USA CORN FARM PROFITS AND ADOPTION OF PRECISION AGRICULTURE

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Motivation for the Study

Decisions by farm managers to adopt new technologies often involve weighing the full costs and benefits of proposed investments. Precision agricultural (PA) technologies require a significant investment of capital as well as the operator's time, and offer the potential of cost savings and higher yields through more precise management of inputs based on field information. Until very recently, the adoption of PA technologies had been sluggish, but the 2010 ARMS survey of corn producers showed an increase in the use of three PA technologies: GPS soil and yield mapping, tractor guidance systems, and variable rate input application. This study investigates whether the increase in adoption has corresponded to an increase in operating profits for U.S. corn production. The specific research questions addressed include:

- Does adoption of PA have an effect on profits?
- What are the factors influencing PA adoption?
- What other factors, including PA adoption, determine operating profits on U.S. corn farms?

What Did the Study Find?

Adoption of GPS-based yield and soil mapping (GPS mapping), guidance systems (GSYS), and variable rate application technologies (VRT) are all influenced by a similar set of factors (results for guidance and VRT in table). A scale effect for adoption is detected with larger farms increasing adoption of all three technologies. Complementarity is found between soil testing for nutrient deficiencies and the adoption of all three PA technologies. Yield goal, representing the farmer's reported yield potential for a farm, has a negative effect on adoption. Since yield goals are generally lower for poorer quality land and on parcels often experiencing difficulties in the application of favored production practices, precision agriculture may be used to offset some of these yield limitations. Use of other more prevalent corn production technologies like GMO seeds was only significant in explaining adoption of VRT.

All three technologies failed to contribute directly to corn-farm operating profits. Estimated impacts of variables affecting adoption and profit are consistent across the different technologies, even though different farms adopted different technologies, demonstrating a robust modeling strategy and reliability of factors influencing profit. Farm financial condition and farmer's primary

occupation influence profits when any of the three technologies are included. Even though corn farming as the operator's primary occupation was not significant itself, primary operators with a high assets-to-debt ratio had larger profits. A recent tractor purchase is associated with higher profits after controlling for geographical location.

Table: Treatment-effects models (1) and (2) – Maximum Likelihood Estimates
(N=1,278)

	Variables	**Guidance Systems (1)**	**VRT (2)**
Operating profit (per acre)	Notill (if used=1, zero otherwise)	0.009 (0.19)	-0.003 (0.08)
	Occupation, Legal-org interaction	0.056 (0.95)	0.051 (0.95)
	Occupation, Assets-to-debt interaction	0.478 (3.42)**	0.329 (2.42)*
	New tractor since 2005	0.186 (4.04)**	0.146 (3.65)**
	State dummy variables for GA, IL, KY, NY, NC, ND		
	Guidance systems/VRT (fitted values from below)	-0.671 (4.06)**	-0.768 (9.91)**
	Constant	5.983 (165.12)**	5.965 (178.20)**
Guidance systems/VRT	Acres farmed	0.390 (4.55)**	0.152 (4.70)**
	GMO seeds	-0.068 (0.36)	0.293 (2.12)*
	Soil testing	0.174 (1.81)	0.187 (2.21)*
	Yield goal	-0.547 (5.85)**	-0.393 (8.67)**

T-stats * $p<0.05$ ** $p<0.01$

Wald test of independent equations (rho = 0): $\text{chi}^2(1)$ =14.82**(1)**, 68.61**(2)**
$\text{Prob} > \text{chi}^2 < 0.0001$

How Was the Study Conducted?

This study makes use of the 2010 Agricultural Resource Management Survey (ARMS) of corn producers. The survey data allow examination of detailed field-level operator information combined with a large sample of corn-farms and their associated financial information. The use of three PA

technologies is examined for each farm – information mapping, guidance systems, and VRT. A treatment-effects empirical model is used to control for selection bias because technology adopters might have had higher profits from corn production even if they had not used PA technologies. After estimating a selection equation for each of the three PA technologies it is possible to include the technology itself with other factors explaining profits.