Originalarbeit

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The Eco-Region Project: Turning the Baltic Sea Region into the world's first EcoRegion – an agricultural perspective

Das Projekt Eco-Region: Die Entwicklung des Ostseeraums zur ersten ÖkoRegion der Welt – aus dem Blickwinkel der Landwirtschaft

Abstract

Increasing pollution of the Baltic Sea poses a massive problem for the Baltic Sea Region (BSR) and its inhabitants. In order to sustainably improve the environmental quality of the BSR, the implementation of adequate good practices is urgently required. Within the framework of the Eco-Region Project, different practices from the sectors agriculture, energy and transport, spatial planning as well as tourism and education are collected in an openly accessible database and at least one of these concrete sustainable development measures will be realised in several model „EcoRegions". Good practices for the sector agriculture, which is one major origin of the severe pollution of the Baltic Sea, will be described in this contribution.

Key words: Baltic Sea, Baltic Sea Action Plan, good practice, organic farming, precision agriculture, sustainability

Zusammenfassung

Die zunehmende Verschmutzung der Ostsee stellt ein schwerwiegendes Problem für den Ostseeraum und seine Bewohner dar. Zur Förderung einer nachhaltigen Entwicklung dieser Region ist eine Umsetzung von ausgesuchten Praxisbeispielen dringend notwendig. Im Rahmen des Projektes Eco-Region werden derartige Maßnahmen aus den Sektoren Landwirtschaft, Energie und Transport, Raumplanung sowie Tourismus und Bildung in einer öffentlich zugänglichen Datenbank gesammelt und darüber hinaus modellhafte „EcoRegionen" entwickelt, in denen jeweils die Umsetzung von mindestens einer dieser Maßnahmen erfolgen soll. Dieser Beitrag beschreibt verschiedene Methoden der guten fachlichen Praxis für die Landwirtschaft, einem Sektor, der maßgeblich zur Verschmutzung der Ostsee beiträgt.

Stichwörter: Baltic Sea Action Plan, gute fachliche Praxis, Nachhaltigkeit, ökologische Landwirtschaft, Ostsee, Precision Agriculture

The EcoRegion Project

The Baltic Sea is one of the most polluted marine bodies in the world (Helcom, 1996). Unfortunately, ongoing processes such as the excessive land use, a growing demand for energy and environmental pollution show that the development in the Baltic Sea Region (BSR) is far from being sustainable. To improve the condition of this unique ecosystem and its valuable resources, the entire BSR needs to implement more good practices in different sectors such as agriculture, energy and transport, spatial planning, tourism and education in order to become truly sustainable. Various good practices aiming to achieve a

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sustainable development already exist and by applying them consequently in the BSR the region has the potential of becoming the world's first EcoRegion. The EcoRegion-project is a follow-up of Baltic21 and the Aalborg Commitments, two independent but interlinked processes with the aim to promote a sustainable development (ECOREGION, 2011). Baltic21 is the regional expression of the global Agenda 21 which was adopted by the United Nations 'Earth Summit' and was initiated by the Prime Ministers of the Baltic Sea countries in 1996. It can be characterised as an open and transparent network to bring people together who are active in a variety of different sectors and supports them to make progress towards transforming the BSR world into sustainable region (ECOREGION, 2011; BALTIC21, 2011).

By signing the Aalborg Commitments, authorities agreed to formulate targets and to implement actions aiming for sustainable development (ANONYMOUS, 2011; ECOREGION, 2011).

Since the problems the BSR is facing cannot be solved by only one sector alone, the concept of „EcoRegion" is to find solutions to regional problems through cross-sectoral and inter-regional cooperation and to promote the integration of sustainable development into policy making. If those practices are elaborated and introduced they can contribute to a sustainable development in the emerging (Eco)Region and will help to ensure prosperous economies, healthy societies and dynamic ecosystems (ECOREGION, 2011). Since agriculture is the main contributor to the discharge of environmentally relevant nutrients such as nitrogen and phosphorus into the Baltic Sea (KREMSER and SCHNUG, 2002), the sector agriculture can be seen as an important corner stone of the EcoRegion project. Thus, this paper suggests practices on how to implement scientific achievements in the agricultural sector into key policy issues and recommendations in order to promote sustainable food systems, nature conservation and to improve finally the water quality of the Baltic Sea.

The Baltic Sea Action Plan

The Baltic Sea Action Plan (BSAP) was established in 2007 by the Helsinki Commission (HELCOM) and aims to „restore the good ecological status of the Baltic marine environment until 2021" by inducing profound, innovative changes of the environmental management in the Baltic Sea region. The BSAP defines four environmental objectives which should be achieved, namely a Baltic Sea unaffected by eutrophication, undisturbed by hazardous substances, with favourable biodiversity and environmentally friendly marine activities (HELCOM, 2007; ELOFSSON, 2010). Eutrophication is one major problem the Baltic Sea has to deal with, since it leads to a reduced water quality, contributes to oxygen deficit in the deepwater and causes loss of biodiversity. Eutrophication is caused by excessive nitrogen (N) and phosphorus (P) inputs, which, among others, are the result of agricultural activities (SCHNUG et al., 2001; HELCOM, 2007; AHVENHARJU et al., 2010). In order to resolve this problem, the BSAP aims to create a status of the Baltic Sea which is reflected by the absence of high nutrient concentrations and algal blooms, clear water, natural oxygen levels, and the natural distribution of plants and animals. To meet this aim, targets for N and P load reductions from each country have been formulated (HELCOM, 2007; ELOFSSON, 2010).

In order to describe to what extent the commitments assured in the BSAP have been and will be put into action, National Implementation Programmes (NIPs) were established. Concerning the eutrophication segment, the assessment of the status of the implementation was examined in 2010 and 5 actions (out of 14) have been adopted (AHVENHARJU et al., 2010):

- National programmes to achieve nutrient reductions
- Advanced municipal waste water treatment
- The substitution of phosphorus in detergents
- Permit systems for major and small animal farms
- The establishment of a list of hot spots concerning animal farms

There will be a closer look to these actions in order to investigate to what extent the guidelines for this sector have been fulfilled in the different member states. Agricultural activities have to be regulated to fulfil the guidelines for the actions „national programmes to achieve nutrient reductions", „permit systems for major and small animal farms" and „the establishment of a list of hot spots concerning animal farms" (Tab. 1., AHVENHARJU et al., 2010). Until 2010, all countries have either prepared or already set national regulation programmes and targets to achieve the targeted nutrient reduction. While Denmark, Estonia and Latvia reported that their national regulations already include BSAP targets, the regulations in Poland and Germany were still under preparation in 2010. Finland, Lithuania and Sweden have been the only member states, so far, who have provided national programmes on eutrophication in the agreed format (Tab. 1., AHVENHARJU et al., 2010). Referring to the HELCOM Recommendation 28 E/4 of the amended Annex III of the Helsinki Convention it is advised to apply measures with view to Best Environmental Practice (BEP) and Best Available Technology (BAT) to reduce the pollution resulting from agricultural activities (HELCOM, 2007). To meet this aim the member states committed to establish a permit system for animal farms according to these criteria outlined in Annex III. Five countries reported that such a system is already in place and three were quite far in progress. The progress in Russia did not exceed the developing phase until now. A positive conclusion was drawn with a view to the progress of preventing nutrient losses from agriculture. In contrast, the results for establishing a list of agricultural hot spots for each country by 2009 were not satisfactory. With the exception of Finland, the member states have not reviewed their hot spots (AHVENHARJU et al., 2010).

The survey carried out by AHVENHARJU et al. (2010) reflects the heterogeneous development in the BSR. Although all countries had an equal amount of time to put activi-

Tab. 1. Status of implementation of selected activities in the eutrophication segment of the BSAP (adapted from AHVENHARJU et al., 2010)

Reference to the HELCOM BSAP	Germany	Denmark	Estonia	Finland	Lithuania	Latvia	Poland	Russia	Sweden	Original Deadline
National programmes on nutrient reduction	2	3	3	4	4	3	2	1	4	2010
Permit systems for animal farms	4	4+	3	4+	3	3	4	1	4+	2012
List of agricultural hot spots	0	N/A	1	4	1	N/A	1	N/A	N/A	2009

Key: no action or action started; action in progress; action implemented; N/A – no data

ties into action, a wide variation concerning the progress was observed between countries. It is open to what extent the deadlines of the actions will be met in the future (AHVENHARJU et al., 2010).

Towards sustainability in agricultural production in the Baltic Sea Region

The conservation of nature and environment for future generations can only be ensured by accomplishing the concept of sustainability. In the *Brundtland* Report, sustainability is defined as a development that „meets the needs of the present without compromising the ability of future generations to meet their own needs" (BRUNDTLAND, 1987). This definition considers two important factors: the problem of environmental degradation that is unfortunately related to economic growth and the need for this growth to reduce world poverty (ADAMS, 2006). At present, anthropogenic activities in the BSR are often not sustainable and a major reason for the miscellaneous problems the BSR has to deal with. According to the Helsinki Commission, *„the Baltic Sea ecosystem has degraded to such an extent that its capacity to deliver goods and services to humans living in the nine coastal states has been hampered"* (HELCOM, 2010). One major contributor of high N and P loads is agriculture due to high livestock densities and the immoderate use of fertilisers in conventional farming systems (SCHNUG et al., 2001; GRANSTEDT et al., 2008). The implementation of approved good practices is recommended to minimise the risk of water, air and soil pollution and thus to conserve nature and environment in the BSR for future generations. In general, codes of good agricultural practice are "*practices that address environmental, economic and social sustainability for on-farm processes, and result in safe and quality food and non-food agricultural products*" (FAO, 2003; SCHNUG et al., 2011). Factors such as landscape, soil type and production engineering vary in the different BSR and led to regionally differentiated development processes and potentials in the past. Hence, one main challenge for sustainable agricultural production in the BSR is the reduction of disparities in rural development. To meet this aim and facilitate the attainment of good practices, information of established good practices and innovations generated by the Baltic 21 sectors agriculture, forestry, tourism, industry, energy spatial planning, transport, and education have been collected and regularly updated within the framework of the Eco-Region project (see: http://www.balticecoregion.eu/).

Examples of Good Practices

Currently, 19 good practices in the field of agriculture have been collected and published on the EcoRegion website (ECOREGION, 2011). Good Practices have been attributed to the following segments: technology, soil protection, recycling, water quality, biodiversity, nature conservation and networks. Next, more detailed information is given exemplary for prominent good practices which promise to deliver a high ecological benefit and an easy implementation.

Implementation of Precision Agriculture technologies
Fertile soils are one of the most valuable non-renewable resources on earth and agricultural production must meet the demand to improve or to preserve their natural status without interfering with other ecosystems (SCHNUG et al., 2011). One important factor to maintain soil fertility is a balanced nutrient content. However, nutrients are one crucial part of agro-ecosystems, since they are not only essential to maintain soil fertility but their ongoing nutrient losses to water bodies as a result of an imbalanced (over-)fertilisation are a major threat for drinking water quality and eutrophication (HANEKLAUS and SCHNUG, 2006). Unfortunately, soils are heterogeneous (Fig. 1.) and subjected to dynamic changes which make a balanced fertilisation difficult (HANEKLAUS and SCHNUG, 2006).

Codes of Good Agricultural Practice (GAP) imply the statuary law on management practices that can be adopted

Fig. 1. Small-scale spatial variability of soil characteristics.

to minimise the risk of water, air and soil pollution. One aim of the implementation of national GAP codes is the reduction of the discharge of nutrients which is closely related to stocking densities in animal production and the high and improper use of fertilisers (SCHNUG et al., 2011). GAP applications can be developed for instance by governments, NGOs and the private sector to improve sustainability of management practices in relation to specific requirements.

Due to the spatial variability, the concentration of plant available nutrients in soils varies correspondingly which leads to a discrepancy between the site-specific nutrient demand on agricultural fields and uniform fertiliser rates (Fig. 2.).

One way to counteract the problem of an imbalanced fertiliser rate and an undesired discharge of nutrients in water-bodies is the implementation of Precision Agriculture technologies. The Local Resource Management (LRM) reflects the agronomic know-how that is required to define algorithms and rules for a spatially variable management. LRM aims at matching agricultural inputs and operations with the spatial distribution of qualitative and quantitative features of natural resources (HANEKLAUS and SCHNUG, 2006). This know-how will be based on computerised data, particularly on big farms. However, the 'local knowledge' of farmers, which reflects a new term for information which is available on a farm, either in terms of amateurish maps, field files and other materialised form of store and comprises also knowledge from personal education, experience or inheritance from former generations is an important source of information, especially on small farms (SCHNUG et al., 2011). The efficient use of local knowledge is a great challenge to operate Precision Agriculture technologies on all scales and turns the farmer into a biological interface between his fields and crops and hard- and software components, respectively.

The application of LRM and precision agriculture to nutrients by transferring the site-specific plant nutrient demand into variable rates regarding the spatial variability of soil and crop parameters is described by the term site-specific nutrient management. The implementation of a site-specific nutrient management enables a balanced fertiliser input at a small scale level by considering the spatial variability of soil features and thus optimises the nutrient supply of plants and reduces the nutrient loss to neighbouring ecosystems at the same time (DOBERMAN and WHITE, 1999; HANEKLAUS and SCHNUG, 2006; SCHNUG et al., 2011). Site-specific nutrient management is not only a mere technology of precision agriculture, it rather aims at a holistic approach to link agronomic, economic, environmental and social demands and thus contributes to a sustainable agricultural production (HANEKLAUS and SCHNUG, 2006). If this requirement is considered, site-

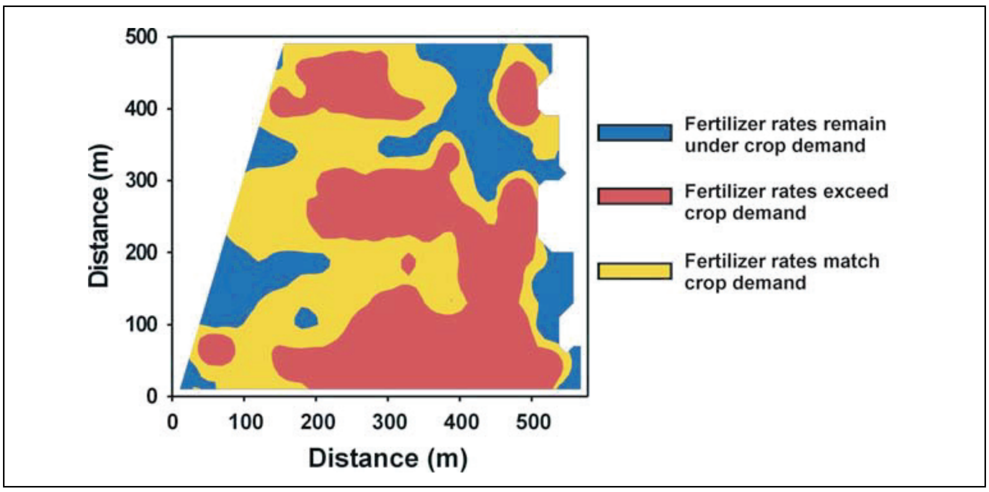

Fig. 2. Discrepancy between site-specific nutrient demand and uniform fertiliser rates (adapted from SCHNUG et al., 2011).

specific nutrient management can be seen as a chance to counteract the problem of nutrient surpluses and deficiencies on field level on a voluntary base before regulatory measures such as taxes and penalties are introduced (HANEKLAUS and SCHNUG, 2006). Provided that all the information available on a particular farm (e.g. soil type, nutrient status, soil-pH, crop) is used efficiently, it is possible to operate site-specific nutrient management on all scales, from small to big farms which makes it applicable in the entire BSR (HANEKLAUS and SCHNUG, 2006).

Besides beneficial effects for the environment, the implementation of Precision Agriculture will also promote the development of new markets for external services. The complexity of these technologies comprises data collection, storage and processing as well as developing algorithms for variable rate applications compared to those uniform rates applied by standard machinery on big farms (SCHNUG et al., 2011).

Central Tyre Inflation System (CTIS) for tractors

A Good Practice to reduce the problem of soil compaction is the development of the Central Tyre Inflation System (CTIS) for tractors, a method which automatically adapts tyre pressure to driving on the field or the road to avoid soil compaction (ANONYMOUS, 2009; VOLK, 2010). Normally, the inflation pressure of agricultural tyres is adjusted for road traffic which is unfortunately too high for agricultural soils. Thus, the high pressure weighing on the soil leads to an increased soil compaction. The CTIS automatically determines and regulates the adequate tyre pressure for road and field, the vehicle weight spreads over a larger soil surface on the field which reduces soil compaction. After field work, the tyres can be inflated to the adequate pressure for driving on the road (ANONYMOUS, 2009; VOLK, 2010).

The significance of this Good Practice becomes evident when the consequences of soil compaction are considered. River flooding associated with extreme rainfalls are a global and serious threat to mankind and were shown to be closely linked to a reduced infiltration rate of soils. The land use system proved to have a significant influence on agricultural activities which influence the infiltration rate on soils. On organically managed soils the population of earthworms is significantly higher and this is related among others to the renouncement of pesticides and a wider crop rotation (ABU-HASHIM, 2011). Other factors which might increase soil compaction and soil sealing, loss of mechanical stability and biological activity are field traffic, tillage and fertiliser practices (SPAROVEK et al., 2002; LILIENTHAL and SCHNUG, 2008).

Beacons for a sustainable phosphorus use in the Baltic Sea Region

P is a non-renewable resource and the current economically mineral P resources are estimated to satisfy the global demand only for another 50 to 100 years (EKARDT et al., 2010). P is an essential nutrient for all living organisms and thus is indispensable for food production. Agriculture is the largest consumer of P. And agriculture is the largest emitter on non-point P losses. Fact is that food production will be compromised for future generations if the anthropogenic and agricultural P cycle is not closed timely. With the strict utilisation of appropriate good practices the BSR could be the first region worldwide with a sustainable P use.

BalticManure – concepts for a sustainable use of manure

Natural ecosystems can be characterised by mostly closed nutrient cycles. The separation of animal husbandry and crop production in agriculture leads to unbalanced nutrient saldos. By off-take with harvest products, nutrients are removed which need to be replaced in order to avoid nutrient mining. Mineral fertilisers are usually applied on arable farms to maintain an optimum nutrient status. In comparison, on livestock farms manure or slurry is produced and favourably used as fertilisers. In particular, livestock enterprises with extremely high stocking densities cause a logistic and environmental problem by surplus applications though manure is basically a valuable resource.

Livestock farms often face a massive nutrient surplus though the maximum output of N by farmyard manure or slurry on agricultural areas is restricted to 170 kg/ha (DÜV, 2006; HANEKLAUS and SCHNUG, 2006). The reason is that the utilisation efficiency of N in farmyard manure is rated too low, mineral fertilisers being applied in addition which contributes to an over-proportional nutrient surplus. Yet another problem is nutrient losses during manure handling. Nitrogen leaching from livestock manures occurs during their application on fields if inadequate technology is employed, when they are distributed on bare soils or in periods without significant crop growth. P is lost to the environment mainly via run-off which is closely related to soil erosion mechanisms and the soil P content (FOGED, 2010).

The EU financed project „BalticManure“ (**Baltic** Forum for Innovative Technologies for Sustainable **Manure** Management) which was initiated in September 2010 aims at improving the existing knowledge on manure handling and use with regard to common manure standards so that the whereabouts are registered completely (JULIUS KÜHN-INSTITUT, 2011). The project will focus on the link between economic growth and environmental benefits to make rural areas more prosperous through sustainable manure management as manure is the only agricultural product that is currently not processed and utilised commercially (BALTIC MANURE, 2011). Manure resources (nutrients and energy) will be used more efficiently and new technologies and business activities developed in the field (JULIUS KÜHN-INSTITUT, 2011).

An advanced understanding of the properties of different manure types and their value as a fertiliser before and after processing will be achieved and existing standards for manure evaluated. New standards for manure types will be established with the overall aim to ensure a safe and sustainable agricultural use of manure in the Baltic Sea Region. Special emphasis will be put on P since this essential nutrient is a limited, non-renewable resource and high concentrations of P in surface waters are a major cause of eutrophication. Within the framework of the project, policy recommendations will be developed to enhance an advanced agronomical and environmentally sound manure and P management in the Baltic Sea Region (JULIUS KÜHN-INSTITUT, 2011).

SUSAN – Sustainable and safe re-use of sewage sludge ashes for nutrient recovery

Sewage sludge is a valuable source of P. However, municipal sewage sludge is often polluted with organic components such as hormones, antibiotics, endocrine disruptors and persistent organic pollutants and heavy metals. Thus, the direct use of sewage sludge on agricultural soils is a controversial issue. With a view to soil protection and food safety a direct use must be excluded and thermal treatment has been proven to be a practical and efficient solution to the problem without compromising plant availability of the final recycled product. In the European project SUSAN (Sustainable and Safe Re-use of Municipal Sewage Sludge for Nutrient Recovery) a sustainable and safe strategy for phosphorus recovery from sewage sludge for agricultural utilisation has been developed; the procedure uses a two-step thermal treatment including mono-incineration of sewage sludge and subsequent thermo-chemical treatment with a chlorine-donor ($MgCl_2$ or $CaCl_2$) of the resulting ash (ADAM et al., 2009; SCHICK et al., 2009). In a screening it was shown that heavy metals were effectively removed from different types of sewage sludge ashes by the thermo-chemical treatment at operating temperatures of about 1000°C. Since the process extracts heavy metals from the sewage sludge ash, 98% of the total mass of the ash is processed into marketable fertiliser; essential nutrients (e. g. Ca, K, and Mg) remain in the ash. The bioavailability of P in thermochemically treated ashes was significantly increased during processing and resulted in P-solubility in citric acid of up to 100%. This means that P in this product is completely plant available. XRD analyses showed that the thermo-chemical treatment is accompanied by a sequence of chemical reactions and transformations of the phosphate-bearing mineral phases (Fig. 3, SCHICK et al., 2009).

Fig. 3. Sewage sludge ash (left) and pelletized, thermochemically treated sewage sludge ash (right).

The results of accompanying pot experiments showed that the recycled products produced dry matter yields that were comparable to current mineral fertiliser applications (ADAM et al., 2009; SCHICK et al., 2009). To ensure a safe and sustainable use of sewage sludges for nutrient recovery in the BSR, the technique can be installed as an attachment to incineration facilities to process sewage sludge ash. Other P-rich waste products suitable for recycling of P in a similar procedure are for instance meat and bone meal.

The significance of territorial cohesion for sustainability in the BSR

To reach the aim of a sustainable development in the BSR, the existing regional differences have to be reduced as far as possible. As circa 80% of the actual food requirement in Germany is produced on a local level, the agricultural sector is the backbone of rural areas. As mentioned earlier, the problems the BSR is facing cannot be solved by only one sector alone; hence, political strategies for rural area should be rather oriented to problems and actions than sectors and favourably on the lowest horizontal level (WBA, 2006).

To ensure a sustainable food production in rural areas and in the vicinity of urban centres, the protection of natural resources is of prime interest. This implies among others the conservation of the characteristic landscapes and settlements, an undisturbed environment (soil, water, air) and a local food production (MAGEL and FRANKE, 2008). To achieve this aim, a rural cluster development, co-operations between science and industry, a regional management and combined efforts on a communal level, territorial governance, have to be promoted (SCHNUG, 2011).

There will be changes in agricultural production and SCHNUG (2011) prognosticated the following future developments:

- **Diversification of food production**: In the future, consumers will have the choice between authentic food and technologically modified products which substitute meat. This will result in the shortfall of big animal enterprises and contributes to a significant reduction of nutrient losses to the environment and the release of climate relevant gases.
- **Local and organically produced foodstuff:** The increase of local and organically produced foodstuff in surrounding areas of urban centres with view to peak oil and peak P will be an effective measure to save natural resources and to deliver high-quality food at the same time (LEE et al., 2008).
- **Local implementation of cross-compliance:** Farmers who comply with the demands of organic farming and thus contribute to flood prevention in the vicinity of rivers will receive direct financial support by communities. Agricultural soils which have been cultivated according to the regulations of organic farming have shown to have an infiltration rate that is twice as high

as that of conventionally cultivated soils (SCHNUG et al., 2006).

- **Combined food and energy production:** Yet, another important step for sustainability in the BSR is the adoption of political regulations for the implementation of tailor-made regional concepts that combine food and energy production. It is an imperative requirement that such concepts must not impair food production, neither locally nor globally. Closed energy and nutrient cycles are an important contribution to improve food security and social justice in accessibility of resources not only locally, but globally.

Concept of regional authentic food production

Since the production of mineral fertilisers and pesticides as well as the transport of agricultural commodities from producer to processor to consumer will be affected by impending shortages of oil and phosphorus, urgent action is required to ensure food security in the future, especially in highly populated regions (LEE et al., 2008). One way to meet this aim is a regional, resource-based organic food production which allows a more efficient and sustainable use of fertilisers, energy and water. Organic farming is defined by the guidelines of the European Union (EU No. 2092/91), thus the inherent beneficial effects of this concept for soil infiltration are guaranteed to a certain extent and are indirectly controllable by complying with the regulation on organic farming. Energy ratios for organic farming are far superior to those for non-organic farming since manufactured fertilisers and synthetic pesticides are not used and lower amounts of indirect fossil fuels are required. Due to peak oil and natural gas it will be inevitable to reduce the total food production in Europe and it will be turn out to be more profitable to transport products only relatively short distances which leads to a more regionalised or even localised consumption (LEE et al., 2008). Instead of artificial fertilisers and pesticides, organic farming largely bases upon a pro-active rather than reactive management regime for weeds pests and diseases and thus can operate effectively with reduced inputs. Organic farms usually have low external N-fertiliser input and it is only allowed to use rock phosphates instead of soluble phosphates. Generally, the total P-fertiliser input is lower than on conventional farms. Important are, however, measures to improve the solubility of rock phosphates, for instance by mixing the mineral component with elemental sulphur and thiobacilli in order to increase the solubility and thus plant availability of P (FAN et al., 2002; SCHNUG et al., 2003).

Enlargement of the organically farmed area in the Baltic Sea Region is a strong argument for efficiently reducing nutrient and pesticide discharges (PAULSEN et al., 2002; LEE et al., 2008; SCHNUG and HANEKLAUS, 2008). Besides shortage of resources, extreme weather events causing extremely high or low rainfalls events are a threat to food security, as well. Concerning the problems of water use efficiency, the decline of soil organic matter as a result of conventional agriculture leads to lower water retention in the case of droughts or to a reduced infiltration rate after heavy rainfall. However, organic farms seem to be characterised by relatively higher and even increasing soil organic matter leading to an increased resilience to extreme weather events. Besides the question of food security, higher prices of agrochemicals and fertilisers will encourage farmers to adapt principles and techniques developed in the field of organic farming (LEE et al., 2008).

Local implementation of cross-compliance

River floods associated to extreme rainfalls are a global and serious threat to mankind. The expansion of organic farming offers yet another, hardly recognised benefit. This is the fact that organically managed soils lessen the drastic effects of extreme flooding as they have an infiltration rate (velocity of water quantities being leached in soils) for rainwater that is as a rule of thumb twice as high as that of conventional soils (Fig. 4.). Main reason is a seven times higher earthworm population because of wider crop rotations and renunciation of pesticides (SCHNUG, 2007; LILIENTHAL and SCHNUG, 2008; ALHASSOUN, 2009). Thus organic farming delivers an important contribution to reduce impacts of climate change (LEE et al., 2008).

To calculate different infiltration scenarios in relation with different land-use concepts, the concept of the HOT model (**H**elp of **O**rganics against **T**orrents) has been developed by a research group of the Julius Kühn-Institut (LILIENTHAL and SCHNUG, 2008; ABU-HASHIM, 2011). This model may induce a compensation of anthropogenic induced soil sealing by promoting the change from conventional to organic farming in areas with regularly occurring flooding events. With view to prophylactic flood control a spatial enlargement of organic farming as a compensation measure for anthropogenic soil sealing is implicitly desirable and should be promoted by agricultural policy (LILIENTHAL and SCHNUG, 2008). It is recommended to affiliate organic farming in sensitive areas as a local cross-compliance and premium pays offer additional bonus for aggrieved parties and consumers which is the availability of local, high-quality produce in the vicinity of urban centres.

Fig. 4. Soil compaction which can be found regularly on headlands decreases the infiltration rate of soils.

Fig. 5. Short rotation forestry along roadsides bear a significant potential for the production of bio-energy.

Food security first! Potentials for energy crops

Yet, another important step for sustainability in the BSR is the adoption of political regulations for the implementation of tailor-made regional concepts that combine food and energy production. It is an imperative requirement that such concepts must not impair food production, neither locally nor globally. Closed energy and nutrient cycles are an important contribution to improve food security and social justice in accessibility of resources not only locally, but globally.

Soils which are not suitable for the production of food seem to be predestined for the cultivation of energy plants. Such areas include for instance reclaimed mining sites and roadsides (Fig. 5.). While roadsides have been utilised for cultivated plants such as orchards in past times, they might enjoy a renaissance as a preferred location for energy crops. Thus they contribute significantly to climate protection and a sparse use of fossil fuels.

Scientists of the Julius Kühn-Institute in Braunschweig (Germany) estimate that an acreage of about 60,000 ha is available if only roadsides of A-roads and motorways including junctions are taken into account. The biomass-to-liquid procedure (BtL) could deliver 240 million litre synthetic fuel ('sunfuel') on basis of short rotation forestry. This volume equals 10% of the total amount of fuel from regenerative sources that is required to substitute 5.75% of diesel fuel. The researchers further suggest to use remote sensing technologies to spot suitable territories with regard to profile and logistics and to evaluate environmental effects. Though the utilisation of roadsides and other peripheral zones will not impair food production, it is important to ensure that contaminants in the biomass will not enter the food chain by applying recycled fertiliser materials on agricultural soils. It is imperative for bio-energy production that the requirements of soil protection are fully acknowledged. Only then agricultural land can be used any time for the cultivation of healthy foodstuff and bio-energy production remains renewable.

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Legal Norms

Düngeverordnung (DüV) – Verordnung über die Anwendung von Düngemitteln, Bodenhilfsstoffen und Kultursubstraten nach den Grundsätzen der guten fachlichen Praxis beim Düngen vom 27.02.2007, Bundesgesetzblatt: Teil 1/Bundesminister der Justiz, p 221.

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