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Incorporating the 1990 Farm Bill into Farm-Level Decision Models: An Application to Cotton Farms: Comment

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The 1990 Farm Bill introduced planting flexibility options while at the same time imposing slightly different program participation provisions from those of the previous farm bill. An article published by Duffy, Cain, and Young (1993) in this journal presents a methodology to model farm-level decision making and program participation. Their model does not truly represent the set-aside and flex requirements when compared to actual program provisions. This comment addresses those shortcomings and proposes appropriate modifications to the model.

The 1990 Farm Bill provisions related to participation requirements introduced two important changes with respect to the 1985 Farm Bill: (a) set-aside land (ARP) for each program crop is proportionately related to the established program crop base rather than to the participating acreage, and (b) a portion of the crop base (designated normal flex acres) can be planted to any crop without receiving deficiency payments and without altering the crop base in the subsequent year. Similarly, another fixed percentage of the crop base, called optional flex acres, can also be flexed and planted to any crop, but will earn deficiency payments only if planted to the original program crop.

The new program provisions are best illustrated by a simple example. Suppose a farmer has established a crop base of 100 acres and participates in the program for that crop. The farmer has to set

aside 10 acres and may flex 15 acres when the ARP and normal flex ratios are 10 and 15%, respectively. This leaves 90 acres that can be planted to the program crop, of which 75 will earn deficiency payments if the farmer decides to fully participate on all of the crop base. As long as set-aside and flex requirements are met (which are dependent on base acreage), the farmer may choose to plant any amount not exceeding 90 acres. For instance, the farmer may choose to plant only 25 acres to the program crop—all of which would receive deficiency payments. Any other crop may be planted on the remaining portion of the plantable base; however, the farmer would be “considered” to have planted only 60 acres when computing base acres in future years (25 planted + 10 optional flex + 15 normal flex + 10 ARP). The difference of 40 acres (100 – 60) represents the result of partial participation and the farmer’s intention to voluntarily reduce program benefits and future base allocations. In the cases of full participation or no participation, the new and old set-aside requirements are identical. In the case of partial participation under the 1990 Farm Bill, however, the amount of land to be idled is fixed and larger than the amount required by the 1985 Farm Bill provisions.

The Problem

Previous farm program participation rules required complex modeling techniques when farm-level resource allocation and government program participation were modeled using mathematical programming. The 1990 Farm Bill introduced further modeling complexities, mainly because of the two changes noted above, again requiring integer pro-

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gramming methods. The 1993 model developed by Duffy, Cain, and Young was basically an extension of the earlier model presented by Perry et al., except that it included additional constraints to model flex acreage provisions and base expansion limitations. Those additional constraints will work properly if the farmer either participates on the entire base or does not participate at all. However, in the case of partial participation (which will be justified later in our comment), the model will result in a lesser amount of land to be idled and flexed than the amount actually required by the program provisions.

To observe this, consider the equation associated with the ARP3 row in the matrix representation of the Duffy, Cain, and Young model (p. 122). Using their notation, the equation states that

$$ACP3 = arp \times AP3,$$

where $ACP3$ is the land to be idled, arp is the set-aside requirement, and $AP3$ is the total program acres including those planted, set aside, and flexed. The actual program provision must consider $BASE3$ rather than the participating acres ($AP3$) as specified in the model.

Replacing $AP3$ with $BASE3$, however, will not correct the equation. If the farmer chooses not to participate, set-aside land should be zero, whereas the equation would imply that a portion of the base would be set aside. Therefore, neither the above equation nor one replacing $AP3$ with $BASE3$ will correctly represent the actual participation requirement. A proper algebraic formulation must include the binary participation variable $Y3$ in a linear integer programming framework.

The equations given by (NFAT3) and (OFAT3) also are not proper representations of normal and optional flex acreage provisions because of the same reasons. Both the normal flex and optional flex acres must be related to the total crop base, not the participating acreage.

The implications of these equations can be seen by considering the example given above. When the farmer chooses to partially participate on 60 acres of the crop base, the 1990 Farm Bill provisions require 10 acres to be set aside. This leaves 50 acres that can be planted to the program crop, of which 35 acres may receive deficiency payments (60 – 10 set-aside – 15 normal flex). According to the

formulation by Duffy, Cain, and Young, however, the farmer has to set aside six acres, and can plant up to 54 acres, of which 45 may receive deficiency payments (60 – 6 set-aside – 9 normal flex). The set-aside and flex equations therefore will not work properly and need to be modified.

An Appropriate Formulation

A correct and linear formulation of the set-aside provision is provided below:

$$(ARP3) \quad M \times (1 - Y3) + ACP3 \geq arp \times BASE3,$$

where $Y3$ equals 1 if the farmer enrolls in the program and zero otherwise, and M is an arbitrarily specified large number.

To see how the above equation works, consider the case for $Y3 = 0$. When M is large enough, the constraint is satisfied without necessitating positive set-aside, $ACP3 > 0$. Since the set-aside variable appears only in this equation and in the objective function with a negative objective coefficient, the model will always set this variable at its lower bound. Therefore, $ACP3 = 0$ in the optimal solution, and there is no set-aside. Now consider the case for $Y3 = 1$. The first term in the equation vanishes, and the lower bound (also the level) of $ACP3$ becomes the fixed portion of the base that must be idled, as required.

A critical argument here is that the set-aside variable $ACP3$ appears only in equation (ARP3) and the objective function, and a negative objective coefficient is assigned to it. This is not true for the normal flex and optional flex variables, $NFA3$ and $OFA3$, which are revenue items. Therefore, a different approach must be used to model the flex activities.

We use an indirect relationship that ties the flex variables to the set-aside variable, which in turn is correctly related to the crop base variable through the revised set-aside equation. The relationship for normal flex is given below:

$$(NFAT3) \quad NFA3 = nflex \times (ACP3/arp),$$

where $nflex$ is the normal flex parameter. If the farmer does not participate in the government program, the revised equation (ARP3) implies

$ACP3 = 0$, which in turn implies that $NFA3 = 0$, as required. Conversely, if the farmer decides to participate, then $Y3 = 1$, and $ACP3 = arp \times BASE3$, as explained above. When this is substituted into revised equation (NFAT3), we obtain the required result, i.e., $NFA3 = nflex \times BASE3$.

Revised equation (NFAT3) creates a complexity when $arp = 0$, because the division involved in that equation cannot be carried out. This difficulty can be overcome, however, by specifying a very small positive arp value instead of zero. This implies a negligibly small positive set-aside variable that will not have a significant effect on the optimum land allocation. In the case of participation, we have $ACP3 = arp \times BASE3$. When this is substituted into revised equation (NFAT3), the normal flex variable $NFA3$ will again be correctly tied to $BASE3$.

The revised model allows for positive set-aside under nonparticipation, i.e., $ACP3 > 0$, and $Y3 = 0$. Although no set-aside is required in this case, the model may choose $ACP3 > 0$, so that a positive $NFA3$ value might more than compensate for the loss from positive set-aside. However, this will never occur since the model has an alternative activity, namely, nonparticipating crop acreage ($AF3$), which yields the same return as flex ($NFA3$) without incurring a positive cost due to set-aside. Therefore, this anomaly is ruled out.

Another similar consideration is the allowance for excessive set-aside when program participation is chosen, particularly when the arp requirement is zero. In this case, the model may choose an excessive value of set-aside so that flex acres may be increased beyond their permitted level through the use of equation (NFAT3). This may occur because our revised equation (ARP3) is defined as greater than inequality, and the value of flex acres (beyond that legally permitted) may compensate for the additional cost of set-aside. By adding the following constraint, the set-aside variable $ACP3$ is effectively prohibited from exceeding its required level when modeled in tandem with the revised inequality equation (ARP3):

$$(ARP3a) \quad ACP3 \leq arp \times BASE3.$$

Optional flex activities can be modeled in exactly the same way by revising equation (OFAT3) in a parallel fashion to (NFAT3).

One final revision to the Duffy, Cain, and Young model is necessary to correctly compute eligible program acres, $PAC3$, now that set-aside and flex acres have been redefined. Equation (PLIM3) should be rewritten as follows:

$$(PLIM3) \quad AP3 - ACP3 - NFA3 - OFA3 \geq PAC3.$$

The above inequality permits partial program participation when optimal, but limits program acres to those permitted by governmental provisions.

The Case for Partial Participation

Duffy, Cain, and Young may not have found partial program participation to be a viable outcome because strict profit maximization in a linear program would imply either full or zero participation. Because their model indicated full participation to be optimal, their results were not affected by the improper model specifications explained above. However, partial participation may be optimal in some cases, such as nonlinear formulations involving risk in farm-level decision making behavior. If the objective function includes penalties for risky behavior because of risk aversion (Monke), partial program participation may be an optimal solution for resource allocation. Highly risk-averse producers may select a crop rotation which does not utilize the entire allocation of base acres, but instead exchanges program benefits for the risk reduction offered by crop diversification. In this case, crop diversification may be the final risk-management objective or the means to reduce base acreage in future years by participating in the government program with less than full use of their base acreage.

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