# Maintenance of permanent grasslands – agri-environmental protection, passive land use or constraint for the structural development?

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## Abstract

This paper studies the role of market driven structural changes, and changes in agricultural policy in reconversion of permanent grassland to cropland in Estonia. Data on parcels of agricultural land and beneficiaries of direct payments in Estonia, from 2013 to 2016, and logistic regression is used in the analysis. It is argued that as a result of crisis in milk market in 2015 and 2016 some of the dairy farms changed their specialisation to cereals, oilseeds and protein crops and reconverted some of their permanent grasslands to cropland. At the same time, dairy farms who quit milk production and became specialised in cattle, sheep and goats preserved their permanent grasslands. In 2015 and 2016 the cheapest maintenance practice of permanent grassland, grass chopping, was restricted on a beneficiary's permanent grasslands that exceeded 10 ha. This stimulated changes in land market. Some of the permanent grasslands that were preserved by passive land owners were transferred to cereals, oilseeds and protein crops farms, and cattle farms. As an adverse effect, this increased likelihood that permanent grasslands were reconverted to cropland. It is concluded that since passive land owners and cereal, oilseeds and protein crops farmers also contribute to maintenance of permanent grasslands, the cheapest maintenance practices should not be restricted. At the same time, it is crucial to improve resilience of grassland farms that contribute the most to permanent grasslands preservation.
Keywords: permanent grasslands, maintenance practices, greening, land use policy

## 1. Introduction

The 2013 CAP reform introduced greening of decoupled area payments. Greening has been considered as one of the main novelties of the 2013 CAP reform (Matthews, 2013; Cortignani et al., 2017), but it has also been criticised for its ineffectiveness in delivering environmental benefits (OECD, 2017). Since 2004, Estonia has applied decoupled area payments in the form of single area payment (SAP). Since 2015, the beneficiaries of the SAP have to apply also for the climate and environment (i.e. greening) payment (hereafter SACEP) which stipulates obligations for crop diversification practice, maintenance of permanent grasslands, and practice of ecological focus areas. Maintenance of permanent grasslands is considered relevant for GHG mitigation and carbon sequestration (Gocht et al., 2016).

In Estonia, permanent grasslands comprise about 1/3$^{rd}$ of the utilised agricultural area (UAA). From 2012 to 2016 the share of permanent grasslands declined from 34.4% to 30.6% (Figure 1). In 2016, the share of permanent grasslands at national level decreased below the agreed minimum threshold. Therefore, in 2017, 1,722 beneficiaries of the SACEP were obliged to restore 8,200 ha of permanent grasslands. What lead to such situation in a country with relatively extensive agriculture and abundance of permanent grasslands?

In the end of the 1980-ies, there was 1.2 million ha of agricultural land in Estonia. During the ownership, land and agricultural reforms in the 1990-ies, about 1/3$^{rd}$ of this land was abandoned, mainly in the regions with low soil fertility (Astover et al., 2006), resulting in fragmentation of agricultural land (Hartvigsen, 2014; Jürgenson, 2016). After the Estonia's EU accession, from 2004 to 2016 the UAA increased by 27% from 792,409 ha to 1,003,505 ha (Figure 1). From 2004 to 2014, about half of the growth of the UAA was due to increase of the area of permanent grassland temporarily not used for production purposes. In 2013, in Estonia, such land comprised 11.1% of the UAA, which was the largest share in the EU (Eurostat, 2019). Large part of this land was abandoned in the 1990-ies.

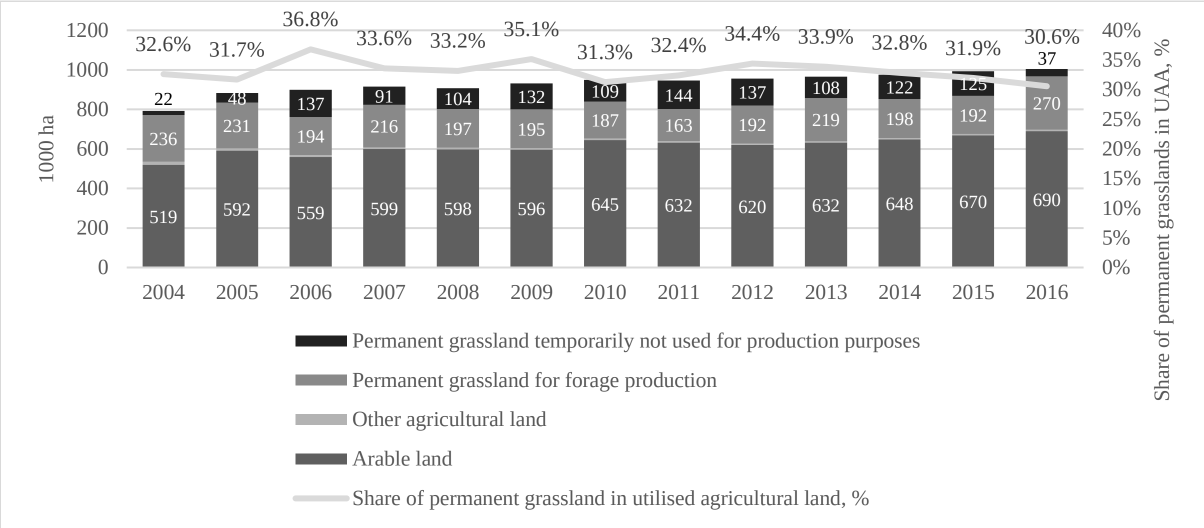


**Figure 1.** Agricultural land use in Estonia from 2004-2016
Source: Statistics Estonia (2019)

In Estonia, the main reason behind the increase of the area of permanent grassland temporarily not used for production purposes was introduction of decoupled SAP in 2004. Increase in SAP payment rate since 2004 has incentivised land owners and land users to maintain their permanent grasslands in good agricultural and environmental conditions (GAEC) even if this land is not used for agricultural production, i.e. for forage production or grazing. Many of such land owners became owners during the agricultural, ownership and land reforms in the 1990-ies (Viira et al., 2009). Nowadays, most of them are not active farmers but rather have sold or rented their agricultural land to farmers, or alternatively maintain the permanent grasslands in GAEC by themselves or buy maintenance service.

The most common maintenance practices of such permanent grasslands are grass harvesting or chopping. The minimum requirement is that permanent grasslands need to be chopped or harvested once during the growing season. Grass chopping means that chopped plant residues are left on the ground. It is the least costly option for maintaining the permanent grasslands temporarily not used for production purposes in GAEC. According to the survey of the beneficiaries of SACEP conducted in Estonia in 2016, the average cost of chopping the grass once during the growing season was 38 euro/ha. Average cost of harvesting and removing the grass was 54 euro/ha (Viira et al., 2016).

This phenomenon has fuelled debates between farmers and land owners, and also within the farming community. From the farmers' point of view, payments for maintaining permanent grassland temporarily not used for production purposes increase the agricultural area eligible for SACEP and dilute average payment rates for active farmers. This argument is supported by Di Corato and Brady (2019) who found that decoupled payments increase passive farming which undermines the Basic Payment Schemes's potential in supporting farmers' incomes. Also, it decelerates the consolidation of agricultural land since part of the agricultural land is maintained in GAEC by land owners who are not active agricultural producers.

Estonia has been considered a country with a high risk of agricultural land abandonment (Terres et al., 2015). Brady et al. (2017) conclude that support to passive farming provides public goods and helps to preserve marginal farmland. Thus, one could argue that preserving permanent grassland temporarily not used for production purposes has also social merits, provides some income for rural land owners and ensures that such permanent grasslands are not abandoned like in the Estonian case in the 1990-ies.

The debate on the issue among the farmers arises from the conflicting interests of arable crop and dairy, beef, sheep and goat farmers. Previous research has demonstrated that area payments capitalise in land value (Brady et al., 2017). Grazing livestock farmers are interested in expanding their permanent grassland area at the least cost while SACEP gives arable crop farmers (and passive land owners) an incentive to maintain permanent grasslands temporarily used for production purposes in GAEC by themselves, and thereby increases land price.

The environmental aspects in the debate mainly revolve around the environmental effects of the maintenance practices. The respondents of the survey conducted in Estonia in 2016 (Viira et al., 2016) raised several environmental issues that are related to the maintenance practices of permanent grasslands. Large machines and equipment used for grass harvesting or chopping harm small wild animals and farmland birds. Lüscher et al. (2015) found that increasing number of mechanical operations decreased the species richness of bees and rare plants. According to the respondents, while chopping the grass and leaving the residues on the ground may have negative effects on wild animals and birds, it helps to avoid abandonment of permanent grasslands. At the same time, respondents suggested that leaving the plant residues on the ground has positive effects on soil fertility and humus content. Also, it was highlighted that in some regions or fields, or in some years, heavy machinery cannot be used for grass harvesting and only lighter machines and chopping equipment can be used. According to the respondents, since the number of cattle, sheep and goats has not increased, there is no use for all the forage that could be harvested from permanent grasslands. Similar problem has been reported in Sweden (Trubins, 2013). Therefore in many cases the harvested forage is left on the edges of fields or forests. The respondents found such practice environmentally harmful and unacceptable for local communities.

Since the 2003 Fischler reform, the CAP has aimed to strengthen farmers' incentives to respond to market signals. From the left panel of Figure 2 it appears that (with a lag of one year) during the periods when output price index of cereals has exceeded input price index, sown area of cereals has increased in Estonia. Increase in sown area of cereals in part coincides with decline in the share of permanent grasslands in the UAA (Figure 1). The right panel of Figure 2 demonstrates than crises in milk market in 2009 and especially in 2015-2016 resulted in reduction of dairy herd. Consequently, demand for forage decreased.

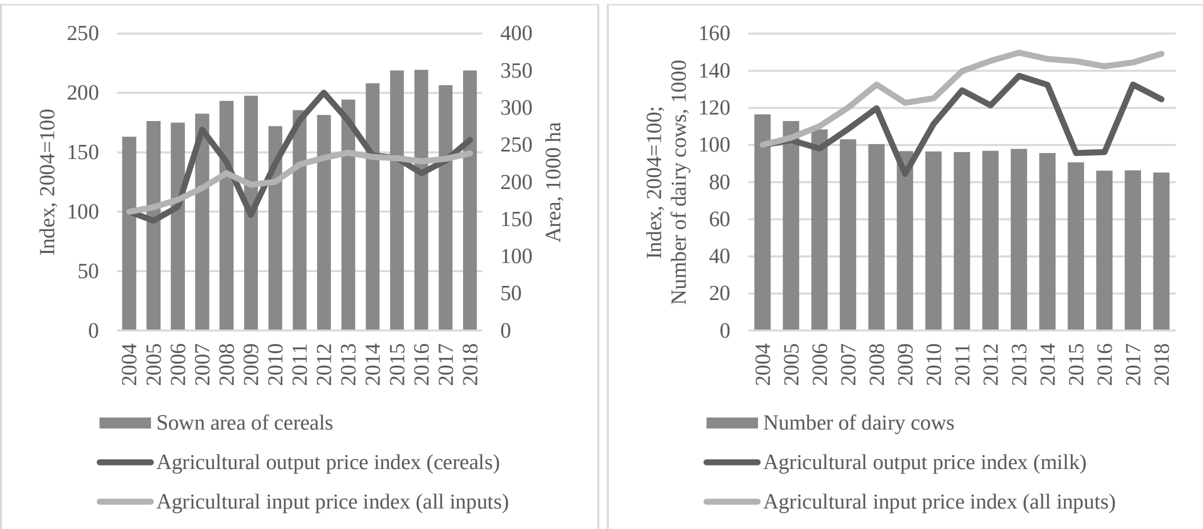


**Figure 2.** Indices of agricultural output and input prices and, sown area of cereals (left panel) and number of dairy cows (right panel) in Estonia, 2004-2018.
Source: Statistics Estonia (2019)

In addition to changes in production, changes occurred also in farm specialisation. From 2010 to 2016, in Estonia, the number specialist field crops farms increased by 30.0% and number of specialist grazing livestock farms decreased by 17.5%. From 2013 to 2016 the number of farms with dairy cows decreased by 31.2%. At the same time the number of farms with other (beef) cattle increased by 17.1% (Statistics Estonia, 2019). This structural development suggests that not all of the dairy farms that quit milk production during 2015-2016 crisis left agricultural sector. Some of those farms probably changed their specialisation and became field crop or beef farms.

In this period a change occurred in agricultural policy in Estonia. From 2014 to 2016 complementary national direct payments were terminated (OECD, 2018). This resulted in decreasing average subsidies per ha of UAA (Table A1) and further decreased farm incomes.

Following the increase in the area of permanent grassland temporarily not used for production purposes from 2004 to 2014, and accompanying debates, Estonia restricted the permanent grasslands maintenance practices eligible for SACEP for 2015 and 2016 (RT I, 22.04.2015, 27; RT I, 22.04.2016, 4). The use of least costly method of chopping the grass and leaving the plant residues on the ground, was strongly restricted[1]. At the same period, dairy farms were facing a crisis in the milk market that was triggered by the import ban of the Russian Federation that started in August 2014, and abolition of milk quotas in the EU since April 2015. Combination of these events lead to reduction of area of permanent grasslands at the national level below the agreed threshold.

This paper aims to explore the role of structural changes in Estonian agriculture, and restrictions on eligible maintenance practices of permanent grasslands imposed in 2015 and 2016, in the reduction of the area of permanent grassland. Information from the national paying agency (ARIB – Estonian Agricultural Registers and Information Board) on agricultural land parcels and beneficiaries of SACEP from 2013-2016, and logistic regression is used for the analysis.

## 2. Data and methodology

One of the aim of the greening of the CAP and SACEP is that permanent grasslands are preserved as permanent grasslands and are not reconverted to any other use, e.g. arable crops. Therefore, the analysis focuses on the land parcels that were covered by permanent grassland in 2013 but by 2016 were reconverted to arable cropland. Data from the ARIB was used for the analysis. In 2013, in Estonia there were 162,187 parcels of agricultural land that were eligible for SAP (Table 1). The total area of these parcels was 921,233 ha and average parcel size was 5.68 ha. There were 59,641 parcels (36.8% of all parcels) of permanent grassland (>5 years) with total area of 255,144 ha (27.7% of total area) and average parcel size of 4.60 ha, and 13,385 parcels (8.3%) of natural grassland with total area of 36,049 ha (3.9%) and average parcel size of 3.58 ha. In total, permanent and natural grasslands comprised 31.6% of area eligible for the SAP.

**Table 1.** Agricultural land parcels eligible for single area payment in Estonia in 2013

| Land parcel type | Number of parcels | Area, ha | Average parcel size, ha |
|---|---|---|---|
| Field crops | 84,936 | 617,308 | 7.27 |
| Permanent crops | 1,859 | 3,072 | 2.63 |
| Fallow | 2,366 | 9,659 | 4.50 |
| Permanent grassland | 59,641 | 255,144 | 4.60 |
| Natural grassland | 13,385 | 36,049 | 3.58 |
| Total | 162,187 | 921,233 | 5.68 |

Source: Own compilation based on the data from ARIB

[1] In 2015, the general restriction was that chopped grass residues could be left on the ground on 10 ha and 10% of the area exceeding 10 ha. In 2016, the chopped grass residues could be left on the ground on 15% of the area eligible for SACEP.

The second dataset from the ARIB that was used in the analysis included information on the beneficiaries of SAP (2013 and 2014) and SACEP (2015 and 2016), about their land use and agricultural animals. Based on the FADN typology, a farm type was assigned for each beneficiary. In addition to typical FADN farm types, an additional farm type was assigned that is named ‘passive land users’. All those beneficiaries of SACEP that did not grow field crops and did not have agricultural animals were considered as ‘passive land users’.

The datasets of land parcels and land users were merged. It appears that the farm types that used most of the agricultural land in 2013 were specialist cereals, oilseeds and protein crops farms (31.7% of the SAP area) and specialist dairy farms (24.9%) (Table 2). The main users of permanent and natural grasslands were specialist dairy farms (22.0% of the area of permanent and natural grasslands), passive land users (21.3%), mixed farms (16.4%) and specialist cattle farms (15.9%). Specialist cereals, oilseeds and protein crops farms used 5.7% of permanent and natural grasslands.

Maintenance of permanent grasslands assumes that permanent grassland parcels are not reconverted into arable or other cropland. Reduction in the area and share of permanent grasslands (Figure 1) suggests that in some cases, permanent grassland parcels have been converted into arable or other cropland. In order to detect such parcels, the land use status of land parcels that in 2013 were either permanent or natural grassland were compared with their respective land use status in 2016.

**Table 2.** Farm types of single area payment beneficiaries and their land use in Estonia in 2013

| Farm type | Number of farms | Field crops, ha | Permanent crops, ha | Fallow, ha | Permanent grassland, ha | Natural grassland, ha | Total*, ha |
|---|---|---|---|---|---|---|---|
| 15 Specialist cereals, oilseeds and protein crops | 2,104 | 272,753 | 47 | 3,114 | 15,056 | 1,486 | 292,455 |
| 1 Specialist field crops except 15 Specialist cereals, oilseeds and protein crops | 1,368 | 24,209 | 123 | 1,302 | 4,545 | 802 | 30,981 |
| 2 Specialist horticulture; 3 Specialist permanent crops; 6 Mixed cropping; 9 Non-classified holdings | 350 | 1,277 | 2,485 | 479 | 922 | 189 | 5,353 |
| 45 Specialist dairying | 1,249 | 162,982 | 63 | 606 | 64,192 | 2,192 | 230,035 |
| 46 Specialist cattle – rearing and fattening | 769 | 12,862 | 72 | 397 | 39,646 | 6,679 | 59,656 |
| 47 Cattle – dairying, rearing and fattening combined | 609 | 13,205 | 29 | 427 | 22,118 | 1,968 | 37,747 |
| 48 Sheep, goats and other grazing livestock | 985 | 5,328 | 36 | 148 | 18,065 | 3,197 | 26,773 |
| 5 Specialist granivores | 15 | 4,812 | 1 | 53 | 94 | 3 | 4,964 |
| 7 Mixed livestock holdings; 8 Mixed crops – livestock | 4,003 | 119,868 | 217 | 3,130 | 42,287 | 5,600 | 171,103 |
| Passive land users | 5,585 | 11 | 1 | 2 | 48,220 | 13,934 | 62,168 |
| Total* | 17,037 | 617,308 | 3,072 | 9,659 | 255,144 | 36,049 | 923,233 |

Source: Own compilation based on the data from ARIB and FADN typology
*Values of ‘Total’ do not add up due to rounding. Originally, the parcel size data had two decimals.

Logistic regression was used to estimate the effect of land user’s farm type, changes in farm type, land parcel size and area (>10 ha) of permanent and natural grasslands on the probability that permanent or natural grassland parcel was converted to arable cropland between 2013 and 2016. The descriptive statistics of the variables are presented in Table 3. Information about 61,891 parcels of permanent and natural grasslands was valid for the regression analysis[2].

[2] In 2013, there were 72,026 parcels of permanent or natural grasslands, i.e. information about the land use type of 15.5% of parcels was not available for 2016. One of the main reason for that is changes in the land parcel ID-s. However, information

R version 3.5.1 was used for estimating the model parameters. The logistic regression model was specified as:

(1) $\text{Logit}(\textit{Pasture\_crops}_j)=\alpha_0+\alpha_{1j}\textit{Parcel}+\alpha_{2j}\textit{Grass\_10}+\alpha_{3j}\textit{Cereal}+\alpha_{4j}\textit{Cereal*Grass\_10}+\alpha_{5j}\textit{Dairy}+\alpha_{6j}\textit{Cattle}+\alpha_{7j}\textit{Passive}+\alpha_{8j}\textit{Passive*Grass\_10}+\alpha_{9j}\textit{Dairy\_cereal}+\alpha_{10j}\textit{Dairy\_cattle}+\varepsilon_j$

The variable *Pasture_crops* is 1 if permanent or natural grassland parcel *j* in 2013 was covered by field crops in 2016. Otherwise its value is 0. In total 20% of parcels that were permanent or natural grassland in 2013 were covered by arable crops in 2016.

*Parcel* is a measure of parcel size. Average parcel size in 2013 was 4.26 ha. We assumed that parcel size has a positive effect on the probability that permanent or natural grassland parcel is converted into cropland.

*Grass_10* is a dummy variable indicating if the user of a parcel of permanent or natural grasslands had in total more than 10 ha of permanent and natural grasslands. 85.5% of permanent and natural grassland parcels were used by farmers or passive land users that had more than 10 ha of permanent and natural grasslands. In the regression model, *Grass_10* is also used in interaction with variables *Cereal* and *Passive*. We assumed that the permanent and natural grassland parcels of those specialised cereals, oilseeds and protein crop farms, and passive land owners that had more than 10 ha of permanent and natural grasslands were more likely reconverted to arable cropland due to the restrictions on maintenance practices imposed in 2015 and 2016.

*Cereal* is a dummy variable indicating if the farm that received SACEP for the parcel *j* was specialised in cereals, oilseeds and protein crops both in 2013 and 2015[3]. In the dataset, 5% of parcels of permanent and natural grasslands were used by specialised cereal, oilseed and protein crops farms. We assumed that due to restrictions in permanent grassland maintenance practices (grass chopping) cereal, oilseeds and protein crops farms were more likely to reconvert their permanent or natural grassland into cropland.

**Table 3.** Definition and descriptive statistics of variables

| Variable | Definition | Scale/measurement | Average | Min | Max | St.dev |
|---|---|---|---|---|---|---|
| **Dependent variable** | | | | | | |
| *Pasture_crops* | Parcel of permanent grassland that has been converted to arable cropland | 0=no; 1=yes | 0.200 | 0 | 1 | 0.400 |
| **Explanatory variables** | | | | | | |
| *Parcel* | Parcel size | Ha | 4.264 | 0.01 | 275.00 | 6.293 |
| *Grass_10* | Farm's permanent and natural grassland area is larger than 10 ha | 0=no; 1=yes | 0.855 | 0 | 1 | 0.352 |
| *Cereal* | Farm specialised in cereals, oilseeds and protein crops | 0=no; 1=yes | 0.050 | 0 | 1 | 0.218 |
| *Dairy* | Farm specialised in dairy | 0=no; 1=yes | 0.131 | 0 | 1 | 0.337 |
| *Cattle* | Farm specialised in cattle, sheep or goat | 0=no; 1=yes | 0.318 | 0 | 1 | 0.466 |
| *Passive* | Passive farmer | 0=no; 1=yes | 0.221 | 0 | 1 | 0.415 |
| *Dairy_cereal* | Farm that converted from dairy to cereals, oilseeds and protein crops | 0=no; 1=yes | 0.002 | 0 | 1 | 0.049 |
| *Dairy_cattle* | Farm that converted from dairy to cattle, sheep or goat | 0=no; 1=yes | 0.015 | 0 | 1 | 0.121 |

Source: Own compilation based on the data from ARIB and FADN typology

about the land use type of 84.5% of parcels of permanent or natural grasslands in 2013 was available also for 2016. We consider it sufficient for the current analysis.

[3] While land use change was detected by comparing the land use type of each parcel in 2013 and 2016, changes in farm specialisation was determined by comparing the 2013 and 2015 farm type information.

*Dairy* is a dummy variable that indicates if the farm that received SACEP for the parcel *j* was specialised in milk production in 2013 and 2015. Specialised dairy farms managed 13.1% of the parcels. We assumed that those specialised dairy farms that did not change their specialisation between 2013 and 2015 had a lower probability to reconvert permanent or natural grasslands into cropland.

*Cattle* is a dummy variable that indicates if the farm that received SACEP for the parcel *j* was specialised in cattle rearing and fattening, in dairying, rearing and fattening combined or in sheep, goats and other grazing livestock both in 2013 and 2015. 31.8% of the parcels were managed by such farms. We assumed that those cattle farms that did not change their specialisation between 2013 and 2015 had a lower probability to reconvert permanent or natural grasslands into cropland.

*Passive* is a dummy variable that indicates if the beneficiary of the SAP in 2013 was passive land user. In total 22.1% of the parcels were used by passive land users. We expected that due to restrictions of eligible permanent grassland maintenance practices, passive land users more likely rented or sold their land to active farmers, and active farmers might have reconverted these permanent or natural grassland parcels to cropland.

*Dairy_cereal* is a dummy variable indicating if the farm that was specialised in milk production in 2013 changed its specialisation and in 2015 was specialised in cereals, oilseeds and protein crops. We expected that those specialised dairy farms who became specialised cereals, oilseeds and protein crop farms by 2015 more likely reconverted their permanent or natural grasslands into cropland.

*Dairy_cattle* is a dummy variable indicating if the farm that was specialised in milk production in 2013 changed its specialisation and in 2015 was specialised in cattle rearing and fattening, in dairying, rearing and fattening combined or in sheep, goats and other grazing livestock. We expected that those specialised dairy farms who became specialised cattle farms by 2015 less likely reconverted their permanent or natural grasslands to cropland.

## 3. Results and discussion

Our results show that parcel size significantly and positively affects the likelihood that the parcel of permanent grassland is reconverted to cropland (Table 4). This result is in line with our expectation and suggests that larger permanent grassland parcels are more attractive for crop production. Arable crop farms use mainly large scale equipment, and larger parcels help crop farmers to save working time and fuel used for manoeuvrings.

In case of land users who had more than 10 ha of permanent and natural grasslands, the probability that permanent and natural grasslands was reconverted to arable cropland was significantly lower. Our assumption was that since the restrictions on permanent grassland maintenance practices affected mainly those farmers and land users that had more than 10 ha of permanent grasslands, these farmers and land users have significantly higher probability that their permanent grasslands were reconverted to cropland.

As expected, specialised cereals, oilseeds and protein crop farms had significantly higher probability of converting their permanent and natural grassland parcels into cropland. This could be explained in three ways. In 2013 and 2014 the cereal prices were favourable (left panel of Figure 2) and gave cereal, oilseeds and protein crop farmers an incentive to increase the area of their cropland. If a farmer had permanent or natural grassland, he/she could have decided to reconvert some of it into cropland. Another explanation is that cereal, oilseeds and protein crops farms did not have equipment for harvesting the grass in 2015 and 2016, after the grass chopping was restricted. Also, grass harvesting service might have been unavailable or there was no use or demand for the harvested grass. The third explanation is that decrease in average sum of subsidies per ha of UAA gave cereals, oilseeds and protein crops farmers a stronger incentive to expand their cropland and therefore, the farmers decided to reconvert permanent grasslands into cropland. Since until 2015 at national level the share of permanent grasslands was above the minimum threshold, reconversion of permanent grassland into cropland was not penalised at the farm level.

**Table 4.** Results of the logistic regression

| Variable | Estimate | Std.Error |
|---|---|---|
| Intercept | -0.688 | -0.011*** |
| *Parcel* | 0.026 | 0.001*** |
| *Grass_10* | -0.335 | 0.036*** |
| *Cereal* | 0.445 | 0.083*** |
| *Cereal*Grass_10* | 0.110 | 0.094 |
| *Dairy* | -0.525 | 0.034*** |
| *Cattle* | -1.074 | 0.029*** |
| *Passive* | -1.631 | 0.068*** |
| *Passive*Grass_10* | 0.811 | 0.075*** |
| *Dairy_cereal* | 1.107 | 0.170*** |
| *Dairy_cattle* | -0.702 | 0.090*** |
| N=61891<br>Null deviance: 61998 on 61890 degrees of freedom<br>Residual deviance: 58623 on 61880 degrees of freedom<br>AIC: 58645 | | |

***Significant at 0.01 level

The fact that specialised cereal, oilseeds and protein crop farms had more than 10 ha of permanent and natural grasslands in 2013 did not significantly affect the probability that the permanent ort natural grassland was reconverted into arable cropland. This suggest that in case of cereal, oilseeds and protein crop farms, the main incentive for reconverting permanent and natural grassland into cropland was favourable market situation and/or decline in average sum of subsides per ha of UAA rather than restrictions on using chopping as a permanent grassland maintenance practice.

The fact that cereal, oilseeds and protein crops farmers more likely reconverted their permanent and natural grasslands to cropland raises the question about the sufficient payment rate for maintaining permanent grasslands in case of active farmers who do not have ruminant animals. From Table A2 it appears that from 2010 to 2012 and in 2014 and 2015 the gross margins 1 and 2 of spring wheat exceeded the SACEP payment rate. The same applies for spring barley gross margins from 2011 to 2013. Figures 1 and 2 show that in these years the agricultural area under cereals increased and share of permanent grasslands decreased. This suggests that if the gross margin of cereal production exceeds the payment for maintenance of permanent grasslands, the probability that specialised cereal, oilseeds and protein crops farms reconvert some of their permanent grasslands to cropland increases. When in 2015 and 2016 the use of the cheapest permanent grassland maintenance practice was restricted, this further increased the relative profitability of production of cereals vs. maintenance of permanent grasslands. Therefore, if the aim is to preserve permanent grasslands, the payment rate for that for cereals, oilseeds and protein crops farms should increase. On the other hand this would result in even higher capitalisation of subsidies in land value (Brady et al., 2017) or stronger persistence of passive farming (Di Corato and Brady, 2019)

Dairy and cattle farms that retained their specialisation between 2013 and 2016 had significantly lower likelihood of reconverting permanent grasslands into cropland. This result was also expected for these farm types had no incentive to do so, and restriction of eligible maintenance methods (grass chopping) was not binding them since they used grazing or grass harvesting for the maintenance of their permanent grasslands. Therefore, resilience of dairy, cattle, sheep and goats farms is important to respond to the societal expectation that permanent grasslands are preserved as a result of agricultural production (Pol et al., 2018).

We expected that in case of passive land users the probability that their permanent grasslands will be converted into cropland is significantly higher. Unexpectedly in case of passive land users the probability that permanent grasslands were converted into cropland was significantly lower. However, the data reveals that 4.4% of the parcels of permanent and natural grasslands that in 2013 were maintained in GAEC by passive land users were used by active farmers in 2016. In 2016, 2.2% of the parcels that in 2013 were maintained by passive land users were used by cereal, oilseeds and protein crops farmers, and another 2.2% of their parcels were used by dairy, beef, sheep and goat farms.

Estimated coefficient of interaction of variables *Passive* and *Grass_10* reveals that if a passive land owner had more than 10 ha of permanent and natural grasslands in 2013, the probability that this land was reconverted to arable cropland by 2016 was significantly higher. This suggests that restricting the eligible permanent grassland maintenance practices might have triggered changes in the agricultural land market. Some of the land used by passive land owners that had more than 10 ha of permanent and natural grasslands had moved to the active farmers, and some of these active farmers (cereal, oilseeds and protein crop farms) reconverted these permanent or natural grasslands to arable cropland. Therefore, the restriction of maintenance practices of permanent grasslands partially resulted in adverse effect – reconversion of part of permanent grasslands to cropland. This suggests that in case of passive land users the eligibility of the cheapest maintenance practice (grass chopping) is preferable to restricting it.

If the dairy farm changed its specialisation to cereals, oilseeds and protein crops, the probability that permanent grasslands were converted into cropland was significantly higher.

On the contrary, when dairy farm changed its specialisation and became cattle, sheep or goat farm, the likelihood that permanent grasslands were converted to cropland, was significantly lower. These results comply with our expectations and further highlight the role of resilience of grassland farms (i.e. dairy, cattle, sheep and goats farms) in preserving permanent grasslands.

Another aspect that is related to ruminant production is related to ammonia emissions. According to the Directive (EU) 2016/2284 Estonia has to ensure that starting from year 2020 the ammonia emissions remain 1% below the 2005 level. From 2005-2018 the number of cattle, sheep, goats and poultry has increased in Estonia, while number of pigs has declined. Considering that approximately 100,000 ha of permanent grasslands were not used for production purposes in 2014, maintenance of these permanent grasslands via agricultural production would require increase in number of ruminant animals. This is feasible, but from the one hand requires further investments into technologies and solutions that reduce ammonia emissions and from the other hand might require stimulus (higher subsidies) for increasing the number of ruminant animals. This suggests that in Estonian case, maintenance of the part of permanent grasslands that are not used for production purposes has to rely on the practices like grass chopping and/or harvesting. To reduce total costs of maintenance of permanent grasslands, the use of the cheapest practice should be eligible. To increase the social acceptance and also reduce possible negative externalities of chopping, the maintenance should be need-based. As suggested by respondents, in many cases, permanent grasslands should be maintained once in two or three years rather than annually (Viira et al., 2016).

In the light of increasing concerns about climate change, demand for climate change mitigation (Eory et al., 2018), changes in dietary recommendations (reduction of consumption of animal products), and aspiration to develop bioeconomy (Pilvere et al., 2015) it should be analysed if part of the (from food production perspective) less valuable permanent grasslands could be afforested or used for growing crops that could be used for bioenergy production or in biorefineries. These permanent grasslands that have higher potential for food production or which are valuable for biodiversity should be preserved as permanent grasslands by using the most appropriate practices for each location and situation. Therefore, the policy for maintenance of permanent grasslands should become more result oriented (Birge et al., 2017). The Estonian case demonstrates that maintenance practice based solutions and/or restrictions can have adverse effects.

## 4. Conclusions

In Estonia, permanent grasslands comprise approximately 1/3$^{rd}$ of the UAA. From 2012 to 2016 the share of permanent grasslands decreased and in 2016 breached the agreed minimum threshold. Market related and agricultural policy related factors had a role in this development. In the periods of favourable cereal prices, the area under cereals has increased and in part this increase has been on the account of permanent grasslands. Cereal farms had significantly higher probability to reconvert permanent grasslands to cropland.

During the crisis in milk market in 2015 and 2016, some dairy farms changed their specialisation. These dairy farms that became specialised in cereal, oilseeds and protein crops had significantly higher probability to reconvert permanent grasslands to cropland. Dairy farms that started cattle, sheep or goats production had significantly lower probability to reconvert their permanent grasslands to cropland.

Agricultural policy related factors are related to restrictions on eligible practices for the maintenance of permanent grasslands in 2015 and 2016. The cheapest practice of grass chopping (and leaving the plant residues on the ground) was restricted for those permanent grasslands of a farmer or passive land user that exceeded 10 ha. Our results indicate that in case of passive landowners whose permanent grassland area exceeded 10 ha, the probability or reconversion of permanent grasslands to cropland was significantly higher. This suggest that restriction of eligible maintenance practices had in some cases adverse effects. Part of the permanent grassland was sold or rented to cereal, oilseeds and protein crops farms that reconverted these permanent grasslands to cropland.

The results suggest that if the CAP aims to preserve permanent grasslands, then it is important to improve the resilience of grassland farms (dairy, cattle, and sheep and goat farms in Estonian context). Also, since part of the permanent grasslands are maintained by specialised cereal, oilseeds and protein crop farms, and passive land users, restrictions on maintenance practices of permanent grasslands can be counterproductive, especially during the periods of relatively favourable market conditions.

However, while it is clear that the CAP has a key role in preservation of permanent grasslands, there is also a need for strong national and/or regional land use policies in member states to address the long term challenges like climate change, biodiversity loss, and bioeconomy development

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## 7. Appendix

**Table A1.** Total subsidies – excluding on investments – per ha of UAA, 2013-2017

| | **2013** | **2014** | **2015** | **2016** | **2017** |
|---|---|---|---|---|---|
| 15 Specialist cereals, oilseeds and protein crops | 188 | 171 | 156 | 157 | 180 |
| 45 Specialist dairying | 206 | 175 | 225 | 185 | 295 |
| 46 Specialist cattle – rearing and fattening | 228 | 198 | 208 | 190 | 206 |
| 47 Cattle – dairying, rearing and fattening combined | 204 | 180 | 187 | 177 | 243 |
| 48 Sheep, goats and other grazing livestock | 228 | 218 | 200 | 179 | 206 |

Source: Agricultural Research Centre (2019a)

**Table A2.** SAP/SACEP payment rate and gross margins of spring wheat and spring barley production, 2010-2018

| | **2010** | **2011** | **2012** | **2013** | **2014** | **2015** | **2016** | **2017** | **2018** |
|---|---|---|---|---|---|---|---|---|---|
| *Spring Wheat, yield 4500 kg/ha* | | | | | | | | | |
| SAP/SACEP payment rate, euro/ha | 79 | 90 | 100 | 109 | 114 | 115 | 115 | 123 | 133 |
| Gross Margin 1, euro/ha* | 564 | 565 | 626 | 521 | 553 | 488 | 382 | 301 | 512 |
| Gross Margin 2, euro/ha** | 163 | 203 | 216 | 92 | 141 | 116 | -3 | 1 | 80 |
| *Spring Barley, yield 4500 kg/ha* | | | | | | | | | |
| SAP/SACEP payment rate, euro/ha | 79 | 90 | 100 | 109 | 114 | 115 | 115 | 123 | 133 |
| Gross Margin 1, euro/ha* | 354 | 529 | 649 | 522 | 438 | 367 | 316 | 445 | 465 |
| Gross Margin 2, euro/ha** | -39 | 187 | 247 | 111 | 43 | 63 | -49 | 80 | 90 |

Source: Agricultural Research Centre (2019b)

*Gross Margin 1 is a difference between value of production, SAP/SACEP and variable costs

** Gross Margin 2 is a difference between value of production, SAP/SACEP, variable costs and costs of machinery operations