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Web Delivery of a Monte Carlo Simulation Model: The Base and Yield Analyzer Experience

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The provision for producers to update base acres and payment yields in the 2002 farm bill afforded an opportunity to test whether it was feasible to deliver a complex simulation model directly to producers. A Monte Carlo simulation model for assessing the economic impacts of the alternative base and yield options on individual farms was developed and made available to producers via the World Wide Web. The experiences and challenges from this collaborative extension and research effort are described, as well as the issues educators might consider before delivering complex software to a national audience via the Web.

Key Words: base and yield update, 2002 farm bill, Monte Carlo simulation

JEL Classification: C15, D83, Q12, Q16

Economic models that incorporate risk have been used in the agricultural economics profession for more than 20 years. Monte Carlo simulation models have been developed to assist producers in assessing risky decisions. These models are generally of such size and complexity that they do not lend themselves to direct use by producers. For example, Richardson and Nixon documented a whole-farm Monte Carlo simulation model to analyze the economic benefits and costs of alternative risk management and policy alternatives for crop producers. Their simulation model was not easily extended to producers and oftentimes not easily extended to extension educators and other researchers. With growing interest in Web-based and distance education, is there a way to deliver risk-based models to producers for addressing realistic problems?

The primary objective of this article is to describe how a complex Monte Carlo simulation model was successfully delivered to a large and diverse audience of agricultural producers using the World Wide Web (WWW). The Base and Yield Analyzer (BYA), developed by the authors, was made available to producers over the Web and is used as the example described here. Secondary objectives are to discuss our experience with delivery issues and to point out lessons learned so that others may avoid our pitfalls.

Background

The Agricultural and Food Policy Center (AFPC) team analyzed several alternative formulas for updating base acres and yields during the 2002 farmbill debate. AFPC team

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members involved in extension education felt that the base and/or yield update decision being considered by Congress was going to be difficult for producers to figure out on their own. In past instances where commodity policy changes were made requiring producer decisions, extension educators in Texas developed and distributed hand worksheets to producers. The base and yield updating decision that was being discussed by Congress was considerably more complicated than the decisions required by previous commodity program changes. The AFPC analysis team decided that software needed to be developed to assist producers with their base and yield updating decision. The first version of the BYA was programmed in Excel in January before the bill was signed into law in May as the Farm Security and Rural Investment Act of 2002.

The first version of the BYA simulation model was programmed using the base and yield update formulas being debated by Congress in January. The formulas in the final bill changed greatly, so the BYA had to be rewritten. However, much was learned from this early effort. First, producers should consider the risk of countercyclical payments when updating bases and yields. Second, the base and yield updating decision had to be made on a whole-farm basis, not crop by crop. Third, farmers did not have ready access to the county average yields for their crops, which were required if insufficient yield data was available for a farm. Fourth, the Texas county agents did not have Excel, as Quatro Pro was the Texas Cooperative Extension (TCE) spreadsheet of choice. Fifth, and most important, it would be just as easy to program BYA for all states as for Texas.

In March, a second version of BYA was programmed using the base and yield update formulas we thought would be included in the final bill. The second BYA simulation model was programmed in Fortran and incorporated stochastic crop prices drawn from an intertemporal–multivariate empirical distribution as described by Richardson, Klose, and Gray. Stochastic prices were used to simulate the random countercyclical payment rates required to correctly analyze the risk of these payments and the benefits of alternative update options. The biggest problem faced at that time was how to display the results for a stochastic analysis of alternative update options so agricultural producers could rank their risky alternatives.

In mid-March, the authors met with U.S. Department of Agriculture–FSA in Washington, DC, in hopes of securing a contact person that could serve as a check on the BYA software. The BYA software was available on the AFPC server and was accessed and demonstrated to FSA personnel. Based on this meeting, FSA chose to work with AFPC to deliver BYA to their county staff and to have AFPC help in the educational efforts at their national training meeting in June. FSA agreed to provide much-needed county average yields for every crop in every county and to provide updates on rule changes. This partnership turned out to be very beneficial to both parties, as AFPC gained access to FSA professionals who have a long history of administering farm programs and program changes and FSA gained access to a group of economists with expertise in risk modeling and delivering educational programs to producers.

Issues of Delivering BYA

FSA indicated in May that the base and yield update rules would change (not that they may change) before sign-up started. Also, FSA indicated that the rules would likely change even during sign-up. Therefore, any software that was written and released to producers based on the farm bill signed in May would have to be recalled and rereleased a number of times. This information caused us to rule out a hurry-up release of BYA in June, July, or August. Also, FSA's warning caused us to find a way to release the software to farmers and be able to update the program as FSA announced new rule changes. Their warning ruled out our initial plans for mailing compact discs to all of the county agents and extension specialists.

The delivery mechanism we chose was to make BYA available on the AFPC website. The website would allow us to post a new version of BYA as soon as the base and yield update rules changed, it would allow us to monitor who was using BYA, and it would ensure that users in all states had access to the latest version of the software.

Web delivery of a Monte Carlo simulation model programmed in Fortran presented its own set of problems. A Dot.Net delivery system was considered until it was determined that the necessary Dot.Net software for Fortran was not available. This led us to develop a user interface in C++ for the Web screens. The interface used a limited number of screens to obtain information from the user in a systematic method, save the information to an input file, call the BYA model, wait while BYA simulated the economic consequences of the update options for the user's data, capture the BYA output, and present the output for the user. This sounds simple, but it is far from simple. Complicating factors were that BYA had to work for every possible program crop, it had to include a database of county average yields for every crop and county in the United States, and it had to run fast. Additional considerations were that BYA had to report risk results in a farmer-friendly format so the analysis would be beneficial to the user.

BYA On-Line

The BYA simulation model and user interface package went on-line at the AFPC website in late August. Three months had been used to develop and test the user interface between Fortran and the Web server and the potential user. The user interface provided instructions, a user's manual with detailed descriptions of the BYA output, and contact information for users who needed help (Richardson, Outlaw, and Klose). Also, the Web interface proved very useful as a means for informing users of recent changes in the rules governing base and yield updates.

The Web-based delivery mechanism proved most useful when FSA changed the rules for updating the base and yield rules. When the rules changed, we reprogrammed the Fortran simulation model, tested it, and then put it on the server. The next user who ran BYA had the benefit of the updated BYA. A notice of the rule change and the change in BYA was added in a Web screen so producers could check if changes in the rules had been made since their last run. This prevented outdated copies of BYA from being used over and over after they were obsolete.

The Web-based delivery allowed users in all states access to the same software at the same time. During the first month of operation, the user load exceeded the server's capacity and caused the server to crash. This problem was corrected with a backup server and a limit on the number of users who could run BYA at the same time. The new server could handle several hundred users at the same time, so the limit on users was removed.

A drawback to delivering BYA on the AFPC server was that wait time degraded as we neared the end of the semester due to increased student usage of the Web. This phenomena had been observed before and happens each year, but it was not a problem until we had BYA users logged into our server, which was behind the campus firewall.

Lessons Learned

We should have started with a bigger and faster server that could have handled more users at the same time. The BYA simulation run time for doing the calculations and ranking the alternatives was less than 2 seconds. The BYA simulation did not take long. However, it had to be done while processing requests for data and processing other users who were submitting data for analysis. All of these simultaneous demands on the server led to problems that could have been alleviated with a faster processor.

The information technology (IT) staff in AFPC developed the user-interface software and provided the hardware support to deliver the BYA simulation model for analyzing the base and yield update problem. They needed more than 3 months to develop and test the user interface. Given more time, they could have developed a method for users to save their input data on their own computer. This proved to be the greatest drawback or limitation to the system, as users had to re-enter their data to rerun BYA when the rules changed. The Government Payment Calculator, presently available on AFPC's website, has a user interface that allows the users to save their input data for a farm on their computers for subsequent analyses.[1] This feature would have greatly increased the usefulness of BYA. Also, the interface had to be reprogrammed on several occasions when FSA made implementation decisions that had not been considered, such as separating irrigated and nonirrigated yields for the same crop on a farm.

We discovered that all Web browsers do not operate the same. Our IT staff made the BYA interface compatible with Microsoft's Internet Explorer, but it would not function correctly with the Netscape browser or even older versions of Explorer. This wasn't a major issue, but it did require many users to download the latest free version of Internet Explorer before they could utilize the BYA software.

Web delivery proved to be very beneficial for documenting the value of BYA to producers. The system recorded the user's county, crops analyzed, and number of base acres for the farm unit. To insure the usefulness of the data, it was monitored and unreasonable observations were removed. For example, records for users who entered very small (1 or 2) or very large (greater than 5,000) base acres were censored. Reports were developed to show BYA usage by commodity (Table 1) and by state (Table 2).

The majority of the BYA runs were for corn and soybeans, each with over 300,000 runs, with wheat, sorghum, and oat users each having more than 100,000 runs. The number of BYA runs exceeded 1.3 million on a commodity basis, but was only 423,327 in terms of number of farms analyzed because of the diversification of crops on farms (Tables 1 and 2). More than 140 million base acres were analyzed by BYA, and the average number of base acres per farm unit analyzed was 389.

[1] The Web address for a simulation model to calculate the timing of government payments for farms is www.afpc.tamu.edu/announcements/20030923-gpc.php.

Table 1. Base and Yield Analyzer Usage by Commodity, 2002–2003

Commodity/Practice	Number of Runs
Barley	50,835
Canola	5,464
Corn	339,538
Cotton	75,667
Crambe	17
Flaxseed	2,599
Mustard	565
Oats	106,183
Rapeseed	136
Rice	14,697
Safflower	843
Sesame	5
Sorghum	117,561
Soybeans	312,395
Sunflowers	20,768
Wheat	253,078
Sum	1,300,351

Additional information about the users should have been recorded. The user interface should have recorded the expected value for each of the base and yield update options. If this information had been recorded, it would be possible to compare BYA analyses to actual base and yield update practices on a county-by-county basis. Additionally, this expected value information would have provided a means for calculating the overall benefit to each base and yield updating option and the contribution of BYA to the economic well-being of farmers and landowners.

We were interested in how many times users actually ran the simulation model, so the data-gathering mechanism counted runs. This proved useful in recording how many people completed an analysis rather than just accessed the system. It was possible to use BYA just to get the information on the county average yields. Also, many producers accessed BYA to see if changes in the base and yield update rules had changed. Thus, the count on number of runs reflected the number of complete analyses that utilized the BYA simulation model. This is also a much more reliable record of use than reporting the number of hits. The to-

Table 2. Regional Base and Yield Analyzer Usage by Farm Unit, September 2002–June 2003

State	No. of Farm Unit Runs	Base Acres	State	No. of Farm Unit Runs	Base Acres
AL	1,651	674,727	NC	7,694	1,459,737
AR	15,849	8,014,970	ND	13,432	8,258,310
AZ	355	179,959	NE	38,148	10,607,760
CA	904	525,347	NH	5	733
CO	4,042	3,268,770	NJ	707	131,841
CT	81	6,156	NM	597	290,459
DE	581	98,619	NV	115	80,355
FL	204	68,117	NY	333	247,782
GA	4,403	1,251,054	OH	15,181	3,028,250
HI	3	1,763	OK	2,636	1,124,943
IA	34,973	8,336,220	OR	339	408,774
ID	1,332	976,704	PA	1,589	158,907
IL	33,824	7,180,120	RI	1	39
IN	24,289	4,336,440	SC	1,510	418,420
KS	28,809	12,219,380	SD	14,956	7,700,070
KY	3,434	885,753	TN	3,251	746,707
LA	1,463	655,709	TX	54,769	20,909,470
MA	9	1,061	UT	184	114,777
MD	1,411	215,002	VA	4,985	626,049
ME	163	21,584	VT	94	11,878
MI	4,283	1,063,548	WA	2,991	2,287,675
MN	68,362	20,922,200	WI	3,730	845,693
MO	19,264	5,199,300	WV	208	38,074
MS	3,930	2,183,880	WY	240	137,897
MT	2,013	2,350,050	Sum	423,327	140,271,031

tal number of hits exceeded 5,725,000 over the September 2–June 30 period.

When BYA users accessed the system may prove useful for future delivery of software on the Web. The number of hits per hour was lowest between 1 and 6 a.m. (CST) and then steadily increased until 10 a.m., with a decrease between 11 a.m. and 1 p.m., and then returned to the prenoon level by 3 p.m. but declined until 7 p.m. (Figure 1). BYA usage during the evening hours of 7–11 (CST) was surprisingly large. The pattern of hourly usage was the same in the peak month, February, as depicted in Figure 1. The usage over the sign-up period (September—mid-April) also had an interesting pattern (Figure 2). Early usage of BYA was heavy, but as farmers got involved in harvest, the number of runs decreased. Usage increased steadily from October to the peak month in February and then abruptly dropped in March. BYA usage continued through June as producers rechecked their sign-up decisions.

Regional usage is not reflected in the figures depicting hits on the website, but it was observed through phone calls, E-mails, and final run statistics in Table 2. Calls to the BYA help desk indicated that when it was too cold to work outside, many farmers called with BYA questions.

The need for a help desk was something we did not factor into the decision to put the BYA on the Web. More than 2,000 users contacted AFPC by phone, fax, or E-mail with questions about using the software. This is a very small number given that BYA was run more than 420,000 times. However, each contact required 30–60 minutes to walk the user through an analysis or to explain the latest rule changes. Each contact started the same way,

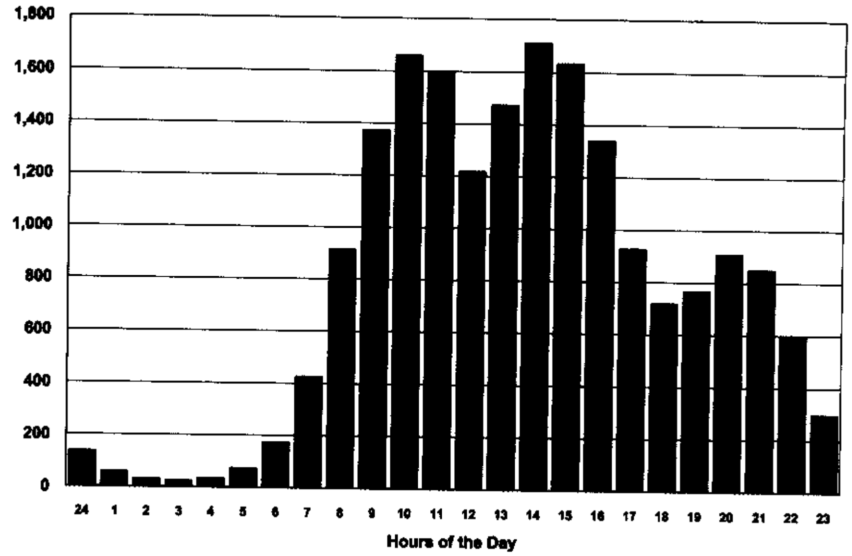

Figure 1.

"I really like BYA! But, there is an error in your BYA calculator. . . ." After each FSA rule change, we had to take each call seriously and reconfirm the rules and assure the caller that they were the one who was a rule change off.

Summary

Despite all the problems and lessons learned, we would do it all over again. The AFPC team learned a few lessons that others considering this type of endeavor may want to take into consideration. First, start early and be proactive, even though it may mean having to start completely over. Making some educated guesses allowed us to get a quick start on the programming so that we were not trying to do it all at once. Second, solicit real partners, not cooperators. It is easy to find colleagues who want to be part of a project they perceive as being important or successful. We were ex-

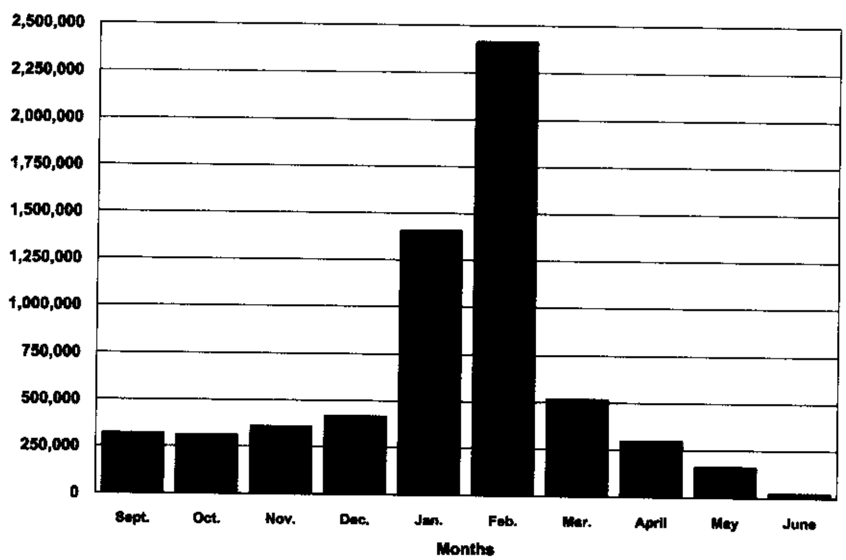

Figure 2.

tremely lucky in teaming with FSA. They had experienced personnel who were receptive to our ideas and provided much-needed data and early warning of rule changes. This relationship made for a real partnership. Third, we should have allowed producers to save their input data. Early on, we agreed to not keep any producer data, which was a big mistake. Allowing users to save their data would have saved them time because of the software updates that were required by the numerous rule changes. Fourth, we missed a real opportunity when we decided not to keep track of user results. We didn't track the benefit gained by the producer for making a more informed decision. And finally, we should have included an online evaluation form, which would have provided sought-after information about the user's opinions of the software and their perception of the benefits of simulating risky crop prices.

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