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Towards a Sustainable Food System in the Baltic Sea Region

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Introduction: Baltic Sea Agriculture

A research report from the Swedish Environmental Advisory Council, titled *A Strategy for Ending Eutrophication of Seas and Coasts*, argues that the Baltic Sea is facing an ecological flip, associated with changes characterized by excessive algal bloom and a fishing industry in crisis (MVB 2005). Eutrophication may be the most severe of the consequences faced by the Baltic Sea. According to HELCOM (2015, p. 12), "Eutrophication is a major problem in the Baltic Sea. Since the beginning of the twentieth century, the Baltic Sea has changed from an oligotrophic clear-water sea into a highly eutrophic marine environment". The increase in algae is the most obvious effect of eutrophication and its most severe impact is the establishment of dead zones, caused by a decrease in dissolved oxygen in bottom waters (Diaz and Rosenberg

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2008). Higher eutrophication diminishes the resilience of the Baltic Sea ecosystem, making it more vulnerable and heightening the likelihood of future disturbances causing a flip, or a regime shift (Folke 2006). "Substantially greater reductions in emissions" are required to avoid further degradation of the state of the Baltic Sea (MVB 2005: p. 31). Political cooperation is regarded as crucial for progress. Since 2004, eight of the nine countries around the Baltic Sea basin have become members of the EU, which may facilitate cooperation Larsson (2005).

Two parts of the food system combine to account for the lion's share of eutrophication in the Baltic Sea. The main source of nutrient emissions is food production in agriculture, followed by emissions from municipal wastewater treatment plants and private households (HELCOM 2005). Addressing different aspects of the food system—ranging from what is produced and consumed to where and how this is done—is therefore important for the environment in general, and with regard to the eutrophication of the Baltic Sea in particular. The main factor responsible for the increase in the load of nitrogen and phosphorus from agriculture to the Baltic Sea in recent decades is the specialization of agriculture, and the separation between crop and animal production (Granstedt 2000). One consequence of this is higher use of chemical fertilizers, and imported feed concentrates with high nitrogen content. Another is clusters of farms with high animal densities and large surpluses of plant nutrients in specific regions. More nutrients are concentrated on farms than can be used in on-farm crop production. As manures are too costly to be transported over large distances, there is a risk of surplus nutrients leaking into the surrounding environment. According to the Swedish Environmental Advisory Council, "drastic emission reductions and changes in our lifestyles" are required to avoid further degradation of the state of the Baltic Sea (MVB 2005: p. 26). One such lifestyle change that would reduce nitrogen emissions is if people consume more vegetables instead of meat. A similar message is conveyed in a government commission report on sustainable consumption (SOU 2005) while the Stockholm County Council takes the argument a step further in its S.M.A.R.T. recommendations (CTN 2001, 2008, 2015) by saying that local organic food is good for the consumer and for the environment.

Sustainable development is an important goal for Sweden, as it is for the UN, e.g. the Sustainable Development Goals (SEPA 2016;

UN 2015). The Swedish parliament has adopted a number of environmental objectives, several of which are directly or indirectly related to agriculture and rural development or the Baltic Sea.[1] Some of its goals include: 20% organic acreage; ecologically, economically and socially sustainable food production; and ecologically, economically and socially sustainable rural development. Several of these goals coincide with services that a growing organic agriculture sector is expected to deliver, e.g. environmentally friendly food production, thriving rural areas with small-scale farms and increased biodiversity (Milestad 2003). Thus, different aspects of sustainability need to be addressed for agriculture to be sustainable. Rockström et al. (2009) have attempted to quantify the safe biophysical boundaries outside which the ecosphere cannot function in a stable state. They have identified nine biophysical "planetary boundaries": climate change, ocean acidification, stratospheric ozone depletion, nitrogen and phosphorus cycles, global freshwater use, change in land use, biodiversity loss, atmospheric aerosol loading and chemical pollution. In the long run, humanity must stay within these boundaries to avoid unacceptable environmental change. In their original publication, Rockström et al. (2009) identify three boundaries as having been already transgressed—climate change, biodiversity loss and the nitrogen cycle. In a later, updated version, Steffen et al. (2015) added the phosphorus cycle and change in land use (referred to as "land-system change"). Thus, in all, four planetary boundaries (nitrogen and phosphorus cycles counted as one) are no longer within a "safe operating space".

Six of these boundaries—climate change, the nitrogen and phosphorus cycles, global freshwater use, land-system change, biosphere integrity (genetic diversity) and chemical pollution/novel entities—are clearly related to agriculture. Atmospheric aerosol loading and ocean acidification are related to agriculture production to a limited extent, while stratospheric ozone depletion is not related to agriculture.

In this chapter, the main focus is on eutrophication, i.e., the nitrogen and phosphorus cycles. Together with other countries in the region, Sweden has agreed, through HELCOM,[2] to participate in an effort to reduce the emission of nutrients in the marine ecosystems to sustainable levels (HELCOM 2007b). This goal has not been reached, but there has been a considerable reduction, particularly in emissions from sewage treatment plants and other point sources. Reduction in emissions from non-point sources has been achieved in eastern Germany, Poland and the Baltic states since their independence from the Soviet Union, a period in which these countries reduced animal production and manure and chemical fertilizer use (HELCOM 2003). With the admission of Poland and the three Baltic states into the EU, however, there is a risk of these gains being reversed. Agricultural production is expected to rise as a consequence of the expansion of EU, and unless steps are taken to reduce nutrient emissions, there could be an increase in the load from new EU members (HELCOM 2004a, 2007a, 2011). In the words of HELCOM (2011: 86): "A worst-case scenario is that the amounts of nitrogen and phosphorus leaching into the Baltic Sea will increase". The latest available HELCOM report reveals reduced inputs of both nitrogen and phosphorus to the Baltic Sea. However, the inputs of nutrients are still higher than the maximum allowable inputs (MAI) (HELCOM 2015: 110). Today, nearly the entire Baltic Sea is considered to be affected by eutrophication. "This indicates that despite measures taken to reduce external inputs of nitrogen and phosphorus to the sea, good water quality status has not yet been reached" (HELCOM 2015: 12).

A production technique called Ecological Recycling Agriculture (ERA), which could be described as a stricter form of organic agriculture, has an important role in this chapter (see Fig. 2.1). The main difference between ERA and conventional agriculture is that there is more recycling of nutrients in ERA. Diaz and Rosenberg (2008) highlight the need for new agricultural methods that close the nutrient cycle. ERA is an example of a method for closing the nutrient loop. Other agricultural techniques may perform better or worse than ERA in terms of production levels or emissions to the environment, but there are not examined here.

The Environmental Pressure from Agriculture

Agricultural production is affecting the environment in various ways, ranging from changes in the rural landscape to leaching of eutrophying nutrients and pesticides. Many of these effects are neither unavoidable

Ecological Recycling Agriculture (ERA) is a form of organic agriculture. Organic agriculture is usually defined according to principles of health, ecology, fairness and care (IFOAM, 2008; KRAV, 2016). The principle of ecology, which is the most relevant here, includes banning chemical pesticides, artificial fertilisers and genetically modified organisms (GMOs). KRAV[ii] develops organic standards in Sweden and is an active member of the International Federation of Organic Farming Movements (IFOAM). KRAV emphasises the importance of nutrient recycling and aims to maximise feed production within animal farms. For agricultural production to be sustainable, the nutrient cycle needs to be closed (e.g., Diaz & Rosenberg, 2008) and ERA is a form of organic agriculture that includes stricter rules on animal feed production on the farm.

An ERA farm is defined as an ecological (organic) farm (or farms working in close cooperation as one farm unit) that does not use artificial fertilisers and pesticides, with a high rate of recycling of nutrients based on organic, integrated crop and animal production and an external feed rate of <0.15, i.e., less than 15% of the feed may be imported from outside the farm. The absence of these or similar restrictions can result in organically certified production that nevertheless causes substantial nutrient losses.

Fig. 2.1 Principles of ecological recycling agriculture. *Source* Adapted from Larsson and Granstedt (2010). www.krav.se

nor irreversible, but are determined by a number of controllable factors, including what is produced and how this is done. This chapter focuses on the effects of food production on the Baltic Sea. Poland is the largest contributor of nitrogen and phosphorus flows to the Baltic Sea. However, when expressed as emissions per capita, the Swedish contribution is considerably higher for nitrogen and marginally higher for phosphorus than Poland. Finnish per capita emissions are even higher (see Sect. 2.1; Larsson 2005; Table 1 in Larsson and Granstedt 2010).

Agricultural production is responsible for around 50% of the nutrients deposited in the Baltic Sea by surrounding countries (HELCOM 2007b). The input of nitrogen, in the form of artificial fertilizers, to agriculture increased drastically during the second half of the twentieth century. However, only a third of this nitrogen input is usefully exported from the system in the form of food products such as milk, meat and bread grain. If meat production is considered in isolation, the losses are even more substantial. A low surplus of nitrogen implies a lower risk of nitrogen loss to watercourses per hectare (Hoffman and Wivstrand 2015). On average, organic farms have a lower surplus of nitrogen per hectare than conventional farms. However, in relation to food production, nitrogen losses to water "are generally similar to or higher in organic production with large variation depending on system and management" (Hoffman and Wivstrand 2015, p. 17). Thus, a general conclusion cannot be drawn regarding emissions of nutrients from organic agriculture (Hoffman et al. 2014).

The extent of nutrient leakage is also affected by the geographical division of food production (Granstedt 2000). The concentration of animal production is high in southern Sweden and low in the rest of the country. Extensive imports of concentrated feed (Deutsch 2004), feed bought from specialist crop farms and additional use of artificial fertilizer, all contribute to a surplus of plant nutrients in the form of manure in southern Sweden. This region also has the most favourable conditions for the leaching of nutrients with respect to soil texture and climate (Fig. 2 in Larsson and Granstedt 2010). One solution would be for Swedish agriculture to have fewer animals, particularly in the southern parts Larsson (2006). This issue is discussed further in Sect. 4. Furthermore, forage could be used to a larger extent instead of grain-based concentrate. Today 40% of the grain produced in Sweden is consumed by humans, while the remaining 60% is used in animal feed (Jordbruksverket 2014). Thus, the existing system requires higher grain production than an extensive production system with grazing animals Larsson (2006).

Socio-economic Aspects of a Sustainable Food System

The environmental effects of food production and their mitigation through agricultural reforms also have a socio-economic impact. Two examples include the European Nitrogen Assessment and a report from the research network BalticSTERN. A study by BalticSTERN found that the willingness of the population around the Baltic Sea to pay for an improved marine environment amounts to €4 billion per year (Ahtiainen et al. 2012). This can be compared with the social costs of nitrogen fertilization in EU agriculture, which have been estimated by the European Nitrogen Assessment to amount to €20–150 billion per year. The annual benefits of nitrogen fertilization for EU27[3] farmers are in the range €10–80 billion (Brink et al. 2011). HELCOM aims for a Baltic Sea with diverse biological components that function in balance and support a wide range of sustainable human economic and social activities by 2021 (HELCOM 2007a).

Sustainable Agriculture

Different concepts have been used interchangeably to describe sustainable agriculture. According to Pretty (2000, p. 26), "the basic challenge for sustainable agriculture is to make better use of available physical and human resources. This can be done by minimizing the use of external inputs, by regenerating internal resources more effectively, or by combinations of both". In addition to the IFOAM (2008) and KRAV (2016) standards for organic agriculture, ERA specifies a spatial dimension and can be described as a form of local organic agriculture. For the purposes of this chapter, sustainable agriculture includes the following attributes: low nutrient losses (i.e., recycling), minimal harm to biodiversity (no pesticides), production of a food basket that consumers demand and contribution to self-reliance/local development. ERA is only one interpretation of sustainable agriculture and is geared towards the first two attributes listed above.

Sustainable agriculture is only one of the aspects of a sustainable food system, which must also include sustainable production, processing, distribution and consumption. It has environmental, social and economic dimensions. The focus of this chapter is the environmental and economic sustainability of the food system.

Defining a Sustainable Food System in the Baltic Sea Region

The Baltic Sea drainage area is densely populated and the Baltic Sea is a very sensitive and environmentally exposed marine ecosystem. A sustainable food system for this region has to acknowledge specific problems that might be of less relevance to other marine environments.

Sustainable agriculture is usually defined more broadly than organic agriculture. Sustainable agriculture "does not mean ruling out any technologies or practices on ideological grounds. If a technology works to improve productivity for farmers and does not cause undue harm to the environment, then it is likely to have some sustainability benefits" (Pretty 2008: 451). Organic farming focuses on the absence of inputs such as chemical fertilizers and pesticides and supports nutrient cycling through animal feed self-sufficiency ratios and limiting the number of animals per hectare (KRAV 2016). However, it is possible that certified organic farming along the coast to the Baltic Sea can result in substantial nutrient losses, causing eutrophication (Hoffman et al. 2014). "For agricultural systems in general, methods need to be developed that close the nutrient cycle from soil to crop and back to agricultural soil" (Diaz and Rosenberg 2008: 926). This is certainly true for the Baltic Sea and other regions where reducing eutrophication is an important social goal. One production method that addresses nutrient losses is ERA (Granstedt 2000; Granstedt et al. 2008; Larsson and Granstedt 2010), which covers all the environmental principles of organic farming and adds quantitative goals for nutrient losses (see Fig. 2.1).

In addition to sustainable agriculture, this chapter addresses the food system, from a wider perspective. Dahlberg (1993: 75) argues that a regenerative (i.e., sustainable) food system includes "not only production, but processing, distribution, use, recycling, and waste disposal". The scientific journal *Agroecology and Sustainable Food Systems* "focuses on the changes that need to occur in the design and management of our food systems in order to balance natural resource use and environmental protection with the needs of production, economic viability, and the social well-being of all people" (Taylor and Francis Online 2015). A sustainable food system therefore encompasses social, economic and environmental aspects of food and agriculture, and sustainable production is one of several aspects that are considered. Kloppenburg et al. (2000) have identified a set of attributes of a sustainable food system. Several of these are related to lifestyle, including health and consumption, e.g. "In a sustainable food system the production and consumption of food would preserve and enhance the health and well-being of both workers and eaters" (Kloppenburg et al. 2000: 183).

Aim and Research Questions: Aspects of Sustainable Food Systems

The aim of this chapter is to examine different aspects of a sustainable food system, with the objective of minimizing eutrophying emissions of nutrients to the Baltic Sea. For this purpose, economic sustainability has been studied across the whole food chain, while ecological sustainability has mainly been considered at the level of the Baltic Sea. This chapter tackles three research questions in order to study the problems relating to a sustainable food system in the Baltic Sea region:

1. What environmental effects (primarily eutrophication) are expected from a large-scale change towards ERA?
2. What governance strategies are effective in supporting ecosystem management and sustainable food systems?
3. What socio-economic effects (food production, household expenditure and firm-level income) are expected from a transition towards organic production/ERA?

Other important questions include: What are the environmental effects of today's typical agriculture and those of ERA? What would be the effects of different large-scale transformations of agricultural production in the Baltic Sea region on the environment and on output? What are the environmental effects of different food baskets and of similar food baskets produced with different techniques? The environmental impact of an average food basket that is mostly produced and processed far away is compared with those of a locally produced and processed food basket. The effects of food transport and of locally produced food have previously been studied by Carlsson-Kanyama (1999) and Pretty et al. (2005), among others.

There is a long tradition of studying the socio-economic consequences of agriculture on the Baltic Sea environment. The external costs of food production and other economic aspects of the eutrophication of the Baltic Sea have been studied by Gren (2001), Gren and Folmer (2003) and Ahtiainen et al. (2012), among others. Collaboration in combating eutrophication in the Baltic Sea has been studied by Elofsson (2007) and others. This chapter builds on this tradition in different ways: it discusses the various effects of measures on production and employment, the economic impacts of different measures from the perspective of households and producers, and the importance of collaboration in combating the eutrophication of the Baltic Sea.

The relevant theories are presented below, followed by an overview of the methods used. The results are presented and discussed from different perspectives, before the concluding remarks.

Methodology

This chapter covers the environmental and economic aspects of sustainable food systems. The journal *Agroecology and Sustainable Food Systems* states, as its aims and scope: "Rather than focus on separate disciplinary components of agriculture and food systems, this journal uses an interdisciplinary approach to food production as one process in a complex landscape of agricultural production, conservation, and human interaction" (Taylor and Francis Online 2015).

A range of methods have been used to study the different aspects of local organic food production and consumption. These are described in greater detail in the BERAS, GEMCONBIO and HealthyGrowth background reports.[4] The main focus of the BERAS project, for example, was to study the environmental effects of ERA in comparison with those of conventional food production. Surplus and emissions of nitrogen and of phosphorus compounds in the agriculture-society system were quantified. Most of this work was done in Sweden and Finland and, to a lesser extent, in other EU countries around the Baltic Sea (Larsson and Gransted 2010; Larsson et al. 2012). Social and economic consequences were also evaluated. The collection of economic primary data (Larsson et al. 2016) and households (Larsson et al. 2012) was limited to firms and households in Sweden.

Results

What Environmental Effects Are Expected from a Large-Scale Change Towards Ecological Recycling Agriculture?

Results from nutrient balance studies in the Baltic Sea region: The ERA system studied in this chapter showed lower levels of nutrient surplus than conventional production. Among the 12 Swedish ERA farms studied in Larsson and Gransted (2010), the average nitrogen surplus was 36 kg N per hectare per year in 2002–2004. The average for Swedish agriculture was 79 kg per hectare per year in 2000–2002 (Table 2.1). The average nitrogen and phosphorus surplus in average agriculture in all countries in the thesis was 56 and 11 kg per hectare, respectively, in 2000. The average nitrogen surplus observed on the selected ERA farms was 32% lower, i.e., 38 kg per hectare. The phosphorus surplus was completely eliminated in ERA agriculture, and there was a net deficit of 1 kg/ha per year. However, since production per hectare was higher using conventional methods, the difference in nutrient surplus was smaller when surplus nitrogen and phosphorus was expressed per unit output of food (animal and crop production) rather than per hectare (see Sect. 2.3.2). Nitrogen and phosphorus surpluses and calculated ammonia (NH_4) losses for all countries covered by the study and the ERA farms are presented in Table 2.1.

Comparing the nutrient load to the Baltic Sea today [Table 3, latest available figures are from 2010 (HELCOM 2015)] and that in 2000 [Table 1 in Larsson and Granstedt (2010), figures are from HELCOM (2005)], the increase in total load of nitrogen from the countries under study, Russia included, was 863 kt per year. Excluding Russia, the total load from the listed countries marginally decreased. Sweden, Finland, Estonia and Demark now produce lower loads of nitrogen, while Latvia, Lithuania, Poland, Germany and Russia have increased their loads. The total load of phosphorus from the countries is lower today (36.1 vs 41.2 kt/yr, including Russia). Sweden, Finland, Estonia, Poland and Germany now have lower loads and Latvia, Lithuania, Denmark and Russia have increased their loads over time.

Table 2.1 Arable land (million hectare, Mha), total load (according to calculations from HELCOM 2005) and calculated total farm-gate surplus of nitrogen (N) and phosphorus (P) and ammonia (NH_4) losses (40%), expressed per unit area (kg/ha) and as kilotonnes per year (kt/yr) in average agriculture and for ERA farms

HELCOM				Average agriculture						ERA agriculture					
Arable land[a]		Loads year 2010[b]		N surplus		P surplus		NH_4 loss		N surplus		P surplus		NH_4 loss	
	Mha	N kt/yr	P kt/yr	kg/ha	kt/yr	kg/ha	kt/yr	kg/ha	kt/yr	kg/ha	kt/yr	kg/ha	kt/yr	kg/ha	kt/yr
Sweden	2.7	119	3.6	79	184	3	8.1	22	58	36	97	−2	−5.4	21	57
Finland	2.4	72	3.0	75	179	7	16.7	14	33	38	91	3	7.2	18	43
Est/Lat/Lit	7.5	174	6.1	19	141	3	21.4	16	117	41	308	−1	−3.8	12	99
Poland	14.2	302	14.8	57	812	19	270.7	15	217	32	456	−2	−28.5	16	233
Germany	2.1	38	0.6	74	152	−2	−4.1	9	19	16	33	−3	−6.2	6	13
Denmark	2.1	57	1.8	129	268	8	16.6	54	112	87	181	5	9.3	49	103
Total[c]	31.0	762	29.9	56	1736	11	329.4	18	556	38	1165	−1	−27.3	18	548

[a]Land in the Baltic Sea drainage area only

[b]HELCOM (2015, Table 4.1a)

[c]Loads from Russia are 101 kt N/yr and 6.2 kt P/yr. Total loads including Russia are 863 kt N/yr and 36.1 kt P/yr (HELCOM 2015)

Source Adapted from Tables 1 and 2 in Larsson and Granstedt (2010) and HELCOM (2015). EST/Lat/Lit = Estonia–Latvia–Lithuania

ERA differs from organic agriculture in one important aspect, namely that animal and plant production are integrated. In this type of system, it is possible to make efficient use of plant nutrients in manure to reduce the nutrient surplus. The need for external nitrogen in such a system is much lower. Note that it is not necessary for each farm to have both animal and vegetable production, as farms within regions can cooperate. However, it is important to use manure in an efficient manner to avoid associated environmental problems. Inappropriate storage and spreading of manure results in a loss of nutrients to water and air. The benefits of using organic fertilizers instead of chemical fertilizers as a means to reduce eutrophication have been questioned (Kirchmann and Bergström 2001; Larsson 2005; Kirchmann et al. 2001). There may be difficulties in applying the right quantity of organic fertilizers and field trials have shown that chemical fertilizers can cause less leaching of nutrients and thus less eutrophication. Then again, it can be argued that in an agricultural system with regional specialization and a need for chemical fertilizers in crop production, there will be a surplus of nutrients in regions specializing in animal production and this surplus is rarely used efficiently in production.

Scaling up the results—scenarios on emissions: Larsson and Granstedt (2010) developed three scenarios based on results from 42 farms in eight EU countries, which are presented in Table 2.1. In the "conventional scenario" (Fig. 2.2), agriculture in Poland and the Baltic countries convert to the production methods currently used in Sweden. This scenario is supported by the present system of EU subsidies. ERA Scenarios 1 and 2 assume the conversion of agriculture across the Baltic Sea drainage area to less intensive local organic agriculture. To echo the conclusions from the Millennium Ecosystem Assessment (2005: 1), these scenarios would "involve significant changes in policies, institutions, and practices that are not currently under way".

In the conventional scenario, nitrogen and phosphorus surplus increase by 58% and 18% per hectare, respectively (Fig. 2.2). If Poland and the Baltic states were to intensify their agriculture according to Danish standards, nutrient loads would increase further (HELCOM 2007b). In this scenario, referred to as "Business as usual in Agriculture", phosphorus loads to the Baltic Proper double and nitrogen loads increase by 70% (HELCOM 2007b). This expected increase may be more than

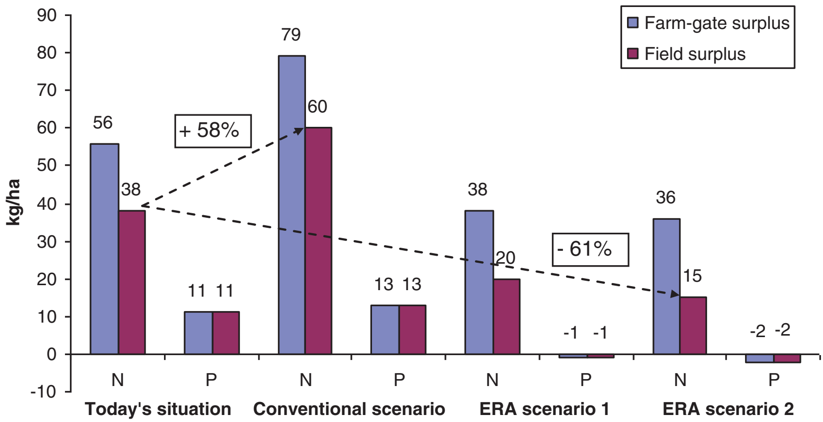

Fig. 2.2 Surplus of nitrogen and phosphorus, kg/ha & yr, in farm-gate and field balances calculated for four alternative governance regimes: Today's agriculture situation (Today's situation); a scenario where agriculture in Poland and the Baltic countries converts to conventional agriculture similar to that in Sweden (Conventional scenario); all agriculture in the Baltic Sea drainage area converts to ERA as practised in the respective countries (ERA Scenario 1); all agriculture converts to ERA as practised in Sweden (ERA Scenario 2). Field surplus equals farm-gate surplus minus ammonia (NH_4) losses, see Table 2.1. *Source* Adapted from Larsson and Granstedt (2010)

what the already stressed ecosystem of the Baltic Sea can cope with (MVB 2005). The consequences of ERA Scenario 1, where all agriculture in the Baltic drainage area converts to ERA, following the techniques used in each country, are very different. Calculations indicate a decrease in the nitrogen surplus of 47% in that case (Fig. 2.2). If all agriculture in the Baltic Sea region were to be converted to ERA as practised in Sweden (ERA Scenario 2), there would be a 61% reduction in the nitrogen surplus. In the two ERA scenarios, there is a negative phosphorus surplus, which would significantly reduce the phosphorus load to the Baltic Sea.

What Governance Strategies Are Effective in Supporting Ecosystem Management and Sustainable Food Systems?

The importance of consumption—Swedish case studies: In addition to production methods, consumption patterns also determine environmental impact. A Swedish government commission report (SOU 2005) proposes increasing the shares of vegetables and local organic food to reduce global warming from the food chain. Larsson et al. (2012) provide results that partly support this proposal. They compared four scenarios:

The environmental impact of conventional Swedish food production applied to an average food basket (Scenario 1) was compared with food produced with ERA methods (Scenario 2); food produced with ERA methods and processed locally (Scenario 3); and an alternative food basket with less meat and more vegetables produced with ERA methods and processed locally (Scenario 4).

Scenario 4 resulted in slightly more than a third of the nitrogen emissions attributed to average Swedish consumption. The nitrogen emissions per hectare in Scenario 4 were higher than in Scenario 2 (average food basket produced with ERA methods), but the total or per capita nitrogen emissions were lower (Larsson et al. 2012). This is due to the differences in the food baskets and the resulting difference in acreage needed for food production. A reference group studied in a household survey in Scenario 4 consumed more vegetables (100% more), less meat (75% less) and substantially more local and organic food than the average Swedish consumer. The share of local and organic food was 33% for the families in this survey. Among "real food" purchases, i.e., excluding sugar, sweets, beverages, etc., 73% was organic, compared with 2% for the average Swede. Today, consumption of organic food has increased, but it is not close to 73% (Larsson et al. 2016). These results agree well with findings from the Environmental Advisory Council that a diet consisting of two-thirds animal products results in fourfold more nitrogen emissions from agriculture into water and air than a fully vegetarian diet (MVB 2005).

If the average Swedish food profile was similar to that of the group in the household survey (Larsson et al. 2012), i.e., more vegetables and less meat, the area currently used for agriculture in Sweden would be more than sufficient. Simply replacing conventional production with ERA without changing consumption patterns would require an additional (and unrealistic) 2.3 million hectare of arable land, an increase of 90%. This larger areal requirement is due to the lower yield per hectare on organic farms and the larger share of ruminant meat (70%, compared with 30% in conventional production), which requires more arable land for feed production compared with pork or poultry (Larsson et al. 2012). On the other hand, conventional production relies to a larger extent on imports, e.g. soy products from agricultural production in other countries. The difference in required area for food production is therefore smaller than might be expected. While this would also lead to a reduction in phosphorus emissions, additional studies on the link between lower surplus and real losses on farm level are needed to provide a quantitative estimate.

Other environmental effects of different governance strategies: Moving towards ERA production and a change in diets could also result in gains with respect to global warming. However, local processing and distribution result in less significant gains.

Scenario 2 (food produced with ERA methods) resulted in a 10% reduction in the Global Warming Potential (GWP) and Scenario 4 (an alternative food basket with less meat and more vegetables produced with ERA methods and processed locally) led to a 40% reduction in GWP compared with Scenario 1 (conventional Swedish food production of an average food basket) (Larsson et al. 2012). The results indicate potential environmental gains from local food production and consumption due to reduced transportation, as reported in previous studies by Carlsson-Kanyama (1999) and Pretty et al. (2005). Local processing and distribution (Scenario 3) resulted in additional GWP reductions, compared with Scenario 2. One explanation for the better environmental performance of Scenario 4 is the smaller share of meat in the food profile. Meat production is generally more energy-intensive than vegetable production.

What Socio-Economic Effects Are Expected from a Transition Towards Ecological Recycling Agriculture?

What are the expected economic consequences for households? The environmental gains from local organic production are promising, but the food produced is more expensive. According to the household survey carried out in Larsson et al. (2012), a food basket high in organic and locally produced food was 24% more expensive than the Swedish average basket. This may obstruct large-scale expansion of environmentally friendly production and consumption. It may be difficult to convince consumers to increase food expenditure for the sake of the environment, and the consumption pattern with high levels of eco-local food found in the case study (Larsson et al. 2012) is unlikely to be found in many places. However, 24% higher food prices that the consumers in the reference group faced (Larsson et al. 2012) may be misleading from a societal perspective. The increased costs are associated with reduced environmental effects compared with conventional food production and consumption, where environmental effects are largely externalized. In other words, it can be argued that local and organic agriculture such as ERA also contributes to economic sustainability at the regional level.

Although local and organic food is more expensive according to the results in Larsson et al. (2012), the demand has increased over time (Larsson et al. 2016).

What are the expected effects on production levels? A large-scale transition from conventional to ERA production in Sweden would result in a 22% reduction in animal production and a 28% reduction in crop production. Annual crop and animal production have also been calculated for conventional and ERA scenarios in Poland and the Baltic states (Fig. 2.3). Neither ERA nor conventional production is currently optimized in Poland or the Baltic states. For conventional production, this was expressed by increasing production in the conventional scenario, where production in Poland and the Baltic states was changed in accordance with conventional, mainly industrial, agriculture in Sweden. The conventional scenario led to an increase in crop production at around 30%, and an increase in animal production at around 40%.

For the two ERA scenarios, production estimates were very different. ERA 1, where all production was altered according to ERA as practised in each country, resulted in 15% lower crop production and 40% lower animal production. This lower output is explained by extensive production with low productivity on ERA farms in Poland and the Baltic countries. The differences between scenarios ERA 1 and ERA 2 shown in Fig. 2.3 illustrate the potential production gains if local organic agriculture in Poland and the Baltic states were to introduce the production methods practised in Sweden. Should ERA as practised in Sweden be introduced on a large-scale in the Baltic Sea drainage area, production

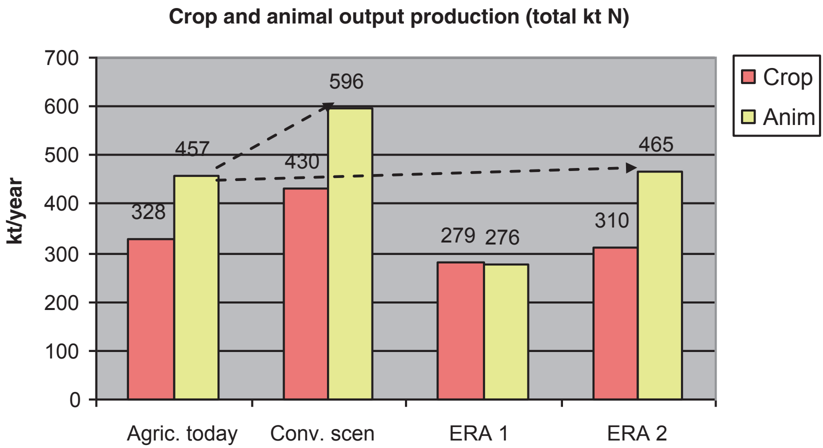

Fig. 2.3 Crop and animal production in the Conventional (Conv.) scenario and two alternative ERA scenarios (1, 2), which resulted in increased, reduced and (close to) unchanged agricultural production, respectively, compared with today's average agriculture. *Source* Adapted from Larsson and Granstedt (2010)

figures would essentially remain at current levels (ERA 2 scenario). In fact, if conversion to efficient ERA methods were restricted to Poland and the Baltic states, output in the region would increase, while nutrient emissions would decrease. This would obviously require a concerted governance effort.

Compared with scenarios carried out by SEPA (2008), the large-scale introduction of ERA in Sweden in Larsson and Granstedt (2010) showed relatively low production losses and relatively high reductions in emissions. Assuming that the recycling principles of ERA are followed, animal production needs to be decreased in southern Sweden, while a corresponding increase is required in central Sweden.

The results from Larsson and Granstedt (2010) indicate that sustainable governance of the Baltic Sea cannot be achieved while simultaneously maximizing agriculture production in the surrounding countries. A clear choice has to be made between these desired outcomes. Production and nutrient emissions differed substantially depending on the selected agriculture regime. The differences in outcomes were most evident in Poland and the Baltic states. Historically, newer EU members have shown relatively modest food output, accompanied by a fairly low nutrient surplus.

Other socio-economic effects: Larsson and Granstedt (2010) discuss economic aspects of introducing ERA on a large-scale, including the effect on income, production levels, employment and reduction costs. The results indicate that benefits outweigh costs at firm level, but that consumers face increased prices. A group of local organic producers in Sweden referred to in Larsson and Granstedt (2010) reported their economic situation to be satisfactory and organic production was often stated to be at least as profitable as conventional production. Production costs were higher and yields lower, but this was compensated for by the price premium received and EU subsidies under the CAP programme paid to organic producers.

Reduction in costs depends on several factors, including demand for food and bioenergy, the extent of measures undertaken and implementation time (Larsson and Granstedt 2010). With a lot of capital bound to present production, as in Sweden, the cost will increase with shorter implementation time. If major measures in the agricultural sector are undertaken, it could prove difficult for other sectors to absorb labour and other factors of production. Finally, if a measure can be targeted at areas with low productivity but high leaching, or if affected areas can be used for alternative production, costs will be reduced.

According to Larsson and Granstedt (2010), the main costs of implementing ERA in Sweden and other old EU member states are probably in the form of farm level infrastructure investments, lower yields and, to some extent, provision of training and advisory services. Social costs for conversion towards local organic production have not yet been estimated. Large-scale conversion might cost more than is gained, but this question is beyond the scope of this chapter. However, over the years the costs of implementing other reduction measures have been estimated and could serve as benchmarks. Gren (2001) has identified three main components of a cost-efficient mix of measures to reduce nitrogen emissions: measures aimed at agriculture; extending the capacity of municipal wastewater treatment plants, and the (re-) creation of wetlands as nitrogen traps. Turner et al. (1999) quantified the marginal costs of these measures for different countries. Several reduction measures have been implemented ever since. This has increased the estimated reduction costs of additional measures. The marginal cost of 1 kg nitrogen reduction in agriculture was SEK 22–42 according to Turner et al.

(1999), whereas more recent estimates by the Swedish Environmental Protection Agency and the Swedish Board of Agriculture are higher, in the range of SEK 10–5800.

According to SEPA (2008), there are cost-efficient measures to carry out water treatment. However, the potential reduction in nitrogen emissions is limited. Many investments in reducing Swedish point-source emissions have already been made and investments to further reduce phosphorus emissions in wastewater treatment plants are not justified (SEPA 2008; Larsson and Granstedt 2010). Other measures thus become more interesting and most reductions have to be made in agriculture.

Elofsson (2003) compared the cost efficiency of different measures to reduce the agricultural load of nitrogen and phosphorus to the Baltic Sea. Reduction in the use of chemical fertilizers was the most important measure identified, followed by changes in land use, primarily increasing the area of catch crops. Using no chemical fertilizers and a change in land use in terms of less intensive production, for example, by introducing ERA production, may or may not be as cost-efficient as the measures examined by Elofsson (2003), but this has not been examined here. Economic aspects of agriculture and the Baltic Sea are discussed below.

Discussion

The aim of this chapter is to examine different aspects of a sustainable food system, with the overall objective of minimizing eutrophying emissions of nutrients to the Baltic Sea. The following sections discuss some of these aspects: socio-economic consequences (Sect. 3.1); and cooperation at different levels (Sect. 3.2).

Costs and Benefits of Measures Targeting Production

In order to reach the targets set out by HELCOM, costly, ambitious and perhaps unrealistic measures are needed (SEPA 2008; Larsson and

Granstedt 2010). SEPA (2008) presents three hypothetical scenarios of large-scale reduction of agricultural production in southern Sweden (see Table 5 in Larsson and Granstedt 2010). Compared with other measures, e.g. those presented in Sect. 2.1 (see also Table 7 in Larsson and Granstedt 2010), these are extremely ambitious and are the only way to match the reduction in nutrient emissions from large-scale conversion to ERA. In the three SEPA scenarios, between 230,000 and 940,000 ha of productive land in coastal zones in southern Sweden are turned fallow. This results in a reduction in nitrogen emissions to the Baltic Sea of 3000–8500 tonnes per year. Large-scale conversion to ERA methods in Sweden are estimated in this chapter to result in a reduction of 15,000–16,000 tonnes worth of nitrogen emissions (Larsson and Granstedt 2010). Turning large areas of productive agricultural land fallow and the large-scale conversion to ERA will both result in substantial losses in food production for Sweden (see Fig. 5 and Table 5 in Larsson and Granstedt 2010).

However, on a regional scale, food production based on ERA techniques could reduce nutrient emissions in comparison with conventional production methods without substantially reducing food production in the Baltic Sea region (Larsson and Granstedt 2010). While this sounds promising, the conversion to ERA requires large investments in new production facilities, mainly at the farm level. The cost of these investments has not been estimated here. However, there are estimates of other reduction measures that can serve as benchmarks. Even though some of the costs referred to are a few years old, they are indicative of the magnitude of expected reduction costs.

Measures to reduce nutrient emissions: A cost-efficient mix of measures, i.e., methods resulting in the largest reduction per krona invested, aimed at agriculture, extending the capacity of municipal wastewater treatment plants and the (re)creation of wetlands as nitrogen traps are needed to reduce nitrogen emissions to the Baltic Sea (Gren 2001). Efforts that target agriculture include cultivation of nitrogen-fixing crops and reduced fertilization. These are also cost-efficient ways to reduce phosphorus emissions (Elofsson 2003). ERA involves a transformation of the farming system. However, the measures suggested by Gren (2001) and Elofsson (2003) can be seen as supporting ERA. ERA does not allow chemical fertilizers, and the less intensive crop production in ERA can be viewed as an alternative to catch crops. Together with efforts aimed at wastewater treatment plants and wetlands, etc., ERA or local organic agriculture could help improve the environmental condition of the Baltic Sea (SEPA 2008; Table 1).

The studies referred to above do not measure costs and benefits of a change towards ERA-like farming. The ERA scenarios (Larsson and Granstedt 2010) would reduce the nitrogen surplus in agriculture by 47–61% and the phosphorus surplus by 100%. If the cost of achieving this is less than the estimated costs of other measures, then ERA is a more cost-effective way to reach reduction targets. The estimated cost of reducing nitrogen emissions ranges from 10 to 5800 SEK/kg (Table 7 in Larsson and Granstedt 2010). For phosphorus, the estimated cost ranges from 350 to 30 000 SEK/kg. A detailed analysis of the cost question is beyond the scope of this chapter.

The effect of the three scenarios from SEPA (2008) mentioned above on Swedish food production is substantial. Much of the affected acreage is in highly productive areas in southern Sweden. In SEPA Scenario 2, the production of several crops is more or less reduced by half, and in Scenario 3, large parts of production in southern Sweden cease (see Table 6 in Larsson and Granstedt 2010). Animal production is also expected to change according to the reduced crop production. In comparison, a large-scale transition from conventional to ERA could prove just as costly. The main costs for implementing ERA in Sweden and other old EU member states are probably in the form of lower yields,[5] training and extension services and farm level infrastructure investments. A large-scale transition from conventional to ERA production in Sweden would reduce animal production by 22% and vegetable production by 28%. To fulfil the recycling principles of ERA, animal production needs to be decreased in southern Sweden, while a corresponding increase is required in central Sweden (see Fig. 2a in Larsson and Granstedt 2010). Many farms that specialize in animal production in southern Sweden would thus become obsolete as a result of the change to a system of local food production. Meanwhile, moving animal production from southern Sweden would require large investments in new production units in central Sweden. This would induce additional costs, over and above the loss in production. It is reasonable that these costs, at least to some degree, are borne by society at large and not by individual farmers. These costs must be considered when deciding on future policies (Larsson 2005, 2006).

Benefits of reduced nutrient emissions: The cost of reducing nitrogen emissions to the Baltic Sea may be high, but so is the willingness to pay (WTP) for reducing eutrophication to sustainable levels. According to Gren et al. (1997a, b), the combined WTP for a healthier Baltic Sea (SEK31 bn) is twice as high as the cost (SEK15 bn) of reducing nitrogen and phosphorus emissions by 50%. The WTP has been notably stable over time. A more recent study shows that people in the nine countries around the Baltic Sea are willing to pay a total of €4 billion (SEK36.8 bn) per year to improve the marine environment (Ahtiainen et al. 2012). However, these figures should be interpreted with a degree of caution. The WTP may be an overestimate and the cost of reducing the emissions may be an underestimate. Even if these figures prove to be incorrect and the reduction costs prove to be higher than the WTP, from a socio-economic perspective it is worth making an effort to improve the situation in the Baltic Sea. Ahtiainen et al. (2012: 25) argue that although their figures are prone to uncertainties, "they suggest that the benefits of reducing eutrophication in the Baltic Sea may be substantial". The relatively high total WTP indicates that taxpayers expect an increase in welfare if investments are made in measures to reduce eutrophication. This is further emphasized by the figures pertaining to the external costs of agricultural production.

The European Nitrogen Assessment estimates the annual environmental costs in EU agriculture of nitrogen fertilization alone to be €20–150 billion (Brink et al. 2011). The annual benefit of nitrogen fertilization for EU farmers is roughly half this cost. This is in contrast to the findings in Larsson et al. (2012), where a household survey revealed that families with a high share of local and organic food in their food basket faced 24% higher food expenses than the average Swedish family. Contrary to findings by Pretty et al. (2005), less was gained from local processing and distribution than by turning to organic production in the study of ERA farms in Larsson et al. (2012).

Today, taxpayers subsidize production which affects them negatively in some ways and leads to immense external costs. Using scarce resources in this manner is not rational. Taxpayers are willing to give up substantial amounts to address these problems—the average Swedish taxpayer is willing to pay €110 per year to reduce the eutrophication of the Baltic Sea (Ahtiainen et al. 2012). There is thus a savings potential in society for a move towards more environmentally friendly agriculture. For this potential to be realized low emission techniques need to be applied (Brink et al. 2011). If not, the low fertilizing efficiency of nitrogen in manure, in comparison with that of chemical fertilizers, and the high emission factors for ammonia could cause the use of manure nitrogen to result in more harm than good for society.

Taking a broader perspective, efforts aimed at environmentally friendly agriculture look even more attractive than other measures. They contribute to reaching the goals of sustainable food production and sustainable rural development set out by the government. A less eutrophied Baltic Sea could also mean improved opportunities for the fishing industry and tourism, etc. It could improve the well-being of a large number of people, irrespective of whether they make use of the Baltic Sea (Larsson 2005, 2006). The WTP for an improved Baltic Sea environment is one expression of this.

There are also costs associated with changing farming practices, as discussed in Sect. 3.1.1, but not all measures imply additional costs, and some may in fact result in overall savings for society. For example, the artificial lowering of grain prices due to subsidized production stimulate its excessive use for feed (60% of total grain production) and there are few incentives to reduce the loss of nutrients. If the agricultural sector had to deal with all the negative effects it caused, this would be reflected in increased food prices but not necessarily in increased costs for society. Consumers currently pay the full price of food production, in the grocery bill, through their tax bill and through a degraded environment (Larsson 2006; Brink et al. 2011).

On Regional Cooperation

The substantial WTP among taxpayers for a healthier Baltic Sea and the pay-off in terms of reduced external costs from agro-environmental investments argue in favour of agricultural production reform (Larsson and Gransted 2010; Larsson et al. 2012; Sect. 3.1). The gains are larger if this action is coordinated internationally: "in order to combat eutrophication (especially in the open sea), nutrient reduction measures should be considered jointly for the whole Baltic Sea region" (HELCOM 2005: 15). For solutions to be cost-efficient, investments need to be made where the highest nutrient reduction can be achieved for the money spent, and this requires international cooperation. All countries would benefit from participation in an effort to combat eutrophication but "some countries [including Sweden] will incur substantially larger benefits than others, which may necessitate the implementation of a redistribution scheme of the increase of the net benefits due to cooperation" (Gren and Folmer 2003: 40).

For example, it may be more efficient for the Baltic Sea region if Sweden were to pay Poland to reduce its emissions to a greater extent in order to offset or compensate for a lower reduction in Swedish emissions. This holds true if the same sum buys a larger reduction in Poland than in Sweden (Larsson 2005). This is already happening in practice. For example, private foundations Baltic Sea 2020 in Sweden and John Nurminen Foundation in Finland are financing water treatment in Warsaw, Poland, because this is predicted to result in larger environmental benefits for the Baltic Sea than similar investments in Sweden and Finland.[6]

Far-reaching measures from individual countries, on the other hand, may not have significant effects (Larsson 2012). Elofsson (2007) argues that there is greater uncertainty around unilateral efforts in terms of costs and reductions achieved compared with bilateral measures. For example, a unilateral Swedish conversion towards ERA is not possible without lowering food production due to lack of arable land (Larsson and Granstedt 2010). If conversion is coordinated between countries in the Baltic Sea region, food production can remain stable while reducing nutrient emissions, according to the ERA 2 scenario in Larsson and Granstedt (2010). Measures towards a more ERA-like agriculture at the regional level, especially in Poland and the Baltic states, may be a cost-effective way to combat eutrophication in the Baltic Sea. A win–win solution thus appears possible (Larsson and Granstedt 2010).

Implications for Policy

A Policy Window for Sustainable Agriculture

After the recovery of the Russian economy and the entry of Poland and the Baltic states in the EU, agricultural production is likely to increase, and with it, nutrient loads (Larsson and Granstedt 2010). "These trends will be highly dependent on the future agricultural policies of the EU" (HELCOM 2004b, p. 18). The awareness among policymakers that the present policy implemented among the new EU members is unsustainable and needs to be changed is growing, and the expansion of EU could be viewed as a policy window (Kingdon 1995) or a window of opportunity (Olsson et al. 2004). Poland and the three Baltic states are currently regulated by EU environmental legislation, but they also have access to funding through the EU Common Agricultural Policy (CAP). This provides an opportunity for decision-makers to stimulate agricultural production in an efficient and environmentally friendly direction. If this present opportunity is missed, there is a risk that the agricultural sector will be modernized in a less desirable direction from the perspective of the Baltic Sea environment (Larsson and Granstedt 2010). Once a new regime is established, it will be difficult to change things around again.

The new, renegotiated CAP that was agreed on by the EU members in 2013 introduced some changes in terms of general support and support for environmentally friendly production. According to the European Commission, the new CAP is "more equitable and greener" and is "adapted to meet the challenges ahead by being more efficient and contributing to a more competitive and sustainable EU agriculture" (European Commission 2013: 1). Others, including the European Environmental Bureau, the largest environmental NGO in Europe, question the green ambitions of the reformed CAP: "the greening of the (CAP) is on course to end in failure by allowing farmers to secure European funding while not taking measures to protect the environment".[7] In a similar vein, Friends of the Earth argues that the Commission's initial plans "were a positive step towards sustainability in farming. However, the CAP reform process was mostly business as usual, with little real reform. Greening—the idea that direct payments to farmers would have to include strong elements of environmental protection and sustainable agri- and eco-system services—was weakened.”.[8]

Whether by influencing agricultural practice among old or new EU members, advocates of ERA or other forms of more sustainable agriculture have to make their alternative attractive to decision-makers. In the words of Smith (2007: 446), “Performance criteria in niche and regime need to come into some kind of correspondence—translating what works in the niche into something that also works in the regime”. Having demonstrated that alternative forms of agriculture (a niche) work, a common ground is needed for alternative agriculture to link with and influence conventional practices (the regime). There is of course a risk that practices that are flexible enough to work under such different contexts are not particularly sustainable. Moreover, the regime, i.e., conventional agriculture, enjoys an influential position whereas the green niche, ERA/organic agriculture, is far from mainstream and is disputed. Thus, there is a “power relation influencing how socio-technical practices that ‘work’ in the context of the niche are subsequently interpreted, adapted and accommodated within the incumbent regime” (Smith 2007: 447).

Implications for New EU Members

According to the results presented in Larsson and Granstedt (2010) and Larsson et al. (2012), sustainable governance of the Baltic Sea cannot be achieved with a policy that strives to maximize agriculture production in the surrounding countries. The outcome in terms of production and nutrient emissions will differ substantially depending on the agriculture policy adopted, especially in Poland and the Baltic states (Larsson and Granstedt 2010). Historically, agricultural production in these countries has resulted in a limited surplus/emission of nutrients and relatively low levels of food production. The rural economies in these countries will most likely change following the access to EU subsidies and the internal market (Larsson et al. 2013). From a policy perspective, it is an opportunity that can be exploited by policy entrepreneurs (Kingdon 1995). As a result, the system could move right in the direction of industrialized agriculture, high yields and, consequently, increased nutrient emissions; or it could move towards an agricultural system of environmentally friendly production with higher yields than today, but lower yields than those offered by a move in a conventional direction.

The Swedish Environmental Advisory Council argues that reducing emissions may not be sufficient to restore the Baltic Sea to its state prior to the industrialization of agriculture. The degradation may have gone on for too long, and there may be an excess of nutrients stored in the sediment. If this is true, the Baltic Sea is heading towards a new stability state, or equilibrium. In order to return to its previous state, a necessary, but perhaps insufficient condition is substantial cuts in emissions. These reductions are required in any case in order to avoid further degradation (MVB 2005; Larsson 2005, 2006). The rural economies of Poland and the Baltic states are going through major changes which are influenced not least by EU's CAP, which offers support for both scenarios above.

Possible Policy Measures Towards a Sustainable Food System

A number of different policy instruments are available to combat the adverse environmental effects of agriculture. Tradable emissions rights for nitrogen and phosphorus are attractive in theory, but less so in practice. Diffuse emissions, such as nitrogen and phosphorus from agriculture, are considered too difficult to control (Collentine 2002). A related tool could be used for animal production or spreading manure (Alkan-Olsson 2004; Larsson and Granstedt 2010). A system of quotas for livestock with reduced quotas in southern Sweden is one possible measure. In central Sweden, increased quotas may be necessary, combined with subsidies, to increase animal production in order to match crop production (Larsson 2006).

However, Larsson et al. (2012) show that in addition to production methods, what is produced and consumed is of interest. Increasing the share of, say, vegetables could be equally important as increasing the share of organically produced food (Larsson et al. 2012). A transition to sustainable agriculture implies a changed production mix. If sustainable agriculture is to become the dominant regime and not just a niche (Smith 2007), the chosen mode of production must be equipped to meet the consumer demand. One of the key issues for Stockholm County Council's S.M.A.R.T. project is to change consumption patterns and to give recommendations for diets that both improve health and reduce environmental impacts (CTN 2001, 2008, 2015). Several of the S.M.A.R.T. recommendations support organic production and ERA, including those aimed at increasing the share of vegetables consumed; increasing the share of organically certified food; choosing meat from among grazing animals, such as lamb; choosing food according to season; and giving preference to local food more often (Larsson 2005, 2006). The importance of food choices for the environment has also been emphasized in Swedish government reports and Södertälje Municipality, south of Stockholm, has turned theory into practice in its policy for public procurement (Ekomatcentrum 2014, 2015). One government commission report (SOU 2004) suggests increasing public procurement of organic food and strengthening domestic science as a subject taught in schools. One measure discussed by the Swedish Environmental Advisory Council (MVB 2005) is to stimulate radical lifestyle changes. This includes consuming more vegetables instead of meat as a way to reduce nitrogen emissions (Larsson 2005, 2006).

Whether the desirable share of public demand for organic food is 25% (SOU 2004), 50% or even 100%, as suggested by Södertälje municipality (Ekomatcentrum 2014; Larsson et al. 2012), is entirely a political discussion. Efforts aimed at local production and processing could be made more attractive if they are framed in terms of public policies or subsidies for local development rather than for environmental benefits. Food basket content and organic production methods are equally important in terms of impact on the environment, and both are more important than local food (Larsson et al. 2012). This should be considered while taking policy decisions.

Smith (2007: 447) asks for a "policy to help nurture green niches and put incumbent regimes under sustainability pressure". The municipal policy on public procurement of organic food in Södertälje, as described above, is an example of such a policy.

While deciding on policy instruments, it is important to evaluate their potential effects. If farmers are hit so hard that, say, all of Swedish or northern European agriculture is threatened, then the proposed solution is not sustainable. The same applies if taxpayers believe that the new agricultural system is too expensive, if production experiences a sharp fall, or if produce becomes so expensive that consumers switch to imported goods. The expansion of EU is a policy window (Olsson et al. 2004)—it creates a choice. If Poland and the Baltic states follow in the footsteps of old EU members in the Baltic Sea region, there is a risk of nutrient emissions increasing by 50–60% (Larsson and Granstedt 2010). If agricultural subsidies are used to steer production towards an environmentally friendly route, this could be avoided. Instead, there is potential for reduced emissions, as well as profitable rationalization of the farming sector (Larsson 2005, 2006).

Concluding Remarks: A Sustainable Food System in the Baltic Sea Region

According to HELCOM, eutrophication is the main threat to the Baltic Sea environment and agriculture is the main source of nutrients entering the Baltic Sea. A transition towards the low-input recycling system of ERA is one way of reducing emissions from agriculture. Large investments have already been made in the agricultural sectors of and the Baltic states. There is potential for outlining a new policy where sustainable governance of the agricultural sector is coherent with sustainable governance of the Baltic Sea. If the relatively efficient ERA production or other sustainable production methods that are in use in Sweden were to be introduced on a large-scale in Poland and the Baltic states, there is a possibility to reduce the emission of nutrients from agriculture without lowering food production. If, however, the new EU members develop in the direction of conventional Swedish agriculture, there is considerable risk of an increase in nutrient emissions in parallel with increased levels of food production. The calculations in this chapter are conservative in comparison with HELCOM figures. If all Baltic Sea agriculture were to change in line with ERA, nitrogen emissions from agriculture would be reduced by half and phosphorus emissions would be completely eliminated.

The Swedish government and the other contracting parties in HELCOM have environmental and economic incentives to use this opportunity in Poland and the Baltic states. The costs of transformation can be relatively modest, albeit high in absolute terms, with a progressive EU agricultural policy. A similar transformation towards sustainable agriculture in Sweden and other older EU members is likely to be more expensive. In order to be successful and efficient, the measures taken should be coordinated internationally.

The large-scale transformation of agriculture in the Swedish or Baltic Sea region is likely to depend on government intervention, since the alternative food basket examined here is more expensive than the Swedish average. However, the increased cost is somewhat misleading from a socio-economic perspective, as this move will greatly reduce environmental costs. Compared with conventional food production, the environmental costs of ERA-produced food are internalized to a great extent. People's WTP for an improved environment is substantial and several of the more cost-efficient solutions for reducing eutrophication of the Baltic Sea are also steps towards adopting ERA, which will reduce the emission of nutrients compared with conventional agriculture. The aggregate crop production in the Baltic Sea region would marginally decrease and animal production would marginally increase if all production were to change to effective ERA. A broader cost efficiency analysis should take these effects into account. The environmental performance can be improved further with changed food profiles, i.e., the content of food baskets. Local production and processing of food are less important in terms of environmental effects but do have an impact on local rural development.

At the national level, using Sweden as an example, a regional nutrient balance is necessary. Assuming that the recycling principles of ERA are followed, animal production should be reduced in southern Sweden, while a corresponding increase is required in central Sweden. Furthermore, an altered food profile with less meat and more vegetables would facilitate the transition to a sustainable food system.

These should also be applicable to the other countries. If ERA is not coupled with an altered food profile, the demand for agricultural land will increase substantially.

Notes

1. The parliament has decided on 16 environmental quality objectives. These are: Reduced Climate Impact; Clean Air; Natural Acidification Only; A Non-Toxic Environment; A Protective Ozone Layer; A Safe Radiation Environment; Zero Eutrophication; Flourishing Lakes and Streams; Good Quality Groundwater; A Balanced Marine Environment, Flourishing Coastal Areas and Archipelagos; Thriving Wetlands; Sustainable Forests; A Varied Agricultural Landscape; A Magnificent Mountain Landscape; A Good Built Environment; Biological Diversity. Details can be found at http://www.miljomal.se/sv/Environmental-Objectives-Portal/. 5 May 2016.
2. The Baltic Marine Environment Protection Commission-Helsinki Commission, www.helcom.fi.
3. Croatia became the 28th member of EU in 2013.
4. See www.beras.eu, http://ecologic.eu/1795 and www.healthygrowth.eu.
5. Over time, world market food prices have been volatile. Higher prices increase the alternative cost of measures that lower the yield and make measures that increase the yield more tempting.
6. Baltic Sea 2020, www.balticsea2020.se/.
7. "New study shows CAP reform risks being greenwashed", http://www.eeb.org/index.cfm/news-events/news/new-study-shows-cap-reform-risks-being-greenwashed/. 7 September 2015.
8. "The Common Agricultural Policy", https://www.foeeurope.org/CAP. 7 September 2015.

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