# U. of Delaware engineer tells mushroom growers how to save energy

NEWARK, Del. — Mushrooms are big business in the U.S. Last year the crop brought in close to $400 million to growers in 27 states, with nearly half of the production centered around southern Chester County, and the adjoining northwestern corner of New Castle County, Delaware.

Today this profitable industry is struggling to stay alive in the face of increasing foreign competition. To survive, American growers must trim costs wherever possible. One way to do this is to reduce the amount of energy they use to produce the crop.

"I pay $50,000 a year to the electric company," says one local grower, "but I don't know what that covers." Others are in the same boat.

To help get a better handle on such energy costs, last year the American Mushroom Institute asked engineers at the University of Delaware's Agricultural Experiment Station to conduct a study of mushroom production similar to one on the broiler growout process they've been working on for the Delmarva poultry industry. That project resulted in a computer model in which all aspects of production have been reduced to mathematical equations which can be readily evaluated in terms of their effect on energy use. Applying this information has saved area poultry producers thousands of dollars over the past six years.

With the help of a $6,000 grant from AMI, Kenneth Mitchell Lomax, a specialist in electrical power and processing at the Experiment Station, set out to develop a similar model of the energy used to grow mushrooms. Since he comes from the Hockessin area where most of Delaware's growers are located, Lomax is familiar with this crop. Working with him on the project have been agricultural engineer Norman E. Collins and Coleen M. Denneny, an undergraduate ag engineering major.

It took them 18 months to develop a systems analysis. The resulting computer model consists of three sections: growth; construction; and management.

To use the growth section, all you need to do is tell the computer which air temperatures you've set your thermostat for inside the mushroom house and how much compost you're starting out with. From that, the computer can tell you the bed temperature of the compost. This is measured to determine the health of microbial action in the bed. The computer also tells you the heat energy produced by this microbial action in BTU's, plus the anticipated mushroom yield in pounds per square foot of bed per day.

"The entire growing program is stated in terms of square foot of bed," says Lomax, "so it doesn't matter how big the house is."

Inputs for the construction section of the model include length of house, topography of the site (which affects building design), and cost of materials to be used. There's also a variable input for the amount of ceiling insulation added. With this information, the computer tells you the cost of constructing a particular mushroom house, including materials and labor. It also gives the cost of attached equipment such as electric motors, fans, air conditioners, and bed boards.

By the time you've completed these two parts of the model, you know the value per square foot of your mushroom operation.

The final section of the model involves management options which affect the cost of production — especially as it relates to energy use. Computer inputs for this section include production and building construction data from sections one and two, plus real weather data and economic information (primarily taxes, interest and inflation rate) over a six-year period.

From these, the computer can tell three things: the fuel requirements for that particular house (total and per unit area); electrical energy requirements (total and per unit); and unit area and annual costs, excluding harvest and salaries.

"The model is a way for us to look at the results of a lot of different construction and management combinations without actually having to try them," explains Lomax. This way, only those which look promising need to be tested in reality. The rest can be disregarded as impractical or uneconomical.

"Our strongest data in the project is energy related," says the engineer. "But our goal isn't energy conservation per se, but increased net profit — which is another way of saying the bottom line."

For example, the model can tell a grower what the optimum amount of ceiling insulation will be in a particular house under selected growing conditions. Insulation thickness (R value) affects both electricity and fuel use. But over-insulating won't pay.

In one case, a grower was told to install R38 insulation in his ceiling.

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## Perry Co. DHIA

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|---|---|---|---|---|---|---|
| Ethel | H | 3 5 | 305 | 19,091 | 3 7 | 714 |
| Vonnie | H | 3 6 | 305 | 18,831 | 4 4 | 823 |
| Stacey | H | 3 1 | 305 | 18,718 | 4 0 | 747 |
| Ronald C Fauth | | | | | | |
| #54 | H | 5 7 | 289 | 18,674 | 3 7 | 682 |
| Richard Kriebel | | | | | | |
| Crissy | H | 9 10 | 305 | 21,254 | 4 3 | 919 |
| Claudia | H | 8 9 | 305 | 20,946 | 3 6 | 761 |
| Ava | H | 5 2 | 302 | 20,416 | 4 1 | 836 |
| Harry R Book, Jr | | | | | | |
| Judy | H | 9 3 | 305 | 16,292 | 4 1 | 670 |
| Jenny | H | 8 3 | 305 | 18,014 | 4 0 | 720 |
| Fairy | H | 4 9 | 305 | 19,500 | 4 1 | 792 |
| Ellen | H | 3 10 | 305 | 20,743 | 4 1 | 842 |
| John R Gabel | | | | | | |
| #214 | H | 4 3 | 305 | 17,526 | 3 9 | 680 |
| #217 | H | 4 10 | 305 | 16,541 | 4 7 | 774 |
| #218 | H | 4 3 | 305 | 18,796 | 3 5 | 656 |
| #225 | Br S | 4 1 | 305 | 16,231 | 4 3 | 694 |
| #233 | H | 3 2 | 305 | 20,142 | 3 5 | 702 |
| John B Sauder, Jr | | | | | | |
| Spunk 55 | H | 5 7 | 305 | 19,524 | 3 4 | 655 |
| #130 | H | 4 3 | 305 | 22,842 | 3 3 | 762 |
| Y133 | H | 3 9 | 293 | 21,241 | 3 7 | 784 |
| Y148 | H | 3 3 | 305 | 20,325 | 3 6 | 726 |
| #51 | H | 2 5 | 305 | 17,016 | 4 0 | 679 |
| Dean McMillen | | | | | | |
| Marcy | H | 2 11 | 298 | 18,988 | 4 4 | 839 |
| Richard G Smith | | | | | | |
| #13 | H | 6 1 | 305 | 22,450 | 3 4 | 753 |
| Clarence S Martin | | | | | | |
| #100 | H | 8 4 | 305 | 24,892 | 3 3 | 816 |
| #47 | H | 5 0 | 305 | 16,603 | 4 0 | 667 |
| Ed & Wilma McMillen | | | | | | |
| Mamaie | .H | 3 4 | 305 | 24,111 | 3 6 | 865 |
| John L King | | | | | | |
| Mable | H | 10 4 | 305 | 20,504 | 3 3 | 677 |
| Katie | H | 6 4 | 305 | 21,979 | 3 5 | 764 |
| Dale Smoker | | | | | | |
| #16 | H | 3 4 | 305 | 25,223 | 3 4 | 866 |
| #40 | H | 9 0 | 305 | 21,759 | 3 4 | 738 |
| #46 | H | 8 0 | 305 | 23,520 | 3 7 | 870 |
| #47 | H | 6 0 | 305 | 21,983 | 4 2 | 932 |
| #51 | H | 3 4 | 305 | 17,048 | 4 1 | 693 |
| #71 | H | 10 0 | 305 | 24,022 | 3 3 | 787 |
| Philip E Brubaker | | | | | | |
| #28 | H | 3 7 | 305 | 18,997 | 3 8 | 719 |
| #7 | H | 9 1 | 305 | 23,060 | 3 6 | 841 |
| #5 | H | 8 1 | 304 | 19,619 | 3 6 | 712 |
| Edwin L Sheibley | | | | | | |
| Queen | H | 5 3 | 305 | 21,697 | 3 4 | 735 |
| Snowbal | H | 5 1 | 295 | 18,819 | 3 5 | 657 |
| Marcy | H | 4 5 | 305 | 21,513 | 3 6 | 769 |
| Goofy | H | 4 0 | 305 | 20,260 | 3 7 | 755 |
| Eugene M Nolt | | | | | | |
| #2 | H | 5 11 | 305 | 18,802 | 3 5 | 654 |
| Henry S Lapp | | | | | | |
| #1 | H | 6 1 | 284 | 18,687 | 3 7 | 685 |
| Arthur E Dum, Jr | | | | | | |
| Daisy | H | 8 0 | 305 | 17,174 | 4 3 | 731 |
| Wayne L Stephens | | | | | | |
| Carol | H | 5-11 | 305 | 19,876 | 3 7 | 740 |
| James M Palm | | | | | | |
| #37 | H | 5 9 | 305 | 21,718 | 3 7 | 806 |
| #55 | H | 0 0 | 272 | 21,039 | 3 1 | 658 |
| M W Smith Farms | | | | | | |
| Sally | H | -2 0 | 305 | 18,380 | 3 7 | 676 |