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MONITORING FRAMEWORK FOR ASSESSING CHANGES OF THE ESTONIAN RURAL LANDSCAPE IN ADOPTING EUROPEAN AGRICULTURAL POLICIES

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Abstract: The article describes the methodology of landscape and biodiversity monitoring in Estonia since 2004 for complying with European Union agricultural and environmental policies. The paper includes an overview of the introduction of the agri-environment programme; specifies how landscape features in agricultural and semi-natural areas are monitored, and to which extent agricultural impacts on environment are buffered by support measures. Designing monitoring networks to be spatially more efficient regarding changes in rural landscapes and assessing agricultural impacts is one of the keys to upgrading monitoring methods and decision-support systems.

Key words: Agriculture, agri-environment programme, biodiversity, Common Agricultural Policy (CAP), Estonia, landscape monitoring, European Union (EU) support schemes

Teesid: EESTI MAAMAASTIKE MUUTUSTE HINDAMISE SEIREKORRALDUS EUROOPA PÕLLUMAJANDUSPOLIITIKA KOHALDAMISEL. Artikkel käsitleb maastiku ja elurikkuse seire arendamist Eestis lähtuvalt Euroopa Liidu põllumajandus- ja keskkonnapoliitikast. Ülevaade põllumajanduse keskkonnaprogrammi käivitamisest arutleb maastikuväärtuste seire ja hindamise võimaluste üle põllumajandus- ja pool-looduslikel aladel, et vähendada põllumajanduse keskkonnamõjusid. Põllumajandusmaastike muutuste hindamisel on võtmeks erinevate keskkonnaseire võrgustike ajalis-ruumiline ühildamine ja meetodite sidustamine.

Võtmesõnad: Põllumajandus, põllumajanduse keskkonnaprogramm, bioloogiline mitmekesisus, Ühtne Põllumajanduspoliitika, Eesti, maastikuseire, Euroopa Liidu toetusskeemid

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1. Introduction

Agriculture is a major influence on rural environment and can both create and destroy the quality of natural resources and countryside features. While traditional agriculture originally contributed to the creation of valuable wildlife habitats and varied rural landscapes, intensification of farming methods has resulted in major damage to these, including the pollution of air and water (EEA 2005b, 2006). The European Union (EU) Common Agricultural Policy (CAP) is a major policy change in the new Member States, aiming to increase agricultural productivity by promoting technological progress and by ensuring the rational development of agricultural production and the optimum utilisation of the factors of production, in particular labour. The European Council adopted the strategy for integrating the environmental dimension into the CAP in 1999 (EEA 2005a). The main element introduced by the CAP in Estonia is the common requirements for food safety, veterinary medicine, plant health, and obviously environmental protection. Another important element of the CAP is the common application of financial support, which has essentially changed the Estonian agricultural sector. A well-targeted and cost-effective approach to environmental integration in the CAP is not automatically guaranteed. Any approach using agricultural policy for environmental protection needs to be underpinned by comprehensive environmental monitoring and effective policy evaluation.

Estonia was an essentially rural nation until the 1960s. The intensification of agriculture in the 1970s and 1980s, which was the period of soviet large-scale collective-type agriculture, resulted in major environmental problems. In the 1990s agriculture was subject to substantial reforms and changes following democratisation process, leading to land reform and institutional changes. Since the beginning of the 1990s, the negative impact of agriculture on the environment has been decreasing to some extent, due to the decrease in production volumes (Astover et al. 2006). At the same time, several problems have persisted, and some new problems have appeared, such as leaving agricultural land out of use, resulting in weeds spreading faster, open agricultural landscapes in peripheral unfavourable areas becoming overgrown with brushwood and loss of valuable semi-natural habitats.

Agricultural land in Estonia covers 12,305 km^2, which is 29% of the total territory (ERDS 2007). According to the Estonian Agricultural Registers and Information Board database, the officially registered farmland includes 8018 km^2 of cultivated land, 3351 km^2 of permanent grassland and about 910 km^2 of natural grassland (ERDS 2007, 2008). Half of agricultural land is defined as less favoured area, of which 55% is in use according to the agricultural census (ERDS 2007). Share of extensively cultivated areas is substantially higher in Estonia compared to the European average – 44.3% for arable land (EU-25 average 10.1%), 54.4% for pastures (EU-25 average 21.2%). Agriculture comprised 2.4% of the Gross Domestic Product and 3.9% of the labour force of Estonia in 2005 (Statistical Office 2006). Despite high political agenda on agriculture and less favoured areas listed, fundamental socio-economic indicators are still declining. As the economic conditions improve, the negative impact on the environment begins to increase again. For example, the use of plant protection products and mineral fertilizers has been growing in recent years, and this may cause water pollution and decrease biological and habitat diversity, and landscape heterogeneity unless modern environmentally friendly technologies are used (Astover et al. 2006). Bengtsson et al. (2005) and Dauber et al. (2005) have demonstrated that increased management intensity of agricultural fields is one of the main causes of the decline of local species richness. According to the Estonian Rural Development Strategy (ERDS) 2007-2013, the main environmental problems related to Estonian agriculture are as follows:

1. Declining biodiversity, mainly due to the loss and degradation of semi-natural habitats connected to land abandonment.
2. Loss of agricultural landscape value, mainly due to land abandonment.
3. Water pollution, mainly due to inadequate manure storage and handling.
4. Soil degradation and the continued risk of erosion (ERDS 2007).

Taking into consideration the background and implications of rural development, the article assesses setting the methodology of monitoring agricultural landscapes in Estonia via the adoption of EU agricultural and environmental policies. Three key questions are raised about support measures and their environmental impact:

1. What are the appropriate geographical features of monitoring?
2. What is the feasible pattern of monitoring network?
3. Which monitoring strategies should be implemented in the framework of the agri-environment programme?

2. Agri-environment programme and landscape monitoring

One response to concerns over biodiversity loss and destruction of rural landscapes has been the introduction of agri-environment schemes, in which farmers are paid to modify their farming practices, in order to receive environmental services and benefits (EEA 2005a). The overall aim of the agri-environment support measure is to facilitate the implementation and continuous use of environmentally friendly agricultural methods. The first extensive agri-environment programmes were developed in Norway, Switzerland, Austria and Sweden, where they have served agri-environment support payment schemes since the mid-1980s (Fjellstad et al. 2001, Folving et al. 2001, Kleijn and Sutherland 2003). In 1985, a green paper on the impact of agriculture on the environment addressed the emerging problems (COM 1985). In 1992, the European Economic Community Regulation 2078/92 was introduced, requiring all EU Member States to apply agri-environment schemes according to environmental needs and potential (EEA 2005a). Support schemes for environment are also an integral part of national Rural Development Plans. Between 50% and 75% of the costs of approved agri-environment schemes are co-funded by the EU, making this regulation a financially attractive form of environmental protection (EC 2003).

As a simultaneous development in the academic community, the exploration of the dynamics of landscape structural features has become an important topic in scientific research in many countries (Bailey and Herzog 2004). In recent years, landscape mapping and classification have evolved into highly innovative processes with extensive use of satellite remote sensing data and automated spatial analysis (Griffiths and Mather 2000, Mücher et al. 2000). An Organisation for Economic Co-operation and Development report (OECD 2002) summarises sophisticated monitoring methodologies, including biodiversity and abiotic landscape components as well as anthropogenic and cultural aspects of landscape. Landscape monitoring is inevitably very often policy-driven (Groom and Reed 2001), or focuses on specific values of natural landscapes that provide indispensable services to society (O'Neill et al. 1994).

What defines and constitutes an ‘agricultural landscape’ varies greatly. All encompassing definition of agricultural landscapes is that they are the visible outcomes resulting from the interaction between agricultural commodity production, natural resources and the environment, and include amenity, heritage, cultural, aesthetic and other societal values. The landscape concept of agri-environment programme sees agricultural landscape functions as an expression of the natural capital stock contained in the landscape, whereas goods and services express the flows of benefits to society. It stresses on provisioning food, though it tends to integrate also nature regulation (water, erosion), habitat (refugium and nursery) and amenity functions (recreation, culture) of landscape (De Groot and Hein 2007). The ethos of the Programme should be directed towards landscape diversity and value. Highly valuable landscapes support regional development; losses in landscape values indicate inevitably social losses. The multifunctional term of landscape is supported by post-modern approach of ‘new’ rurality which focuses heavily on externalities of agriculture and consumption of countryside. There is no clear consensus on final definitions of landscape functions and considering the complexity of man-environment interactions in multifunctional landscapes as there are still few comprehensive studies to link the physical and ecological characteristics of landscapes to their potential economic values (OECD 2001). Landscape and agriculture employ land use as a base characteristic (Vejre et al. 2007).

The objective of agri-environment programme (AEP) is also to develop and define framework for evaluating the societal benefits of agricultural landscapes. The monitoring system needs to be set to different types of landscapes (natural, semi-natural and cultivated) at different scales (landscape, ecosystem, plot). Special attention is paid to spatial aspects of landscape functions to account spatial heterogeneity of functions and in order to implement assessment and monitoring of fields in appropriate way. Landscape effects can be manifested at two non-exclusive levels, landscape and habitat heterogeneity (Weibull et al. 2003). It is therefore important to emphasise that evaluation and implementation of agri-environment programmes must incorporate the expected gain in species richness as a result of species differences between local communities.

3. The introduction of the agri-environment programme in Estonia

Landscape approach has gained an increased role in environmental management and policy in the 1990s. The transition of Estonia from the fragmented character of environmental protection activities of the former Soviet Union to a centralised national environmental protection strategy including coherent action plans and monitoring programme was set up in the first half of the decade. At the beginning of the 1990s the sustainable landscape management was quite exceptional outside conservation areas as introducing traditional approach of environmental regulations was the first priority. Meanwhile, the total restructuring characterised agriculture. In general, the marginalisation of farming areas was a process driven by a combination of social, economic, political and environmental factors.

Estonia has implemented a national agri-environment programme in accordance with the adoption of Rural Development Regulation 1257/99 (Council Regulation 1999). The application of the measure was meant to preserve and promote biological and landscape diversity, and increase the income of farmers who operate in an environmentally sustainable manner (ERDS 2006). The development of AEP and its evaluation began with defining the strategy and setting policy targets, followed by developing the draft national pilot, selecting indicators and pilot areas for evaluation. One major task was a pilot Programme project for testing the practical implementation in the Estonian context, evaluating the effectiveness of the proposed measures, finding out the detailed management prescriptions, in order to better achieve the objectives of the scheme, gaining an indication of the average payments per farm business, and also demonstrating and promoting the concept of a Programme in Estonia (Sepp et al. 2004). During the preparation of proposals more broad-based consultations within and outside the agricultural sector were added, in order to enhance general awareness of the Estonian agri-environment policy and practice. In total, more than 150 stakeholder groups were consulted during the project (ERDS 2008).

The implementation of the full set of AEP, which contributes to the draft evaluation and monitoring methodologies, started in pilot areas in 2001 with 64 farms receiving grants. These pilot areas were Palamuse rural municipality in Jõgeva county and Lümanda and Kihelkonna rural municipalities in Saaremaa. In addition to the nation-wide measures already available, in pilot areas support was granted for environmentally friendly management: breeding of the Estonian horse, restoration and maintenance of stonewalls, management of overgrown agricultural land, and in Palamuse also the establishment of ponds and mixed-species hedgerows. In 2002, a new pilot project was launched in 55 rural municipalities (at least one municipality per county) mainly located on islands and in less favoured areas.

As a result of pilot tests and lessons learnt, the Estonian agri-environment programme uses a complimentary mixture of a general scheme and supplementary schemes to encourage the adoption of a variety of agricultural production methods. These are designed to protect the environment and maintain the countryside by using agricultural land in ways compatible with the protection and improvement of rural environment and natural resources, including air, water, soil and genetic diversity; the conservation of high biological values farmed environments, which are under threat; the upkeep of traditional landscapes and historical features on agricultural land, and the use of environmental planning , a ‘whole farm agri-environment plan’ by those farmers participating in AEP. Several sub-programmes were cancelled during the first evaluation period due to lack or missing data, e.g. the supplementary creation of ponds and wetlands and abandoned land scheme. Valuable landscapes (see Palang et al. 2011) were loosely defined, using district level maps 1:100,000. Also, hedgerow support was initially introduced, though these are not traditional elements in the Estonian landscape. Test period indicated that a holistic approach is needed to develop complex indicators for assessment of agricultural landscapes.

4. The structure of the agri-environment programme in Estonia

Agricultural Research Centre, subordinated to the Ministry of Agriculture, coordinated data collection on agri-environment evaluation. The Centre acted as an independent evaluator for the agri-environmental programme. The function of the Estonian Agricultural Registers and Information Board subordinated to the Ministry is to maintain the register of agricultural supports and agricultural parcels and to allocate support.

In the first period from 2004-2006, four schemes were designed and prepared: Environmentally-friendly Production Scheme (EPS), as supportive measures Organic Farming (OF), Local Endangered Breeds (LEB), and Establishment, Restoration and Maintenance of Stonewalls (ES) (figure 1).

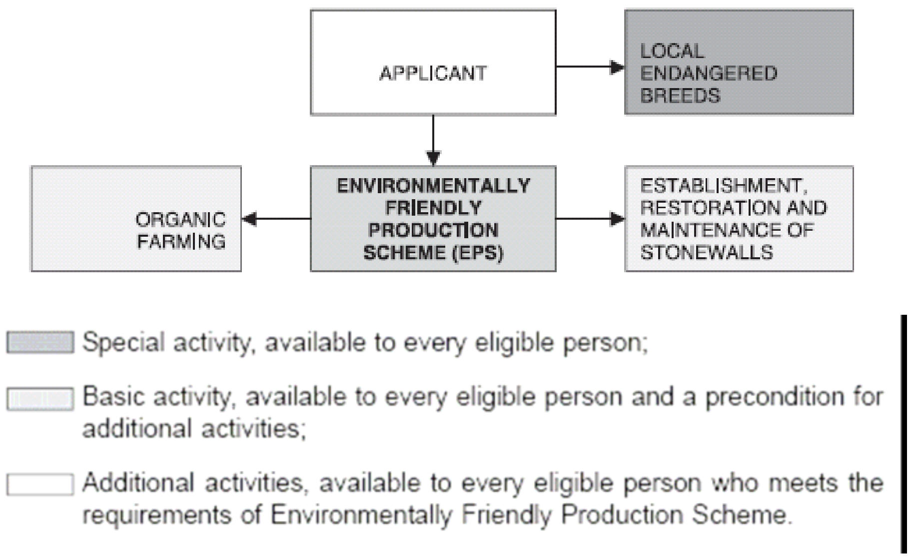

Fig 1. The structure of agri-environment supports in Estonia in 2004-2006.

The main objectives of the agri-environment programme are to direct agriculture towards more sustainable practices and to avoid damage to semi-natural and natural habitats and landscape elements on the farm. EPS payments enable the protection of semi-natural communities – the first priority from a biodiversity point of view. Also other measures envisaged in the Estonian Rural Development Strategy (ERDS), including financial support paid to the keepers of endangered local breeds of livestock, are directly related to biological diversity. ERDSAt the same time, the ERDS includes such benefits as reforestation support, which, on the contrary, might damage biodiversity. EPS and OF as farm management orientated programmes address multiple objectives. From the point of view of landscape preservation, both are most widespread and effective. Some schemes such as LEB and ES target single or few objectives.

The total ERDS budget of the agri-environmental programme period 2004-2006 was €188 million. The biggest support, €71 million (38% of total) has been given for environmentally-friendly production scheme. In 2006, agri-environment support covered a total area of 505,000 ha, i.e. 62% of all cultivated land (table 1). In addition, 8707 approved applicants received €7.2 million as Less Favoured Area (LFA) payments for 2885 km^2 designated cultivated land in 2006. The number of LFA beneficiaries has levelled as 8320 holdings supported for cultivated land 3394 km^2 in 2009 (Agricultural Research Centre 2010).

SUPPORT SCHEMES	2004	2005	2006

Environmentally-friendly Production Scheme (EPS)			
Number of approved applicants	5643	5479	4928
Area (ha)	452,979	451,702	450,000
Support (€)	13,876,515	18,141,509	15,147,061
Organic Farming (OF)			
Number of approved applicants	731	909	927
Area (ha)	37,526	49,400	55,000
Support (€)	3,201,771	4,262,277	4,454,642
Keeping animals of Local Endangered Breeds (LEB)			
Number of approved applicants	207	447	597
Number of animals	800	1397	na
Support (€)	104,165	231,226	357,905
Establishment, Restoring and Maintenance of Stonewalls (ES)			
Number of approved applicants	0	334	na
Support (€)	0	423,976	1,227,104
Less Favoured Areas (LFA)			
Number of approved applicants	8330	8903	8707
Area (ha)	298,877	318,725	288,491
Support (€)	7,452,418	7,942,303	7,209,234
Total agri-environment support (€) without LFA	**17,182,452**	**22,635,012**	**21,186,711**

Tab 1. The agri-environment support in Estonia in 2004-2006 (Agricultural Registers and Information Board).

During the first year of full implementation in 2004, the number of approved applicants of agri-environmental support reached 6 546, 35% from total agricultural holdings. Similarly, EPS covers 30-35% of agricultural land (ERDS 2008). In comparison with the general dynamics of support in 2004-2006, the number of approved applicants increased in 2005, and then stabilised. Due to the available practice of the pilot stage the supported area reached quite high values already in 2004 and stayed within the range in the next years (figure 2). As an exception, the organic farming continues to increase its area.

For Environmentally-friendly Production Scheme (EPS) and Less Favoured Areas (LFA) support, the natural capacity of covered area was nearly met already in 2005, reaching its maximum by number of approved applicants, area and support. Applicants owning less than 50 ha of land comprise 87% of support receivers getting almost one fifth of the total support sum. At the same time, farmers owning more than 500 ha of land receive ca 55% of the total sum. It is obvious that large producers receive the majority of support and more benefits (see Blacksell, this issue).

Organic Farming (OF) support payments have been made all over Estonia already since 2000. Since 2005, new commitments are only accepted in case of applicants whose field belongs to Natura 2000 areas. In 2003, there were 764 approved organic farmers in Estonia; support was applied for an area of 38,588 ha. The support for OF grew substantially since 2005, as the launching year was characterised by a high number of failed complications. 69,682 ha of land under organic farming was supported in 2006 expanding to 88,437 ha in 2009 (Agricultural Research Centre 2010).

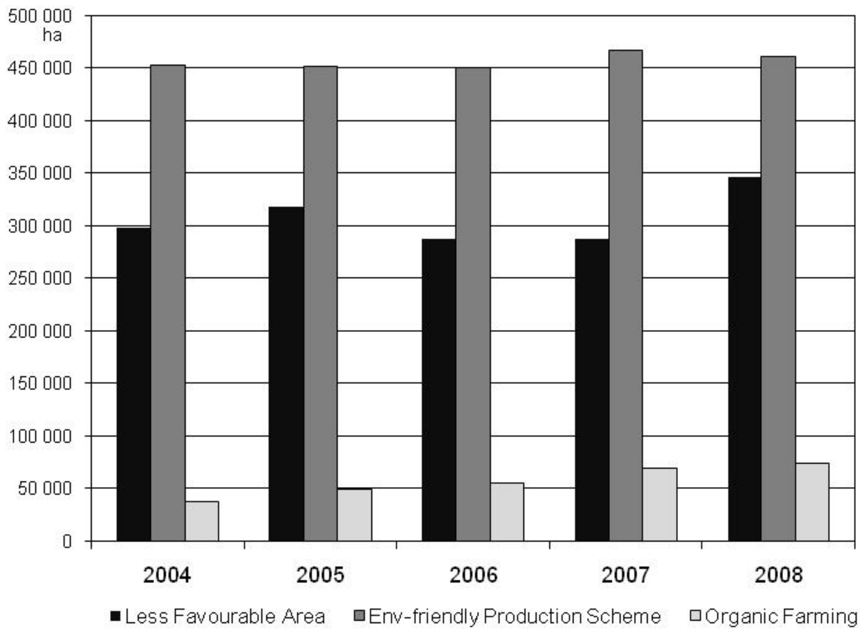

Fig 2. The area supported from Less Favoured Areas (LFA), Environmentally-friendly Production Scheme (EPS) and Organic Farming (OF) in Estonia in 2004-2008.

The implementation of Local Endangered Breeds (LEB) support is slow. If in 2004 support was granted only for Estonian native horses, then since 2005 also owners of Estonian heavy draught and Tori horse and Estonian native cattle could apply for support nationwide. 207 farms received LEB support in 2004, increasing to 681 farms in 2006 (ERDS 2008).

The Establishment, Restoration and Maintenance of Stonewalls (ES) has been supported in two pilot areas in Estonia since 2001. In 2005 ES was launched all over Estonia when support was applied for the establishment of 19 km, for the restoration of 39 km and for the maintenance of 26 km of stonewalls (ERDS 2008). Applicants could apply support for five years, receiving every year a fixed sum per meter.

Less favoured areas (LFA) cover 22,590 km^2 (50% of the total territory of Estonia), of which the share of agricultural land is 6270 km^2. According to the agricultural census, just 3490 km^2 of this land is in use (see map in figure 5). It means that vast land abandoned in the 1990s is left out from the register and use. The targeted 4000 km^2 of agricultural land applied for in 2004 was not achieved, wavering around 3000 km^2. The number of applicants in LFA has increased; however, the area itself has been quite stable during the implementation period (Agricultural Research Centre 2010). The support is €25 per ha which 3 times lower than EU average (ERDS 2008).

The total area of nature reserves reached 16% of Estonian territory in 2006 due to Natura 2000 process (12% until 2004). The total area of Natura 2000 sites in the country is 6918 km^2, agricultural lands within them make up 550 km^2 (8%). The establishment of the Estonian Natura 2000 Network, including 509 Special Areas of Conservation (Habitats Directive) and 66 Special Protection Areas (Birds Directive), supported by nature areas with mixed use and nature corridor areas, aims to defragment nature and forest reserves (see figure 4). Collective farming and rural change during the Soviet decades affected fatally semi-natural habitats (see table 2). In 2006, the AEP sub-measure for management of semi-natural habitats in Natura 2000 sites was introduced to perform the task of enhancing biodiversity and preserving valuable, agricultural landscapes and forests.. The support is €32 per ha, with the total allocation of €1.2 million during the period 2001-2004. The implementation of Natura measure should ensure the maintenance of 40 000 ha of semi-natural habitats in Estonia, though according to the inventory there are around 100 000 ha of seminatural habitats which need constant management in order to preserve its high nature value.

Maintenance constitutes mowing and/or grazing, in addition, the expenses also comprise allocations for supporting the construction of fences. Restoration constitutes all types of work associated with ridding the semi-natural communities of brushwood and thinning the tree layer (Sammul et al. 2008). Assessments of the extent of high nature-value grassland show an increase in the 2000s. The reasons for this include increased maintenance of less productive grasslands. Also, alike in pastures and meadows, Nature 2000 forest support was introduced since 2006. The conservation status of species from farmland habitats is less critical.

Type of habitat	1950s	2000
Alvar	44,000	9,000
Flooded meadow	100,000	15,000
Wooded meadow	800,000	1,500
Wooded pasture	200,000	3,000
Total	**1,144,000**	**28,500**

Tab 2. Change in the area of semi-natural habitats in Estonia, ha (Sammul et al. 2000).

The main problem in applying for agri-environment support was the insufficiency of the advisory system, i.e. there were too few certified advisers. The termination of state-owned land management contracts between the rural municipalities and producers was also a critical issue. Introduction of the required crop rotation and the preparation of documents were the most difficult steps for farmers and agricultural producers. For both parties, evaluators and producers stress the importance of standardised and unified implementation of support schemes. The practice of the first period demonstrates certain 'greed' of applicants, as there were several debates on the area covered.

As a result of the implementation of measures, the environmental awareness of the applicants increased, environmental planning was adopted, and environmentally-friendly farming practises were introduced. The allocation of support by different environmental measures in 2007-2013 stresses EPS, leaving far behind LFA support and Natura 2000 supports for forests and semi-natural communities (figure 3). Natura-related, and reforestation support were introduced since 2007.

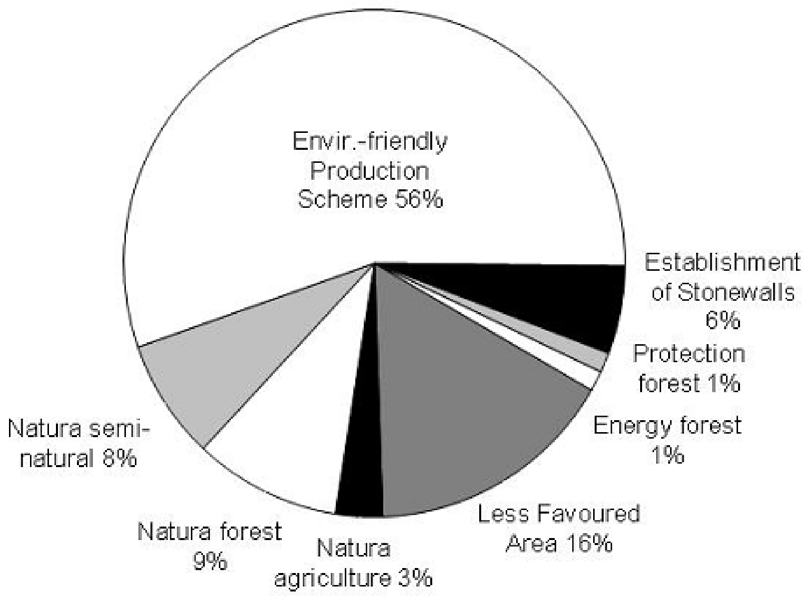

Fig 3. Allocation of environmental support by measures in Estonia in 2007-2013 (ERDS 2007).

5. Monitoring network for the agri-environment programme

The agri-environment programme is applied in two sections – monitoring and evaluation. Monitoring provides information on the progress of implementation by collecting data on the use of resources (inputs) to create activity (outputs) among the intended beneficiaries. Agri-environment monitoring should primarily provide uniform, basic data about the composition, spatial distribution and status of agricultural land, and should repeat these descriptions over time. The classification of ecosystems is based on either vegetation, habitat or land-use classification units. Regular monitoring should improve the understanding of the forces behind agricultural impacts and the probability of optimising conservation, restoration and management of agricultural landscapes (Roose et al. 2007). Evaluation goes beyond monitoring and reporting, and its idea is to assess the performance of measures by collecting additional information on the results and environmental impact.

In order to be able to monitor the implementation of agri-environment support payments and to evaluate their performance against the objectives set for them, it is necessary to develop an appropriate set of indicators (EEA 2005a, O'Neill et al. 1994). The list of impact indicators is quite universal, kept short, no more than 3-4 indicators per addressed topic aiming the simple evaluation and cost-efficiency of monitoring and management. These must be decided in advance or early on in the implementation of agri-environment support payments, so that data on their effects could be collected.

1. Result indicators relate to the direct and immediate effects brought about by agri-environment support payments and provide information mainly about changes in the farming activities of the participating farmers (left column in table 3).
2. Impact indicators refer mainly to the environmental consequences of changing farming activities with agri-environment support payments (Kleijn and Sutherland 2003) (right column in table 3).

Result indicators	**Impact indicators**
Number of farms under Environment Management Scheme (EMS) agreement	Environmental awareness of farmers − OF, EPS
	Farm income − OF, EPS
	Share of organic products sold as organic − OF
Total area of farmland under EMS agreement	Soil organic matter levels (%)− OF, EPS
	Soil fertility (pH, K and P) − OF, EPS
Number of farmers receiving training within EMS agreement	N utilisation % (± kg N /ha/year) − OF, EPS
	N total balance nutrient (NPK) total balance (kg/ha/year) − OF, EPS
Number of Whole Farm Maps with semi-natural habitats and valuable landscape elements marked on them	Number of pesticide treatments − EPS
	Concentration of solutes in groundwater − OF, EPS
	Vascular plants – structure, coverage and species richness− OF, EPS
The length of field margins per ha	Soil microbial community – hydrolytical activity− OF, EPS
The number of singular objects per ha that are preserved	Earthworm communities – abundance and species diversity− OF, EPS
The length of linear landscape elements that are preserved	Butterflies – abundance and species diversity− OF, EPS
Area of farmland covered by crop during wintertime due to EMS agreement	Carabids – abundance and species diversity− OF, EPS
Length of uncropped and uncultivated midfield strips and buffer strips to EMS agreement	Birds – indicative species (number of species and density) − OF, EPS
Change in the size of fields due to EMS agreement	Change in landscape structure in terms of point, linear and area elements − all
	Change in landscape structure in terms of land cover types− all
	General upkeep (visual appearance) of the farm− OF, EPS

Tab 3. Result and impact indicators of the agri-environment programme, applicable support schemes.

As the monitoring of environmental impact is complex (Brandt et al. 2002), a large amount of time and effort was therefore needed to reach the agreement of impact indicators for five main topic areas:

- Landscape: 3 impact indicators,
- Soils: 3 impact indicators,
- Water: 3 impact indicators,
- Biodiversity: 4 impact indicators,
- Socio-economic: 3 impact indicators (listed in table 3).

The majority of objectives relate to the protection of water, conservation of biodiversity and landscapes. Soil protection, the mitigation of climate change and the protection of air quality are far less frequently indicated as the objectives of the scheme, though these impacts are listed in addition the table 4.

The Estonian approach for defining indicators and evaluation areas for Programme is based on a hierarchical approach of three levels: field level (earthworms, plants), farm level (bumble-bees, birds), and landscape district level (birds, landscape structure) (Sepp et al. 2004). Selection of sites depends on the available data, existing methodologies and practices, and existing monitoring programmes, including the national monitoring programme. Some indicators can have relevance only at specific scales of analysis, while others can be used at different spatial levels. For instance, the indicator ‘diversity of the scenery’ has significance at the level of ‘landscape’, whereas the indicator ‘length of field boundaries’ is meaningful both at the levels of ‘field’ and ‘farm’. The final methodology of monitoring was applied in 2004 with the study of two groups of indicators related to landscapes: landscape structure in terms of point, linear and area elements and evaluation of visual appearance of farm. The environmental impact and strength of support measures is presented in table 4.

Measures	**Human health**	**Water quality**	**Air and climate**	**Biodiversity**	**Landscapes**	**Soils**	**Rural heritage**
Environmentally-friendly Production Scheme (EPS)	probable	incidental	incidental	positive	positive	positive	neutral
Organic Farming (OF)	positive	positive	positive	positive	positive	positive	neutral
Local Endangered Breeds (LEB)	neutral	neutral	neutral	positive	positive	neutral	positive
Establishment of Stonewalls (ES)	neutral	neutral	neutral	positive	positive	neutral	positive
Less favoured Areas (LFA)	neutral	neutral	neutral	incidental	positive	neutral	neutral
Natura 2000 agricultural support	neutral	neutral	neutral	indirect positive	indirect positive	neutral	positive
Natura 2000 semi-natural communities	indirect positive	indirect positive	indirect positive	positive	positive	indirect positive	neutral

Tab 4. Impact of agri-environment support measure on environment.

Another question concerning the development of monitoring set is the selection of monitoring sites. Representation by the typological classes is the first pre-requisite. Another condition is seeking to achieve total national coverage. It is arguable whether the data of the national monitoring network is sufficient and cohesive enough for reporting, although these are generally used as indicators, or indexes in European reports (Roose et al. 2007). The strategic set should be distributed by Estonian landscape districts and according to the availability of other available monitoring sets (figure 4). On the other hand, every monitoring set is unique, depending on its own criteria such as coverage, patterns, features, linkages to policy, etc. Thus, setting sub-programmes is quite an autonomous process following the main objectives, functionality and proceedings of the agri-environment programme. It is crucial to cover all landscape regions, a variety of farming practises (intensive, extensive regions) and farming types (plant production, animal husbandry, mixed farming). The most common approach is the comparative monitoring of biodiversity in the agri-environment scheme and control areas at one point in time.

Initially, the indicators were tested in the complex study which targeted OF scheme. It is proved by pilot implementation that the number of monitoring sites, 12 landscapes sites (fig 5), 66 biodiversity sites is not sufficient for full nationwide coverage.

The total density map of national environmental monitoring network is derived by summing up 9 environmental topical maps, the distance dispersion model at a 50 km search radius, shown in figure 4 with layout of monitoring stations and Nature areas. According to the dispersion model, stratified information on a multitude of themes which coincide with AEP is available in the non-agricultural metropolitan areas near Tallinn, Pärnu and in north-eastern Estonia. Though, some conservation areas such as the Endla and Viidumäe national parks are extensively covered by monitoring set. Unmonitored areas belong to bigger landscape districts in sparsely populated remote forest and rural areas. As a regard the 50 km search radius, it was assumed that a data transfer function is applicable for such a distance in many cases as well 50 km could be taken as the average maximum distance between the nearest-neighbour monitoring stations in the landscape scale. In general, the national environmental monitoring programme covers the Programme less than expected, as the objectives, indicators, monitoring methods and data management differ substantially. In fact, both networks (the national environmental and agri-environment) originate in the pre-Natura period and do not reflect the location and other features of Natura network.

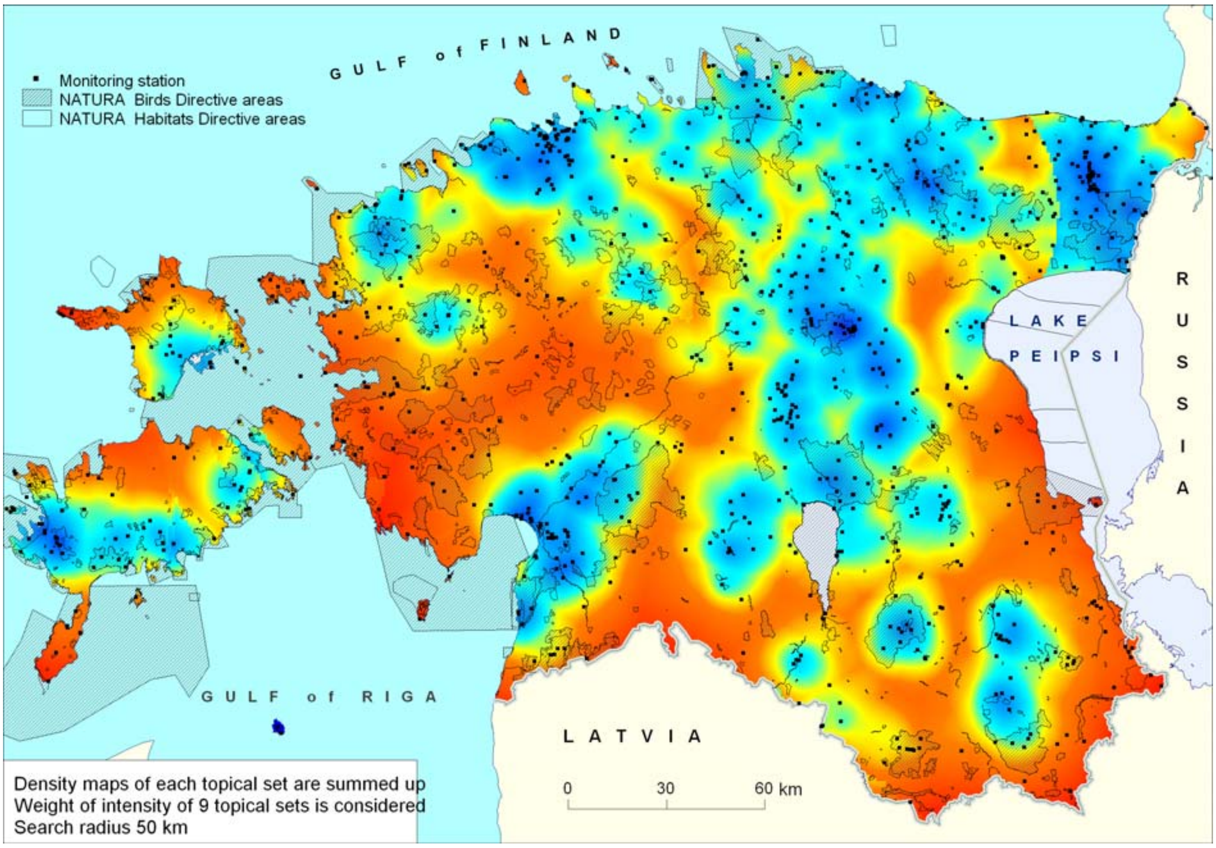

Fig 4. Total density of monitoring stations of the national environmental monitoring programme.

5.1 Biodiversity monitoring

Biodiversity indicators are as follows: abundance and species composition of plants in fields and field edges, the number and diversity of bumblebees in fields and field edges, the number and diversity of soil earthworm (*Lumbricidae*) communities, the functional structure and hydrolytical activity of soil micro-organisms, the number and diversity of carabids (*Carabidae*) in fields and field edges, the presence of protected species (communities) in agricultural landscape. The distribution of monitoring topics according to support schemes is as follows: earthworms, soil microbes (OF, EPS), birds (OF, EPS, reference), vascular plants (OF, EPS, reference) and bumblebees (OF, EPS, reference) (Sepp et al. 2005).

The comparison of data of different landscape districts from various years has methodological restrictions due to the variance of climate conditions. In some cases the ecological structure of habitat influences more the presence of sensitive species in community than by agricultural activities. The intentional segregation of highly intensive agricultural production zones from biodiversity-rich conservation zones is unlikely to succeed due to the complexity of the ecological and social dynamics between these zones. Also, there has been debate on the most essential background parameters for interpretation the results of biodiversity monitoring (Sepp et al. 2005, ERDS 2008).

There is an option of matching two monitoring streams, as the national monitoring programme of biological and landscape diversity includes 37 sub-programmes, ten of which focus on habitat diversity (Roose et al. 2007). More than half of them are aimed at monitoring changes in biodiversity of semi-natural communities (wooded meadows, alvars, etc.). All habitat types covered by the monitoring programme are included in the annexes of EU directives (i.e. Natura 2000 habitat types). Biodiversity of habitats is monitored in 120 sites. There are 25 sub-programmes dealing with species diversity monitoring. Various vascular plants and mosses (ca 160 species) are monitored on more than 600 plots (Third national report 2005). Ten sub-programmes have been created for the monitoring of birds, covering all main bird groups. In 16 sub-programmes, different species groups are monitored (among invertebrates – butterflies, moths, ants, molluscs and beetles; among vertebrates – amphibians, reptiles, large carnivores, bats, beaver and otter, seals, flying squirrel, etc.). The recent changes in the Estonian National Biological Diversity Monitoring Programme have been directed mainly towards monitoring the status of species and habitats of Natura 2000. Changing status of semi-natural habitats as well extensive monitoring requires further specification and validation of methods (Aavik and Liira 2009).

5.2 Landscape monitoring

The diversity of landscape types in Estonia has been caused by various natural conditions. The preservation of natural and semi-natural habitats is required in a relatively large number of landscape types. The presence of a large proportion of landscapes that have nearly disappeared in the rest of Europe, needs an exclusive monitoring set. Change in landscape structure in terms of point, linear and area elements (all measures), general upkeep (visual appearance) of the farm (OF, EPS), and proportion of stonewalls on agricultural land that have been restored, have been selected as indicators. The national environmental programme gives the basic reference set (figure 5). Indicators of landscape structure describe changes of point, linear and area elements using methods of landscape metrics (Sepp et al. 2004). The inclusion of landscape structure as key indicators is even more important in practical educational reasons as farmers' awareness of importance of field margins, preserving linear and point elements in the field is very low. Statistical measures of landscape can serve to describe the structure of landscape, hence interpreting changes in these indicators in terms of what is a positive or negative change in landscape structure is elaborated poorly. The Shannon and Simpson indexes as many other landscape metrics parameters which can be easily found using quite standard software packages (FRAGSTATS, MapInfo, Idrisi etc.) are not sensitive enough to assess the change in landscapes. The percent of restored stonewalls on agricultural land is indicates quite well the measures of landscape restoration scheme. General upkeep and visual appearance of the farm have been chosen as an indicator of landscape attractiveness although this is quite subjective and depends very much on photo interpretation. Also, methodology does not cover all aspects of attractiveness. Basically, all the landscape indicators chosen have a potential to describe adequately the efficiency of agri-environment support schemes applied. Most of these indicators are widely used throughout EU.

Fig 5. National monitoring set of agricultural landscapes and Less Favoured Areas (LFA) (green).

6. Discussion

Environmental trends in agriculture are driven not just by the CAP policy framework, but also by market, socio-economic and technological factors. Thus, agricultural or environmental policy cannot easily influence all the farm sector trends that have an impact on the environment. Secondly, environmental integration at policy level is a complex process. The issue to be discussed comprehensively is the coherence of agricultural and environmental policy and its institution representation. It depends not only on the legal framework, institutional setting or the implementation of measures, but also on involvement of different decision-making levels, cooperation between administrative bodies, appropriate policy evaluation procedures and control. A wide range of environmental legislation has set objectives, and to a lesser extent targets, for environmental management in the agricultural sector. Most of these target indicators are quite fuzzy not allowing an assessment of whether they are reached or not (EEA 2005b). Still, AEP data series are still too short to assess landscape change and impacts on ecosystems in Estonia due to CAP. The researchers tend rather rushing to interpret and draw conclusions from preliminary data and analysis, in particular if based on quantitative methods. Policy-makers and governmental officials are looking for monitoring and evaluation reports which are holistic, objective, and balanced. Both stakeholders in the process cannot lean on long term experience and 'culture' in the field of assessment of impacts of AEP on ecosystems. Communication channels between all major parties, farmers, authorities and academia can be improved.

As a part of socio-economic debate in this field, there are considerably more studies in intensively farmed areas. Naturally, the uptake of schemes is higher in areas farmed under extensive systems. Agri-environment schemes targeted at intensive areas are expected to enhance species diversity over time (Herzog et al. 2006). Agri-environment schemes are expected to maintain this diversity by protecting areas from intensification or abandonment. Changes in land-use intensity will have a greater impact on biodiversity on extensively farmed land than on intensively used farmland. Agri-environment schemes that aim to protect biodiversity in extensively farmed areas may therefore be more effective than those aiming to improve biodiversity in intensively farmed areas (Kleijn and Sutherland 2003). The share of agri-environment payments in gross farm income can be used to assess to what extent farms are diversified towards delivering environmental services. In economic terms, the implemented support schemes promoted farmers' entrepreneurship, economic vitality, increased value added per employee and cultivated area.

The discussion of methods and approaches continues to search for a key to integrate different monitoring schemes. Integrated approach can yield additional insight into how environmental and agricultural factors affect species diversity (Veech et al. 2002, Wagner et al. 2000). Hendrickx et al. (2007) demonstrate in their study that the effects of agricultural change operate at a landscape level, and that examining species diversity at a local level fails to explain the total species richness of an agricultural landscape. Thus, the preservation of diverse agricultural landscapes should focus on species enhancement of entire agricultural areas rather than just on diversity of local communities.

The criteria of selection for sampling strategy should follow spatial relationships for the subject as well as for wider purposes (Dramstad et al. 2002, Lausch and Hertzog 2002). Human impacts on the agricultural landscape often occur on a site-specific basis. If we try to mitigate environmental impacts on a site-specific basis, it is difficult to account for the cumulative effects of that result (Brandt et al. 2002, Sepp et al. 2004). Some species are favoured by a large number of forest or field edges, others by homogeneous landscapes (Bender et al. 2003, Aavik and Liira 2009). Matching and overlapping of landscape and biodiversity could be one solution though the geographical location of monitoring sites differs vastly. Some Estonian landscapes are characterised by high heterogeneity and others by low heterogeneity (at a specified scale of measurement) (Sepp et al. 2004). Again, the value of spatial heterogeneity as a monitoring measure resides in the fact that it can indicate landscape change.

The reporting standard might have an impact on the design of the monitoring network (Roose et al 2007). When optimising the monitoring network, different models have been applied, which do not only deal with the spatial features of monitoring, but also with the complexity of the subject and implications on agriculture. The major issue for further development of the agri-environment programme is combining results of landscape and biodiversity evaluations.

Collecting the baseline data, which is missing in several cases, is of crucial importance. Teder et al. (2007) propose recording the presence and absence of taxa and ecosystems in a target area in landscape scale, mapping their distribution in space, and assessing their status repeatedly over time. The whole system has to be standardized, hierarchical and accumulative in order to facilitate aggregating measures of biodiversity status and trends into regional and global indices.

A particular problem for environmental statistics is the referred spatial unit. Whereas socio-economic indicators are usually available for administrative entities or areas, many environmental phenomena often manifest themselves regardless of administrative boundaries (Brandt et al. 1994, Dramstad et al. 2002). Relating environmental indices to districts delimited according to ecological criteria (landscape districts, catchments, landscape types, etc.) would increase their sensitivity and interpretability. Socio-economic indicators should be made available at the level of landscape districts, and administrative structures requested for the implementation of measures must also be created at this level. These structures must then coordinate their actions with the existing administrative bodies. Whether they are related to eco-regions or administrative units, landscape metrics need to be harmonised (Lausch and Herzog 2002).

While planning introducing agri-environment programme, several alternatives were formulated with different contributions to the objectives, to serve as a basis for the adopted measures and for selecting recommended methodologies based on an evaluation of trade-offs among the objectives of indicators. Cost values and operational costs for the evaluation have been introduced as a forerunner 'absorbed' by environmental quality objectives and benefits of the measures in the agricultural sector. The attention was accordingly focused on concepts and methods of monitoring and evaluation, estimating information cost, assessing cost-efficiency for such measures and corresponding projects. Cost-efficiency of data capture and evaluation is fully considered in the designing stage of AEP in Estonia.

7. Conclusion

This article introduces the implementation of the agri-environment programme in Estonia, focusing on the preparation and start-up implications and circumstances of the monitoring and evaluation of support schemes. The condition of environment is relatively good, but for maintaining it, it is necessary to carry on the agri-environment and other measures contributing to the sustainable rural development. The EU agriculture policy provides an important opportunity to improve environmental management and maximise environmental gain in the farming sector in Estonia. The design of the CAP includes a broad range of agri-environment policy instruments that can support the implementation of wider environmental policies, such as Natura 2000 as well economic incentives for diversification, and wellbeing of rural communities.

The preservation of cultural landscapes and biodiversity through time has become one of the basic environmental policy objectives in agriculture. As local extinction processes in highly fragmented landscapes shape biodiversity, priority should be given to the conservation of diverse agricultural landscape remnants in Europe alike Estonia represents. Agricultural landscape indicators provide policy makers with an informative tool recording the current state of landscape and how its appearance including the cultural features is changing, establishing the share of agricultural land under an agri-environment scheme.

The effectiveness of agri-environment schemes in particular depends on national-level implementation and geographic targeting. The Estonian agri-environment programme can be assessed as successful and it has justified itself. This preliminary work indicates that the landscape indicators chosen for AEP have a potential to describe adequately the efficiency of agri-environment support scheme applied. The chosen methods of monitoring and evaluation provide appropriate indicators about level of human pressure on different categories of agricultural land. The selected and mapped landscape features clearly distinguish anthropogenic areas from semi-natural areas. Biodiversity sets are expanded due to Natura 2000 inventories and coverage.

A multi-scale object-based monitoring and analysis of landscape gives a good overview of human pressure and landscape change. The adequacy of landscape monitoring according to the spatial relation of the environmental monitoring set is explored by landscape district. Biodiversity sets can easily be applied as data sources for landscape monitoring in national parks and protected areas. The representation on landscapes and land cover types is rather different. For that reason the application of the data transfer functions needs further investigation and modelling on a small and meso-scale level.

However, for further study it will be useful to compare the density and other characteristics of some landscape elements with some reference data in each particular region, for example, with the density and characters of landscape elements before the intensive collectivisation of agriculture during the soviet period. Applicability of modern monitoring and evaluation techniques depends on conceptual maturity, but very much also on flexibility in data management and application. The potential of integrated methods for the agri-environment programme should be further examined in the CAP. Understanding the influence of different impacts and measures on agri-environment development and their interaction with policy is an important step for understanding opportunities for integrating environmental concerns into the CAP and for monitoring and evaluation. A more thorough evaluation of the extent to which the Programme has fulfilled its objectives is planned at the end of the second cycle of national inventory in 2013. Confrontation the centre *vs.* the periphery, urban and rural has become an important source of tension. Needless to stress, agriculture as economic sector is based on the use of Estonia's own resources and has an important stabilising role for rural development in the globalisation era.

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