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FOR SUSTAINABLE AGRICULTURE

# Economically optimal enterprise mix for Iowa farms

Abstract: FARMOR, a computer simulation program developed by this project, will allow producers to make calculations about the best mix of enterprises for their unique farm operation.

**Question & Answer**

**Q: Given the limited amount of resources of a certain farm, what crops and livestock should be raised to maximize profit and how much profit fluctuation will result from production and market risks?**

**A:** These questions are addressed by a computer simulation called FARMOR that will determine a combination of farm enterprises that will enable prediction of maximum profits and then will outline year-to-year profit variations that may occur.

**Background**

The project produced a research and decision-making computer program referred to as Farm Optimization and Risk-analysis, or FARMOR. The program utilizes linear programming to determine an optimal enterprise mix, and repetitive simulation for risk analysis.

The primary goal was to develop a model that incorporated production and price risk into a constrained optimization that allows researchers to evaluate technologies in a farming system framework. Specific objectives were to:

1. Develop a stochastic (involves a random variable) constrained optimization model that supports the research of the Initiative for Future Agriculture and Food Systems (IFAFS) Program's Western Iowa Land Use project and contribute to that effort;
2. Expand the flexibility of the model to incorporate a variety of resources, enterprises, and technologies; and
3. Make the model user-friendly and accessible to encourage evaluation of the technologies proven in small plot research and transferred to a whole farm simulation.

**Approach and methods**

The FARMOR program was developed in three segments. The first describes the farm, the second determines the optimal enterprise mix, and the last analyzes the profit risks of that enterprise mix.

The first portion of the program lists the enterprises from which the researcher can select to include in the model. The enterprises are limited to crops and livestock commonly raised in Iowa, such as corn, soybeans, alfalfa, pasture, oats, swing farrowing and finish, cow-calf herds and cattle finishing. An expected per acre yield is chosen for the crop production methods. If terrace or strip farming is an option, it can be selected to allow sloped land to be farmed. Phosphorus balance in the soil also can be selected as a constraint which will limit fertilizer and manure application. Soil erosion can be limited in the model by selecting that option and entering an acceptable amount of soil loss. Information entered in the budget is stochastic, but the default information is based upon the Iowa Crop Budget and Iowa Livestock Budget published annually by ISU Extension. Other resources such as labor and operating capital also are defined. The relationship between crop yield and price also is stochastic, and can be adjusted by the researcher.

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**Budget:**
$15,000 for one year

The second section of the optimal enterprise mix is completely automated, as are most of the program calculations, making it easier to use. Enterprise inputs and outputs with their associated costs or values are located in rows of the program and the quantity of each is adjusted until a maximum return is determined and all restraints are satisfied. The user is then directed to a summary page that describes the optimal combinations of enterprises to maximize revenue. This summary page can hold the results of two simulations for simple comparison. Statistical reports also can be produced to describe the shadow price of each constraining resource. (Shadow price is the additional profit potential that comes with one more unit of a limited resource. An example is the additional profit that would be made if one more acre of crop ground were available.)

The third piece of the FARMOR program focuses on the profit risk of the optimal enterprise mix. Average yields, market prices, and production costs are used to determine the most economically desirable combination of enterprises. Because actual yields and prices routinely differ from the average, it is beneficial to test how these fluctuating values affect returns in an optimized arrangement. Based on averages and standard deviations, 100 random yields and prices are produced using random number generation and biased matrixes that capture the relationships among yield, price, and different crops.
For example, corn and soybean yields tend to follow a similar trend because of growing conditions, and corn prices usually decrease when yields are higher because increased supply is available. These 100 yield and price scenarios are used with the production budgets to estimate the profits in 100 scenario years. These "annual" profits are represented by an average, standard deviation, and histogram. All reports generated by FARMOR are printable.

To use FARMOR, the researcher will enter a description of a farm scenario based on resources, limitations, preferences, and production costs. Based on this description, the program first will find the best combination of enterprises that will maximize profits based on average yields and prices. Finally, this optimal mix is tested in a variable environment over 100 random occurrences, and the resulting variations in profits will be reported.

**Impact of results**

Several case study farms have been beta-tested through the FARMOR simulation. Further impacts of FARMOR will be assessed after the program is distributed for use and feedback is received on the program's operations. This program is intended for use by researchers and extension staff who are helping producers to analysis their profit potential.

The IFAFS group has developed the I-FARM web tool, and FARMOR was used to build a comparative analysis of the two simulation programs. The FARMOR optimization was compared with the I-FARM simulation for five different farming and livestock production scenarios. FARMOR estimated soil loss while optimizing returns and constraining nutrient application to farm and land enterprises available. Several improvements in FARMOR were made as a result of this cooperative analysis; among them was a phosphorus nutrient balance constraint to avoid excess phosphorus application.

**Education and outreach**

The FARMOR program was to be distributed to interested producers and ISU Extension personnel, starting with ten farm management field specialists who received the program and instructions at the spring 2006 Farm Management in-service training session. Extension staff will be encouraged to make copies of the program to share with their producer clients. Additional workshops will be scheduled to accommodate producers and other researchers interested in learning the program. The program is available through ISU Extension farm management specialists and ultimately may be available on the ISU Extension web site.

**Leveraged funds**

None under this project.

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