

Research & Technology



Agricultural Research Service, USDA

Does Off-Farm Work Hinder “Smart” Farming?

As off-farm income takes on greater importance in the portfolio of farm household activities, less time is available for farm management. Management, the key to “smart” farming, is time-intensive. But management does not typically figure in analysts’ calculations of economic returns to alternative production technologies or farming systems. The result could be misleading in understanding the benefits of technology adoption, particularly if farm households, like most of their nonfarm counterparts, are willing to forego some financial return from farming to gain convenience.

Smart farming typically substitutes management for capital. Smart farming is the practice of collecting data (or paying someone to collect data) on specific, variable aspects of a farm’s production system; analyzing the data to discern whether, how much, or when a farm input is needed; and adjusting practices to optimize input use.

Examples of smart farming include:

- soil testing to determine the extent of nitrogen and phosphorus application needed on a particular field for optimal crop growth—a practice directed at

avoiding out-of-pocket and environmental costs of over-fertilization;

- integrated pest management (IPM)—scouting for insect pests and using economic thresholds to help ensure optimal insecticide timing, to derive the most from expenditures on input applications, and, when insect populations stay low, to avoid the expense of “insurance” use of insecticides altogether;
- precision farming to apply inputs in optimal patterns within and across fields.

Economic assessments of smart farming management systems invariably show a potential reduction in variable production costs that is greater than the value of any concurrent loss in average yield. The assessments sometimes demonstrate both lower variable input costs and higher average yields.

Not All Farms Practice “Smart” Farming

More than 35 years after the introduction of integrated pest management systems, the Clinton Administration goal of IPM practice on 75 percent of crop acres in the U.S. has not been achieved, despite long-

standing evidence that IPM systems tend to increase net returns (as traditionally measured) by optimizing pest control actions and inputs. Moreover, nitrogen testing of soil occurred on less than half of corn acreage in 1996. As for precision farming, 14 percent of U.S. grain and oilseed farmers had embraced aspects of this practice by 1998, but adoption growth rates are slow.

These paths of technology adoption stand in stark contrast with the remarkable rates of adoption for genetically engineered (GE) insect-resistant and herbicide-tolerant crops (see previous article). In the case of herbicide-tolerant soybeans, first available in 1996, adoption grew to nearly 70 percent in just 5 years, despite no significant impacts on farm financial net returns attributable to adoption. Indeed, empirical results from more than 20 studies of the financial implications of first-generation GE corn and soybeans have been mixed. They tell a story quite dissimilar to IPM’s tale. Though not always profitable by standard measures, adoption of GE seed has been soaring.

A major difference between planting GE crop varieties and practicing IPM is that the former is management saving while the latter is management using.

The Appeal of “Convenience Agriculture”

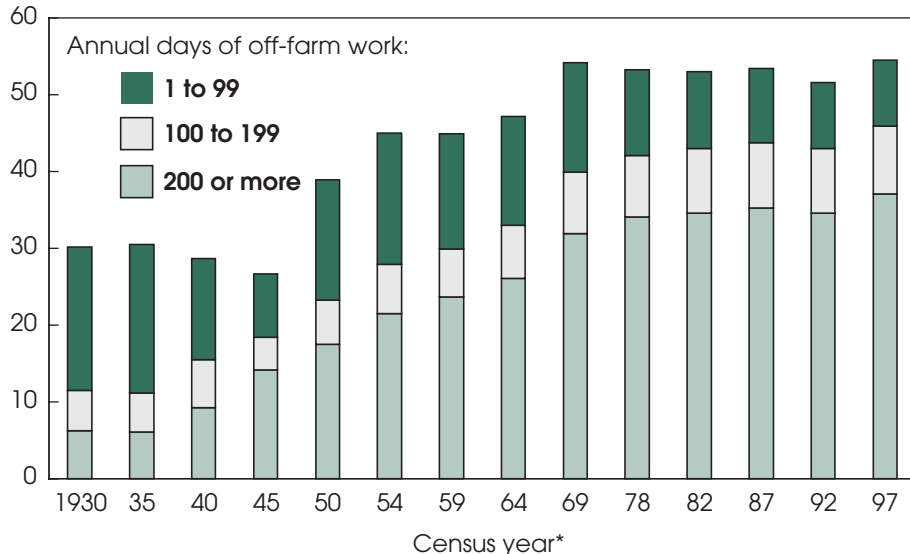
When asked what motivated their adoption of GE crop varieties, farmers often respond that these varieties are simply easier to use. Cultivation of these crop varieties is characterized by simplicity and flexibility. A great advantage of adoption is that it saves time... *and takes no extra thought*. It is convenient.

Farm operators are likely to be as appreciative of convenience as is the busy, multi-tasking member of the average U.S. household. In fact, farm households are increasingly similar to nonfarm households in terms of working spouses, diversity of income sources, and dependence on the general economy (*AO* August 2002).

While one-third of farm operators have worked off the farm essentially full time since the 1970s, this is not the full story. What has changed most over the last few

A Third of Farm Operators Have Worked Off-Farm Essentially Full-Time Since the 1970s

Percent of operators



*Data for 1974 are unavailable.
Sources: U.S. Bureau of the Census, 1930-92 Censuses of Agriculture; and National Agricultural Statistics Service, USDA, 1997 Census of Agriculture.

Economic Research Service, USDA

decades is the *importance* of off-farm income to farm households. Since 1999, less than 10 percent of farm household income (including government payments to the farm operator) derives from the farm operation. The rest—the vast majority—is off-farm income. Off-farm income comes from off-farm employment of the operator, off-farm work by the operator's spouse, nonfarm businesses run by the operator or household members, and a gamut of investments.

The observed trend in importance of off-farm income has many causes: higher wage rates in non-farm jobs, more females in the general workforce, and efficient household financial management. The common feature of all sources of off-farm income is that each takes time away from concentration on the farm business, if not time off the farm altogether. In 2002, when a farm operator and spouse are working at the kitchen table (or at their computer), they are as likely to be poring over brokerage account statements or bringing work home from the office, as they are to be reviewing farm accounts or scrutinizing ratios of livestock weight gains to feed rations.

As more time and more thought is devoted to off-farm endeavors, less of each is available for farm management and/or leisure by the operator or members of the operator's household. Recognizing that farm households face time/management constraints generates several lines of inquiry:

- whether the traditional ways of measuring the economic returns to new technologies capture the convenience factor,

Off-Farm Share of Operator Household Income

	Farms		
	Small	Large	All
	<i>Percent</i>		
1960	--	--	52.8
1964	--	--	59.2
1969	--	--	61.5
1979	--	--	74.1
1987	--	--	61.9
1997	98.7	27.9	88.2
1998	101.9	28.2	88.1
1999	100.0	25.9	90.1
2000	104.6	32.5	95.8

-- Not available.
Large farms are those with over \$250,000 in annual sales. Off-farm share is over 100 percent if income from farm business is negative.

Economic Research Service, USDA

- the implications of structural shifts for off-farm activity and, consequently, for the feasibility of various technologies, and
- the effect of farm programs on interactions among off- and onfarm work and on preferences for certain types of production technologies.

The Measurement Dilemma: "Time Is Money"

The standard metric for farm profitability is net returns to labor and management. The farm-level profitability of technology adoption is typically calculated as the difference between net returns with and without the technology. In this month's article on GE crops, for example, farm-level financial implications of adoption are measured by estimating the change in variable production costs (mainly seed and pesticide costs) plus the value of change in average yield associated with specific GE varieties, and comparing the results with those for their conventional counterparts.

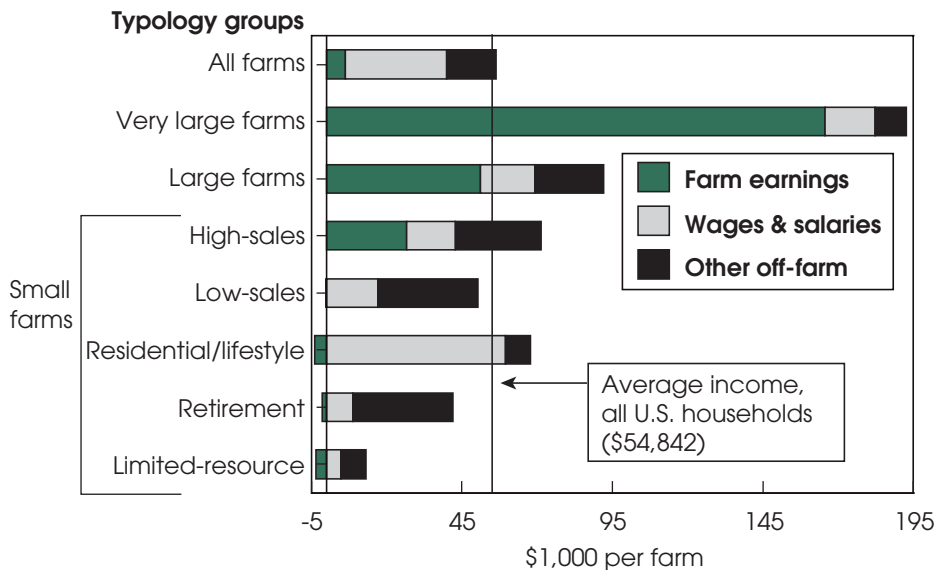
This widely accepted practice of measuring profitability holds the value of management time/thought/effort constant when comparing returns to various production practices, technologies, or systems. It measures *financial* returns quite well. But it gives an incomplete picture of *economic* returns because it excludes changes in the value of management.

If increased importance of off-farm income acts also to increase the opportunity cost of spending time on farm management (lost opportunity to spend time in another pursuit), then the consequences of this exclusion become serious. An indication of negative net returns, as typically measured, can be misleading if unmeasured management costs are actually decreasing (in which case total *economic* returns might actually be increasing). This appears to be the case with herbicide-tolerant soybeans. It may be the case with other "convenience technologies."

Two potential ways out of the measurement dilemma are discussed here. Analysts could use the prevailing off-farm wage rate as a proxy for the value of a unit of management time. Assuming that

Research & Technology

Operators on Small Farms Derive Most or All Household Income From Off-Farm Sources



Source: USDA's 1999 Agricultural Resource Management Survey (ARMS).
Economic Research Service, USDA

differences in management time necessitated by various practices or technologies were known, changes in the value of management could be incorporated into a more robust measurement of economic returns. An alternative is to examine net returns in terms of a farm household's total income, rather than limiting it to income generated by the farm operation. With this approach, the tradeoffs between time spent managing the farm operation and time spent generating off-farm income become inherent in calculations of the impact of a change in farm production practice.

Either of these approaches to more precise measurement of net economic returns is data demanding. Also, both fail to account for the value of leisure, which is how farm operator time could be spent if not devoted to generating income.

Farm Structure, Off-Farm Work, & Technology Adoption

Analysis by USDA's Economic Research Service (ERS) demonstrates that, for a large sample of corn/soybean farm operations, there is a definite tradeoff between time spent onfarm and in off-farm employment. For these farm households, it seems clear that economies of scope (derived from engaging in multiple

income-generating activities, on and off the farm, as a single economic unit) can substitute for economies of scale in farming. Thus, households operating small corn/soybean farms that lack economies of scale may be more likely to devote time to off-farm employment, more likely to adopt management-saving technology, and less likely to adopt management-intensive technologies.

Evidence from ERS research on the adoption of the growth hormone bovine somatotropin (rBST) in dairy production suggests that the relationship between scale of farm operation and management intensity of production technology holds for large farms as well. Use of rBST is very management-intensive. While in 2000 only about 17 percent of U.S. dairy operations were using rBST, these operations accounted for 32 percent of all dairy cows. In this case, it is the larger operations that could accommodate management-intensive technology. This makes sense in the context of off-farm work, since it is only for large and very large farms that off-farm income has *not* represented the majority of farm household income in recent years.

Economists have become accustomed to considering capital-intensive technologies

as scale-dependent. Perhaps management intensity should also be viewed as a potential source of scale bias.

Does Farm Policy Play a Role?

The direction of farm policy affects many farm household decisions. ERS research on the effects of different types of farm program payments on the time allocation of operators and spouses has implications for off-farm work and technology adoption. Research has shown that, in accordance with the theory of labor supply, an increase in decoupled farm program payments (payments not linked to production) is likely to result in decreased off-farm work and increased leisure time spent by farm household members. By facilitating substitution of leisure for off-farm work, decoupled payments should have a neutral impact on the management intensity of adopted technologies.

By contrast, it was found that an increase in farm program payments linked to or coupled with production is associated with less off-farm work, but *more* farm income generation. In this case, there is a substitution of effort on the farm for effort off the farm. Relatively less off-farm effort may diminish the appeal of management-extensive or "convenience" technologies that do not also exhibit strong, positive net returns exclusive of management time saved.

Food for Thought

At the downstream branches of the agriculture and food system are convenience stores and convenience foods. It is likely that, as off-farm income takes the lead in farm household portfolios, farm operators at the upstream branches of that system will also take advantage of convenience. Individuals developing new technologies or analyzing their implications will want to keep this development in mind, and measure its impact to the extent possible. And because it appears that structural change and government policy can reinforce or dampen the value of convenience in farm management, they will also influence the direction of technological change in agriculture. **AO**

Katherine R. Smith (202) 694-5500
ksmith@ers.usda.gov