Farm Level Economics and How to Change Behaviour

How to Change Behaviour

Carrots and Sticks

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Why are Economic Instruments Needed?

The relationship between agriculture and the environment is diverse. Agriculture may have adverse effects for the ecosystem, for instance on the waterways or on the soil. On the other hand, if managed properly it can create value in the form of an aesthetic landscape and a habitat for many birds. The integration of environmental concerns with agricultural policies is therefore important. Integration can be accomplished through the use of economic instruments, educational activities or administrative measures. The type of instrument recommended depends to a large degree on the particular characteristic of the problem. It is important to use an instrument suited for the particular problem in question. We may for instance look at instruments that aim at decreasing nutrient flows to waterways. The relationship between nutrient emissions and cyanobacteria blooms is described in Fact box 1.

Nutrients entering waterways originate partly from non-point sources, partly from point sources (see Fact box 2). The main non-point sources are agriculture, forestry, boat traffic, settlements and deposition from the air, whereas the main point sources are industry and munici-
The economic instruments that can be used for decreasing non-point source pollution, e.g. from agriculture, are different from large point sources of pollution such as factories or municipalities. Therefore, in the design of instruments care has to be taken with regard to the mechanisms of nutrient transport and their origin.

The problems of soil compaction or acidification may look different than eutrophication or reduction in biodiversity. However, the various forms of environmental damage often have one thing in common. Environmental degradation consists of problems that are often not taken care of by the free market mechanism and which imply one type of failure of the market mechanism. In order to correct for market failure, economic instruments or in some cases environmental regulations are needed. Through carrots and sticks created by economic instruments, it is in theory possible to integrate the environmental problem with functioning markets in order to increase social welfare (i.e. improve the situation compared with the free market situation). Instruments can also be administrative (i.e. based on regulations or directives) or informational (i.e. based on education, extension and information). A short list of instruments is presented in Fact Box 3. It is worthwhile noting that these are instruments from the point of view of an environmental planner, not from an individual manager or producer. An individual farmer, for instance, can influence the environmental problem by management measures, i.e. good agricultural practices. Environmental instruments are those carrots and sticks which the environmental planner uses in order to induce the individual producer to use environmentally sound management measures.

The major advantage of economic instruments in comparison with command-and-control measures is their ability to achieve a given environmental objective at lower cost. Another advantage is the stimulus to adopt new technology. The choice of economic instrument depends on a number of criteria against which it is to be evaluated. Following Weersink and Livernois (1996), some possible alternative criteria are:

1. **Environmental effectiveness.** By environmental effectiveness is meant goal-accomplishment or environmental performance. An instrument must be effective in achieving its environmental goal. A measure which to a larger degree accomplishes the objectives set out is preferable to one that does not accomplish the same objectives (e.g. Braden and Segerson, 1993).

2. **Cost efficiency, cost effectiveness.** By cost effectiveness is meant the ability of an instrument to achieve
its goal in relation to its cost. A certain reduction in emissions might be achieved in several ways and by different instruments. An instrument A might lead to a certain emissions reduction at a lower cost than an instrument B. In this case A is said to be more cost-effective than B. One also has to make a distinction between cost effectiveness on social level and farm level. The cost effectiveness of one instrument need not be the same for the society (consumers, producers and taxpayers) and for the producers. On the other hand, there is a distinction between cost efficiency and cost effectiveness. According to Perman et al. (1996), a cost-efficient instrument achieves a particular target at the minimum overall cost to society, whereas a cost-effective instrument attains some target, but not necessarily the best target, at a minimum cost to society.

3. **Transaction costs for businesses.** The introduction of a new economic instrument implies transaction costs for farmers. The concept of transaction costs was introduced by Ronald Coase (1937), according to whom transaction costs are extra costs in the market for information search, implementation of changes and bargaining. The existence of such transaction costs in agriculture because of changes in regulations has been shown e.g. by Slangen (1997), Vernimmen et al. (2000), Vatn et al. (2002), Perling and Poleman (2004) and Rørstad et al. (2007).

4. **Cost of monitoring.** An economic instrument needs to be monitored and followed-up. Different instruments involve different degrees of monitoring. Transaction costs for the administrators need to be considered.

5. **Incentives to technological change.** Different instruments may have different incentives for farmers to develop and take into use new technology. A regulatory directive, on the contrary, often does not involve similar carrots or sticks for technological change.

6. **Distributional effects.** The introduction of an economic instrument affects the distribution of how social costs are borne between producers and consumers, between production lines, between regions between the industry sector and government (e.g. Weersink and Livernois, 1996).

7. **Flexibility.** The flexibility of the economic instrument may be important when new information is obtained (see the Stern review on the economics of climate change, 2006).

8. **Consistency with other policies.** Economic instruments need to be consistent with other policy objectives (production policy, income policy, trade policy, fiscal policy).

Finally, it is worth noting that economic instruments can be used for many different agricultural problem settings. Different problems may need different policy design. It is therefore possible to make a distinction between policy instruments for nutrient pollution reduction from point sources and non-point sources (see Fact Box 2), for soil erosion, for pesticides, for biodiversity, for landscape and for greenhouse gases.

### Theory of Externalities

The basic economic theory behind economic instruments is the theory of externalities. Arthur Cecil Pigou was the first to propose the use of a tax to correct the market mechanism for externalities. He made a distinction between private and social marginal net benefits. He also claimed that the government can correct the market mechanism for market failures through imposition of taxes or subsidies, i.e. he claimed externalities can be internalised with the markets through the use of a tax or a subsidy. The most well-known work of Pigou is the book ‘The Economics of Welfare’ (1920), in which he developed these ideas. An external cost exists when two conditions prevail: 1) An activity by one agent causes a loss of welfare to another agent; and 2) the loss of welfare is uncompensated. Both conditions need to be fulfilled. If the loss of welfare is compensated, the externality is said to be internalised (Pearce and Turner, 1991). Another way to express the phenomenon according to Baumol and Oates (1988) is that an externality is present when two conditions are fulfilled:

**Condition 1.**

An externality is present whenever some individual’s utility or production relationships include real (nonmonetary) variables, whose val-
ues are chosen by others (persons, corporations, governments) without particular attention to the effects on A’s welfare.

**Condition 2.**
The decision maker, whose activity affects others’ utility levels or enters their production functions, does not pay (receive) in compensation for this activity an amount equal in value to the resulting costs (or benefits) to others’.

If the producer of the externality is forced to compensate the victims for the damage imposed, the external costs are said to be internalised, or in short the externality is internalised (Baumol and Oates, 1988).

We may think of an example modified after Goodstein (1999). Let us imagine a paper factory discharging emissions that pollute a stream so that most fish are dying and bathing is becoming impossible. Obviously the factory is causing a negative externality (social costs) both for fishermen and for people using the river for recreation. The factory does not compensate the fishermen or the swimmers. Both conditions for an externality are met. This implies that the full social and private costs of the factory are different. Figure 60.1 illustrates this.

Both the demand D and supply curves of paper are illustrated in the figure. The supply curve S including only private costs (excluding social costs) leads to too low a price on paper and a higher quantity of paper produced (Q) than the social optimum. The intersection between the demand curve and supply curve, which takes into account the full social costs $S'$, leads to a production corresponding only to $Q^*$. The social and the private optimum differ in this case. Obviously the social optimum can be reached by imposing a tax $t = (P' - P)$ on the paper itself (or on some of its inputs or the emissions). It is important to note that this does not imply zero pollution. If we look at costs alone, we would like them to be as low as possible, but there is a trade-off between costs and production.

**Environmental Taxes**

Using the theory of externalities, it has been shown that a tax on the externality (e.g. a tax on a point-source discharge to a watercourse) can optimise social welfare when markets are competitive and information is complete. This is illustrated by Figure 60.2.

In Figure 60.2 the marginal externality curve MEC is shown. In general, the negative externalities which follow from economic activity and production increase with increasing activity. For example, waterways may be able to tolerate a modest amount of emissions. If the intensity of emissions increases, the self-purifying capacity of a river or a lake may be exceeded or the total carrying capacity may be in danger. This implies rising marginal externalities for each marginal unit of production. The curve MNPB, on the other hand, shows the marginal net private benefits from production for the polluting pro-
Fact Box 4. Tax on Fertilisers

Rougour et al. (2001) have compiled experiences with fertiliser taxes in Europe. According to this compilation, the price elasticity of demand for fertilisers in Austria, Finland and Sweden varied between -0.1 and -0.5. In Finland, taxes on nitrogen (N) fertilisers were in use between 1 July 1976 and 1 July 1994 and on phosphorus (P) fertiliser between 1 January 1992 and 1 July 1994. The tax on N varied between FIM 0.03/kg and FIM 2.90/kg. For P-fertilisers the tax was FIM 1.70/kg (Sumelius, 1994; Bäckman, 1999). These taxes were abolished when Finland joined the European Union, but Swedish farmers have paid taxes on artificial fertilisers since 1 July 1984.

Some estimates of the cost efficiency of these fertiliser taxes exist. A distinction between the social cost efficiency and the private cost efficiency has been made in many cases. The social abatement cost for Finnish fertiliser taxes, which are compensated for by an acreage subsidy, was estimated at FIM 24.7 (EUR 4.15) per abated kg N leaching using a Danish leakage function (the reduction in leaching was simulated to be 30%). According to the results, the use of buffer zones was a more cost efficient way to reduce leaching than fertiliser taxes (Lankoski and Ollikainen, 1999). In Norway, Vatn et al. (1997) estimated the corresponding social marginal abatement cost to be about NOK 4/kg abated N leaching. The social average cost was estimated at NOK 20/kg reduced N leaching (the variation was NOK 13-37/kg abated N leaching). The private cost for the farmers varied between NOK 96-138/kg abated N leaching (EUR 12.8-18.4). The difference between private and social costs in this case depends on the fact that the agricultural support has been deducted from the social costs. Sumelius et al. (2005) estimated marginal abatement costs of an N fertiliser tax and an N quota in Croatia which aims to prevent NO_x levels from rising. On a sample of maize-producing farms the marginal social costs were found to be negative (i.e. a social return). The average abatement cost of both N taxes and a quota was estimated at EUR 0.921/mg NO_x 1^-1, (EUR 0.208/mg N 1^-1). None of the studies cited took account of transaction costs or monitoring costs.

The Coase Theorem

The discussion on the need to regulate an externality has not gone undisputed. According to Nobel Prize winner Ronald Coase (1960), if a polluter and the victim can bargain about the outcome of how much of the externality (social cost) should be allowed and what the compensation to the victims should be, negotiation should lead to an efficient outcome regardless of the initial property rights. In other words, let the victims and the polluter negotiate instead of imposing taxes or other instruments from the outside. It has been shown that the theorem only holds under limited restrictions (no transaction costs for negotiations, perfect information, and small number of victims).
Permits and Quotas

One possibility to regulate undesired emissions is to establish emissions permits or quotas (an emission standard) for pollution sources. A precondition for such a system is that it is possible to measure the emissions. This is not always possible. However, it is possible to use a quota for the inputs, e.g. for fertilisers. Production quotas are common in many countries (e.g. for milk and sugar within the EU). Denmark has established quotas for nitrogen fertilisers and since 2002 it is possible to sell and buy such N quotas, which have been tightened within a certain time period. The N quotas are set according to the crop: In cereal production the quota is 105 kg N/ha, in other crop cultivation 145 kg N/ha; within dairy production 122 kg N/ha and within pork production 106 kg N/ha. The system of N quotas has reduced the use of N fertilisers by 22%. The average price of an N quota is DKK 28/kg N, although the variation is large: DKK 7.9-85/kg N. The average marginal value is in most cases below DKK 10/kg N, which means that farmers selling N quotas have received a good price for them (Jacobsen, 2004). The total reduction in N leaching as a consequence of N quotas is 4 tons of N. According to Grant and Waagepetersen (2003), the overall reduction in N leaching from agriculture is estimated to be 143,000 tonnes (from 311,000 tonnes in the middle of the 1980s to 168,000 tonnes in 2002), so the quota system accounts for a small proportion. Note, however, that these estimates on reduced N leaching include a high degree of uncertainty. A problem with most studies on quotas is that the costs of monitoring may be substantial. Alternatively, monitoring may be done in a less costly way, but enforcement may then pose problems.

Marketable Emission Permits

Instead of regulating the price of the externality with charges or taxes, it is also possible to regulate the quantity of the externality by setting a total level standard S and then letting the polluters bargain about emission permits. Such an economic instrument is called a system of marketable emission permits, (also called emission trading permits, or tradeable permits). The first one to propose such a system was Martin L. Weitzman in his seminal article in 1974. According to Weitzman, whether emission taxes or emission permits are more effective depends on the curvature of the marginal cost curve. Emission permits are recommended when the aim is to achieve a certain reduction in emissions, $\Delta Q$, at least cost, and when the quantities of emissions can be measured. The reduction in emissions will be achieved cost-effectively if permissions to emit are traded freely once such a level has been established. While it must be possible to measure or approximate the emissions, it is not necessary for the social planner to know the cost curves of reduction (marginal and average control cost curves). According to the theory, the initial distribution of pollution rights will not affect the end outcome. The market mechanism will guarantee that a cost-efficient distribution of marketable emission permits develops. Every polluter will decrease its pollution to the point where the marginal abatement cost is equal to the marginal control costs (marginal abatement cost) (Baumol and Oates, 1988). This is illustrated in Figure 60.3 for a market with only two polluting companies.
Company 1 initially emits an amount $Q_1$ and company 2 a somewhat higher amount, $Q_2$, so that the total amount of emissions is $Q^* = Q_1 + Q_2$. The social planner decides that the total level of emissions can be $S$ at maximum and a corresponding amount of permits $S = Q^{**}$ is issued so that both companies can buy based upon best offer. The companies can also trade these permits with each other after initial purchase. From Figure 60.3 it is evident that company 1 has lower marginal abatement costs (control costs) $MAC_1$ than company 2, which has marginal abatement costs $MAC_2$. Company 1 will reduce its emission to $Q'_1$ because this is less expensive than buying emission permits. However, it is more expensive to reduce emissions to a higher degree than $Q_1 - Q'_1$ than buying permits. Therefore company 1 will buy emission permits corresponding to $Q'_1$. Company 2 will correspondingly reduce its emissions by an amount corresponding to $Q_2 - Q'_2$ and buy $Q'_2$ permits. The total amount of emission will correspond to $Q^{**}$ and the reduction in emissions $\Delta Q = Q^* - Q^{**}$ will be achieved cost efficiently. When implemented in this way the major advantage with a system with marketable emission permits is cost efficiency. However, in order to implement such a system emissions need to be determined and followed-up. The Emission Trading Programme (ETS) for greenhouse gases of the European Union is based on marketable emission permits.

A system of marketable emissions is of limited relevance for non-point source pollution, since emissions according to definitions are diffuse and emissions cannot generally be measured.

Trading programmes based on emissions-for-estimated loadings have been proposed, as well as emissions-for-input trading in order to overcome the problem (Horan and Shortle, 2001).

Subsidies, Agri-environmental Schemes

Subsidies are common economic instruments for reducing agricultural pollution. The purpose is often to change agricultural practices in an environmentally friendly manner and to lower the cost of these technologies. The subsidy is in this case cost-sharing. Practical examples of implementation are various agri-environmental schemes where annual farm level costs of implementing good agricultural practices are lowered through an area-based payment (see e.g. Sumelius, 1999). Such agricultural practices typically may be buffer strips or zones, reduced tillage, animal density restrictions, restricted fertiliser doses and timely restriction of manure spreading. Such agri-environmental schemes have been implemented in Finland since 1995. Partly because of the scheme, partly because of changes in the input-output price relationship, average fertiliser doses have decreased, from 101.6 kg N/ha and 20.0 kg P/ha in the cropping year 1994/05 to 73.9 kg N/ha and 8.6 kg P/ha in 2005/2006 (Yearbook of Farm Statistics, 2006). However, in two follow-up studies of the agri-environmental schemes in four watersheds, no significant changes in leaching of nutrients as a consequence of the agri-environmental schemes were found (Palva et al., 2001; Pyykkönen et al., 2004). One possible explanation is that natural factors such as soil type, slope and precipitation have such a large influence that the scheme is too rough an instrument for directing practices on problematic parcels. Another possible explanation is that old practices persist and some fields are still overfertilised. A third explanation is that animal husbandry has become more and more concentrated and that manure is spread on the same parcels from year to year.

Another common application is subsidies for organic agriculture (e.g. Reeder, 2005; Pietola and Lansink, 2001). Investment support for manure facilities is also common. Subsidies for design-based technologies are another typical example. According to Horan and Shortle (2001, p. 24-25), if authorities are willing to use subsidies at levels that will have an impact, one can expect an impact from input base incentives.

Subsidies have some drawbacks. They are not in accordance with the Polluters Pays Principle, which is somewhat problematic, especially in the case when emissions can be measured. Subsidies may also increase the probability of entry decisions of polluting companies, so total loading may increase. However, sharing the cost of measures for good agricultural practices and best management practices has been advocated in order to increase the probability of farmers adopting measures for which the social benefits exceed the costs (Carpentier, 1996). Subsidies can be designed so that they induce farmers to adopt environmentally sound agricultural measures.
Such measures and their farm level cost efficiency are presented in Table 60.1, which is taken from a Danish study (Jacobsen, 2004).

According to the table, the most cost-efficient measure on farm level seems to be tightened requirements on utilisation of N in animal manure, followed by wetlands, better utilisation of feed, decreased recommended doses for fertilisation and catch crops. Transaction costs for the businesses and the administrative costs of monitoring were not taken into account. Note also that most of these measures were probably not subsidised.

### Penalties, Liabilities

A liability rule is classified as an ambient-based incentive. An individual who can be proved to have spoilt the assets or health of some others may be ordered to pay a penalty. For instance, a producer or pesticide dealer contaminating groundwater with pesticides may be given fines and ordered to pay damages. The liability rule is ambient-based, since the sanctions are only imposed after the damage has been done. In this way it is supposed to serve as an *ex ante* incentive, preventing high levels of pesticides in groundwater (Shortle and Abler, 1997; Horan and Shortle, 2001).

### Command and Control (Administrative Instruments)

The most common type of environmental policies is based on some sort of *standard* or *direct regulation* (Hodge, 1995). This approach is called ‘command and control’, or administrative instruments. It can take various forms. For instance, it can be a stipulation that manure storage has to correspond to a certain minimum volume in order not to spread manure in winter time; it may concern time of spreading manure; it may be a certain maximum limit on animal density; or it may be cross-compliance conditions in order to be eligible for a certain programme such as the cross-compliance measures within the European Union. The major advantage with command and control measures according to Hodge is that they are easy to introduce and administer. However, the problematic issue with command and control measures relates to the fact that they are often not very cost-effective. The amount of information to be collected for command and control measures to be effective is often substantial because of a diversity of conditions characterising operating firms (e.g. agricultural enterprises). For instance, a regulation stipulating maximum fertiliser doses may come into force. Leaching and surface runoff, on the other hand, depend upon the soil type, the crop, the timing and the yield level, factors which involve individual information not only on farm but on field level. In order to be cost-effective, the regulation would have to be able to account for all these factors, not only on each farm but in each field of every single farm. Costs of implementing a standard on emissions differ substantially between different businesses. Because of this, a uniform standard regulation seldom minimises costs. On the other hand, it seems plausible that most farmers have more detailed information on their own farm than the regulator. It would be better to use an instrument that can make use of this

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<th>Table 60.1. Cost efficiency on farm level of the water environmental plan II (Vandmiljøplan II) (Jacobsen, 2004).</th>
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<tr>
<td><strong>Annual costs</strong></td>
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<td><strong>Million DKK</strong></td>
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<tr>
<td>Wetlands(^1)</td>
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<td>Environmentally Sensitive Areas directives</td>
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<td>Plantation of forests(^1)</td>
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<td>Organic agriculture</td>
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<td>Better utilisation of feed</td>
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<td>Tightened requirements on animal density(^2)</td>
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<td>Catch crops (6%)</td>
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<td>Tightened requirements on utilisation of N in animal manure (15%)</td>
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<td>Decreased recommendations for fertilisation (10%)</td>
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<td><strong>Total</strong></td>
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1) Calculated with a 4% interest rate  
2) For dairy cows from 2.3 animal units (AU)/ha to 1.7 AU/ha, for pigs and plant cultivation farms from 1.7 AU/ha to 1.4 AU/ha and for other farms from 2.0 AU/ha to 1.4 AU/ha
information. The kind of information that is needed in that case is described in two other chapters of this book. Gustafson (this volume) outline the factors influencing leaching of nitrogen and the complexities connected to soil and climate, while Ulén et al. (this volume) discuss phosphorus management and best management practices in order to reduce phosphorus losses.

Those variables are typically site-specific and are likely to be better known by the farmer who is cultivating the fields.

When are regulations generally preferred? According to Horan and Shortle (2001), such a situation exists when the societal cost of the use of an input or process exceeds the expected benefits for any level of use. Hazardous pesticides are a clear example. Another may be the social desirability to avoid long-term soil compaction due to high axle load traffic (Håkansson and Petelkau, 1994; Alakukku 1997).

Some of the most important international regulations from the Baltic Sea point of view are the Nitrate Directive, the Water Framework Directive and the Baltic Sea Action Plan. Increased concern that NO\textsubscript{3} leaching was becoming a significant problem led to the Nitrate Directive addressed to EU Member States in 1991. The main objective of the Nitrate Directive is to reduce water pollution resulting from, or induced by, the NO\textsubscript{3} that comes from agricultural sources, and to prevent further such pollution. The Nitrate Directive recognises ground- and surfacewater containing more than 50 mg NO\textsubscript{3} l\textsuperscript{-1} as being situated in vulnerable zones (Directive 91/676/EEC). A more recent EU Directive, the Water Framework Directive, requires the state of surface waters to be sustained and improved by controlling the input of nutrients, the aim being for all surface waters to have a good ecological status by 2015 (Directive 2000/60/EC, Ekholm et al., 2007). The Baltic Sea Action Plan is a plan signed by all the countries around the Baltic Sea which aims at reducing losses of nitrogen and phosphorus in 2008. It allows the countries to develop national programmes to achieve the reductions in a cost-effective way. The measures may include reduction in agricultural inputs, including manure, as well as improvement in the treatment of wastewater. In accordance with the relevant parts of this Convention, the Contracting Parties must apply the measures and take into account Best Environmental Practice (BEP) and Best Available Technology (BAT) to reduce the pollution from agricultural activities. These measures concern animal density, storage of manure, location and design of farm animal houses, application of manure and application rates for nutrients and other factors influencing losses of nitrogen and phosphorus (HELCOM, 2007, 2008).

**Labelling**

Labelling of food is one way of providing information to consumers about technologies used by farmers and possible environmental, animal welfare or other effects. A label may provide a guarantee for consumers that a product is produced in an environmentally friendly way. Possible higher costs of production are passed on to consumers in order to prevent undesired effects of technologies. In this way consumers are made aware about the effects of their consumption decisions. Labels typically may be organically produced products, local products or animal products where a given husbandry method has been used to take care of animal welfare (e.g. producing free range eggs). Labelling is usually put in practice by the food trading chains and retailers. Appropriate legislation about what are correct labelling practices is therefore important.

**Conclusions**

This chapter reviewed a number of carrots and sticks for internalising external effects of agriculture, typically linked to an environmental issue. Many of the instruments described have a theoretical foundation. However, all instruments rest on some assumptions. These assumptions are adequate for some situations but less adequate for others. The environmental tax is suitable when externalities can be measured, which is rarely the case. A somewhat good proxy would be emissions from point sources. Because of spatial and temporal heterogeneity, measurement is not feasible for non-point sources. Instead, input taxes are being applied. Taxes on inputs
have the disadvantage that inputs are taxed regardless of intensity level. On low intensity level, a tax on an input on a non-leaching soil may be quite a different thing from a tax on a negative externality. The assumption of perfect information by the regulator is often not valid. Information is also often assymetrical. Tradeable permits can only be used when emissions can be measured. Command and control measures, on the other hand, are usually quite costly rough measures. Given these shortcomings, well-designed instruments particularly suitable for the problem at hand should be employed.
References


Chapter 56


Chapter 57


Information Bulletin of Minister of Agriculture of Russian Federation, No 11-12, 2006


Results of Soviet Authority Decades in Figures: 1917-1927, pp. 419-423

Chapter 58


The international project ‘Development of agricultural education in Northwest region of Russia with use of experience of Denmark’. Section. Operative administration of business: the curriculum on speciality ‘Farmer-manager’ developed for agricultural colleges of Northwest region of Russia based on the experience of Denmark.’ (‘An agricultural education Programme developed for the North-West Region of Russia focusing on operational farm management’.


Chapter 59


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Vammala


References


Stern Review on the economics of climate change. 2006. HM treasury http://www.hm-treasury.gov.uk/independent_reviews/stern_review_economics_climate_change/stern_review_report.cfm


References


Chapter 61


Swedish Board of Agriculture, SBA. 2009. *Focus on Nutrients* - a project run jointly by the Swedish agricultural industry, the Swedish county administrative boards and the Swedish Board of Agriculture.