The contribution of individual farm simulation programs in ex ante evaluation of agricultural policy measures

Henri Prins and Sjaak Wolfert
LEI, Wageningen UR, P.O. Box 29703, Den Haag, 2502 LS, The Netherlands, henri.prins@wur.nl

***Abstract*—Although many policy reforms – whether they come form the EU or from the national government – aim at a changing behavior of the farmers, the traditional models calculating the effects of those reforms do not explicitly include the decision making of the farmer. In this paper a approach is described in which the farmer and his decision making is put in the center of the model. By running the model over each individual farm from a representative sample, calculating the effects and subsequently aggregating this results to macro level it proves to provide a surprising result. Not only information for the average farm or the totalized result on macro level is available, but also the variance of results between farms in the future situation is given. Like in traditional models, it is very well possible to define and compare the results of different variants.**

I. Introduction

GOVERNMENTS regularly require *ex ante* evaluations of a wide range of intended policy measures. These can be measures due to European CAP reforms or measures at the national level. For these evaluations usually models are applied. Traditional models that forecast the effects of policy changes on farm management are usually based on 1) general macro- or micro-economic laws, 2) LP-models optimizing for profit or 3) simulation models. These kind of models are mostly based on the principle of the farmer as a homo economicus, who tries to reach maximum profit given the external and internal restrictions. However, in reality, economic motives are not the only main incentives for farmer's decision making. Decision-making in reality is a much more interactive and heuristic search process [1]. From the farmers point of view political measures are considered as external developments that may influence strategic and tactic adjustments in farm management [2].

The objective of this paper is to describe an approach that puts the farmer in a central position in this process by simulating the farmers decision making. The approach is explained by means of a case study that has been conducted.

The case discusses the consequences of decoupling the EU-support from the production of starch potatoes within the framework of the Mid Term Review in 2003. In particular modeling of the behavior of the individual farmer in reaction to this specific policy intention.

Henri Prins is with LEI, Part of Wageningen UR, PO-box 29703, 2502 LS The Hague, The Netherlands (e-mail: henri.prins@wur.nl)

Sjaak Wolfert is with LEI, Part of Wageningen UR, PO-box 29703, 2502 LS The Hague, The Netherlands (e-mail: sjaak.wolfert@wur.nl)

II. Case Description

IN 2003 the Dutch Ministry of Agriculture asked to investigate the consequences of the Mid Term Review, and in particular the intended decoupling of the EU-support for starch potatoes [3].

Due to decoupling, the relative gross margins between the different crops change substantially (table I). In case of full decoupling the average gross margin of starch potatoes would fall from 1.785 euro per ha to 1.010 euro per ha. The most competitive crop is cereals with a gross margin of successively 830 euro and 595 euro per ha. Another crop is ware potatoes with an average gross margin of 1.535 euro per ha. This makes it for starch potato growers very attractive to change their cropping plan to the disadvantage of starch potatoes. There are, however, a number of considerations which can make an individual farmer to decide to let his cropping plan unchanged.

The Dutch government, however, was concerned that the possible substantial decrease of starch potato growing would imply some undesirable regional consequences. It would possibly cause a decrease of the supply of raw materials to the starch processing industry, which plays a central role in the regional economy.

TABLE I
AVERAGE GROSS MARGIN OF THE RELEVANT CROPS BEFORE AND AFTER DECOUPLINGOF THE EU-SUPPORT (IN €/HA)

Crop	Before decoupling	After decoupling
Cereals	830	595
Sugar beets	1960	1960
Starch potatoes	1785	1010
Ware potatoes	1535	1535

Therefore the Ministry of Agriculture required a evaluation in which the possible consequences were presented not only of the intended policy of the EU, but also of some alternative plans, such as halving the decoupling of the EU-support for starch potatoes.

III. Method

Giving the farmer a role in the models requires not only agronomic and economic relations but also the farmer's behavior should be modeled explicitly. There are a large number of farmers, who all will react in their own way. Every farmer will choose a solution that fits within his idea how to run his farm under changing circumstances.

The solution a farmer chooses in reaction to policy changes depends – besides the farm structure - on his personal farming style, his personal goals and his personal competences. For example, think of organic versus conventional farmers, growers versus stoppers, bulk producers versus producers of quality products and safe players versus daredevils.

Artificial intelligence methods were used to build a model which can handle the farmers influence on farm measures. Knowledge of experts was included in the model and was used to forecast the measures of individual farmers.

IV. Materials

The dataset used is the Dutch FADN data, a representative sample of 32 starch potato farms. In this dataset are both financial and technical data available. Direct information about the farmer himself however is incomplete. Only information such as age, family situation and additional incomes is available. It is decided to derive the farmer's behavior from the available financial and technical data. The idea behind this decision is that one must be able to say some relevant things about the farmer himself looking at the farm structure, the farm performances and the size of certain inputs. For example, if you see a certain farm grow significantly yearly you can safely assume that the farmer has a growth strategy. Or if a farm has very low inputs for pesticides and fertilizers you can assume the farmer has an environmental friendly attitude. This kind of strategies can be of interest for the measures a farmer will take.

The required expertise about the farmers behavior was derived from three experts. This derivation consists of four steps. The experts were asked (1) to mention some measures on farm level which could be taken in relation to the changed situation, (2) to indicate the conditions, the possibilities and the bottlenecks on farm level to carry out those measures, in other words to chart the field of considerations, (3) to what extend the measure would be implemented on the individual farm and (4) the consequences and possible side-effects of the measure.

V. Verification of Expert Knowledge and Calibration of the Model

After building the model and after implementation of the knowledge in the model it has to be verified. For this purpose farmers were invited to think about possible future policy changes and what their reaction would be. To facilitate the farmer a so called 'game simulation' was built. The game is an interactive simulation model with agronomic input-output relations. Several policies can be added to the model as prior condition for the farm management. It is up to the farmer to find management solutions to solve the problem in a way he would do in reality.

The actual farm data of the invited farmers were put in the game and the farmer can select within a set of measures. After implementing the measure the farmer gets information about the fact if the measures are sufficient to meet the conditions. He also is informed about the effects of the measures, such as income, required labor input and investments. This

TABLE II
Considerations concerning the measure 'Replace starch potatoes by cereals'

Considerations	Expert knowledge
Consideration 1:	*Buying out the delivery contract*
Direction:	Negative: increasing the redemption money makes the measure less likely
Indifference value	€0 (the influence on the decision does not come of if the fee is zero)
Fuzzy-rejection value	€50 per undelivered ton (at this sum the measure would certainly be rejected)
Explanation	At this moment AVEBE claims a redemption sum of about €25 per undelivered ton. Assuming a term of five years this corresponds to €5 per ton. Because of fiscal reasons the influence of his consideration is halved.
Consideration 2:	*Attachment to potato growing*
Direction:	Negative: the more a farmer is attached to potato growing the less he tends to stop it.
Indifference value	50% on a scale of -100% to +100%
Fuzzy-rejection value	100%
Explanation	At a score of 100% the farmer is certainly attached, a score of -100% means he is certainly not attached to potato growing. The attachment is expressed is a figure by taking into account the investments in potato growing, the physic yield and the place of potatoes in the cropping plan.
Consideration 3:	*Labor*
Direction:	Positive: less labor supply means more tending to change crops
Indifference value	0 (no saving means no influence on the decision)
Fuzzy-rejection value	200 (a saving of 200 hours will certainly make the farmer change crops)
Explanation	Cereals require less hours per ha compared to starch potatoes
Consideration 4:	*The estimated financial effect*
Direction:	Positive: The higher the financial profit the more the farmer tends to switch to cereals
Indifference value	1% of farm gross margin of the total farm
Fuzzy-rejection value	9% of farm gross margin of the total farm
Explanation	The decision is strongly influenced by financial effects. The effects are based on the situation on the individual farm. So a farmer who achieves a high gross margin for starch potatoes and a low margin for cereals will hesitate to change crops
Consideration 5:	*Fiscal aspects of changing*
Direction:	Negative: the measure is rejected if the farm size would fall below the 'hard border'
Hard border	100 standard farm units
Explanation	By changing starch potatoes by cereals to economic size of the farm decreases. If this size passes the border 100 standard farm units certain fiscal advantages are cancelled.

information about the consequences of the farmers decisions are presented, so the farmer is able to use it to make adjustments in his tactical or strategic farm management.

The setting in which the game simulations were executed was a workshop with ten participating farmers. The workshop gave opportunity for both individual measures as for group discussion.

The outcomes of the workshops were used to improve the behavior model.

VI. Application for the case study

The experts gave ten different measures on farm level, varying from measures to improve the tactical management to strategic measures like changing the cropping plan and farm enlarging. In this paper one measure is selected to explain the method: 'Replace starch potatoes by cereals'. In the frame (table II) the five considerations belonging to this measure are shown.

The decision model is build on the principals of the IMAGINE tool [4]. It simulates the process of decision making by the farmer by weighing the various considerations on farm level. That may be economic effects (like the considerations 1 and 4 in the case), personal preferences (consideration 2), technical limits (consideration 3), fiscal impacts (consideration 5) or considerations in the field of financing (no. 1). By means of this model the different considerations are mutually balanced, and eventually reduced to the simple go/no go on farm level. In an other module in the model the consequences for farm income, farm production, labor input and even fertilizer inputs are calculated, based on agro technical and economic relations.

The farms joining in the Dutch FADN data are rigorously selected by means of stratified sample methods. Therefore it is very well possible to run the model for all the participating farms and to aggregate the results to regional or national level.

The model has been run for some variants. This variants differ in the percentage in which the decoupling will take place and to what extend the processing industry will be able to compensate the effects of decoupling by paying a better price.

VII. Case results

Table III shows the main results of the study, namely the average changing of the cropping plan under different variants.

The results show how the farmers react on the changed circumstances. Many farms switch to cereals or ware potatoes if the decoupling would be fully implied and if the processing company would not be able to pay a better price for their raw materials, i.e. starch potatoes.

The effect is a halving of the starch potato production. This figure is calculated by aggregation of the representative sample to macro level The consequence of such a decrease would be closing of at least one starch processing unit and the loss of thousands of jobs.

Paying a good price for starch potatoes would prevent a lot of farmers from switching. However, it is doubtful if the situation on the starch market allows a higher price.

Another variant is a 50% decoupling of the EU- support. The model shows only relative small effects for the starch potato production.

VIII. Conclusions and discussion

TABLE III
AVERAGE CROPPING PLAN, STARCH POTATO PRODUCTION AND CHANGING OF NET-PROFIT PER HA ON STARCH POTATO FARMS UNDER DIFFERENT VARIANTS

Variant		Basis	1	2	3	4
Variant description						
Decoupling rate[a]	%	0	100	100	100	50
Market price starch potatoes	cts/kg	Basis	Basis	+0.50	+1.00	Basis
Variant results						
Cereals	%	31	33	32	31	31
Starch potatoes	%	31	14	23	30	29
Seed potatoes	%	6	4	5	6	6
Ware potatoes	%	6	23	14	7	8
Sugar beets	%	17	17	17	17	17
Other crops or fallow	%	9	9	9	9	9
Total starch potato production	mln ton	1.93	0.86	1.43	1.89	1.80
Farm income[b]	€/ha	Basis	+8	+43	+130	-70

[a] decoupling percentage of the EU-support for starch potatoes
[b] compared to the basis variant

T is concluded that full decoupling of the EU-support for starch potatoes would have a lot of negative side-effects. The expected production loss would cost the job for thousands of people in an economic weak region. It would also disturb the market for ware potatoes. Increase of the growing of ware potatoes could imply an extra production of 1 million ton. This is about 2% of the total production in the EU. Considering the fact that in the ware potato market is the supply usually stronger than the demand this extra production could have big negative consequences for ware potato growers all over the EU.

The results of this study was one of the reasons why the Netherlands stood up for a partial decoupling of the EU-support. The discussions and negotiations lead to the outcome that the decoupling is only realized for 40%, which had no significant negative effects on the production of starch production.

This modeling approach has applied several times now, as well for arable as for dairy farms. The results at farm level have been aggregated to regional or national level. An important advantage of the method is that the whole variance of farm structure and farm results stays in sight; they are not leveled out in averages. This makes it possible to report a far more complete and distinctive picture of the future compared to the older methods.

For the future some adaptations in the model are foreseen. The most important one is implementation of secondary

effects on price developments. In this particular case study the reaction of the ware potato price as a result of the increasing production would be an improvement of the method and could provide even more realistic outcomes.

REFERENCES

[1] H. A. Simon, “Administrative behavior - a study of decision-making process in administrative organizations.” The Free Press, New York, 1997.

[2] J. Wolfert, “Sustainable agriculture, how to make it work?, A modeling approach to support management of a mixed ecological farm”, PhD Thesis Wageningen University, Wageningen, The Netherlands, 2002

[3] A. B. Smit and H. Prins, “Gevolgen van invoering van de Mid Term Review voor de akkerbouw in Noordoost-Nederland”, Report 6.03.03, LEI, The Hague, The Netherlands, 2003

[4] W. H. G. J. Hennen, “Detector; knowledge-based systems for dairy farm management support and policy analysis”, Onderzoekverslag 125, LEI, The Hague, The Netherlands, 1995