When economic perspectives are not sufficient, can incentives for pro-environmental behaviour help? Empirical evidence from afforestation schemes in Ireland

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Abstract

This article aims at explaining participation in forestry incentive schemes in order to understand the low rates observed and to provide recommendations for correcting and designing public policies. To do this, we used a unique dataset of more than 1,500 Irish farmers surveyed in 2012 about their motives for afforestation in the context of premium schemes supporting tree planting on agricultural lands. Together with economic information about farm incomes, value of forestry output and forestry premium, this data makes it possible to reconcile social and economic analyses to understand the behaviour is adopted. We thus estimated the afforestation (past and future_ decisions and tested the effect of economic incentives and other motives such as social and intrinsic motives (e.g., patrimonial attachment, pro-environmental behaviour). Using a full information econometric model of past and planned participation, we showed that the low attention paid to economic motives by farmers explains the low participation. Specifically, public policy oriented towards pro-environmental behaviour and land attachment would be more efficient. We find significant crowding-out effects.

Keywords: Economic and non-economic motives, scheme participation, afforestation, pro-environmental behaviour, crowding-out effect

JEL codes: C34; D91; Q15; Q23

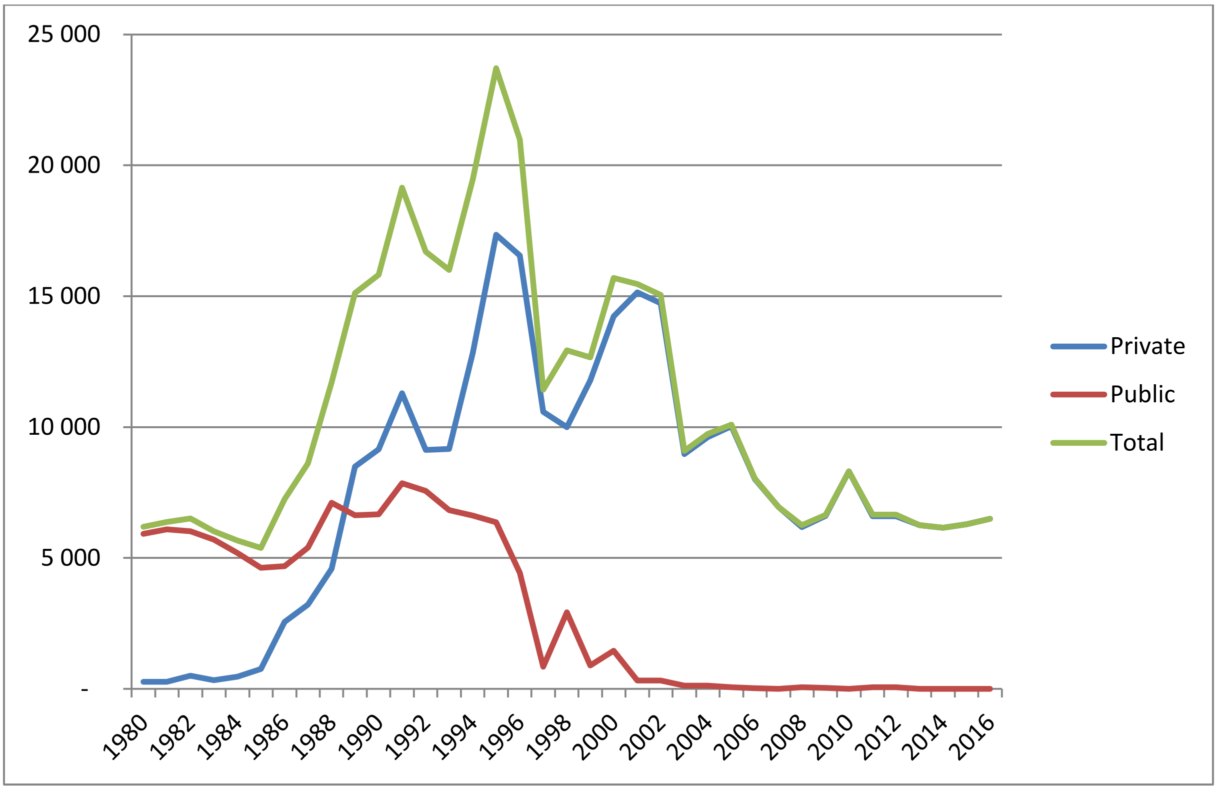
1. Introduction

Since the early 1900's, when the forest cover was at its lowest level (i.e., 1% of land area), the Republic of Ireland has experienced continuous periods of afforestation culminating in a current forest cover of 10.5%, i.e. 700,000 ha (NFI, 2012). Much of the afforestation up until 1980 was undertaken by the State on public lands. Private landowners, in particular farmers, began to engage in afforestation in the mid-1980s in response to the introduction of financial incentives co-funded by the European Community. The objective of these early afforestation schemes was to provide farmers with complementary activities and new job opportunities in the forest sector, as well as new economic perspectives for the country in the context of an overall decline in farm revenues (Duesberg et al. 2014). More recently, the social, environmental and recreational benefits that can accrue from a vibrant forestry estate have been recognised. Hence recent afforestation schemes recognised that apart from economic objectives, the schemes should "contribute towards climate change mitigation; provide a sustainable source of wood biomass for energy purposes; provide a sustainable basis for development of the rural economy; increase the area of purpose-designed recreational and amenity forests; improve water quality through riparian planting; increase overall biodiversity by providing woodland habitat which is under-represented in the complex of habitat types" (Forest Service, 2012). Since 1986, the afforestation schemes have provided grants that essentially cover the cost of establishing the forest and premiums. The latter are paid annually for the first 15 years (prior to 2014 this would have been 20 years) on a per hectare basis to those who afforest. The values for both the grants and premiums have changed on a number of occasions since 1986.

Ireland's first national forestry strategy "Growing for the Future" was launched in 1996. It set targets for afforestation: 25,000 ha per annum between 1997 to the year 2000, thereafter 20,000 ha per annum were to be planted to the year 2030 (DAFF, 1996). The rationale for setting such ambitious targets was that they would result in a critical mass of timber being produced (defined as a "scale of timber production large enough to make true competition and the operation of market forces possible and to support a range of process industries (DAFF, 1996, p. 2)), i.e., an annual output of 12 million m^3 by the year 2030. The private sector, i.e. farmers, was to account for 70% of the afforestation. However, the participation of farmers in these afforestation schemes has never reached the target levels

(Forest Service 2009, Duesberg et al. 2014). Fig. 1 presents the annual levels of afforestation on public and private areas over the period 1980-2016, and shows that afforestation rates have been declining (both private and public) since 1995.[1]

Figure 1. Afforestation over the period 1980-2016 in Ireland



Data source: Afforestation statistics 2016 – Forest service, Department of Agriculture, Food and the Marine. https://www.agriculture.gov.ie/forestservice/forestservicegeneralinformation/foreststatisticsandmapping/afforestationstatistics/. Graphic: Our own construct.

Several studies have been conducted to investigate the reasons for the lower than targeted rate of participation in afforestation schemes In Ireland. A number of them have focused on the role of goals, values or motivations of farmers with regard to afforestation (e.g., Duesberg et al. 2013, Duesberg et al. 2014a and b) and are inspired by the literature of sociological research or more generally by social sciences. Other studies have explored the effect of the economic returns from converting agricultural land to forestry on the decision to afforest (e.g. Breen et al. 2010, Upton et al. 2013, Ryan and O'Donoghue 2016).[2]

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[1] The figures show a negative overall trend of private afforestation since 1995, the year at its highest level with 17,343 ha planted, although a slight increase can be seen over the three years 2000-2002 well beyond 11,000 ha and then a stagnation around 6,500 ha over the last ten years of observations.

[2] There are also many empirical studies that searched to estimate the influence of factors such as farm structure and socio-demographic variables on the Irish farmers' afforestation willingness, among them Collier

In this paper, we intend to unify these theories by using behavioural economics to study the role and effects of psychological, emotional, social, and cognitive factors on decision-making with respect to afforestation. Our econometric study is based on a model of behavioural economics, which distinguishes extrinsic (economic and social) and intrinsic values. The study aims, by the way of the motivation crowding theory (Frey and Jegen 2001, Benabou and Tirole 2006), to show that external intervention via monetary rewards or punishments can undermine intrinsic motivations.

To do this, we used a dataset relating to more than 1,500 Irish farmers surveyed in 2012 about their motives for afforestation in the context of premium schemes supporting tree planting on agricultural lands. Together with county-level economic information about farm incomes, values of forestry output and forestry premiums, we aimed to identify which motives animate the farmers and explain the low rates of afforestation despite the strong monetary incentives that are offered. We thus estimated the afforestation decisions and tested the effect of economic incentives and other motives such as social and intrinsic motives (e.g., patrimonial attachment, environment). Using a full information econometric model of past and planned participation, as well as afforestation levels, we offer empirical evidence supporting incentives and pro-social behaviour, and specifically of crowding-out effect, from afforestation incentive schemes in Ireland.

et al. (2002), Farrelly (2006), Frawley and Leavy (2001), Hannan and Commins (1993), Ní Dhubháin and Gardiner (1994).

2. Related literature

2.1 Motives and other factors influencing afforestation decisions

Afforestation has been promoted in Europe for decade. National afforestation programmes have been complemented by European Union financial support most notably provided through Council Regulation (EEC) No 2080/92. The general aim of this and other EU afforestation policies has been the expansion of woodland in agricultural areas and in doing so supporting economic growth in rural areas and/or generating ecological benefits (Marey-Perez et al., 2008).

Offering financial incentives to farmers to afforest land is based on the assumption that farmers' decision to afforest land is based on profit maximisation goals. A number of studies have identified that farmer make economically optimal decisions with regard to afforestation (e.g. Wiemers and Behan). However, an even greater number show that if profit maximisation is the primary influencer of farmer participation in forestry, many more farmers than currently do would have engaged in this activity (e.g. Breen, 2010).

Socio-demographic characteristics of the farmer and the farm also influence participation. In particular farm size is important; with the likelihood of afforestation being undertaken increasing as farm size increases (e.g., Ni Dhubháin and Gardiner, 1994).

Alongside the economic and socio-demographic factors, there is a another set of factors which can be collectively referred to as intrinsic and/or social values. Farmers may choose not to afforest land as they do not see it an appropriate use of farmland, in particular good quality farm land (Frawley, 1998). Duesberg et al. (2013) found that intrinsic values played an important role in farm afforestation. They found that many farmers chose not to afforest land because of their values and beliefs about farming, i.e. many farmers considered it shameful to afforest land used for food production, even if this returns a greater profit.

3. The economic model

Our economic model is based on the incentives and prosocial behaviour model of Bénabou and Tirole (2006) (BT hereafter). This model was also used by Polomé (2016) to help understand adoption of biodiversity-related protection programs by private forest owners, and to explain low responses to incentive schemes. In our study, the farmers have planted trees their land, and thus who have transformed part of their farm to forestry. We thus extend the BT model by integrating farm activities, alternative revenues and patrimonial attachment.

Farmers who produce a farm output q with a current income $\pi(q)$ are the focus of our study. These farmers could engage in a new activity (partially replacing their current farm activity) by afforesting some or all of their land. In accepting the principle of afforestation, farmers explicitly choose a participation level $a > 0$ (i.e., an area planted with trees on their farmlands). This new forest activity can be considered as "good" from a social point of view, because it provides an expected public benefit in terms of new economic activities (associated with employment, new markets, etc.) and positive externalities by way of environmental improvement (through new biodiversity support, carbon sequestration, etc.).

The afforestation is expected to provide a reduced farm income, but also (additional) future forest revenues R depending on the level a:

$$E[\pi(q|1-a)] + E[R|a] \quad (1)$$

It is assumed that Farmer v will participate in the afforestation scheme if:

$$E[\pi(q|1-a)] + E[R|a] - \pi(q) > \rho_v(a), \quad (2)$$

that is, the farmer participates in the scheme if his/her profit differential exceeds a non-observed individual value ρ_v. This value ρ_v can be interpreted as the farmer receptivity for forest/nature/environmental good, prosocial activity, but also some kind of attachment to their land and current activity. According to the weight put on these different values and the attributes of the afforestation scenario (mainly a), it can therefore be either positive or negative.

Note that we assume that $\pi(q) > E[\pi(q|1-a)]$, so that the term $[\pi(q) - E[\pi(q|1-a)]]$ corresponds to the opportunity cost of abandoning a part of farm revenues,[3] that can be brought closer to the utility cost $C(a)$ in the BT model. Therefore, Eq. (2) can also be written as:

$$E[R|a] - C(a) > \rho_v(a), \quad (3)$$

which means that afforestation participation occurs if the expected additional forestry revenue minus the opportunity cost is greater than the individual value ρ_v.

Moreover, as in the BT model, the participation level a yields a proportional monetary reward $y \times a$. The incentive rate $y > 0$ reflects a proportional subsidy (a premium per ha planted with trees, in this case of afforestation scheme).

Now turning to the farmer's valuations of their action, participation yields a direct benefit plus a cost (or a benefit) from the look of the peers. Let v_a and v_y be the farmer's intrinsic valuations for contributing to the social good and for money, respectively. In addition to what was proposed by BT, we consider a patrimonial (land and farm activity) attachment value referred to as v_l, which gives a feeling of abandon (because of lifestyle related to farming, or just because producing food is considered as a very important job).

Participation at level a yields the following net direct benefit to the farmer v:

$$(v_a + v_y y)a - v_l a \quad (4)$$

Like BT, we define μ_a and μ_y as the agent's reputational concerns for contributing to the social good and for money. The reputational concerns are defined as being their prosocial appearance γ_a, their "money interested-people" appearance γ_y, and their "patrimonial abandon" appearance γ_l, times a factor $x > 0$ which measures the "visibility" of individual actions, such as the "probability that they will be observed by others, number of people who will hear about it, etc." according to BT, such that: $\mu_a = x\gamma_a$, $\mu_y = x\gamma_y$, and $\mu_l = x\gamma_l$.

The reputational payoff from choosing a, given an incentive rate y, is assumed to depend linearly on expectations of v_a, v_y and v_l the agent's intrinsic valuations of public good, money, and patrimonial attachment, respectively:

$$\mu_a E(v_a|a, y) - \mu_y E(v_y|a, y) - \mu_l E(v_l|a, y) \quad (5)$$

[3] Reducing the farm land generates a loss of farm income due to a drop in farm production, even though the farmer may continue to receive farm payments for the land not dedicated to the farm output anymore.

A farmer with preference v has the following individual value ρ_v for a participation level a:

$$\rho_v(a) = (v_a + v_y y)a - v_l a \ + \mu_a E(v_a|a,y) - \mu_y E(v_y|a,y) - \mu_l E(v_l|a,y) \qquad (6)$$

By adding the opportunity cost $C(a)$, the expression $\rho_v(a) + C(a)$ corresponds to the utility function in the BT model, to a factor $-[v_l a + \mu_l E(v_l|a,y)]$. Hence, to the classical crowding-out effect $-\mu_y E(v_y|a,y)$ explaining a decreasing participation in an incentive scheme, our model highlights added values, namely the feeling of patrimonial abandon $-v_l a$ as well as the fear of the look of the peers about this patrimonial abandon $-\mu_l E(v_l|a,y)$.

4. Econometric strategy

4.1 The econometric model of decision making

We assume that ρ_v defined by Eq. (5) is a linear function of the farmer characteristics, the patrimonial attachment, and the motives for tree planting:

$$\rho_v = \alpha_1 X_v + \alpha_2 W_v + \alpha_3 Z_v + \varepsilon_v, \quad (7)$$

where X_v is a vector of individual characteristics, W_v a vector of indicators for patrimonial attachment, Z_v a vector of proxies that summarise the motives for tree planting (or not), and ε_v is the error reflecting unobservable random factors.

From Eq. (2), we know that the farmer joins the afforestation program if:

$$E[R|a] - C(a) > \alpha_1 X_v + \alpha_2 W_v + \alpha_3 Z_v + \varepsilon_v \quad (8)$$

The decision criterion may be written in the form of a probit model: if $\mathrm{P}^* > 0$ the farmer v has decided to afforest a part of his/her land (PARTICIP $= 1$), otherwise not (PARTICIP $= 0$), where:

$$P_v^* = cte + \delta_1 R(a) + \delta_2 C(a) - \alpha_1 X_v - \alpha_2 W_v - \alpha_3 Z_v + \varepsilon_P, \quad (9)$$

where the new error term ε_P is the sum of ε_v and the unobserved part of the forest revenues $R(a)$.

4.2 The decisions to afforest

Farmers actually implement a simultaneous decision consisting in choosing to participate in the afforestation scheme and choosing the level of afforestation a by deciding an area (hectares) to plant with trees. Due to the high number of zero values, the size of tree area afforested (referred to as AFFOREST) constitutes a standard censored Tobit, where $\mathrm{AFFOREST_v} = \mathrm{T_v^*}$ if $\mathrm{T_v^*} > 0$, and $\mathrm{AFFOREST_v} = 0$ otherwise. As the presence in the sample for observation of the participation level equation is determined by the decision to join the programme, this latter equation is considered as a selection equation. The structural model is thus:

$$P_v^* = \beta_P X_v^P + \varepsilon_v^P \quad (10)$$

$$T_v^* = \beta_T X_v^T + \varepsilon_v^T \quad (11)$$

The vector of error terms $(\varepsilon_v^P, \varepsilon_v^T)$ follows a bivariate normal distribution whose correlation coefficient is denoted ρ_{PT} and $\mathrm{Var}\ (\varepsilon_v^T) = \sigma_T^2$. The variance of ε_v^P is normalized to 1 for identification purposes in the probit equation.

Farmers were also asked whether they were currently considering afforesting (more) land as part of the state's farm afforestation scheme. The binary answer requested allows us to also model this decision as a probit:

$$R_v^* = \gamma_R \mathrm{PARTICIP} + \beta_R X_v^R + \varepsilon_v^R \qquad (12)$$

Note that we introduce the decision of participation as an explanatory variable in the equation intended to represent the (planned) choice to afforest (more), because we think that having already joined the afforestation program (or not) is a potential determinant of the probability to consider afforesting (more) land (or not).

4.3 The simultaneous equations model of multiple decision-making

In order to obtain efficient estimated structural parameters of our decision-making model, the three Eqs (10)-(12) are estimated simultaneously:

$$\begin{aligned} P_v^* &= \beta_P X_v^P + \varepsilon_v^P \\ T_v^* &= \beta_T X_v^T + \varepsilon_v^T \qquad (13) \\ R_v^* &= \gamma_R \mathrm{PARTICIP} + \beta_R X_v^R + \varepsilon_v^R \end{aligned}$$

We assume that $(\varepsilon_v^P, \varepsilon_v^T, \varepsilon_v^R)$ follow a trivariate normal distribution whose correlation coefficients are denoted ρ_{PT}, ρ_{TR} and ρ_{PR}. The variances of ε_v^P and ε_v^R are normalized to 1, but $Var(\varepsilon_v^T) = \sigma_T^2$ has to be estimated. The system is estimated with a full-information maximum likelihood method using the Conditional Mixed Process program (CMP) developed by Roodman (2011).

5. The data

5.1 Survey and sample selection

The dataset used in this study was collected as part of a study of farmers' afforestation intentions and part afforestation activities conducted by Duesberg et al. (2014). In their study a questionnaire was distributed by the Irish Department of Agriculture, Food and the Marine (DAFM) in spring 2012 to a random sample of 4,000 farmers from all over Ireland. Over 1,529 farmers responded representing a response rate of 38%. Duesberg et al.'s (2014) questionnaire queried whether farmers had afforested part of their farm in the past and whether they planned to afforest in the future.

5.2 Data description and summary statistics

5.2.1 Endogenous variables

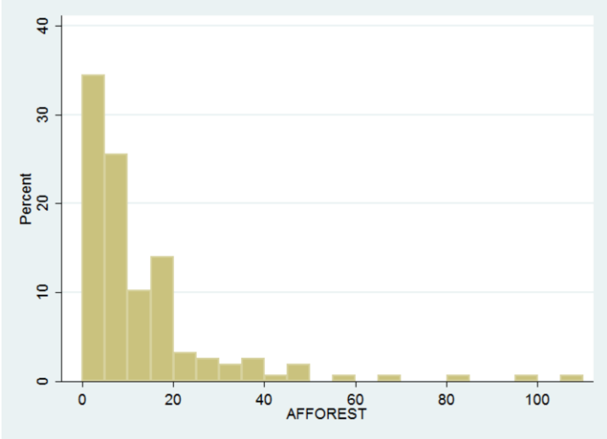
Participation in State's afforestation scheme in Ireland is low. Table 1 reports summary statistics on participation and the level of afforestation (i.e., afforested areas in ha) when farmers decided to participate.

Table 1. Cross statistics of participation and afforestation level ($N = 1,119$)

			AFFOREST (ha)			
PARTICIP	Freq.	%	Mean	Std. Dev.	Min	Max
0	962	85.97	0	0	0	0
1	157	14.03	13.46	16.83	0.100	106

In our sample, 157 have afforested their land, which represents 14% of the interviewed farmers. Note that a few farmers (eight) report zero values for the planted areas. We assumed that these areas were actually small, i.e., less than one hectare, and chose to arbitrarily attribute them 0.1 values. Fig. 2 shows the distribution of afforested areas.

Figure 2. Distribution of afforested areas (in hectare)



Note: 157 farms (over a total number of 1,119 farms in our sample) with afforested lands

Table 2. Cross statistics between past participation and planned participation

		PLANNED		
PARTICIP		0	1	Total
	0	876	86	962
		(88.13%)	(68.80%)	(85.97%)
	1	118	39	157
		(11.87%)	(31.20%)	(14.03%)
Total		994	125	1,119
		(100%)	(100%)	(100%)

Note: Figures in parentheses are relative frequency within its column of each cell.

Table 2 is a two-way table of frequencies (with relative frequencies in parentheses) of past and planned participations in the afforestation scheme. For example, 876 farmers did not and will not participate in the State's afforestation program. About 31% of farmers already engaged in afforestation also planned to continue to afforest and 69% of those who planned to afforest will do for the first time.

5.2.2 Economic and socio-demographic variables

Duesberg et al.'s (2014) survey was designed to study non-economic motives for afforestation scheme participation and thus specific questions on economic data, such as revenues from farming, were not gathered. Nevertheless, some information on farm activities was collected, namely, survey participants were asked to identify what activity/farming system they practiced on the farm. Nine farm activity categories have been defined according to the Irish Central Statistics Office nomenclature (see Census of Agriculture 2010):[4] (1) Dairying (referred to as DAIRY), (2) Dairying+other (DAIRYPLUS), (3) Cattle rearing (CATTLEREAR), (4) Cattle other (CATTLEOTHER), (5) Sheep (SHEEP), (6) Mixed cattle and sheep (CATTLESHEEP), (7) Tillage (TILLAGE), (8) Mixed tillage + grazing livestock (MIXTILLAGE), (9) Other farm activities (OTHER). Farm income and thus the opportunity cost of tree planting for farmers varies according to the farm activity (Ryan et al. 2016). Table 3 presents simple statistics on farm activities in our sample, after removing missing data.

Table 3. Summary Statistics on farm activities ($N = 1,119$)

Variable	Mean	Std. Dev.	Min	Max
DAIRY	0.124	0.330	0	1
DAIRYPLUS	0.072	0.259	0	1
CATTLEREAR r	0.299	0.458	0	1
CATTLEOTHER	0.172	0.377	0	1
SHEEP	0.102	0.303	0	1
CATTLESHEEP	0.112	0.315	0	1
TILLAGE	0.038	0.190	0	1
MIXTILLAGE	0.049	0.216	0	1
OTHER	0.032	0.177	0	1

We also know which county the farm is located in, how many hectares of land are farmed (including land rented from others), referred to as FARMAREA, and how many hectares of land are owned by the farmer, from which we computed the share of total farm land owned by the farmer (FARMOWNED).

To have information on income variations between farms, we used estimates given by the Irish Farmers Association (i.e. IFA 2014) at the Irish county level. This IFA report provides useful data for our study, such as farm structure (i.e., number of farms, farm size and stock on farm), land area under private forestry, farm income and direct payments, and values of output and exports. We built a total farm income per farm (INCOME) as the sum of farm income and direct payments (i.e., SFP, REPS, AEOS, DAS, SCWS)[5] divided by the number of farms, but excluding forestry premium (PREMIUM), this latter being used as an indicator of the expected premium for afforestation computed per farm. In order to have income information related to farm activities and individual farm heterogeneity, we created new variables by crossing county-specific farm income and farm activity variables. We also used

[4] http://www.cso.ie/en/media/csoie/releasespublications/documents/agriculture/2010/full2010.pdf

[5] SFP means Single Farm Payment, REPS: Rural Environment Protection Scheme, AEOS: Agri-Environment Options Scheme, DAS: Disadvantaged Area Scheme, SCWS: Suckler Cow Welfare Scheme.

the monetary value of forestry output divided by the number of farms, as a proxy of expected forestry revenue per farm (variable FOROUTPUT).[6] Finally, land yield (variable YIELD) which is an indicator of site productivity for forestry was computed from Farrelly et al. (2011). Table 4 provide summary statistics of all of these economics variables collected at the county level.

Table 4. Summary statistics economic variables

Variable	Unit	Mean	Std. Dev.	Min	Max
INCOME	Thousands €/ farm	29.49	10.53	13.29	46.40
PREMIUM	Thousands €/ farm	0.535	0.224	0.110	0.910
FOROUTPUT	Thousands €/ farm	0.250	0.005	0.244	0.264
YIELD	$m^3/ha^{-1}/yr^{-1}$	17.41	2.902	12.46	21.60

Note: Number of observations: 26 counties.

At the individual farmer level, the survey collected information on the current occupation (full-time farming, full-time off-farm job, part-time off-farm job, retired, or other) of the farmer, his/her highest level of education or training completed (primary, secondary, vocational agricultural training, trade based qualification, third level or above), and also the gender, the age, the marital status (married, living with partner, single, widow/widower, divorced/separated), as well as the number of children (younger than 18 years, 18 years or older, no children). Table 5 presents summary statistics of individual characteristics of farms and farmers.

Table 5. Summary statistics on individual characteristics of farmers ($N = 1,119$)

Variable	Mean	Std. Dev.	Min	Max
Farmed area	46.75	40.20	1	400
Owned area	37.42	32.13	0	300
Share of owned area	0.888	0.456	0	8.8
Full-time farm	0.540	0.499	0	1
Full off-farm	0.155	0.362	0	1
Part off-farm	0.197	0.398	0	1
Retired	0.062	0.241	0	1
Gender	1.094	0.295	0	1
Age	53.46	12.90	23	95
Married	0.761	0.427	0	1
Living with partner	0.039	0.194	0	1
Single	0.149	0.356	0	1
Widow/widower	0.037	0.188	0	1

[6] Data obtained from Table 10.8 providing the value of total Economic Activity in 2012, in the Annual Review and Outlook for Agriculture, Food and the Marine 2013/2014, Department of Agriculture, Food and the Marine (DAFM). Private forestry accounts for 13% of volume of total forestry available for processing in 2012: see Table 10.1, Roundwood available for processing.

Divorced/separated	0.024	0.154	0	1
Younger than 18 years	0.747	1.212	0	6
18 years or older	1.516	1.982	0	12
No children	0.234	0.537	0	1
Education	2.678	1.344	1	5

5.2.3 Patrimonial attachment

An important objective of the survey was to identify the farmers' feelings for their farm, their activity and their land. The different options presented were based on five statements supposed to identify the multi-faced description of patrimonial attachment: (i) enjoying farm activities and lifestyle (referred as to ENJOY), (ii) producing food is a very important job (FOOD), (iii) being independent and his/her own boss (INDE), (iv) having challenges and ambition for the farm (AMBITION), (v) farm from family asset and to successors (FARMASSET). The answers were given on a 5-point Likert-type scale from "Strongly disagree" to "Strongly agree". These attitudes have been translated in ordinal multinomial variables. Table 6 displays summary statistics of these attitudinal variables.

Table 6. Summary statistics of attitudinal variables ($N = 1,119$)

Variable	Mean	Std. Dev.	Min	Max
ENJOY	4.077	0.850	0	5
FOOD	4.105	0.801	0	5
INDE	4.235	0.834	0	5
AMBITION	3.748	1.001	0	5
FARMASSET	4.292	0.868	0	5

5.2.4 Motives (not) to tree planting

Statements were presented to farmers to describe their motives for deciding to plant trees (or not) in the future; these motives included: to earn more money (FORMONEY); "because I have really bad land that's good for nothing else" (BADLAND), to have a good future asset (FORASSET), for biodiversity conservation (FORBIODIV). Tables 7 and 8 provide frequencies of motives to tree planting against participation to afforestation scheme and current planned afforestation, respectively.

Table 7. Crossed frequencies for Afforestation participation and motives to tree planting

Why will you plant?						
PARTICIP	None	FORMONEY	BADLAND	FORASSET	FORBIODIV	Total
No	656	52	90	84	80	962

Yes	60	12	29	38	18	157
Total	716	64	119	122	98	1,119

Table 8. Crossed frequencies for current planned afforestation and motives to tree planting

Why will you plant?						
PLANNED	None	FORMONEY	BADLAND	FORASSET	FORBIODIV	Total
No	700	46	82	93	73	994
Yes	16	18	37	29	25	125
Total	716	64	119	122	98	1,119

Most farmers (64%) do no find a good reason among the four statements to plant. The two statements for which they agree more are having a good future asset for their successors and because they currently exploit a bad land (11% each). They are followed by its contribution to biodiversity conservation (9%). Earning more money with forestry is the last reason for which farmers could plant, with only 6% of respondents.

Tables 9 and 10 provide frequencies of different motives to tree planting for participation to afforestation scheme and current planned afforestation, respectively. The first reason why farmers do not plant trees on their land is because forestry is too long-term (LONGFOREST) (27%), then because producing food is important (PRODFOOD) (20%). The third motive is related to the work made by earlier generations on farmland (EARLYGENERA) (14%). Other motives for not planting are the fear to lose money (LOSEMONEY) (11.5%) and the current job satisfaction (FARMSATI) (9.5%).

Table 9. Crossed frequencies for Afforestation participation and motives NOT to tree planting

Why won't you plant?							
PARTICIP	None	LOSEMONEY	LONGFOREST	PRODFOOD	FARMSATI	EARLYGENERA	Total
No	143	107	272	193	99	148	962
Yes	52	22	31	34	7	11	157
Total	195	129	303	227	106	159	1,119

Table 10. Crossed frequencies for current planned afforestation and motives NOT to tree planting

Why won't you plant?							
PLANNED	None	LOSEMONEY	LONGFOREST	PRODFOOD	FARMSATI	EARLYGENERA	Total
No	137	114	291	201	102	149	994
Yes	58	15	12	26	4	10	125
Total	195	129	303	227	106	159	1,119

5.2.5 Creation of visibility, crowding-out effect and other variables

The "visibility" variable

In BT and our model, the reputational payoff is dependent on a factor $x > 0$ which measures "the visibility or salience" of individual actions, such as the "probability that it will be observed by others, number of people who will hear about it, etc." As written by Polomé (2016), "if the economic incentive […] is not visible to a third party, then economic motives cannot be inferred from the forest owner's actions, and therefore, there is no crowding-out." In our survey, we assume that the visibility of economic incentives can be computed from a question searching to elicit the degree of information possessed by the farmers about the incentive scheme: "Are you aware of the following details of the state's farm afforestation scheme?", where eight specific details concerning the economic incentives in the afforestation scheme are given, to which farmers have to answer yes or no. Table 11 displays the results about the level of information on afforestation scheme of farmers.

Table 11. Knowledge of details of the state's farm afforestation scheme ($N = 1,119$)

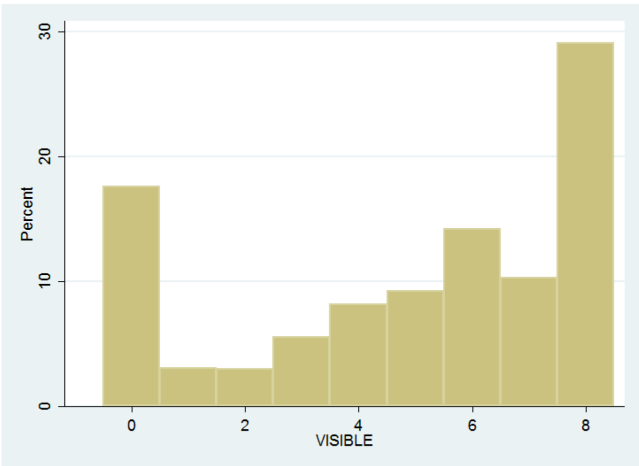
Detail of the state's farm afforestation scheme	Yes	No	% Yes	% No
It covers 100% of planting costs (100%COST)	720	399	64.34	35.66
It pays an annual premium for planting (ANNUPREM)	875	244	78.19	21.81
It pays this annual premium for the duration of 20 years (DUR20)	794	325	70.96	29.04
It pays annual premiums that start from 149 € for planting one acre of enclosed land (VALPREM)	512	607	45.76	54.24
It pays premiums that are tax-free (TAXFREE)	679	440	60.68	39.32
It allows farmers to keep the Single Farm Payment on the area planted (SFP)	617	502	55.14	44.86
It offers compensatory payments under the Forest Environment Protection Scheme of up to 200 € for farmers in REPS (COMPENS)	450	669	40.21	59.79
It leaves the ownership of land with the farmer (OWNLAND)	877	242	78.37	21.63

Note: The denomination of variables is in parentheses.

We learn from Table 11 that a great majority of farmers (almost 80% of the sample) knows that the afforestation scheme pays an annual premium for planting to the farmers and leaves them the ownership of their land. At the opposite, farmers seem less aware about the amounts distributed: only 45% knows the minimum payment for planting, nor the existence of compensatory payments for farmers in REPS (40%), and only 55% know that they may keep their SFP on planted areas.

We create an ordinal multinomial variable (referred as to VISIBLE) that counts the number of 'yes' for each individual. For the less informed farmers, the variable may take the value 0. For the more informed farmers, this value may be eight at the maximum. Fig 3 presents a histogram of the variable VISIBLE over the eight categories, scaled in percentages. We can notice that the frequency of zero is quite important, with about 18% of farmers who seem not to know any of the details of the afforestation scheme. However, as expected, the rest of the farmers know well the afforestation scheme according to one or more specifications and with an increasing trend of the number of the more and more informed farmers, until 29% of farmers knowing the eight details of the scheme.

Figure 3. Distribution of the variable VISIBLE



Note: 1,119 obs.

Crowding-out effect variables

In contrast to the approach adopted by Polomé (2016), where two motives invoked at the same and having a negative effect on the probability of adoption is evidence of a crowding-out effect, we created a cross-product associating the visibility variable and a specific motive in favour of tree planting. This term is supposed to reflect the effect of the extrinsic economic incentives jointly with any other motive on the probability of afforestation participation. In particular if the effect of such a cross-product based on the contribution to a public good (e.g., afforestation for biodiversity conservation) is negative, then it is a crowding-out of prosocial behaviour by extrinsic incentives in the sense of BT: providing visible rewards (by way of different monetary advantages) reduces the likelihood of afforestation participation of farmers having some prosocial motives. This is corresponds to the term $-\mu_y E(v_y|a, y)$ in Eq. (4). Likewise, the look of the peers can have a negative effect on participation even though farm activity does not yield sufficient incomes. This is what we called the fear of the look of the peers concerning the abandonment of farm activities and captured by $- \mu_l E(v_l|a, y)$.) in our model.

6. Estimation results on farm afforestation decision-making

Estimation results of the simultaneous equations model (13) are displayed in Table 12 below. Since the value of the coefficient cannot be directly interpreted, the first column reports the marginal effects (computed at the mean values of the explanatory variables) of the probit model (PARTICIP). The following second column reports the estimates of the tobit model for the level of afforestation (AFFOREST). The last column reports the marginal effects of the probit to reconsider planting (PLANNED).

Table 12. Estimation results of the simultaneous equations model

Variable	PARTICIP Marg. effect	AFFOREST Coef.	PLANNED Marg. effect
PARTICIP			0.0888*
			(0.0498)
FARMAREA	0.000591***	0.133***	0.000259**
	(0.000190)	(0.0304)	(0.000105)
FARMOWNED	0.0584***	7.968**	-0.0125
	(0.0219)	(3.513)	(0.0105)
Farm activities (Reference mode:* CATTLESHEEP*)			
CATTLEREAR	-0.0949**	-1.275	-0.0494*
	(0.0386)	(6.761)	(0.0266)
CATTLEOTHER	-0.181**	14.99	0.0621
	(0.0838)	(12.60)	(0.0482)
SHEEP	-0.180***	27.66***	-0.00649
	(0.0674)	(7.090)	(0.0345)
DAIRY	-0.197	8.758	0.0719
	(0.130)	(16.37)	(0.0698)
DAIRYPLUS	-0.314***	65.02*	-0.0333
	(0.113)	(38.69)	(0.0789)
TILLAGE	-0.0199	-39.55**	-0.232**
	(0.140)	(16.22)	(0.109)
MIXTILLAGE	-0.0546	-5.269	-0.0204
	(0.0467)	(3.215)	(0.0245)
OTHER	0.0931	-3.423	-0.106
	(0.122)	(14.92)	(0.0662)
INCOME x CATTLEREAR	0.00166*	0.0695	0.00120
	(0.000993)	(0.225)	(0.000753)
INCOME x CATTLEOTHER	0.00410**	-0.417	-0.00217
	(0.00199)	(0.307)	(0.00143)
INCOME x SHEEP	0.00260	-0.568**	0.000670
	(0.00210)	(0.244)	(0.00115)
INCOME x DAIRY	0.00351	-0.0999	-0.00352**
	(0.00327)	(0.410)	(0.00174)
INCOME x DAIRYPLUS	0.00576***	-1.645*	0.000790
	(0.00221)	(0.920)	(0.00157)
INCOME x TILLAGE	4.70e-05	0.783	0.00593**

	(0.00367)	(0.488)	(0.00289)
INCOME x OTHER	-0.000462	-0.319	0.00353
	(0.00345)	(0.441)	(0.00225)
PREMIUM	0.117***	-13.08**	-0.0324
	(0.0431)	(6.008)	(0.0237)
YIELD	-0.00626*	0.393	-0.00107
	(0.00336)	(0.369)	(0.00184)
FOROUTPUT	1.027	-269.8	0.313
	(1.565)	(277.1)	(0.860)
Patrimonial attachment			
ENJOY	0.0173	1.351	-0.00741
	(0.0111)	(2.246)	(0.00640)
FOOD	-0.0163	3.276*	-0.00135
	(0.0144)	(1.781)	(0.00840)
INDE	-0.0133*	2.555	0.0121*
	(0.00802)	(1.624)	(0.00629)
AMBITION	-0.00929	-3.479**	0.00601
	(0.00781)	(1.707)	(0.00569)
FARMASSET	0.0285***	-3.706***	-0.0125**
	(0.00860)	(1.298)	(0.00549)
Motives			
FORMONEY	0.0774	11.96	0.137***
	(0.0548)	(8.764)	(0.0280)
BADLAND	0.191***	6.968	0.161***
	(0.0386)	(8.408)	(0.0313)
FORASSET	0.214***	24.59***	0.0810***
	(0.0472)	(7.590)	(0.0312)
FORBIODIV	0.177***	5.490	0.105***
	(0.0414)	(6.904)	(0.0229)
LOSEMONEY	-0.0209	0.108	-0.0527***
	(0.0256)	(4.750)	(0.0138)
LONGFOREST	-0.0226	-1.791	-0.0263**
	(0.0156)	(4.541)	(0.0113)
PRODFOOD	-0.0459***	-3.858	-0.0759***
	(0.0131)	(4.627)	(0.0110)
FARMSATI	-0.0887***	3.221	-0.0854***
	(0.0280)	(1.992)	(0.0244)
EARLYGENERA	-0.0955***	6.523	-0.0494***
	(0.0325)	(5.386)	(0.0166)
Information on scheme			
100%COST	0.110***	2.368	0.0140
	(0.0240)	(4.808)	(0.0161)
ANNUPREM	-0.0583	-6.395	-0.0322
	(0.0400)	(6.279)	(0.0230)
DUR20	0.0467	5.810	0.0159
	(0.0352)	(6.277)	(0.0238)
VALPREM	0.0428**	-2.009	-0.0136
	(0.0202)	(3.675)	(0.00913)
TAXFREE	0.0914***	1.801	0.0189

	(0.0241)	(5.433)	(0.0159)
SFP	-0.0285	2.632	0.0123
	(0.0189)	(2.371)	(0.0211)
COMPENS	0.0165	2.382	-0.0175
	(0.0189)	(2.968)	(0.0164)
OWNLAND	-0.104***	14.14***	-0.0534**
	(0.0310)	(4.551)	(0.0219)
Crowding-out effect			
VISIBLE*FORBIODIV	-0.0210***	-0.487	-0.00565
	(0.00682)	(1.028)	(0.00435)
VISIBLE*FORMONEY	4.59e-05	-3.477**	-0.00951*
	(0.00866)	(1.427)	(0.00519)
VISIBLE*FORASSET	-0.0166**	-4.208***	-0.00258
	(0.00730)	(1.095)	(0.00491)
Crowding-out effect (look of peers about farm abandon)			
VISIBLE*BADLAND	-0.0194***	-1.852	-0.0130***
	(0.00628)	(1.271)	(0.00395)
Socio-demographic variables			
FULLOFFARM	0.00860		-0.00105
	(0.0237)		(0.0146)
PARTOFFARM	-0.0159		0.0224
	(0.0194)		(0.0178)
RETIRED	0.0579**		-0.0120
	(0.0261)		(0.0228)
EDUCATION	-0.000984		0.00337
	(0.00721)		(0.00344)
AGE	0.000480		0.000130
	(0.000813)		(0.000416)
Constant	--	65.08	--
	--	(66.97)	--
$\ln(\sigma_T)$		2.717***	
		(0.143)	
atan (ρ_{PT})	-0.926***		
	(0.230)		
atan (ρ_{PR})	-0.632*		
	(0.328)		
atan (ρ_{TR})	0.606***		
	(0.206)		

Notes: $N = 1{,}119$. County robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

To begin, it is useful to observe the significance of the correlation coefficients in order to assess the relevance of our model based on the estimation of simultaneous equations. All coefficients are significantly different from zero, which confirms the links between equations, especially concerning unobserved heterogeneity.

More specifically, because the coefficient ρ_{PT} is significantly negative, that both confirms the selection bias between participation and planted area decisions, and the left censoring at zero. We also found a negative correlation between the participation equation and the planned planting equation (i.e., the parameter ρ_{PR}), significant at the 10% level. This means that the variable PARTICIP is endogenous in the PLANNED equation and that unobservable heterogeneity explains lower participation in a second round when a part of farm land is already planted with trees. However, we found a positive and significant correlation (ρ_{TR}) between the unexplained variance of the tree planted area equation and the planned planting equation, leading us to conclude that unobserved factors explain higher planned participation when tree planted areas are larger. From these results, we may speculate that farmers are convinced of the benefits of afforestation only when they planted a significant area of their farmland.

First of all, we can observe that the size of the farmed land (FARMAREA) significantly increases the probability of past and planned participation in afforestation scheme, but in small proportions. For example, a marginal effect of 0.000591 means that an increase of the land of 1 ha increases the probability to participate of 0.06 percentage points (pp). More specifically, for a predicted probability of 11.4%, that means that this probability would increase to 11.46%. The same applies for the share of owned land (FARMOWNED) but the effect is much stronger (with a value of 0.0584), since for a 1 ha larger property the probability to participate would increase to 17.24%.

The results also suggest that participation differs according to farm activities. Estimates must be interpreted with respect to the reference "Mixed cattle and sheep" (i.e., the variable CATTLESHEEP). We find that a certain number of activities (i.e., CATTLEREAR, CATTLEOTHER, and SHEEP) are less likely to engage in an afforestation scheme, with the most important effect for the variable DAIRYPLUS for which the probability is lower by 31.4 pp. However, these results have to be put next to estimates of the cross-products of incomes and activities. Indeed, we can note that for the same activities, the probability to participate is increasing with the farm income. The richest farms are more inclined to plant trees on their land. For example, a rise of annual income by €10,000 increases the probability of afforestation by 5.76 pp.

The premium per farm has found to have a strong significant influence in estimating the probability of scheme participation. The value of the marginal effect at the mean of the sample is calculated at 0.117. This means that an increase of €1,000 of the annual premium per farm implies an increase of 11.7 pp of the probability of participation. In other words, this multiplies by two the predicted probability of participation. Contrariwise, yield has a negative impact on the probability. Although forest production will be higher as yield increases so too will farm production. The output value of forest per ha has no significant effect on the probability.

Concerning attitudinal variables about the attachment to the land and farm activity, the fact that farm is a family asset to pass on to successors has surprisingly a significantly positive impact on the participation in afforestation. The marginal effect indicates that the probability is increased by 2.85 pp when farmers agree the most with this statement. Only the desire to be independent and his/her own boss seems to have a negative effect on afforestation, but the result is only significant at the 10% level.

Among the motives explaining the afforestation scheme participation, forestry as a source of revenues (FORMONEY) or a loss of money (LOSEMONEY) has strictly no impact on the decision. Moreover, on the one hand, the marginal effects of variables FORASSET, BADLAND, and FORBIODIV have significant and positive impacts on the afforestation decision, with increases of probability of participation in incentive schemes by 21.4, 19.1, and 17.7 pp, respectively. Note that each of these three motives has much more impact that an increase of the annual premium by €1,000, evaluated at 11.7 pp. This means that the afforestation decision is driven by the bad land on which they can't farm, the good asset that forest could be for the family in the future, and the contribution for forest biodiversity conservation, ranked from the most to the lowest impacting. On the other hand, the production of food (PRODFOOD), the satisfaction given by farming (FARMSATI) and the lot of work made by earlier generations (EARLYGENERA) are the reasons that have a significant negative effect on the decision to afforest, but at a lesser extent, with estimated marginal effects at -0.0459, -0.0887, and -0.0955, respectively.

However, it is interesting to look closely the marginal effects of cross-terms between positive motives for tree planting and the variable VISIBLE, built to capture the visibility of economic conditions of afforestation scheme. While the individual information on details of afforestation scheme has the expected positive sign on the participation, the global information provided by the variable VISIBLE associated with non-economic motives appears to have the opposite effect, comforting us in the choice of this variable. The marginal effect of VISIBLE*FORBIODIV is highly significantly different from zero and equal to -0.0210, can be interpreted as follows: a larger visibility of one point on a scale from 1 to 8 reduces the likelihood of a farmer planting trees for a biodiversity motive by 2.1 pp. The same applies for farmers who see the forest as an asset for successors, the probability to plant decreases by 1.66 pp (variable VISIBLE*FORASSET). These results appear as evidence that the visibility of economic incentives reduces participation in this case, and thus partially crowd-out environmental and social (intrinsic) motivations. Furthermore, we also find a significantly negative effect of the variable VISIBLE*BADLAND, with a value of -0.0194. Even if the replacement of bad farmland by tree planting could be a motive for scheme participation, the visibility of economic conditions of afforestation schemes reduces its probability. We speculate that the fear of the look of peers who know the economic conditions of the scheme and maybe less the specific individual conditions of farming is an additional factor of crowding-out. It is worth noting that the sum of crowding-out for a one-point increase of visibility corresponds to a decrease of 5.7 pp, that is equivalent to dividing the mean probability of participation of 11.4 by two.

Finally, we found no significant associations between scheme participation and socio-demographic variables, but retired farmers who seem to have a larger propensity to afforest their land.

We used the same explanatory variables as determinants of the afforestation level, except we excluded the socio-demographic variables from the AFFOREST equation to make it possible to identify the complete model. In general, the sign of the effects of variables were the same as those found in the PARTICIP equation. However, we found some differences for a few variables. For example, even though SHEEP and DAIRYPLUS farms participate less in the afforestation scheme, when they decide to participate, once the farm area is controlled for, they plant more than other farm systems. However, their income has a negative effect; higher incomes tending to diminish this planted area. We also found a negative effect of the amount of the annual premium on the afforestation intensity. A possible explanation is the higher premium values are paid for broadleaf species compared to conifers; broadleaf species tend to be planted on more productive land and farmers would tend to release smaller areas of good quality land for afforestation compared to better quality land.

We also found expected results such as a lower planted area when the farmer has ambition for his/her farm or when the farm is regarded as a family asset to pass on. On the other hand, motives seems not to have effect on the afforestation level, except when tree planting is seen as a good future asset for future generations. Finally, we highlight some crowing-out effects from the variables VISIBLE*FORMONEY and VISIBLE*FORASSET. A possible explanation is the planting for money motive may be negatively affected when the actual monetary incentives that are available become visible, i.e. the monetary benefits may have been overestimated initially.

When farmers already participated in afforestation scheme, they are likely to participate more in afforesting more. This proves that they are convinced by the past operation. Most importantly, all motives for planting or not planting are now significant factors of planned participation with expected signs, including economic motives. This seems to show that farmers are now better informed on economic conditions of the afforestation scheme and also on forestry than when they were when they first faced to the participation decision. And we still find evidence of crowding-out effect, more specifically for those who are motivated by their bad farmland.

7. Discussion and conclusions

Increasing the amount of premium is not the best channel to embark the farmers in afforestation of their lands.

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Other possible titles:

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