ECOLOGICAL EFFECTS OF PAYMENT DECOUPLING IN A CASE STUDY REGION IN GERMANY

Sandra Uthes, Claudia Sattler, Franz-Josef Reinhardt, Annette Piorr, Peter Zander,*
Leibniz-Centre for Agricultural Landscape Research (ZALF), Eberswalder Straße 84, D-14374 Müncheberg, Germany.
Email: Uthes@zalf.de

Kathrin Happe, Martin Damgaard, Amanda Osuch
Leibniz-Institute of Agricultural Development in Central and Eastern Europe (IAMO), Theodor-Lieser-Straße 2 D-06114 Halle, Germany)

Abstract

The paper explores the ecological effects of a policy change from coupled direct payments to decoupled single farm payments in a case study region in Germany. Since decoupling is expected to affect agricultural production and trade, both statically with respect to the incentive prices of agricultural inputs or outputs, and dynamically with respect to their investment decisions, we have developed a modelling approach that is built on two micro-economic models – AgriPoliS (agent-based) and MODAM (linear programming + fuzzy-logic-based environmental impact assessment). The model linking makes it possible to analyse dynamically both structural change of the farming sector and agricultural-management-related environmental impacts. Our analysis comes to ambiguous results. In comparison to Agenda 2000, payment decoupling leads to greater land abandonment and reduced stocking numbers, especially in the beef sector. On arable land, the trend goes towards intensification, while on grassland cross-compliance leads to a more extensive agricultural management.

Keywords: *payment decoupling, environmental impact assessment, indicators*

Introduction

Agricultural intensification, over-production and export dumping in Europe as induced by the old CAP have long been viewed critical. The old CAP (Agenda 2000 and before) had been designed to insulate producers from fluctuations in market prices and raise farm household incomes with negative impacts on developing countries and on the environment. As a result of this objective, producers of certain farm commodities were subsidized with payments linked to commodity prices and production levels. In responding to the distorted market signals, farmers produced a different mix of commodities than they would with no market distortions. In June 2003 a new CAP has been adopted due to stronger interest in market liberalization and obligations under multilateral trade agreements. An important element of this latest reform besides market measures (mainly confined to the cereals sector) and a strengthening of the second pillar - is to “decouple” farm income support from prices or production. Decoupled payments are implemented as lump-sum payments either per acre or per farm, based on historical plantings of program crops and yields. The objective of decoupled payments which are linked to the respect of basic environmental, food safety and animal welfare standards is to gear the CAP more towards consumers and taxpayers, while at the same time removing market distorting signals (OECD 2001).

Existing studies come to the conclusion that payment decoupling in general will have positive impacts on the environment. The expected positive environmental benefit arises because decoupling should lead farmers to more extensive production, thus reducing pressure on natural resources. decoupling may have positive impacts on biodiversity and soils but less high impacts in terms of landscape, water and climate change and air quality DEFRA (2002). According to Donnellan and Hanrahan (2003), the policy change will lead to a substantial reduction in the contribution made by agriculture to greenhouse gas emissions mainly due to lower total stock numbers. To meet the non-rotational set aside requirement to receive the payments, Farmers are expected to take their least productive (or higher cost) land out of production which should also be accompanied by positive environmental effects (CRER 2003).

In this paper, we analyse the environmental effects of payment decoupling by looking at a case study region in eastern Germany (Ostprignitz-Ruppin, abbreviated OPR). The paper is organized as follows. In the section 2, we introduce our case study region, followed by the description of the modelling approach and model settings of the two scenarios BAS, which simulates an assumed continuation of the Agenda 2000 policy, and REF, which simulates a policy change from Agenda 2000 to decoupled single farm payments. In section 3, we present the outcomes of both scenarios with respect to structural change and agricultural land use. The discussion in section 4 is organized along three questions: Firstly, does a decoupling of direct payments lead to more extensive production in the considered region? Second, do the farms abandon agricultural land in marginal areas? And third, what are the ecological effects in the areas that remain in production? In the conclusions, we come to a closing overall evaluation by summarizing key findings.

Methods

Case study region

The case study region Ostprignitz-Ruppin (OPR) covers about 2510 km² and is situated in northeastern Germany in the federal state of Brandenburg, Germany. OPR is sparsely populated (43 inhabitants per km²) and dominated by agricultural land use. About 35 % of the total area are arable land and almost 14 % are meadows and pastures. Especially the southern part of the region is rich in grassland, while the northern part is characterised by a high share of forests and woodland. The overall landscape structure is versatile including water bodies, heath land and swamp areas. In 2003, the region's agricultural land was under the management of overall 585 farms. The land provides rather disadvantageous conditions for crop production due to the sandy soils and the low yearly precipitation, which amounts to only 520 mm per year on average. Although 60 % of the farms in the region are smaller than 50 ha the average farm size of 200 ha is well above the average farm size of 24 ha in western Germany (MLUV 2006).

Modelling approach

The modelling approach constitutes of two models: AgriPoliS (Agricultural Policy Simulator) and MODAM (Multi-Objective Decision Support Tool for Agro-ecosystem Management).
The spatial and dynamic agent-based model ***AgriPoliS*** simulates the future structural development of farms based on economic considerations (cf. Happe et al. 2006). To accomplish this task each farm is represented by an individually acting agent that acts and interacts within an environment consisting of other farms, factor and product markets, and space. Farm activities encompass land use and production decisions, rental activities, labour allocation decisions, and investments. The entire system is embedded within the overall economic, political, and technological framework conditions. During the simulation, a farm develops endogenously. It can change its characteristics such as size, labour endowment, specialisation and production activities in response to changes in its environment influenced by the technological and political settings. Thus, some farms will thrive and continue farming from one period to the next others may exit depending on alternative options for using their resources. Farms exit if their profits are below the opportunity costs or if the farm becomes illiquid. The spatial component of AgriPoliS is grid-based and considers each individual plot as a standardised spatial entity (cell) of a specific size (1 ha). Cells can represent different land characteristics. For OPR, we consider arable land of

three qualities (SRI[1] 25 - very low yield potential; SRI 38 - low yield potential; SRI 50 - medium yield potential) and two types of grassland (extensive and intensive). The plots can be owned or rented by the farms. Depending on data availability, the spatial grid can be initialised based on soil maps. Alternatively, space can represent key spatial statistics. The representation of farms in the case study region in the model is based on FADN data. Farms are allocated on the spatial grid based on farm characteristics (Kjeldsen et al. 2006). AgriPoliS is simulated for 15 time periods starting in with the base year 2001 The policy change from Agenda 2000 (BAS) to decoupled payments (REF) sets in after three periods (see Table 5 for the policy settings in the two scenarios). In period 5 and 9, respectively, the current structural characteristics of individual farms with respect to farmed arable and grassland, labour input, animals kept and crops grown, etc. are passed on to MODAM for a detailed simulation of the land use related environmental impacts.

Table 5: Policy settings

Scenario	*Policy settings*
BAS	Agenda 2000 crop and livestock specific premiums set aside minimum (10 %) and maximum constraints (33 %)
REF	Decoupled single farm payment no crop or livestock specific premiums only minimum set aside constraints single farm payment based on historical payments under Agenda 2000 minimum care 6n grassland obligatory to get the premium

The spatial linear programming model ***MODAM*** (Zander 2003, Zander and Kächele 1999) has been developed for the analysis of relations between economic and ecological objectives in agricultural land use. MODAM is based on a highly disaggregated region-specific variety of production alternatives for agricultural crop, fodder and livestock production. Based on the economically and ecologically evaluated production alternatives linear programming models are generated that maximize the decision unit's economic performance (either farm or region). MODAM's plant production consists of cropping practices, a cropping practice being the sum of all single work steps that are necessary to grow a certain crop with an expected yield level on a specific site-type. The ecological evaluation in MODAM is indicator-based and makes use of a fuzzy-logic-based assessment approach. The approach is based on expert knowledge and data gained from literature reviews (cf. Sattler et al. 2006). Fuzzy-logic is a concept derived from classical set theory and binary or two-valued logic that has been introduced by Zadeh (1965) and (1994). Fuzzy-logic is a suitable concept when only uncertain information and imprecise data are available, which is often true regarding the knowledge we have about how different forms of agricultural land use affect the abiotic and biotic environment.

The assessment makes use of rule-based algorithms and can be run with comparatively fewer data than process-orientated models. Fuzzy-logic has been used in quite a number of studies dealing with environmental impact assessment, for instance to model soil erosion (Mitra et al. 1998), to calculate nitrate leaching (Mertens and Huwe 2002), to evaluate pesticide use options (Werf and Zimmer 1996), to assess the marginality of agricultural land use (Cassel-Gintz et al. 1997). The model development for the fuzzy-based environmental impact assessment follows a cyclic procedure. In a first step, a prototype model is elaborated based on literature studies and expert questioning, using the method of rapid prototyping (Gottlob et al. 1990). Relevant influencing factors are identified and the inter-dependencies are defined using if-then-conditions. The prototype development is followed by an adaptation and refinement procedure of the assessment modules through expert validation (Reus et al. 2002).

[1] Soil Rating Index

Result of the assessment is a one-dimensional site-specific index value, the Index of Goal Attainment (IGA), ranging between zero and one. The term 'goal attainment' refers to indicator-related goal definitions, such as 'prevention of nitrate leaching' or 'enhancement of habitat quality for skylarks'. IGAs are calculated for each cropping practice in MODAM. The closer the index value is to one the higher is the assessed suitability of a certain production practice to contribute to goal attainment. For OPR, up to now assessment modules for five abiotic and five biotic indicators have been implemented (see Table 6).

Table 6: Overview on indicators and related environmental goals

	Abbrev.	*Environmental goal/**Indicator***
abiotic	NO3	Lower risk of **nitrate leaching** to groundwater
	NP	Lower risk of **nutrient (N/P) entries** into surface waters
	Pest	Lower risk of **pesticide entries** into ground- and surface waters
	GWR	Improve potential for **groundwater recharge**/proliferation
	WaEro	Lower risk of **water erosion**
biotic	Amph	Improve habitat potential for **red belly toad** (amphibians)
	Sky	Improve habitat potential for **skylarks** (field breeding bird)
	Hare	Improve habitat potential for **field hares** (mammal)
	Hover	Improve habitat potential for **hover flies** (beneficial insect)
	Flora	Improve habitat potential for **wild flora species** (fall germinating)

Results

Structural change in OPR

Table 7 gives an overview on the structural development of the farms in the region for the respective scenario and time step, starting from an initial number of 585 farms in BAS00. The scenario name is composed of the scenario itself and the respective time step, period 5 reflecting the short-term effects two years after the policy change, and period 9 reflecting rather long-term effects. Both scenarios cannot slow down overall structural change. The number of farms decreases considerably both in the short and in the long-term, while at the same time average farm size increases. Comparing both policies, the effect is more pronounced in the baseline scenario, while under decoupling comparatively more farms stay in the sector.

Table 7: Regional characteristics by scenario

	BAS00	*BAS05*	*REF05*	*BAS09*	*REF09*
UAA [ha]	120,957	115,577	110,561	113,498	98,715
Arable land [ha]	88,506	88,506	85,562	88,475	80,491
Grassland [ha]	32,417	23,793	24,999	20,679	18,224
Number of farms [n]	585	331	407	227	286
Average farm size [ha]	206	349	271	499	345
Farms per category [n]:					
Arable	99	127	309	121	206
Cattle	357	112	-	37	-
Dairy	72	54	60	41	53
Mixed	49	27	9	18	6
Pigs	8	11	29	10	21
Animals kept [n]:				r	
Dairy cows	12,066	8,765	12,766	8,077	12,379
Suckler cows	16,623	2,962	0	2,848	0
Beef cattle	16,196	4,461	0	288	0
Pigs for fattening	11,616	7,439	4,439	2,042	2,044
Sows	3,673	2,057	2,057	1,324	1,324

Additionally, a decline in utilized agricultural area (UAA) can be observed. This effect is more pronounced in the REF scenario, in period 5 UAA has decreased by almost 9 % (BAS05: 4 %), in period 9 by even 18 % (BAS09: 6 %). In both periods, comparatively more grassland than arable land is abandoned. In Tab. 3 the change in UAA is broken down to site-types. On arable land, in both scenarios, the farms keep their most productive sites (soil fertility class 50) in production, while the area used on the less productive sites decreases (effect again stronger in the REF scenario).

Table 8: UAA by site type

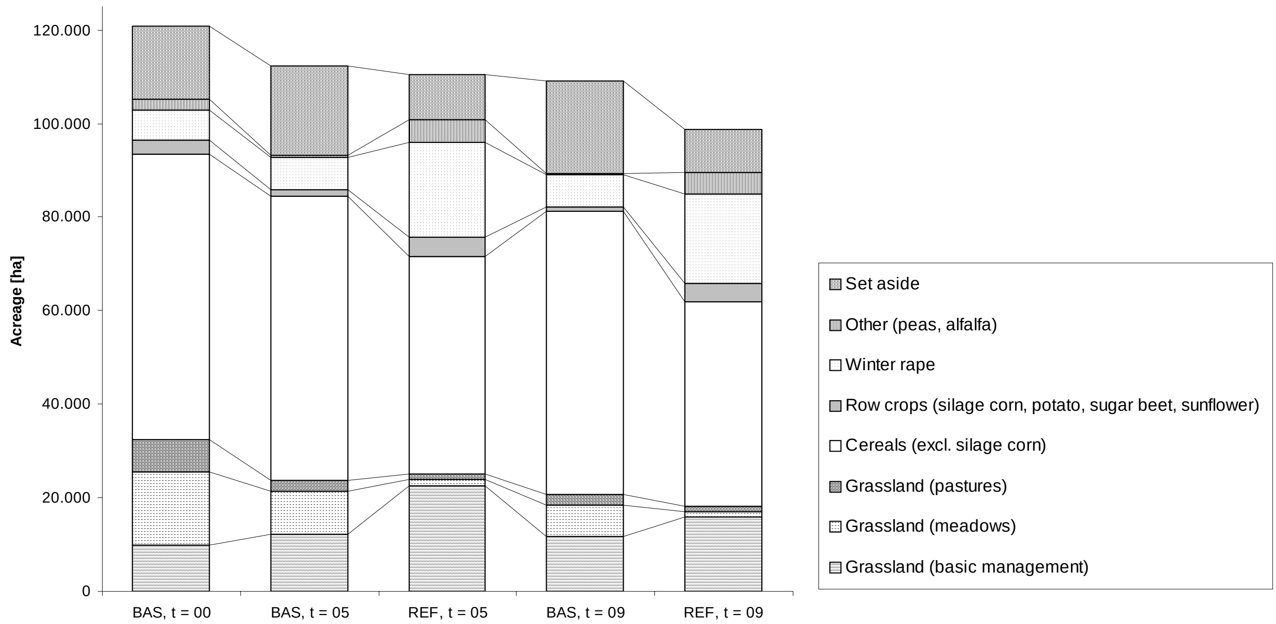
Site type	*BAS00*	*BAS05*	*REF05*	*BAS09*	*REF09*
Arable land (soil fertility 25) [ha]	3073	3073 (+/- 0)	2783 (-290)	3073 (+/- 0)	2509 (-564)
Arable land (soil fertility 38) [ha]	83773	83773 (+/- 0)	81119 (-2654)	83742 (-31)	76354 (-7419)
Arable land (soil fertility 50) [ha]	1660	1660 (+/- 0)	1660 (+/- 0)	1660 (+/- 0)	1628 (-32)
Extensive grassland [ha]	9472	7754 (-1718)	7335 (-2137)	6779 (-2693)	5549 (-3923)
Intensive grassland [ha]	22979	19317 (-3662)	17664 (-5315)	18244 (-4735)	12675 (-10304)

The decrease in grassland is also greater than in the BAS scenario due to lower stocking numbers (Table 7) caused by the phased out livestock premiums for suckler cows and beef cattle. Dairy production in both year 5 and 9 remains on the high level of year 0 (it is even increasing a little) while the reduction of fattening pigs and breeding sows resembles to the respective periods in the baseline scenario.

Land use changes

Phasing out coupled direct payments changes the cropping pattern considerably (Figure 3). The initial cereals area of 61,151 ha is reduced by 24 % (REF05) and 29 % (REF09) respectively, while in both periods the BAS scenario leads only to a reduction of 1 %. The share of cereals mainly decreases for the benefit of winter rape and row crops. These crops gain in importance, because under Agenda 2000 coupled direct payments for cereals had distorted their relative profitability.

Figure 3: Land use changes at regional level by scenario; t = 00, 05 and 09

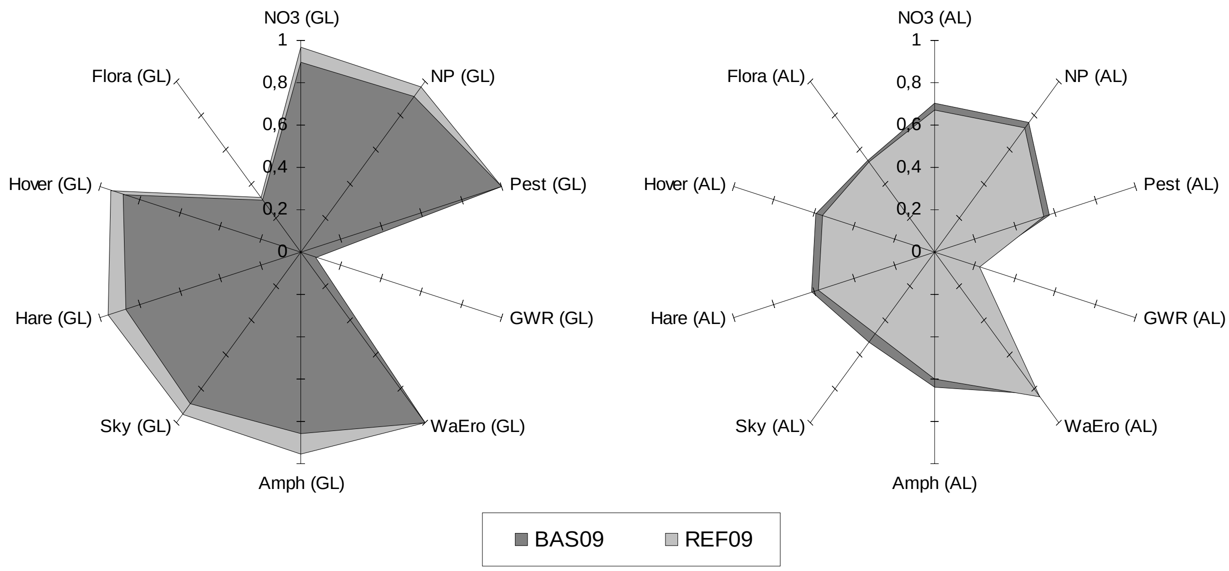


The overall share of agriculturally used grassland in REF also decreases, which is mainly due to decreasing number of animals kept on pastures systems (suckler cows) or dependent on green fodder (beef). On the other hand, the newly induced cross compliance requirements lead to a greater grassland area under basic management. In comparison to BAS, the share of set aside decreases more than in REF. As the farmers can no longer gain specific payments for set aside, this option becomes less attractive and the farms only set aside the minimum requirement of 10 % of their land.

Environmental impacts

Land use changes triggered by the structural development of farms also go along with a change in environmental impacts. Figure 4 shows the aggregated IGA values for arable land and grassland at regional level for the 10 indicators for both scenarios. To demonstrate long-term effects of both scenarios, only period 9 is represented (for the indicator abbreviation see table 2).

Figure 4: Aggregated IGA values at the regional level for arable land (AL) and grassland (GL) by indicator and scenario



In both scenarios, for 8 out of 10 indicators IGA values calculated for grassland are higher than for arable land due to the lower production intensity on grassland, in terms of fertiliser and pesticide inputs posing lower risks to the environment, e.g. with respect to nitrate leaching or pesticide contamination (e.g. Haas et al. 1998). Grassland provides permanent soil coverage, with an associated lower risk of soil losses caused by water erosion. Observed grassland management with one or two cuts per year is quite extensive so the disturbance potential for biotic indicators is evaluated to be rather low in comparison to arable land (e.g. Barnes et al. 1983). Exceptions are groundwater recharge (GWR) due to the lower infiltration rates on grassland compared to arable land (cf. Reichert 2000), and fall germinating wild flora species (flora), since annual weeds are dependent on regular tillage operations and have low chances to persist in dense grassland vegetation (cf. van Elsen 2000).

On arable land, the environmental impacts come off best in BAS09, while on grassland REF09 exhibits the best overall evaluation results. This contrast is mostly due to the higher share of grassland under basic management as induced by cross compliance, while on arable land the share of crops with higher input intensities such as silage corn, potatoes, or winter rape increases, which are all associated with lower IGA values (see appendix 1).

Discussion

A consistent simulation of the two considered scenarios yields a lot of insights, which cannot all be discussed in this contribution. For this reason, we will focus our discussion on the three questions posed in the introductory section.

1. Does decoupling of direct payments lead to more extensive production in the region?

In our analysis, at first glance the overall reduced stocking numbers in the beef sector support the assumption that decoupling leads to a more extensive production which might lower the overall production of ammonia, methane and nitrogen oxide in the region. But indeed, reduced stocking numbers concern exclusively the extensive types of animal husbandry namely suckler cows and beef cattle. Non-supported intensive pig and dairy production become the prevailing husbandry systems after the policy change, systems which are usually associated with local concentrations of ammonia and methane production. The reduced share of set-aside arable land is also an argument against decoupling supporting a more extensive agriculture. On the other hand, there are positive effects induced by the cross compliance requirement of decoupling, especially the increased share of grassland under basic management.

2. Do the farms abandon agricultural land in marginal areas?

A general fear with respect to decoupling is that farmers will not just adopt a more extensive production but abandon agricultural land in marginal areas. Although land abandonment can contribute to an overall extensification, simply because less agricultural area is used, there might also be some trade-offs with respect to keeping the landscape open and a general loss of conservation with possible negative impacts on groundwater recharge and biodiversity. Since marginal areas have always been managed rather extensively, an abandonment of these areas does not actually reduce the overall pressure on natural resources. The loss in extensive grassland area has to be viewed critically especially in wetland areas where open space is important for the water household related functions. With respect to arable land, our analysis showed that under both policy options the farms took their least productive sites out of production (SRI 25 and SRI 38), while the used agricultural area in the most productive areas remained nearly constant (slight decrease only in REF09). As decoupled payments are conditional on cross-compliance which require continued farming, cases of total abandoning of farming, while still retaining payments, did not occur.

3. What are the ecological effects on the areas that remain in production?

On grassland decoupling led to an improvement of the overall situation due to the increased area under basic management as a result of introduced cross compliance conditions. With respect to arable land, our analysis showed that under decoupling conditions agriculture became rather more intensive with associated negative environmental effects due to the change of the cropping pattern towards a reduction of cereals and an increase of winter rape and row crops and the reduced set aside share.

Conclusions

In general, we observed that decoupling could not slow down overall structural change, and leads especially to a loss of traditionally extensive livestock farms in OPR. More land was abandoned in comparison to the Agenda 2000 scenario. On the agricultural area, two opposing trends were identified. On arable land decoupled direct payments changed the cropping pattern towards more intensive crops, while on grassland positive environmental impacts could be observed. The trend towards intensification in productive areas does not necessarily have to lead to a more critical environmental situation locally, but should be viewed critically. However, at least partly, we could observe that the overall objectives of decoupling are translated into reality: more environmental protection where needed (cross-compliance effect) and more market orientation on the productive sites (decoupled payment effect).

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Appendix

Appendix 1: Average IGA per crop, calculated for integrated farming practices

Crop	NO3	NP	Pest	GWR	WaEro	Amph	Sky	Hare	Hover	Flora
Grassland:										
Grassland (basic management)	1,00	1,00	1,00	0,03	1,00	1,00	0,96	1,00	0,95	0,24
Grassland (meadow)	0,59	0,71	1,00	0,14	1,00	0,60	0,63	0,60	0,62	0,18
Grassland (pasture)	1,00	0,89	1,00	0,14	1,00	0,76	0,94	0,87	0,93	0,39
Arable land:										
Set aside	1,00	1,00	0,92	0,04	1,00	0,94	0,92	0,95	0,92	0,72
Winter barley	0,44	0,64	0,25	0,32	0,75	0,39	0,17	0,32	0,34	0,42
Winter rye	0,49	0,65	0,39	0,35	0,72	0,48	0,23	0,41	0,40	0,44
Winter wheat	0,45	0,61	0,19	0,38	0,57	0,37	0,12	0,31	0,29	0,42
Winter rape	0,40	0,48	0,31	0,36	0,59	0,33	0,21	0,29	0,27	0,39
Silage corn	0,52	0,35	0,67	0,76	0,33	0,58	0,40	0,39	0,41	0,17
Sunflower	0,49	0,55	0,75	0,74	0,47	0,47	0,44	0,42	0,41	0,19
Potato	0,53	0,62	0,20	0,62	0,19	0,31	0,24	0,12	0,32	0,13
Sugar beet	0,43	0,50	0,27	0,62	0,28	0,32	0,15	0,23	0,22	0,15
Pea	0,55	0,60	0,46	0,46	0,50	0,59	0,40	0,56	0,52	0,23
Alfalfa	0,67	0,54	1,00	0,14	0,91	0,65	0,59	0,66	0,72	0,40