Policy impact analysis of penalty and reward scenarios to promote flowering cover crops using a business simulation game

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Abstract

Due to several existing limitations for the use of silage maize as biogas substrate, flowering cover crops are currently a much-discussed alternative. Using a business simulation game, the present study investigates whether the implementation of a reward and a penalty policy will improve the uptake of flowering cover crops in the production programs of farmers. The results indicate that penalty policies lead to a stronger increase in the size of the cultivation area of flowering cover crops than reward policies, even though both policies have the same income effect.

Keywords: flowering cover crops; alternative biogas substrate; business simulation game; policy impact analysis.

1 Introduction

Fossil energy sources are finite resources and contribute significantly to anthropogenic global warming by the release of CO_2 emissions. Therefore, the German government has decided to promote the expansion of renewable energy sources with the "Act on granting priority to renewable energy sources" (Bundesgesetzblatt, 2011). This determines the remuneration for electricity generated from renewable energy sources and was last adjusted in 2012. Due to the opportunity of income stabilization, many farmers have invested in renewable energies (Mbzibain et al., 2013). In Germany, the number of biogas plants increased between 2001 and 2011 from 1,300 to 7,320 with a total installed capacity of 2,997 megawatts (Fachverband Biogas e.V., 2012). Thus, the cultivation of energy crops, such as maize and whole crop silage, increased sharply (FNR, 2012). Due to its high yield of dry matter and its energy content, maize is the preferred crop for biogas (Herrmann, 2013). The expansion of energy production from biomass, however, is not necessarily considered as positive and leads to serious environmental problems (Herrmann, 2013). For the future development of electricity production from biomass, it is essential to reconcile the production of biogas substrate and nature conservation. Therefore, the fermentation use of silage produced from flowering cover crops in biogas plants is being explored. Initial results show that flowering cover crops are well suited for fermentation in biogas plants. Further advantages include low input, the creation of habitats for wildlife, and also the increasing acceptance shown by the positive public response to fields that are used for or surrounded by flowering cover crops (Vollrath et al., 2010).

For the aforementioned reasons, a political aim could be the integration of flowering cover crops cultivation into the production programs of farmers. However, the introduction of a new policy is accompanied by high costs (Gong and Janssen, 2012). Prior to the introduction of a policy, a policy impact analysis is therefore essential to evaluate whether a policy measure is effective. Experiments and in particular business simulation games with an appropriate design can be used. In both, laboratory experiments and business simulation games, incentives can be set to motivate participants to make "well-conceived" decisions (Hertwig and Ortmann, 2001). Business simulation games make it possible to design a realistic decision-making situation being an important advantage compared to classical laboratory experiments (Levitt and List, 2007). Thus, especially business simulation games seem to be suitable for policy impact analysis.

This paper explicitly examines the farmers' reaction to the implementation of reward and penalty policies in order to promote the share of flowering cover crops in the agricultural landscape. Incentive and penalty strategies lead to comply the human behavior with rules and laws and, in this way, establish a social order (Tyler, 2006). Penalty payments pursue a strategy of deterrence in order to prevent that rules are broken, whereas rewards present an incentive to direct human behavior in a desired direction (Tyler and Blader, 2005). Thus the following hypothesis can be derived:

H1: Regardless whether the policymakers introduce a reward for growing flowering cover crops or a penalty for not growing flowering cover crops, the share of flowering cover crops in the production program of farmers will increase.

In the economic literature, it has been hinted that the effects of penalty policies differ from reward policies (Tyler, 2006). Kahneman and Tversky (1979), as well as Kahneman et al. (1991) found evidence for loss aversion meaning that people weigh a monetary loss more heavily than an equally high profit. Concerning a reward and a penalty policy with the same income effect means that the loss of the penalty payment is weighed higher than the reward payment. Even the opportunity cost effect supports the assumption that reward and penalty policies differ in their effect on human behavior. Out of pocket costs, such as penalty payments, are given a higher weight than opportunity costs, which correspond to a foregone reward payment (Kahneman et al., 1991). Another reason for the different impact of penalty and reward policies is the normative commitment of laws. If laws make sense for people and they accept them, they do not break the laws even if it is possible without facing consequences (Tyler, 2006). Therefore, the following hypothesis can be derived:

H2: The penalty policy changes the cultivation behavior of farmers regarding the scope of flowering cover crops better than a reward policy with the same income effect.

Flowering cover crops can be cultivated as nature conservation measures (Wratten et al., 2012; Thomas et al., 2009), or even as a biogas substrate for energy production with additional ecological benefits (Vollrath and Werner, 2012). If new policy measures promote the use of flowering cover crops as biogas substrate, we assume that the cultivation area of flowering cover crops used as a biogas substrate increases because of the higher revenues that are generated compared to the cultivation of these crops for nature conservation. Hence, flowering cover crops are used to complement the production of biogas substrate. Thus, the following hypothesis is derived:

H3: The implementation of reward and penalty policies would promote the cultivation of flowering cover crops for biogas substrate.

Farmers that cultivate flowering cover crops behave eco-consciously, because they create habitats for wildlife and insects. Regarding the socio-demographic and socio-economic variables and their influence on the environmental behavior of farmers, only limited literature exists. Buttel et al. (1981) investigated the impact of age, education, income, size of agricultural enterprises, and the organic or conventional land use on the environmental behavior. As significant factors, only the negative effect of age and the positive effect of the organic operation focus can be detected. Carr and Tait (1991) indicate that the productivity and effectiveness idea can affect the management behavior of farmers with detriment to nature conservation (see also Lütz and Bastian, 2002). The connectedness of farmers to nature influences the environmental concern (Gosling and Williams, 2010). This leads to the following hypothesis:

H4: Socio-demographic and socio-economic variables impact *the cultivation of flowering cover crops for nature conservation and for the production of biogas*.

For testing these hypotheses we designed a multi-period, single-person business simulation game which is incentive compatible and projects farmers in a realistic farming situation. The novelty of this paper lies in the policy impact analysis that is geared towards implementing flowering cover crops in the production program of farmers. In recent years, scientists have dealt with flowering crops and their environmental benefits. Primary research has focused on the nature conservation concept and the impacts on biodiversity (Haenke et al., 2009; Haaland and Gyllin, 2010). Vollrath et al. (2010) as well as Vollrath and Werner (2012) investigated the benefits of flowering cover crops as biogas substrate. To our knowledge, there are no publications that address the individual effect of policies to increase the quantity of flowering cover crops in the agricultural landscape. Furthermore, a new aspect is that a business simulation game conducted with real farmers is used for the policy impact analysis.

The article is structured as follows: First, the methodology is described (section 2). Afterwards, the results are presented (section 3). The article ends with a summary and future prospect (section 4).

2 Methodology

The experiment is divided into three sections. In the first section, a multi-period one-person business simulation game is carried out. Subsequently, a Holt-and-Laury lottery (HLL) (Holt and Laury, 2002) is performed to investigate the participants' risk attitude. In the third section of the experiment, socio-demographic and socio-economic information about the participants is collected. The computer based experiment is carried out with farmers who know that they are participating in an experiment and that their decision-making behavior is documented and analyzed. Furthermore, the experiment was conducted on an agricultural trade fair and not in a laboratory setting. Hence, the experiment can be classified as an 'extra-laboratory experiment' according to Charness et al. (2013).

The Holt-and-Laury lottery will not be discussed extensively because the methodology presented by Holt and Laury (2002) has not been changed and this method is already established in agricultural economics (Brick et al. 2012). The participants are asked ten times to choose between the two lotteries A and B. In lottery A, the participants can either win € 200 or € 160, whereas the riskier lottery B offers a prize of either € 385 or € 10. The probabilities of the lotteries are systematically varied, hence, there exist ten different decision situations. The HLL-value indicates the number of safe choices when the decision from lottery A changes to the more risky lottery B and represents the risk attitude. Farmers who chose lottery A four times are risk neutral. When farmers chose the safer lottery A one to three times, it indicates risk seeking whereby a HLL-value between five and nine shows risk aversion.

2.1 Structure of the business simulation game

In the first section of the experiment - the business simulation game - participants are randomly assigned to one of three policy scenarios which are defined as follows:

Scenario 1 (reference scenario): The policy framework remains unchanged over the entire duration of the business simulation game.

Scenario 2 (reward scenario): The participants are informed that the transfer payment decreases by 10% to € 270 per hectare. Simultaneously, policymakers introduce an additional premium of € 300 per hectare for growing flowering cover crops. The government pays a maximum amount of € 3,000 per farm and, thus, subsidizes a maximum cultivation area of ten hectares of flowering cover crops.

Scenario 3 (penalty scenario): The policy punishes all participants who use less than 10% of their farmland for the cultivation of flowering cover crops. Each hectare lacking to fulfill the growing requirement will incur a penalty of € 300.

Scenarios 2 and 3 do not differ in their profit impact. In order to compare the participants' behavior in the scenarios, always three different farmers play the simulation game with the same price and weather developments, but with different underlying policy scenarios. It is to note that, in most cases, it does not make sense to follow the policy measures when aiming at profit maximization.

The following described framework remains constant for the reference scenario and changes for the reward and the penalty policy in production period 7. The design of the experiment is characterized by deterministic and stochastic parameters which are summarized in table 1.

Table 1. Deterministic and stochastic parameters of the business simulation game.

Deterministic parameters	Stochastic parameters
• Virtual farm with 100 ha arable land • Twelve production periods • € 100,000 initial capital • Living costs of € 30,000 each period • Price of € 35 per ton of biogas substrate • Minimum extent of winter wheat and silage maize • Maximum extent of winter wheat, silage maize, sorghum and flowering cover crops	• Political framework conditions • Prices for winter wheat and silage maize • Yields of all crops due to stochastic weather conditions

Participants are asked to manage a virtual 100-hectare arable farm over twelve production periods. Each production period depicts one year of farming and equals to one round of the business simulation game. Each participant receives an initial capital of € 100,000. In each production period, living costs in the amount of € 30,000 are deducted. The periods in the business simulation game build on one another and, at the beginning of each period, the participants are informed about the results of the previous one. A production period is completed as soon as the participant has made the following decisions:

1. Production program decision: Design of the production program for using the total farmland available to cultivate winter wheat, silage maize, sorghum, and flowering cover crops.
2. Contract decision: Conclusion of a substrate supply contract of 0 t, 1,500 t, 3,000 t, or 4,500 t of fresh mass for a neighboring biogas plant. For fulfilling the obligation to deliver, silage maize, sorghum, and flowering cover crops are under deliberation.

For the production program decision, further rules are given. One crop rotation includes at least two crops. This restriction is implemented by setting a minimum requirement of 5 ha of cultivation for winter wheat and silage maize. For all production methods, a maximum cultivation extent of 70 hectares of farmland can be used. All cultivation extents have to be integers, apart from this limitation, no specific field sizes were given. The completed substrate quantity delivered is paid with € 35 per ton independently of whether the fresh weight consists of silage maize, sorghum, or flowering cover crops.

The prices as well as the yields are depicted as uncertain factors in the business simulation game which make the decision situation more realistic (Harrison and List, 2004). They change randomly from period to period and, thus, vary between the participants. Starting from an initial value that is equal for all farmers in the game, the market prices follow an binomial arithmetic Brownian motion (Dixit and Pindyck, 1994: 59). The occurring market prices fall or rise in each period by € 20 per ton for winter wheat and € 1.50 per ton for silage maize with a probability of 50% starting from the price in the previous period. Also, the weather conditions influence the gross margins of the production alternatives. We distinguish between above-average, average and below-average weather conditions expecting above-average and below-average weather with a probability of 20% each and average weather with a probability of 60%. Above-average weather means that the yields per hectare of all crops reach their maximum, whereas, for below-average weather, the yields fall to a minimum.

Despite the uncertain yields per hectare, the chosen supply contract must be fulfilled by 100%. If this is not possible on the basis of the own harvest, the lacking amount of substrate must be purchased on the market for the double of the current market price of silage maize. If the harvest of biomass exceeds the contract, the surplus is sold for the market price of silage maize. As there are not any storage facilities available for the crops harvested, all goods are sold for the current prices at the end of each period. After each completed period, every participant receives a premium of € 300 per hectare. The prices and the occurred weather conditions of the previous period are announced at the beginning of each new production period. Furthermore, participants receive additional information about the profit achieved as well as the cultivation and contract decisions of the previous periods. The earned assets sum up until the end of the game.

2.2 Representation allowance and incentives

In order to attract participants, each participant receives a representation allowance of € 10. The planned playing period of 30 minutes corresponds to an average hourly wage of € 20. In the German agricultural sector, the average hourly wage is € 9.92 (DESTATIS, 2010). Hence, the allowance is more than twice as high as the average hourly wage and should motivate the farmers to participate in the business simulation game.

For compatibility reasons, additional monetary incentives for "well-conceived" decisions are set. In total, € 2,005 can be won by the participants. This amount of money corresponds to an expected value of € 16.71 for each of the planned 120 participants. Since the playing period is already paid by the representation allowance, the expected gain covers the opportunity costs for further 50 minutes for making well-conceived decisions.

Former studies have shown that incentives influence the behavior of participants. They work harder and think twice if the incentive depends on their own performance (Camerer and Hogarth, 1999; Duersch et al., 2009). Different payment systems for incentives exist. On the one hand, each participant receives a small incentive or, one the other hand, a fraction of all participants receives a high incentive. Camerer and Hogarth (1999) note that participants overestimate the probability of being selected if only one participant is paid. Therefore, we decided that only a fraction of participants receives high incentives. Out of the 120 participants that are planned to take part in the game, four farmers will be drawn by lot and win a cash prize. The first three cash prizes will be given to three farmers who participated in the business simulation game. Each of the three cash prizes depends on the business success and totals to a maximum of € 540. Winners receive the share of the maximum monetary gain that corresponds to their business success. The fourth cash prize can be won when taking part in the Holt-and-Laury lottery. In this part of the experiment, the participants are aware of the cash prize they could win and the amount of money which depends on their own decisions. For the determination of the cash prize, one participant is randomly drawn by a lot and will have the chance to win between € 10 and € 385 – depending on his risk attitude – in a Holt-and-Laury Lottery carried out solely for him.

2.3. Analysis of data

Due to the same framework in the first 6 production periods, it can be analyzed how the cultivation area of flowering cover crops changes when the reward or penalty policy appears. The average size of the cultivation area of flowering cover crops is presented in table 2 for the production periods 1 to 6 and 7 to 12 for each of the 3 policy scenarios. The H-Test according to Kruskal and Wallis shows that the cultivation areas of flowering cover crops do not differ significantly between the three policy scenarios in the periods 1 to 6 (p-value = 0.812).

Table 2. Average cultivation area of flowering cover crops (41 participants in each policy scenario).

Policy scenario	Area of flowering cover crops periods 1-6 Mean	SD	Area of flowering cover crops periods 7-12 Mean	SD	p-value
1	10.21	13.55	9.88	12.68	0.732
2	7.92	11.86	10.01	9.87	0.080 *
3	8.22	10.74	12.73	10.31	0.001 ***
Average	8.78	12.13	10.87	11.09	

For scenario 1 (reference scenario), the cultivation area in the first 6 periods does not differ significantly from the size of the cultivation area in periods 7 to 12. In contrast, the cultivation area changed significantly with the introduction of a reward (scenario 2) or penalty policy (scenario 3).

For analyzing the effect of the reward and the penalty policy, regression models are estimated with the software 'gretl 1.7'. The Hausman-test indicates that the random effect estimator is not consistent (p-value = 0.048) and, therefore, a fixed effect model should be estimated. However, it is not possible to use the fixed effect model on the basis of the data. The influence of the socio-demographic and socio-economic parameters cannot be depicted as they do not change while participating in the business simulation game. Consequently, a pooled regression is used for the estimation.

3 Results and discussion

3.1 Description of the sample

The experiment was conducted at the agricultural exhibition "EuroTier" that took place between 13th and 16th of November 2012 in Hanover (Germany). Nine hundred and forty-six visitors of the exhibition were randomly chosen and directly contacted and invited to participate in the business simulation game. In total, 123 farmers (13% of those contacted) successfully completed the experiment, with 41 farmers playing in each policy scenario. To complete the experiment, the participants needed on average 43 minutes. The socio-demographic and socio-economic characteristics of the participants in the three policy scenarios are summarized in table 3.

Table 3. Socio-demographic and socio-economic characteristics of the participants (41 participants in each policy scenario).

Characteristics	Policy scenario 1 Mean	SD	Policy scenario 2 Mean	SD	Policy scenario 3 Mean	SD	p-value
Age	31.8	12.7	28.8	10.3	27.7	9.4	0.140
Percent of female participants	12.2%	-	14.6%	-	9.8%	-	0.800
Years of education	13.6	3.3	13.7	3.5	13.8	3.2	0.961
HLL-value [(a)]	5.9	2.0	5.2	2.2	5.1	1.6	0.228
Farm manager	39.0%	-	34.1%	-	29.3%	-	0.855
Farms farmed on a part-time basis	19.5%	-	7.3%	-	14.6%	-	0.273
Farmland in ha	225.5	392.3	196.9	220.4	312.5	617.4	0.759

(a) 1-3 = risk seeking, 4 = risk neutral, 5-9 = risk averse

On average, the participants were 29 years old, including the youngest participant of 16 years, and the oldest of 62 years. The agricultural enterprises of the participants comprise on average 245 ha of farmland. The largest farm works 3,000 ha of arable land. Fourteen percent of the participants run their agricultural businesses on a part-time basis. The sample consists of 12% female participants. The average HLL-value of 5.4 indicates that the participants are slightly risk averse. Using the H-test according to Kruskal and Wallis and the chi-square test, it can be shown that the socio-demographic and socio-economic characteristics of the participants in the three policy scenarios do not differ significantly from each other.

3.2 Hypotheses testing

There are four initial situations: The cropping areas of flowering cover crops for all three policy scenarios for the first 6 periods represent the reference situation (situation 1). The policy scenarios 1 to 3, which occur at the seventh production period, reflect the policy implementation effects (situations 2 to 4). In table 4, they are referred to as dummy scenario 1 to 3 and deal with the baseline of situation 1. Model 1 reflects the effects of the independent variables on the total cropping area of flowering cover crops. Furthermore, models 2 and 3 highlight the effects separated for the cultivation of flowering cover crops for biogas production or nature conservation purposes.

Hypothesis H1 is confirmed: In both, the reward and the penalty scenarios, the share of flowering cover crops increases significantly (model 1). Participants confronted with the reward policy grow on average 2.285 hectares more flowering cover crops in comparison to the reference periods 1 to 6. Whereas participants confronted with the penalty policy increase the share of flowering cover crops on average by 5.176 hectares. Compared to the reference situation of periods 1 to 6, no significant changes occur in the reference scenario in the periods 7 to 12. Consequently, the incentive strategy of the reward policy and the deterrence strategy of the penalty policy caused a change in the participants' behavior regarding the cultivation of flowering cover crops.

Hypothesis H2 is confirmed: The implementation of a penalty policy leads to a stronger increase in the size of the cultivation area of flowering cover crops than the implementation of a reward policy (model 1), although the policies do not differ in their income effect. A linear restriction reveals that the effects of the reward and the penalty policy differ from each other on a significance level of 10%. Thus, the loss aversion and the opportunity cost effect as well as the normative commitment of laws have to be taken into account when estimating policy consequences. These effects influence the awareness of reward and penalty scenarios.

Hypothesis H3 is confirmed: A penalty policy results in an increase in the cultivation of flowering cover crops to produce biogas substrate by 2.720 ha (model 2). In contrast, the introduction of a reward policy has no significant effect on the cultivation of flowering cover crops for biogas plants. Despite having the same income effect of the policy scenarios 2 and 3, only the penalty policy (scenario 3) achieved a significant increase in the cultivation of flowering cover crops in order to produce biogas substrate.

Table 4. Pooled regression to explain the cultivation area of flowering cover crops (N = 1,476), robust standard errors[(a)].

	Model 1 dependent variable: flowering cover crops cumulative		**Model 2** dependent variable: flowering cover crops biogas plant		**Model 3** dependent variable: flowering cover crops nature conservation	
	Coefficient	t-statistic	Coefficient	t-statistic	Coefficient	t-statistic
Constant	28.012	4.343 ***	8.775	2.437 **	19.239	4.254 ***
Dummy scenario 1	1.145	0.952	0.493	0.616	0.653	0.938
Dummy scenario 2	2.285	1.765 *	0.948	1.084	1.337	1.470
Dummy scenario 3	5.176	4.071 ***	2.720	3.042 ***	2.456	2.528 **
Profit differential[(b)]	-1.375	-1.722 *	-1.074	-1.811 *	-0.301	-0.473
Risk attitude[(c)]	0.247	0.796	0.155	0.820	0.093	0.385
Substrate delivery amount 1,500 t	-2.206	-1.180	2.221	2.470 **	-4.427	-2.418 **
Substrate delivery amount 3,000 t	-2.157	-1.334	2.484	2.667 ***	-4.641	-2.883 ***
Substrate delivery amount 4,500 t	-6.123	-3.947 ***	1.504	1.596	-7.627	-4.693 ***
Age	-0.084	-1.234	-0.086	-2.418 **	-0.003	-0.056
Gender[(d)]	6.042	3.203 ***	3.225	3.460 ***	2.816	2.061 **
Years of education	-0.664	-2.739 ***	-0.268	-2.073 **	-0.396	-2.379 **
Earning power[(e)]	-6.361	-2.776 ***	-2.518	-2.012 **	-3.842	-2.313 **
Farming[(f)]	-5.515	-1.683 *	-3.259	-1.665 *	-2.256	-1.306
Renewable energy[(g)]	-2.168	-1.674 *	-1.512	-1.949 *	-0.656	-0.727
Profit flowering cover crops[(h)]	3.327	2.235 **	0.927	1.183	2.400	2.323 **
Nature flowering cover crops[(i)]	1.529	1.040	1.852	2.336 **	-0.322	-0.298
Agri-environment[(j)]	0.975	1.126	1.024	2.374 **	-0.049	-0.083
F-value	19.677 ***		10.777 ***		16.541 ***	
R^2	0.187		0.112		0.162	

(a) * = p-value < 0.10; ** = p-value < 0.05; *** = p-value < 0.01.
(b) Difference between maximum possible and maximum achievable profit with policy compliance in € 1,000.
(c) 1-3 = risk seeking, 4 = risk neutral, 5-9 = risk averse.
(d) 1 = female, 0 = male.
(e) 1 = mainstay farm, 0 = part-time farm.
(f) 1 = conventional, 0 = organic.
(g) Do you have invested in renewable energies except of biogas plants? 1 = yes, 0 = no.
(h) Do you think it is possible to earn money by growing flowering cover crops? 1 = yes, 0 = no.
(i) Do you think the cultivation of flowering cover crops for nature conservation makes sense? 1 = yes, 0 = no.
(j) Do you agree or disagree with agri-environment measures? 1 = total disagree to 5 = total agree.

Hypothesis H4 is confirmed: The model results show that socio-demographic and socio-economic variables have a significant influence on the size of the cultivation area of flowering cover crops. The variables "gender", "years of education", "earning power" and "farming" have a highly significant influence on the size of the cultivation area of flowering cover crops (model 1). Interestingly, these effects differ if the two kinds of flowering cover crops are separately estimated (models 2 and 3). The parameters "gender", "years of education", and "earning power" have a significant impact on the size of the cultivation area of flowering cover crops on both variations but in varying degrees. Considering model 2, the variable "age" is significant. The negative impact of "age" on the size of the cultivation area of flowering cover crops for energy production implies that farmers with increasing age are more skeptical towards alternative biogas substrates. In contrast, there is no significant influence of this parameter on the size of the cultivation area of flowering cover crops for nature conservation (model 3). Female participants grow significantly more flowering cover crops for biogas production and for nature conservation than men. Consequently, female farmers may be more open to alternative methods of cultivation and nature conservation concerns. Participating farmers, for who the farm is the main source of income, grow significantly fewer flowering cover crops for biogas plants and for nature conservation. Participants who think that it is possible to make profit with the cultivation of flowering cover crops grow more of them for nature conservation. However, there is no significant effect upon the size of the cultivation area of flowering cover crops for biogas plants. It becomes clear that there are different socio-demographic and socio-economic factors influencing the reaction and implementation of policies.

A further result is the effect of the substrate delivery contracts. This effect differs with regard to the production alternative of flowering cover crops. The decision for a delivery amount of 1,500 t or 3,000 t has a positive influence on the cultivation of flowering cover crops as biogas substrate. It has a negative impact on the size of the cultivation area of flowering cover crops for nature purposes. It can also be seen that the profit differential affects the behavior of cultivating flowering cover crops. For each € 1,000 profit differential, the participants grow 1.375 ha on average less of the flowering cover crops (model 1).

4 Conclusion and outlook

The cultivation of silage maize has risen due to the increasing number of biogas plants and the good qualities of maize as biogas substrate. However, the increased cultivation of maize is not always positively considered and leads to ecological problems. For reaching the aim of the German government that is the sustainable development of renewable energy, the cultivation of alternative biogas substrates has to be promoted. Flowering cover crops are a promising biogas substrate with additional ecological benefits. In the present study, a business simulation game is used to investigate whether the implementation of a reward and a penalty policy will improve the uptake of flowering cover crops in the production programs of farmers. Participating farmers of the game manage a virtual farm and have to make cultivation and contract decisions in each of the twelve production periods. The reward and the penalty policy which occur during the simulation do not differ in terms of their income effect.

The results reveal that both the reward and the penalty policy leads to an increase of cultivating flowering cover crops. The implementation of a penalty policy has more positive effects on the cultivation of flowering cover crops than the implementation of a reward policy. Moreover, the results show that the human behavior is influenced by the loss aversion and the opportunity cost effect as well as the normative commitment of laws. The implementation of the reward policy has no effect on the cultivation of flowering cover crops used as biogas substrate. In contrast, the introduction of the penalty policy promotes the use of flowering cover crops as biogas substrate. Therefore, with equal costs of policy implementation and the aim to increase the use of flowering cover crops as biogas substrate, the implementation of a penalty policy seem to be promising over a reward policy. Another finding is that socio-demographic and socio-economic parameters influence the cultivation behavior of farmers. The business simulation game can be seen as an important step to investigate the influence of socio-demographic and socio-economic effects on cultivation decisions.

For policy impact analysis, the business simulation game has been a first step to predict the behavior of farmers regarding the implementation of a reward and a penalty policy. The results are very promising and provide first hints and starting points for policymakers. Nevertheless, the participants of the business simulation game are rather young and do not represent the average German farmer. Therefore, the sample is not representative and external validity has not been completely achieved. To improve the external validity, the experiment should be carried out with a representative sample of German farmers.

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