Farm Energy Calculators:

Evaluations and Recommendations

A study by the

National Center for Appropriate Technology

June 2009

Funded by the

USDA Risk Management Agency

Research and Development Risk Management Partnership
#06IE08310060-P

Principal Investigator: Mike Morris, Ph.D.

Researchers: Holly Hill, Tracy Mumma, Al Kurki

3040 Continental Drive
P.0. Box 3838
Butte, MT 59702-3838

www.ncat.org

1-800-ASK-NCAT

Table of Contents

Acknowledgements

This report is one product of the project “Building Farm Energy Self-Sufficiency: Tools for Self-Protection.” The authors would like to thank the USDA Risk Management Agency for providing funding for this project, through a Research and Development Risk Management Partnership. We would especially like to thank Parm Shahi of the USDA Risk Management Agency for his support and involvement.

We would also like to thank the agricultural producers who served as energy calculator reviewers: Randell Agrella (Falcon, MO), Errol Ahlers (Cole Camp, MO), Ressa Charter (Shepherd, MT), Rob Faux (Tripoli, IA), Sam Funk (Manhattan, KS), Gordon Garrison (Estherville, IA), Vince Heiman (Hartland, WI), Sarah Kahl (Prairie Grove, AR), Steve Mann (Kansas City, MO), Ole Norgaard (Lewistown, MT), Greg & Nancy Rasmussen (Lockwood, MO), Mike Schwab (Cedar Grove, IN), and Steve Smith (Marshalltown, IA). We greatly appreciate the time, thoughtfulness, and common sense that these reviewers brought to this project.

Finally, we are grateful to the energy experts who were interviewed for this report. We would especially like to thank Stefanie Aschmann (USDA Natural Resources Conservation Service), Jennifer Brinker (GDS Associates), Neal Elliott (American Council for an Energy Efficient Economy), Rich Hackner (GDS Associates), Richard Hiatt (Rural Electricity Resource Council), Stan Hitt (USDA Natural Resources Conservation Service), Craig Metz (EnSave), Dave Ryan (NCAT), Scott Sanford (University of Wisconsin Extension), and Joe Schultz (GDS Associates).

The conclusions and recommendations in this report are solely those of the authors and are not intended to represent the views of the people and organizations above.

Executive Summary

Because of the high cost and difficulty of performing professional energy audits in rural areas, do-it-yourself energy calculators offer a promising alternative for promoting energy efficiency on farms and ranches. The National Center for Appropriate Technology studied about 75 energy calculators and invited a group of twelve agricultural producers to test and review 23 of these tools.

The reviewers found most of the tools user friendly and useful, and all reviewers said that they would rather use these kinds of self-help tools than hire an energy professional. On the other hand, reviewers were skeptical about the reliability of the tools and tended to use them in a casual and exploratory way. For many reasons—including the lack of reliable cost and payback information and the complexity of farming operations—the reviewers generally viewed these tools as inadequate to motivate or justify changes in their own behavior.

Among other limitations, most do-it-yourself tools have a hard time taking a broad look at farming operations, getting beyond a snapshot in time, encouraging innovation, and providing accurate and current costs. In all of these ways they are inferior to an on-site audit by an energy professional. As tools address these limitations by becoming more complicated, more comprehensive in their coverage of topics, and more specific in their recommendations, they run into daunting problems of usability, liability, accuracy, and maintenance.

Nonetheless, when appropriately focused and skillfully designed, agricultural energy calculators are promising awareness and educational tools that perform some tasks extremely well and deserve further exploration and development.

1. Introduction

1.1 Growing Interest in Farm Energy Usage

Up until recently, very few people outside of professional agriculture knew or cared much about the topic of farm energy usage. That has changed. Not only agricultural producers themselves, but many agencies, organizations, and members of the general public have taken a keen interest in promoting energy alternatives for U.S. agriculture. Among the reasons for this interest:

- High and fluctuating energy costs have created economic challenges for farms and ranches.
- Growing concerns about "Peak Oil" have led many to ask how agriculture will feed the world's growing population if fossil fuels become scarce and much more expensive.
- The U.S. food system has been portrayed as vulnerable to energy price spikes and disruptions, including those that could be caused by market manipulation or acts of terrorism.
- The scrutiny of farmlands, as promising locations for biofuels, wind, and other renewable energy development, has created a need for baseline information about how farms are currently using and managing energy.
- The U.S. Department of Agriculture has launched major new funding programs to encourage both renewable energy development and energy efficiency improvements in agriculture and rural small businesses.
- The federal American Recovery and Reinvestment Act of 2009 has made funding available for many other energy efficiency, renewable energy, and job creation efforts.

1.2 Farm Energy Audits: the Need for Alternatives

In a home or business, energy efficiency efforts often begin with a site visit by an energy professional who conducts an *energy audit*. The auditor inspects energy-consuming processes and equipment, and prepares a report describing possible changes that could reduce energy consumption or cost.

This approach has not always been successful for farms and ranches, however, and the availability of energy audits remains extremely limited in most rural parts of the United States.

- Because of their rural locations, farms are typically time consuming (and therefore expensive) for energy professionals to visit.
- Many farms use modest amounts of energy, and cannot justify the expense of a professional energy audit, commonly costing $1,000 to $2,000 or more.
- Farms are complicated "holistic" operations. Changes in one process may require re-thinking or adjusting several others.
- The engineering professionals who have the technical skills to do energy audits often have little or no experience with farms.

As an alternative to a site visit by an energy professional, do-it-yourself energy assessment tools have an obvious appeal. Agricultural producers tend to be resourceful, handy, and knowledgeable about their own equipment. Far more than the average urban homeowner, they would seem capable of making their own energy-saving improvements. An important question, therefore is: *To what extent can self-help tools substitute for an on-site visit and audit by an energy professional?*

To what extent can self-help tools substitute for an on-site visit and audit by an energy professional?

1.3 What Is a Farm Energy Calculator?

For purposes of this report, an *energy calculator* is a tool that enables the user to estimate energy consumption and cost and identify energy-saving opportunities. Most energy calculators today are computer-based, and dozens of these tools have recently appeared on the Internet. Not much has been known, however, about the usefulness of these tools for agricultural producers. During 2008 and early 2009, the National Center for Appropriate Technology (NCAT) looked into this question.

The term "calculator" is used broadly here, to include a wide variety of energy awareness and decision-making tools. Most of these tools do far more than just mathematical calculations. The tools studied in this report are either intended for use by agricultural producers, or at least seem useful to agricultural producers. Most of these focus on energy efficiency and conservation, although a few renewable energy tools and greenhouse gas calculators are also included.

The focus of a farm energy calculator can be as narrow as an individual piece of equipment—such as a tractor block heater or electric irrigation pump—or as broad as a whole farm. Among the broader tools, some include energy within a larger context. For example, the "integrated crop and livestock production and biomass planning tool" under development by Iowa State University (known as *I-Farm*) covers multiple topics, many with energy implications.

The simplest online calculators have a checklist or multiple choice format. The user chooses from options on the screen, often with knowledge off the top of the head regarding fuel costs, equipment types, acreage, or location. Some calculators offer default values, while giving the user the option of typing in a more accurate value if one is known.

A slightly more interactive approach combines checkboxes with numeric entries. These numbers may be readily-known, like zip codes or current fuel prices, or they may require basic research on the part of the user, such as monthly electric bill rates, or equipment horsepower. More in-depth calculators require more research and record-keeping, asking, for example, about lighting wattages or the number of hours that a piece of equipment runs each day.

A next step in complexity is the online spreadsheet, where the user locates the correct cells for inputs and types in numeric values. Some spreadsheet-style calculators allow the user to create an account and store values. This makes it possible for the user to run multiple scenarios with alternative inputs or return to the calculations at a later time.

At the far end of the complexity spectrum are software programs, made available for downloading from the Internet. These tools are installed on the user's own computer, alleviating privacy concerns. However, these programs require a commitment of time, computer skills, and computer memory that may discourage the casual user.

1.4 The Purpose of This Report

This report describes the range of currently available farm energy calculators, evaluates many of these tools, and offers recommendations for increasing their usefulness and usability. Agricultural producers were invited to review a select group of calculators. NCAT staff conducted interviews with calculator developers, energy professionals, and professional auditors. NCAT also drew on its own experience. Since the late 1980s, NCAT has conducted a wide variety of energy projects for agricultural producers, and has conducted hundreds of energy audits on farms and ranches.

This report is intended to be useful to agencies, utilities, and other organizations that have already created energy calculators, to groups that are considering this approach, and to agricultural producers who are looking for energy alternatives. The conclusions will also be of interest to a wider audience, insofar as they shed light on some realities about energy usage and decision-making in agriculture.

2. Evaluation by Agricultural Producers

2.1 Methods

In 2007 and 2008, NCAT identified about 75 do-it-yourself energy calculators relevant to agriculture. NCAT staff studied 32 of these in detail, and chose 23 for testing and review by agricultural producers. One goal of this review process was to learn whether farmers and ranchers find these tools, in general, to be usable and useful. Another goal was to identify strengths and weaknesses of individual calculators.

Within this selected group of 23 tools, NCAT included all 13 calculators that were being developed by the USDA Natural Resources Conservation Service (NRCS). These included all nine Energy Self-Assessment Tools that were being developed by a group of researchers in Wisconsin under an NRCS Conservation Innovation Grant, as well as all four NRCS Energy Consumption Awareness Tools (“Energy Estimators”) that were developed by NRCS staff.

The study gave special attention to the NRCS calculators because they were created by highly professional teams, have many attractive features, and because the agency’s decision to try this innovative do-it-yourself approach has obvious national importance. The remaining ten calculators were chosen because they received favorable reviews from NCAT staff, had some special or unique feature, or were representative examples of some type.

In early October 2008, NCAT posted a request for reviewers on its websites and on various email list serves. The announcement offered to pay agricultural producers for up to six hours of work at a rate of $40 per hour.

NCAT received replies from 29 farmers and ranchers, sent instructions to all of these, and gave them one month to complete their testing. Twelve of these completed their evaluations by the deadline. These came from Missouri (4), Iowa (2), Montana (2), Kansas (1), Arkansas (1), Indiana (1), and Wisconsin (1). Their farming and ranching operations varied from three to 650 acres, and included certified organic produce, value-added market lambs, free range poultry, grass-fed beef, organic wheat, fruit orchards, breeder hens, corn, and soybeans.

Two limitations of this study should be mentioned from the start:

- NCAT investigators relied heavily on comments from an extremely limited sample of agricultural producers. The twelve agricultural producers who served as reviewers certainly do not represent the farm population as a whole, and they may tend (among other things) to have above-average computer literacy. Their opinions and insights should obviously be checked against common sense and other available evidence.
- NCAT arrived at some tentative conclusions about the usefulness of self-help tools in general, but the study was by no means comprehensive. Reviewers were asked to focus on a diverse group of 23 calculators that seemed promising or had unique or unusual features. For one reason or another, many excellent calculators were not included in this group.

Below are the instructions given to reviewers:

GROUP 1 *Evaluate at least three tools from this group.*

NRCS Energy Self Assessment Tools http://www.ruralenergy.wisc.edu/

Dairy	Grain Drying	Greenhouse	Irrigation	
Lighting	Livestock	Potato Storage	Ventilation	Water Fountain

GROUP 2 *Test and evaluate as many calculators from this group as you like.*

- Energy Estimator: Animal Housing – USDA-NRCS
  http://ahat.sc.egov.usda.gov
- Energy Estimator: Irrigation – USDA-NRCS
  http://ipat.sc.egov.usda.gov
- Energy Estimator: Nitrogen – USDA-NRCS
  http://nfat.sc.egov.usda.gov
- Energy Estimator: Tillage – USDA-NRCS
  http://ecat.sc.egov.usda.gov
- Farm Energy Audit – Alliant Energy
  http://alliantenergy.com/docs/groups/public/documents/pub/p010003.hcsp
- Savings Calculator for Farms – Wisconsin Public Service
  http://www.wisconsinpublicservice.com/farm/calculators.aspx
- Farm Assessment Toolkit - Wisconsin Focus on Energy
  http://www.soils.wisc.edu/foe/login
- Average Farm Energy Calculator - Central Iowa Power Cooperative
  http://www.cipco.org/energyFarm.asp
- Pumping Energy Calculator – California Agricultural Pumping Efficiency Program http://www.pumpefficiency.org/Pumptesting/costanalysis.asp
- Irrigation Operating Cost Calculator - Nebraska Public Power District
  http://www.nppd.com/My_Business/Irrigation/Additional_Files/cost_calculator.asp
- Energy Use/Costs for Pumping – Wateright
  http://www.wateright.org/site2/advisories/energy.asp
- Energy Cost Calculator - Penn State
  http://energy.cas.psu.edu/costcomparator.html
- I-Farm Integrated Crop and Livestock Production and Biomass Planning Tool – Iowa State University http://i-farmtools.org/
- Biofuels Calculator - Bioenergy West Midlands
  www.bioenergywm.org/documents/Biofuels%20Calculator.xls

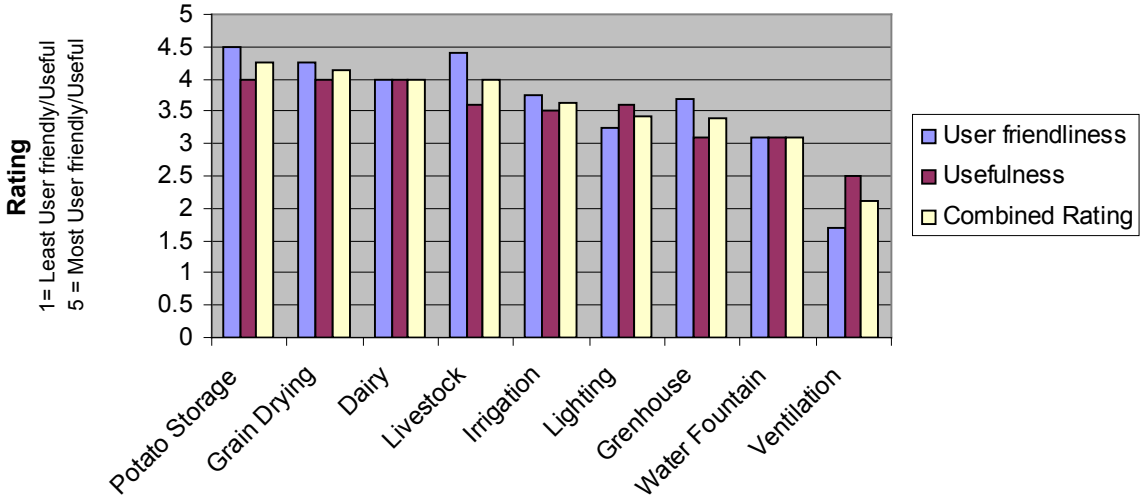
Reviewers completed a separate evaluation form for each calculator tested, with four main headings: User Friendliness, Usefulness, Strengths, and Weaknesses. Evaluators rated each calculator for both user friendliness and usefulness on a scale from 1-5, with 1 being lowest. The twelve reviewers submitted a total of 78 evaluation forms. Each reviewer also participated in a follow-up phone interview, sharing impressions and suggestions for improvement. Among other topics, these phone interviews raised the question of whether the producer would prefer to use do-it-yourself tools or to have a site visit and audit by an energy professional.

Appendix 1 includes many of the detailed comments from producers. The next few sections briefly summarize the reviewer comments on the three major groups of calculators: NRCS Energy Self Assessment Tools, NRCS Energy Estimator Consumption Awareness Tools, and all other tools.

2.2 Reviews: NRCS Self Assessment Tools

The nine NRCS Self Assessment Tools were created in 2006-2008, through a collaboration between the USDA-Natural Resources Conservation Service (NRCS), the University of Wisconsin-Madison, Wisconsin Focus on Energy, and GDS Associates, Inc. Each reviewer was asked to evaluate at least three of the nine tools. The resulting coverage was as follows: Lighting (8 reviewers), Water Fountain (7 reviewers), Greenhouse (6 reviewers), Livestock (5 reviewers), Grain Drying (4 reviewers), Irrigation (4 reviewers), Ventilation (3 reviewers), Potato Storage (2 reviewers), and Dairy (1 reviewer).

The chart below shows how producers ranked these tools based on user friendliness and usefulness, and also gives a combined rating—an average of user friendliness and usefulness. Despite the small sample size, these scores are suggestive, especially in combination with reviewer comments. For detailed comments, see Appendix 1.



Overall, reviewers found the NRCS Energy Self Assessment Tools user friendly and useful, with eight of the nine tools receiving an average score of at least 3 in both categories. Reviewers appreciated the photographs of equipment and the pop-up boxes with definitions and helpful information. Perhaps the most common complaint was that users wanted more information about equipment costs and the expected return on their investment. In some cases, reviewers found navigation around and between pages to be inconvenient. Some reviewers also received distracting or inappropriate error messages.

A few representative comments about the Energy Self Assessment Tools:

- "The energy self assessment tools are fantastic. They are able to compare quite quickly and quite easily what the results are. Going through and inputting and comparing numbers is quick and easy."
- "Very easy to use. Very self-explanatory."
- "The frequently asked questions are a good bonus to have. They are very informative."
- "Programming errors need fixing. Someone needs to assume that your clientele will enter characters, negatives, zeros or other odd stuff either by accident or because they are not too bright. You can't allow your tool to go to a programmer's error page in any circumstance. That makes you look extremely unprofessional and you will lose any credibility you had."

"The energy self assessment tools are fantastic... Going through and inputting and comparing numbers is quick and easy."

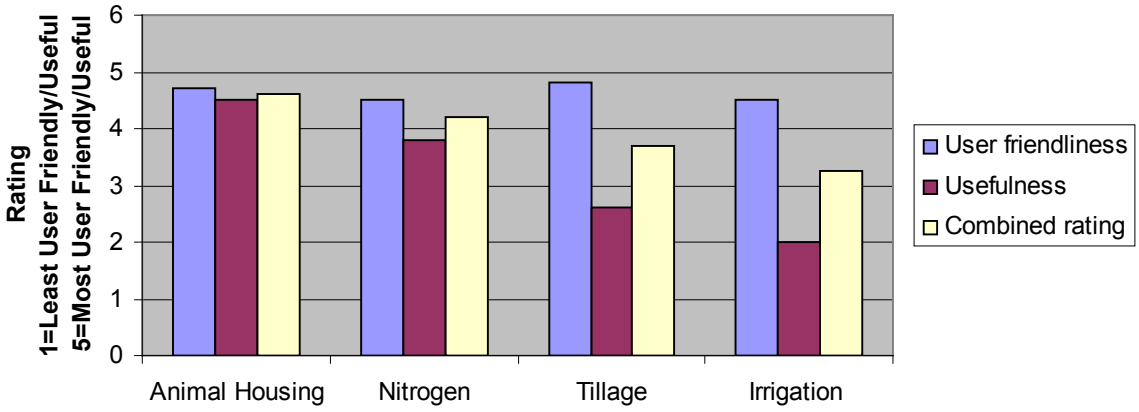
- "I don't think I am alone as a farmer when I tell you to get right to the content. Let me get the details in there and then give me the results. Kill the prequalify step unless it serves a purpose I can't see."

2.3 Reviews: NRCS Energy Consumption Awareness Tools

The USDA-Natural Resources Conservation Service (NRCS) has also developed four energy tools to increase energy awareness. These cover animal housing, irrigation, nitrogen, and tillage. NRCS staff sometimes refer to these as "three click tools," since the user progresses through three screens and receives results and options on the fourth screen. The first screen merely asks for the user's zip code, followed by two screens asking for information about farming operations and equipment, energy usage, and local energy costs.

Reviewers were encouraged to test as many calculators as they liked from this group. Their choices were as follows: Nitrogen (6 reviewers), Tillage (5 reviewers), Animal Housing (3 reviewers), and Irrigation (2 reviewers). The chart below shows how producers ranked the Energy Consumption Awareness tools based on user friendliness, usefulness and a combined score, averaging the two. For detailed comments, see Appendix 1.

NRCS Energy Consumption Awareness Tools Ratings



Overall, reviewers found the NRCS Energy Consumption Awareness Tools easy to use, and praised the simple layout with user friendly input options. All four tools received average scores of at least 4.5 for user-friendliness.

On the other hand, reviewers scored the Tillage and Irrigation tools below 3 (on average) for usefulness. This is not surprising, considering that the Awareness Tools give users a limited ability to tailor inputs to their own situation. As stated in the instructions to the Animal Housing tool: "This tool does not provide operation-specific recommendations; it provides an idea of the type of energy cost savings that a producer might expect from making simple changes to the operation. Results should not be construed as actual savings, but only as estimates."

A few representative comments about the Energy Consumption Awareness Tools:

- "The advantage of having the computer do so much calculation based on a few inputs is obvious. I have done calculations like this on my own and while they are not difficult, involving only simple arithmetic, they are very tedious."

"The advantage of having the computer do so much calculation based on a few inputs is obvious."

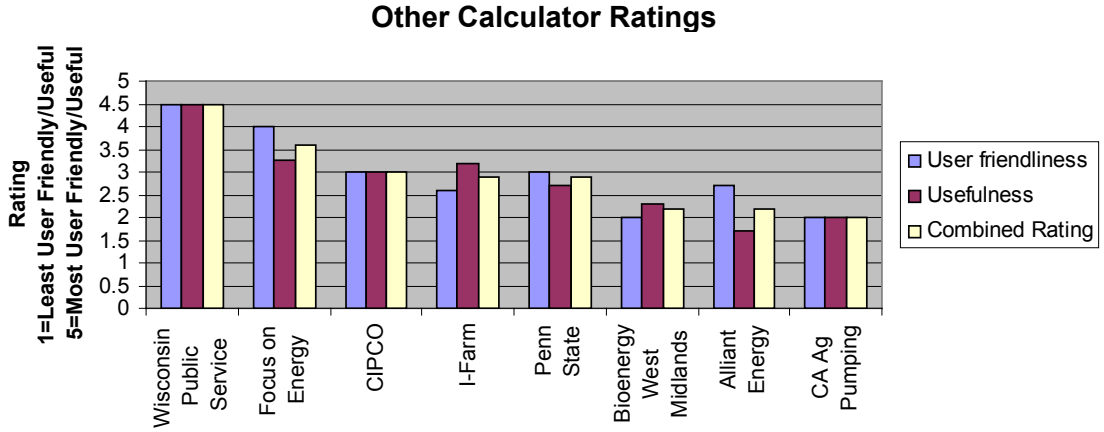
- "Too many built in system number are used, not enough user selections are used, does not encourage the user to go back and change the numbers to compare expenses and saving. Farmers are smarter than the information level of this program, not impressed."

2.4 Reviews: Other Calculators

Reviewers were invited to test as many calculators as they liked from the following list:

- I-Farm Integrated Crop and Livestock Production and Biomass Planning Tool – Iowa State University (5 reviewers)
- Biofuels Calculator - Bioenergy West Midlands (3 reviewers)
- Energy Cost Calculator - Penn State (3 reviewers)
- Farm Assessment Toolkit - Wisconsin Focus on Energy (3 reviewers)
- Farm Energy Audit – Alliant Energy (3 reviewers)
- Average Farm Energy Calculator - Central Iowa Power Cooperative (2 reviewers)
- Savings Calculator for Farms – Wisconsin Public Service (2 reviewers)
- Pumping Energy Calculator – California Agricultural Pumping Efficiency (1 reviewer)
- Energy Use/Costs for Pumping – Wateright (0 reviewers)
- Irrigation Operating Cost Calculator - Nebraska Public Power District (0 reviewers)

The chart below shows how reviewers ranked the eight tools that were tested. Again, note that the sample size is extremely small and these ratings are, at best, suggestive. For many specific comments from the reviewers, see Appendix 1.



Reviewers found some of the calculators in this group quite difficult to use. For example, only one of the five reviewers who tested the I-FARM calculator from Iowa State University was able to get results. This one reviewer said, “I believe it is probably an extremely useful tool for anyone with sufficient knowledge to set up a meaningful simulation. The scope of the data and calculations is really amazing!” Some other reviewer comments about this calculator were:

- “The user interface is very confusing and not attractive for use by general farm population. I would like to know if any producers not involved with this program or ‘drafted’ by it are using this program at all.”
- “Pictures and graphics apparently made it slow to load. This calculator is certainly not for the faint of heart, looking for a few superficial answers!”
- “It couldn’t be used.”

Some reviewers with dial-up Internet access had trouble accessing calculators in this group, especially calculators that used Excel spreadsheets. As with many of the tools evaluated, several reviewers noted the lack of information about return on investment.

Recommendations included adding more cost/savings analysis information, including links for help and more information, and making the tools available for a wider variety of producers.

2.5 General Comments about Calculators: Usefulness and User-Friendliness

In their written comments and interviews, reviewers repeatedly emphasized the need for economic information—especially capital cost and return on investment—if these tools are to be truly useful. They also asked for specific equipment recommendations, including name brands.

Most reviewers also expressed a low level of trust for these tools, approaching them in a casual and exploratory way. Many stated emphatically that they would not consider basing a major decision on results from any calculator.

"There are just a handful I would say that are useful, but the bulk of them wouldn't spur anybody to make a change."

A few representative comments:

- "I think they (calculator developers) need to focus in on what is the goal. How do they plan on producers using them and is that something a producer really wants? There are just a handful I would say that are useful, but the bulk of them wouldn't spur anybody to make a change."
- "It (a web-based energy calculator) can be helpful, I think. But you're going to run into a couple things. You're still going to have that subset that looks at the internet as a newfangled nuisance. Some aren't even going to try."
- "I think they're already motivated to make changes if they come to the tool. However, I see the tool potentially giving us the impetus to finish. Give me some hard data on returns on investment. That might be the actual push I need to get an electrician."
- "I think the calculators are a good idea. The thing I kept coming across is that they provide general savings potential, but what are the initial capital costs? Be upfront on capital costs. People are instantaneously skeptical about energy efficiency costs. Agricultural producers are generally cash poor. The tendency is to think we can keep muddling through with yearly costs as long as we don't have to put cash up front now."

"Be upfront on capital costs. People are instantaneously skeptical about energy efficiency costs."

- "It's going to depend on the results. If one says you save $5, nobody's going to be interested, especially if you have to spend $2,000 to do it. But, if you're going to save a lot of money… It's going to be a cost and return thing. Most farmers I know aren't opposed to saving money."

2.6 General Comments: Do-It-Yourself Versus Professional Energy Audit

In the interviews, all participants were asked whether they would rather use a do-it-yourself tool or have a professional energy audit that included a site visit. All twelve reviewers said they would rather use a do-it-yourself tool than have a professional audit. Many cited reasons of cost, while others said they did not feel the need for professional help or were wary about the potential hassles of a professional assessment. Two reviewers said that an audit might be useful for larger farms than their own. A few representative comments:

- "An auditor would not be especially helpful. The changes are too big. It depends on what this engineer is capable of doing and if he can look at the whole operation as one unit or only look at one piece of it."
- "I have been in this business since 1977 and I have learned things by the seat of my pants. And in some ways that's better than having someone try to tell you what to do."
- "I'd say using these tools would probably take the place of that (an energy audit). I think a lot of farmers maybe feel like when

All twelve reviewers said they would rather use a do-it-yourself tool than have a professional audit.

a professional comes out that they're telling them how to run their operation while using the calculators they might be more inclined to try it in that instance."

- "If it (energy audit) was expensive?! No. I know we wouldn't use it. Going on the website and doing the evaluations like we did, I would do that. We try to keep up to date and know what we're doing. We would never pay someone to come out to do that (an energy audit)."

"We try to keep up to date and know what we're doing. We would never pay someone to come out to do that (an energy audit)."

- "On a dairy it might be very useful. But at my use level, it's probably more appropriate for me to do it through these calculators and talk to somebody at the power company without paying for it. The calculators were enjoyable for me."
- "For smaller operations, doing an online evaluation would be sufficient. I think for some large scale operations, a professional coming out to help them would be great. They would be able to save a fair bit of money with help. If the tools (online energy calculators) were more specific, they could do it themselves."
- "In my case I would be just as happy given the tools. Just play with the tools until I can get enough info for myself. Part of the problem with the energy audit is that they would have to focus on certain types of farming operations. Since my operation would be entirely different (small scale vegetable and poultry), they wouldn't be able to give me the types of details that I want."
- "One advantage of having a guy come out is that he can compare from farm to farm and make suggestions. The challenge is being able to open your eyes to realize other people can help you to make decisions."
- "From my perspective farmers are very independent. The ones who wouldn't go online to begin with wouldn't care to throw money at an audit."

"Farmers are very independent. The ones who wouldn't go online to begin with wouldn't care to throw money at an audit."

3. Comments from Energy Professionals

3.1 Comments from Energy Engineers and Auditors

Ten energy professionals were interviewed for this report. These included four members of the calculator design team at GDS Associates, two members of the calculator design team at NRCS, representatives from a company that provides farm energy audits (EnSave), and staff members from three energy conservation organizations: NCAT, the American Council for an Energy Efficiency Economy, and the Rural Electricity Resource Council. Six of these people were licensed professional energy engineers, and all had extensive experience promoting energy conservation on farms.

While many of the energy professionals interviewed for this report were optimistic about the potential of farm energy calculators, others were openly skeptical. One person commented:

> "Attempting to create an on-line farm energy audit (like we find for home audits) does more harm than good. There are too many variables that need to be evaluated on-site. The person carrying out the audit must possess an understanding of the processes used in agriculture. Just a few of these include grain drying principles and methods; lighting upgrades that work on farms; fan ventilation calculations; Irrigation methods and crop requirements; and pump mechanics. Unlike a home audit that has a very limited number of processes (water heating, basic lighting, & heat loss from the structure) a farm has multiple processes that are very site-specific. These can't be incorporated into a 'cookie cutter' on-line audit."

Some energy professionals emphasized the knowledge, experience, and powers of observation required to conduct a professional energy study. Others expressed liability and safety concerns related to encouraging untrained people to do their own energy studies.

3.2 Comments from Calculator Developers

On the whole, the calculator developers interviewed during this study were well aware of the difficulties they were facing, but saw their efforts as exploratory, promising, low-cost (compared to a professional audit), and the best available option for many farms.

Below are a few representative comments:

- "Marketing will be very important to increase usage of these calculators."
- "Farms tend to set targets; that's an advantage in encouraging them to try the calculators."
- "Internet usage has grown rapidly in the past few years, and it may be premature to reach any conclusions about the value of this approach. On-line tools will certainly be one of many vehicles for promoting better energy management."
- "Other approaches (such as videos or one-on-one training) may be more effective in changing behavior, but on-line tools are so much less costly that they need to be explored."
- "Compared to other businesses, farmers just getting caught up on business planning. Energy will be one of the next steps, but it's not happening yet. Budgets often don't include energy and manure management."
- "To work well, calculators have to be intuitive; they shouldn't require a prep session. They will also need to align with other needs (such as federal funding programs and emerging carbon markets)."

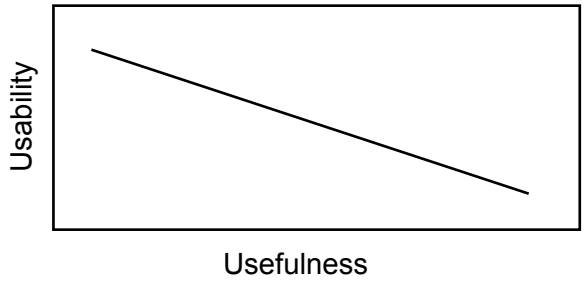
"Compared to other businesses, farmers are just getting caught up on business planning. Energy will be one of the next steps, but it's not happening yet."

4. Discussion: Challenges

This section summarizes some challenges and concerns that emerged from the testing and interviews.

4.1 Achieving Both Usefulness and Usability

In their testing, NCAT staff found that usefulness and usability tended to have an inverse relationship, as shown in the diagram below. Calculators that were easy to use tended to give results so vague that they were difficult to put into application. On the other hand, calculators that generated precisely tailored results required extensive collection of inputs, and became so complicated that it seemed they would deter all but the most dedicated and skilled user. Calculators were rarely both easy to use and immediately useful.



This pattern was less evident in the evaluations by producers, however. With only a few exceptions, the calculators that were rated most useful by producers were also rated most user-friendly, and the calculators rated least user-friendly were also found least useful.

4.2 Changing Behavior

Using a farm energy calculator is usually a low-risk proposition, because inputs are not saved, reported, or even indexed to those of other users. Whether anything happens with the results is entirely up to the user.

Some calculators try to facilitate action by including referrals to service providers or sources of additional information. Other tools, such as the NRCS Energy Consumption Awareness Tools, present themselves as merely educational, and caution users not to rely on them as the sole basis for decisions. Nonetheless, the greatest challenge faced by any energy calculator must be bridging the gap from theory to practice: compelling on-the-ground improvements in energy usage.

The greatest challenge faced by any energy calculator must be bridging the gap from theory to practice.

4.3 Coping with Liability Problems

Just as troubling as the possibility that no one will change their behavior is the possibility that people will change their behavior too hastily, in ways that will lead to disappointment, financial loss, or even physical injury. Most energy projects require some amount of professional help, and do-it-yourself devices should not create a false sense of confidence.

4.4 Collecting Enough Information, But Not Too Much

All calculator developers face the challenge of collecting enough information to deliver useful results, but as calculators get more complicated, users have a harder time completing the inputs in one sitting. This is not just because of the number of questions, but also because some information will need to be looked up or collected.

This presents the calculator developer with a difficult decision: Do you provide a way to store data online, thereby raising questions of privacy and online security? Or do you offer the calculator as software to be run on the user's own computer? While the latter route alleviates privacy and security concerns, it also deters some users with slow Internet connections, older computers, or limited computer skills.

4.5 Establishing Credibility

As already mentioned, the reviewers in this study approached calculators with a heavy dose of skepticism. Some expressed a distrust of anything found on the Internet—where sloppy work, bad advice, and financial scams are all too common. But growers were also keenly aware of the complexity of agricultural decision-making, the many possibilities for error, and the potential for personal economic loss from any mistake.

Many of the small glitches noticed by reviewers should be seen in this context. Grammatical errors, unclear explanations, buttons that don't work properly, and minor programming errors are all red flags for users who are predisposed to be hyper-sensitive about the reliability of these tools.

Users are predisposed to be hyper-sensitive about the reliability of these tools.

Winning the trust of users is going to be an uphill battle. This lesson was unmistakeable in the interviews, and it would be hard to overstate the importance of impeccable attention to detail in all these areas. At the same time, the people (mostly engineers) who are technically qualified to create these calculators rarely have the skills to meet this high standard of writing, website design, and training.

4.6 Keeping Information Up to Date

All but the simplest calculators tend to go out of date fairly quickly and need ongoing maintenance. The reviewers in this study made the point that specific economic information would be essential before they could consider basing actual decisions on these tools. Yet maintaining this kind of information may be practically impossible. The costs of equipment and fuel are a moving target, and the labor required to keep this information up to date would often be prohibitive.

4.7 Getting Beyond a Narrow Scope

Most calculators are too limited in scope to make a real difference in a diversified operation's bottom line—since they consider only a tiny aspect of an operation's energy use independently, rather than as a component of an overall strategy. For example, many calculators help farmers decide which fuel to use for a certain farm task, but very few calculators help determine whether that task is itself essential, or whether a different production practice might be a better choice.

4.8 Getting Beyond a Snapshot in Time

Energy calculators are usually snapshot approaches that have a hard time considering multi-year periods. For example, while a particular crop may be energy demanding in terms of tillage or other requirements, it may play a critical role in a longer rotational strategy. Similarly, some practices represent one-time energy expenditures that contribute to a longer-term goal, such as clipping for weed management. The "snapshot" aspect of most calculators also makes it difficult for them to account for seasonal variations in fuel cost, or to predict the effect of future fuel prices and/or supplies.

On the whole, dealing with the variability of a farm's operations over time is an especial weakness of calculators. Because of extreme variability in weather, markets, and even type of product, few operations have constant energy use from year to year. Consequently, some of the most effective tools focus on single-product operations, like dairies or wineries, rather than diversified operations or farms that rotate crops.

Dealing with the variability of a farm's operations over time is an especial weakness of calculators.

4.9 Factoring In Hidden Costs

Calculators struggle to estimate the full cost in any switch to a new way of doing things. For example, many fuel value calculators assume that all things are equal other than fuel type. However, retrofitting equipment buying new equipment to accept different fuels clearly involves costs. There are also hidden costs involved in the time and risk required to change practices or techniques. Even the most comprehensive calculator can't predict the cost of training operators to new methods, or making certain that a new piece of equipment performs optimally.

4.10 Encouraging Innovation

Calculators are also challenged to account for "out of the box" thinking. For example, many dairy efficiency calculators merely contrast conventional and more efficient equipment. They don't suggest—or allow for input of—alternative practices such as solar water heating or other

types of renewable energy generation. Similarly, livestock facility calculators focus on incremental improvements in ventilation equipment and lighting. Rarely if ever do they raise the possibility of radically different approaches such as pasture-based production.

Granted, spurring changes in production method is perhaps too much to expect from an online tool, but it is nonetheless important to recognize that calculators tend to reinforce existing production practices modified by incremental improvements. Calculators rarely introduce—or support a producer's voluntary transition to—dramatically different approaches.

Calculators tend to reinforce existing production practices modified by incremental improvements.

5. Recommendations

The following recommendations are intended to make calculators more useful, more user-friendly, and more widely used.

Target an audience.

Because of the wide variation among agricultural operations, the most successful tools are usually focused on a specific target audience and promoted to that audience. Some successful calculators aim for broad participation at a lower level of commitment, aiming to raise awareness or stimulate interest. Other calculators aim for a higher level of commitment and trust from a smaller number of users. Both approaches can be successful, but the purpose and expectations must be explained clearly to users.

Tackle credibility questions head on.

Users encountering these tools on the Internet will come with questions like "Who created this tool?", "What are your credentials?", and "Why should I trust you?" In one way or another, these questions should be answered directly and prominently.

Keep calculators simple.

Reviewers greatly appreciated the time-saving benefits of some rudimentary tools that merely automated or simplified time-consuming calculations. On the other hand, comments from the reviewers suggest that, with few exceptions, calculators requiring complicated inputs are simply not going to get much use. Complicated tools tend to collapse from their own weight. Winning the trust of users would require meticulously clear instructions and a high degree of graphic sophistication and functionality. Achieving this high standard would greatly increase the development time and cost of these tools, and may require an interdisciplinary team of writers, trainers, engineers, programmers, and website designers.

With few exceptions, calculators requiring complicated inputs are simply not going to get much use.

Help users identify areas of significant energy use.

Because agricultural operations are so different from one another, areas of great potential for some farms are relatively insignificant for others. It might make sense to begin with a broad survey to identify major areas of energy use, and then narrow the focus to those areas individually.

Help users take the next step.

The most useful calculators guide the user on to the next step once energy saving opportunities have been identified. Tools that simply offer general tips or improvements tend to leave the user stranded at that point, with no specific information on how to achieve those improvements. Evaluators in this study appreciated links to additional information and resources.

Identify specific products, companies, and name brands.

Although calculator developers may be leery of recommending particular products, or, in the case of government-sponsored tools, unable to endorse particular brands, this creates a serious gap between theory and practice. On the other hand, naming brands must be done carefully to avoid raising doubts in the user's mind about the impartiality of a website or tool.

Learn from other online calculators.

There are many types of online calculators in common usage, with farm energy calculators being a relatively late entry into the field. Aside from the familiar home mortgage calculators, there are many calculators related specifically to farming. These include calculators for machinery cost, land leases, seeding and fertilizer rates, enterprise budgets, and even carbon footprints—all part of a long tradition of do-it-yourself planning tools for agriculture.

Energy calculators might imitate features of some of the more popular calculators. Farm energy calculators could also be promoted, linked, or located with these more familiar tools, rather than relegated to lower levels of energy-specific websites, as many are.

Promote the tools.

It is doubtful that many agricultural producers are actively looking for these tools on the Internet. And if someone were to come across one of these tools, it seems doubtful that they would trust it or invest much effort into using it. Unless calculator developers make a conscious effort to make agricultural producers aware of the existence of their tools, and win their confidence, the tools are probably not going to get more than occasional and casual use.

One main conclusion from this study is that issues of trust and credibility are major challenges for the do-it-yourself approach, at least as challenging as the better-known questions surrounding computer literacy and high speed Internet access among rural people. Internet use, technical competence, and connection speeds are increasing. But growing sophistication and better access will not solve the credibility problems, and they may make them worse.

Issues of trust and credibility are major challenges for the do-it-yourself approach.

Consider endorsements or sponsorships for credibility.

Calculators could be endorsed or promoted by organizations that the intended audience would find credible. As an example of this, the Iowa Soybean Association is acting as the sponsor for an in-field energy audit program. Association members have served as test cases for a pilot phase of the audit program designed to develop a calculator tool useable by the wider Association membership.

In this same vein, calculator sponsors might consider developing partnerships or alliances with trade organizations or periodicals that would expose their product to new audiences.

Offer creative incentives.

Beyond the obvious incentive of potential energy and dollar savings, organizations could offer other types of incentives. One possibility could be a certification for users who achieve a high level of results using the tool. This certification might be used by qualifying producers as a marketing tool, or might make them eligible to participate in some type of cooperative marketing by the certification program. A new greenhouse grower certification program in Michigan takes this approach. Of course, administering such a program and verifying participant qualifications would represents a significant added burden on the calculator developer.

Encourage curiosity and experimentation.

Many online tools seem to begin from the dubious assumption that users are ready to make decisions and invest in improvements. The reality is that most online calculator users are going to be casual users.

The reality is that most online calculator users are going to be casual users.

A strength of online calculators is their ability to be interactive: allowing the user to perform repeated iterations with changed variables. Therefore, an especially desirable feature of an energy calculator is the ability to back up and change some inputs, without having to go back all the way to the beginning. A calculator might even go farther in encouraging experimentation: allowing a range of inputs in a single step, or a built-in calculation loop that would ask users if they want to perform a particular step over again with another input value.

Use phased approaches.

One way to balance the need for simplicity with the input requirements for usefulness is to take a phased approach. A simple initial calculator with a few inputs yields a preliminary result. This pre-screening process ensures that the calculator is relevant to the user before asking them to invest extensive effort. The NRCS Self Assessment Tools incorporate this feature, requiring the user to answer a few "prequalification" questions to determine if energy savings are likely.

It is worth noting, however, that some reviewers complained that all of these prequalification screens were annoying and unnecessary. Extra screens and steps should be added only when they are truly a time-saver or convenience feature for users.

Include plenty of default values.

One of the most frustrating experiences for a calculator user is to proceed through screen after screen of inputs, only to encounter an input blank that is either unknown or not applicable. In some calculators this halts the process unless the user guesses at an appropriate value. Many of these users are likely to give up at this point. Internet users, in particular, are accustomed to moving effortlessly from screen to screen.

The most user-friendly calculators offer default options for each required input. These allow the user to complete a calculation and achieve a relatively accurate—even if not perfectly tailored—result.

6. Summary List of User-Friendly Features

The following desirable features of tools were singled during the evaluations and and interviews:

- Clearly explains the tool's purpose.
- Clearly explains the tool's limitations, including geographic ones.
- Works flawlessly within its stated limits.
- Does not waste the user's time.
- Clearly establishes and explains the qualifications and objectivity of the creators.
- Gives appropriate (but not exaggerated or paranoid) safety and liability information.
- Addresses privacy issues forthrightly and respectfully. Clearly explains the reason for gathering any personal information.
- No "log in", registration, or password requirements, for tools on the internet.

- Either provides capital cost and payback (return on investment) information or explains why this information is not given.
- Respectfully acknowledges non-standard or unusual farm types, practices, or crops—if only to explain why these are not covered.
- Offers plenty of default values with optional numeric input.
- Shows photographs and drawings of equipment.
- Provides easily accessible help screens.
- Includes pop-up boxes with definitions, explanations, and more information.
- Gives case studies and actual examples, including capital cost and payback.
- Incorporates a prequalification step or phase—where this saves the user time and trouble.
- Alerts the user in advance to gather information that will need to be on hand to complete the exercise, such as power bill information or wattages.
- Allows easy changing of entries, experimentation, and recalculating without starting over.
- Gives specific products and name brands.
- Provides links to more information, sources of equipment, and funding.
- Offers visual cues, such as colors and borders, to separate different topics or highlight important fields.
- Has no programming errors. The user never receives an error message or sees a blank or frozen screen.
- Uses flawless spelling, punctuation, and grammar that send a positive signal about the care and competence of the designers.
- Gives clear explanations in plain, non-technical language. Does not sound academic or mathematical. Empowers users rather than intimidating them.
- Offers “Cancel” buttons on every screen—clear escape routes.
- Provides benchmarks for making quick ballpark comparisons: average energy consumption and cost values for similar farms or operations.
- Loads quickly, works well on slower computers or dial-up Intenet connections.
- Allows the user to save input information and return later.
- Has gone through extensive usability testing with agricultural producers.

7. Conclusions

Agricultural producers have a long tradition of using calculators of one sort or another. The growers in this study were receptive to do-it-yourself approaches and comfortable using them. In fact, all reviewers said they would rather use these tools than hire an energy professional.

These reasons alone would justify further efforts to develop good computer-based tools. Moreover, sophisticated new options for creating these tools are now readily available, such as mapping, video, and a variety of interactive features.

At the same time, the limitations of these tools need to be clearly recognized. The best examples to date have been simple to use, focused on particular farming operations, equipment

types, geographical regions, and energy uses. They have been modest in their aims, set up for learning and experimentation rather than yielding actual decisions or recommendations about equipment purchases or management changes. Do-it-yourself tools excel on specific topics, such as lighting and grain drying, where the options are straightforward, well-studied, not especially numerous, and essentially the same in all parts of the country.

The more ambitious tools in this study, covering whole farms, multiple farm types, multi-year periods, and so on, have been less successful. As tools become more complicated to use, more comprehensive in their coverage of topics, and more specific in their recommendations, they run into daunting problems of usability, liability, accuracy, and maintenance. Many of these problems can probably be solved, but only through full-blown (and expensive) development and promotional efforts.

The best farm energy calculators do certain jobs extremely well, and they have the potential to become even more useful. But the self-help tools reviewed during this study would provide an extremely limited substitute for an on-site visit and audit by an energy professional.

The self-help tools reviewed during this study would provide an extremely limited substitute for an on-site visit and audit by an energy professional.

Do-it-yourself tools have a hard time taking a broad look at farming operations, considering relationships among energy using systems, getting beyond a snapshot in time, encouraging innovation, or providing accurate and current costs. Trained energy auditors can do all of these things extremely well, and they can also explain their recommendations face-to-face, reducing the chances of misunderstanding. Moreover, even if a do-it-yourself tool could overcome all these obstacles, it would still face difficult liability issues.

Although energy calculators have been a successful approach for homeowners, farms are quite different from houses. Most farms—even small ones—are much more complicated than a house. Also, farms are businesses: people's livelihoods depend on them. For these reasons, farms are going to need highly reliable energy information. The bar is going to be higher than it would be for the average homeowner trying to reduce power bills.

In the near term, most farmers and ranchers will probably keep making energy decisions the way they always have: by talking to neighbors, equipment dealers, and installers, reading agricultural publications, and listening to radio programs and trusted organizations. Do-it-yourself online tools are certainly not going to replace this decision-making process any time soon, but they are already playing a significant role, and they can take on greater importance if they fit into this existing network of information and trust.

Appendix 1: Comments from Reviewers

NRCS Energy Self Assessment Tools

Potato Storage Self Assessment Tool

The Potato Storage Energy Self Assessment Tool estimates energy savings based on storage period, fan horsepower ratings, and number of fans.

User friendliness
The two evaluators who reviewed this tool gave it an average rating of 4.25 out of 5 for user friendliness. One reviewer got stuck at Step 3, which asked for information about storage bins. The reviewer was unsure whether to delete unused bin rows.

- "Very easy to use. Very self explanatory."

Usefulness
This tool received an average rating of 4 out of 5 for usefulness.

- "Not sure what the calculator was telling me. I put in the data and it showed User Input and then estimated savings, but what caused the estimated savings? Would it be going to premium fan motors or is it telling me what I am saving because I am actually storing potatoes? I do like the idea of the estimated investment amount and the simple payback years – I am just unsure of what I should be investing in – again is it the premium fan motor?"
- "Very useful information on the step 4 page. I like that savings in CO_2 emissions were given."

Strengths
Strengths cited included simple input screens and the frequently asked questions in Step 2.

- "The frequently asked questions are a good bonus to have. They are very informative."

Weaknesses
Step 3 and Step 4 were both somewhat confusing. One tester wished he could have changed parameters in Step 4 page to quickly recalculate different scenarios, rather than having to go back to Step 3.

Grain Drying Self-Assessment Tool

The Grain Drying Energy Self Assessment Tool estimates the efficiency of grain drying operations and provides a comparison to typical efficiency values for similar types of grain dryers.

User friendliness
The four reviewers gave this tool an average rating of 4.25 out of 5 for user friendliness. Reviewers appreciated the use of colors, bold text, and pop-up boxes with graphics and definitions.

- "So easy and the info links provide averages if you do not know what to initially put in. Those averages greatly help and avoid inputting data that could drastically change the analysis figures at the end. This entire program is simple to understand and follow. The use of colors and bold text help to read and quickly pick out important fields and paragraphs that supply hints. This is easy and simple to follow and fill in, making it enjoyable and not a chore. I had no problems, but I did not understand a couple of title names so I clicked on a bold text that gave a clear definition – easy!"
- "I am in an area where we don't need to dry grains, but I found the calculator very interesting to understand different aspects of drying especially corn. I found it very easy to use."

Usefulness
This tool received a rating of 4 out of 5. Reviewers liked the comparison of results at the end. One indicated that the tool seemed more suited for larger grain operations than small ones. Another reviewer found that the tool confirmed the efficiency of the drying method he was already using. A third reviewer wished he could calculate the cost of *increasing* moisture in grains, since he is located in a region where grain drying is not necessary.

- "Did not take into consideration of the cost of the necessary added equipment to predict a pay back on investment."

Strengths
Reviewers appreciated the pop-up boxes with definitions of drying options. They also liked the inclusion of default average values for certain data fields, allowing quick calculations without looking up information. One reviewer cited the tool's ability to help large operations realize cost savings as a strength, while another reviewer appreciated the options for small producers to achieve results.

- "The page identifiers at the top of the page are nice to go back and make a change and rerun the calculations – fast and simple since it holds the original values that were inputted."
- "The money saved in a large operation can be well realized with these calculations."
- "Each drying option has definitions to describe the type of systems and what may be included or needed. Great color coding of information lines to make you want to reach each – eye attracting colors made me naturally read all of those areas – good. This is a very useful tool, much of the guessing that is not common everyday information like energy prices is available as an average value. This system saves many many hours of research and making multiple calculations to effectively evaluate all systems and options."

Weaknesses

- "Did not calculate pay back periods or quantities."
- "There are some missing questions such as the fan size, motor horsepower, fan type, etc."
- "Never got stuck but it assumes you are using some kind of heat to dry the grain even though your interview says you are using a natural air dryer. Too many assumptions on their part."
- "The only weakness that I see is the cost contra savings. Could you make a page that would address this issue, meaning that you found out that you can save $xxxx this way of drying your corn, the next page would then give you the opportunity to put in the cost of changing your system and it would come up with a calculation and overview that says that you would have your investment paid back in this amount of time, maybe even a cash flow chart…"

Dairy Self Assessment Tool

The Dairy Energy Self Assessment Tool calculates the potential energy savings for scroll refrigeration compressors, refrigeration heat recovery, well-water cooled precoolers (heat exchangers), variable-speed milk pumps, and variable-speed vacuum pumps.

User friendliness
The one evaluator who reviewed this tool scored it 4 out of 5 for user friendliness. The reviewer noted that one spot required using the "Help" box, but the explanation provided was not helpful.

Usefulness
This tool received a rating of 4 out of 5.

- "It appears to do the job although the savings potential was lower than I had expected."

Strengths

The reviewer noted that this calculator took into consideration some factors he would not otherwise have considered, such as using a washing machine for laundry and multiple bulk tanks.

Weaknesses

- "It appears to be aimed at larger dairies because the minimum number of cows being milked was 100. At most I only milk about 80. I didn't see anything about the feeding system either."

Livestock Self Assessment Tool

The Livestock Energy Self Assessment Tool reviews water fountains, ventilation fans and lighting for energy savings potential.

User friendliness

The five reviewers who tried this tool gave it an average rating of 4.4 out of 5 for user friendliness. One indicated that it was, "far and away the easiest of the three I evaluated." Another user, though, kept receiving the following error, "HTTP 403.9 – Access Forbidden: Too many users are connected." He eventually got through after several tries, but found the error frustrating.

- "It is easy to use. Just simple questions on how livestock are kept cool."
- "I found the calculator easy to use, nothing confused or slowed me down, though I am computer savvy and familiar with radio buttons and drop down menus."
- "This calculator was very easy and fun to use. No problems at all."

Usefulness

This tool received an average rating of 3.6 out of 5 for usefulness. Reviewers had varying impressions of usefulness for this tool. Some found this tool only marginally useful.

- "I found this calculator only marginally useful, as it really only consisted of the prequalify section which led to other calculators to use. It was useful in terms of pointing out which areas might have room for improvement and then directing the user to other calculators. I think an additional category could be water pumping energy use, for range watering as well as confined area watering."

Strengths

- "It is quick and to the point."
- "Easy to use and full of useful concepts and information."
- "Calculator was straight forward and led directly to other calculators."
- "Told me exactly which assessments would be helpful."

Weaknesses

- "It should include a category for water pumping energy use."
- "Perhaps a bit more explanation at the beginning of the calculator would be useful – I wasn't sure what it was supposed to tell me...A few explanatory sentences at the top of the page would easily satisfy my objection."
- "The introduction states that livestock production is not particularly energy-intensive. Maybe not, but energy expense is still a critical field. I don't know if fuel usage is compared in this energy calculator, but I know that miles traveled delivering livestock and livestock products are extremely important to my bottom line."

Irrigation Self Assessment Tool

The Irrigation Energy Self Assessment Tool estimates potential energy savings from reducing system pressure, increasing pumping efficiency, and using irrigation scheduling for irrigation management

User friendliness

The four reviewers who tested this tool gave it an average rating of 3.75 out of 5 for user friendliness. Some found this calculator easy to use, while others found it complicated. One reviewer was frustrated by the photos, thinking he should click on the photo that matched his system. He did not see the entry fields below the photos. Another reviewer wished that the final question on the Step 2 page about Irrigation Scheduling had more options than simply "Yes" or "No," since an irrigator might use some of these methods but not all of them.

One reviewer commented that the "flow" of this tool was harder to figure out than some of the others, and wished there had been more information on irrigation scheduling, soil permeability, and related topics.

- "Nice! This is very fitting for all irrigation systems and starting on the first page is easy to follow and fill out! For those that are thinking about or planning one type of system, this provides information and a fast way to compare."
- "I hate the prequalify step on all of these. I don't care—if I come to this site, I want to run the calculations."
- What is the zip code for? I saw its use in greenhouses, but not lighting. It SHOULD be a factor in irrigation. You can make many suggestions based on the prevailing climate potentially. But, if you are NOT doing that, why make me go through the exercise of entering my zip code for this? Are you just hoping to track where your hits come from? Use the cookie you set to do that.

Usefulness

This tool received an average rating of 3.5 out of 5 for usefulness. One evaluator was in the process of planning a new irrigation system for his farm and found that he was able to compare options: "I was able to run three completely different situations and change and reevaluate each in less than two hours – fast. That same work would have taken me over six hours and removed all chances of math errors."

Another reviewer felt that all of the calculators, including this one, were intended for larger operations than his own.

- "Once again some ballpark estimates of costs of any alternative pumps or equipment would make the cost savings mean more."
- The only thing that detracts from the usefulness is the variability of conditions that make PSI needs so different, so a lot of cost savings might not be available if you need the pressure for whatever reason, but this is made clear in the more information links, so no change to be made."

Strengths

- "Short, straightforward format."
- "The recommendations for utilizing alternate fuel sources were especially intriguing, and the results seemed reasonable, under my intuitive analysis."
- "Includes all kinds of irrigation."
- "Recalculate button for different energy sources."
- "Comprehensive questions, especially on center pivot."
- "The greatest value is being able to change just the energy type from gas to electric or LP or diesel."
- "The page status identifier on each page makes it easy to flip back and change numbers to compare the savings."

Weaknesses

- "More definition selections would have been nice."
- "The amount of info needed is a little daunting, I know there isn't much to do about this, but the some kind of graphic that you could build with the info might make it seem easier."
- "Options available did not accurately match my situation. Unfortunately, the smallest available pipe size was 2 inches, so I know my energy consumption must be markedly higher than the result given in the calculator."

Lighting Self Assessment Tool

The Lighting Energy Self Assessment Tool covers all types of lighting commonly used in agriculture, including incandescent, halogen, mercury vapor, compact fluorescent (CFL), T-12 fluorescent, metal halide, T-8 fluorescent, high pressure sodium, and T-5 fluorescent lamps.

User friendliness

The eight evaluators who reviewed this tool gave it an average score of 3.25 out of 5 for user friendliness. Problems included inconvenient navigation, trouble accessing bulb description windows, and difficulty remembering names of bulbs—requiring the user to go back and forth between screens to access photos of bulbs.

- "This calculator was easy to use with the exception of when I forgot to put in one entry of how many hours the lights were on. When I went back to the previous page all of my information was gone and I had to re-enter it again."

Two reviewers received the following error message, "Server Error in "/" Application". It appears that this problem has since been resolved by the developers.

Usefulness

This tool received an average rating of 3.6 out of 5 for usefulness. Reviewers had several recommendations for making the lighting tool more useful:

- Include information on cost of changing to more efficient lighting, return on investment info.
- "I would like to have a window rating bulbs, by manufacturer, similar to a 'consumer report'. My experience indicates bulb quality varies considerably."
- Include information on motion sensors and timers.
- Investigate method for user to save data and come back later.

Strengths

- "The broad range of lighting types."
- "The focus on cost savings, concisely summarized at the end, with less emphasis on "greening" relatively. This seems to be the better tack, due to climate change and green overload, but everybody likes saving money."
- "Good description of different types of lights available and optional equipment to use with the lights."

Weaknesses

- "It would have been nice to know what the average cost would be to change to the more efficient lighting." [There were many other similar comments.]
- "The prequalify step seemed redundant and wasteful to me time-wise. Why did I spend time thinking so hard about how many of each I had at all locations – only to have to split them out in the next step?"

- "I got an error message when I tried to click any of the categories for "click for more info:" on Step 3: Lighting System Input."
- "Needs a window relating bulb quality to manufacturer."
- "Report rows should show the number of fixtures for chosen lighting type."
- "There is no consideration given for the fixture with your calculator. What good is it to tell me to replace a compact fluorescent with a linear T-8? At the least, should you give a note that this change will require changing the fixture?"
- "I don't think I am alone as a farmer when I tell you to get right to the content. Let me get the details in there and then give me the results. Kill the prequalify step unless it serves a purpose I can't see."

Greenhouse Self Assessment Tool

The Greenhouse Energy Self Assessment Tool examines heaters and boilers, thermal curtains, and glazing as potential energy saving options in greenhouses.

User friendliness

The six evaluators who tried this tool gave it an average rating of 3.7 out of 5 for user friendliness. Most found it easy to use and appreciated the links to clarify information.

- "So easy and the info links for each data block make answering the questions much easier and takes away some of the guessing and consequently makes it more accurate. This entire program is simple to understand and follow. I had no problems, but I did not understand a couple of title names so I clicked on a bold text that gave a clear definition- easy!"

Usefulness

This tool received an average rating of 3.1 out of 5 for usefulness. A couple reviewers who were planning to build greenhouses found the tool useful for comparing methods and construction options.

- "The results were way off. It predicted an annual fuel cost of $215,684 for my greenhouse where as I expect the figure will be much closer to $ 9,000. On a second go through, it predicted a fuel cost of $720,030."
- "Really incredible!! Since I am planning on erecting a grow tunnel, this is very useful in the prebuilding stage. Starting with the first selection page (w/ pictures), it gave energy/efficiency hints under the "more information"- that alone is worth the time and effort to log on and read. Downloadable PDF files for temperature change info is available if it does not automatically come up. This is the most beneficial tool I have ever seen and hugely valuable, even compared to the other tools categories. Good job to the creators!!"

Recommendations for making the tool more useful included adding an applet allowing users to "draw" their greenhouse or one that would build a picture as height and material data was inputted. Another reviewer suggested using estimated costs for various changes based on an "average greenhouse" to give users a better idea of what their initial outlays would be. This average comparison could explicitly show "low hanging fruit" improvements that provide a visual model to reduce the gap between seeing potential savings and actually doing something.

Strengths

- "The 'Set all like roof' button for glazing materials is a good idea."
- "The 'Combined Analysis' tool at the end is very useful."
- "The system is very adaptable and broad in its scope to cover and relate to any type of structure and shape."

- "It gives some percentages to use when examining various energy saving measures."
- "The analysis page provides great information, not only for the selection you make but also provides comparison and increased efficiency values."

Weaknesses

- "My heat source wasn't included. (I use ordinary electric heaters on moderate heating nights, and unvented kerosene heat for colder conditions.)"
- Could use some construction cost analysis."
- "The more information link for "How leaky is your greenhouse?" is titled "Infiltration Loss." I think it might as well say "Infiltration Loss ("Leakiness")" or something just to be clear."
- "I didn't see where I could work with a high tunnel efficiency situation."
- "I was troubled by the "How leaky is your greenhouse?" question. It seems to me that since infiltration is such an extremely important parameter of greenhouse design/operation, this would represent an oversimplification that might possibly adversely impact the usefulness of the calculator."
- "Mixing in instruction links and idea links during the entry form is, in my opinion, a very bad idea. Let me enter the data. Then, show me the appropriate links that I SHOULD look at based on the data I enter."

Water Fountain Self Assessment Tool

The Water Fountain Energy Self Assessment Tool allows comparison of many different types of heated water fountains to unheated, super insulated water fountains.

User friendliness

The seven reviewers who tried this tool gave it an average user friendliness score of 3.1 out of 5. Five of the seven reviewers had trouble. One indicated that the waterer choice was not wide enough, and did not cover his situation. (He uses Nelson watering bowls and heated buckets.) Another user was unable to enter "total weight" on the option for other animal types.

- "The input of this calculator is as easy and user-friendly as any of the other calculators but I rated it low because the illustrations were a little confusing. The word descriptions are pretty good, though I think could be simplified some, i.e. Instead of 'open trough' say 'uncovered' or cover or uncovered trough so it's easier to narrow down which you have."

Usefulness

This tool received an average rating of 3.1 out of 5 for usefulness. Reviewers found this tool fairly useful but indicated, as with other calculators, that incorporating initial upgrade costs would make results more useful.

- "So it tells me that I could save $29/year with a frost-free unit. It sure doesn't talk about costs."
- "This is fairly useful, but limited by the relative simplicity of the choice, i.e. either you have super insulated, energy free water fountains or you should upgrade to them. Again, a ball-park estimate of the initial upgrade cost would make the implications of the choice clearer."

Strengths

- "The water fountain energy.pdf supplement."
- "I like the potential greenhouse gas reduction row."
- "Easy to use, easy to see the savings available."
- "Being able to enter all your different types of water fountains on one page."

Weaknesses

- "I thought that giving ND and SD climate typifying places wasn't enough, I don't really know much about their climate, except that ND is colder, but I don't know how important that is to the calculations."
- "Some of the water fountain illustrations (i.e. the first three) aren't that clear of depictions."
- "The dropdown boxes for type of animals display inappropriate choices. Hog feeder shows all other animals. Could result in user failing to pick correct animal if reusing after running analysis."
- "When clicked button to print results it said error occurred and gave me a blank page. I went ahead and hit the print button to see what happened. It did print out the results like it should, they just did not show up when the print button was hit."
- "The calculator only gives you choices for fountains with heat, especially the super energy insulated. The super energy insulated does not need heat to survive in the average winter. I have one that only has a 4 inch ground air vent and it survived the winter of 2007-2008."
- "Did not identify waterers by brands, wattage, insulation, projected heat loss, and made no provision for number of animals using waterer."
- "It didn't show the ground contact/concrete tanks as an option."

Ventilation Self Assessment Tool

The Ventilation Energy Self Assessment Tool evaluates the user's ventilation equipment for exhausting air from a building or circulation fans for cooling animals.

User friendliness
The three reviewers who tried this tool gave it an average rating of just 1.7 out of 5. Only one reviewer was able to get results; the others got error messages.

- "I don't trust the numbers at the back side of this calculator. For a very small barn, I got an enormous energy price for a high speed fan and a large reduction in energy needs for a HVLS fan."

Usefulness
This tool received an average rating of 2.5 out of 5 for usefulness. The reviewer who was able to use the calculator found the information useful, although he did not trust the results he received.

Strengths

- "Appreciated the links to information."

Weaknesses

- "The usefulness for smaller operations is questionable – including results."
- "The geographic comparisons were very limited."
- "The political statements were somewhat bogus."
- "I would forego the political commentary in a scientific lingo scenario. Just provide the facts."

NRCS Energy Consumption Awareness Tools

Animal Housing Awareness Tool

This tool evaluates major energy costs in lighting, ventilation and heating costs for swine and poultry. It evaluates major energy costs with lighting air circulation, milk cooling, water heating and milk harvesting costs for typical dairy.

User friendliness
The three reviewers who tried this tool gave it an average rating of 4.7 out of 5 for user friendliness. All reviewers found the calculator to be easy to use.

Usefulness
This tool received an average rating of 4.5 out of 5 for usefulness. Reviewers found this tool to be generally useful.

- "This calculator is useful, however, I would have liked to seen breeder hens included in the choices of poultry. The only poultry choice was broilers."
- "Some additional options for lighting and other energy factors such as ventilation types might be useful."

Strengths

- "Gives 6 different scenarios on monetary and energy savings. Very good. It lets you if know if you make one change, several changes, or all changes what you can save."
- "Broader scope than some other calculators included with this evaluation."

Weaknesses

- "Some budgeting/comparisons might be a good step for producers to examine their own baseline versus this limited analysis."
- "Should have more animal choices such as breeder hens, lambs, goats, beef cattle."
- "Should power consumption for water be figure in here or can that be gotten in the livestock calculator?"

Nitrogen Awareness Tool

This NRCS energy consumption tool enables users to calculate the cost of nitrogen product use on their farm or ranch.

User friendliness

This six evaluators who tried this tool gave it an average rating of 4.5 out of 5 for user friendliness. Reviewers found the tool easy to use and liked links for "More Information." One user was unable to maximize the "Fertilizer Material" window or scroll down on the Step 1 page.

- "Extremely easy to use; would be a great tool for modeling various management scenarios."

Usefulness

This tool received an average rating of 3.8 out of 5 for usefulness. Users found this tool useful in comparing general application methods and types of fertilizer. Reviewers had several suggestions for improvement, however, including the following:

- "A possible improvement might be to be able to input one's actual fertilizer costs, or projected increases to make comparisons, a different type of calculator could even provide a way to calculate yield vs. inputs, i.e. whether it is worth it to fully fertilize for high yields in volatile crop price circumstances."
- "This tool provides result numbers but needs to be updated to today's fertilizer costs. At today's cost of over $800.00 per ton the final numbers are not realistic. The results given should have the formulas that were used attached to the results somewhere, so that actual results can be worked out."
- "It would be a very useful tool if the management scenarios under evaluation happened to fall within the limited range of options offered on the calculator. Unfortunately, the limitation was twofold: 1) Only chemical (non organic) forms of nitrogen were considered. Since I farm organically, this obviously limited the usefulness of the calculator. (Admittedly, this is not so

simple when considering organic forms of nitrogen, since the rate at which these become accessible to plants must somehow be accounted for. 2) Only my state's predominant crops were included. If I were growing anything else, as organic producers frequently do, the calculator would have no utility for me at all."

- "Confused on results when comparing alternative practices to current practice. Urea use on cool and warm season pasture – fertilizer cost was more, acreage was same, application rate was one more pound per acre yet results told me cost would be $52.00 less. Not sure how that can be true. Clicked on the help interpreting your results, which is full of good information, but it did not explain how this practice could cost less when the fertilizer cost more and it took more fertilizer to do the job."

Strengths

- "The advantage of having the computer do so much calculation based on a few inputs is obvious. I have done calculations like this on my own and while they are not difficult, involving only simple arithmetic, they are very tedious."
- "Good options on crops, especially breaking out warm/cool season pastures and types of fertilizer."
- "Easy to use and has a nice selection of crops to choose from. Area specific is nice."

Weaknesses

- "Could other sources of nitrogen be figured into this calculator such as using cover crops in the winter for the field cropland, using poultry litter and/or legumes in the pasture/hay field section."
- "Could have window describing timing, placement, and enhanced efficiency options."
- "Unable to input specific prices."
- "The lack of formulas to use to establish personal fertilizer costs. If the tool contained the ability to change costs per ton then it would be very useful."

Tillage Awareness Tool

This tool estimates diesel fuel use and cost in the production of key crops in the user's area and compares energy use between conventional tillage and alternative tillage systems.

User friendliness

The five reviewers who tried this tool gave it an average score of 4.8 out of 5 for user friendliness. None of the reviewers had trouble using this tool.

- "Easy to use, simple input boxes w/ info pop-ups if needed. Easy to identify selection options and click buttons – nice layout."

Usefulness

This tool received an average rating of 2.6 out of 5 for usefulness. Reviewers found the tillage tool only marginally useful, commenting that the calculator does not allow the user to customize information about individual tillage systems, equipment size and time info. It also doesn't take into consideration investments in machinery.

- "Does not explain results or allow changing input #s to compare fuel use, tillage systems, and equipment size and time info."
- "Results are obvious."
- "This calculator only looks at one parameter; there are other issues like price of Roundup, sawflies and investments in machinery that a farmer would need to also consider."

Strengths

- “It can give you a very clear overview of energy savings which I like and it is easy to use.”
- “Simple, the pop-up windows w/ definition or selection info are helpful and nice. The “print” option on the page is nice and useful!”

Weaknesses

- ““Only fuel use and cost of that fuel given – no info related to tillage equipment, time, equipment size, technology (GPS), or other systems. Too many built in system number are used, not enough user selections are used, does not encourage the user to go back and change the numbers to compare expenses and saving. Farmers are smarter than the information level of this program, not impressed.”
- “I was going to say that there are many variables that could influence the costs/savings but then I saw the “disclaimer” on tractor size, soil type, etc.”

Irrigation Awareness Tool

This tool allows users to estimate energy costs of pumping water in the irrigation operations.

User friendliness

The two reviewers who tried this tool gave it an average rating of 4.5 out of 5 for user friendliness. Reviewers found that the irrigation tool had a simple layout and was easy to use.

- “I like the simple layout and category. Data blocks have definitions or links. It asks for first, then list links for my state – nice! Visually simple to locate and use tabs/links.”

Usefulness

This tool received a rating of 2 out of 5 for usefulness. Although user friendly, evaluators didn’t find this tool to be especially useful as it does not allow for much user specificity.

- “It appeared to be fairly accurate and addressed the crops I grow.”
- “It only asked me for six pieces of information, using built in factors for the rest to complete the calculation. My time would have been better spent doing it myself.”

Strengths

- “It addresses vegetable crops.”
- “Definitions and information attachment are very information and useful, good explanations and assistance. Short simple info pages (2). After completing, at the top of the page – item tabs are shown to back up to a previous page to make changes to compare the calculation numbers.”

Weaknesses

- “Some of the pop-up windows did not work.”
- “Did not ask much information – too basic. It should have had a list of info to fill out – inputting what you know and calculations giving a range instead of an exact value – which spread would narrow as more info was inputted. I tried going back and changing some items of the calculations. I do not know what the current electric rat is; a link to another site for prices would have helped.”
- “Does not appear to identify needed water quantities for crops.”

Other Calculators

Savings Calculators for Farms, Wisconsin Public Service Corporation

The Wisconsin Public Service Corporation calculators help the user estimate savings by using energy efficient equipment for specific applications: Tractor Heater Timers, Vacuum Pumps, Ventilation Systems, and Milk Precoolers.

User friendliness

The two growers who tried this tool gave it an average score of 4.5 out of 5 for user friendliness. Users appreciated the simple instructions and detailed information that was easy to use.

Usefulness

This tool received a rating of 4.5 out of 5 for usefulness. As a result of using this calculator, one reviewer intends to add timers to tractors and road vehicles. Another reviewer appreciated that this calculator budgeted capital expenditures with savings in energy costs and added that this is a model that should be more widely used. One evaluator indicated that this calculator was "Overall, one of the most useful I have evaluated to date."

Strengths

- "Very good calculator with the correct balance of supplementary information."
- "Payback calculated in years with installation cost is a great feature."
- "Describes heater types and gives examples of use time savings for various wattages."

Weaknesses

- "Could not match heater size to expected low temp and engine type."

Farm Assessment Toolkit, Wisconsin Focus on Energy

Developed jointly by the University of Wisconsin Extension and Focus on Energy, this on-line toolkit assesses the user's farm energy efficiency, identifies areas for improvement and suggests energy efficient equipment options.

User friendliness

The three reviewers who tried this tool gave it an average score of 4 out of 5 for user friendliness. Reviewers found this calculator generally easy to use. One reviewer acknowledged that the tool provided step-by step instructions; however, he didn't like the login requirement. "I do not appreciate having to find a login for the system. It makes me want to end before I started."

Usefulness

This tool received a rating of 3.25 out of 5 for usefulness. Evaluators found that the Farm Assessment Toolkit was useful as an interactive tool to answer basic energy-related questions, but not particularly useful as a tool for calculating specific energy savings. Reviewers also indicated that the tool was specific to Wisconsin farms; therefore it was not especially useful to farmers located elsewhere.

Strengths

- "I learned a few new facts and came away with a new idea or two, such as the use of IR interior glazing on my poly walls/ceilings, and the use of a horizontal night blanket on my ceilings."
- "The breadth of information was useful."

Weaknesses

- "The login and nearly hidden entry into the system past the verbiage was not user-friendly."
- "I did not care for having to create an "account" and log in. I'm not apt to do that when surfing unless I have a compelling reason to do so."
- "No allowance for size of operation."
- "It didn't actually generate much useful information for me. It was too brief and really didn't yield much of anything."

Average Farm Energy Calculator, Central Iowa Power Cooperative

This calculator allows the producer to input different types of electrical equipment on a farm and provides a typical usage total for comparison, as well as suggestions on how to save energy.

User friendliness

The two reviewers who tried this tool gave it an average score of 3 out of 5 for user friendliness. Users found it fairly easy to input information; however one reviewer was unable to enter energy data for more than one appliance of each kind.

Usefulness

This tool received a rating of 3 out of 5 for usefulness. One user found the tool to have adequate usefulness; another found that the results were confusing and "quite a let down". This evaluator would like more information in terms of cost and recommendations.

Strengths

- "Common categories for Iowa Dairy/Hog farms."

Weaknesses

- "Lack of a true budgetary component."

I-Farm Integrated Crop and Livestock Production and Biomass Planning Tool, Iowa State University

I-FARM is a database-driven farming systems simulation model that predicts economic returns and ecosystem impacts of farm operations, integrating both crop and livestock components.

User friendliness

The five reviewers who tested this tool gave it a rating of 2.6 out of 5 for user friendliness. Reviewers were intimidated by the length of time required to use this tool. The tool provides usage options for inexperienced (5 minute tour), somewhat experienced (30 minute tour), and experienced users. Most evaluators chose the "Inexperienced User" 5 minute tour. One evaluator went through the 30 minute tour and a final evaluator was unable to navigate away from the home page. Reviewers noted that it was not clear where to click on the home page to start using the tool. The reviewer completing the 30 minute tool tried inputting information about his own particular scenario and got stuck modeling the correct machinery for his operation and had to give up at that point.

Usefulness

This tool received an average rating of 3.2 out of 5 for usefulness. The reviewers completing the 5 minute tour found the tool of little use, but the one reviewer who completed the 30 minute tour said, "I believe it is probably an extremely useful tool for anyone with sufficient knowledge to set up a meaningful simulation. The scope of the data and calculations is really amazing!"

Strengths

- "Since it is apparently such a detailed calculator, the 5 minute and 30 minute tours are a good idea. I also lied being able to store scenarios to be able to come back later on and continue working with the calculator."
- "Very technical. Possibly too technical."

Weaknesses

- "Pictures and graphics apparently made it slow to load. This calculator is certainly not for the faint of heart, looking for a few superficial answers!"
- "Its weaknesses were really my own weaknesses: I hadn't sufficient knowledge to make it deliver a meaningful result."
- "It couldn't be used."
- "Time consuming (initially)."
- "The user interface is very confusing and not attractive for use by general farm population. I would like to know if any producers not involved with this program of 'drafted' by it are using this program at all."

Energy Cost Calculator, Penn State

The Energy Cost Calculator is an Excel spreadsheet with two worksheets. By entering the unit price for various fuels, the user can determine the cost per million British thermal units. It also provides the energy content and heat conversion efficiency information for varying fuels. Three farmer evaluators chose to test this calculator.

User friendliness

This tool received a rating of 3 out of 5 for user friendliness. Two reviewers found this tool very easy to use. The usability score was low, however, because one user was unable to access the Excel spreadsheets, due to file size and using a dial-up internet connection.

Usefulness

This tool received a rating of 2.7 out of 5 for usefulness. Users found this calculator marginally useful. One reviewer suggested that listing the fuels from top to bottom in order of costliness might make it more useful.

Strengths

- "Quick way to compare cost of energy sources."
- "Looking at energy sources and the "power" in each is a good methodology to start with."

Weaknesses

- "The file size for dial up is frustrating."
- "Could use a window explaining effects of soil moisture on wood and corn and some insight into the relative cost of devices needed to use different types of fuels."

Biofuels Calculator, Bioenergy West Midlands

This calculator helps the user to assess the potential economic viability of producing biodiesel and oilseed rape oil in farm operations. Three farmer evaluators chose to test this calculator.

User friendliness

This tool received a rating of 2 out of 5 for user friendliness. Reviewers found it confusing and difficult to input data metric units. "Totally lost dealing in litres and hectares."

Usefulness

This tool received a rating of 2.3 out of 5 for usefulness. Two of the reviewers indicated that it would be more useful if it were applicable to gallons and acres. A third user found the tool very useful, however. “This is a great calculator because it integrates the ‘farmer’s option’ that can be compared against 5 other generic options and takes into account capital costs to give a solid comparison. The calculator also does a comprehensive job of comparing opportunity costs of seed and fuel.”

Strengths

- “Side by side comparison of ‘farmer’s option’ input data and other alternatives.”
- “Inclusion of capital costs in comparison.”

Weaknesses

- “The system does not appear geared for U.S. production considerations.”
- “Lack of clarity about seed crushing vs. biodiesel production.”
- “Potential difficulty for people unfamiliar with Excel.”

Farm Energy Audit, Alliant Energy

This calculator from Alliant Energy, a public utility holding company in Madison, Wisconsin, estimates the electric energy use of equipment and appliances that the user operates on-farm.

User friendliness

The three reviewers gave this tool an average rating of 2.7 out of 5 for user friendliness. Evaluators found some of the input terms confusing and technical–sounding. Users indicated that this tool did not provide step-by-step instructions and was not applicable in some cases to their specific operation (i.e. vegetable and flower production).

Usefulness

This tool received a rating of 1.7 out of 5 for usefulness. Reviewers found the tool mainly suited for traditional, high-energy users like large dairy and swine operations.

Strengths

- “It does collect some fairly detailed data for a subset of farm operations.”
- “Good for those with specific enterprises to map out their energy use.”

Weaknesses

- “Geared for higher energy use enterprises and electric customers.”
- “Not much of an overall audit.”

Pumping Energy Calculator, California Agricultural Pumping Efficiency

This tool analyzes the potential cost savings for retrofitted electric-powered water pumps.

User friendliness

The one reviewer who tried this tool gave it a score of 2 out of 5 for user friendliness. The reviewer of this calculator found that some of the various input terms came across as dauntingly technical and confusing, such as “Overall Pumping Plant Efficiency.” The reviewer indicated that incorporated links to “More Information” might make this calculator easier to use.

Usefulness

This tool received a rating of 2 out of 5 for usefulness. This tool was not rated to be very useful as it is not very clear about what constitutes a retrofit. “In general, if I came across this in a search I’d pretty much write it off and look for something else just on the basis that the proposed

alternative is unclear and whatever it is, it's something that the makers of the calculator want to sell you."

Strengths

- "Simple format."

Weaknesses

- "Lack of clarity about proposed alternative."
- "Lack of more information links."

Appendix 2: Calculator Descriptions (by NCAT Staff)

Alliant Energy Farm Energy Audit

Sponsor/Developer: Alliant Energy

URL: http://alliantenergy.com/docs/groups/public/documents/pub/p010003.hcsp

Calculator applies to: Whole-farm electric usage, encompassing dairy equipment, refrigeration, ventilation fans, barn and outdoor lighting, and equipment such as portable heaters.

Input notes: Inputs off your last electric bill, amount and kwh, as well as horsepower of equipment, wattage, and hours used.

Results type: Energy saving measures.

Additional notes:

- Electric use only; limited usefulness in operations outside dairies or poultry houses.
- Very slow to return output.
- You have to be quite aware of the size of your equipment and how much it runs each day to complete this. In that regard it's probably useful for raising awareness from the input side as well as the results, but it also makes it difficult to complete in one sitting, because few people know all these wattages off the top of their head.

Date tested: 12/14/07

Name: **Energy Efficiency Calculators**

Sponsor/Developer: Alliant Energy

URL: http://www.alliantenergy.com/docs/groups/public/documents/pub/p013446.hcsp

Calculator applies to: Residential and small business lighting, heating, cooling, and commercial and industrial air compressors, air conditioning, lighting, and variable frequency drives.

Input notes:

- Inputs are easy and straightforward, primarily size of equipment and hours used, and energy cost per kWh.

Results type: Dollar figure and energy savings from retrofitting energy efficient equipment.

Additional notes:

- Some of these are applicable for farms, particularly shop and barn lighting.
- They are basic, just illustrating potential savings of swapping one technology for another, with no consideration for cost of making the switch or operational savings options.

Date tested: 12/17/07

Name: **Cotton Greenhouse Gas Calculator**

Sponsor/Developer: Institute of Sustainable Research, Queensland University of Technology

URL: http://www.isr.qut.edu.au/tools/index.jsp

Calculator applies to: Greenhouse gas emissions from cotton production in areas of New South Wales and Queensland.

Input notes:

- Select region and locality from topo map with one-click on map choice.
- Enter annual fuel use, land area, and nitrogen fertilizer application in tons per hectare.

Results type: Numeric result in tons of CO_2 per hectare for each activity, as well as pie chart showing fuel use, soil use, and nitrogen application as share of total emissions.

Additional notes:

- Easy to use, but it must make tremendous assumptions about practices to be so easy-input.
- Results are somewhat illuminating, but only show entries relative to each other, not to a typical operation.
- Makes no suggestions for improvement or rating on a chart or anything—just a flat number.

Date tested: 12/20/07

Name: **BEST Winery Tool for Oregon**

Sponsor/Developer: Developed by Lawrence Berkeley National Laboratory, for the California wine industry. The University of Oregon Solar Monitoring Laboratory has adapted it for Oregon.

URL: http://solardat.uoregon.edu/OregonBestWinery.html

Calculator applies to: Helps wine industry professionals track and manage energy and water resources. For wineries that produce most types of wines, with tanks and barrels inside a building.

Input notes:

- Program in Excel. The program and User's Manual are downloaded for use on your own computer. This makes it more challenging to open, but you can save and modify as needed.
- Enter location, then enter annual production volumes of different production steps in the winery. Energy use data, cost data, and water consumption. Wine inventory storage is an optional section.
- An optional input sheet of entries allows you to tailor the production process more specifically to your own operation.

Results type: Energy Intensity Index and Water Intensity-—comparison of your winery to one with the same characteristics but efficient technology, plus calculation of Energy Efficiency Potential and Water Efficiency Potential. Also offers CO_2 emissions reduction potential. Then offers a menu of efficiency improvement opportunities, including descriptions, and with average payback periods.

Additional notes:

- Benchmarking approach compares "intensity" that is defined as energy per unit of output, to provide a standard across all scales of plants.
- This is nicely done and an in-depth model. Its applicability is narrow, though. It's so specific that I need to know something about the industry in order to even run trials of the calculations.
- Has a default or "typical" assumed value, but lets you customize it more if you want it to be more specific to your operation. This must make the programming more complicated, but it makes the tool a lot more useful.
- This is nicely laid out. It's complicated, but color coding and visual separation make it easier to understand.

Date tested: 2/27/08

Name: **Average Farm**

Sponsor/Developer: Central Iowa Power Cooperative

URL: http://www.cipco.org/energyFarm.asp

Calculator applies to: Electrical equipment.

Input notes:

- This looks a lot like the Alliant calculator, but is actually much friendlier to use. It is wider-ranging, encompassing things like tank heaters, welder, yard lighting, as well as dairy equipment, hog housing, poultry equipment and grain dryers.
- Equipment is entered with a simple check on the list. It has an interesting double-entry system that allows the user to input either estimated kwh used, or enter an "assistant" like "number of cows," from which the calculator derives an assumed kwh number. So the calculation can either be based on assumptions or not, depending on how much work the user puts into it.
- The calculator also has you enter a particular month for the specific figures you enter, so comparisons are by month.

Results type: Gives you a numeric average for an operation with the same equipment, and you see if your usage is higher. Links individual equipment names to appropriate spot in a list of energy-saving tips for equipment.

Additional notes:

- This is a well-designed calculator. Input is easy, and scope is fairly wide, though limited to electrical equipment.
- Results are somewhat vague, but given the low-investment inputs, it's hard to imagine how they could be more specific.

Date tested: 12/16/07

Name: **Job and Economic Development Impact (JEDI) Model**

Sponsor/Developer: Wind Powering America

URL: http://www.eere.energy.gov/windandhydro/windpoweringamerica/filter_detail.asp?itemid=707

Calculator applies to: Economic impacts of constructing and operating wind power plants.

Input notes:

- Users enter basic information about a wind project (including the state location, the year of construction, and the size of the facility) to determine project cost (i.e., specific expenditures) and the income (i.e., wages and salary), economic activity, and number of jobs that will accrue to the state (or local region) from the project.
- The program, a largeish Excel file, must be downloaded to run. It contains default information for all fields, with specific defaults for each state. It notes that there's greater accuracy for each default field replaced with project-specific numbers.

Results type: Numeric in spreadsheets.

Additional notes:

- Again, this is geared to large commercial scale, and dwells quite a bit on economic impacts to the community and larger region. It's much less useful for the individual farmer.
- The input and output are both complex and require some familiarity with Excel to navigate.

Date tested: 12/17/07

Name: **Commercial Fertilizer Calculator**

Sponsor/Developer: North Carolina Cooperative Extension

URL: http://www.ces.ncsu.edu/cumberland/fertpage/fertcalc_com2.html

Calculator applies to: Compute the pounds per acre needed of Nitrogen, Phosphorus and Potassium fertilizers.

Input notes: Enter pounds of N, P and K per acre, then percentage of N, P, and K in sources.

Results type: Calculator gives you rate of fertilizer to apply in pounds per acre.

Additional notes:

- This is representative of a number of basic fertilizer calculators offered by Extension and others.
- They are simple, common, and familiar to farmers. Because there are so many of them, it seems that this type of calculator must be in common usage.
- Does not account for alternative sources of nutrients, or provide any context for application practices or environmental effects like water quality, or overall measures of soil quality. Also, these are only indirectly related to energy, in that they are designed to prevent over-fertilization and thus reduce inputs to some extent.

Date tested: 1/6/08

Name: **My Solar Estimator**

Sponsor/Developer: FindSolar.com (American Solar Energy Society and others)

URL: http://www.findsolar.com/index.php?page=rightforme

Calculator applies to: Meant to give an initial idea of price, savings and system size.
Input notes: Input state and county from drop-down boxes, then utility, type of system (pv, solar hot water, pool heating, space heating), then electric bill information.

Results type: Full report with numeric values and text explanations. Spells out assumptions spelled out at the end, with notes on how they affect the figures. Includes payback, estimated system size—including roof area—efficiency estimates, and more.

Additional notes

- This is an easy-to-use calculator, with really understandable results.
- It shows you what you entered, and allows you to change those values and instantly recalculate to get new results.
- Explains how values were derived, and what might be manipulated to make values change.
- Purpose is fairly narrow, and this is primarily residential, but very useful nonetheless.

Date tested: 12/7/07

Name: **Fuel Value Calculator**

Sponsor/Developer: Forest Products Laboratory

URL: www.fpl.fs.fed.us/documnts/techline/fuel_value_calculator.pdf (Instructions)

http://www.fpl.fs.fed.us/tmu/resources/documents/fuel-value-calculator.xls (Calculator download)

Calculator applies to: Standardizes units to compare costs for different fuels per million BTU

Input notes:

- Select current-use fuel from a list and enter your cost per unit.
- The Excel version downloads and opens automatically. No Excel knowledge is needed to use this. (This calculator is also available in hard copy, as a wheel-type gadget.)
- The input list includes quite a few biomass fuel sources: lots of different grades of wood, as well as switchgrass and shelled corn.

Results type: Numeric list of what other fuels would cost for an equivalent amount of energy.

Additional notes:

- Usefulness of this is limited, because it is straight fuel costs across the board, and takes no consideration of equipment or costs of changing fuel.

Date tested: 12/18/07

Name: **Genesis Dairy Farm Energy Savings Calculator**

Sponsor/Developer: Genesis Energy, New Zealand

URL: http://www.dairysavings.co.nz/

Calculator applies to: Dairy electricity. Separate calculators cover water heating, milking systems, and milk chilling. Efficient lighting addressed with text, but not with a calculator.

Input notes:

- Entry boxes for numeric values contain defaults, which makes it easier to use because you have some format for the entry.
- Account information, water heating information are simple to input. Then the financial analysis inputs are more demanding, requiring estimates of electric rates over the next four years and tax rates.
- Allows you to save input information if you want to return later.

Results type: Very detailed results, offering several equipment recommendations and providing installation cost, estimated dollar savings, and simple payback times, as well as detailed financial analysis.

Additional notes: The site consistently links actual audit results with the calculators, which seems to improve the usefulness of both audits and calculators.

Date tested: 12/16/07

Name: **Is a digester right for your farm?**

Sponsor/Developer Engineer Mark Moser, printed in Hoard's Dairyman

URL: http://www.rcmdigesters.com/publications/HoardsDairyman.pdf

Calculator applies to: Scoring sheet to guide farm owners thinking about an anaerobic digester.

Input notes:

- Not interactive, this is simply a score sheet with weighted values for inputs like electric rate, number of cows, reason for wanting to install a digester, and use of depreciation on taxes.
- User inputs appropriate scores and totals, then scores in the good old point range.

Results type: Numeric score correlates with point ranges that predict chance of success as questionable, probable, or best.

Additional notes:

- This is somewhat outside the scope of our comparison, because it's not interactive online, but it represents a niche that most other calculators don't cover: energy generation potential.
- Additionally, the format is worth considering, though not interactive—the scorecard approach is tried and true, familiar for people to use, and simple.
- The scorecard approach is overt. You can instantly see how each input is weighted, and which responses you would need to change to arrive at a different outcome.

Date tested: 1/5/08

Name: **I-Farm integrated crop and livestock production and biomass planning tool**

Sponsor/Developer: Iowa State University

URL: http://i-farmtools.org/

Calculator applies to: Whole farm model and decision tool. Database-driven farming systems simulation model that predicts economic returns and ecosystem impacts of farm operations, integrating both crop and livestock components.

Input notes:

- Includes field selection (aerial) maps for Iowa, Vermont, Pennsylvania and New York, and soils data for 28 states, focusing on upper Midwest.
- "A series of input sets are available in the retrieve-menu that can be loaded in order to avoid time consuming input procedures"
- It offers three tiers of use on first screen: quick tour, 30-minute tour, or extended features including GIS interface.
- The "5-minute tour" requires no inputs; they assign sample farm characteristics. It's a very complicated program, but instructions appear as an overlay to walk you through the particular tier of use you've chosen.

Results type: "Detailed simulation output tables," including energy requirements for field operations at the farm scale.

Additional notes:

- Online program accommodates up to 50 simultaneous users, so nothing to download.
- This is complicated, but they do a very good job walking the user through.
- It's not entirely energy-focused; in fact that's a pretty minor component.
- This is a good example of a program that expands or extends to go as far as the user wants to go. It offers a simple starting point, yet doesn't have to stay simple, which enhances usefulness greatly.

- Probably the greatest disadvantage is that it is geographically limited. Instead of having one program trying to amass enough info to cover the whole country, it would be great to have state-based programs that are smaller, but more relevant.

Date tested: 1/5/08

Name: **Interactive Energy Calculators—Photovoltaic System Economics**

Sponsor/Developer: www.infinitepower.org (Texas State Energy Conservation Office)

URL: http://www.infinitepower.org/calc_pv.htm

Calculator applies to: Simple, "back of the envelope" calculation of PV system economics

Input notes: Fill-in-the-box input, with defaults for some values, and a "?" button adjacent to each box with more information on how to derive input for that value.

Results type: Electric Utility column calculates bottom line of displaced cost, adjacent to bottom line of pv system cost. Footnote boxes allow adjustment for electric rate increase and/or declining value of money over time.

Additional notes:

- Defaults are Texas-based.
- This simple calculator just sizes a PV system based on straight demand load, with no additional considerations. Limited usefulness, but it's good at what it does.

Date tested: 12/18/07

Name: **Interactive Energy Calculators—Solar Water Heating Calculator**

Sponsor/Developer: www.infinitepower.org (Texas State Energy Conservation Office)

URL: http://www.infinitepower.org/calc_water.htm

Calculator applies to: Explore the energy usage of your water heater, and estimate whether a solar water heater could save you money.

Input notes:

- Input characteristics of water heater, then compare gas and electric water heaters to each other and to solar.
- Requires inputs not readily known, like gallons of hot water used per day, ambient water temperature, insulation of tank. Default cost of solar system at $2000.

Results type: Numeric, payback time for solar water heater for specific % of hot water supply.

Additional notes: Residential scale, but a possible model for dairy hot water system calculator. Straight replacement of technology with other technology; no big picture considerations.

Date tested: 12/18/07

Name: **Iowa Wind Assessment Calculator**

Sponsor/Developer: Iowa Energy Center

URL: http://www.energy.iastate.edu/Renewable/wind/windstudy-index.htm

Calculator applies to: Wind turbine output calculator for locations in Iowa, based on wind speed data.

Input notes: Input location, turbine type, size and brand name, tower height and month or annual specification. Also asks for loss factor.

Results type: Numeric wind speed average, air density, capacity factor, and kWh for specified period.

Additional notes:

- Simple and straightforward, somewhat limited by requiring you to already know the manufacturer you're going to use and tower height.
- If you could leave it open and look at the range for comparison, it would be easier than having to go back and plug in one number after another to look at what varying height and brand does to the results.

Date tested: 12/16/07

Name: **Irrigation Operating Cost Calculator**

Sponsor/Developer: Nebraska Public Power District

URL: http://www.nppd.com/My_Business/Irrigation/Additional_Files/cost_calculator.asp

Calculator applies to: A simple comparison of operating costs associated with irrigating using electric, diesel, propane, and natural gas motors.
Input notes: Enter electricity cost, diesel cost, propane cost, and natural gas cost.
Defaults appear in the boxes, so there is some entry basis.

Results type: Operating cost charts; you choose between estimated total season irrigating cost and estimated irrigation costs per bushel.

Additional notes:

- This calculator seems overly simple. This is really just a comparison of swapping one fuel for another, with no efficiency considerations.
- The assumptions make it easy to use, but not truly relevant to an individual user's operation.

Date tested: 2/22/08

Name: **USDA-NRCS Energy Estimator: Animal Housing**

Sponsor/Developer: NRCS

URL: http://ahat.sc.egov.usda.gov/

Calculator applies to: Inform you of the energy cost centers and help you estimate the energy costs for three animal housing operations on your farm or ranch: dairy cows, swine and poultry.

Input notes:

- Zip code and animal type on first screen.
- 2nd screen: Number of confined animals and pounds of milk produced and energy cost per unit.
- 3rd screen: Housing system ventilation and lighting details and milk cooling, water heating, and milk handling inputs. These are presented as inputting type of system, and then answering yes/no questions about conservation practices (like maintenance).

Results type: Your estimated use, estimated cost, and estimated savings if you adopt the very obvious things they asked you if you had on the previous page. No payback estimates, just flat out savings estimates.

Additional notes:

- Dairy cows allows only option of “confined” cows. Poultry housing is “based on a standard broiler house of 40x500 feet”. Calculators are limited by not applying to grass-based dairy or pastured poultry.
- The “do you do maintenance?” questions are too general and overt to be useful additions.
- Options for pre-cooling milk and pre-heating water don’t include alternative or renewable choices—no solar option or alternative cooling.
- This has an implicit acceptance of confinement operations that some will find objectionable.

Date tested: 2/1/08

Name: **USDA-NRCS Energy Estimator: Irrigation**

Sponsor/Developer: NRCS

URL: http://ipat.sc.egov.usda.gov/

Calculator applies to: Enables you to estimate energy cost of pumping water in the irrigation operations on your farm or ranch, based on irrigation methods for predominant crops in your state.
Input notes:

Enter zip code on first screen. Input system type and power source, well lift, system pressure and energy cost. Then answer yes/no questions: Do you use a flow meter, irrigation scheduling, and do regular maintenance and upgrades? Next screen, input crops and acreage, and option of inputting seasonal gross application. (Lots of different crops offered here)
Results type: Dollar value energy costs for use of your system today, and comparison row of costs if you implement the three savings tools they questioned about. Reports savings from any of the three tools you’re already using. Also a comparison column that projects costs if you do a pumping plant evaluation and adjustment (explained in minor detail in a separate screen.)

Additional notes:

- Although you input crops, the results don’t really seem very crop specific. It seems like this could be enhanced by putting your use on a spectrum, or comparing to others growing the same crop, because there’s no real consideration of the actual level of water consumption, aside from the delivery method. It’s just how to make the system operation more efficient to reduce cost.
- Also, recommendation of “install a flow meter” is a little bit of a dead end. Resources just route you to general publications and local NRCS office—not necessarily user friendly for someone who wants to proactively take the next step.

Date tested: 2/1/08

Name: **USDA-NRCS Energy Estimator: Nitrogen**

Sponsor/Developer: NRCS

URL: http://nfat.sc.egov.usda.gov/

Calculator applies to: Calculate the cost of nitrogen product use. Cost estimates based on nitrogen fertilizer management methods for the predominant crops in your state.

Input notes:

- Enter your zip code and fertilizer materials available in your area. Only five fertilizer options to choose from; that limits usability for people who want to practice alternatives, or use manure.

- Next screen, you input your acres of crop, form of nitrogen, pounds of nitrogen applied per acre and dollars per ton cost of nitrogen. Note that in order to use this tool, you have to have already done quite a bit of homework to know what's available.
- Third screen you input timing, placement, and "enhanced efficiency product" from drop-down menus that are fairly restrictive.

Results type: Charts comparing your cost of nitrogen under current practices with alternatives that are possible with materials in your area and improved practices in timing and placement. Results do contain a footnote about sources of free nitrogen, and there's a page of help interpreting results.

Additional notes:

- Emphasis that this is an "awareness tool." Before entry, they direct you to a note that lists all the relevant considerations that aren't considered by this tool. And it stresses that results are estimates. Since this note is optional and delays starting the actual tool, it seems doubtful many users actually read it. Maybe it would be better to have the caveats while you wait for the results to calculate; by then you have something invested, so might be more inclined to read the note.
- By the time you know all the figures needed to input into this calculator, you probably don't need the calculator to know which source is the best value.
- This tool was frustrating to use because it seems too constrained in the alternatives it offers.

Date tested: 1/24/2008

Name: **USDA-NRCS Energy Estimator: Tillage**

Sponsor/Developer: NRCS

URL: http://ecat.sc.egov.usda.gov/

Calculator applies to: Estimates diesel fuel use and costs in the production of key crops in your area and compares potential energy savings between conventional tillage and alternative tillage systems.
Input notes:

Zip code pulls up most common crops for your crop management zone. You are limited to inputting your acreage of those crops. It estimates fuel consumption, then asks you for per gallon fuel cost to calculate savings potential. After results it allows you to enter a different fuel cost to recalculate.

Results type: Provides you a Total Farm Diesel Fuel Consumption Estimate with conventional tillage, mulch-till, and no-till scenarios. After cost, it provides you with total fuel cost per year estimate for all three scenarios.

Additional notes:

- This is simpler than the NRCS nitrogen tool, I think, and easier to use.
- It's somewhat frustrating to be limited to only the very mainstream crops.
- It's nice the way they line up the mulch-till and no-till options for comparison, and even offer definitions of these systems—but there's no further guidance on how one would go about adopting them if one wanted to.
- Assumptions are spelled out very briefly in an optional screen.

Date tested: 2/1/08

Name: **Wind Energy Finance Calculator**

Sponsor/Developer: National Renewable Energy Laboratory

URL: http://analysis.nrel.gov/windfinance/login.asp

Calculator applies to: Calculating costs of electricity from a potential new wind energy power project, based on assumptions of technology, location, and financing. This is primarily utility-scale generation, not on-farm.

Input notes:

- Requires login; will store project information inputs for next visit.
- General assumptions, capital costs, operating expenses, financing, tax and economic assumptions.
- Straightforward design, but not very useful to the individual farmer, and entirely based on assumptions.

Results type: Numerical, with chart of after-tax cash flow over course of numerous years.

Additional notes:

- This is a complicated tool.
- It might be useful to project developers, but they probably hire analysts to do this sort of projection.
- For a layperson considering wind project involvement, this tool probably wouldn't be very helpful.

Date tested: 12/16/07

Name: **Organic Fertilizer Calculator**

Sponsor/Developer: Oregon Tilth and Oregon State University Extension

URL: http://smallfarms.oregonstate.edu/organic-fertilizer-calculator

Calculator applies to: Choose fertilizers that are the most cost effective and that best match your soil and crop requirements. Based on percentages of plant-available nitrogen delivered by different combinations of fertilizer materials.

Input notes:

- Calculator is an Excel file that must be downloaded to use. You would have to have some Excel familiarity to know how to use it; it doesn't walk you through at all.
- The spreadsheet that opens is pretty overwhelming and difficult to figure out at first glance. Once you do, though, it's easy to manipulate values and run many different scenarios to see what might be best. Calculations are instant.

Results type: Numeric.

Additional notes:

- Offers commercial scale, with per-acre calculations, and small-scale, with per-square-foot calculations.
- About thirty commercial fertilizers and fertilizer materials are included, with ability to enter more if you have the fertilizer analysis for them.
- Useful tool if you're computer savvy enough to run it.

Date tested: 12/14/07

Name: **Energy Cost Calculator**

Sponsor/Developer: Penn State

URL: http://energy.cas.psu.edu/costcomparator.html

Calculator applies to: Compares various forms of energy in dollars per million BTUs.

Input notes:

Excel spreadsheet. You enter costs of various forms of energy on the first page, or use their defaults. It includes a column that shows heat conversion efficiency for various fuels. Instant calculations of cost per million BTUs as numbers are entered.

Results type: Numeric in table, plus page 2 of Excel file generates bar chart of results.

Additional notes:

- This is quite similar to the Forest Products Laboratory (FPL) calculator, though it relies on you to supply different current fuel costs, rather than displaying a ceiling cost like the FPL one does.
- Also like the FPL, usefulness is limited even though this is easy to use, because it's not like you can just switch back and forth between fuels without considering equipment costs.

Date tested: 12/18/07

Name: **The Poultryhouse.com Electronic Calculator for Broiler House Minimum Ventilation Fan Timer Settings**

Sponsor/Developer: Alabama Poultry Engineering and Economics

URL: http://www.aces.edu/poultryventilation/documents/MinVentTimerCalculator.pdf

Calculator applies to: Designed to help poultry growers do the best possible job of setting fan timers used in cold weather minimum ventilation.

Input notes:

- This is online as a PDF form that does your calculations for you, but is not saveable.
- Enter CFM capacity of fans you are running.
- Enter total number of birds in house, and per-bird ventilation rate needed. A chart of typical per-bird rates, dependent on age, is included, which offers a helpful default.

Results type: Numeric: number of seconds "on" time for a 5-minute timer.
Additional notes:

- Assumptions and caveats are spelled out clearly on the calculator, in a different color font. The PDF format calculator is workable, but seems cumbersome compared to HTML versions. This is a straightforward calculator, though aimed more at bird health than energy savings.
- Once again, it seems like a calculator has to be this specific to be effective, yet when it is this specific, the potential for energy savings is comparatively small.

Date tested: 2/23/08

Name: **Agriculture Cost Estimator**

Sponsor/Developer: AgWeb, sponsored by Propane Education & Research Council

URL: www.agweb.com/Propane_Calc.aspx

Calculator applies to: Compare the costs of using propane gas to the cost of using other energy sources for grain drying and irrigation pumping.

Input notes:

- Grain Drying: Input percent of moisture to remove, number of bushels, and propane and electricity costs.
- Irrigation pumping: Input dynamic head, pumping rate in gallons per minute, and cost per gallon of propane, diesel and gasoline and natural gas.

Results type: Numeric, cost of each fuel per bushel and in total for number of bushels entered. For irrigation, results in dollar values for various fuels.

Additional notes:

- Very basic; this says it compares propane to other fuels, but electricity is the only comparison on the chart for grain drying. Simply compares the two fuels, with no efficiency considerations or conservation recommendations.
- Not especially useful from an energy-saving viewpoint, and not an especially user-friendly calculator model.

Date tested: 12/20/07

Name: **Pumping Energy Calculator – Pumping Cost Analysis**

Sponsor/Developer: California Agricultural Pumping Efficiency Program

URL: http://www.pumpefficiency.org/Pumptesting/costanalysis.asp

Calculator applies to: Cost analysis for electric-powered pumps.

Input notes: Enter pump details: submersible, well, horsepower, amount pumped, electric rate, then details like flow rate, discharge pressure, pumping water level, and losses.

Results type: Calculator runs a parallel column of figures, showing the change to your inputs after assumed retrofit to pump. Assumptions are explained in some detail. Total savings are also summarized.

Additional notes:

- This is pretty straightforward—some inputs might be more challenging to obtain, but inputting them is simple, and results are clear.
- Application is limited to electric pumps and not placed at all in the context of overall energy use. For example, does improving pump efficiency provide more of a saving than changing tillage or fertilization practices?

Date tested: 1/6/08

Name: **PV Watts**

Sponsor/Developer: National Renewable Energy Laboratory

URL: http://rredc.nrel.gov/solar/calculators/PVWATTS/version2/

Calculator applies to: performance estimates for location-specific grid-connected PV systems.

Input notes:

- Input is done using GIS map and adjusting default numeric values.
- The system is a bit awkward to use, but not especially unfriendly.
- Online instructions are copious.

Results type: Numeric chart, with indication of kWh produced per month, and then figures of cost savings based on input of current electric cost.

Additional notes:

- The program seems more cumbersome than it needs to be for the information it actually delivers—the maps are not easy to navigate and they seem to contribute fairly little to the actual calculation, which would probably be just as accurate from entering your zip code or street address.
- This is a useful tool for someone considering solar, but it seems like it could have a more simple layer for someone mildly interested and then go into detail from there.

Date tested: 12/17/07

Name: **Interactive Renewable Energy Calculator - RECalculator**

Sponsor/Developer: International Energy Agency

URL: http://www.recabs.org/energy_calculator

Calculator applies to: Compares societal costs and benefits of different forms of energy on the large scale.

Input notes:

- This sophisticated calculator works on a very friendly, drag and drop basis, instantly running calculations and re-running output whenever you change variables. It has some baselines for comparison, and then you drag over whatever systems you want to compare, from a side menu.

Results type: Color bar graph.

Additional notes:

- This is on an enormous scale, comparing one fuel to another in terms of cost, discount rate, CO_2, environmental externalities, system integration, security of fuel supply, local benefits.
- It isn't really any value to an individual, and I've included it here primarily because it's such a nice, user-friendly model of output and user interface.

Date tested: 12/17/07

Name: **RETScreen Wind Energy Project Model**

Sponsor/Developer: Natural Resources Canada

URL: http://www.retscreen.net/ang/g_win.php

Calculator applies to: Evaluates energy production, life-cycle costs and greenhouse gas emissions reduction for central-grid, isolated-grid and off-grid wind energy projects, ranging in size from large scale multi-turbine wind farms to small scale single-turbine wind-diesel hybrid systems. Also includes hydro projects, combined heat and power, biomass and solar case studies.

Input notes:

This is an extensive, in-depth system, with training manual, and engineering algorithms for the project available. It's the sort of tool a professional might use in designing a project.

Results type: Extensive data output of spreadsheets, charts and graphs.

Additional notes:

- This is a major, comprehensive program—not really an individual farm energy calculator, even though it's available free online with a lot of support material.

Date tested: 12/16/07

Name: **Energy Use/Costs for Pumping**

Sponsor/Developer: Wateright

URL: http://www.wateright.org/site2/advisories/energy.asp

Calculator applies to: Calculate energy requirements and costs with calculator, then use formulas to estimate electric use for irrigation, estimate fuel requirements for irrigation pumping, and find options for reducing energy cost.

Input notes: Pump flow, total dynamic head (there are instructions for calculating this), plant efficiency, fuel consumption, cost of energy, hours of operation, total pumped per season.

Results type: Numeric, it calculates flow, head, water horsepower, and use and costs for you, with specifics like unit cost of water.

Additional notes:

- Calculator is pretty usable, though not very friendly in tone. The additional formulas on estimating electric use and fuel requirements, and options for reducing cost look very intimidating and mathematical. The language is quite academic, and this definitely seems like it would repel the casual user. This seems a worthwhile tool, but lacking in public appeal.

Date tested: 2/22/08

Name: **Wind Project Calculator**

Sponsor/Developer: Windustry

URL: www.windustry.com/calculator/default.htm

Calculator applies to: Estimate the cash flows for investing in a commercial-scale wind turbine and the rate of return on the cash investments, for up to 20-year period.
Input notes:

Requires free registration to use; not an instant process, requires mailback, login, password creation.

Calculator is for commercial scale projects, though site has information on individual farm-scale wind projects.

Calculator is an Excel spreadsheet with numerous pages to work between. Requires some knowledge of Excel; is extensive and complicated. Generates numerous charts, such as annual revenue, electricity sales revenue, loan payments, annual expenses.

Results type: Numeric and chart.

Additional notes:

- This is very detailed and probably quite useful for what it was designed for, which is community wind projects. It's not the kind of thing an individual landowner would work with to consider paybacks.

Date tested: 12/16/07

Name: **Savings Calculators for Farms**

Sponsor/Developer: Wisconsin Public Service

URL: http://www.wisconsinpublicservice.com/farm/calculators.aspx

Calculator applies to: 4 separate calculators: Tractor heater timers, vacuum pumps, ventilation systems, and milk precoolers.

Input notes:

- Simple and straightforward. Requires knowing your electric rate and equipment sizes and operation time, but pretty basic.
- Somewhat inflexible in entries, seems like more of an educational tool than an aid in knowing what size equipment to install, or a way to test different scenarios.
- For precooler, calculator just shows use of precooler versus no precooler.

Results type: Numeric energy and cost savings and (on some) payback time for energy efficiency steps. Sometimes steps are unspecified, sometimes general background explaining efficiency options.

Additional notes:

- The ones with payback time are helpful. The ones that show energy and cost savings of an "energy-efficient system" without naming the system or exploring its cost are informative but not especially useful in the real world.

Date tested: 12/15/07

Appendix 3: List of Calculators

(Alphabetical by source)

* AgWeb.com — Agriculture Cost Estimator
www.agweb.com/Propane_Calc.aspx

* Alberta Agriculture, Food & Rural Development — AFFIRM V2.0 Software
www.agric.gov.ab.ca/app19/calc/index.jsp?type=Crop

* Alberta Agriculture, Food & Rural Development — Grains, Forage and Straw Nutrient Use
www.agric.gov.ab.ca/app19/calc/index.jsp?type=Crop

* Alliant Energy — Energy Efficiency Calculators
www.alliantenergy.com/docs/groups/public/documents/pub/p013446.hcsp

* Alliant Energy, Farm Energy Audit
http://alliantenergy.com/docs/groups/public/documents/pub/p010003.hcsp

* Bergey Windpower — Small Wind Project Calculator
www.bergey.com/Technical.htm

* BEST Winery Benchmarking and Energy and Water Savings Tool for Oregon
http://solardat.uoregon.edu/OregonBestWinery.html

* Bioenergy West Midlands — Biofuels calculator
www.bioenergywm.org/documents/Biofuels%20Calculator.xls

* Biorealis Systems, Inc. — Anaerobic Digester Calculator
http://biorealis.com/wwwroot/digester_revised.html

* California Biomass Collaborative — Cost of Energy Calculator
http://faculty.engineering.ucdavis.edu/jenkins/CBC/Calculator/index.html

* California Agricultural Pumping Efficiency Program — Pumping Cost Analysis
www.pumpefficiency.org/Pumptesting/costanalysis.asp

* Central Iowa Power Cooperative — Average Farm Energy Calculator
www.cipco.org/energyFarm.asp

* Compare Energy Costs
http://www.oznet.ksu.edu/mil/Tools.htm

* Cornell Cooperative Extension of Lewis County Fuel Use Estimator
http://counties.cce.cornell.edu/franklin/document/doc/price%20of%20fuel%20to%20haul%20manure-1.xls

* C-Plan Carbon Calculator
www.cplan.org.uk/calculator.asp

* EERE — Theoretical Ethanol Yield Calculator
www1.eere.energy.gov/biomass/ethanol_yield_calculator.html

* Findsolar.com — My Solar Estimator
www.findsolar.com/index.php?page=rightforme

* Fuel Cost Online
www.oznet.ksu.edu/mil/Tools.htm

* Genesis Energy — Dairy Energy Calculator
www.dairysavings.co.nz

* Hoard's Dairymen — Is an anaerobic digester right for your farm?
www.rcmdigesters.com/publications/HoardsDairyman.pdf

* Home-Grown Cereals Authority — Bioethanol Greenhouse Gas Calculator
www.hgca.com/content.output/2135/2135/Resources/Tools/Bioethanol%20Greenhouse%20Gas%20Calculator.mspx

* Institute of Sustainable Research — Cotton Greenhouse Gas Calculator
www.isr.qut.edu.au/tools/index.jsp

* Iowa State University Ag Decision Maker — Grain Drying Cost Calculator
www.extension.iastate.edu/agdm/crops/pdf/a1-20.pdf

* Iowa State University Ag Decision Maker — Grain Transportation Costs
www.extension.iastate.edu/agdm/crops/pdf/a3-29.pdf

* Iowa State University — I-Farm
http://i-farmtools.org

* Meridian Energy — How Does Your Farm Dairy Compare?
www.meridianenergy.co.nz/dairy/Default.aspx

* Montana State University — Farm Energy Calculator
www.montana.edu/extensionecon/software/CropMixTillageEnergyPriceBioD.swf

* National Biodiesel Board — Biodiesel emissions reduction calculator
http://www.biodiesel.org/tools/calculator/default.aspx?AspxAutoDetectCookieSupport=1

* National Renewable Energy Laboratory — PV Watts
http://rredc.nrel.gov/solar/calculators/PVWATTS/version2/#directions

* National Renewable Energy Laboratory — Wind Energy Finance Calculator
http://analysis.nrel.gov/windfinance/login.asp

* Nebraska Public Power District — Irrigation Operating Cost Calculator
www.nppd.com/My_Business/Irrigation/Additional_Files/cost_calculator.asp

* Noble Foundation Agricultural Tools — Dry Fertilizer Calculator
www.noble.org/Tools/index.html

* North Carolina State University — Commercial Fertilizer Calculator
www.ces.ncsu.edu/cumberland/fertpage/fertcalc_com2.html

* Ohio State University Agronomic Crops Network — Economic Nitrogen Recommendation Spreadsheet-2007
http://agcrops.osu.edu/fertility/documents/New_Nitrogen_Recommendations_2007_003.xls

* Oregon Tilth and Oregon State University Extension — Fertilizer Calculator
http://smallfarms.oregonstate.edu/organic-fertilizer-calculator

* Penn State — Energy Cost Calculator
http://energy.cas.psu.edu/costcomparator.html

* Poultryhouse.com—Electronic calculator for broiler house minimum ventilation fan timer settings
www.aces.edu/poultryventilation/documents/MinVentTimerCalculator.pdf

* Propane Education and Research Council
www.propanecouncil.org/files/GrainDrying_Instructions.pdf

* Puget Sound Green Fleets Guide — Emissions Calculator
http://psgreenfleets.org/calculate-emissions

* RBC Royal Bank — Online Ag Advisor
www.rbcroyalbank.com/agriculture/agadvisor/

* RECaBS — Interactive Renewable Energy Calculator
www.recabs.org/energy_calculator

* RETScreen International Wind Energy Project Model
www.retscreen.net/ang/g_win.php

* Texas A&M — High Plains (Texas) Cotton Nitrogen Fertilizer Calculator
http://lubbock.tamu.edu/soilfertility/calcinstructions.php

* Texas State Energy Conservation Office — Energy Calculators and Software
www.infinitepower.org/calculators.htm

* Union Gas — CO2 and heating cost calculator
www.uniongas.com/greenhousecalculator/

* University of Idaho Agricultural Economics and Rural Sociology—Machine Cost 1.30 Software
www.ag.uidaho.edu/aers/r_machcost_inst.htm

* University of Kentucky — Energy Calculators
http://ces.ca.uky.edu/energy/calculators.htm

* University of Kentucky — Fuel Price Comparison
http://ces.ca.uky.edu/energy/calculators.htm

* University of Manitoba—Natural Systems Agriculture Fertilizer Replacement Value of Legume Green Manure Crops
www.umanitoba.ca/outreach/naturalagriculture/articles/frv.html

* University of Missouri — NITROMAX
http://agebb.missouri.edu/commag/crops/fert/nitro/intro.htm

* University of Tennessee Institute of Agriculture — Sustainable Dairy Systems software
http://economics.ag.utk.edu/dairy.html

* University of Wisconsin Extension and Focus on Energy — Farm Assessment Toolkit
www.soils.wisc.edu/foe/login

* USDA — Fuel Value Calculator
www.fpl.fs.fed.us/tmu/resources/documents/fuel-value-calculator.xls

* USDA-NRCS — Energy Estimator: Animal Housing
http://ahat.sc.egov.usda.gov

* USDA-NRCS — Energy Estimator: Irrigation
http://ipat.sc.egov.usda.gov

* USDA-NRCS — Energy Estimator: Nitrogen
http://nfat.sc.egov.usda.gov

* USDA-NRCS — Energy Estimator: Tillage
http://ecat.sc.egov.usda.gov

* USDA-NRCS — RUSLE2 Fuel Use Calculator
www.wi.nrcs.usda.gov/technical/consplan/rusle.html

* USDA-NRCS — Energy Self Assessment
http://www.ruralenergy.wisc.edu/

* Wateright — Energy Use/Costs for Pumping
www.wateright.org/site2/advisories/energy.asp

* Wind Powering America — Job and Economic Development Impact (JEDI) Model
www.eere.energy.gov/windandhydro/windpoweringamerica/filter_detail.asp?itemid=707

* Windustry — Wind Project Calculator
www.windustry.com/calculator/default.htm

* Wisconsin Public Service Corporation — Savings Calculators for Farms
www.wisconsinpublicservice.com/farm/calculators.aspx

* Washington State University — Farm Management Resources
www.farm-mgmt.wsu.edu/Software.html

Multiple-calculator Listings

* Alberta Agriculture, Food & Rural Development
www.agric.gov.ab.ca/app19/calc/index.jsp?type=Crop

* Iowa State University Ag Decision Maker
www.extension.iastate.edu/agdm/decisionaidscd.html

* Kansas State University AgManager.info — Decision-Making Tools
www.agmanager.info/farmmgt/machinery/default.asp

* Martindale's Calculators Online Center: Agriculture
www.martindalecenter.com/Calculators1_2_A.html

* USDA-NRCS Tools by Landuse
www.economics.nrcs.usda.gov/technical/tools/index.html