FIELDPRINT CALCULATOR: RESULTS FROM THE TEXAS HIGH PLAINS

Miranda Gillum
Phillip Johnson
Texas Tech University
Lubbock, TX

Abstract

The Fieldprint Calculator is an analytical tool – developed by Field to Market: The Keystone Alliance for Sustainable Agriculture – that evaluates crop production operations and computes metrics to measure their sustainability and operational efficiency. The objective of the study was to evaluate the relationship between the sustainability metrics generated by the Fieldprint Calculator and profitability. The data used for this study was from fields with irrigated cotton production across seven years from 2007 to 2013 in the Texas Alliance for Water Conservation (TAWC) project located in the Texas High Plains region. The sites were evaluated using the Fieldprint Calculator with sustainability index values calculated for each field. Least squares regression analysis was used to evaluate the relationship between gross margin as the dependent variable and the sustainability metrics as the independent variables. The results indicated that a "positive" relationship exists between sustainability and profitability. This study was funded by National Cotton Council and Texas Alliance for Water Conservation.

Background

Sustainability in agricultural production is an important issue that is being addressed by many in the agricultural industry. Field to Market developed the Fieldprint Calculator to enable agricultural producers to measure the sustainability of their operations, and researchers to analyze the effects on sustainability and the environment of different production practices (Field to Market). The Fieldprint Calculator evaluates a producer's sustainability based on seven metrics: land use (ac/lb), irrigation water use (in/lb), energy use (gallons of diesel/lb), greenhouse gas emissions (lbs CO_2/lb), soil conservation (tons of soil loss/ac/yr), a soil carbon index and a water quality index. Land use refers to the production efficiency of a particular field and is directly related to yield. If one field produces more yield per acre than another, it is more efficient and has a lower land use metric, meaning it requires less land to produce the same amount of crop. Irrigation water use is the amount of water applied per acre. Energy use accounts for all direct and indirect energy from production inputs used for an operation. Direct energy use is from inputs such as fuel used for irrigation and tillage operations. Indirect energy is energy used in the manufacture and transportation of inputs such as fertilizer and chemicals, and capital assets such as equipment. Greenhouse gas emissions are measured as the amount of CO_2 produced and is generally related to direct and indirect energy usage. The soil conservation metric accounts for estimated soil erosion in the field. Water quality refers to the quality of runoff water at the edge of the field. Soil carbon is a measure of the level of organic carbon in the soil.

The calculator generates these metrics and provides a graphic sustainability footprint in the form of a spider graph. By assessing these metrics, the calculator enables a producer to explore different management decisions in order to improve the sustainability of their farming operation. Additionally, the calculator allows each farmer to compare their current farming practices to the county, state, and national averages in order to understand how their sustainability compares to other operations.

The objective of this study was to analyze and evaluate the relationship of the sustainability metrics derived from the FieldPrint Calculator on profitability. Data used in the study was from the Texas Alliance for Water Conservation for sites with irrigated cotton production in the years 2007 through 2013.

Materials and Methods

The Texas Alliance for Water Conservation (TAWC) is a collaborative project with agricultural producers in Hale and Floyd counties of Texas. The project focuses on conserving water while maintaining and improving agricultural production. Data used in this study was from 20 producers in the TAWC project with 32 field sites that were in irrigated cotton production from the years 2007 through 2013, representing a total of 139 observations. These fields range in size from 13 acres to 398 acres, and include no-till, strip-till and conventional tillage operations, as well as different irrigation methods such as center pivot, drip, and furrow. For this study, only irrigated cotton fields were evaluated. Producers provided field information on irrigation; tillage operations; chemical input applications of fertilizer, herbicide, insecticide, and harvest aides; and crop yield. Cost and return budgets were developed for each site to estimate the cost of production and profitability. Profitability was calculated as gross margin which is cash receipts less cash costs.

Data from the TAWC sites was entered into the Fieldprint Calculator to estimate the sustainability metrics. Several of the sustainability metrics are expressed relative to the unit of crop production. For example, the irrigation metric is expressed as inches of irrigation per lb of production. This construct means that the metric values become smaller as resource use becomes more efficient or the production of externalities such as greenhouse gas emissions are reduced. Since cotton is a joint product comprised of lint and seed production, the Fieldprint Calculator computes values based on a lint equivalent yield (LEY). The LEY is calculated by dividing the lint yield by the proportion of revenues attributed to lint which was assumed to be 83%, with 17% of revenues coming from seed production. For example, a lint yield of 1200 lbs would be converted to a LEY of 1446 lbs to account for the seed yield.

The sustainability metrics were each converted to an index based on the mean value of each metric for the 139 observations. The conversion of the metrics to an index value standardized the units for each metric. A regression analysis was performed using the least squares method with gross margin as the dependent variable, the index value for each metric, and dummy variables for each year as independent variables. Four of the seven metrics were evaluated as independent variables. The water quality and soil carbon metrics were not included in the analysis. The energy and greenhouse gas emission metrics were combined into one variable (EG) due to the high level of correlation (93%) between the two indexes by taking an average of the indexes for each metric.

The model was first estimated with the four sustainability variables (land use, irrigation, energy/greenhouse gas, and soil conservation) and the six dummy variables representing 2008 through 2013 (2007 was the base year). After estimating the model in SAS, the p-value for the soil conservation variable indicated that it did not have a significant effect on gross margin; therefore, the soil conservation variable was removed from the model. The model was then estimated using land use (LU), irrigation water use (Irr), the squared value of Irr, the energy/greenhouse gas variable (EG), the squared value of the EG variable, and the dummy variable for years 2007 through 2013. The results indicated that the irrigation squared variable was not significant; therefore, it was removed from the model.

The final model was specified as follows.

$$\mathbf{GM = \beta_1 + \beta_2{*}LU + \beta_3{*}Irr + \beta_4{*}EG + \beta_5{*}EG^2 + \beta_6{*}D08 + \beta_7{*}D09 + \beta_8{*}D10 + \beta_9{*}D11 + \beta_{10}{*}D12 + \beta_{11}{*}D13}$$

Where:

GM = Gross Margin

LU = Land Use

EG = Average of Energy Use and Greenhouse Gas Emissions

EG^2 = Squared value of EG

D08 = Crop produced in 2008

D09 = Crop produced in 2009

D10 = Crop produced in 2010

D11 = Crop produced in 2011

D12 = Crop produced in 2012

D13 = Crop produced in 2013

Results and Discussion

The results of the regression analysis are given in Table 1. Four variables were used to evaluate the effects of sustainability on profitability: land use, irrigation water use, energy/greenhouse gas emissions, and energy/greenhouse gas emissions squared. Dummy variables were used for each year of production to account for the variations due to weather and prices across production years with 2007 being the base year. Gross margin was the dependent variable and is defined as cash income minus cash expenses.

The regression results show that all coefficients for the sustainability metrics had the appropriate signs and values, and were significant at the 95% confidence level. The p-value for the 2009 dummy variable was not significant, however the variable was retained in the model.

Table 1. Results of Regression Equation with Gross Margin as the Dependent Variable.

Variable	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1162.72106	66.49842	17.48	<.0001
LU	-5.40225	0.43376	-12.45	<.0001
Irr	-1.59417	0.41116	-3.88	0.0002
EG	-4.15072	0.96326	-4.31	<.0001
EG^2	0.01484	0.00220	6.76	<.0001
D08	-121.11846	53.55237	-2.26	0.0254
D09	-59.31872	50.73969	-1.17	0.2445
D10	196.03276	49.86895	3.93	0.0001
D11	520.02370	58.71094	8.86	<.0001
D12	543.68462	51.32438	10.59	<.0001
D13	325.23226	51.50706	6.31	<.0001

A general model was derived by evaluating the dummy variables for each year at their mean value which increased the intercept by approximately 250 dollars. This allowed the model to be simplified to only reflect the relationship between the sustainability metrics and gross margin. The resulting equation is:

$$\mathbf{GM = 1415.077 - 5.40225*LU - 1.59417*Irr - 4.15072*EG + 0.014844*EG^2}$$

A lower index value for a sustainability metric is considered to be better because it indicates a more sustainable operation. The negative coefficients for the sustainability metrics indicate that as a producer lowers their index values their gross margin will increase. For example, if a producer has an index value of 100 for each metric, the derived gross margin is $448.80 per acre. If the value of the irrigation metric index is reduced to 80 while the other metrics remain at an index value of 100, the derived gross margin increases to $480.69 as shown in Table 2.

Table 2. Derived Estimates of Gross Margin.

		Index		**Index**	
Intercept			1415.077		1415.077
LU	-5.40225	100	-540.225	100	-540.225
Irr	-1.59417	100	-159.417	80	-127.534
EG	-4.15072	100	-415.072	100	-415.072
EG^2	0.014844	10000	148.4416	10000	148.442
		Gross Margin	$448.80	**Gross Margin**	$480.69

Conclusions

Analysis of the Fieldprint Calculator's data output from TAWC sites in the Texas High Plains region showed that as sustainability metrics improved, there was a positive effect on gross margin. Given the results of this study, there is an incentive for producers to adopt production practices that lower the metrics evaluated by the Fieldprint Calculator which increases their sustainability. By using the resources provided by the Fieldprint Calculator, a producer can determine management practices that will aid in lowering their sustainability index and should be encouraged to do so given the results of this study.

Acknowledgements

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References

Field to Market, https://www.fieldtomarket.org/fieldprint-calculator/.