Assessing new technology: farm by farm

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Every day seems to bring a new technology to farmers. Global positioning, infrared analysis, herbicide-resistant crops, new hybrids, and variable rate applications are a few relatively recent innovations in agricultural technologies.

The changes are coming so fast that it is hard to keep pace with them. And these new technologies and changes do not come without a cost. Recently a farmer remarked to me that many of his neighbors were shifting their production to a contract basis simply because the increased complexity made them feel that they could not keep up with the changes; it seemed easier to have someone else do the "keeping up" and evaluating.

Contract production is certainly one approach. However, the contractor reaps the majority of the rewards for adopting technological changes, reducing the role of the farmer to that of a hired employee.

Economic theory holds that the early adopters of a clearly superior technology are the ones who benefit most because by the time late adopters begin to use the new technologies, profits generated through improvements have been factored into the market price.

The challenge is knowing which technologies are superior and which offer only marginal benefits. Some technologies are not the most efficient initially, but as they are refined over time, they become the most effective choices. Knowing which technologies to adopt--and when to adopt them--are critical questions facing farmers. The problem is further complicated when one considers the impact of the new technologies on sustainability.

There are no magic solutions. It is important for farmers to realize that what may be right for one farm may not be right for another. Farmers need to seek the most appropriate technologies for their individual operations--not necessarily the newest technology.

Evaluating a new technology

Evaluating any technology involves two steps. First, farmers must know their goals. This has been said so often that it may seem like a cliché, but it is critical in evaluating the appropriateness of a new technology. Economists often assume profit maximization is the only goal. However, there are additional considerations and goals.

Different technologies use different resource mixes. This mix of resources can determine whether a technology is appropriate. For example, some farmers adopt technologies to save labor. If the labor that is freed up has a higher use, then such technologies will usually be appropriate. The labor that is freed up may be used for more work, more leisure, or family time. The key question is, what value is placed on the labor saved? An appropriate technology for a starting farmer may not be appropriate for one reaching retirement age. Similarly, technologies that involve working with computers and high-technology equipment may not be appropriate for someone who prefers working with animals.

The second step in evaluating alternative technologies is accurate assessment of resources. Economists typically talk about four resource categories: land, labor, capital, and management. "Land" includes all the plants and animals inhabiting it. "Capital" includes both the liquid assets we typically think of as cash and also the stock assets such as buildings and equipment and the technologies they incorporate. "Labor" denotes the physical activities involved on all farms. "Management" is the combining of these resources. On most family farms, labor and management tasks are performed by the same individuals.

A further classification of resources proposed by University of Missouri agricultural economist John Ikerd is "internal" versus "external." He uses these terms in discussing agricultural change. We used to rely on the resources that were internal to the farm. But now, we have substituted not only capital for labor but external resources for internal resources. These changes in production agriculture have dramatically

increased production levels--but they have also greatly expanded the cost of production. Farms have essentially become a place that money passes through. A professor at Tuskegee University once said, "We have reached the level of sophistication in this country where everybody is making a profit on agricultural commodities except the farmers who produce them."

When evaluating a new technology, it is important to remember that we are seeking the appropriate technology for a given set of goals and resources. The farmer must determine whether adoption of a new technology involves relatively minor (incremental) changes versus significant alterations in the farming operation (embodied technologies).

A "partial budget" (see next section) is the best evaluation technique for assessing an incremental technological change. But effectively evaluating changes ("alternative technologies") that will have a significant impact requires whole-farm analysis.

Not all technologies fall clearly into one category or another. But classifying the technology change is not as important as using the right tool to evaluate it. The partial budget approach is easiest, but in many instances the change requires a more substantial analysis.

Partial budgeting

While the partial budget concept is relatively simple, its implementation can be complex. A partial budget examines how adopting a new technology or way of operating the farm affects profitability. It compares the existing situation with the new or alternative method.

There are four categories of changes to estimate in a partial budget procedure. First, one must estimate the added or new cost of adopting the technology. Next, one must estimate the additional revenue generated by using the new technology. The third parameter to estimate is the decreased cost of not using the technology that is being replaced. Finally, the lost revenue must be estimated.

Even if a new technology is profitable, it may not necessarily be appropriate for a particular farm. Other factors need to be considered when determining whether to adopt a new technology. Resource use and mix, impact on sustainability, and changes in the nature of the tasks all could have an impact on the

desirability of the change.

Whole-farm analysis
If a new technology requires major changes in the farming operation, it will be necessary to evaluate the new technology using whole-farm analysis. Under whole-farm analysis, all of the enterprises on the farm are evaluated. The first step is to determine profitability and resource use under the current system. The second step is to estimate the changes under the new system.

Whole-farm analysis is necessary when certain production factors may limit full implementation of the new technology. A partial budget will not identify these weak areas. For example, if a new technology requires more labor at peak labor demand periods, then labor availability becomes a constraint that must be addressed if the new technology is to succeed. Similarly, the new technology could require a large capital investment. If the capital is not available, either internally or through borrowing, then the new technology cannot be implemented.

In preparing the whole-farm analysis, all enterprises must be identified and considered. Input requirements and outputs must also be estimated, and financial characteristics must be identified. Conducting a whole-farm analysis is time-consuming, but computer programs and spreadsheets can help. In addition, private companies provide such analysis for a fee. ISU Extension also offers a Farm Financial Planning Service.

Example
A new technology being considered by some swine producers is hoop houses. The hoop house is a relatively simple structure consisting of a tarp stretched over a tubular frame. The hoop houses are used primarily as a facility for finishing pigs.

When comparing hoop houses to confinement feeding, either the partial budget or the whole-farm analysis can be used. The most appropriate technique depends on the purpose of the comparison. Comparing the hoop structures does illustrate some important points to remember when evaluating a new technology.

The Iowa State University Midwest Plan Service publication (MWPS AED-41, February 1997) compares the costs and expected returns of using a

hoop-house facility versus a confinement building (see following table).

Selected Costs Comparisons for Hoops and Confinement Swine Production*

Item	Confinement	Hoop
Facility		
Building	$64.29	$19.64
Feed & manure hand. equip.	12.86	12.86
Total Investment (per pig sold)	77.14	32.50
Fixed Costs (per pig sold)	10.18	5.36
Operating Costs (per pig sold)	94.70	98.96
Total Cost (per pig sold)	104.88	104.32
Total Cost (per CWT live)	41.95	41.73
Net Cost (per CWT)	41.35	41.73

**Source: Hoop Structures for Grow-Finish Swine, MWPS, AED 41, Feb. 1997. Note that the operating cost estimate assumes 0.21 hours of labor for confinement and 0.4 hours of labor for hoops. The net cost assumes a $.60 per hundredweight premium for confinements.*

The comparison shows that the confinement system would have a $.38 per CWT (100 pounds live weight) advantage over the hoop finishing system. Yet it also illustrates the importance of considering different resource constraints when evaluating technologies.

If capital is the limiting factor, the most profitable strategy might be the hoops. For example, if a farmer had $200,000 to invest in swine facilities, it would be enough to build a confinement facility holding 1,111 pigs or a hoop facility for 3,636 pigs. For hog prices over $41.73, the added volume would suffice to offset the $.38 per CWT difference in expected returns. But if labor were the limiting factor, the advantage would shift to confinement because of its different labor requirements.

A full comparison of hoops and confinements should address odor, air quality, pork quality, disease problems, manure handling, bedding straw (for the hoops), and other factors. While it is possible to estimate and quantify many of these factors, in the end

the decision about which is the most appropriate technology must be made at the individual farm level.

Discussion

Whether a partial budget or whole-farm analysis is used, successfully evaluating new technologies involves several key factors. First, it is critical to identify all of the areas that will be impacted by a new technology. Decisions are often made by focusing on a single aspect of a technology when in reality the level of the change and its impact are much broader.

With new technologies, it is often hard to get good estimates of how the technology will perform under individual circumstances. The cost and benefit estimates are not readily available. In these cases, it is important to gather as much information as possible to help form the best estimate and to analyze the change with several different assumptions regarding the performance of the technology. When possible, test the new technology on a small scale first.

Placing value on costs and revenues also differs in some circumstances. Labor savings may be the best example. As noted, the labor change should be entered at its value. In some cases extra time is quite valuable and in other cases not as valuable. Similarly, labor savings at different times of the year will have different values depending on individual circumstances. Assessing the relative value of machinery changes can also be difficult.

Remember to distinguish between per unit and whole-farm analysis. The per unit profit may be lower, but because of scale changes, the profitability of the whole farm may actually increase.

Another major difficulty is estimating and valuing changes in risk. Some new technologies may have higher expected returns, but the variance of the returns has also increased. What happens to risk is extremely important in determining the appropriateness of alternative technologies for different farms. There is a distinction between risk and uncertainty. Because risk has a known variability, the expected variation in returns can be calculated. Uncertainty occurs when a technology is not well proven and the variability is unknown. Both risk and uncertainty can affect the choice of appropriate technology. Yet risk and uncertainty are extremely difficult to quantify. Many new and alternative technologies will have different

impacts on worker health, food safety, and environmental impacts.

Finally, the effects of technologies on the mix of the resources used can have a major impact on the technology's desirability. With some technologies, farmers may rely almost entirely on hired labor and contribute their own labor as management. That's why it is important to know your goals when assessing new technologies.

Conclusion

When evaluating a new technology, collect as much background information as possible. Trade publications, company literature, university research, Extension, and other farmers are all potential information sources. It is important to factor in all the information, consider the source, and adjust it for individual circumstances.

New technologies can represent a totally new way of doing things, a modification in current practices, or simply a refinement of current technology. Some can be implemented relatively easily, while others will involve considerable changes and risk. These factors must all be considered.

A new or different technology is not necessarily better. In some circumstances, the old way remains the most efficient choice for the resources. Willard Cochrane, University of Minnesota Professor Emeritus, coined the term "technology treadmill" several years ago. We must diligently evaluate and assess new technologies to avoid being trapped on the treadmill. Using technology appropriately is key to a successful farming operation.

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