An analysis of the effectiveness of the set-aside policy of the European Common Agricultural Policy.

by

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Abstract

This paper concentrates on the problem of evaluating the effectiveness of the set-aside policy of the 1992 CAP reform. The reform was initiated with the main goal of reducing output of various agricultural products, especially wheat. The choice given to farmers, through the reform, to join either a rotational or a non-rotational set-aside scheme may create an effectiveness problem. The two schemes are compared by analysing the wheat farmer's decision making together with the associated level of output. The effectiveness of the policy in reducing output would be enhanced if farmers were to choose the scheme that produces the least output. But the nature of the schemes with their different set-aside rates and policy periods is shown to create incentives for farmers to choose the scheme which is less effective in reducing output. With the aim of improving effectiveness, an increase in the non-rotational set-aside rate is shown to be preferable to a decrease in the policy period or the set-aside rate of the rotational scheme. However, diversity of land quality types on farms is also shown to diminish the effectiveness of the policy.

1. Introduction

The major concern in the European Union (EU) since the initiation of the May 1992 reform of the Common Agricultural Policy (CAP) has been the effectiveness of this reform in reducing output. By introducing the mandatory set-aside policy, together with a lowering of the intervention price, output of certain overproduced agricultural goods is expected to decrease. Under this policy the farmer is given the choice between a rotational and a non-rotational set-aside scheme. To join the rotational scheme the farmer has to take 15% of the farm land out of production every year and rotate this over the whole farm for a period of six years. Thus, after six years, 90% of the land will have been set-aside for one year. The non-rotational scheme requires 20% to be set-aside, permanently[1]. This choice between the two schemes creates a potential for undesired outcomes. In particular, when a farmer chooses the scheme which results in relatively more output the effectiveness of the policy is diminished.

The effectiveness of the 1992 reform has been discussed in several papers. This problem is typically raised in the context of "slippage" whereby the proportionate reduction in output is seen to be less then the proportionate reduction in land under crop. Brown (1993) states that due to the heterogeneity of European land, farmers will set-aside poor land permanently increasing average yield and thereby contributing to the slippage effect. Also in Fraser (1994) the problem of slippage connected to varying land quality is discussed especially with reference to the rotational scheme. The effectiveness of the policy was found to be dependent on whether poor land remains in production or is set-aside. Similar results on the size of slippage have been found in an analysis of US commodity programs (Hoag et al., 1993), but set-aside decisions were also found to be dependent on other factors than land quality such as field size, shape and accessibility. In the following discussion heterogeneous land quality has been used as the main factor influencing slippage. Section 2 summarises the model and results from Rygnestad and Fraser (1994) concerning a farmer's choice of scheme under the current regulations. In section 3 the effectiveness of the set-aside policy is discussed initially using the concept of the slippage coefficient but it is found to be more informative to compare total output for the two schemes. Section 4 combines the results of the two previous sections to demonstrate how output is affected if the farmer's choice of scheme is included The last two sections contain a sensitivity analysis of policy parameters and concluding remarks.

2. Model

In Rygnestad and Fraser (1994) a variable input model is outlined in order to analyse a farmer's choice between the set-aside schemes of the EU. Some assumptions are included:

- The farmer's aim is to maximise profit and there is no uncertanty.
- All wheat is sold on the European market at the intervention price (i.e. the intervention price is expected to be constant and always lie above the world market price).
- The farmer is expected to obey the EU regulations in order to receive the set-aside premium and the compensatory payment (i.e. there is no fraud).
- Set-aside land does not bring any profits. Whatever is grown there makes only enough production income to exactly cover the costs associated with cultivating the area.

To obtain the profit function total revenue, R, is derived from three sources: production income from selling wheat on the market, the set-aside premium and the compensatory payment.

$$R = L \cdot (1-\alpha) \cdot w \cdot IP + L \cdot \alpha \cdot w_a \cdot s + L \cdot (1-\alpha) \cdot w_a \cdot k \qquad (1)$$

where

$L =$ area of land (ha)

$\alpha =$ set-aside rate (land taken out of production, %)

$w =$ actual yield (t/ha)

$IP =$ intervention price for wheat (ECU/t)

$w_a =$ average yield (reference yield, t/ha)

$s =$ set-aside premium (ECU/t)

$k =$ compensatory payment (ECU/t)

In the model costs are divided into three parts: fertiliser costs derived from the use of nitrogen fertiliser, VC_F; harvesting costs such as labour, fuel, maintenance and storage, VC_H; and fixed costs, FC, containing all other costs.

$$\text{Total costs} = L \cdot (1-\alpha) \cdot VC_F + L \cdot (1-\alpha) \cdot VC_H \cdot m + L \cdot FC \qquad (2)$$

where

$VC_F = c_F \cdot N^*$

$c_F =$ cost of nitrogen fertiliser (ECU/t)

$N^* =$ optimal use of nitrogen fertiliser (t/ha)

VC_H = harvesting costs (ECU/ha)

m = parameter for land quality (see equation (3))

FC = fixed costs (ECU/ha)

To find the farm yield as well as the optimal use of nitrogen the model incorporates a yield response function given by the Mitscherlich form (Paris, 1992 and Fraser, 1994):

$$w(N) = m\cdot(1-d\cdot e^{-b\cdot N}) \quad (3)$$

For different values of the **m**, **d** and **b** parameters this function gives the relationship between the use of nitrogen, N, and the yield, w. In the response function **m** indicates the quality of the land. The remaining parameters, **d** and **b**, determine the starting-point and the slope of the curve, respectively.

Since the farmer is assumed to be a profit maximiser, the optimal use of nitrogen, N_t^*, can be found by using equations (1) and (2) to construct the yearly profit function, π_t:

$$\pi_t = L\cdot(1-\alpha)\cdot w(N_t)\cdot IP + L\cdot\alpha\cdot w_a\cdot s + L\cdot(1-\alpha)\cdot w_a\cdot k - L\cdot(1-\alpha)\cdot c_F\cdot N_t - L\cdot(1-\alpha)\cdot VC_H\cdot m - L\cdot FC \quad (4)$$

where:

t = 0.. 5 (years)

In the model it is further assumed both that there are constant returns to scale and that the optimal nitrogen decision in one period does not affect the optimal decision in a subsequent period. In other words, there is no carry-over effect of nitrogen from year to year and so the optimal level of nitrogen application is independent of t and the same for all land of the same quality. As a consequence, the farmer tries to maximise by choice of N the net present value, NPV, of the profit over a six year period:

$$\max_{N} \quad NPV = \sum_{t=0}^{5} [\pi /(1+r)^t] \tag{5}$$

where:

r = the discount rate

The first order condition for maximising the NPV of profit is:

$$\delta NPV / \delta N = 0 \tag{6}$$

From the first order condition the optimal nitrogen use is found as a function of the parameters of the yield response function, the cost of nitrogen fertiliser and the intervention price:

$$N^* = -1/b \cdot \ln[c_F/(IP \cdot m \cdot d \cdot b)] \tag{7}$$

The model considers three land qualities with different yields: average land (giving the reference yield), good land and poor land. Table 2.1 shows the yield, optimal nitrogen use, cost-structure, parameter values and NPV ratio for each yield response function used in the model as calculated in previous equations. The **d** parameter is chosen to be equal to 0.9 to allow for a yield of 1.0t/ha on average land when no nitrogen is applied on the field. The **b** parameter is set at 1 and gives the slope of the curve. The price of nitrogen fertiliser is set initially such that there is no difference in NPV between the two set-aside schemes at the average yield (the reference yield=5.08 t/ha). However, in the rotational scheme it is subsequently assumed that in the year following set-aside cropping land requires a reduced amount of nitrogen fertiliser to maintain the same level of yield. The yield response function is changed by decreasing the d parameter in equation (3) from 0.90 to 0.85, 0.83 and 0.87 for average, good and poor land, respectively[2]. On average land this shift of the response curve increases the yield for zero use of nitrogen from 1.0 to 1.5t/ha. This benefit of reduced fertiliser requirement is assumed to be greatest on good quality land, thereby reducing fertiliser use relatively more Table 2.2 shows the nitrogen use in a year with and without the rotational benefit. Note that the effect of this added benefit in the rotational scheme is to make this scheme the preferred choice in a situation of land of average quality[3].

This model was used to analyse the farmer's choice of set-aside scheme. The land quality combinations for which each of the two schemes is preferred are shown in Figure 2. Generally, the rotational scheme is favoured by the effect on profits of keeping more good land in production through a lower set-aside rate and by the effect on profits of lower fertiliser costs associated with rotation; while the non-rotational scheme is favoured by the effect on profits of keeping poor land our of production permanently. As Figure 2 shows, with current policy and parameter values the non-rotational scheme is preferred for the vast majority of land quality combinations.

3. Measuring the effectiveness of the set-aside policy

Most of the literature on measuring the effectiveness of land diversion policies has used the concept of the slippage coefficient. In Gardner (1987) the slippage coefficient was developed as a measure of efficiency and defined as:

$$1 - \frac{\%\ \text{change in output}}{\%\ \text{acreage reduction}} \tag{8}$$

For example, if output decreases by 12% from full production when the acreage reduction is 15%, then the slippage coefficient is calculated as 20%. Factors that induce slippage are: increased productivity on set-aside land when this is brought into production again; setting-aside of poor quality land; farmers choosing to opt-out; and fraud (i e. not obeying the regulations). Note that in this paper increased productivity takes the form of lower fertiliser costs and not higher yield, so that slippage is due entirely to the setting aside of poor quality land.

On homogeneous land the two set-aside schemes are equally efficient at reducing output (i.e. the slippage coefficient is equal to zero). Under the rotational scheme the maximum slippage coefficient is found to be 11.49% when 10% is of the land is of good quality and 90% is poor. The 90% of the land that is rotated under the scheme is of poor quality inducing a relatively small reduction in output compared to the acreage reduction. The non-rotational scheme has higher slippage coefficients under most land quality combinations with a maximum of 50.94% on a farm with 20% poor and 80% good land. As the total set-aside area is of poor land quality, the change of output is at its minimum, resulting in relatively high slippage. However, the slippage of the non-rotational scheme was expected to be higher, and this was the main reason for introducing different set-aside rates in the two schemes (i.e. 15% and 20% in the rotational and the non-rotational scheme, respectively). Consequently, with a higher set-aside rate, the non-rotational scheme may be the more effective of the two schemes in reducing output, even if it is not the more efficient (as defined by the slippage coefficient). Since the aim of the policy is to reduce output, the approach taken in the following discussion is to focus on the change in relative output after the six year policy period for different combinations of land quality as a comparison of the effectiveness of the two schemes in achieving a reduction in output.

For homogeneous average land output is higher in the rotational scheme because the set-aside rate is lower. In comparing farms with an increasing amount of poor land, output under the non-rotational scheme does not differ until poor land represents more than 20% of the total area. Above this level output is lower for the farm where the land in production is more extensively poor. In the rotational scheme, however, output decreases continuously as the proportion of poor land in the rotation increases. Moreover, this difference in production pattern means that the rotational scheme does not always give the highest output. Typically because good land is always kept in production under the non-rotational scheme, at some land quality combinations this scheme produces more output. For example, on a farm with between 15.15% and 43.77% of poor land and any combination of average and good land for the remainder, output under the non-rotational scheme is higher. Figure 3 provides, in detail, for which combinations of land quality output is higher under the rotational scheme (areas **a** and **c**) and those for which output is higher under the non-rotational scheme (area **b**). It shows that, in general, output will be higher under the rotational scheme if land is of relatively homogeneous quality, whereas diversity in land quality typically means output will be higher under the non-rotational scheme with current set-aside policy settings (i.e. 15% rotational and 20% non-rotational)

4. The farmer's choice of scheme and the associated total output

The relative level of output under the two schemes can be combined with the farmer's choice between the schemes to analyse the effectiveness of the policy. To lower total output more effectively it is preferable that a farmer in areas **a** or **c** (see Figure 3) chooses the non-rotational scheme, and that a farmer in area **b** chooses the rotational scheme. Figure 4 combines the farmer's choice as shown in Figure 2 with relative output as shown in Figure 3. Based on Figure 2, areas I and II show where the rotational scheme is the more profitable while areas III, IV and V indicate where the non-rotational option is preferred. Since for the effectiveness of the policy areas I, II and III (equivalent to area **a** in Figure 3) should exhibit a choice of the non-rotational scheme, it follows that the farmer's choice in areas I and II is not conductive to the policy's effectiveness. In area IV (equivalent to area **b** in Figure 3) the non-rotational option is chosen, which again is not consistent with the effectiveness of the policy. Finally, area V (equivalent to area **c** in Figure 3) exhibits a choice by the farmer which supports the effectiveness of the policy. Overall, it can be seen that the effectiveness of the policy is only supported by the farmer's choice of scheme in areas III and V. In particular, the more diverse is land quality on farms (e.g. area IV in Figure 4) the less effective will the policy be in reducing output.

5. Sensitivity analysis of policy parameters

The level of the non-rotational set-aside rate has been set above the rotational rate in order to make the policy as a whole more effective in lowering output[4]. But, as Figure 4 shows, with a non-rotational set-aside rate of 20% the majority of feasible land quality combinations encourage the farmer to choose the less effective scheme for reducing output. However, if the non-rotational rate is increased this effectiveness problem diminishes Figure 5.1 shows the situation with a 25% non-rotational set-aside rate. Area I remains as in Figure 4 while area II has increased slightly, but area IV has decreased significantly[5]. The preferred choice for the farmer also results in less output in area III/V which is considerably larger than in Figure 4 (Areas III and V in Figure 4 represent 33% of feasible land quality combinations, while area III/V in Figure 5.1 represents 82% of feasible land quality combinations).

A further parameter in the set-aside policy is the period of time applying to rotational set-aside As stated in the introduction, in the current policy this period is set at six years. the effects of this setting (see Figure 4) can be compared with the situation where the policy period is reduced to three years (see Figure 5.2). Figure 5.2 shows a marked increase in the area of feasible land quality combinations where the farmer's choice also results in less output (Areas III and V in Figure 5.2 represents 77% of feasible combinations). However, it should be recognised that this increase is due essentially to a decrease in the effectiveness of the rotational scheme relative to the non-rotational scheme. In particular, the reduction in the rotation period means that a greater proportion of good land can be kept permanently in production. Consequently, the change to three years results in an overall increase in the output from the rotational scheme and so area V is considerably larger in this situation (Area

V represents 58% of feasible combinations in Figure 5.2 compared to 21% in Figure 4). Note also that associated with this policy change is an increase in Areas I and II representing an effectiveness-diminishing increase in the proportion of feasible land quality combinations for which the rotational scheme is preferred and gives the higher output.

Finally, as stated in footnote 4, recent ammendments to the set-aside policy have been to reduce the rotational set-aside rate from 15% to 12% and the non-rotational rate to 18% in some cases. The effects of these changes are shown in Figure 5.3. Figure 5.3 shows a marked increase in the area of feasible land quality combinations where the farmer's choice also results in less output (Areas III/V in Figure 5.3 represents 75% of feasible combinations). However, as in Figure 5.2, it should be recognised that this increase is essentially caused by an overall decrease in the effectiveness of the rotational scheme relative to the non-rotational scheme, including an increase in the proportion of feasible land quality combinations for which the rotational scheme is preferred and gives the higher output.

6. Concluding remarks

In conclusion this model indicates that the effectiveness of the set-aside policy is highly dependent both on the relative level of the rotational and non-rotational set-aside rates and on the length of the policy period An increased difference between the set-aside rates in the two schemes achieved by increasing the level of non-rotational set-aside was shown to increase the overall effectiveness of the policy in reducing output. Moreover a similar consequence was observed for a reduction in the policy period or the set-aside rate of the rotational scheme, but this was largely achieved by increasing the output from the rotational scheme in situations where the non-rotational scheme was preferred. Therefore, the results in this paper suggest that an increase in the non-rotational set-aside rate is preferable to a reduction in the policy period or the rotational set-aside rate as a means of increasing the overall effectiveness of the policy.

Clearly the heterogeneity of land quality on farms also has an impact on the effectiveness of the policy, with Figure 4 showing that effectiveness is generally diminished by greater diversity of land quality types on farms. This suggests that the likely success of the reform across farming areas could be analysed if the land quality combinations were recorded for each area. This would be an appropriate next step in utilising this model to analyse empirically the effectiveness of the set-aside policy in the European Union.

7. References

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Footnotes

1 The difference between the rotational and non-rotational set-aside rates may be varied from region to region to ensure no discrimination (Agra Europe, 1992). Also the number of years required in this scheme is under discussion. Suggestions of 5 years have been made (Agra Europe, 1993).

2 Benefits from joining the rotational scheme could also appear through increased yield for constant nitrogen in subsequent years. This effect can be introduced by changing the other parameters (m and/or b) in the yield function. For illustrative purposes the benefit has been specified through lower fertiliser costs.

3 Note aslo that optimal yield is independent of the value of **d**. This can be seen by substituting the expression for optimal N in equation (7) into the yield function in equation (3).

4 Conflicting goals within the CAP has lead to a reduction of the non-rotational set-aside rate to 18% in some cases (Agra Europe 1993). This has been allowed in nitrate sensitive areas where fertiliser restrictions already exist. Thus, production is kept down by other means. A larger efficiency problem is that the set-aside rate also is lowered in areas where more than 13% of the base area has been set-aside. Both these exemptions have been bargaining points in the CAP reform negotiations. Also, during the Council meeting in October this year (1994) the farm ministers decided to reduce the rotational set-aside rate from 15% to 12% (European AgriBusiness, 1994).

5 With a larger non-rotational rate, the farmer finds it more profitable to include poor and average quality land in a rotation for slightly more homogeneously good land combinations.

Table 2.1: Yield, input, cost-structure response functions and NPV ratios for the three land qualities

	Unit	Average land	Good land	Poor land
Yield, $w(N^*)$ ▪	t/ha	5.08	7.08	3.08
N^*	t/ha	0.6043	0.7866	0.3811
c_F	ECU/t	491.82	491.82	491.82
VC_F	ECU/ha	297.20	386.87	187.45
Harvesting costs	ECU/ha	150	180	120
FC	ECU/ha	250	250	250
Total costs	ECU/ha	697 2	816.87	557.45
m		10	12	8
d		0.90	0.90	0.90
b		1	1	1
NPV (R)/ NPV (NR)		1	1.0113	0.9875

R - Rotational set-aside scheme NR - Non-rotatonal set-aside scheme

▪ Yield response function : $w(N^*) = m\cdot(1-d\cdot e^{-b\cdot N^*})$

Other data used in the analysis: IP = 100 ECU/t

k = 45 ECU/t

s = 57 ECU/t

r = 8%

Table 2.2: Nitrogen use in a year with and without the rotational benefit and NPV ratios for all three land qualities.

	Yield each year	Nitrogen use without benefit	Nitrogen use with benefit •	NPV (R)/ NPV (NR)
Average land	5.08	0.6043	0.5471 (-9.46%)	1.0116
Good land	7.08	0.7866	0.7056 (-10.29%)	1.0248
Poor land	3.08	0.3811	0.3472 (-8.89%)	0.9958

R - Rotational set-aside scheme NR - Non-rotatonal set-aside scheme

Unit = t/ha

Numbers in brackets show the change in nitrogen use.

• Only on land that has been set-aside the previous year.

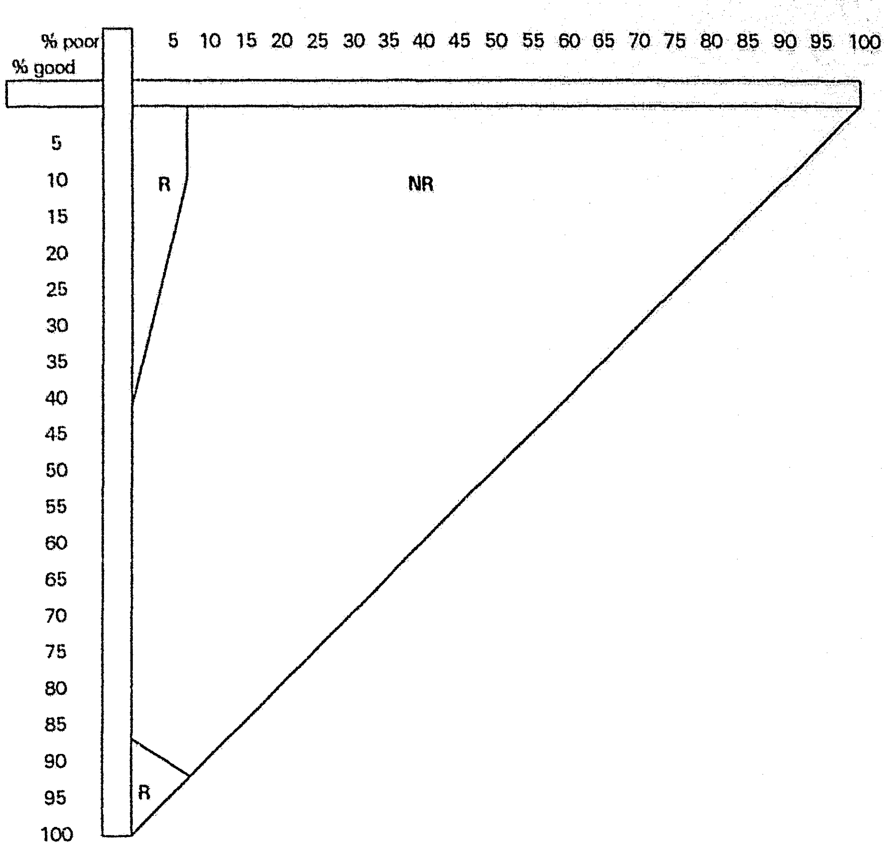

Figure 2: The preferred set-aside scheme for different combinations of land quality, and for reduced fertiliser costs associated with rotating set-aside land.

Note: The rest of the land is of average quality

R - The rotational scheme is preferred

NR - The non-rotational scheme is preferred

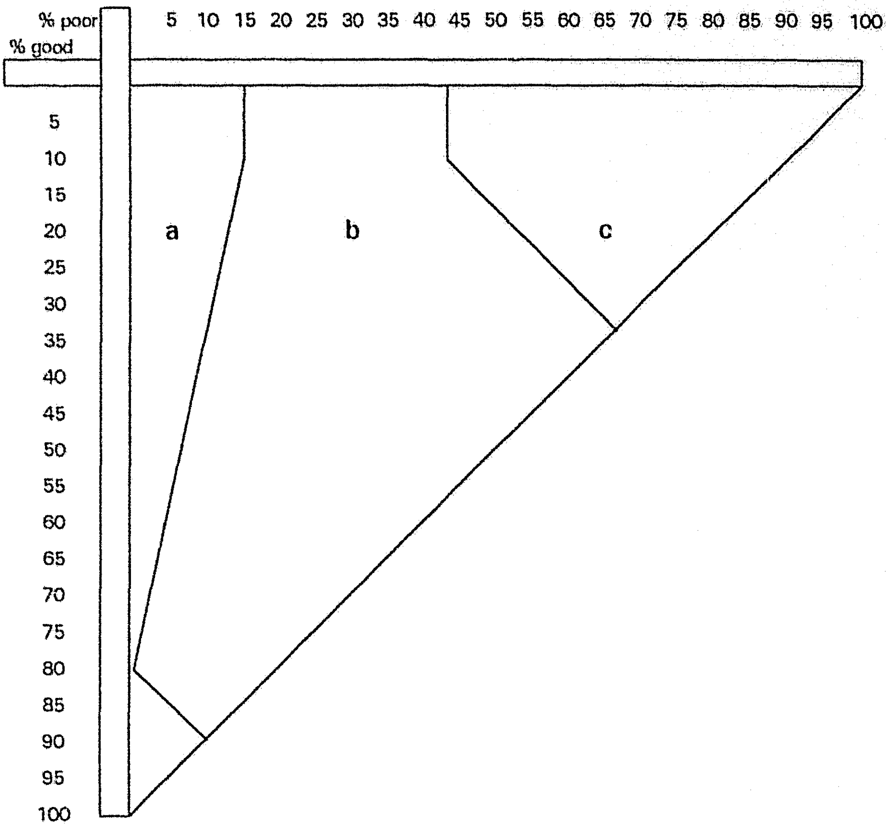

Figure 3: Difference in output between the rotational and non-rotational set-aside scheme after six years.

Note: The rest of the land is average quality

a and c - Output in the rotational scheme is higher

b - Output in the non-rotational scheme is higher

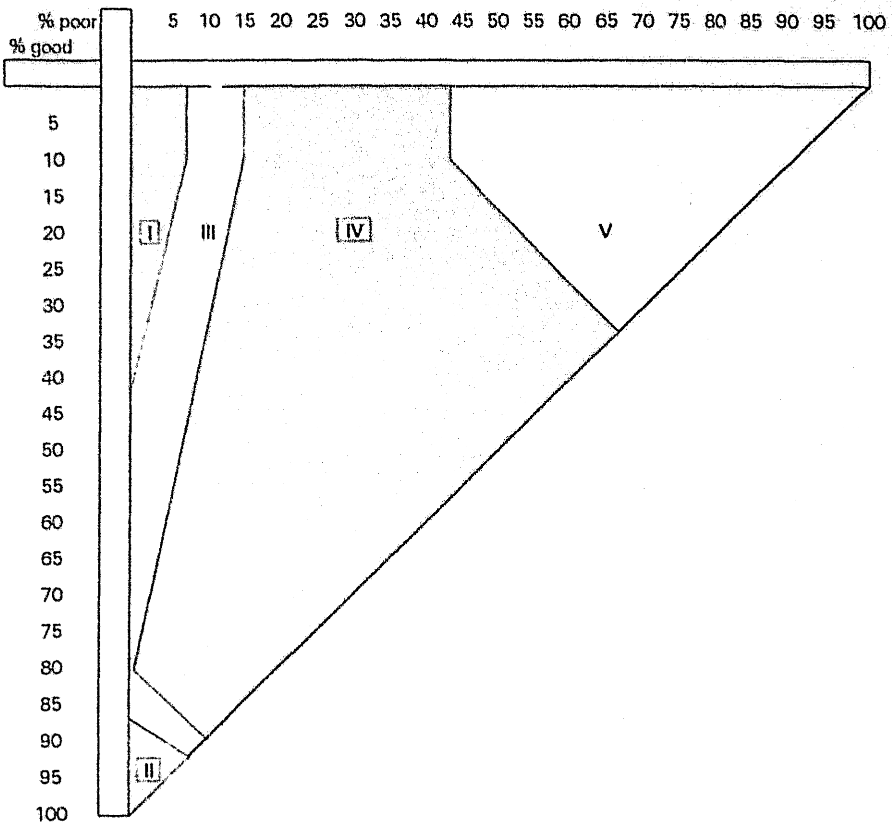

Figure 4: Difference in output between the rotational and non-rotational set-aside scheme after six years including the farmer's choice.

Note: The rest of the land is average quality

I and II - The rotational scheme is preferred and gives the higher output

III - The non-rotational scheme is preferred and the rotational scheme gives the higher output

IV - The non-rotational scheme is preferred and gives the higher output

V - The non-rotational scheme is preferred and the rotational scheme gives the higher output

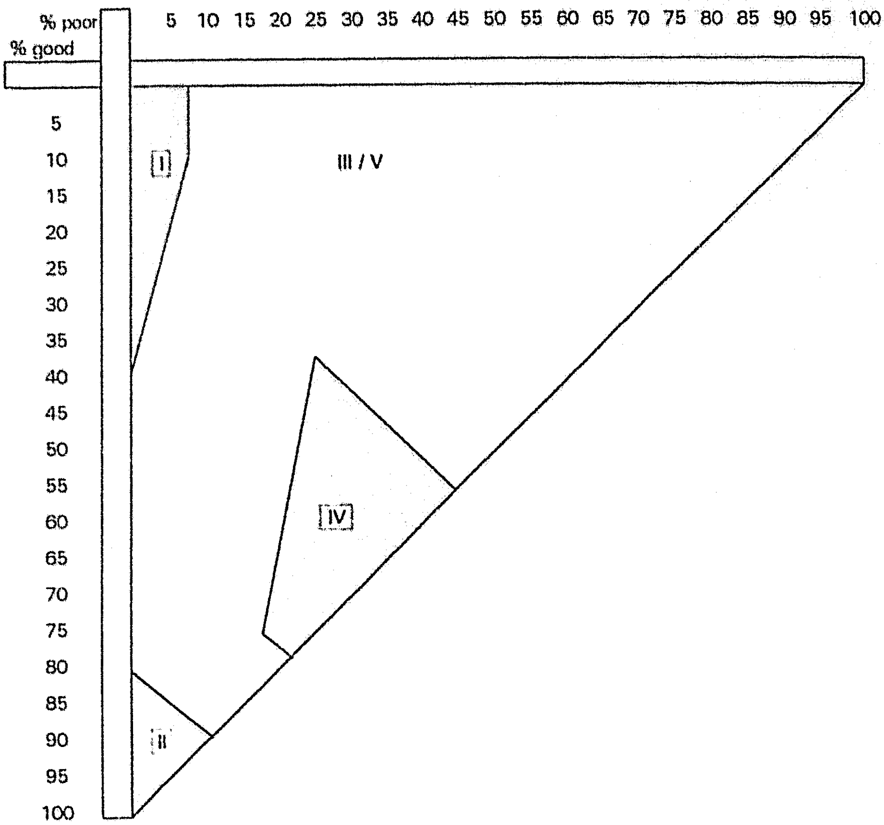

Figure 5.1: Difference in output between the rotational and non-rotational scheme with an 25% set-aside rate after six years including the farmer's choice.

Note: The rest of the land is average quality

I and II - The rotational scheme is preferred and gives the higher output

III/V - The non-rotational scheme is preferred and the rotational scheme gives the higher output

IV - The non-rotational scheme is preferred and gives the higher output

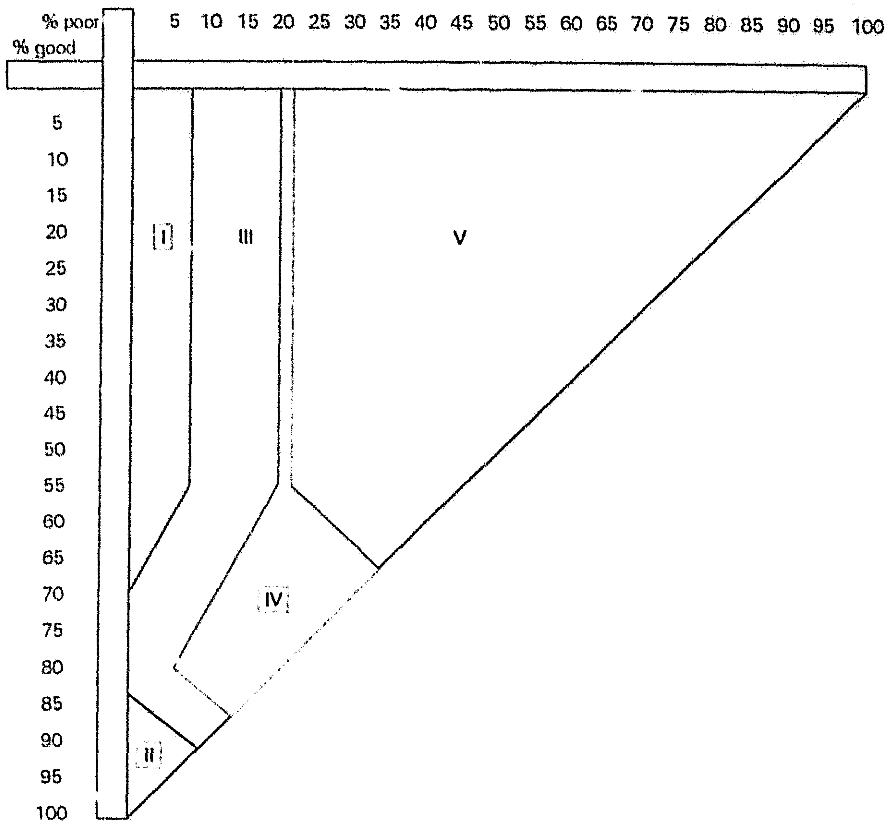

Figure 5.2: Difference in output between the rotational and non-rotational scheme set-aside scheme with a three year policy period including the farmer's choice.

Note: The rest of the land is average quality

I and II - The rotational scheme is preferred and gives the higher output

III - The non-rotational scheme is preferred and the rotational scheme gives the higher output

IV - The non-rotational scheme is preferred and gives the higher output

V - The non-rotational scheme is preferred and the rotational scheme gives the higher output

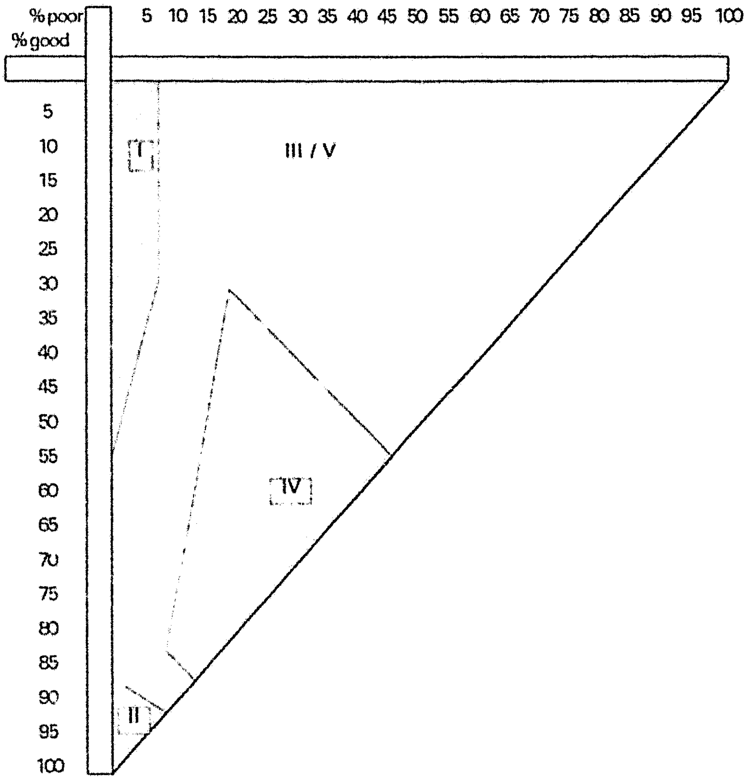

Figure 5.3: Difference in output between the rotational and non-rotational scheme with a 18% non-rotational set-aside rate and a 12% rotational set-aside rate after six years including the farmer's choice.

Note: The rest of the land is average quality

I and II - The rotational scheme is preferred and gives the higher output

III/V - The non-rotational scheme is preferred and the rotational scheme gives the higher output

IV - The non-rotational scheme is preferred and gives the higher output