Cost Efficiency of International Corn Production

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Abstract

The objective of this paper was to examine the cost efficiency of corn production for typical farms involved in the cash crop *agri benchmark* network. Average cost efficiency for 32 typical farms, representing 12 countries, was 0.720. Seed and direct inputs other than seed, fertilizer, and crop protection inputs, were found to be under-utilized, and labor was found to be over-utilized on the typical farms.

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Introduction

Understanding changes in production and production systems is a critical ingredient to understanding global production agriculture. The *agri benchmark* concept of typical farms was developed at the von Thunen-Institute (vTI) in Braunschweig, Germany to further understanding of current production systems and farmers' decision making. Activities or profit centers examined by the *agri benchmark* network (www.agribenchmark.org) include beef, cash crops, dairy, pigs and poultry, horticulture, and organic. Cash crops studied include barley, corn, cotton, palm oil, potato, pulse, rapeseed, rice, soybean, sugar beet, sunflower, and wheat.

The objective of this paper is to examine the cost efficiency of corn production for typical farms involved in the cash crop *agri benchmark* network. Estimated cost efficiency indices are related to cost shares.

Methods

Cost efficiency was the primary measure of interest in this study. Cost efficiency represents the product of technical and allocative efficiency. A technically efficient firm produces on the production frontier and an allocatively efficiency firm uses the optimal mix of inputs. Thus, a cost efficient firm produces on the production frontier and uses the optimal mix of inputs. Efficiency indices or scores range from 0 to 1 where an index of 1 indicates that a firm is efficient.

Data envelopment analysis (DEA) was used to measure technical, allocative, and cost efficiency under variable returns to scale in this paper. DEA compares the farms in terms of their input use and resulting output level to construct a benchmark or best practice frontier. Information pertaining to the estimation of technical, allocative, and cost efficiency under variable returns to scale can be found in Fare, Grosskopf, and Lovell, 1985; and Coelli et al., 2005.

Input cost shares were compared for typical farms in the following groups: farms with a cost efficiency level that was one standard deviation below the average cost efficiency level, all farms, and farms with a cost efficiency level that was one standard deviation above the average cost efficiency level. Correlation coefficients between cost efficiency and input cost shares were also computed. A positive and significant correlation between cost efficiency and an input share indicated that a particular input was under-utilized. Conversely, a negative correlation would be indicative of an input that was over-utilized.

Data

Corn production data for 2012 for 32 typical farms representing 12 countries that participated in the cash crop *agri benchmark* network were used to compute the efficiency indices. Countries with corn data in 2012 are listed in table 1. Gross revenue divided by corn price was used as the output measure. Gross revenue included crop production, crop insurance indemnities, and direct government payments. Inputs included seed, nitrogen, phosphorus, potassium, plant protection, other direct inputs, labor, and miscellaneous. The plant protection input included herbicides, fungicides, and insecticides. The other direct input included crop establishment cost, energy costs associated with drying, irrigation cost, crop insurance, and finance cost on direct inputs. Labor included hired and family labor. Miscellaneous cost included all costs not included in the other categories such as contractor cost; machinery and building depreciation and finance cost; repairs and maintenance; energy cost other than drying cost; land cost; and general farm insurance.

Typical farms used in the *agri benchmark* are defined using country initials, hectares in the farm, and location in the country. For example, the US1215INC farm is a U.S. farm with 1215 hectares located in central Indiana. The other U.S. farms are defined as follows: US1215INS is a farm with 1215 hectares located in southern Indiana, US2025KS is a farm with 2025 hectares located in northwest Kansas, US700IA is a farm with 700 hectares located in Iowa, and US900ND is a farm with 900 hectares located in eastern North Dakota. There are two farms labeled US2025KS in the figures below. This reflects the fact that this typical farm has both irrigated corn and non-irrigated corn.

Results

Before discussing the efficiency indices, we will discuss corn yields and cost shares for the typical farms. Figure 1 illustrates the average corn yield per hectare in 2012 for the 32 typical farms. Corn yield per hectare ranged from 3.6 tons per hectare for one of the South African farms to 13.0 tons per hectare for one of the French farms. The average yield per hectare was 7.33 tons. With respect to the U.S. farms, it is important to note that the two Indiana farms (US1215INC and US1215INS) were greatly impacted by the 2012 drought. Yields for these two farms typically average 10.4 tons per hectare or similar to the yield for the Iowa farm (US700IA).

Figure 2 presents input cost shares by typical farm for 2012. Costs were broken down into six categories for the figure: seed, fertilizer, plant protection, other direct cost, labor, and miscellaneous cost. Obviously, the cost shares vary considerably among countries. These differences in cost shares were due to differences in production systems, input prices, and inefficiency. If the differences were primarily due to production systems and input prices, then inefficiency, discussed below, would be a minor issue.

To further illustrate input cost share differences, labor cost as proportion of total cost for each typical farm is provided in figure 3. The input cost share for labor ranged from 1.8 percent for one of the farms in Bulgaria to 51.6 percent for one of the Chinese farms, and averaged 13.1 percent. Again, these differences in labor cost shares can be explained by differences in production systems and input prices if inefficiency is not problematic.

Technical, allocative, and cost efficiency averaged 0.951, 0.758, and 0.720, respectively. These results indicate that allocative efficiency was a larger problem than technical efficiency, and that at least part of the differences in the input cost shares were due to inefficiency. Cost efficiency ranged from 0.181 to 1.000. There were five typical farms with a cost efficiency index of one (two from Argentina, one from the Czech Republic, one from France, and the irrigated corn farm in northwest Kansas). Cost efficiency for the U.S. farms ranged from 0.534 for the central Indiana farm to 1.000 for the northwest Kansas irrigated farm.

To gain further insight into differences in input cost shares among the typical farms, the input cost shares were summarized for three groups of farms: those with a cost efficiency index that was one standard deviation below the average, all farms, and those with a cost efficiency index more than one standard deviation above the average. The resulting input cost shares are presented in table 2. There were five typical farms in the first group: one from Bulgaria and four from China. The six typical farms with a cost efficiency index that was one standard deviation above the average included the five farms with a cost efficiency index of 1.000 and the third farm from Argentina. Comparisons between the first and third groups indicated that the input cost shares for the high cost efficiency group for seed, fertilizer, plant protection, and other direct cost were above those for the low cost efficiency group, and that the input cost shares for labor and miscellaneous cost for the high cost efficiency group were relatively lower.

Table 3 presents correlation coefficients between cost efficiency and input cost shares. The correlation coefficients for seed, other direct cost, and labor were significant. The input cost shares for seed and other direct cost (i.e., direct costs not included in seed, fertilizer, and plant protection costs) were positively correlated with cost efficiency. The input cost share for labor was negatively correlated with cost efficiency. Correlation coefficient results suggest that in general, seed and other direct inputs were under-utilized, and labor was over-utilized.

Conclusions and Implications

The objective of this paper was to examine the cost efficiency of corn production for typical farms involved in the cash crop *agri benchmark* network. Data for 2012 from 32 typical farms in 12 countries were used to generate efficiency indices. Technical, allocative, and cost efficiency averaged 0.951, 0.758, and 0.720, respectively. Allocative inefficiency, resulting from inefficient input mixes, was the primary driver of cost inefficiency.

Cost efficiency was related to input cost shares. Input cost shares varied substantially across the typical farms. Analysis of the relationship between cost efficiency and input cost shares indicated that seed and other direct inputs were under-utilized and labor was over-utilized.

The results in this study are very preliminary. Future analysis will examine corn data for more than one year, data for crops other than corn, and examine the interactions between corn and other crops grown on the typical farms.

<u>References</u>

Agri benchmark web site: www.agribenchmark.com.

Coelli, T.J., D.S. Prasada Rao, C.J. O'Donnell, and G.E. Battese. *An Introduction to Efficiency and Productivity Analysis,* Second Edition. New York: Springer, 2005.

Fare, R., S. Grosskopf, and C.A.K. Lovell. *The Measurement of the Efficiency of Production.* Boston: Kluwer-Nijhoff, 1985.

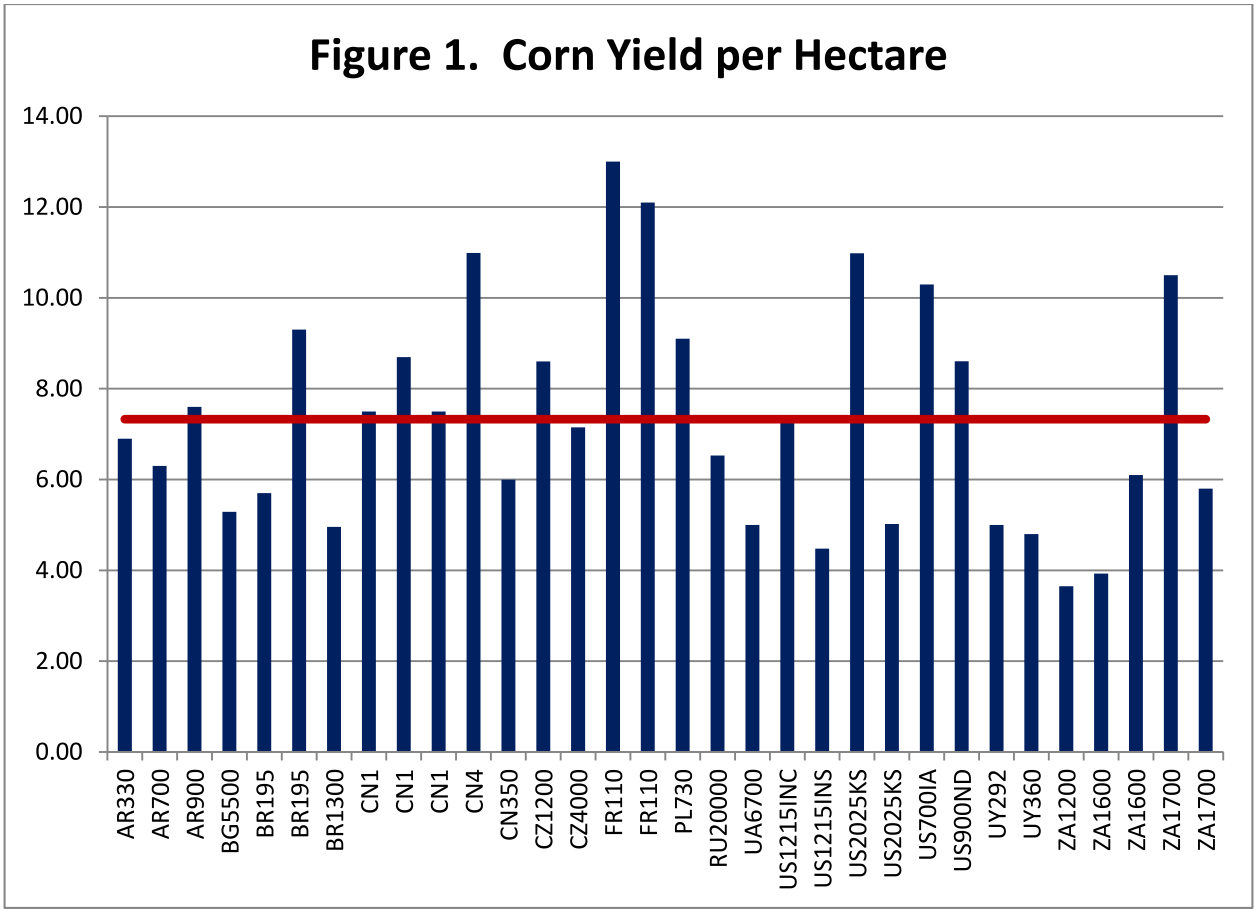

Figure 1. Corn Yield per Hectare
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
AR330
AR700
AR900
BG5500
BR195
BR195
BR1300
CN1
CN1
CN1
CN4
CN350
CZ1200
CZ4000
FR110
FR110
PL730
RU20000
UA6700
US1215INC
US1215INS
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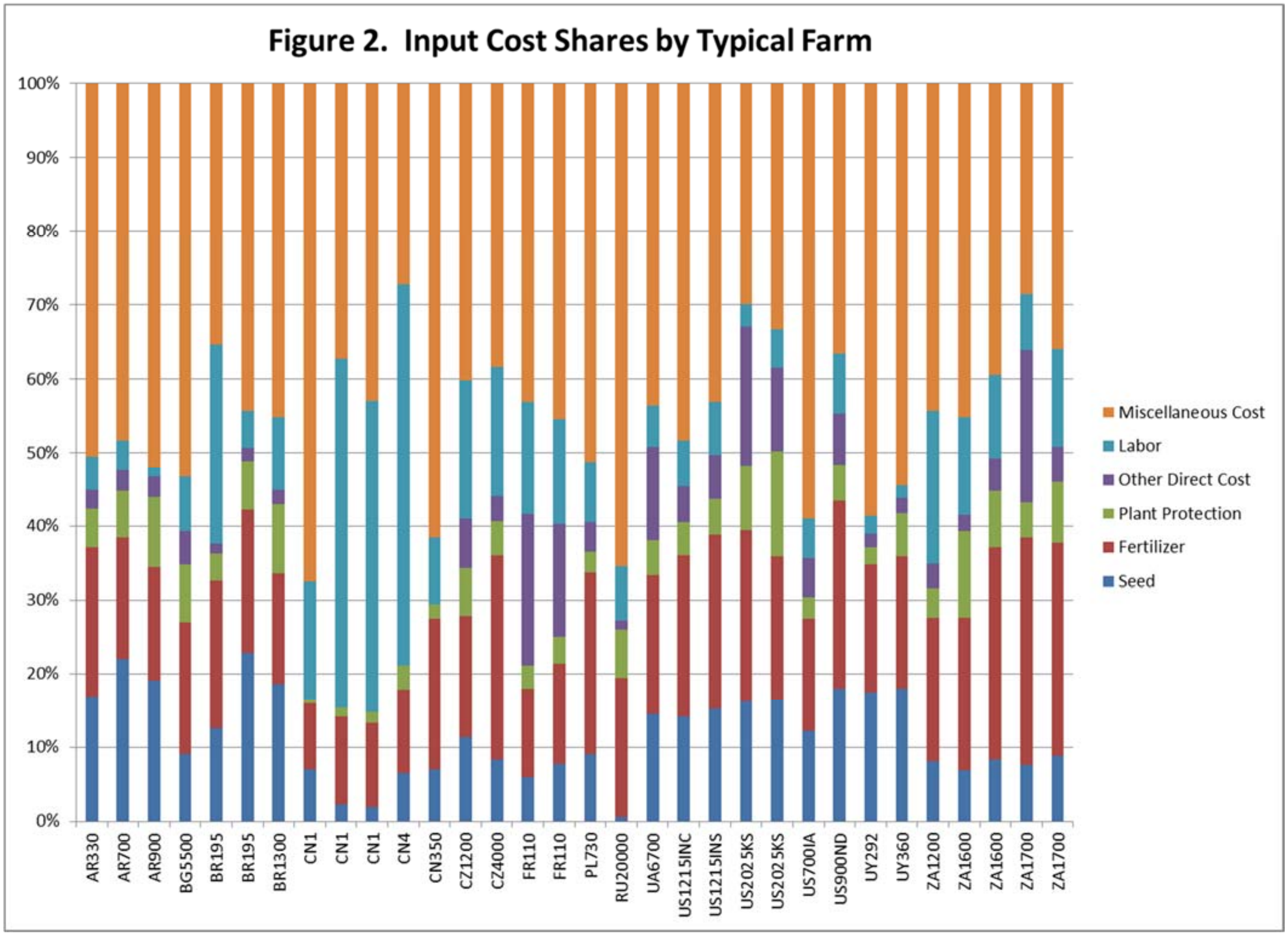

Figure 2. Input Cost Shares by Typical Farm

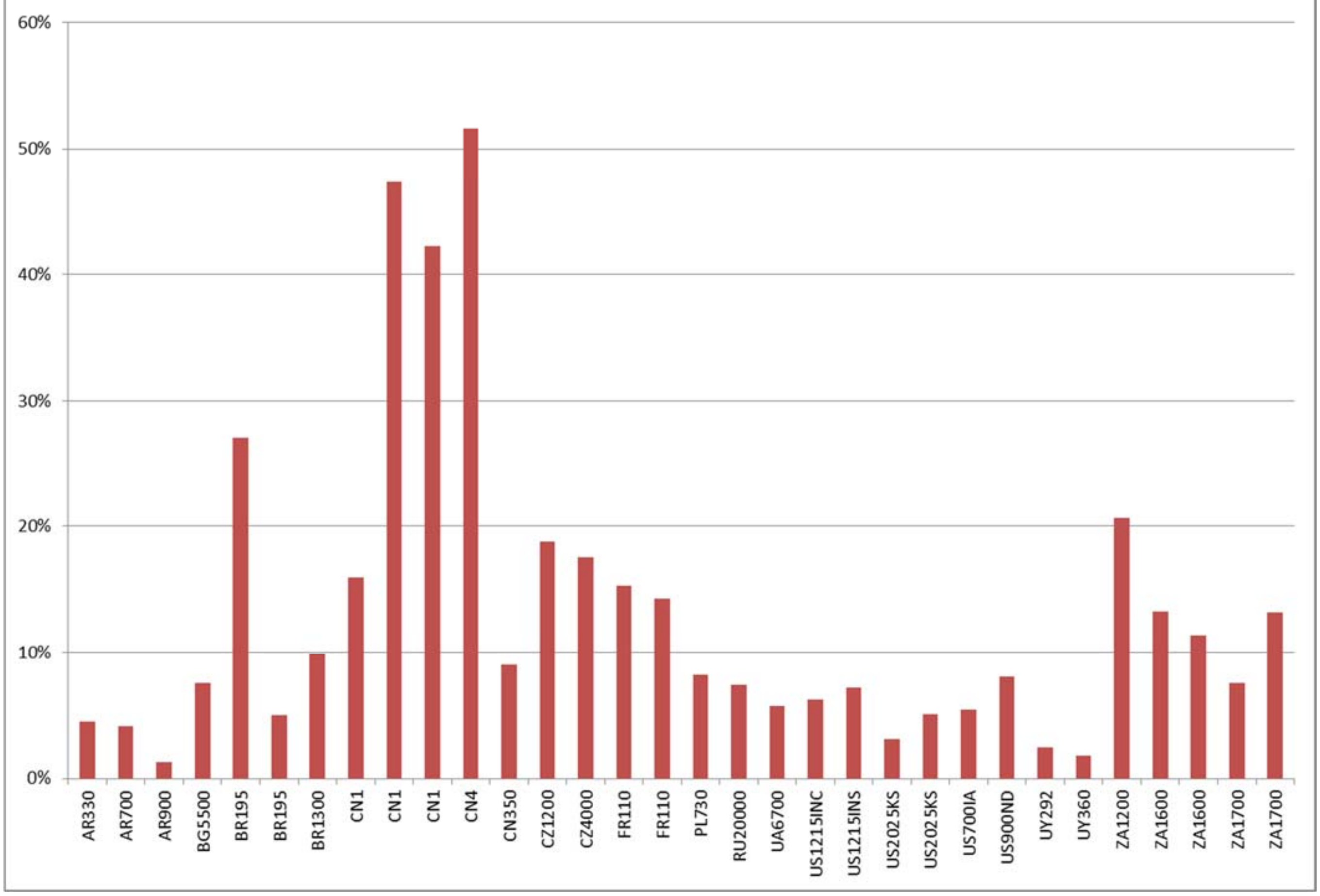

Figure 3. Labor Cost as a Proportion of Total Cost

Table 1. Abbreviations for Countries Involved in Agri-Benchmark Cash Crop Network with Corn Data.

Country	Abbeviation
Argentina	AR
Bulgaria	BG
Brazil	BR
China	CN
Czech Republic	CZ
France	FR
Poland	PL
Russia	RU
Ukraine	UA
United States	US
Uruguay	UY
South Africa	ZA

Table 2. Input Cost Shares by Cost Efficiency Groups.

Cost Share	Average - 1 Std Dev	Average All Farms	Average + 1 Std Dev
Seed	5.4%	12.0%	15.2%
Fertilizer	14.2%	20.9%	17.3%
Plant Protection	2.5%	5.8%	6.6%
Other Direct Cost	0.9%	5.5%	9.0%
Labor	24.4%	11.8%	7.8%
Miscellaneous Cost	52.5%	44.0%	44.0%

Table 3. Correlation Coefficients between Cost Efficiency and Input Cost Shares.

Cost Share	Correlation Coefficient	Significance (p-values)
Seed	0.415	0.018
Fertilizer	0.207	0.255
Plant Protection	0.281	0.119
Other Direct Cost	0.398	0.024
Labor	-0.357	0.045
Miscellaneous Cost	-0.226	0.214