched from many resources, set as the database. This study investigated the impact of conventional cotton on crop yield at the global and country level and assessed the effect of conventional cotton on farm level costs and benefits, and extends the existing literature by considering all countries and by focusing on a wide scope of literature. Four countries (USA, Australia, China and India) were considered to be chosen in terms of growing area and economic performance of conventional cotton. The database included peer-reviewed scientific articles as well as non peer-reviewed sources from grey literature. Such non peer-reviewed sources were mainly official reports from governmental organizations or agencies/institutes funded by governments, official international and national statistics as well as conference proceedings, and also from academic, governmental, civil society or from a company.

Database contained peer-reviewed and non peer-reviewed between the publication year of 1998 and 2012. A total of 129 papers were successfully collected which at least consists of one of the economic indicators (yield, net return, seed cost, pesticide cost, management and labor cost). 53 papers were successfully considered in the database then the data were tabulated and accounted for by using Microsoft Excel 2007. 16 samples (number of data tabulation) were taken based on the average data which consist of all economic indicators (yield, seed cost, pesticide cost, management and labor cost, and net return) for regression analysis. Furthermore, the data base included general information on the cotton trait (herbicide tolerance, stacked gene, Bt) from field survey and field trial.

2.2. Variable Selection

This study examined the relationship of net return with multiple variables. To simplify, net returns refer to the return to farm operator for their labor, management system, pesticide and seed, after all production expenses have been paid. Production costs refer to the expenditure of using input during the production process to produce the cotton. The question is that are net returns dependent on the yield, seed cost, pesticide cost, management and labor cost? Therefore, the technique of linear regression and correlation was used, in which case should predict the value of net returns using independent variables.

2.3. Model Establishment

Comparative statistics provide a broad overview about the agronomic and economic effects of conventional cotton. However, such statistics become less effective in separating the effects of individual changes while controlling for the effects of other variables. Individual effects of variables while controlling for the effects of others can be estimated by employing a multiple regression [6]. In this regression, net revenue is taken as the dependent variable while yield, seed cost, pesticide cost, management and labor cost are taken as the independent variables. This model is used to further explore the relationship between net return per hectare, yield and various production inputs, such as pesticide use, seed cost, management and labor cost. Based on the theoretical foundation, the regression model was established which can be written as:

$$Y = b_0 + b_1X_1 + b_2X_2 + \dots + b_iX_i + \epsilon \quad (1)$$

Where:

b_i = partial slope coefficient (also called partial regression coefficient, metric coefficient); it represents the change in Y associated with a one-unit increase in X_i when all other independent variables are held constant. It was observed that b_0 is the sample estimate of β_0 , b_i is the sample estimate of β_i , and β_s are the parameters from the whole population in which the sampling was conducted. The dependent variable and the explanatory variable must be specified as:

Y = Net return

X_1 = Yield

X_2 = Seed cost

X_3 = Pesticide cost

X_4 = Management and labor cost.

We performed SPSS 16.0 to determine the intercept and regression coefficients, after that we tested them for significance by doing the Analysis of Variance (ANOVA). ANOVA determines if regression coefficients that the probable model calculates should be present in the final model as a predictor or not. A P -value or sig-value for coefficients significance test was conducted. If P -value for a coefficient was less than 0.05 ($P < 0.05$), the coefficient is statistically significant and the related variable should be present in the model as a predictor, but if it was higher than 0.05 ($P < 0.05$), the coefficient is not statistically significant and the related variable should not be present as a predictor [7].

Coefficient of determination or R-square (R^2) shows how the model of predictors fits the dependent or independent variables (higher R^2 , higher fit of the model and higher model goodness). Moreover, significant test for intercept (b_0) is similar to regression coefficients [8]. Significance test of the coefficient and R^2 helps researchers to decide what predictor is more important and must be presented in the model. Besides this, when the number of the predictors increased, usually most of the variables are strongly correlated with each other and it is not necessary to present all of these correlated variables in the model since they can be used in place of one another [9].

3. Results

We employed a regression analysis in order to investigate the correlation between dependent variable (Y = Net Revenue) and predictor variable (X1 = Yield, X2 = Seed, X3 = Pesticide, X4 = Management and Labor). Data presented in

Table 1 show that under the condition level, $\alpha = 0.05$ $F = 28.448$, p value = 0.000 (< 0.05). This means indicated that the goodness of fitting of equation is highly significant. Because p value of F is smaller than 0.05, therefore the overall significance is good and also indicated that there is no multicollinearity problem.

Table 1. Model summary and analysis of variance between independent an dependent variables of conventional cotton.

Model Summary ^b					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin Watson
1	0.955a	0.912	.880	111.97310	2.100
ANOVA					
Model	Sum of Squares	Df	Mean Square	F	Sig.
1 Regression	1426723.719	4	356680.930	28.448	.000a
Residual	137917.719	11	12537.974		
Total	1564641.437	15			

a Predictors (Constant), Management and Labor, Seed, Yield, Pesticide

b Dependent Variable

To express the quality of fit between a regression model and the sample data, the coefficient of multiple determinations (R^2) was used ranging in value from 0.0 to 0.1. Table 1 shows the value of R^2 as 0.912 indicating that the fitting degree is high, and the linear relationship between predictors and dependent variable is significant. Higher value of R^2 indicates a better fit of the model to the sample observations. However, adding any regressor variable to this model, even an irrelevant regressor, yields a greater R^2 . For this reason, R^2 by itself is not a good measure of the quality of fit. To overcome this deficiency in R^2 , an adjusted value could be used. Therefore, the adjusted R^2 was used on this model which is a more reliable indicator of model quality.

We found that the value of adjusted R^2 is 0.88. As such, 88% of the variability in Net revenue in conventional cotton can be predicted from the relation of the independent variable (yield, seed, pesticide, management and labor), while the remaining can be explained by the outlier beyond the model.

In the case of one explanatory variable, the coefficient of determination is simply the square of the coefficient of correlation namely r^2 . Table 2 shows the relationship between the dependent and explanatory variables. This study performed Pearson correlation matrixes focused on the strong correlation (positive or negative) between the dependent and independent variables.

Table 2. Correlation matrixes between independent variable and dependent variable of conventional cotton.

		Net Return	Yield	Seed	Pesticide	Management and Labor
Pearson Correlation	Net Return	1.000	.407	-.082	.024	-.426
	Yield	.407	1.000	.361	.443*	.577
	Seed	-.082	.361	1.000	.255	.312
	Pesticide	.024	.443	.255	1.000	.618
	Management and labor	-.426	.577*	.312	.618*	1.000
Sig. (1-tailed)	Net Return		.059	.382	.465	.050
	Yield		.059	.085	.043	.010
	Seed		.382	.085	.170	.120
	Pesticide		.465	.043	.170	.005
	Management and labor		.050	.010	.120	.005

*. Correlation is significant at the 0.05 level (1-tailed)

Table 2 depicts that the relationship between management and labor cost and pesticide indicated a strong positive correlation ($r = 0.618$) with r^2 significant level < 0.05 (0.005), then yield and management and labor cost ($r = 0.577$) with r^2 significance level < 0.05 (0.010). The relationship between yield and pesticide cost presented a strong positive correlation ($r=0.443$) with r^2 significant level < 0.05 (0.043). Moreover, we found a significant negative effect between management and labor cost and net return ($r=-0.426$) with r^2 significance test 0.05.

Furthermore, Table 3 performed the multicollinearity test

and the model test for this study. From the table 3 we represent that to independent variable yield (X1), the estimation of regression is 388.135, standard error is 45.000, t test value is 8.625, t test significance is 0.000, lower than 0.01. That is think independent variable yield is highly significant. Then, to predictors variable pesticide and management and labor, we can find that t test significance is 0.012, and 0.000 lower than 0.05, respectively. Therefore, the coefficient of independent variable is highly significant. Overall, we can say that net return variability can be significantly affected by yield, pesticide and management and labor.

Table 3. Multicollinearity test and model test of regression analysis of conventional cotton.

Model	Unstandardized Coefficient		Standardized Coefficient	t	Sig.	Collinearity Statistics	
	B	Std. Error	Beta			Tolerance	VIF
1 (Constant)	-64.890	93.569		-.694	.502		
Yield*	388.135	45.000	.979	8.625	.000	.622	1.609
Seed	-4.640	2.742	-.164	-1.692	.119	.851	1.175
Pesticide*	1.897	.633	.345	2.996	.012	.605	1.652
Manag & labor*	-1.017	.112	-1.153	-9.104	.000	.500	2.002

*. Significant at the 0.05 level

The obtained results showed that the prediction equation for net return in conventional cotton (Y) is formulated using the predictors as follows:

$$Y = -64.890 + 388.135 X_1 - 4.640 X_2 + 1.897X_3 - 1.017 X_4$$

In addition, we test the multicollinearity of the model using variance inflation factor (VIF) which indicated that overall results is lower than 10. That is this model does not has the multicollinearity problem. Moreover, autocorrelation test on this model was carried out by Durbin Watson (DW) analysis which indicated that DW = 2.1. According to DW checking table, under 0.01 significant level then $D_u < DW < 4 - D_u$ (n=15, K = 4) then $1.70 < 2.1 < 4 - 1.70$, that is this equation has no problem with autocorrelation.

4. Discussion

Regression analysis reveals that net return mostly is affected by yield gain. That is yield gain is the main factor influencing farmers’ income. The database depicts that yield gain varies from country to country, trait to trait, year to year due to the climatic conditions, site specific and geographical dependent. Moreover, the impact of yield difference on conventional cotton was dependent upon the level of pest pressure, location, year, climatic factors, and time of planting.

A question commonly asked is whether one explanatory variable is more important than the other. The effect of any given explanatory variable depends on which other variables have been included in the regression model. The question cannot be answered by simply looking at the respective values of the β coefficients, because the value of the β coefficients depends on the unit of the explanatory variable. In this case, yield gain is measured by kg/hectare and the others (seed cost, pesticide cost, management and labor cost) are measured by USD/hectare. There can be no comparison between such disparate quantities; instead we look at the t-ratios between response variable and explanatory variables, in which 8.625 was for the yield which was higher than that of any other independent variables. Therefore, the effect of the yield gain is greater than that of other explanatory variables. A strong positive correlation between yield and net return indicates that increased yield of using conventional cotton leads to higher revenue of cotton grower.

A negative t-ratio of management and labor cost showed by -9.104 indicating cotton growers with high management

and labor cost was expected to have lower net return unless they will have higher yield that can offset higher labor expenditure to optimize the return. Interestingly, this study consistent with [10, 11, 12, 13] that the implementation of GM cotton required cotton growers higher management and labor costs due to the goodness of crop management system such as consultant fee, irrigation costs, and other management costs.

Moreover, the t-ratio of pesticide cost shows a positive value (2.996), while expecting cotton growers need more chemical spray to reduce the yield losses due to the pest pressure. In other words, when farmers expect to incur large yield losses from cotton bollworm, they spray more. That is, the more they spray, the higher the expected yield. However, the higher pesticide use was due to the less resistant of conventional cotton variety againts the bollworm attack [14, 15, 16, 17]. The increased use of pesticide could also be due to the the differences in naturally occurring fluctuations in pest population especially for cotton bollworm which varied from country to country, county to county, year to year, site specific, climatic conditions and geographical dependent. In contrast, study about GM (genetically Modified) cotton that its implication rely on the chemical spray due to the secondary pest which might decrease the potential yield of GM cotton [2, 17, 18]. This means that GM cotton might face a serious problem of secondary pest infestation even its resistant to cotton bollworm.

The observed economic impacts of conventional cotton in any ‘place’ will depend on the yield potential of crop varieties, the pest infestation, and general and seasonal dependent climate and weather conditions, as well as government intervention [19].

5. Conclusions

Regression analysis in this paper presented the relationship between net return, yield, and production cost. The relationship is that producers expect higher yields of conventional cotton. Therefore, a significantly higher yield is needed to optimize revenue. Another correlation is due to the fact that the higher chemical spray is needed in order to optimize the yield. This is due to the fact that conventional cotton is the less resistant crop of pest infestation. Therefore, the more the chemical spray, the higher the cotton yield. Moreover, the correlation between net return and management and labor costs indicated that growing conventional cotton is time consuming for cotton harvest. Due

to the less resistant of conventional cotton, consequently, the higher the chemical spray, the higher the management and labor cost which can affect the net return of cotton growers.

In this study, statistical inferences of regression analysis reveal that yield, seed cost, pesticide cost, management and labor cost effectively influence net return in conventional cotton. Other factors which determine relative economic profitability beyond those economic indicators have been ignored but should be considered and taken into account for the future research. It is a concern that this study relied on the individual studies. Thus, the data observed might not be adequately addressed to capture the effect of using conventional cotton due to the fact that these studies might use totally different methodologies to assess the economic benefit of conventional cotton. For instance, such assessment might be based on the impact different studies, using field trials or surveys, have on public research institutes or private companies which probably show presence of biases that can occur with different methodologies.

As a result of the aforementioned points, the analysis presented some interesting points that shed light on the diversity that can be observed in the literature and which helped fuel the divergent viewpoints held in the development of conventional cotton. Thus, this study is a representative of the entire economic standpoint based on the literature searched with different goals and methodologies, as well as the study's purpose.

The results presented here do support the economic analysis of growing conventional cotton and might be compared with transgenic cotton, and by adding-up individual studies through the meta-data, there is the risk of comparing apples and oranges. Nonetheless, the analysis presented shows that conventional cotton is still being considered as the alternative crop which might contribute to poverty reduction and rural economic development, and all of these aspects should be considered in the assessment of the whole of cotton economic analyses for the future research.

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