Multifunctional Agriculture
Implications for Policy Design

by

Eirik Romstad, Arild Vatn, Per Kristian Rørstad & Viil Søyland

Ås - NLH 2000
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Preface

The research underlying this report is part of a program initiated by the Norwegian Ministry of Agriculture, aiming at elucidating on the multifunctional role of agriculture and optimal policy instruments. The program has been divided into several projects, dealing with different parts of multifunctionality. The other projects have mainly focused on the relationships between the production of private and public goods in agriculture.

The present report focuses on the choice of policy instruments to obtain desired levels of the various goods involved. In doing so, we draw on the insights conveyed by the other projects. They have been very helpful in supplying information, specifying and characterizing the various interlinkages. These insights are necessary when analyzing and discussing principles for an optimal mix of instruments.

We would further like to thank Olvar Berland, Lars Håkonsen and Agnar Hegrenes for comments on earlier versions of this report. The evaluations and any remaining errors are of course still our responsibility.

The evaluations and policy implications presented in this report may not be shared by the other projects in the program, nor by the Norwegian Ministry of Agriculture.

Ås, March 2000

The authors
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Summary

Lately, the concept of multifunctional agriculture has gained substantial international attention. The implications of this concept for agricultural policy – both nationally and internationally – are controversial. This report aims at clarifying the concept and analyzing the effects of various policy instruments that may help to obtain the desired level of various public goods provided by agriculture. The analysis is general. Still, the report emphasizes the situation for countries like Norway, whose agriculture is not competitive on the world market.

Multifunctionality is a systems oriented concept. It addresses the fact that in addition to the provision of private goods like food and fiber, agriculture also provides a set of public goods. The most central public good elements are:

- **Landscape values**: biodiversity, cultural heritage, amenity value of the landscape, recreation/access, scientific/educational value.
- **Food related aspects**: food security, food safety and food quality.
- **Rural activity**: rural settlement and economic activity.

These goods are normally site or region specific. In addition, agricultural production results in negative external effects, like nutrient runoff, erosion, and pollution from pesticide and herbicide use.

The public goods linked to agriculture partly from the use of inputs, the production methods, or qualities concerning the private goods themselves. The public goods may further be unique, i.e., agriculture is the only provider, or they might be secondary. The latter implies that other sectors may also provide the good. The links between the private and public goods provisioning may finally be characterized as joint, complementary, or competing.

Joint provision implies a technical interdependency, in our case between the private and public good. This interlinkage is such that inputs cannot be assigned to either of the two productions. Within this functional framework, jointness may either be in fixed proportions, or there may exist a competitive range – i.e., a range where there is a trade-off between the goods.
Complementarity is in this study understood as a situation where one good – e.g., a private good – contributes to the quality of an input to the production of the second good, e.g., the public good. In most situations the two productions become competing as the volume is expanded. Competing then means that the production of one of the goods will simultaneously reduce the potential to produce the other good. In some situations of relevance to this study, the private and public goods will be competing in all plausible ranges of production.

While jointness is described in functional terms, complementarity is phrased within the concept of production possibility sets. The distinction between the two is not always easy to make. On the other hand, the two analytical frameworks have different implications for the choice of policy instruments.

A large part of this study is devoted to characterizing the relationships between the production of private and public goods in agriculture. Here, the study is specifically linked to the Norwegian setting and is based on a set of studies undertaken by other research groups. Characterizing the goods is difficult both due to the high level of complexity and the need for weighting non-quantified aspects. The connections between food production and production of the public goods are portrayed along three dimensions; area use, intensity in production, and mode of production. The latter is introduced to cover the fact that the two first relationships are often dependent on production methods.

Our examination conveys a rather complex picture. Some main properties still seem to emerge. The landscape values are dominantly characterized as complementary or competing to food production, while the range of complementarity is variable. In the case of biodiversity, the range of complementarity is limited if we focus at the intensity in production of the private good. In the case of area use the range of complementarity is, under Norwegian conditions, much larger. Actually, the agricultural area adds to biodiversity, as its current share of the total area is low. Conflicts arise though, especially when wetlands etc. are drained, or when agricultural interests face the concern of managing large predators. Concerning amenity values, even the level of intensity can be fairly high before one gets into the competitive ranges. Here, the specific element of open space can further be viewed as approximate joint with agricultural acreage.
Food security, food safety and rural activities demonstrate on the other hand clear resemblances with jointness. Also in these cases, conclusions must, however, be drawn with care. Regarding food security, the conclusion holds as far as existing production and resource use is necessary for future security levels. This again depends partly on the type of expected crises. Considering food safety, national production contributes directly to the public good as long as the general level of diseases, etc., is lower than in the countries where imports originate from. We further observe that if the food and animal related diseases are different across countries, national production contributes positively to the realization of food safety, even though it cannot be said that any country has a higher standard in itself. Both in the case of food security and food safety the jointness is dependent on the mode of production. Agriculture's contribution to rural economic activity depends to a large degree on the volume of the sector. Again, the type of production is important, through its varying effect on the generation of various downstream and upstream activities.

A typical case where private and public goods production compete in almost the whole range of production is water quality. Erosion, nutrient leaching and pesticide use are of particular relevance in this matter. However, the effects on water quality are diverse. Also in this case production methods play an important role for the degree of competition.

Many of the public good components addressed in this study are so-called relational, implying that the values of some components depend on the status of others. This is typical both within and between the three groups of public goods, and makes it even more challenging to formulate policies. Moreover, it makes it more difficult to draw a distinct line between what are the unique and secondary roles of agriculture in providing these public goods.

Rural settlement, partly food security and maybe also the amenity values of the landscape, can be supplied by other sectors than agriculture. In the case of amenity values it relates to whether a landscape is more than just a 'scenery.' We conclude that the interlinkages to other landscape goods and the values attached to authentic activities make it sensible to categorize landscape amenity values as unique to agriculture. Even in the case of rural settlement, different ways of supplying the good are not fully equivalent. The settlement patterns will be influenced by type of activity, and the conclusion depends, among other things, on the spatial specification of the goal.
One should also note that both jointness and complementarity influence the costs of producing different goods. This implies that one cannot compare the cost of producing each public good in isolation. Even though other sectors might supply each secondary good at lower costs when separately delivered, agriculture may be the least costly solution when several goods are considered together. In general, if goods can be jointly produced, there is a potential for cost savings. This is often overlooked in the academic literature where partial relations are most frequently analyzed. Given that agriculture already produces some public goods, the extra cost of adding others to the list may be low. The validity of this conclusion seems to depend heavily on cost structures and the type of production methods used.

This brings us to the issue of how to evaluate various policies in our field. In this report we start out from the foundation of modern welfare theory, being based on the Pareto principle, either in the form of the improvement or the potential improvement criterion. Under certain assumptions – especially the assumption that markets are complete – it is accepted that a market (private exchange) economy is Pareto efficient. In situations with deviations from this – e.g., public goods – corrective measures may be warranted.

Welfare theory is based on the presumption that rights are defined. In a society, rights have the twin role of defining both which interests that are to be protected, and following from that, which resource allocations become efficient. Thus, there is a risk of circularity embedded in any efficiency evaluation. Within national states, there exists institutionalized authority structures that define the rights distribution. This rights structure implicitly defines a social welfare function. Any welfare economic analysis therefore entails a weighting of different interests rooted in the rights structure and perceptions about fairness and equality.

At the international arena these problems are augmented. The reason for this is that there exists no common authority structure that defines the overall welfare function. Trade policy is one of the key questions in this connection. "Undistorted" international commodity markets may deteriorate or damage the realization of important public goods in some countries. Net domestic effects of international trade for some commodities may then be negative for these societies. This is a key international rights issue. Should a country be allowed to pursue policies that secure domestic public goods, even if these policies limit the export countries' access to domestic markets? Certainly, choosing rights principles is a very difficult issue when no
common social welfare function exists. We find it, however, inconsistent to determine the
outcome on the basis of who is willing (or able) to pay the most for a specific rights structure.
Rights structures cannot be defined in this way.

The distinction made between 'trade' and 'non-trade concerns' is at the core of this rights
issue. Non-trade concerns are normally restricted to public goods provisioning. If private and
public goods are interrelated in production, such a distinction cannot be drawn. Instead the
issue becomes a question about defining rights – i.e., defining what is a legitimate protection,
and parallel what is an illegitimate harm to somebody. The concept of trade distortions
follows from a theory where the assumptions are such that trade represents a gain for every-
body. When this is not the case, avoiding 'trade distortions' actually becomes a restriction on
the system. It forces (some) countries to choose less efficient solutions.

Concerning our more specific evaluation of various policy measures, resource allocation
mechanisms (RAM) constitute an important foundation. There are three necessary criteria for
a RAM to yield predictable outcomes:

(i) **Fulfillment of the participation constraint**, which implies that for agents to voluntarily
take part, their utility (or profits) must exceed their reservation utility (or profits).

(ii) **Informational viability and efficiency**, which implies that any proposed policy cannot
require more information than what is available, and that for a given level of policy
performance, the informational costs should be minimized.

(iii) **Incentive compatibility**, which implies that it must be in the self interest of agents to act
in the prescribed way.

The type of goal function governing farmers' adaptation influences policy choices. Normally,
profit maximization is assumed. This is the basis also for our study. We discuss, however, some
consequences of other behavioral rules like utility maximization or norms driven choices. An
implication particularly related to norms, is that social and cultural aspects will influence policy
performance.

In a policy evaluation of our kind, transaction costs are important. There will normally be large
costs related to observing many of the goods involved, administering policies, controlling
outcomes. etc. This introduces the trade-off problem between precision of a policy and its
related transaction costs. While paying directly for each public good component may imply the highest precision, the attached transaction costs may deem such policies inefficient.

On the basis of the above principles, we have analyzed the effectiveness of various policy instruments relevant to multifunctional agriculture. The analysis is conducted in a stepwise manner. First, we look at the case where private and public goods are joint. Thereafter, we move to the case with complementary/competing characteristics. In both these settings we assume profit maximizing farmers. The next step is to look at the case when public goods are relational. Finally, we study the consequences of changing behavioral assumptions to utility maximization or norm following.

Under jointness note that the public good is a function of the level of private goods provisioning. In the international/WTO context a policy problem emerges as soon as there is a deviation between what a country considers an optimal production of the public good and what will be the level of such provisioning given free trade in the market for private goods. Taken to the limit, if a country is unable to compete in the market for private goods, the joint supply of public goods will vanish. In this case we find that a price support equal to the marginal value of the jointly produced public good(s) is the most cost efficient. There are two remarks to be made to this conclusion. First, if the public good can be separately observed, a direct payment is possible, but will invariably result in increased transaction costs. Second, in many cases jointness will exhibit a competitive range. In such a situation some payment directed towards the public good may be warranted.

In the case of complementarity or competing relationships, the argument for some form of direct payments increases considerably. It is often argued that removing all existing price supports will be enough to solve the problem of public goods provisioning. This does normally not hold if producer incomes fall below the reservation level, or due to the existence of complementarities and the combined income and substitution effects of the policy. Reducing total income to the sector may even reduce complementary public goods provisioning if the income effect is greater than the substitution effect. The conclusion of this analysis is that one must consider two relationships. First, one must balance the direct payment for the public good and the price of the private good – i.e., the marginal incentives must be right. Second, one must
secure optimality in total – i.e., that the volume of private and public goods provisioning corresponds to the desired volumes.

These conclusions need some qualification and specification. Transaction costs (information, monitoring and control) may make it irrelevant to pay directly for some public goods. It will therefore often be necessary to look for some proxies or indicators. We have analyzed several policy instruments, including product price support, indicator payments, input and production method subsidies, index payments, (conditional) lump sum transfers, and cross compliance payments. All these solutions imply various ways of striking a balance between precision and transaction costs.

All the above types of payments – even lump sum transfers – influence the supply of the private good. As earlier emphasized, interlinkages will transfer effects between private and public goods. Finally, even in the case of complementary goods, there may exist situations where price subsidies (private goods) become the least costly solution. This conclusion is partly related to transaction costs. Moreover, there may also be situations where some price support is necessary to take full advantage of the complementarities involved.

Moving to situations where the public goods are relational and complex add extra challenges to the analysis. Our findings can be summarized in the following observations. If goods are relational, it is in principle impossible to construct a payment scheme per good or attribute that brings about the optimal provisioning. One way of safeguarding against this is to provide an additional payment if several objectives are met simultaneously. This may be a good approximation. However, it works less well if relations also cross farm borders. This is, for example, the case for many landscape attributes.

A high degree of complexity makes it difficult to rely only on economic instruments and incentives. Even at each farm there exists multiple combinations of public goods attributes. Examples of this include the mix of fields, border zones, hedgerows, trees, paths, buildings. In such a situation, social norms about what constitute good practices make it easier to obtain the desired solutions.

From this we conclude that it seems necessary to formulate (1) a management contract, and (2) an educational package, including activities promoting local dialogue. The management
contract may include elements of cross compliance. Certainly, the standard caveats concerning transaction costs still apply.

Other behavioral rules than expected profit maximization warrant additional considerations. If farmers obtain direct utility from the production of public goods, this will increase supply beyond profit maximum. The conclusion is opposite if they achieve disutility. This is important in policy formulation, as it is necessary to devote some caution concerning the way policies and instruments are drafted as far as this in itself may influence farmers' perception of the good.

It is observed that farmers' choices – at least to some extent – are governed by norms concerning what is good agronomy and what it means to be a good farmer. This must be carefully taken account of, especially if policies are to be radically transformed. Large direct payments for public goods may be perceived as alienation. On the other hand, the norm behavioral aspect may be utilized to produce greater conformity over time if policies are carefully developed. Certainly, there is room for changing farmers' perceptions regarding their role in the society. Well conducted, such a process may also reduce transaction costs substantially. Such processes, however, requires participation by the farmers' communities.

We have argued that some price supports are warranted to reach certain policy objectives. Should it then take the form of budget subsidies or should it be formulated as import levies? Such levies are the most controversial option, but there are two reasons for using them:

- When imports themselves inhibit the attainment of a public good, reducing imports is the direct policy response. Import tariffs achieve this. One caveat must be emphasized, though, namely the effect on secondary markets.
- Payments for collective goods over public budgets instead of import levies entail additional social costs whenever the marginal costs of public funds exceeds one.

Concluding this study, we have encountered two major trade-off problems in the field of public goods provisioning from agriculture. First, it is the trade-off between precision and transaction costs. Second, we have the trade-off between the provisioning of public goods that are joint with the production of private goods, versus the provisioning of goods that are complementary or competing. At least in countries with problems concerning the competitiveness of its agriculture on the world market, jointness warrants some price supports. On the other hand,
high levels of such supports may result in losses concerning goods or allocations being moved too far into the competing ranges.

The interlinkages encountered in this study make it necessary to think in *systems*. Piecemeal strategies are doomed to fail. Further, it seems important to try to formulate policies where the conflicts between producing public and private goods are reduced. Developing an agriculture with larger synergies across different good categories, may turn out to be very important in a 'landscape of goal conflicts' and high transaction costs attached to many solutions. This implies a redirection of agricultural practices so that public good provisioning becomes much more of an inherent and integrated part of the business of agriculture itself. This implies a focus not only on each good, but also on the production methods.

As is seen from the above, to formulate a good policy package for multifunctional agriculture is not a simple task. We conclude that under Norwegian conditions a policy should include:

1. payments for public goods/positive externalities and taxes (or other regulations) to reduce negative externalities,
2. the use of regionally differentiated product prices including some import levies,
3. the use of management contracts to further secure the provisioning of public goods, and
4. informational measures and locally based public good provisioning campaigns.

Agricultural production is interlinked with many public goods. Any policy directed at changing the amount of public goods provided by agriculture will therefore influence trade patterns. This raises the following issues that the international community needs to address:

- Clarifying the rights structure, i.e., what are legitimate national concerns when policies to deal with these issues will influence trade patterns.
- What constitutes fair and equitable principles for balancing domestic provision levels of public goods vis-a-vis the need for transparent rules in international trade?
1 Introduction

1.1 Multifunctionality in Agriculture

This report aims at elucidating the multifunctional role of agriculture, and to identify policy instruments that promote production of public goods related to the agricultural sector.

The upcoming round of the WTO negotiations forms an important background for this report. Agriculture will be high on the agenda, and there is an increasing focus on non-trade concerns (NTC), like environmental, cultural and ethical issues. Article 20 of the Agreement on Agriculture (AoA) establishes that the non-trade concerns are to be taken into account in the continuation of the negotiations on agriculture in the WTO (Ministry of Foreign Affairs 1994). These concerns aim at goods that are not handled properly by markets (e.g., public goods). However, there is a difference between how the NTCs are handled and the concept of multifunctionality. Under the latter, both tradable and non-tradable goods are integrated into one consistent framework and not treated as separate issues.

The term multifunctional agriculture implies that agriculture entails more than what is traditionally perceived as its main function; producing food and fiber. The most central elements of multifunctional agriculture are:

- **landscape**: biodiversity, cultural heritage, amenity value of the landscape, recreation and access, scientific and educational value,
- **food related issues**: food security, food safety and food quality, and
- **rural concerns**: rural settlement and economic activity

In addition to these attributes, modern agricultural production also results in some negative external effects. These effects include nutrient runoffs, erosion, and the risk of accumulation of pesticide and herbicide residuals in soils, water and the food chain.

The public goods mentioned above are diverse in character, and are therefore linked to agriculture in various ways. They may arise from the use of certain inputs, from the type of
production, as well as being attached to the final production of private goods. This is illustrated in Figure 1.1.

**Figure 1.1:** Production of private and public goods in agriculture.

Multifunctionality is a relatively new concept embracing older ideas. Lately, it has gained acceptance, most notably within the OECD (1998a). Cultural landscape values, the environmental challenges of agriculture, the link to rural settlement and food security were elements of the agricultural policy even prior to the introduction of the multifunctionality concept. Previously, however these different elements were treated more or less separately. As mentioned above, the main aim of the notion of multifunctionality is to bring the issues into a consistent framework.

While our point of departure is general, the empirical reference for the analysis is the multifunctional role of Norwegian agriculture. This implies that our applications and our focus are influenced by the situation in Norway. It is therefore important to acknowledge that the connections between agriculture and public goods may vary both between and within countries.

In this report we will focus on the everyday functions of agricultural production, and policy instruments that are needed to maintain these functions. Goods like rare landscapes and buildings of high preservation value may require more specialized management, and particular public supervision. Such special elements are hence outside the scope of this report. However, the fact that many "everyday" functions and goods of high preservation value in agriculture are interlinked, will in some cases make it difficult to strictly limit the analyses to the "everyday" functions alone.
The main aims of this report are:

*To provide knowledge of what policy instruments are reasonable to use to ensure the production and maintenance of the public goods attached to agriculture. In connection to this it is particularly important to evaluate varying combinations of product prices, direct payments and income support. Legal and pedagogic measure will also be evaluated.*

The choice of policy instruments raises many important aspects like efficiency, effectiveness, transparency, flexibility and targetedness. Another central point is legitimacy. In the WTO negotiation process the national policy instruments have to be legitimate in relation to the international community and the final agreement. In addition, the policy instruments should be legitimate at the domestic level; towards farmers, politicians and the population in general.

The question about what is legitimate policies is closely tied to the rights structure, or more precisely: the rights structure will imply which polices that are legitimate and which are not. This raises the issue *how to assign rights*, in particular at the international arena where there is no "agreed-upon" rights structure. One example of this problem relates to the notion of trade distortions. If the production of private and public goods is linked, policy instruments that are currently classified as trade distorting may provide the highest domestic welfare levels. If a country is not allowed to use such measures, domestic welfare is reduced. An important question then is how settle such a dispute – i.e., defining the rights. This issue also illustrates the current difference between how NTCs are handled and the concept of multifunctionality.

### 1.2 The Structure of the Report

Chapter 2 presents the general theoretical background for our analysis. Central concepts, like private and public goods, are defined and explained. Particular emphasis is put on the framework of multiproduct production. In our context the concepts of joint, competing and complementarity in production, as well as the framework of production possibility sets are central. On the consumption side the existence of relational aspects accentuates the need for spatial analyses. This further complicates the welfare assessments.
Chapter 3 describes the different functions of Norwegian agriculture. Landscape and biodiversity, food security and rural concerns are some of these functions. In addition to describing the goods, we have elaborated on the linkages to agricultural production, and in particular along the three dimensions land use, intensity and type or mode of production.

In Chapter 4 we discuss how to evaluate policy consequences. Our starting point will be the core conclusions of welfare theory where we recapture the main result that under certain assumptions the market will achieve efficiency in resource allocation. Next, we discuss implications of relaxing these (restrictive) assumptions, namely introducing public goods. We also point to some important relationships between efficiency, rights, and legitimacy.

In Chapter 5 we discuss criteria for evaluating instruments that could be used to produce the desired policy outcomes. First, we look at the concept of resource allocation mechanisms, which places particular emphasis on the criteria needed to obtain predictable outcomes from regulatory policies. Thereafter we discuss consequences for policy evaluation of different assumptions about farmers' behavior. Finally, we investigate at the role of transaction costs in policy evaluations related to multifunctional agriculture.

Chapter 6 is devoted to a discussion of various strategies for securing desired levels of public goods provisioning in agriculture. We start by looking at the case where private and public goods are jointly produced. Thereafter, we move to settings where these goods are complementary or competing in resource use. From this basis we extend the analyses in two directions, looking at the consequences of (a) goods being relational and (b) farmers' pursuing other goals than profit maximization. We close this chapter by analyzing potential welfare impacts from the way public goods is financed.

The issues studied in this report are highly complex and diverse. Policies that may work well in one setting may not work at all or be less relevant in other settings. These effects may vary from one set of private and public goods to another. Moreover, what works under one set of behavioral assumptions may not function well in other behavioral settings. In Chapter 7 we propose a way to resolve these various conflicts. Our proposal is a system of measures that seems to be a reasonable compromise between the different considerations. Our conclusions are general and principal. The type of problems involved and the lack of appropriate data do not allow for any quantitative conclusions.
2 Multifunctionality in a Theoretical Framework

2.1 Defining Multifunctionality

In Chapter 1 we introduced the concept of multifunctionality by looking at agricultural production as a system producing both private and public goods. What makes it relevant to talk about these goods as a multiple set of functions, is that they are interlinked. It is therefore difficult to perceive of the listed public goods – e.g., landscape values, food safety, etc. – as independent of the primary production. Rather, these public goods are characteristics of the system as a whole. To a large degree this stems from the fact that agricultural production is directly interlinked with the ecosystems it operates within and the space that it occupies.

While some effects are unique, some can be defined as secondary. This means, in our terms, that these effects still are functions of the system, but they can also be provided by other activities than agriculture. It is hard to draw a distinct line here since what is not unique or not normally depends on several qualitative aspects. The regional effects of different activities perceived to be equal at one geographical level, may be viewed to be different at a lower level since the spatial distribution may vary, i.e., uniqueness also depends on the level of the analysis. The distinction between unique and secondary is still analytically helpful. Both aspects are embedded in the multifunctionality concept. The policy implications may, however, differ for unique and secondary effects.

On the basis of this we define multifunctionality as follows:

*Multifunctionality is the set of interlinked outputs from a productive activity where some goods are private and some are public. The public goods may be produced only by this activity, i.e., they are unique for the production in mind – or they may also be provided by other activities, i.e., they are secondary.*

What may be considered unique tasks and secondary effects may vary from region to region or from country to country, depending on natural, cultural, social and political conditions.
Figure 2.1 gives an overview of the situation as we interpret it for Norwegian conditions.

Figure 2.1: Unique tasks and secondary effects of Norwegian agriculture.

Unique tasks are related to landscape values, food safety and parts of food security. Rural settlement is a secondary effect (as other sectors than agriculture also can contribute to this goal). Food security is a borderline case. Domestic agriculture clearly has an important role here, but so may food imports and fisheries. There is some controversy whether food safety is a borderline case or not.

The interrelationships defining our area of study have great implications for the formulation of efficient policies. In general, if the goods produced are or can be linked, it is not sufficient to look at the supply of the various goods independently when evaluating different policies. There may exist a potential for cost savings by looking at the different outputs together. As emphasized by Hoel and Moene (1993), if goods can be jointly produced, costs may be reduced. Picking the least costly solution for each good in isolation, will most probably not produce the least costly total result.

The aim of this chapter is to develop a theoretical framework for the study of multifunctionality. First, we will clarify more in detail what is meant by private and public goods. Second, we will discuss the meaning of multi-product production more theoretically – i.e., we will
utilize concepts like complementary, competing and joint production to further explain what the concept of multifunctionality implies. Finally, we will focus on complementarity and jointness in consumption, since the characteristics here also influence what become candidates for an efficient policy package.

### 2.2 Private and Public Goods

There is much confusion regarding the concept of public goods. More specifically there is confusion regarding what classes of goods that are unlikely to be efficiently allocated in markets and those that are not. Randall (1983) is one of the few analytically tractable and systematic approaches to this question. Figure 2.2 is a slight modification of Randall (1983). The major difference between his classification and ours is that he has discrete demarcations along the two dimensions rivalry\(^1\) and excludability\(^2\), while we prefer to use continuous scales on excludability and rivalness.

![Figure 2.2: Excludable and rival goods (modified after Randall, 1983).](image)

Dividing goods by the dimensions excludability and rivalry helps resolve the issue of market allocation and efficiency. Figure 2.2 shows that the crucial dimension for efficient allocation by the market is the degree of excludability as indicated by the jagged line. The more exclusive a good is, the more likely it becomes that the market is able to provide efficient

---

1 A good is *rival in consumption* when one person's consumption of the good makes it impossible for another person to consume that good.

2 A good is *excludable in consumption* when it is possible for one person to prevent others from enjoying the good, for example by fencing of the good or protecting it so others cannot get access to it.
allocations. The primary reason for this is that when exclusion is possible, it becomes possible to charge individuals for enjoying the good. If, in addition, the good is rival in consumption, others cannot free ride on someone else's acquisition of the good. This reduces the likelihood of strategic behavior on behalf of consumers or providers, thus increasing the likelihood that the market price will reflect peoples' willingness to pay (demand) and producers' marginal costs of production (supply). This implies that market intervention may be warranted for more types of goods than pure public goods, i.e., for other goods than those that have low degrees of both rivalness and excludability. In such a perspective the term public goods is not very precise when it comes to providing a demarcation between situations when policy intervention may be warranted and where the market should be "left to itself".4

There is no easy way out of this terminology caveat. This is particularly the case when it comes to agriculture. Assume that some agricultural production takes place. This has implications for land use, peoples' access to the landscape and the scenic views people experience. While access in some cases may be deemed exclusive, it is far more difficult to exclude people from enjoying the scenery. Hence, farming leads to various public good attributes, some that are non-exclusive, some that are non-rival, and some that are both. This implies that some of the attributes "created by farming" cannot be efficiently allocated by the market, let alone by the market for the private goods provided by agriculture. This perspective has clear linkages to the concept of externalities, and has major advantages:

(1) It directly points to the incentive dimension of policy — some factors are outside the objective sphere of agents, thereby facilitating a risk that these factors may not be accounted for unless appropriate policies (incentives) are put in place.

(2) In a cost-benefit perspective on policy, it implies that even if we observe some externality, it may not be worth while to correct for the externality. More specifically, the externality may be Pareto-irrelevant (see Dahlman (1979) for a further discussion).

3 Other factors that are important for efficient allocation by the market relate to the market power of the various market participants. More specifically, are the market participants likely to display price-taking behavior (see any good book on industrial organization, for example Tirole, 1988).

4 A market cannot be perceived as an institution that just emerges from itself. For any market to function, there needs to be certain rules on regulations in place, defining the rights of participants and the sanctions facing those not in compliance with the implicit contract market participation is. In such a perspective, the rights and obligations of market participants emerge over time. This implies that a historical and contextual perspective is needed when analyzing markets and thereby market allocations.
In terms of multifunctional agriculture, the latter point is of particular relevance. Agriculture produces both positive and negative externalities. Due to the information problems associated with agriculture (for example nonpoint source pollution and its public good attributes — like biodiversity), one also encounters the possibility that some externalities from agriculture are likely to be Pareto irrelevant.

2.3 Multi-product Production

2.3.1 Basic Concepts

Multi-product production occurs when an enterprise produces more than one good. Reasons for multi-product production include:

- *Technical jointness* making it impossible to produce one product without the simultaneous production of one or more other products (Frisch, 1971).
- *Cost advantage*: the cost of producing two or more products is lower than producing each product separately. This could be based in technological jointness or in pure cost benefits from producing more than one product (economies of scope) (Hoel and Moene, 1993).
- A potential to utilize capacity in capital, labor and land over time.
- *Strategic reasons*: producing close substitutes to gain market power or economies of scale in marketing (Hoel and Moene, 1993).

However, the production of more than one output may also imply competition in production. Resources used as inputs for both products may make the productions competing, as the inputs become scarce. Table 2.1 provides an overview of these aspects of multi-product production central to this work. In principle there is no difference in the production of private and public goods. In the rest of section 2.3.1 we will therefore use traditional theoretical examples of private good production, when discussing joint, competing and complementary production.
Table 2.1: Competing, complementary and joint production.

<table>
<thead>
<tr>
<th>COMPETING</th>
<th>COMPLEMENTARY</th>
<th>JOINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two productions are competing (complementary) when an increase in the production of one good ($y_1$) reduces (increases) the possibility to produce another good ($y_2$), given an input $x$. The equations below illustrate this as the production of output ($y_1$ and $y_2$) depends on the inputs ($x$), as well as the other output(s).</td>
<td>Joint production originates from a technical process, making it impossible to produce one good ($y_1$) without the simultaneous production of one or more other goods ($y_2$), given a non-allocable input ($q$).</td>
<td></td>
</tr>
<tr>
<td>$y_1 = f(y_2, x_{11})$, $\frac{dy_1}{dy_2} &lt; 0$</td>
<td>$y_1 = f(y_2, x_{11})$, $\frac{dy_1}{dy_2} &gt; 0$</td>
<td>$y_1 = f(q)$</td>
</tr>
<tr>
<td>$y_2 = f(y_1, x_{12})$, $\frac{dy_2}{dy_1} &lt; 0$</td>
<td>$y_2 = f(y_1, x_{12})$, $\frac{dy_2}{dy_1} &gt; 0$</td>
<td>$y_2 = f(q)$</td>
</tr>
<tr>
<td>$x = x_{11} + x_{12}$ : input</td>
<td>$x = x_{11} + x_{12}$ : input</td>
<td>$q$ : non-allocable input</td>
</tr>
</tbody>
</table>

2.3.1.1 Competing Outputs

Given resources, the simultaneous production of two or more goods is normally competing. This implies that the production of one of the goods will reduce the potential to produce the other good (Chambers, 1988). Hence, the transformation function is negatively sloped. In other terms, the technology allows substitutability of outputs (Gravelle and Rees, 1990).

Competing productions can occur at constant rates of substitution, increasing rate of substitution and decreasing rate of substitution. However, the latter is not common and not central in this study. We will therefore not elaborate any further on this.

Competing production at constant rates of substitution occurs where the returns to scale are constant for both products (Figure 2.3). The production of the two goods $y_1$ and $y_2$ both depend on the same resource input. In a situation where (some) resource inputs are limited, resource use is competing among.

Figure 2.3:
Linear production in $y_1$ and $y_2$. 
In Figure 2.4 the transformation function illustrates that the two goods are competing in production at a constant scale, given a fixed and scarce resource input. Production of barley and oats, with land as the fixed input, is an example of two products that substitute at constant scale.

Competing productions under increasing rate of substitution hold true when the product function for the independent products has a decreasing resource productivity (Heady, 1952). Additional units of input increase production, however the marginal productivity of each extra unit of input decreases, as illustrated in Figure 2.5.

Under increasing rate of substitution the product transformation curve is concave to the origin, implying an increasing rate of displacement of one output ($y_1$) for an other ($y_2$), with a fixed input bundle. This is illustrated in Figure 2.6, where $B$ is the set of all ($y_1 - y_2$) combinations that are technically feasible given a certain input level and the present technology (Chambers, 1988). The two products are competing in input use, but they do not substitute at a constant scale.

Production of two different grains (like barley and oats) with fertilizer as the scarce input is one example of this where the effects of reallocating one unit of fertilizer from one production to the other depend on the marginal productivity of fertilizer for both products at the present allocation.
2.3.1.2 Complementary and Competing Products

Two products are technical complements when an increase in one output also result in an increase in output of the other (with resources held constant) (Heady, 1952). Technical complementarity arise as a result of one of the following reasons (Heady 1952:222):

1. "One enterprise may contribute an element of production, a joint product of the first, required by a second enterprise."
2. "One enterprise may divert surplus resources from a second product."
3. "The products may interact with each other as the proportions of non-usable joint products change with varying levels of output from a fixed technical unit."

The most common type in agriculture is (1). This is also the most important type with respect to multifunctional agriculture. Crop rotation is the traditional example in agriculture when (1) above holds. Legumes and grass may contribute to other productions through increasing soil fertility (addition of nitrogen or organic matter), or removing negative inputs (as root rot nematodes). Nitrogen, organic matter and improved soil structure serve as the joint products from one enterprise. These joint, intermediate products increase output of another product (jointness is discussed and defined below). The products themselves (like hay and wheat) are according to Heady (1952:222) not joint, but complementary. The complementarity occurs within a certain range, until the production of one product reaches a maximum. Production beyond this point will make the two productions competing, as illustrated in Figure 2.7, by point H.

![Figure 2.7: Complementary-competing production possibilities (Heady, 1952:224)](figure)

In the competitive range of the production of hay and wheat, the positive effect of increased soil fertility is overshadowed by the competition in land. Another example of complementary
and competing productions is growing winter wheat and raising cattle. Fall grazing on winter wheat, up to a certain level, increases output of both meat and wheat. Grazing beyond this level will reduce wheat output.

Another example of complementary-competing relationships is cultural landscape and agricultural production. Open area is a joint product of agricultural production, and it is an important part of the cultural landscape increasing diversity in the landscape. However, too much agricultural production in one place may result in too much open landscape. In such cases this will reduce the value of the landscape through reduced diversity. Open area is therefore both complementary and competing concerning the value of the cultural landscape.

Agricultural land is in the above example both an input and an output, respectively as input to agricultural production and as part of the output cultural landscape. This may also be the case for other commodities, like biodiversity. At the farm level some commodities are both inputs and outputs. Hay is one example of this. Conceptualizing agricultural production into the various production models and frameworks is therefore not a straightforward exercise.

2.3.1.3 Joint Products

Joint production originates according to Frisch (1971) from a technical process, making it impossible to produce one product without the simultaneous production of one or more other products. The value of each product as a share of the total value of the production determines what is the main product, the byproduct and waste. A change in price may change the "ranking" of the different products. (Frisch 1971:23). As relative prices of products are altered, the relative importance of the products changes. An increased price for public goods might change what is looked upon as the main product, even though the amount produced are unchanged. In the longer run, through input and/or technology changes, relative amounts may also change.

Gravelle and Rees (1981:177) take the same position as Frisch when they define jointness:

In some cases where one firm produces more than one output it may be possible to relate the output of each product to a specific part of the bundle of inputs used by the firm, so that the firm has a production function for each output ...
If the firm is producing several outputs, and inputs cannot be assigned to outputs in this way the firm is said to be producing joint products.

Gravelle and Rees (1981:177) further comment that "When there is joint production decentralization (instructing each product division to minimize cost) will not lead to minimum total cost because of the interdependence between the costs of each product."

Joint products may come in fixed proportions, i.e. they are "commodities which, if they are to be produced at all, are forthcoming only in inflexible proportions" (Heady 1952:203). Traditional examples of this include mutton and wool, wheat and straw, etc. Given a fixed amount of resources or a limited fund a specific amount of $y_1$ and $y_2$ may be produced. In Figure 2.8, a, b, and c indicate different output combinations at different levels of resources (inputs) or funds.

However, there is in many instances a certain possibility of substitution. Keeping within the language of standard agricultural products, one can select between alternative breeds over time. Heady calls this "Joint products with a competitive range" (Heady 1952:203-204).

Figure 2.9 shows such "opportunity curves" for a single level of factor or cost outlay. Here mutton can be increased at the expense of wool, but only up to a maximum output of mutton at $y_2$. Beyond this level both productions will be reduced. However, "variation in the proportions of joint products from given resources can generally be made in agriculture only through changes in breeds and strains." (Heady, 1952:217). As in Figure 2.8, a, b, and c indicate various output combinations at different levels of resources (inputs) or funds. Shifts in the curves may also be a result of changes in technology.
2.3.1.4 Joint Products and Costs

An alternative way of defining jointness is found in Shumway et al. (1984). They distinguish between jointness and non-jointness on the basis of price. Consequently, productions are joint if the price of one product influences production of another product, or as they put it:

"...the clearest possible delineation between jointness and no jointness in inputs appears to be

\[
\frac{\partial y_i^*}{\partial p_j} = 0 \quad (i \neq j) \quad \text{for no jointness, and} \quad \frac{\partial y_i^*}{\partial p_j} \neq 0 \quad (i \neq j) \quad \text{for jointness.}
\]

If corn supply responds to soybean and wheat prices, jointness is implied." Shumway et al. (1984:74).

Further, they point out that, «If production is joint, then separate production, cost, profit or indirect profit functions for individual products cannot be written. However, a supply function can still be formulated for each product, and a total demand function for each product can still be specified for each input» (Shumway et al. 1984:75).

2.3.1.5 Jointness – A Conclusion

The definitions used by Shumway et al. deviates substantially from Frisch/Gravelle and Rees. The former authors actually expand the concept in a way making most production relationships 'joint'. In this report we will understand jointness strictly as a technical relationship between two or more productions, where the outputs are produced in a fixed ratio, or where there are certain possibilities for substitution due to changes in production methods. This is synonymous to the existence of non-allocable inputs (Frisch/Gravelle and Rees), and represents the traditional (and narrow) definition of joint production (Lynne, 1988:947). The production of one output is not separable from the production of the other output(s), or as Hall presents it; "A technology expressed by a transformation function is said to be joint if there is no way to portray it in terms of separate production function, and non-joint if it can be so portrayed" (Hall, 1973:880). However, "As Frisch notes, an intermediate form of multi-product production usually occurs in reality, where there are both allocable and non-allocable inputs" (Lynne, 1988:949).
2.3.1.6 Jointness and "Waste", "Waste" as a Joint Product

Frisch (1971) notes that in presence of jointness in production both byproducts and waste may be produced. The production of waste implies that there could be a negative effect and/or a price attached to one of the products, and that the total value of the joint products is less than for the main product(s) isolated. This is also pointed out by Bowes and Krutilla (1989:251) using forests as an example: "Jointness in production is not always attended by positive effects on one forest output when another output is expanded. Stated differently, an increase in the level of production of one forest output may lead to an increase in the level of producing a joint output—or, in the limit, may preempt the opportunity to produce the second (joint) output".

2.3.2 Jointness: Dynamics and Costs

The production theoretical concepts and models we have analyzed in the previous sections, are important in structuring the arguments about what are good policies for directing the production of private and public goods in agriculture. We will argue that the relationships between agricultural production and the production of public goods are partly of a joint character, partly we observe complementarity, and finally we observe cases where there is competition over resources. The empirical foundations for this will be explored in Chapter 3. Here, we will investigate the theoretical perspectives further. We start by going more deeply into the concept of jointness. In Section 2.3.3 we will continue to look more in depth at competition and complementarity – e.g. production possibility sets and changes in these.

2.3.2.1 Joint Production: A Functional Relationship

Following the previous discussions, we can view the relationship between two joint products – the main product and its byproduct(s) – as functional. The byproducts may take the form of either a private or a public good. In our case the interesting situation is where the byproduct is public. Is it reasonable to believe some of the public goods listed in Chapter 1 to be jointly produced with the agricultural production. Denoting the private good y and the public good z, we can sketch the following relationships:
Panel I and II show the volume and the value of \( z \) as a function of the volume of \( y \). As the curves are drawn, the jointness is principally in fixed proportions. Decreasing marginal value of \( z \) is assumed. This seems to be the most typical situation. \( s \) is to be understood as a resource constraint – for example the amount of arable land in the actual country.

The functional relationship between \( y \) and \( z \) may take a variety of forms. We may use food safety – e.g. phyto sanitary standards – to illustrate this. Sanitary standards are vulnerable to the level of trade since the risk of diseases to be spread is larger the larger the level of trade is. This implies that there is a positive relationship between the level of nationally produced \( y \) and food safety.\(^5\) In this situation the relationships may even be such that \( z \) is substantially reduced even with small reductions in nationally produced \( y \) (i.e. going from no to small import levels), while additional reductions in \( y \) will only have minor implications. What is the best description of the relationships involved, depends on the dynamics of the disease.

Looking at \( z = f(y) \), the relationship may vary from farm to farm. This is illustrated by introducing a distribution around \( z = f(y) \) and \( V(z) = g(y) \), capturing the variations that may exist. One may understand this variation in two ways:

1. The amount and value of \( z \) as a function of \( y \) is dependent on the resource characteristics of each farm, locality, etc.
2. The farmer may influence the amount and/or value of \( z \) within some limits - i.e., the assumption of fixed proportions has to be relaxed.

---

\(^5\) This conclusion may be dependent on the standard of the national production system - that the country in mind has a better standard concerning the disease than at least some of the countries from which imports take place. For a more complete discussion of the relationships between trade and food safety, see Section 3.3.2.
It is moreover reasonable to assume that the relationships in Figure 2.10 will vary with the chosen production method (confer Figure 1.1). This variation may be such that it is sensible to operate with distinct functions for each production method. All these points have implications for the choice of policy instruments (see Chapter 6).

2.3.2.2 Variations in the Costs of Producing the Private Good
As emphasized by Gravelle and Rees (1981) (see Section 2.3.1) the decentralized price formation will not lead to minimum total costs if jointness is involved. They evaluate a situation where both products are private. In the case of public goods the problem is even greater. The problem is that the production of the public good $z$ is also implicitly dependent on the price of the private good $y$. In a situation with a uniform price for $y$ all over the world $p^{wm}$, the supply of the public goods attached to the private good will depend on the competitiveness of the private good production. This will not yield an optimal production of $y$ and $z$ jointly other than in very special cases. Figure 2.11 depicts a situation where the costs of producing $y$ vary regionally.

![Figure 2.11](image)

**Figure 2.11:** Production of the private good $y$ in three regions with different marginal costs. ($p^{wm}$: world market price, $y_i (i = \{1, 2\})$: privately optimal production).

Given a uniform price the amount of $y$ produced will be $y_1$, $y_2$ and 0 respectively in regions with marginal costs depicted $MC_1$, $MC_2$ and $MC_3$. This is optimal only as far as there is no public good jointly produced with $y$. Looking at the total bundle of $y$ and $z$ it may be optimal to produce some $y$ also in region 3. The optimal level depends on the degree of jointness and the value of the joint product. We shall return to the optimality conditions in Chapter 6.
2.3.3 More on Production Possibility Sets

In situations where goods are complementary or competing, the analysis is best fostered by the perspective of production possibility sets. The conventional definition of such sets assumes that physical input use is constant at the production possibility frontier (Debertin, 1986). This also implies that production costs are kept constant for any allocation of \( y \) and \( z \) on the frontier. In the case of multi-product - multi-input production, assuming that input use is kept constant is a restrictive assumption. Letting the production possibility frontier be defined by any combination of \( y \) and \( z \) that does not exceed a given cost is a more flexible approach (Chambers, 1988). This gives the following constrained joint revenue maximization problem for a single producer:

\[
\begin{align*}
\text{Max} & \quad p_y y + p_z z \\
\text{s.t.} & \quad C(y, z) \leq \mathcal{C}
\end{align*}
\]

The less than or equal sign in [2.1] is replaced by an equal sign when the cost constraint has to be met. This gives the following Lagrangian:

\[
\ell = p_y y + p_z z + \lambda [\mathcal{C} - C(y, z)]
\]

with the following first order conditions:

\[
\begin{align*}
\frac{\partial \ell}{\partial y} &= p_y - \lambda \frac{\partial C}{\partial y} = 0 \\
\frac{\partial \ell}{\partial z} &= p_z - \lambda \frac{\partial C}{\partial z} = 0 \\
\frac{\partial \ell}{\partial \lambda} &= \mathcal{C} - C(y, z) = 0
\end{align*}
\]

With standard assumptions on the second order conditions this gives the familiar expression for the (marginal) rate of product transformation between \( y \) and \( z \):

\[
RPT_{yz} = - \frac{p_y}{p_z}
\]

i.e., that the optimal allocation of \( y \) and \( z \) is determined by their relative prices, \( p_y \) and \( p_z \). Figure 2.12 illustrates this.
Figure 2.12: The production possibility frontier and the optimal allocation.

Note that all joint pairs \((y, z)\) on the production possibility frontier (the product transformation curve) can be achieved with the same costs, \(C\). For positive prices on \(y\) and \(z\) the profit maximizing allocations must then be located on the thick portion of the production possibility frontier.

Naive understandings of equation [2.4] may lead to serious misinterpretations of the effects of price changes. Suppose that the price on \(y\), \(p_y\), is dramatically reduced, illustrated by the new price line \(\frac{ap_y}{p_z}\), where \(a < 1\). This is often interpreted as a movement along the production possibility frontier (here from A to B). As long as costs are constrained to \(C\) this holds. However, from [2.3a] it follows that the price drop changes the optimal amount of \(y\), and thereby also the optimal resource use (costs). If the cost constraint is relaxed, the production possibility set shrinks, resulting in the allocation illustrated by point D instead of point B (the naive interpretation), as illustrated in Figure 2.13.

Figure 2.13: Substitution and income effects when costs are allowed to vary.\(^6\)

\(^6\) The change in the size of the production possibility set in Figure 2.13 from the decrease in \(p_y\) to \(ap_y\) is made large for demonstrative purposes, but it illustrates that when costs are not constrained to a fixed amount, there could be both substitution and income effects.
As long as costs are not constrained, the production possibility set may shrink, yielding two effects: (i) the *substitution effect*\(^7\) from A to B, brought about from the change in \(p_y\) illustrated by \(a\) (\(\neq 1\)), and (ii) the *income effect* from B to D brought about by the fact that the reduced income from the fall of \(p_y\) without an offsetting increase in the price on \(z\), \(p_z\) changes the allowable costs (total resource use) that is consistent with profit maximization.\(^8\)

To allow for continued production, suppose that the price on \(z\) is increased by the fraction \(b\) (> 1) to compensate for the price drop on \(y\). From the first order conditions (equation [2.3a]-[2.3c]), the change in relative prices and allowable costs may make other production technologies relatively more profitable. The shift from D to E in Figure 2.14 illustrates one such shift.

![Figure 2.14: Joint effect when the price on z is increased.](image)

In Figure 2.14 the E-frontier is drawn such that the relative price increase caused by \(b\) on \(z\) leads to an increase in the production of both \(y\) and \(z\). Such a shift requires that the income effect is larger than the substitution effect. That could for example occur if the increased payment for \(z\) leads to a new technology becoming profitable or if the allowable costs that results from such a payment leads to more land being taken into production. Such changes are often not immediate as they may require additional investments. These investments would only be undertaken if they are profitable from the producer's point of view, and corresponds to Johansen's (1972) *putty-clay* framework. Cross compliance payments or other payments

---

\(^7\) In consumer economics one also distinguishes between the substitution and the income effect from price changes when doing demand analysis (Varian, 1984). Generally, the substitution effect is greater than the income effect, but this does not always need to be the case.

\(^8\) This type of effect was observed in Sweden when they reduced their agricultural prices in the 1980s, without replacing the price drop on \(y\) with some other payments like a price increase on \(z\).
requiring some production or practices to take place, could trigger similar effects, or reinforce this effects if used together with some increased payment on \( z \).

In addition to the (cost constrained) production possibility sets, there usually is a frontier bordering all production possibility sets. This frontier defines the maximum attainable amounts to produce of the various goods or attributes, and is denoted the *grand production possibility frontier* (GPF). The GPF corresponds to Russell's (1993) *agri-environmental frontier*, i.e., the maximum feasible production of the pair \((y, z)\). In physical terms the GPF is useful as it provides some indication on the potential gains that are available for policy changes. However, one must be careful to use the GPF in welfare analyses. The primary reason for this is that the underlying costs (resource use) differ between the various production possibility sets contained by the GPF.

To illustrate this, consider Figure 2.15 with three scenarios for the production of one public good, \( z_i \) where \( i \in \{a, b, c\} \) and one private good, \( y \). All these scenarios assume that there is no payment for providing \( z \).

![Figure 2.15: GPFs and profit maximizing production possibility areas.](image)

Let \( y^* \) denote the profit maximizing production level of the private good \( y \) in absence of any payment for the public good, \( z, i \in \{a,b,c\} \) and for a given cost constraint. The three interior thin and solid lines represent the frontiers of the respective profit maximizing production possibility sets, and \( y^* \) represents the corresponding profit maximizing output level for the private good. The outer thicker solid lines represent the GPF, while the shaded regions are the probability distribution over the provision of \( z \) given \( y^* \). Reasons for such a spread in the provision level of \( z \) include variations in local conditions, farmers' attitudes, etc. These are factors not captured in the model from which the production possibility sets are derived. Two aspects should be noted from Figure 2.15. First, the shape of the GPF may vary.
(A) Panel A depicts a situation where the frontier is everywhere increasing in $z_a$ until some maximum value of $y$, $y_{\text{max}}$, indicating that the more one produces of the private good, the larger the potential becomes for providing $z_a$.  

(B) In panel B the converse situation is illustrated — as the production of the private good increases, the potential for producing the public good decreases.

(C) Panel C is a combination of panels A and B, where the potential for producing the public good increases for commodity production levels up to $y_{\text{max}}$, and decreases for commodity production beyond that level.

Second, none of the observed allocations are on the GPF. This does not imply that farmers have chosen privately sub-optimal allocations, but that the prices do not support allocations at the GPF. Also note that when there is no price on $z$ (i.e., $p_z = 0$) there is no incentives for producing $z$ beyond the level where it positively affects the output of the private good, $y$, (panels A and B) or has no negative impact on private good production (panel C).

### 2.3.4 Reconciling the Concepts

Section 2.3.2 dealt with situations where $z$ is perceived as a joint product with commodity production, $y$, while in Section 2.3.3 we address a situation of multiple products. The two approaches capture different aspects of the production processes and interlinkages. At the same time they are related. For example, in the case of joint products in fixed proportions (Figure 2.8), the expansion path represents a functional relationship. The limited degree of substitutability in this case may therefore not warrant the use of the analytically more complicated production possibility approach.

Moreover, both approaches are modeling tools. As always in science, models represent simplifications. Different modeling approaches highlight various aspects of the situation they depict. Which modeling approach that is chosen depends on several aspects, including which of the approaches that most fruitfully brings across the main point the scientists want to stress. The choice of the "byproduct" or the multiple production framework is no different in this respect.

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9 The strongly upwards sloping segments in panels A and C indicate that there is some sort of technical complementarity between $y$ and $z$.

10 This corresponds to the standard result in production economic theory that it is extremely rare that attaining the maximum production level will be consistent with profit maximization.
We will use both these two approaches. Our choice of approach for the various applications in the ensuing chapters will be governed by which framework that most closely captures the main effects we want to highlight. To recapture:

In the "joint product" approach the relationship between $y$ and $z$ is primarily governed by physical or biological factors. This can be expressed in the form $z = f(y) + \varepsilon(y)$, where $f(y)$ denotes an expected level of $z$ in terms of $y$, and $\varepsilon(y)$ denotes some random variation in $z$ around $f(y)$.

In the multiple product framework the relative prices, the joint cost function, and the cost constraint are the driving forces. The primary advantage with the multiple product framework is that the economic effects of changing relative prices or other costs are easily understood. However, it is analytically a more complicated framework. Another difficulty with this approach is the lack of data in a multi-product format.\textsuperscript{11}

Still many of the complicated effects that are presented in Chapter 3 can be fruitfully modeled in a "joint product" framework, provided that care is taken in choosing variables. An example may be useful.

\begin{figure}[h]
\centering
\includegraphics[width=0.5\textwidth]{figure2.16.png}
\caption{Biological diversity ($z$) and production intensity (yields per hectare, $y$).}
\end{figure}

Consider the relationship between commodity production and biological diversity. The amount of commodities produced is a product of acreage and production intensity. While the effects of acreage on biological diversity depend on many factors, it is generally accepted that

\textsuperscript{11}Most of the available data on the relationship between agricultural production and associated goods (attributes) has been collected by agronomists or natural scientists, implying that the data stress biological or physical relationships.
the functional relationship between production intensity and biological diversity is one where biological diversity increases for low degrees of production intensity, while it decreases for production intensities exceeding a certain level, $y_{z}^{text{max}}$. Figure 2.16 illustrates this.

### 2.4 Consumption: Relational and Non-Homogenous Goods

Many public goods from agriculture entail significant complementarities. In private goods markets we know the standard examples like "wine and cheese", "eggs and bacon", etc. Generally, an increase in the price of one of the complementary goods will decrease consumption also of the other (Varian, 1993).

Complementarities like the ones mentioned above do not create any problems for resource allocation. However, in the case of public goods that are provided by agriculture, the situation may be such that the "consumer" will not be in a position to choose freely between the complements. In the case of a landscape, it consists of a given set of attributes, and the different "consumers" receive the same bundle of goods. Thus, there are two aspects involved here.

First, the character and value of the good depend on the mix of attributes. The good consists of relational parts, meaning that the value of one element depends on the level and form of another. The prime example here is the aesthetic value of a landscape. It consists of different elements like open space/crop land, hedgerows, stone fences, forest patches, farmhouses, paths, etc. The value of the landscape depends on all elements. If the land is owned by different agents, this implies a need for coordination between the agents to bring necessary continuity and variation into the landscape.

Similarly, one can go one step up in the hierarchy of goods and look at the linkages between the more aggregate types of public goods listed in Chapter 1. As an example, the value of rural settlement may be influenced by other public goods, like the cultural landscape. Accordingly people may have preferences for specific types of rural settlements because of the kind of landscape it provides. This example also indicates the problems involved when drawing a definite line between unique goods and secondary effects of agriculture. The aspects of relational goods blur the distinction, as it also has implications for policy formulation.

Second, since all consumers actually have to consume the same good, the selection of elements to be produced must be made through a public process. The interests across different
individuals or societal groups cannot be satisfied without making compromises. Certainly, some will have stronger interests/greater capacities to pay. Still, public or social agreements have to be made.

This brings us to the question of how homogeneous the goods are. While we in most analyses of market transactions assume goods to be identical, this can hardly be the case for many of the goods produced by agriculture – both private and public goods. This is the basic feature of food quality and sanitary conditions. It is, however, typical also for most landscape values where variation is an important part of what creates value.

The existence of non-homogeneous goods raises two important issues. First, it increases the need for information substantially – both for the consumers and the policy makers. Even more important, this feature also influences the working of markets as allocation mechanisms since the presumption about markets as competitive tends to break down. Each quality of the good will be delivered by only a single or just a few producers.

Goods that are competing in production may be complementary in consumption, as the case is for a footpath and crop land. The footpath and the agricultural products are competing in production (if land is scarce), while they may be complementary in consumption as the cultural landscape influences the aesthetic value of the path.

With the simultaneous presence of a good and a bad, the bad decreases the value of the good consumed. This may be the case for a footpath in combination with grassland where there is recently spread manure, a path alongside a polluted river or close to a landfill. The odor from the manure or the view of a gray or dead river will for most people decrease the total utility derived from using the footpath and enjoy the view. In this case it is not possible to consume the good without the simultaneous consumption of the bad.
3 The Norwegian Multifunctional Agriculture

3.1 Introduction

Agricultural production is practiced under extremely different conditions throughout the world. This has mainly to do with differences in natural conditions. However, there are also substantial differences in social, cultural, political and economic conditions.

The harsh climate in Norway limits the agricultural production possibilities. Norway is the northernmost country in Europe, and agriculture is practiced further north than in any other country of the world. Nevertheless, the conditions for agricultural production in Norway differ significantly, from the inland in the east, over the mountainous areas to the coastline in the west, and along the 1,750 km distance from north to south. It is a mountainous country with a long coastline. The average yearly temperatures that varies between 7.7 to -3.1 °C.

The population density in Norway is low, only 13 persons/km², making many areas vulnerable to depopulation. In addition, the large distances make infrastructure expensive and transportation costs high. Arable land in Norway represents about 3 percent of the total area. This amounts to 0.23 ha arable land per capita, which is lower than the world average of 0.26 ha. The Norwegian domestic agricultural production provides about 50 percent of the domestic consumption, measured in energy units.

The average farm size is 11 ha, and the average herd size on dairy farms is 12 cows. The main products of Norwegian agriculture are dairy products, meat, grain and temperate vegetables, and some hardy fruits (apples, pears and cherries). In line with the domestic agricultural policy, grain is mainly grown in the southeastern and eastern areas, while dairy and meat are the main products in the rest of the country. The low population density, the large distances, the harsh climate, and the difficult topography all adds to the low competitiveness of Norwegian agriculture.

The main aim of this chapter is to elaborate on the public goods derived from agricultural activity, with focus on; the landscape with its natural, semi-natural and cultural components, rural activity and food related issues like food security, food safety and food quality. All
sections are structured in a similar way; by first presenting a general description of the public good, then discussing its linkage to agricultural activity.

Different features of agricultural activity have quite different impacts on public good production. In turn, this has implications for the choice of policy instruments. We have chosen to divide agricultural activity into *area use, intensity* and *type/mode of production*. Our discussion on public good production is related to each of these features. When a particular feature is omitted in the discussion, it is because we have deemed the relationship to be irrelevant. On the basis of this discussion, the public goods are presented in a table, as illustrated below.

**Table 3.1**: Example table for a particular public good.

<table>
<thead>
<tr>
<th>Public good in question</th>
<th>Area</th>
<th>Intensity</th>
<th>Type/ Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>a graphical illustration of the relationship between public (vertical axis) and private good (horizontal axis)</td>
<td>+ and/or</td>
<td>graphical illustration of the relationship between public (vertical axis) and private good (horizontal axis)</td>
<td>✓</td>
</tr>
<tr>
<td>production at a constant intensity, implying that changes in private good production is a result of changes in area in production.</td>
<td></td>
<td>production with a constant area in production, implying that changes in private good production is a result of changes in input intensity.</td>
<td></td>
</tr>
</tbody>
</table>

Area in the table is framed in two ways: (i) as how the presence of agricultural area, in a location, may contribute to the associated public good (illustrated by + and/or −), and (ii) as how different levels of agricultural area influence public good production (illustrated graphically). Area is defined as acreage, either in relative terms of total area in a region, or as an absolute measure. The term area implies that input intensity is assumed to be fixed.

Intensity of production as we use it here, denotes fertilizer/ha, yield/ha or animals/ha (animal/animal shed). When we find it necessary, additional comments make it clear which intensity measure(s) we relate our discussion to. Intensity is further framed as how a change in intensity will influence public good production (illustrated graphically). Intensity implies that area is assumed to be fixed.
Type/mode of production is a discrete measure, i.e., it is divided into distinct categories. It is often an important factor for the production of associated public goods. Where there is such a linkage, we have made a mark (/) with further explanations in the text.

The signs presented in the tables do not provide a conclusive answer regarding the inter-linkage(s) between agricultural commodity and public good production. A more thorough discussion is given in the text. However, the reader should also keep in mind that the linkage(s) between agricultural activity and public good production is influenced by more than the three features acreage/land use, production intensity, and mode/type of production. Additional factors include:

- **Location**: Many public goods are site specific. What is a public good one place may not be (looked upon as) a public good in another location.

- **Values**: What is looked upon as a public good, and how valuable it is varies from individual to individual, like for the amenity value of the landscape or food security.

- **Time perspective**: Having a short or long term perspective may influence how one looks upon public goods associated with agricultural production. In addition, the public good perspective may change with time.

- **Scientific knowledge**: Lack of scientific knowledge on the linkage between private and public good production, may make it difficult to indicate what is an "optimal" level of private goods production. Lack of knowledge (scientific or general) may also make it difficult/impossible to point out what are public goods and not.

- **The status quo situation**: The initial level of agricultural production is central for how a change in it will influence public good provision.

Throughout this chapter we will describe physical relations and not estimate values of the public goods in question. However, just denoting something a public good means adding a value to it, especially where it is not clear that the goods are of value for all\(^\text{12}\). Therefore, we would like to make the reader aware of some assumptions related to values that are pertinent to our discussion. These assumptions include:

\(^{12}\) Either because it does not have a value for all, there is not done enough scientific work in the field, or that science at present is unable to provide any reliable answer(s).
There is attached greater value toward a varied than a monotonous landscape.

Historic and cultural components of the landscape make it more valuable.

The value of a component may differ from location to location.

People and the society attach value to some general level of food safety, food security and food quality.

We will elaborate more on these assumptions later on in the report.

The type of analyses we conduct in this chapter is both complex and as illustrated above, characterized by much uncertainty. This chapter is thus a first step in structuring the available knowledge on the various topics embedded in the term multifunctional agriculture. Due to the complexities involved and the fact that we on many occasions have had to weight different non-quantified aspects against each other when conducting the classifications, the results are dependent on the authors' perceptions of the various issues.

The chapter draws on several reports commissioned by the Norwegian Ministry of Agriculture on various aspects of multifunctional agriculture. This work has involved the following Norwegian research institutes or university departments:

- The Centre for Rural Research and Department of Botany at the Norwegian University of Science and Technology: Olsson and Rønningen (1999).
- A joint report by the Norwegian Agricultural Economics Research Institute and the Norwegian Institute of Urban and Regional Research: Johansen et al. (1999).

In addition we have also drawn on two other reports: Flaten (1997) and Bredahl et al. (1999).

### 3.2 The Landscape

#### 3.2.1 General Features of the Landscape

A landscape is a combination of many components. Natural conditions or human activity may have implications for many landscape attributes. For example, agricultural activity has influenced the Norwegian landscape through 4,000 years and created semi-natural biological communities and landscapes. Present agricultural practices influence both the natural and semi-natural landscapes and may both deteriorate and maintain these.
Diversity is a central concept when dealing with landscapes. We talk of biodiversity and landscape diversity creating an aesthetically more valuable landscape. The values of Norwegian landscapes are also attached to the diversity in the cultural components (like buildings) throughout the country. The semi-natural landscape has values attached to:

- biological diversity,
- cultural and historical components,
- amenity value of the landscape; aesthetics and a productive landscape,
- recreation and access, and
- scientific and educational interests.

These components are of public interest at the same time as they may contribute to private economic activity, like (farm) tourism. We will, however, concentrate on the public good aspects. Agricultural activity is central to all these components, and they may be joint, complementary or competing in production, depending on the nature of the agricultural activity. There is also a strong interdependency between the components, and it is often difficult to isolate them. People value landscapes based on their total impressions, and their knowledge about the landscapes (biology, own and other use patterns). As already emphasized, the value of different components depends on the status of others. An old farm building has a value in itself at the same time as its surrounding is of vital importance for the building as a component in the landscape. Bergland (1994) found that people value a combination of landscape components higher than each component isolated, the so-called super additivity property.

Landscapes are created by natural condition and human influence, at present and through time. Agriculture has a unique role when it comes to producing these public goods and contributing to the total value of the landscape. Still, there might be situations where one could imagine that management tasks could be taken over by nature groups or non-farm enterprises. In many cases farmers will have an advantage in nature management as they already have knowledge about the local environment, and are equipped with many of the tools needed for landscape management. This linkage is stronger the closer the environmental benefits are tied to agricultural activity (OECD, 1998b).

Another point related to non-agricultural nature management is its connection to other landscape attributes, and the wider context. Is the value the same when the original context is
lost, and the landscape is only a scene and not a byproduct of agricultural activity? (Olsson and Rønningen, 1999).

Landscapes can be divided into different categories according to criteria for landscape conservation. These criteria include rareness, representativity, authenticity, diversity, intrinsic value. All these criteria are used for landscape registrations. Such registrations have been and still are carried out in several European countries. The Nordic Council of Ministers (1991) stressed that the degree of totality was an important factor, in which the ordinary or everyday landscapes clearly are central.

The Nordic Council of Ministers (ibid.) further divided the landscape into three categories: (i) cultural landscapes with specially high conservation value, (ii) cultural landscapes with special values, and (iii) ordinary agricultural landscapes.

**Figure 3.1:** Classification of landscapes according to differences in preservation value (modified after the Nordic Council of Ministers, 1991).

The width of the left triangle in Figure 3.1 illustrates that in acreage terms there is a larger portion of the landscape that can be termed the "everyday landscape" than "high value/rare landscapes". Already at this stage note that the suggested division of landscapes by preservation values have implications for landscape management, indicated by the inverse triangle at the right hand side of Figure 3.1. The wider the inverse triangle, the more time and resources should in principle be spent on management. This implies that there are more management options available for high value/rare landscapes than the everyday landscapes per hectare. Chapter 6 in this report primarily deals with policies for the everyday landscapes.
However, these three classes of qualities may be strongly interwoven and inseparable. Rare landscapes or landscape preserves and the "ordinary" landscape may be interlinked, as they are systems that functionally are linked. As Olsson and Rønningen (1999:45) points out: "A large number of farms have areas that belong to two or all three categories." Another central point is that conservation may make areas lose their practical and cultural function while they may maintain their recreational and biological functions. An interesting example of this is maintenance of summer farms through non-agricultural management. The summer farm is taken out of its context and looses its practical function. With only the buildings left its cultural significance and significance for production are reduced. Thereby it looses some of its value as a public good. In the longer run adjacent areas may be afforested if there are no agricultural practices providing animals grazing in the area, and through afforestation much of the aesthetic and recreational values may also be lost or changed.

According to Olsson and Rønningen (1999:21) biodiversity and landscape values arising from agricultural activities are threatened by the following practices or activities:

1. Intensification of agricultural practices.
2. Abandonment of traditional use.
3. Afforestation.

These practices or activities may result in homogenous, low diversity landscapes and habitats (Olsson and Rønningen, 1999). Intensification, abandonment and afforestation are also linked to marginalization of less competitive farms, farming practices or regions. Low intensity farming systems supporting semi-natural habitats and wildlife species of conservation importance, "may be threatened by either increased or decreased production pressures." (Brouwer and Lowe, 1998:16). Accordingly, both increasing intensity and abandoning production may be detrimental to semi-natural habitats.

### 3.2.2 Public Goals

The government (Ministry of Agriculture, 1992) emphasizes that the environment is of vital importance for a sustainable agricultural practice. The main environmental challenges tied to agriculture are:

- proper management of the land resources,
- preservation of ecological functions and endangered species and ecological systems,
- preservation and development of the cultural landscape,
- reducing erosion and the loss of nutrients to water and air, and
- taking care of cultural mementos and relics and values attached to open air recreation.

These elements are also central in the latest white paper from the government (Ministry of Agriculture, 1999), but not yet discussed in the Parliament.

### 3.2.3 Biological Diversity

Biodiversity, as the concept is used here, includes genetic, species and ecosystem diversity. Moreover, biodiversity includes *agrobiodiversity*, which covers diversity among elements of semi-natural habitats as well as diversity of organisms in the arable field. Development and maintenance of semi-natural habitats require direct or indirect human activity like burning, grazing, etc. (Olsson and Rønningen, 1999).

Converting natural areas into agricultural land may reduce biological diversity. This is especially the case if rare or biologically diverse areas are converted, like wetlands being drained and turned into agricultural land. In Norway arable land represents only about 3% of the total area. Relatively speaking, agricultural land can therefore be perceived as scarce, and in many locations agricultural land constitute a rare composition of plants, insects and animals. In this respect agricultural area in production may increase biodiversity locally as well as at the national level.

Up to a certain level, biodiversity may be positively linked to the area used for agricultural production. For example, landscape components like border zones and mosaic patterns require some open area. In addition to acreage, the shape of the fields, distances between farm fields, and the type of production also influence biodiversity. Border zones and non cultivated islands in the agricultural landscape function as habitats for other plants, insects and animals than those found out in the fields themselves or in the forest. These areas are hence essential for biodiversity (Olsson, pers. comm.). Due to the small fraction of the total area that is agricultural land, agricultural acreage and biodiversity are generally complementary. However, in regions with where a larger percentage of the total area is agricultural land, increased agricultural acreage may be competing vis-a-vis biodiversity.
Figure 3.2 illustrates these points. At low relative shares of agricultural land, increases in the agricultural acreage is complementary, i.e., the more area in agricultural production, the larger the ability to improve/maintain the biological diversity (like through increased amount of border zones). The relationship turns competing (at point H in Figure 3.2) when the fields are enlarged and merged, and the amount of border zones and the mosaics of the landscape are reduced, resulting in loss of micro habitats.

Consequently, marginalization and afforestation may decrease biodiversity. As Dragun (1998:52-53) points out: "The dilemma is that while it does appear that the much earlier deciduous forest was biologically much more diverse, it is probably not environmentally feasible as a function of coevolution to recreate such a system. ... The fact remains that a reversion to coniferous forests will actually reduce biodiversity".

Figure 3.3 illustrates this in a production possibility framework. Being at point A biological diversity cannot be increased by decreasing agricultural production even though biodiversity was higher with less agricultural production in the former period (PPF before removal of deciduous forests). The irreversible effect of already having removed these forests (or for example wetlands) makes it impossible to return the same high level of biological diversity as before.

Increased intensity will in most cases have a negative influence on biodiversity, as the use of herbicides and pesticides, overgrazing, etc. decrease diversity in species. Species diversity is
reduced in the fields (soil organisms), as well as in the immediate surroundings of the field. A pressure to increase intensity may also decrease the variety of domesticated animal breeds, like for dairy cows where old and traditionally used breeds go out of production as they produce too little milk. However, it is also possible to imagine cases where intensity is too low, like when there are too few animals grazing to keep bushes and vegetation down, turning open space habitats into forest and thereby changing and destroying them.

Type/mode of production may be of vital importance. Semi-natural biological communities are dependent upon human activity for maintenance and development. Examples of this include biological diversity on summer mountain farms, mountainous areas, other range resources, or the coastal heath lands in Norway.

Different conservation interests may be in conflict, like biodiversity and wild animals. Areas dependent upon grazing for maintenance of semi-natural biodiversity, may at the same time be habitats for carnivores, like wolves, bears, lynx or wolverines. This may lead to a conflict where either the wild animals or the grazing herds and thereby the semi-natural landscape are losers.
Table 3.2: Interlinkages between area, intensity and form of production and biodiversity.

<table>
<thead>
<tr>
<th>Biodiversity</th>
<th>Area</th>
<th>Intensity</th>
<th>Type/ Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>+/−</td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>

Additional comments

- Agrobiodiversity adds to biodiversity at the same time as agricultural areas compete with other natural areas and its biodiversity.
- Areas in production provide open landscape, border zones and mosaics in the landscape, where biodiversity may be great or of a special character. This connection may go from being complementary to becoming competing, like for increasing area at the cost of border zones.
- Increased intensity will normally have a negative effect on the biodiversity, through increased pesticide use, overgrazing etc.
- However, there is a critical level where intensity may be too low, as pointed out in the text and by the figure.
- Diversity in production methods is important for the diversity in semi natural landscapes, like border zones, low land, coastal and mountainous grazing by different animals, etc.
- Diversity in production methods is also of importance for the diversity in the arable fields.

So far we have discussed the influence agricultural production has on biodiversity. However, it must be pointed out that biodiversity is of vital importance for agricultural production. In the words of Olsson and Rønningen (1999:11): "... biological diversity is a fundamental basis for agricultural production and food security, as well as valuable ingredient – or prerequisite – for ecological stability". An example of this is the impact of the biological diversity in the soil (various fungi, bacteria, worms, etc.) on agricultural production.

### 3.2.4 Cultural Heritage

The cultural heritage from agriculture, is linked to skills and knowledge about management of the natural landscape, buildings, traditions, handicrafts, stories and music. These factors have historic, archaeological, practical, identity and symbolic values, among others.
Agriculture is an important basis for the Norwegian identity and culture. The landscape, and its cultural content add to understanding the life of former generations. This contributes to the identity and symbolic values of agriculture and the landscape. The rural culture is closely linked to it and is to a high degree a determining factor for the total landscape picture.

The cultural heritage enhances the value of the landscape aesthetics through buildings, stories and music tied to the landscape, etc. Thereby, it also enhances the recreational value of the landscape. The recreational value is also influenced by the degree of access. As pointed out below the "every man's" right in Norway is based in prescriptive law, which again is closely related to the cultural heritage, and the general understanding of property rights of both users and owners. Hence, the traditional ownership structures are also part of the cultural heritage.

Cultural variation in agriculture implies a range of modes of production throughout the country, which maintains and/or creates increased biological diversity. Cultural variation is thus also linked to the biological diversity (Olsson and Rønningen, 1999). The cultural heritage derived from agriculture relies on a continuation of agricultural practices in Norway. To sustain the linkage between agriculture, the landscape and the cultural heritage, some agricultural production must be maintained. This linkage is tied to land being farmed. Because of local and regional differences the maintenance of different types/modes of agriculture is central. A central point in this connection is that there is a sufficient number of farmers having farming as their full or part-time occupation. Another, but somewhat different aspect is that traditional buildings, stone fences etc. will have a higher aesthetic value if it is seen in combination with a living agriculture, traditional or modern. The open landscape is also an important factor as it makes the buildings etc. more visible to the public. However, an increasing amount of agricultural land may have an adverse effect on the cultural heritage as one diverts from the original pattern of production, and as the landscape part of the cultural heritage is deteriorated or lost.

A high and increasing level of intensity in agriculture will most probably have a negative effect on the cultural heritage. Knowledge about traditional agricultural and more recent production methods may be lost. In addition the cultural landscape may deteriorate. However, at very low levels of intensity in agriculture one may envisage that increasing intensity will
have a positive effects on the cultural heritage, through maintenance of the cultural landscapes and upholding agricultural knowledge and a diversity of production methods.

The cultural heritage in agriculture is often tied to particular modes of production. Different type/modes of production adds to different types of cultural heritage, and some modes of production adds more than others. In addition the type/mode of production is central to the cultural diversity in agriculture, locally and nationally.

Table 3.3: Interlinkages between area, intensity, form of production and cultural heritage.

<table>
<thead>
<tr>
<th>Area</th>
<th>Intensity</th>
<th>Type/ Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cultural heritage</td>
<td>+</td>
<td>√</td>
</tr>
</tbody>
</table>

Area in production donates a context to the cultural heritage. Areas in production providing open space also make cultural "monuments", like buildings and stone fences, visible in the landscape. However, increasing agricultural area further may have an adverse effect on the cultural heritage.

To the degree increased intensity deteriorates the natural or cultural landscape it has a negative influence on the cultural heritage. Increased intensity in production also means moving away from traditional production methods, and therefore also knowledge about these production methods. However, at low intensity levels increased intensity may have a positive effect.

A variety and local difference in type/mode of production is central to the diversity of the cultural heritage locally and nationally. Different type/modes of production adds to different types of cultural heritage.

3.2.5 Amenity Values of the Landscape

The aesthetics of a landscape depend on its totality, and will therefore be heavily influenced by the factors mentioned above; biodiversity and cultural components. Other important factors are open space and activity. In addition, the amenity value of the landscape depends on the cultural as well as the natural landscape. Each of these factors isolated adds to the amenity value, while it is probably the combination of them that contributes the most, creating
diversity and variation in the landscape. Aesthetic qualities also include factors like place identity, and the value of recognition and identity (Olsson and Rønningen, 1999).

The beauty of the landscape can be attached to different components and values for different people. The two main amenity values of a landscape are attached to the:

- **Aesthetic values**: People find the landscape beautiful to look at, because of what they see. This is closely linked to diversity in the agricultural landscape and mosaics with the natural landscape. Some components adding to the mosaics of the landscape are border zones, hedgerows, stone fences and the open landscape and forests in combination, all combined with the natural landscape. Studies show that there is a strong interest and a high willingness to pay to keep the landscape more open and diverse (Brouwer and Lowe, 1998:16). People may find the landscape beautiful to look at irrespective of how it is produced. However, for some people the production method may be determining for how great a value they attach to the landscape. For example, the aesthetic value of the landscape may be reduced if it is taken out of its original context.

- **Productive/"active" landscape**: People find the landscape nice to look at, because it gives signal of activity and a living society, management of natural resources and resource use.

A central point – as Bromley (1997) points out – is that the essence of the policy debate over amenity values from agriculture is that there is no "right" or "correct" level of rural amenity. If the value of the landscape is attached to the productive landscape reflecting activity, area farmed is of vital importance. On the other hand, if the landscape value is aesthetics only, it does not matter if the area is farmed or managed in another way, as long as the landscape is aesthetically nice to look at. Accordingly, the linkage to agriculture depends on what is looked upon as valuable; the landscape itself or that the landscape mirrors activity.

As pointed out above, agriculture adds to the amenity value of the landscape, through increasing the diversity of the landscape and creating an active landscape. However, in some areas introducing agricultural production reduces/deteriorates the amenity value of the landscape, like where agriculture occupies areas that previously were aesthetically valuable natural landscapes.
Agricultural production will in most cases imply open space, as illustrated in Figure 3.4. In some areas crop production result in open space, while in other areas open areas are created and maintained by grazing, as around summer mountain farms. The production of open space may however go from having a positive effect on the amenity value of the landscape to reducing it, as illustrated in Figure 3.5. This happens as open space is created at the cost of other component in the landscape, also creating a more monotonous landscape.

Intensity in production will influence the amenity value of the landscape. Assuming diversity increases the amenity value, more intensive production creating a more monotonous agriculture will reduce the amenity value. Highly intensive agricultural production may also provide negative external effects, and thereby reduce the amenity value of the landscape. However, some people may find a "clean" and/or high yielding grain field aesthetically more valuable than a field full of weeds, implying a value loss if intensity gets too low.

The type/mode of production is clearly central to the amenity value. Variation in type/modes of production adds to the diversity of the landscape by contributing with different components; as grain or vegetable fields, a variety of grazing livestock, activity at different times of the season and, a variety of farm buildings etc. On the other hand, some type/modes of production clearly contribute more to the amenity value of the landscape than others, like raising sheep versus raising pigs.
### Table 3.4: Interlinkages between area, intensity and form of production and the amenity value of the landscape.

<table>
<thead>
<tr>
<th>Area: agricultural area in production</th>
<th>Intensity: intensity of agricultural production</th>
<th>Mode / Type: mode/type of agricultural production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amenity value of the landscape</td>
<td>+/(-)</td>
<td>√</td>
</tr>
<tr>
<td>Additional comments</td>
<td>Mainly a positive connection as area in production contributes to the active landscape and to its diversity. However, the relationship between the amenity value of the landscape and agricultural production, may go from being complementary to becoming competing as open space increases and diversity is lost.</td>
<td>The interlinkage is negative at high intensity levels, making the landscape more monotonous and provides negative external effects. The linkage will further vary quite a lot depending on which intensity factor one looks at.</td>
</tr>
</tbody>
</table>

Area: agricultural area in production
Intensity: intensity of agricultural production
Mode / Type: mode/type of agricultural production
+ : positive effect, - : negative effect, ( ): weak linkage
√: connection between mode/type of production and the public good

### 3.2.6 Recreation and Access

All year around, the landscape is important for recreation. The landscape provides space for recreation like going for walks, skiing, biking, camping, etc. at the same time as it contributes to the recreational value through its aesthetics.

An important factor for recreation is access; that people can use the landscape freely and over larger distances. In Norway the "public right of access" provides the right to free access and to utilize various resources in the outlyings. These rights date back a thousand years and are now based in prescriptive law and the Outdoor Recreation Act\(^\text{13}\) (Norges lover, 1997). This law provides general access to outlyings all year around, while general access to agricultural land (inlaying) is limited to the period of the year where the ground normally is frozen or covered by snow (November 1\(^\text{st}\) to April 1\(^\text{st}\)). The general access right provides a right to pick

\(^{13}\) Friluftsloven av 28. Juni 1957.
berries and mushrooms (as long as it is for noncommercial use), tent, bike, bath, ski, etc. in privately and publicly owned outlying areas.

Agricultural activity may contribute to the recreational value of the landscape, through the aesthetics or through providing forest roads and pathways and thereby improving access. Agricultural fields will normally hinder access in the cropping season, while they may improve access in the frost period.

Table 3.5: Interlinkages between area, intensity, form of production and recreation/access.

<table>
<thead>
<tr>
<th>Recreation / access</th>
<th>Area</th>
<th>Intensity</th>
<th>Type/ Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Increased area in production may both improve and hinder access, depending on season and if dirt roads etc. are developed or removed.</td>
<td>+/-</td>
<td>The type/mode of production influence recreation and access. However, the relationship is depends on the particular form of production.</td>
<td></td>
</tr>
</tbody>
</table>

The conflicting interests in land use may be most articulate in densely populated areas located near by the best agricultural land. Developing green structures in these areas should allow ecological as well as recreational improvements.

3.2.7 Scientific and Educational Value

All component of the landscape from culture and buildings, to border zones and biodiversity have, or may get a scientific and/or educational value. "The scientific aspects cover numerous disciplines from archaeology, history, geography to plant and animal ecology, economy and architecture" (Rønningen and Olsson, 1999). The educational and scientific values are hence closely tied to the public goods mentioned above in this chapter. Here, we will only briefly discuss the direct educational and scientific aspects.

The scientific and educational value may be of interest for institutions as universities and research institutions as an outdoor classroom or an archive (Rønningen and Olsson, 1999). However, the active agricultural landscape may also function as a contributor of knowledge.
for the public in general. This knowledge is attached to the linkages between nature, the production system and food.

Agricultural production clearly contributes to the scientific and educational value of the landscape. However, introducing agriculture in natural areas that are rare and/or scientifically valuable in themselves may have negative implications. The marginal scientific and educational value of area in production decreases as the share of agricultural land increases. Scientific and educational values may be attached to different levels of intensity. However, increasing intensity to a level deteriorating the natural condition (pollution, erosion or reduced biodiversity) will have an adverse effect.

Different type or modes of production contribute to the scientific and educational value in various ways. Some production methods may have a higher scientific or educational value than others. The type and mode of production are also important for how the population in general experience agriculture.

**Table 3.6: Interlinkages between area, intensity and form of production and scientific/educational value.**

<table>
<thead>
<tr>
<th>Area</th>
<th>Intensity</th>
<th>Type/ Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scientific and educational value</td>
<td>+</td>
<td>√</td>
</tr>
</tbody>
</table>

Additional comments

Agricultural production increases the scientific/educational value of the landscape. An exception is introducing agriculture in natural areas that are special and scientifically valuable in themselves. The marginal scientific value of agricultural land decreases as the share of agricultural land increases.

Scientific/educational value may be attached to different levels of intensity in agriculture.

Different types/modes of production contribute to the scientific/educational value in different ways. Landscape heterogeneity and contiguous areas are in some aspects conflicting, but are both important for the scientific and educational values of landscapes.

Area: agricultural area in production
Intensity: intensity of agricultural production
Mode/Type: mode/type of agricultural production
+ : positive effect, - : negative effect, ( ) : weak linkage
√: connection between mode/type of production and the public good

- 44 -
3.3 Food Related Aspects

3.3.1 Food Security

In this section we will focus on food security, food safety and food quality, and thereby at food as more than a private good. We will look at the concepts in relation to agricultural production. More specifically, to what degree these aspects have public good attributes, and to what extent these aspects are part of the multifunctional agriculture.

3.3.1.1 Factors Influencing Food Security

"Food security is access by all people at all times to the food needed for a healthy and active life" (FAO, 1999). Availability, stability, access and adequacy are all important dimensions to fulfill such a food security definition.

This, and other definitions of food security are best suited for developing countries where poverty is a problem, and where food security is a day to day problem. Food security in developed countries is most relevant to discuss in relation to crisis situations, as food is normally available for all in a normal situation. An interpretation of food security in a rich industrialized country like Norway could be:

"All citizens in a country have access to enough and healthy food in crisis, nationally or internationally" (Flaten, 1999:4).

Food security can be reached at the individual level, the household level, the national level, and the global level. Bredahl et al. (1999:9) notes that accomplishing food security at different levels, has different policy implications. In the 1970s the focus was on global food availability. The recent focus is more in the direction of the individual and the household level. This shift is linked to Sen's discussions on entitlement and food security, and recognition that availability of food in the market did not entitle the individual or household to consume the food (Bredahl et al., 1999).

A combination of stocks, imports, robust present production and proper management of future production potential can create stability in food supply. We will return to this topic later. Food security and stability in the longer run are linked to the sustainability in production, nationally and globally.
Food preparedness is a concept used in NOU (1991) and Ministry of Agriculture (1992), in relation to the discussion of food security. Food preparedness is the relationship between food production and storage, and energy need in times of crisis. It is therefore tied to the access of food in a shorter time perspective, with an embargo of maximum three years (NOU 1991). Food security on the other hand includes management of natural resources and the environment, and thus the long term effects on food production and the environment.

Changes in the threat perspective the last decades have changed the focus from embargo and war threats, more over to environmental problems. This has created a need for a longer term perspective in the food security debate (NOU, 1991:313). Thus, the perspective has to be moved away from a one-sided focus on present production and more in the direction of management of natural resources. This includes preservation of agricultural land, use of sustainable agricultural practices, development of skills and knowledge among farmers and advisors, etc.

For food to be adequate it has to be safe to eat, and the menu combined in a nutritionally healthy way. Hence, food safety is an important dimension of food security. Another, but closely related dimension is food quality. Foods consist of many attributes; like nutrition value, taste, smell, use quality, health effects, looks, cultural value, ethical value, etc. From these attributes one can decide upon the safety and quality of the product. Safety and quality are tied to health effects and nutrition level, as well as consumer satisfaction. We will return to these issues in separate chapters on food safety and quality.

### 3.3.1.2 Production Potential

The importance of present production relative to the production potential is a much discussed topic in the food security debate. Current production and production methods may be out of line with respect to the needs for inputs and outputs under various crisis scenarios (OECD, 1998b:16-17). In brief, production in "normal times" does not necessarily equal the needs in times of crisis. Maintaining the food production potential is therefore one of the key elements of a food security policy under certain crisis scenarios. This is recognized by the OECD as the following statement indicates: "... on the other hand it may be easier and faster to make current production more autonomous than bring idle land back into cultivation or convert forests to arable land." (OECD, 1998b). Further, the OECD points out that the benefits from
maintaining production "above market levels" must be weighed against the costs involved to taxpayers and consumers.

Brunstad et al. (1995, p.42-43) state that a crucial condition for the production potential is that the factors of production are present. Factors of production are land, labor, agricultural skills, animal and plant material and capital equipment. These factors may either be stored, built up in crisis situation, or they may depend on a certain level of production to be maintained. To a certain degree the production potential depends upon present domestic production, as this helps to maintain the factors of production in a non-crisis situation. The level of present production also determines how quickly the production potential may be brought into use in a crisis situation. Another point is that national production will be limited in case of embargoes or war as the access to some factors of production could be reduced or disappear. The degree of changes needed in a crisis agriculture will also be a determining factor for the importance of the present production. Switching into a crisis menu will change the composition of products demanded, thereby changing the need for inputs. The production potential is therefore contingent on the availability of various inputs. Some, or parts, of these inputs are dependent on an ongoing active production, while some inputs may be stored or accumulated prior to a crisis situation. Determining factors for production possibilities include:

- how long it will take to reestablish a new agricultural sector,
- how long it will take to reestablish and expand the animal capital,
- the necessary changes in technology and input use to meet various types of crisis, and
- how well suited is the present competence of producers and advisors if production methods have to change dramatically.

Another central point is that land that is not in production may be easier to use for other purposes, than if the land is in production, and owned and used by a farmer. Hence, land set aside for future possible agricultural production, will probably be more vulnerable to alternate non-reversible use, like building projects and roads, than land in production. Private interests tied to the land as agricultural land will decline. This makes it more difficult for farmers and their organizations to protect the land from irreversible use compared to situations where the land is not farmed. This is an important factor as the acreage of arable land in Norway is low per capita (0.23 ha per capita, of which only 25% is suitable for cereal production).
3.3.1.3 Different Crises Scenarios

The main crisis scenarios are as follows:

- International conflicts leading to lock out or embargo, ABC warfare, unstable world markets, trade sanctions, or breakdown of international transport systems.
- Environmental crises like droughts, nuclear accidents, pollution of water ways, plant or animal diseases, polluted or contaminated end products (food or feed), etc.

Additional features of a crisis that have implications for the food security situation for a country include:

- **Size and location**: local, regional, national or international/transboundary.
- **Time horizon**: short term, middle term, long term effects (natural disasters, plant or animal diseases, nuclear accidents, climate changes).
- **Time for warning prior to the occurrence of the crisis situation** (i.e., time to prepare): is the crisis sudden and unexpected or gradually building up.

The above points illustrate that the characteristics of a crisis can vary enormously. After the second world war, wars and embargoes were looked upon as the main threats. Lately – and especially after the Tsjernobyl nuclear accident in 1986 – environmental crises have come into focus. Changes in what is perceived as the most likely crisis scenarios have implications for the means needed to maintain food security.

3.3.1.4 Maintaining Food Security

Depending on the kind of crisis scenario, food security can be maintained in different ways. The strategy choices for achieving food security in a country like Norway depend on:

- the probabilities of various scenarios occurring,
- the risk attitudes of the public and the political authorities,
- perceptions of what constitutes minimum standards for food security, and
- the willingness to pay for additional food security.

In Figure 3.6 the axis A-B shows the degree of self sufficiency, where a-b is the relevant self sufficiency interval. The area outside the oval is irrelevant, as it might be either too expensive
to accomplish (too close to B), or it yields a domestic production level that is so low that the
risks of relying (too much) on imports become unacceptable (too close to A).

The implicit understanding of substitutability between imports and domestic production, and
storage and production potential depend on the following assumptions:

- Sufficiently homogenous products.
- Sufficient food safety and quality.
- Use of a crisis menu in the long run.
- Sustainable present production processes.

Figure 3.6 also includes the time perspective. Domestic production and imports may provide
food security for both short and long term scenarios. However, depending on the kind of
crisis other means may be necessary, or will provide a better food security. Specific short and
long run means are respectively storage and the maintenance of the production potential. In a
long run perspective Figure 3.6 implies that food security can be well maintained through
imports, domestic production and a good production potential, while storage is of minor im-
portance. The appropriateness of various food security measures depends on other features of
the crisis. Imports, but also to some extent domestic production as means to provide food
security, are vulnerable to location, size and warning time of the crisis. The time dimension
is, however, less important to the suitability of these two means in a crisis situation.

Imports, production potential, present production and storage all provide food security in
different ways. Table 3.7 contains a short summary of the main features of the four food
security means.
Table 3.7: Food security means and their main features.

<table>
<thead>
<tr>
<th>Food security means</th>
<th>The main features of the food security means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imports</td>
<td>− important in the long and short run, especially under national environmental crisis or reduction in present production</td>
</tr>
<tr>
<td>Production potential</td>
<td>− important in the long run, if global supply falls or if areas nationally go out of production (leading to need for new productive land)</td>
</tr>
<tr>
<td>Present production</td>
<td>− influences production potential, and may accordingly be important in the longer run</td>
</tr>
<tr>
<td></td>
<td>− important for short run food security in case of sudden global supply reductions</td>
</tr>
<tr>
<td></td>
<td>− in the short run relatively more important when storage (storage capacity) is low</td>
</tr>
<tr>
<td>Storage</td>
<td>− important in the very short run and for the period it takes to build up agricultural production</td>
</tr>
<tr>
<td></td>
<td>− important, in the short run, when present production is low and supply fails</td>
</tr>
</tbody>
</table>

The government (Ministry of Agriculture, 1992) has stated that the degree of food self sufficiency, defined by the ratio between consumption of food produced in Norway and total food consumption in Norway, is not a good measuring stick for the total food preparedness in Norway. The production potential and long term food security are more central, especially if ecological and resource crises become the main threats. The concept of food self sufficiency does not include the possibility of readjustment in a crisis situation. Readjustment is possible, both at the consumer as well as on the supply side, through the use of crisis menus, storage of food and inputs, taking new land into production, etc. The Ministry of Agriculture prefers the concept "ability to be self sufficient" which includes the possibilities of readjustment.

In the latest white paper from the government (Ministry of Agriculture, 1999) there is a stronger emphasis on the need for an "active" agricultural sector. In this lies a recognition that, in order to meet a crisis, we need to have a certain size of the sector and that the agricultural knowledge must be maintained.

A related but wider concept used in the food security literature, is food self reliance. It allows for using a diversified pattern of imports and exports to obtain self sufficiency. Food self reliance hence focuses less on domestic production than food self sufficiency, something that is essential in countries with large variations in domestic food production (Bredahl et al., 1999:5). However, food self reliance is a useful strategy for food security – also for a country...
like Norway – as food self sufficiency in normal times is an unrealistic aim and the variability in possible crisis scenarios is large.

3.3.1.5 Liberalizing Trade

The potential welfare gains from utilizing comparative advantages and liberalizing trade worldwide may seem substantial in a welfare economic perspective. Nevertheless, there are disadvantages attached to liberalizing markets for agricultural products. We will briefly elaborate upon some environment and resource related problems influencing the long-term food security:

- Specialized production regionally or nationally makes agriculture an industrial production, more than a biologically based production where all parts of the process are integrated. As production is specialized some by-products become redundant or less attractive. An example is manure in an area with high animal density, where manure may become a waste product creating pollution instead of being used as an input. At other locations the situation may be the reverse, like in specialized grain areas. In the long run, this imbalance may lead to great global environmental and resource problems.

- What is optimal for each country isolated in normal times may not be optimal for the world as a whole, especially not in a crisis situation. Liberalizing markets for agricultural products implies a total reduction in arable land worldwide (the magnitude of this reduction is however not known). Fewer resources are brought into agriculture, and inputs like land may be reallocated to other sectors or purposes. This implies that the production potential could decline at the worldwide scale, something that could have large unwanted consequences in a crisis situation where high productive areas go out of production. Such crises could be sudden (like from a nuclear accident), or gradual (from the depletion of ground water reserves used for irrigation).

- Another central question in relation to globalization of markets is related to transportation costs, or more precisely: are transportation correctly priced? If costs connected to pollution and energy use in transportation are not fully included in the price, transportation costs become too low. Consequently, the price of transported goods in relation to locally produced goods is too low. The external effects of
transportation, as mentioned above, often imply long-term and uncertain costs that makes value estimation, and thereby correct pricing, difficult or even impossible. The aggregate problems of incorrect transportation costs increase as global markets grow.

In relation to food security Ohga (1999) emphasizes the vulnerability of nations depending on imports. His primary concern is that high dependency on imports may leave the exporter with political and economic power. According to Ohga (1999) there are two main concerns for a country relying on imports; (i) their capacity to maintain food imports and (ii) the reliability of access to these imports.

However, a stable and predictable trading system is of great importance for most nations in relation to food security. This is particularly the case for Norway, which imports around 50% of the food consumed, measured in energy units (Ministry of Agriculture, 1992). Anderson (1998) brings up a related theme, emphasizing the effect of economically interdependent nations, and the smaller likelihood for going to war with each other.

Anderson (1998) suggests a diversified portfolio of foreign suppliers as the best way to reduce the risk of a fall in food supplies in crisis situations. We are insecure if this can be a realistic alternative. Our concern is twofold:

- How can such an approach be in line with WTO obligations, like the most favored nation (MFN) principle?
- Unless the importing country is able to get binding contracts with food exporters, the importing country has no guarantees that the suppliers do not sell to buyers offering higher prices. This problem could be augmented if food, for whatever reasons, becomes scarce in the exporting country.

3.3.1.6 Food Security - A Public Good?

In a rich country (like Norway) food is a private good that is traded in markets like any other private goods. Hence, it is only relevant to discuss food security in such an economy in relation to a crisis situation. Food is special related to many other goods at it is a staple good. This may make people more reluctant to come into situations where there is a risk that the good will become scarce. Knowing there is a national strategy for food security in a hypothetical crisis situation may function as a public good in non-crisis times, as it makes people
feel more secure. Hence, national measures for increased food security work like a public insurance. The costs of such measures are similar to the payments for insurance. The "insurance premium" consist of components like food storage costs, costs of agricultural policy instruments, welfare losses of having higher national prices, etc. In case of a crisis where markets are destabilized, a food security policy stabilizing food supply can be looked upon as a public good. The benefits derived from a stabilized market by one consumer will not influence the benefits derived by others, i.e., these benefits are non-exclusive. As for other security installations provided by a nation (like military defense) food security is a public good. A high degree of food security will be beneficial to all in a crisis situation. Another and far more complicated discussion is what level of food security a country should adopt, and the best approach for providing this level.

Anderson (1998:5) claims that food security "requires no more than a certain level of household income plus a well-functioning market for staple foods." This implies that Anderson perceives food security as a private good, under the condition of well functioning markets. However, the condition of a well-functioning market is questionable. In a crisis situation (which is the only relevant situation in relation to food security in a rich country like Norway) it is likely that the conditions for a well functioning market are not met. Large fluctuations in prices and quantities might occur, and political or social conditions may make the market unstable or transportation systems fail. More specifically, the effects of a crisis on the market depend on the nature of the crisis.

3.3.1.7 Public Goals

The Ministry of Agriculture (1992:18) states that "The main strategy in relation to food security must be to develop a more sustainable agriculture. Which must have fundamentals of both ecological and economic character. ... Both natural and economic resources must be managed and used in a reasonable and efficient way." (our translation).

Food security is part of the main strategy for the agricultural sector; to create a robust agriculture. This strategy aims at making the Norwegian agriculture more competitive and less detrimental to the environment, including the production potential (Ministry of Agriculture,

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14 The possibility of food markets ceasing to work well in crisis situations is one of the reasons why Norway – like many other countries – has contingent plans for severe situations of food shortages, involving the use of rationing cards and other mechanisms for avoiding food suppliers to capture scarcity rents.
1992). The governmental report *Norwegian agricultural policy: Challenges, goals and means* (NOU 1991) states that a primary goal of Norwegian agricultural policy is a sustainable management of natural resources, and that this goal must be seen in conjunction with food security. This perspective is illustrated in Figure 3.7.

![Figure 3.7: The Norwegian perspective on food security (NOU 1991:312).](image)

In the WTO, the OECD and the EU, as well as in the Norwegian agricultural policy, food security is mentioned explicitly as an important issue that needs special consideration. Breidahl (1999: 47) states that "... since food security is universally accepted as one of several NTC's [it] will form a major part of agricultural negotiations within the next round of the World Trade Organization."

### 3.3.1.8 Linkages to Agriculture

National food production and food security are to a large degree joint products. However, food security and agricultural production may also be competing (mostly in the longer run) in a situation where production methods are non-sustainable. This situation does not call for a halt in production, but rather a change towards a more sustainable production. This also implies that long and short-term food security objectives may be contradictory.

The importance of present production depends on to what degree it provides sufficient and relevant inputs for production in a crisis situation. One input is agricultural land. Land already in production will shorten the transition period. Reasons for this include that less land needs to be reestablished from fallow land or from land in other non-irreversible use (like forest production). Availability of suitable land for food production in various regions could be important in situations where the transport sector does not function well, for example if fossil fuel supplies are limited.
Provided that production is sustainable, increased intensity may increase food security. Increased intensity in agricultural production normally implies increased amounts of food produced in the short run (Figure 3.8). Increased food production through higher intensity and keeping area constant may conflict with the goal of long run food security. There are various reasons for this, including soil loss and negative effects of pesticide use. However, for inputs – like nitrogen and phosphorus – the relationship is complementary. The primary reason for this is that parts of these nutrients that are not used by the plants are stored in the soil.\textsuperscript{15} Figure 3.9 illustrates the long term impacts.

![Short run relationship between insensitivity of production and food production.](image1)

**Figure 3.8:** Short run relationship between insensitivity of production and food production.

![Relationship between intensity of production and food security.](image2)

**Figure 3.9:** Relationship between intensity of production and food security.

The mode of present agricultural production plays an important role, as it provides specific inputs. Diversified agricultural production consisting of different modes, also provides different skills and maintains local, or site specific knowledge for local environments and site specific needs. Modes and locations of agricultural production that do not play a major role in normal times may become important in a crisis situation.

\textsuperscript{15}It should be noted that excessive use of nutrients like nitrogen and phosphorus lead to increased nutrient runoffs, thereby having negative effects on water quality in waterways and in some cases, also the ground water. Storing nutrients in the soil is generally not a good idea as parts of these nutrients will leach, i.e., it is comparable to saving in a bank with negative interest rates.
Table 3.8: Interlinkages between area, intensity and form of production and food security.

<table>
<thead>
<tr>
<th>Food security</th>
<th>Area: agricultural area in production</th>
<th>Intensity: intensity of agricultural production</th>
<th>Mode / Type: mode/type of agricultural production</th>
</tr>
</thead>
<tbody>
<tr>
<td>+</td>
<td>Important as an available input in a crisis situation, and as nation-wide input.</td>
<td>Increased intensity in production may increase or decrease food security depending on the sustainability of the production.</td>
<td>A diversified production and knowledge may be beneficial in a crisis situation where production methods have to change as the availability of inputs change and a crisis menu may be introduced.</td>
</tr>
</tbody>
</table>

It is difficult to find the "right" level of food security. The choice of level of production, production potential, storage and imports is a discussion of risk attitudes and public and political "willingness to pay" for food security. Food security policies can thus be regarded as a risk insurance (Ministry of Agriculture, 1998). However, what is certain, is that a combination of possible crisis scenarios demands a combination of food security instruments. Hence, food self-reliance is likely to be an aim for many countries, in particular if the domestic production capacity is far below domestic consumption.

3.3.2 Food Safety

Two central concerns related to food safety are:

- That the consumers get what he expects through labeling, product appearance, and other information.
- That the product is safe to consume in the sense that is does not give food related diseases, does not contain additives or chemical residues that are detrimental to health, the product is old or provide any other health risk through consumption. The quality of the entire production chain is important regarding these factors.
Scientific performance criteria can be of practical use in obtaining food safety provided that testing is not too costly. These costs vary from one product to another. Food safety properties are hence product specific.

Standards and minimum levels are often used to provide adequate levels of food safety for the population as a whole. The provision of a minimum level of food safety is a public good, reducing the risk of getting sick from eating, thereby reducing public health expenditures as well as disutility from being sick. In addition, a minimum level of food safety will reduce the cost of collecting information for the consumer. There is a wide consensus that standards are necessary. However, there is wide disagreement on where to set the national or international standards. To a large extent this is a question of risk attitude, which varies from individual to individual and from country to country.

The main international body for food standards is the Codex Alimentarius Commission (CODEX). Its main task is to protect consumers' health and assure that food trade follows fair practices. CODEX has a variety of criteria for labeling, and attempts to harmonize food labeling (CODEX, 1991). Among other requirements, labeling due to production process is normally only allowed if it is based in scientific research and reasoning. This implies that non-verifiable impacts from production processes on product quality, precautionary principles, and many other non-market aspects of food quality, are not covered by CODEX.

The core ideas of Norwegian laws and regulations concerning food are the protection of public health, and maintenance of honesty in sales (NOU, 1996). International cooperation, quality along the complete food production chain, openness in relation to the consumer and best available knowledge are important points in relation to these objectives (Ministry of Agriculture, 1997).

The Norwegian Veterinary Association (1998) expresses concern for increased risk for food borne diseases, as a result of increased imports of fresh food. This concern is based on the fact that the frequency of a number of food borne diseases is considerably larger in other parts of Europe than in Norway (and Sweden and Finland). One of the most important contaminants in relation to this is Salmonella (The Norwegian Veterinary Association, 1998). In regions where domestic food health standards exceed the standards of products that can be
bought in the international markets, high domestic production levels reduce the risk of contracting such diseases (Romstad, 1999).

Food safety as a public good is thus directly tied to the volume and quality of national production. Increased volume of domestic production improves food safety as long as the prevalence and/or the number of contaminants in national products is less than for imported products. Domestic production increases could be a result of increased area in production or higher intensity. Another central point is that different regions have different food related diseases. This implies that an exchange of food between these regions could reduce food safety in both regions, irrespective of the initial food safety level. The effect of trade on food safety depends clearly on the particular good traded; how severe the food contamination is, etc. As mentioned earlier, the food safety risk is highest when trading in fresh products.

Increased intensity implying increased production nationally may improve food safety. However, increased intensity in production may have a negative effect on food safety as it may increase the vulnerability to diseases in an animal herd. This may again lead to increased risk for contaminated meat, by contaminants like Salmonella. In the parts of the world where the development of large units have taken place, the number of diseases have emerged, and "... there is clear evidence that animals thrive less efficiently in large numbers," (Sainsbury, 1998:5). However, intensification does not necessarily lead to worsened animal health, but it requires that farmers are aware of the dangers tied to intensification. Increased transportation of animals may also decrease food safety as it may lead to a spreading of diseases already present at one location. Known occurrences of this include Salmonella prevalence which is lowered if animals are not moved between locations (Paisley, pers. comm.).

The mode or type of production is of vital for the level of food safety. Some modes of production are clearly less amenable to diseases and pests than others. Another central point is that diversity in modes of production implies less monotonous production locally and nationally, which again may provide lower prevalence of diseases and pests. This is tied to the fact that contagious and infectious particles can travel great distances from infected sites (Sainsbury, 1998), making longer distances between similar production favorable.

Another, and related, issue is the effects of gene modified organisms (GMOs). Here there is a considerable larger degree of uncertainty. The effects may roughly be divided into two
groups: the effects on human (and animal) health and the effects on the ecosystems. Regarding the former, it is especially the long term effects that are uncertain. When it comes to the effects on the ecosystems, the key question is: do the modified genes spread into the natural ecosystems and if they do, what are the consequences?

Table 3.9: Interlinkages between area, intensity and the form of agricultural production and the food safety.

<table>
<thead>
<tr>
<th>Area</th>
<th>Intensity</th>
<th>Mode / Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food safety</td>
<td>(+)</td>
<td></td>
</tr>
</tbody>
</table>

Additional comments

Areas in production in a country having higher food safety standards than other region have a positive effect on food safety.

Increased intensity, implying increased national production may provide better food safety as long as trade implies increased risks for diseases. However, increased intensity may have a negative effect on animal health, which may have a negative effect on food safety.

An agricultural production where there is a diversity of forms of production, on farms and between farms and regions, leads to a less monotone production, that again may lead to a better plant and animal health and thereby a better food safety.

Area: agricultural area in production
Intensity: intensity of agricultural production
Mode / Type: mode/type of agricultural production
+ : positive effect, - : negative effect, ( ) : weak linkage
√ : connection between mode/type of production and the public good

3.3.3 Food Quality

Food safety is a part of the total food quality of a product, thus making food quality a wider concept than food safety. The quality of a product is one of the factors determining demand for a product. Other factors include the product price, income and demographic and seasonal variation and information about the product. When dealing with food quality we find it convenient to talk of attributes rather than the good as such. The primary reason for this is the common assumption that the consumer maximizes utility on the basis of attributes and not on the good as such (Lancaster, 1966).
Food consists of a combination of attributes that add up to the total quality of the product. The attributes can further be divided into product and production process related attributes as seen in Table 3.10 below. Defining food quality this way makes it difficult to determine the quality of a product only on the basis of the physical product characteristics.

We define food quality widely. Our definition includes the whole life cycle of the product, from producer to consumer. This implies that food contains private, public and ethical attributes (Hatlestad and Søyland, 1998). Hence, externalities provided in the agricultural production process may influence the quality of the product. Thus, food which usually is perceived a private good, also has characteristics of being a public good. Hatlestad and Søyland therefore introduce the notion of food as an "impure private good". Some of the attributes may be provided perfectly by the market (taste, smell, use quality, etc.), while other attributes with public good or ethical elements, will only partly be efficiently provided by the market. This emphasizes the need for a conscious food policy to take account for non-market aspects.

To decide which product and product quality to purchase, the consumer needs information about the different attributes. Labeling, marketing and more general information and knowledge are central here. However, for information to be valuable for the consumer it has to be easily accessible, understandable, credible, etc.

Heterogeneous preferences among consumers and varying production conditions and costs for producers have implications for how we perceive food markets. In particular, one may envisage several market segments for the "same food product" (like eggs from hens kept in cage, and hens not kept in cage). Whether these market segments are manifested in separate markets (i.e., varying prices) or not, depend on excludability, institutional factors, observability in addition to information and credibility.

Domestic agricultural production provides consumers with national or local food quality varieties. These qualities may be taste, looks or other use qualities, but they may also be tied to the production process. Domestically produced agricultural products may for some consumers have an additional value even though the products themselves are equal to imported products. This may be tied to public good production in agriculture, a wish to have a viable domestic agricultural sector, or that some consumers find the domestic production process more ethically acceptable than other production processes.
Table 3.10 focuses on the product as well as the production process. In this relation the term "like products" is important. This term is used in international trade agreements, like the EEA agreement and the WTO agreement. In both agreements, "like products" are defined on the basis of product and not production process. This makes discrimination between products on the basis of production process illegal, as no import shall be treated less favorable than domestically produced like products (Esty, 1994). In this way, protectionist measures that discriminate between domestic and non-domestic products are avoided. The question is if otherwise like products produced by the aid of different production methods are "like products". This includes issues related to animal health and treatment, the use of hormones or genetically modified organisms in production.

Table 3.10: The product and non-product related attributes adding to food quality (modified after Hatlestad and Søyland 1998).

<table>
<thead>
<tr>
<th>FOOD QUALITY</th>
<th>PRODUCT RELATED</th>
<th>NON-PRODUCT RELATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eating quality</td>
<td>Taste</td>
<td>Negative external effects</td>
</tr>
<tr>
<td></td>
<td>Looks</td>
<td>– Pollution of soil, waterways, air</td>
</tr>
<tr>
<td></td>
<td>Smell</td>
<td>– Erosion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>– Pesticide residuals</td>
</tr>
<tr>
<td>Use quality</td>
<td>Production of public goods / Positive externalities</td>
<td></td>
</tr>
<tr>
<td>Nutrition</td>
<td>– Landscape values</td>
<td></td>
</tr>
<tr>
<td>Health effects from</td>
<td>– Biodiversity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Rural settlement / employment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Food security</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethical quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Religious values</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Animal protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Genetic manipulation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Hormone use</td>
<td></td>
</tr>
<tr>
<td>External quality</td>
<td>Closeness to markets/ Quality control</td>
<td></td>
</tr>
<tr>
<td></td>
<td>– Information as a public good</td>
<td></td>
</tr>
<tr>
<td>Price</td>
<td>Transport and storage</td>
<td></td>
</tr>
</tbody>
</table>
Minimum requirements or other national regulations for production processes are ways to reduce transaction costs related to collecting information about the products and the production process. This may be looked upon as a public good in itself, as it reduces the cost of collecting information for the consumers, and provides a minimum level of food quality for everybody. Another, and possibly negative effect, is that such regulation reduce the amount of varieties for the consumer to choose between. Labeling is another way to inform about the attributes of a product – both product and production process related. There is, however, an informational problem. More specifically, increased amounts of information make the marginal value of information on additional attributes decrease (Mahé, 1997).

As trade is growing and "consumers seem increasingly sensitive to concern of health, environment, ethics and hedonism..." (Mahé, 1997:44), the "like products"/production process issues taken up here is an emerging issue in the international agricultural trade debate.

### 3.4 Rural Activity

#### 3.4.1 Introduction

When designing policy instruments for rural concerns it is essential to ask why we want viable rural areas. Do we want viable rural areas because it has a value in itself, or because of the other "goods" related to it? Moreover, it is central in relation to the multifunctional agriculture to investigate if these other goods are tied to agricultural production or other aspects of rural settlement.

If getting higher settlement or employment in rural areas is the aim, it does not matter what economic activity one supports, as long as it comply with requirements like targetedness and efficiency. Anderson (1998:11) suggests that "... general rather than a sector-specific safety nets and adjustment assistance packages are the most efficient and equitable ways to compensate potential losers from economic development." In Buckwell's (1997:352) wording: "... whatever changes are made in agricultural policy, it has little to offer rural development. This is dependent much more on general economic policy, regional policy and other areas of public provision of infrastructure, transport, health, education, and social policy." Brunstad et al. (1995:43) are concerned about the cost per capita for providing infrastructure
in non-densely populated areas. They state that, as long as depopulation is undesirable, these costs constitute an argument for keeping the population density above some "critical level". Further, they write that "the most efficient way to achieving this goal would seem to be some general income support to all inhabitants in remote areas". However, they also point out that "... in many remote areas agriculture is the only source of employment." OECD (1998b:15) reaches to the same conclusion: "Employment creation in one economic sector has an opportunity cost in terms of employment that could have been created with same amount of money in another sector. Supporting agricultural employment makes therefor only sense if it is cheaper to maintain a job in farming than to create one outside of agriculture, and vice versa, or if agricultural employment is valued more highly than nonagricultural employment."

However, supporting agriculture yields more than one effect. As seen from Figure 2.1, rural concerns may be looked upon as a secondary objective of the agriculture, as "other activities" may provide rural settlement as well as the agricultural sector. Still the marginal gain from supporting agriculture instead of other sectors, may be greater as agriculture provides goods like cultural landscape, an active landscape, food security, etc., in addition to rural settlement.

When dealing with multifunctionality in agriculture, the interesting point in relation to rural concerns must be what kind of role agriculture plays. To what degree are rural concerns directly or indirectly tied to the agricultural sector, and how important is agriculture for their quality? There are two dimension involved here:

(1) What role does agriculture play to maintain a rural community (in general)?

(2) What role does agriculture play in contributing to the quality of rural areas or communities?

The first dimension relates to quantitative measures. It is tied to the direct economic contribution from agriculture (number of people employed in the sector, contribution to the local municipalities, stability, etc.), and linkages in the agricultural production chain (upwards and downwards). The other dimension is more of a qualitative value. It is tied to the particular nature of agriculture in relation to other sectors in the rural areas, like land use, production of public goods, cultural heritage, etc.
3.4.2 Goods and Preferences Tied to Rural Settlement

In addition to being a policy goal in itself rural settlement provides other benefits. Below we present a list with some of the goods and values attached to rural settlement.

− Rural settlement may have a value in itself, an intrinsic value, disconnected from the points mentioned below. This may be linked to the status quo situation, with a relatively high degree of rural settlement, which may be valued higher than an unknown future situation.

− A traditional way of looking at rural settlement is that it forms a part of the civil and military defense considerations, providing strategic security for the nation. Specifically, disperse settlement is a way of claiming territory.

− Rural settlement functions as a contributor to a more diverse society. A society consists of inhabitants with different preferences concerning ways of living. Rural settlement provides increased possibilities for people to meet these preferences by supplying a multitude of different cultural, natural and social settings (Johansen et al., 1999). Reduced rural settlement lowers the cultural and social diversity at the national as well as the local level. It also makes the rural areas less accessible for future settlement and employment. A high degree of rural settlement may also reduce problems related to urbanization.

− In dispersed rural settlements agriculture adds to diversity locally by supplying components like landscape and cultural elements. More centralized rural settlements provide fewer opportunities for agriculture. The resulting landscape and reduced diversity in the way people live in such settlements represent a more monotonous society.

− In addition, to the value of being able to live in rural areas at present, there is an option value of rural settlement. This option value is the possibility to live in rural areas later, or to come back to rural areas. Preservation of rural areas and a diversified society may also be of great value for future generations, socially, culturally, historically, and as a place to live.
Values attached to rural settlement may be based on preferences concerning public goods derived from agriculture, and not in the rural settlement as such. Table 3.11 presents some of the agriculturally connected public goods, which to a large extent influence the quality of the rural nature, landscape, culture and society.

Agriculture may be particularly important in order to maintain economic activity in marginal and mountainous areas. These areas are particularly important for the maintenance of the agrobiodiversity, like on summer mountain farms, mountainous grazing land and heath lands in coastal areas. Agricultural production in these areas is also particularly important for maintenance of the cultural heritage and the cultural diversity throughout the country. Another central point for agricultural production in rural areas is that it contributes to the preservation of agricultural land and production potential on a wide geographical basis, which again may contribute to food security.

**Table 3.11:** The impact on public good production from rural settlement providing agricultural production.

<table>
<thead>
<tr>
<th>Rural settlement providing agricultural production</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity</td>
<td>+</td>
</tr>
<tr>
<td>Area (agricultural land)</td>
<td>+</td>
</tr>
<tr>
<td>Openness</td>
<td>+</td>
</tr>
<tr>
<td>Borders/mosaics</td>
<td>+</td>
</tr>
<tr>
<td>Active landscape</td>
<td>+</td>
</tr>
<tr>
<td>Cultural heritage</td>
<td>+</td>
</tr>
<tr>
<td>Recreation</td>
<td>+/-</td>
</tr>
<tr>
<td>Access</td>
<td>+/-</td>
</tr>
<tr>
<td>Food security</td>
<td>+</td>
</tr>
<tr>
<td>Food safety</td>
<td>+</td>
</tr>
<tr>
<td>Food quality</td>
<td>+</td>
</tr>
<tr>
<td>Negative external effects</td>
<td>-</td>
</tr>
</tbody>
</table>

+ : positive effect, - : negative effect, ( ) : weak linkage

The qualitative effect of the agriculturally related public good components adds to the value of rural settlement making the total picture more valuable than each of the components (relational goods). Preferences tied to rural settlement may accordingly be hard to attach to a
single component. This illustrates the complexity of agricultural production and its multi-functional nature. Agricultural production contributes to rural settlement in general, and at the same time rural settlement is characterized by factors provided by agricultural production. This implies that there may be joint production of public goods in agriculture, like for cultural landscape and the provision of rural settlement.

The provision of public goods may also be provided together with public bads, like agricultural pollution. This may reduce the total value of specific rural settlement forms.

3.4.3 Public Goals Related to Rural Settlement

The Norwegian regional policy has two main concerns; development of sustainable regions and to guarantee a minimum welfare standard to everybody (Blekesaune, 1999). These objectives are mirrored in the agricultural policy which states that the rural and agricultural policy must contribute to viable rural districts, and that this is a prerequisite for the maintenance of rural settlement and for securing living conditions in all areas (Ministry of Agriculture, 1992). This objective is repeated in Ministry of Labour and Local Government (1997), "On the Regional and Peripheral Policy". It states that it is important that rural and regional policies maintain the overall structure of the settlement pattern, and develop viable regions in every part of the country.

3.4.4 The Linkages to Agriculture

3.4.4.1 Introduction

Blekesaune (1999:22) uses Almås' indicators of rurality when classifying municipalities as rural, semi-rural, semi-urban or urban. The indicators are population density, distance from larger centers, the proportion of those who work in agriculture and the proportion of self-employment. Each of these indicators gives scores from 0-3, resulting in total scores in the range 0-12. Municipalities with scores of 0-2 are classified as rural. Similarly, a score of 3-5 indicate semi-rural, 6-8 indicate semi-urban and 9-12 are indicated to be urban (Blekesaune, 1999). Using this classification, the share of rural municipalities has declined. Johansen et al. (1999) arrives at similar results. Here, the municipalities are divided into 14 groups with
respect to the potential nearby labor market. The division is based on size and location of the center, and the possibility to commute to it.\textsuperscript{16}

A problem related to the numbers presented in these reports is the level of resolution used in the analysis. There is a high and unverifiable number of different forms of rural settlement, and the accuracy and power of explanation of the numbers presented are therefore limited. Classifying rural settlements into broad categories hides the variability within each group. The actual diversity in terms of the way Norwegians live is therefore higher than indicated by these reports. This implies, however, that one should be somewhat careful when concluding about the changes in the rural residential patterns.

\textbf{3.4.4.2 The Importance of the Agricultural Sector for Rural Settlement}

In 1997 agriculture represented 3.4\% of total employment in Norway (Johansen \textit{et al.}, 1999). As a core industry, agriculture employs 97 459 people, with 9 368 and 24 866 as forward and backward linkage jobs, respectively. Altogether agriculture provides about 132 000 jobs (Johansen \textit{et al.}, 1999). From 1987 to 1997 agricultural employment decreased by 20\%. In 1990 16\% of the population in rural areas were employed in agriculture (Blekesaune, 1999). The corresponding figure for urban areas was 2\% (Blekesaune, ibid.). These numbers and the analysis done by Johansen \textit{et al.} (1999) both show that some parts of the country rely significantly more on agriculture than others. "The actual geographic situation could thus be regarded as a relevant indicator identifying regions adequate for multifunctional agriculture." (Johansen \textit{et al.}, 1999:50). In addition, the Johansen \textit{et al.} report shows that agriculture plays a more important role in less densely inhabited areas.

The total \textit{employment multiplier}\textsuperscript{17} for agriculture in Norway is estimated to be 1.35 (Johansen and Onsager, 1993). This estimate increases to 1.58 if one includes the part of the food processing industry that uses imported raw materials (Johansen \textit{et al.}, 1999). The crucial point in determining the direct employment impacts of agriculture is to what extent the Norwegian food processing industry that uses imported raw materials also depend on the existence of domestic production. For parts of the domestic food processing industry this is

\textsuperscript{16}For further details see Johansen \textit{et al.} (1999:45-46).

\textsuperscript{17}The size of the multiplier is influenced by; the level of input and output, the total level of income in the sector, the level of unemployment, regional level in consideration. For further details on this see Johansen \textit{et al.} 1999:53.
the case. The justification for this conclusion is that some of the industry uses imported raw materials in seasons with reduced availability domestically produced raw materials.

The multiplier effect varies substantially from county to county. It has the greatest effect in counties with a larger proportion of agricultural production than the national average. A large share of the agricultural products appears to be processed in more central areas (Johansen et al., 1999). Consequently, a substantial amount of the multiplier effect "leaks" to the more central counties. Since the multiplier is below two, the direct effect of reduction in production is larger than the indirect effect.

The large share of part time farming in rural areas implies that farm households are important for the non-farm economic activities in the rural areas. Sixteen percent of the population in rural areas are employed in farming and only 13% of the farms in rural areas are "full-time family farms"18 (Blekesaune, 1999). This implies that a significant part of the population in rural areas consists of people who are part of the farm household at the same time as they contribute in the off-farm economic sector. In some areas this makes the off farm sector vulnerable to large changes in the agricultural sector. One also has to take into account the importance of the whole farm-households' contribution to the social "sector" and cultural factors provided by the farm households (Blekesaune, 1999). In areas where the economy is non-diversified, declining farm numbers would cause severe local consequences. The production of services, and activities generated from the population's income require a certain level of income and demand. If these activities are close to operating at their minimum level, small changes in the local income level can have relatively dramatic effects (Johansen et al., 1999).

In summary, farming is important for the viability of many rural communities. Farm households contribute to off-farm supply of labor, as well as on-farm demand for labor (seasonal and other). Other linkages to the off-farm economic activities (processing of agricultural products, use of service institutions, economies of scale effects in the municipality, tourism, etc.) add to the total picture. This implies that farm-household labor is more important for the non-farm economic activities in rural areas than the multiplier effect from farming would indicate (Blekesaune, 1999).

18 More than 90% of the family's total income is derived from farming.
3.4.4.3 Stability of the Farm Sector

Stability is an important factor for the viability of economically marginal areas with few sources of income. Hence, it is central to look at how the agricultural sector contributes in this respect, and to discuss if and how the stability of the agricultural sector differs from other sectors in rural areas.

The agricultural sector may be more stable as family farming is more of a lifestyle than most other jobs. One reason for this may be that the living and working place is the same. Cultural conditions, social reasons, property rights and the special heritage system for farms in Norway, may make it more difficult to leave farming than other sectors. The family farm is a strong notion among farmers as farms have often been in the same family for centuries. Characteristics like low mobility, high age and little education make it difficult for many farmers to find new jobs in times of reduced profitability in agriculture, especially in the short run.

The high share of fixed costs and low mobility of capital in agriculture may make inputs like capital, land and labor stay longer in agriculture than in other sectors. All these points indicate that people will tend to remain longer in agriculture than what would be looked upon as rational in economic terms. This is also pointed out by the OECD, who states that farm employment may also be considered more stable as it is less mobile and affected by the business cycle than other groups (OECD, 1998b). Hence, the agricultural sector maintains employment more easily than other sectors in an overall economic recession (Johansen et al., 1999:42). Accordingly, agriculture may function as an alternative to other employment sources, and the agricultural sector represents trends contrary to the general development in the labor market.

3.4.4.4 Importance of the Off-Labor Market for the Agricultural Sector

One fourth of the farmers in urban areas are spare time farmers, while in rural areas only one of eight farmers are spare time farmers. Almost one third of the farms in rural areas are part time farms. This implies that farmers in rural areas are more dependent of a farm income of a certain size to continue farming, while this is not the case in urban areas. The same is illustrated by share of income derived from farming which is respectively 50 % and 40 % for "rural" and "urban" farmers. Blekesaune (1999) suggests that a reason for this is probably that

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19 The family farm is a strong notion among farmers as farms have often been in the same family for centuries.
20 Spare time farming: less than 10% of total income comes from the farm. Part time farming: farm income contributes between 10-90% of the household income (Blekesaune, 1999:29).

- 69 -
farming in urban areas is less of an obstacle for the farmers' mobility on the off-farm labor market than for farmers in rural areas. He points at two underlying reason for this:

- In the rural areas there is a larger share of animal farms than close to the urban areas. This reduces the farmer's flexibility regarding what type of off-farm work that is suitable. As such, farming may actually be an obstacle for flexibility in the labor market.
- There are simply fewer jobs in the rural areas.

Off farm income may help the farm households cover their short term consumption needs in periods with negative reproduction of farm capital. Hence, the interdependency of the agricultural economy and the labor market (on- and off farm work) is of vital importance for the maintenance of the family-based agricultural structure (Blekesaune, 1999).

3.4.4.5 What Kind of Rural Settlement Do We Want?
The choice of policy instruments depends on what kind of rural settlement one desires. Two opposing categories are "centralized" settlement and "dispersed" rural settlement.

Centralized settlement is made up by people living in centers or towns and its immediate surroundings in all parts of the country. The main part of the population will find work in the towns or centers, and the dependency upon agriculture as a source of income will decrease. Depending on distances, people can work in the central areas and live outside. Agricultural production could be maintained through part time and spare time farming in areas sufficiently close to the centers and the off farm labor market. In rural areas farther from the centers agricultural production will go down. People who prefer living in rural surroundings will be willing to travel to get to work in the (nearby) towns or cities, provided the infrastructure is sufficient. In smaller towns or centers where living conditions (with respect to noise, pollution, space, etc.) are not that different from living in rural areas, the relative advantage from living outside the town/center is less. This implies that people in these areas will have a weaker incentive to live and continue (spare or part time) farming far outside the centers.

"Spread out" rural settlement consists of settlement and hence employment possibilities irrespective of distance to towns or centers. This makes the local employment possibilities in rural areas more important, especially where distances to centers/towns are large. Unless there are other possible income sources, this increases the importance of agricultural
production as a factor in rural policies. In areas where there are no economic or social foundation for a center or alternative income sources, the dependency upon agriculture (and other primary productions like forestry or fisheries) as a source of income is greater than elsewhere. Accordingly, to maintain settlement in these areas some kind of agricultural support is an essential instrument. However, such support is not necessarily sufficient to maintain settlement.

The choice of policy instruments for rural settlement depends both on what kind of rural settlement one wants and how one looks upon the importance of agricultural production and its additional effects in rural settlement. Both the desired rural settlement pattern and the policy instruments to accomplish this pattern must be chosen on the basis of which factors are the central ones. Is rural viability in itself a central factor, or is the key issue related to the benefits associated with particular rural settlement patterns?

3.5 Negative Externalities

While pollution and other negative externalities from agriculture may not be considered part of the multifunctionality concept, they are effects of the production system and need to be considered in a full policy evaluation. This is a very broad field. For simplicity and without loss of generality, we will therefore focus very shortly on three issues: erosion, loss of nutrients and pesticide use.

In general, increased agricultural area will imply higher losses of soil and nutrients to various water bodies. Higher area intensity – i.e., inputs of nutrients and use of pesticides – will lead to more pollution. This being the broad picture, it is lots of variation that need consideration.

Modeling analyses made by Vatn et al. (1996: chapter 6) show that under the growing conditions of Southeast Norway leaching of nitrates does not increase as a function of fertilizer intensity before one reaches levels of about 60 % of current fertilizer levels. Actually, the analyses – at least for grain – show reduced leaching for low levels due to better crop stand. Agronomists, like Vagstad (1990), have argued that the relationship between fertilizer intensity and leaching is even less strong than what is implied in the work by Vatn et al. The reason for this is that for normal fertilizer levels, nitrogen is still the minimum factor for plant growth except in years with low precipitation. This argument may be of some relevance for grains, but not for grass production.
Analyses show that erosion levels are extremely dependent on agronomic practices (Vatn et al., 1996). Thus, area is not a good proxy. Type of crop (grass land versus grain) and soil management practices are the most important factors. It is therefore no clear relationship between yields (area-intensity) and erosion with one notable exception: For some soils and climates "reduced tillage" may lower yields. If high yields are important for farm profitability, farmers are unlikely to choose these tillage practices.

If we turn to pesticides, it is reasonable to assume losses to be proportional or increasing to application rates. In this case there is a distinction to be made between weed controls and the control of pests. While it is reasonable to assume that the herbicide use will be more profitable the larger the potential crop, this will not so much be the case for fungicides. This follows from the fact that even at rather low yield levels it seems profitable to use fungicides to protect the crop. Certainly, the level of the attack will influence this conclusion.

### 3.6 Summary on Interlinkages

Table 3.12 illustrates possible interlinkages between area, intensity and type or mode of agricultural production and the goods provided by the multifunctional agriculture. It is primarily a summary of the tables previously presented in this chapter. The table provides a suggestion of likely interlinkages between the agricultural production and various public goods. It is, however, incomplete, and depending on the particular situation, in time, location, or production level the signs in the cells may change. The signs presented here are based on the discussion of each of the points in the previous subchapters. Our main aim of presenting such a table is twofold:

- to provide a point of departure for further discussion on the different interlinkages,
- and

- to provide a framework that illustrates the complexity of the multifunctional aspects.

As can be seen from Table 3.12 area and types of production are to a large extent positively linked to the public goods produced by agriculture. Intensity in commodity production on the other hand, is to a larger extent negatively linked to the production of public goods.
Table 3.12: Interlinkages between area, intensity and form of production and public goods provided by agriculture.

<table>
<thead>
<tr>
<th>Area: agricultural area in production</th>
<th>Intensity: intensity of agricultural production</th>
<th>Mode / Type: mode/type of agricultural production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>Intensity</td>
<td>Mode / Type</td>
</tr>
<tr>
<td>Biodiversity</td>
<td>+/-</td>
<td>√</td>
</tr>
<tr>
<td>Cultural heritage</td>
<td>+</td>
<td>( )</td>
</tr>
<tr>
<td>Amenity value of the landscape</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Openness and borders/mosaics*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active landscape*</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>The total amenity value of the landscape influenced by openness, borders/mosaics and the active landscape</td>
<td>+/(-)</td>
<td></td>
</tr>
<tr>
<td>Recreation / Access</td>
<td>+/-</td>
<td>( )</td>
</tr>
<tr>
<td>Scientific/Educational value</td>
<td>+</td>
<td></td>
</tr>
<tr>
<td>Food security</td>
<td>+/-</td>
<td></td>
</tr>
<tr>
<td>Food safety</td>
<td>(+)</td>
<td></td>
</tr>
<tr>
<td>Rural settlement</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Negative external effects (e.g., measured as water quality)</td>
<td>(-)</td>
<td>-</td>
</tr>
</tbody>
</table>

Area: agricultural area in production
Intensity: intensity of agricultural production
Mode / Type: mode/type of agricultural production
+ : positive effect, - : negative effect, ( ) : weak linkage
x : column no input to row
* : adds to the amenity value of the landscape
√: connection between mode/type of production and the public good
Table 3.13 shows the interlinkages between the public goods (and bads) provided by agriculture. Combined with the table above one can envisage the complexity of effects of applying or changing a policy instruments. In addition, many of interlinkages are uncertain or even unknown. Other interlinkages depend entirely on the level of agricultural production or the public good. Some interlinkages may go from being positive to becoming negative. Examples of this include open space and the related vegetation borders, or mosaics in the landscape. Where the point of departure is a low level of open space, more open space will give more border zones and mosaics (however, this also depends on the shape of the open space). If, on the other hand, open space is dominating initially, more open space will probably decrease the amount of border zones and thereby the mosaics of the landscape. There is considerable uncertainty and the lack of knowledge tied to the interlinkages of the multifunctional agriculture. The main purpose of the table is therefore to illustrate the complexity of the multifunctional agriculture and form a point of departure for further discussions.

**Table 3.13: Interlinkages between the public goods provided by agriculture.**

<table>
<thead>
<tr>
<th></th>
<th>B</th>
<th>CH</th>
<th>O</th>
<th>BM</th>
<th>AL</th>
<th>RA</th>
<th>FS*</th>
<th>FSA</th>
<th>FQ</th>
<th>RS</th>
<th>SE</th>
<th>A</th>
<th>NE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity (B)</td>
<td></td>
<td>+</td>
<td>CC</td>
<td>+</td>
<td>CC</td>
<td>(-)</td>
<td>?</td>
<td>?</td>
<td>x</td>
<td>+</td>
<td>x</td>
<td>+/-</td>
<td>-</td>
</tr>
<tr>
<td>Cultural heritage (CH)</td>
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<td>Openness (O)</td>
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<td>Borders/mosaics (BM)</td>
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<td>Active landscape (AL)</td>
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<td>Recreation/Access (RA)</td>
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<td>Food security (FS)</td>
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<td>Food safety (FSA)</td>
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<td>Food quality (FQ)</td>
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<td>Rural settlement (RS)</td>
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<td>Area (ag. land) (A)</td>
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<td>Neg. ext. effects (NE)</td>
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+ : positive effect, - : negative effect, +/-: depending on the situation the interlinkage may positive or negative ( ) : weak linkage, x: column no input to row, ?: uncertain/unknown effect
*: implying food production nationally as one of the means to provide food security
CC: relationship going from complementary to competing between the public goods in production
3.7 Unique and Secondary Tasks of Agriculture

Dividing the tasks of agriculture into two categories helps us see where agriculture is unique supplying a good and where other sectors can contribute. Which category a good belongs to will vary from country to country, as well as from region to region. In the introduction we defined regional concerns as a secondary task for the agricultural sector nationally. However, there are regions in Norway where agriculture has a unique task when it comes to rural settlement or employment, as discussed in the chapter on rural concerns. When it comes to food aspects the national agricultural sector may belong to both categories. If the food safety level nationally is higher than the international level, food production nationally has a unique task when it comes to food safety. Food security on the other hand may belong to both categories depending on the type and level of food security one wants to accomplish.

When it comes to the unique tasks of agriculture, other sectors can contribute, but they will never be able to fully replace the agricultural sector. An example is animals grazing and creating a special composition of plants or an open landscape. Another unique task of agriculture is the creation of a productive or active landscape, where people find the landscape nice to look at because it signals activity, management and use of natural resources, and life.

One of the main messages to be drawn from this chapter is the following: A policy instrument applied in agriculture may influence the production of several goods at the same time, directly or indirectly, and in a positive or negative way.

If supporting agricultural production enables agriculture to produce public goods simultaneously (jointly or complementary), this may be superior to supporting production of each of the public goods isolated. In this way the secondary objectives of agriculture, like rural settlement, may to a larger extent be provided by agriculture than what would be optimal for rural settlement isolated. However, one must keep in mind that negative externalities may also be produced simultaneously with agricultural production. In turn, this reduces the total positive effects of supporting agricultural production.

The reader should keep in mind that this chapter concentrates on the interlinkages between agricultural production and public goods as well as some interlinkages between various public goods. This chapter does not include an assessment of the economic implications of
changing policy instruments for the agricultural sector. We will, however, present one example, namely reduced price supports, to illustrate what kind of effects that could occur.

Reduced price supports and the ensuing extensification effect is known as the so called "double dividend" in agri-environmental policies (Potter and Goodwin, 1998). A decrease in price supports may lead to extensification of agriculture as fewer resources like fertilizer and pesticides are applied in the sector. According to our summary tables this will to a large extent improve the public goods produced by agriculture. Moreover, negative externalities like pollution and erosion from agriculture, are likely to be reduced.

However, another implication may be that large marginal areas go out of production, as these areas no longer provide an economic foundation for living in these areas. According to the tables this may to a large extent reduce the public goods derived from agriculture, as open areas are covered by forest, local agrobiodiversity is lost, etc. Marginalization of farms also implies marginalization of farmers that embody skills that may be essential for conservation (Potter, 1996).

Another interesting and closely related situation is if intensification leads to the merging of fields or increasing livestock units. Such changes may become economically necessary for a farming to be privately profitable in the future. According to the tables above, intensification will in general have a negative effect on the public goods in agriculture. However, if the alternative is that the farm goes out of production, the implications for public good production may be even worse. These examples illustrate that there are many consideration to be included when applying or changing policy instruments.
4 Welfare Effects – Efficiency and Rights

How can various policy options be evaluated? Welfare economics constitutes a theoretical basis for such evaluations. In this chapter we provide a brief overview of some important results in welfare economics and discuss their relevance for policies concerning multifunctional agriculture as it has been presented in chapters 2 and 3.

4.1 Welfare Economics and Policy Evaluation

The starting point of modern welfare economics is the Pareto criterion. Its basic implication is that if everyone prefers the allocation $a'$ over $a$, it is noncontroversial to assert that $a'$ is "better" than $a$ (Varian, 1992). Moreover, any allocation change that moves society from $a$ in the direction of $a'$ is assumed to improve social welfare.

Such uniform preferences are rare. Often, some people would prefer $a'$ over $a$ while others prefer $a$ over $a'$. One implication of using the Pareto criterion in such cases is that society would be unable to make a welfare ranking and choose between the two allocations. The Pareto compensation criterion resolves this issue by suggesting the following test: $a'$ is potentially Pareto preferred over $a$ if there exists some reallocation of $a'$ such that everyone prefers the reallocation to $a$.

A potential Pareto improvement takes place if the "winners" of a proposed change are able to compensate the "losers". Whether compensation takes place or not is not so important in terms of ranking allocations. The reason for this is that the basic welfare theorems show that the issue of allocative efficiency can be separated from the income distribution. As such, both the Pareto welfare measures deal with efficiency. An important implication of Pareto efficiency is that it is impossible to make someone else better off without making someone else worse off, i.e., there are no wasteful practices taking place. As Pareto efficiency does not provide any information on economic distribution, it is also perceived to be value free. The latter has been one of the primary reasons why Pareto efficiency is a much used welfare criterion in theoretical economics.
An equally important question to knowing what are Pareto efficient outcomes is knowing how to achieve them. A benign dictatorship with full information on everyone's preferences, all production activities etc. will produce a Pareto efficient outcome. The informational requirements of such a dictatorship are immense.

Provided that markets are complete (every good or attribute can be traded in a market) and consumers' have self regarding utility functions, Arrow (1951) showed that a competitive (market) economy would result in a price vector, \( p \), that would also lead to a Pareto efficient outcome. This has later been known as the Arrow-Debreu model (Boadway and Bruce, 1984). These results are formalized utilizing the concept of a Walrasian equilibrium into two theorems of welfare economics. This yields the standard result from welfare economics that a market (exchange) economy will provide a Pareto-efficient allocation under the following conditions (see Boadway and Bruce (1984) and Varian (1992) for a further discussion):

− **Markets are complete**, i.e., all current and future commodities and services can be traded in the market. This implies that there exists contingent markets for future outcomes.\(^{21}\)
− Individual *utility functions are self regarding*, i.e., individuals only consider their own welfare when making decisions in the market.\(^{22}\)
− All agents display *price taking behavior*.

These conditions are quite restrictive. In the ensuing sections the implications of relaxing these assumptions will be discussed.

### 4.2 Efficiency, Rights and Legitimacy

As outlined above, welfare theory shows under which conditions markets provide Pareto-efficient allocations. To the standard list normally displayed in welfare economic literature (as above), we would like to add that rights are distributed, products are homogeneous, and transactions costs\(^{23}\) are zero. Given the various assumptions, trade barriers or production subsidies will reduce aggregate welfare. State "intervention" is, however, permitted if markets

\(^{21}\) Further, the notion of complete markets relates to goods being rival and excludable in consumption (see Chapter 2).

\(^{22}\) There is some controversy on the necessity of the condition of self regarding utility functions, more specifically if the effect of "good feelings" onto others (like altruism) makes Pareto efficiency not hold (i.e., an absolute property), or if this condition should be interpreted as the lack of envy.

\(^{23}\) Transaction costs are defined as the costs of gathering information, making decisions/contracts, etc., and controlling/policing. Zero transaction costs thus implies costless information, i.e., full information.
fail to stand up to the defined presumptions (Bator 1958). Public goods (non-exclusiveness and non-rivalry) or externalities (non-exclusiveness) constitute the prime case where regulation or public supply is accepted or prescribed (Boadway and Bruce 1984).

As we see it, there are three issues that need careful consideration when using welfare theory as a basis for policy evaluations especially when free trade is concerned:

− the distinction made between efficiency and distribution – i.e., the role of rights (institutions) and legitimacy in defining what becomes efficient solutions,
− the lack of a common social welfare function or authority structure in international trade, and
− problems following from the fact that private and public goods are interrelated in production and/or consumption.

As we will see, these aspects are linked. The issue of non-zero transaction costs will be dealt with in Chapter 5.

### 4.2.1 The Role of Rights and Legitimacy

In a society rights have a twin role of defining both which interests are to be protected and following from that which resource allocations become efficient (Bromley, 1989). Welfare theory focuses on the last issue – i.e., rights (or endowments) are taken for given. The distribution of rights is a normative issue outside the scope of economics. In most institutional reforms like setting rules for international trade, the issue is foremost about defining or redefining rights. Still, the issue is very often cast in efficiency terms. This may cause confusion.

Let us start with a simple example – the problem of defining what is a positive or negative externality. Trying to clarify this on pure physical grounds has shown to fail (Coase, 1960; Vatn and Bromley, 1997). Whether A is presumed to restrict B's possibilities when A lets his trees grow high, or B restricts A's possibilities when requiring them cut, is a question of defining what is the right and for whom. Whether it is the trees or the lack of sun that is to be protected cannot be defined on the basis of physical characteristics. It is only through defining rights to resources that it becomes clear what is a harm or a sacrifice (Bromley, 1991).
Given zero transaction costs rights are only important for the distribution of goods, not for the optimal resource allocation. If B wants sun more than A wants trees – i.e., if B is willing to pay more for sun than A for the trees – they will be cut independent of who has the initial right.\textsuperscript{24}

In a situation with positive transaction costs – i.e., in a real world circumstance – this is not so. Since trading, setting up agreements, etc. are costly, the distribution of rights is crucial to resource use that becomes efficient. Scheele (1999) discusses this issue explicitly for agriculture and the environment, showing the need for defining a baseline – e.g., in his case using "good agronomic practice" as a reference point. From the definition of that baseline it becomes possible to evaluate whether an activity implies a positive or negative change – for example if the Provider Gets or Polluters Pays Principle should be used.

Rights have to be defined and secured by a certain authority structure like the state. Implicit in the rights definition there is a certain social welfare function, i.e., a weighting of the different interests in a society. It is on the basis of these rights that individuals or firms can make their bargains. Thus, there are two levels: a constitutional or basic policy level defining rights, and an operational level making choices or bargains given these right structures.

What is a legitimate right has both a formal understanding and a wider meaning. Its formal meaning relates to the law – i.e., rights that are defined through a constituted political process in a society and sanctioned by its legal institutions (see as an example Merrian-Webster, 1993). In a wider, social perspective Almås (1999) understands legitimacy in the following way:

"Legitimacy in this context means that decisions made by the authorities will be accepted as valid because they build on accepted rules and principles as they at the same time conform to political and ethical values of the society. Legitimate government means that the need for power and control is limited, since people feel a moral obligation to obey the laws and rules." (Almås 1999:3, our translation).

Certainly, building legitimacy at the operational level becomes more difficult the larger the involved society is, the more conflicting the involved interests are, etc. On the international arena the issue of legitimacy is particularly challenging.

\textsuperscript{24}This is known as the Coase theorem (Coase, 1960).
4.2.2 International Trade and the Lack of a Common Social Welfare Function

The special problem facing international trade is the process of defining rights between countries or agents in different countries. Here, there is no common authority structure like a government or a parliament defining a common welfare function, deciding when something is a harm to somebody, etc. This issue has to be determined on the basis of a bargain between states.

By this we do not imply that international agreements etc. are not binding. If you are a member of NATO or WTO, you are assumed to follow the rules or "laws" of the international body. The point is that it is an agreement between independent and formally equal powers, developed and sanctioned as such.

In reality, these independent powers are not equal. This is important, but still not our main concern here. Rather we emphasize that defining a right must follow from an authority structure that is common to all states – i.e., some sort of a "super state". Since there is no common norm, we observe that efficiency arguments "intrude" the arena as a legitimate, even determinate argument over which rights should exist. This "intrusion" creates confusion. We observe this in the debate about "trade distortions".

When a trade regime is set up giving country A the right to export its products freely to country B and vice versa, this is based on the argument that both countries will gain from trade. When for example country B realizes that the external effects of that trade is such that the net effect for B is negative, it may want to change the regime. Should that issue be determined on the basis of who gains the most from either institutional structure or should each country be given a right to define some standards to protect itself. Certainly this is a very difficult issue when no common authority structure or social welfare function exists. It is, however, logically wrong to determine the outcome on the basis of who is willing (or able) to pay the most for specific rights principles.
4.2.3 What is a "Trade Distortion"?

The above problem is not a problem in the case where all goods are strictly private and no external effects occur across countries. What concerns us here is the case when the same good has both private and public attributes, or when there are interrelations between the production of the two types of goods. As is shown in Chapter 3, this is typically the case with many functions related to agriculture.

The distinction that often is made between "trade" and "non-trade concerns" may illustrate the problem. This division is very much interpreted as a distinction between private and public goods. The logic seems to be that a country should be free to choose its policy when nationally defined public goods are involved as long as this does not distort (international) commodity markets. This logic is one justification for the establishment of the Green Box in the previous WTO round.

Suppose that two types of goods are interrelated in production. Then one cannot make such a distinction. Even payments for public goods via Green Box measures will have spill-over effects on the market for private goods. For some countries – for example those with substantial competitive disadvantages in the private goods market – the situation may be such that it becomes preferable for these to link some payments to production of the private good as well to obtain the desired level of an attached public good. From the pervious paragraph it follows that his will be a "distortionary" practice, thereby reducing overall efficiency. This conclusion does not hold in general as it does not contain costs and gain considerations. Instead, the claim that such practices reduce efficiency is based on the assumption that the two types of goods are distinctly demarcatable. From this it follows that a country is free to chose its own policy concerning public goods only if it does not influence trade. If so, trade has become a goal in itself. Put differently, in a situation with interrelations between private and public goods provision, a free trade requirement actually becomes a restriction on the system. As a defined right, the contribution from economics in this matter is limited. It is a

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25 We should also add, when distribution does not matter and welfare is defined only as the sum of the individuals’ utility.

26 From the literature on optimization we know that such restrictions generally reduce the objective value (like social welfare). The only case where such restrictions do not influence the objective value is if the restriction is non-binding.
political issue. Any interpretations that reducing trade distortions are generally welfare enhancing are at best questionable.

The issue is rather about who harms who: The country that is not allowed to export on "equal terms" with domestic farmers, or the country that is not allowed to support public goods production in the way most rational for that country, because "equal terms" in the private market may then be jeopardized. This is a general problem, even though it is more difficult to handle the stronger the link is between private and public goods provision.

According to Coase (1960) and Dahlman (1979) one should be very careful with analyses based on first best assumptions as defined in welfare theory. First best is generally not attainable. Therefore, one should instead make comparative analysis on the basis of attainable structures and realistic assumptions about goods and markets. We also add human capabilities to the our list of analysis criteria.
5 Criteria for Policy Measures

The purpose of this chapter is to discuss criteria for evaluating policy measures. While we in Chapter 4 discussed the basic issue of efficiency and rights – e.g., the role and content of the efficiency concept in policy formulation – we will now turn to the principal-agent problem: How to motivate the agents (farmers) to adapt in a way that conforms with defined policy goals in a cost-efficient manner? This is a discussion about incentives, allocation mechanisms and information feasibility. It relates, however, also to the objectives of the agents. Finally, the cost of running the policy – e.g., the administration or transaction costs issue will be discussed.

5.1 Resource Allocation Mechanisms

Traditional economic welfare analysis consists of comparing marginal benefits and costs of policies. Here we focus on one of the main preconditions for welfare maximization, that the sought after outcome is attainable. This involves investigating the incentive compatibility of policies and their informational requirements. However, this is not sufficient to ensure attainability of economic policy. For this to take place a more complete perspective on agent behavior is needed. An important part of this perspective is the notion of resource allocation mechanisms (RAM).

Any economic system or mechanism is a communication process, where messages are exchanged between agents. Each agent transmits messages to which other agents respond according to their self-interest. A successful RAM utilizes this, so that each agent without necessarily understanding the complete process, is induced to cooperate in the determination of a satisfactory bundle of goods and services (Campbell, 1987). As such RAMs are extensions of the principal-agent model. Necessary features of any RAM are: (1) fulfillment of the participation constraint, (2) informational viability and efficiency, and (3) incentive compatibility. In addition, it is desirable that a RAM is able to rank welfare between polices.

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27 This section builds on Romstad, 1998.
The importance of these properties, and necessary modifications due to conflicts between them will be discussed briefly.

(1) **Fulfillment of the participation constraint** requires that the suggested RAM generates allocations that make all the firms, and all consumers at least as well off as their reservation utility or profit level.

(2) **Informational viability** is important because RAMs that do not satisfy this property have informational requirements that exceed the available information. For any RAM that is not informationally viable it is therefore impossible to verify if its intended outcome has been met. Informational viability requires (a) that agents only use accessible information about the other agents, and (b) that the amount of information is such that it can be treated (Campbell, 1987). Formally, (a) is called the privacy preserving property of the RAM, implying that only public information about one agent can be used by the other agents. A convenient way of formalizing (b) is that the message space of the proposed RAM must be a finite Euclidean space. This means that the vector of information exchanged between the agents has finite dimensionality.

**Informational efficiency** means that there exists no known RAM that satisfies the stated objectives at less cost of gathering and processing information (Campbell, 1987).28

(3) **Incentive compatibility** means that it should be in the self interest of the firms to act in the prescribed way. Unfortunately, joint incentive compatibility and Pareto-optimality are not always possible.29

According to the theory of second best, it is uncertain whether applying marginal cost pricing in the sectors under consideration will move the entire economy closer to the Pareto-optimum, unless the optimality conditions are met in the rest of the economy (Lipsey and Lancaster, 1956; Boadway and Bruce, 1984). In general, the latter will not be the case. Thus, Pareto-optimality may not be applicable for RAMs seeking to correct for externalities.

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28 *Informational efficiency* as used in the mechanism design literature as many common features with the term *transaction costs* used in the institutional economics literature. The main common feature of the two terms is that both acknowledge that collecting and processing information is not costless.

29 The reason for this is that creating incentives usually does not come without costs. More formally, whenever the *incentive compatibility constraint* is binding, it reduces the first-best optimal value, i.e., social welfare. See Campbell (1987) for a further discussion, and Hurwicz (1972) for a formal proof.
Spulber (1989) suggests replacing Pareto-optimality with Second-Best Pareto-Optimality (SBPO). The difference between Pareto-optimality and SBPO is that while the former denotes a situation on the grand utility frontier, the latter is not quite on the frontier. Instead, it focuses on the existence of other feasible allocations. SBPO occurs when there exists no other feasible allocation that gives a higher utility (Spulber, 1989).

In terms of applied policy design, one may rightfully ask how relevant it is to require allocations to meet some welfare indicator like Pareto-optimality or SBPO. For one, there are large uncertainties — and in some cases well-founded disagreements⁴⁰ — regarding welfare estimation. Still, it is well known that any policy induced allocation that is a candidate for maximizing welfare must be efficient. In other words, the transaction cost of the policy should be the least for the given allocation. If this is not the case, there exists some other policy with lower transaction costs yielding the same allocation. This implies that some of the saved transaction costs of the alternate policy could be redistributed and improve the welfare of at least one individual in society. This line of reasoning is equivalent of the rationale behind the equivalence of the two definitions of Pareto-optimality.⁴¹

Informational viability and efficiency and incentive compatibility are required for the proposed RAM to yield a predictable outcome. Fulfillment of the participation constraint is important to facilitate the implementation of the RAM. For any given allocation, the RAM should provide this allocation at the least social costs to be a candidate for a welfare maximizing policy.

### 5.2 Profit Maximization

Making sense of the *incentive compatibility* criterion and the *participation constraint* involves making assumptions about agents' objectives. Farmers are often assumed to maximize expected profits. In such a framework a farmer will choose the activity that yields the greatest expected profits, provided that these profits exceed the individual farmer's *reservation profits* (π). If this is not met, the farmer chooses to quit farming. This corresponds to the *participation constraint* in Section 5.1.

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⁴⁰The issue of valuation of non-market goods is not addressed in this paper. A good summary of the discussion of the valuation of public goods — in particular related to contingent valuation — can be found in the *Journal of Economic Perspectives* (1994) in articles by Diamond and Hausman (1994) and Portney (1994). A more institutional oriented critique of contingent valuation can be found in Vatn and Bromley (1994).

Profits equal the sum of revenues, which could come from many sources, less the associated costs must. Assume that the joint cost function $C_\theta (y,z)$ exhibit the standard properties.\textsuperscript{32} Expressed in the dual formulation, the agent's profit function and the participation constraint per hectare may exhibit the following elements:

$$\begin{aligned}
\left\{ \begin{array}{c}
\text{Max} \\
y, z, \theta
\end{array} \right. \pi &= (1 + \Delta)p_y y + p_z z - C_\theta (y,z) - I_\theta + a + LS \\
\text{s.t. } \pi &\geq \pi
\end{aligned}$$

where $\Delta$ denotes a commodity price subsidy,
$p_y$ denotes a vector of commodity market prices,
y denotes a vector of market (private) commodities,
p_z denotes a vector of direct payments for public good attributes,
z denotes a vector of public good attributes,
p_z denotes a vector of indicator based payments,
$\hat{z}$ denotes a a vector of indicators over public good attributes,
$C_\theta$ denotes a cost function for technology $\theta$,
$I_\theta$ denotes the additional investment needed for technology $\theta$,
a denotes a per hectare area (or per animal head) payment,
LS denotes a lump sum transfer, and
$\pi$ denotes the producer's reservation profits.

Equation [5.1] lists various types of policy instruments that could be used to bring accordance between farmers' goals and public policy objectives. The policy instruments in [5.1] is not complete, and some of the listed policies may not meet the necessary criteria for a successful resource allocation mechanism. We shall return to these issues in Chapter 6.

### 5.3 Utility Maximization or Norm Based Behavior

Farmers' goal function may be even more complex than the one above. They may maximize expected utility instead of profits. Further, they may follow local or more uniform norms about what is appropriate behavior. Finally, perceived rights may influence choices.

#### 5.3.1 Utility Maximization

In the theory of farmers' behavior it has long been emphasized that for the dominant form of organization – household based production – utility maximization reflects decision making better than a purely profit oriented model (Chayanov, 1966; Nakajima, 1986; Singh et al.,

\textsuperscript{32} See Chambers (1988) for an overview.
1986). The main basis for this theory is the observation that the farm is both a production and consumption unit and that this form of organization brings in a trade-off between income generating activities and goods like leisure that is not considered relevant in the conventional firm decision making models.

Our point of departure is inspired by this literature, but in our case the trade-off between income and leisure is not the most relevant. Instead farmers' own utility or perception of what is a nice landscape, a nice field, a good animal welfare standard or even what it means to be a farmer is the important type of consideration. The latter may concern the integrity of the farmer as a business manager, the level of control and documentation accepted, the type of goods the farmer finds it legitimate or interesting to produce, etc.

5.3.2 Norm Based Decisions

Even though utility maximization makes it possible to include a wide array of considerations or elements besides income, its implicit choice rule – optimization – may also be limiting. Choices may instead be driven by norms or habits. These may be local or more universal. In the farmers' communities are many codexes concerning "good agronomy", landscape maintenance, etc. that are subject to different types of social definition and control (Vedeld, 1997).

While norms are socially defined rules about what is considered right or appropriate behavior, habits are more individual approximations that can – at least partly – be explained as a way to simplify complex decisions (Screpanti, 1995). Even habits may have a social origin in that they represent a form of common experience, in this case among farmers, formulated as rules for what is a reasonable solution to different complex problems (ibid.).

Both norms and habits describe a form of routine behavior. An implication of this is that norms and habit based behavior may lead to delayed adaptations to new circumstances. Further, the concept of norms also signifies that behavior to some extent involves (a) social conformity considerations and maybe (b) ethical concerns. The first aspect relates to the issue of social identification – i.e., how the producer/farmer interprets his role in society and what it is that constitutes her identity. The second aspect relates to what is the right or appropriate thing to do under certain circumstances.
Certainly, utility functions and norms may change over time. Still, when a policy reform is undertaken, evaluations of which effect factors like this may have on the final result is of high importance. A policy towards increased payments for collective goods like landscape attributes, biodiversity, may be well accepted. It may, however, also produce great hostility because it does not fit well with farmers' perceptions concerning what is an interesting or legitimate good. Especially the strong "production ideology" that seems to dominate farmers' societies, may pose a challenge to transform the mind sets towards landscape production as an important goal or product in itself.

Lowe and Ward (1997) documents an example of this is where they demonstrate the instrumental effect of a change in farmers' attitudes on the result of environmental policy – in their case concerning English manure policies. The implementation of regulations concerning storing and spreading resulted in a sort of a 'seek and hide game' where farmers supported each other to avoid policing. This attitude with its unfortunate policy effect was substantially changed when a program on explaining the reasons for the policy and its potential environmental effects was set in motion. Similar dynamics are described for Norwegian manure policies in Vedeld et al. (1998).

5.3.3 Legitimacy and the Role of Perceived Rights

Changing policies means changing rules and thus the rights explicitly or implicitly involved. It is therefore of importance to evaluate the effects of this on expected behavior. The literature in this field is not much developed. Tyler (1990) states that the effects of an institutional system depend on its legitimacy as viewed by those involved – in general whether people decide to work with or against the system objectives.

In the literature about environmental valuation it has for long been accepted that there is a large difference between the willingness to pay for a good and the willingness to accept compensation for giving up the same good (Gregory, 1986; Knetsch, 1990). Tversky and Kahneman (1986) explain these observations with the existence of "loss aversion". Others like Vatn and Bromley (1994) term it a rights or endowment effect. Here, the explanation runs directly from the entitlement structure: You will not (easily) give up what you consider yours.

Such mechanisms may explain at least some of the controversies observed around an important environmental issue in Norway these days – the reestablishment of large predators.
in certain districts. The conflicts are especially high where sheep farming is important. Over the last years one has – among other things – tried to motivate farmers to change their practices in sheep farming or to shift to other productions like milk. Farmers are reluctant to do this. One endorsed hypothesis is that they look upon such an adaptation as an implicit acceptance of a new rights structure. They find themselves being "bribed to sell" the right of a predator free environment – a well established value in the local communities.

5.3.4 Consequences for Policy Evaluation
The consequences of the above points for policy evaluations are many. For one it complicates the analysis, making it rather rare to see such reasoning involved to any extent. Moreover, we are unable to provide anything near a reasonable coverage of these aspects at the level we perform this study. Still, some general insights will be utilized in our analysis. These are:

− When evaluating the efficiency of a policy measure, one must have in mind the wider aims of the individuals/groups involved. The degree of concurrence between policy aims and the aims of agents are crucial. What "in theory" is perceived as a sensible policy, may induce behavior that yields undesired results.

− Information and dialogue must be a part of any policy change. Changes in motivation and a deeper understanding of the arguments behind the policy alterations are necessary conditions for most policy reorientations. The importance is greater the more fundamental the change is.

5.4 Transaction Costs and Precision
There are transaction costs attached to any institutional structure – i.e. one encounters costs of information gathering, decision making and contract formulation. Normally, also costs of controlling or policing agreements, etc. will be involved. These costs vary between systems and instruments. Taking transaction costs into consideration when evaluating policies is challenging. It is no wonder that these costs are assumed to be zero in most analyses. On the other hand, in such a world any economic organization actually becomes efficient (Eggertsson
When making proposals on the basis of efficiency arguments, transaction costs is a core issue.

Striking the right balance between transaction costs and precision, is one of the key issues. Let us look at an example: The aim to preserve or enrich agricultural landscapes may involve policy measures at different levels or scales. Acreage payments, payments per head of desired animals, and other indirect payments constitute one group of instruments. With this type of measures one will be able to influence some of the larger or medium scale features of the landscape. Such instruments will, however, have no or maybe even a negative effect on hedges, vegetation corridors, etc., if used as the only policy instrument. To obtain a development or conservation of these landscape elements, additional instruments may be necessary. These more specific instruments usually entail increased costs of information gathering, control, etc. Whether this is desirable or not, depends on the trade-off between increased level of goal attainment and increased administrative resource use – i.e., the trade-off between enhanced precision and increased transaction costs.

This simple example has relevance for all types of instruments and levels of analyses. Thus, in some cases the most simple solution from an administrative perspective – production supports – may be targeted enough. The loss in precision is less than the gain in transaction costs compared with the alternatives. In other cases this is far from satisfactory concerning precision, and one has to pay more directly for the good to obtain a reasonable outcome.

Debates over what is an efficient policy often reveal arguments that policy instruments must be well targeted. Certainly, we agree. Still, the above trade-off must be kept in mind. The challenge is to balance between the following two polar positions:

(A) That measures that are not directly targeted are illegitimate.

(B) That due to high transaction costs targeting is the wrong focus.

Both these polar positions run the risk of a priori eliminating many interesting – i.e., more welfare enhancing – policy options from consideration. This is actually about the distinction

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33 If transaction costs are zero, there will first of all be no costs attached to making decisions, monitoring, enforcement, etc. This means that one cannot distinguish between economies or policies along that dimension. Further, since information is cost free and organizing is cost free, there will be no trade to prices that are not efficient. Certainly, a world without transaction costs are strange, and the reasoning developed here should show that one should be extremely careful when making analyses under the assumption of zero transaction costs.
between Pareto relevancy and Pareto irrelevancy\(^\text{34}\) (Dahlman, 1979). If increased precision increases transaction costs more than the gains in environmental quality, claiming high precision or targeting may make a specific policy appear Pareto irrelevant. One should, however, not stop searching for alternative policy options in such situations. Instead, there may exist large domains where net gains exist if one is willing to reduce somewhat on the precision requirements. We shall close this section with three comments on this.

First, the above relates to the famous Tinbergen result that in general one needs one instrument per objective that one wants to achieve (Tinbergen, 1950). In situations with strong (but not perfect) interrelationships between various policy goals, the presence of transaction cost may make it more optimal to apply fewer instruments than what is implied by Tinbergen's result. Specifically, it may be less costly to structure the policy such that two goals that are positively related are obtained by the way of only one measure. Reduced transaction costs may more than pay for the reduced precision.

Second, reducing precision to obtain reductions in transaction costs may be efficient, but not accepted as fair. It may imply that not all persons or firms providing a public good will actually get paid and conversely that some who does not provide gets paid. In the case of a public bad (negative externality), some that does not cause a negative externality could still be taxed.\(^\text{35}\)

Third, in a situation with complex goods it is possible to reduce transaction costs by utilizing farmers' own insights and by making them conform to the formulated policy aims. This can be obtained by creating a cooperative climate. Referring to the analysis in Section 5.3 above, this is important, but not a trivial task.

\(^{34}\)A solution or change is Pareto relevant if (aggregate) gains are greater than (aggregate) costs, while it is Pareto irrelevant if the situation is opposite.

\(^{35}\)A prime case of the latter kind is related to the use of fertilizer taxes. For an overview of the Norwegian debate concerning this issue, see Vatn \textit{et al.} (1996) and Krogh \textit{et al.} (1998).
6 Evaluating Different Policy Strategies

6.1 Introduction

In this chapter we will discuss the potential of various policy strategies for securing the desired provision levels of private and public goods from agriculture. We will build the arguments in a stepwise manner. First, we will analyze some type situations – i.e., situations where public goods are joint, complementary and competing. This way a set of principles and their relevance for certain conditions will be illuminated. For simplicity reasons we will at this stage assume that the public goods are not relational, i.e., they can be individually supplied, and that the farmers' objective function is to maximize profits.

Thereafter, we will enrich the analyses by first looking at a situation where the public good exhibits relational characteristics – especially the case where the value of the good depends on choices made by more than one farmer. Second, we will evaluate the effect of other objectives than profit maximization. We will close the chapter by assessing some public finance impacts and implications on the design of policies to provide public goods.

Our aim is not to present the optimal solution, nor do we claim to know what the optimal solution is. That would demand knowledge far beyond what is attainable, at least at this stage, with respect to the public priority of different goods, and the technical relationships between their provision.36 Instead, our priority is to clarify important mechanisms and highlight some considerations that need to be made when choosing polices.

6.2 Policy Instruments when Private and Public Goods are Joint

Suppose that the production of the public good is joint with the production of the private good. Under free trade the provision of the public good then depends on the competitiveness of the sector producing the private good. As indicated in Chapter 2, this will rarely be optimal. In a country whose agriculture is internationally competitive, one may not need any

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36One may ask if sufficient data ever will be available for such an analysis to become possible.
specific policy concerning the jointly produced public good as the private good is produced irrespective of any support. Consequently, the public good is "automatically" produced. This is, however, the conclusion only as far as the public good provision following from the size of the private good production is sufficient. In a country where national production of the private good is not able to compete with imports, the situation may be different. A decline in the production of the private good may then lead to sub optimal levels of the public good. The latter situation is pertinent for Norway (and many other countries with high production costs in their agricultural sector). We therefore look more closely at the latter situation.

In general, we can formulate the following welfare maximization problem in a situation where private goods \( y \) and public goods \( z \) are involved. We presume that \( y \) can be produced both domestically and bought on the world market, while \( z \) has to be produced domestically:

\[
\text{max } U = U(y, z) \tag{6.1}
\]

subject to:

\[
y = y_n + y_i \tag{6.2}
\]

\[
\overline{C} \geq C(y_n, y_i, z) \tag{6.3}
\]

where:

- \( U \) is social welfare
- \( y \) is a private good
- \( y_n \) is the amount of the private good produced nationally
- \( y_i \) is the amount of the private good available on the world market
- \( z \) is a public good
- \( \overline{C} \) is the resource restriction
- \( C \) is the cost function

In a situation with joint production of \( y \) and \( z \), we have:

\[
z = z(y_n) \tag{6.4}
\]

as equation 6.3 is properly reformulated to:

\[
\overline{C} \geq C(y_n, y_i) \tag{6.5}
\]

This gives the following Lagrangian:

\[
\mathcal{L} = U(y_n, y_i, z(y_i)) + \lambda [\overline{C} - C(y_n, y_i)] \tag{6.6}
\]

with the following first order conditions for the strict cost equality related to \( y_n \) and \( y_i \) respectively:
\[
\frac{\partial \pi}{\partial y_n} = \frac{\partial U}{\partial y_n} + \frac{\partial U}{\partial z} \frac{\partial z}{\partial y_n} - \lambda \frac{\partial C}{\partial y_n} = 0
\]

\[6.7\]

\[
\frac{\partial \pi}{\partial y_i} = \frac{\partial U}{\partial y_i} - \lambda \frac{\partial C}{\partial y_i} = 0
\]

\[6.8\]

Assuming the private good (private good components) \(y_n\) and \(y_i\) to be of equal quality and a world market price \(p_{ym}^w = \frac{\partial C}{\partial y_i}\) that is inelastic with respect to demand from the country we are looking at, we get the following condition by rearranging [6.7]:

\[
p_{ym}^w + \frac{1}{\lambda} \frac{\partial U}{\partial z} \frac{\partial z}{\partial y_n} = \frac{\partial C}{\partial y_n}
\]

\[6.9\]

or

\[
\frac{1}{\lambda} \frac{\partial U}{\partial z} \frac{\partial z}{\partial y_n} = \frac{\partial C}{\partial y_n} - p_{ym}^w
\]

\[6.10\]

which means that at the optimal production level the scaled\(^{37}\) marginal utility of \(z\) equals the difference between the marginal costs of producing \(y_n\) and the world market price of \(y\).

How can this be obtained? To answer this question we need to consider the farmers' objective function. At this stage we assume that the farmer maximizes (expected) profits. Simplifying equation [5.1] in terms of policy options, and by assuming one farmer we get:

\[
\text{max } \pi = p_y y_n + p_z z - C(y_n, z)
\]

\[6.11\]

where \(p_y\) is the price the farmer obtains for the private good \(p_z\) is the price (payment) the farmer obtains for the public good

Substituting equation [6.4] into [6.11] and differentiating, we get the following optimality condition with respect to \(y_n\):

\[
\frac{\partial \pi}{\partial y_n} = p_y + p_z \frac{\partial z(y_n^*)}{\partial y_n} - \frac{\partial C}{\partial y_n}
\]

\[6.12\]

From equation [6.10] we see that will be equality between the social and private optimum if:

\[
p_y = p_{ym}^w, \quad p_z = \frac{1}{\lambda} \frac{\partial U}{\partial z(y_n^*)}
\]

\[6.13\]

where \(y_n^*\) is the optimal amount of \(y_n\).

This means (i) that the price of the private good should be at the level of world market prices, and (ii) that there is a public good component that should obtain a price equal to its marginal utility with respect to \(z\) as a function of \(y_n\), where \(y_n\) is at its optimal level. It follows from the assumptions than one only needs to pay via the private good \(y\). If the public good is

\(^{37}\lambda\) is to be interpreted as the shadow value/marginal utility of income by which utility is scaled.
observable, one could also pay directly for the public good component. This, however, results in a welfare loss due to the extra transaction costs of such a payment.

Figure 6.1 illustrates these results from producing the private good nationally. The upper part of the figure (part I) shows total costs and gains at sector level. \( TU_{yn} (wm) \) denotes total utility from producing the private good measured at world market prices. \( TC_{yn} \) is the total costs accompanied with that production in our country. Finally, \( TU_z \) depicts the total gain from providing the public good \( z \) when it is jointly produced with the private good.

\[
\begin{align*}
TU_{yn} (wm) & \quad TC_{yn} \\
TU_z & \quad TU_{yn} (wm)
\end{align*}
\]

**Figure 6.1:** Optimal pricing in the case of joint production of private and public goods.

The lower part of Figure 6.1 (part II) gives a principal depiction of the marginal values. While the marginal utility of \( y_n, MU_{yn} \), is constant at world market price \( P_{ym} \), marginal costs, \( MC_{yn} \), are increasing. Marginal costs of producing \( y \) is below world market prices only up till \( y' \), as the country's agriculture is not very competitive in the production of \( y \). With no additional measures, production of \( y_n \) will be \( y_n' \). This is, however, not optimal. There is a region to the right of \( y_n' \) where the marginal income from the production of \( z, MU_z \), is greater than the separate loss following the production of \( y_n \) \( (MC_{yn} - MU_{yn}) \). The combined marginal utility
from producing both $y$ and $z$, $MU_{y,n,z}$ (i.e., $MU_y + MU_z$), crosses $MC_y$ at $y^*_n$ (to the right of $y_n^*$). This is the optimal level of production considering the joint effects of $y_n$ and $z$. The accompanying total value of $z$ is $V_z^*$. If the farmer meets a price equal $p_2 (= p_y^{wm} + p_z)$, she will produce the optimal amount of $y_n$.

Whether this increase ($p_z$) should take the form of an import levy or price subsidy over the state budget depends partly on the character of the public good and the distortions attached to the financing instrument. The latter will be discussed later. Further, since both production costs for the private good and the value of the public good most probably vary between regions, it seems reasonable to differentiate production prices also within one country. This tells us that at least some of the payment for the public good component needs to be paid for from public funds.

Following the analyses of Chapter 3, there are in our view three domains where the concept of jointness seems to be of special relevance. That is food security, food safety and rural concerns.\textsuperscript{38} In the case of food safety – biosanitary status – trade may introduce different types of risks. Thus, the collective good is directly attached to the volume and quality of national production. This is an argument for using import levies. Håkonsen (1999) reaches the same conclusion by viewing diseases following imports as a negative externality. He proposes an import levy as a way of internalizing potential environmental costs attached to imports. As far as food security is also enhanced by the existing level of food production (Chapter 3), a parallel argument of jointness and policy is valid.

Turning to rural concerns, important links also exist to the production volumes as is illustrated by the multiplier effect. Since other industries may replace agriculture in producing local activity, we do not consider the employment a unique responsibility of agriculture. We have already presented two comments to such a conclusion. First, the issue of uniqueness is also an issue about at which geographical level one makes the policy assessment. Second, when comparing the costs of job creation one must compare at the margin - i.e., correct the analyses for the whole range of different functions or values that are attached to the different industries.

\textsuperscript{38}Food security, food safety and rural concerns are all joint to aggregate domestic production levels. To the extent these are secondary, this implies that the costs of any domestic price supports above what is found optimal to reach the primary roles of agriculture in terms of these three objectives are a matter of the costs.
As indicated in Chapter 2, jointness may not exist in fixed proportions. Ranges of substitution will probably exist in most cases. These may vary from the insignificant to being of specific importance for the resource allocation. In such cases it may be reasonable to direct some payment or restrict some alternative resource uses so that the more desired outcome concerning the public good can be reached. Again, the issue from an efficiency point is the tradeoff between precision and transaction costs. The larger the ranges of substitution are and the more valuable the public good at stake is, the greater is the need for some measures directed towards the public good.

The value of the public good component attached to food production depends – at least partly – on the type of production methods undertaken. This means that even in a case where the links between production of private and public good are very strong, it will probably be desirable to link (some of) the payment to requirements about production methods, resource conservation, etc. Ways of designing such payments are discussed in more detail in Section 6.3. Again, the attached increase in transaction costs must be part of a final evaluation. Still, we believe that there are gains to be captured here.

Price supports will under any circumstances be only a part of the policy. Thus, one has to take into account which other measures that are suited to obtain other goods like landscape values and other cases where the relationships are more of the complementary or competing characteristics. We will turn to these issues in the next section.

### 6.3 Policy Instruments when Private and Public Goods are Complementary or Competing

The social welfare maximization problem is principally the same irrespective of whether goods are joint, complementary or competing.\(^{39}\) This implies also in this case that the principal still seeks to maximize an expression like [6.1]. The difference between the formulation used in the previous and here is that the principal's policy instruments are expanded. This corresponds to the formulation in equations [5.1] and [5.2] from Chapter 5.

To simplify the presentation we therefore only restate the agent's optimization problem. This corresponds to the following expansion of equation [6.11].

\(^{39}\)Some of these additional policy instruments may, however, be more relevant in situations where production is complementary or competing.
\[
\left\{ \begin{array}{l}
\text{Max} \\
y, z, \theta
\end{array} \right\} \pi = (1 + \Delta) p_y y + p_z z + p_z \tilde{z} - C_{\theta}(y, z) - I_{\theta} + a + LS \geq \pi \quad [6.14]
\]

where

- \(\Delta\) denotes a commodity price subsidy,
- \(p_y\) denotes a vector of commodity market prices,
- \(y\) denotes a vector of market (private) commodities,
- \(p_z\) denotes a vector of direct payments for public good attributes,
- \(z\) denotes a vector of public good attributes,
- \(p_z\) denotes a vector of indicator based payments,
- \(\tilde{z}\) denotes a vector of indicators over public good attributes,
- \(C_{\theta}\) denotes a cost function for technology \(\theta\),
- \(I_{\theta}\) denotes the additional investment needed for technology \(\theta\),
- \(a\) denotes a per hectare area payment,
- \(LS\) denotes a lump sum transfer, and
- \(\pi\) denotes the producer’s reservation profits.

In the next sections these policy instruments will be discussed successively in more detail.

### 6.3.1 Price Supports

Price supports are of particular relevance in countries where the costs of agricultural productions are high. Even in the case of complementarity in the production, price supports could be part of an efficient agri-environmental policy. Suppose that the relationship between a private commodity, \(y\), and some public good attribute, \(z_1\), is of the form depicted in panel A of Figure 2.14 in Section 2.3.3. When it is costly to monitor the public good attribute, the standard deviation of the probability distribution is small and the probability distribution is skewed towards the frontier, a correctly set price support could increase the provision level of \(z_1\). In that case it would meet the necessary RAM criteria. There are, however, three potential caveats from such a policy.

1. It may not lead to any significant increase in the provision level of the public good attribute for two reasons:

   - The price support on the private commodity provides no incentives for increasing the production of the public good attribute. Any increase in the provision of the public good attribute would therefore be a by-product of the increase of the private commodity. Moreover, it would depend on how the distribution of the public good attribute changes with increased levels of the private good.
An increase in the supply of the public good would come as a result of the "income effect" (an outward shift in the production possibility set) that is larger than the substitution effect.

(2) It could increase the quantity of \( y \) beyond the social optimum. This problem may be reduced if the price to consumers is set in the market. A supply increase will then lead to a drop in the market price until the commodity market equilibrium is restored.

(3) Suppose that there is some other public good, \( z_2 \), that also is closely linked to the production level of \( y \), but that this relationship is of type B in Figure 2.15. This could imply that less of the second public good attribute would be provided. The overall welfare implication of these changes (a possible increase in the first public good attribute and a possible decrease of the second public good attribute) depends on the relative values and magnitudes of the change in the provision levels for the two public goods in hand.

### 6.3.2 Direct Payments for Production of Public Good Attributes

Direct incentives is one of the nice features of payments for producing public goods. This is particularly important if the relationship between goods and attributes is better described by a production possibility area, rather than through a functional relationship. To see this consider Figure 6.2. There, a grand production possibility frontier resembling panel C of Figure 2.15 is recaptured with three different initial allocations (marked by a dark point, \( \bullet \), and the initial relative price line marked by a thin dotted line) for two goods, \( y \) and \( z \). The placement of the dot indicates the production possibility set with the least associated costs. Also assume that at the initial allocation there is too little provided of \( z \).

In panel A the initial location is such that a change in the relative price alone in the favor of \( z \) (no income increase) is likely to induce the desired changes and increase the provision level of \( z \) at a minor expense of \( y \). As the initial allocation and allocation \( A \) are on the same production possibility frontier, such a move is also welfare enhancing under the assumption that there is too little provided of \( z \).
Figure 6.2: Initial allocations and the effects of direct payments for \( z \).

In panel B a slight increase in the relative price on \( z \) and a reduction in the price of \( y \) to offset the income effect leaves the producer within the same production possibility set, and only leads to a minor increase in the production of the public good. Here, an increase in the budget coupled with the right incentives could lead to an allocation close to \( B \), which would mean a clear increase in the public good provided. A side effect of this is also an increase in the amount of the private good provided. The main point in panel B is that the potential gains from a change in the relative price in favor of \( z \) and with an offsetting price decrease on \( y \) is likely to be minor. The reason for this is that the initial allocation is close to the GPF in an area on the GPF where \( y \) and \( z \) are likely to be complements in some other production possibility set.

Panel C depicts a situation that in principle resembles that of panel B. The principal difference is that while in panel B the distance from the initial allocation to an apparent complementary region of the GPF is small measured in terms of \( z \), the converse is the case in panel C, i.e., the distance in \( z \) is relatively large, and the slope of the GPF suggests a competing region. Thus, in panel C one gets a reasonably large change from a relative price change in favor of \( z \), but the potential gains from facilitating a shift to another production possibility set are promising. To induce such a shift income also needs to be increased.

The feasibility of direct payments depends crucially on the observability of the public good. Using the RAM terminology, this corresponds to informational feasibility. However, for the allocation resulting from a direct payment to be a candidate for welfare maximization, the same allocation cannot be achieved at lower informational (transaction) costs. If this is not the case, direct payments constitute an informationally inefficient policy.
Suppose that no other policy achieves the same allocation or an allocation with more of the public good attribute. In a strict sense, direct payments then become informationally efficient. This does, however, not imply that the policy per se meets the welfare criteria. Utilizing the reasoning on transaction costs and precision in Section 5.4, one also needs to compare the marginal benefits and costs of various policies. Provided that precision is not overwhelmingly important and the transaction and monitoring costs are high, it is very likely that some other policy resulting in lower provision levels may be more consistent with the objective of maximizing social welfare.

### 6.3.3 Indicator Payments

The idea behind the use of indicators is that instead of measuring the direct effects, one measures some proxy variables that are closely linked to the policy objective variables. Indicators are of particular interest and relevance whenever it is technically difficult or costly to measure the policy objective variables, or extremely inexpensive to use the indicator instead (Parris, 1999).

The use of indicators carries over to the application of policy instrument(s). Instead of paying directly for the desired public good attributes, payments are made on the indicator. The desired effect on the policy good attributes then depends on how strong the linkages are between the indicator variables, \( z \), and the policy goods, \( z \). Reduced transaction costs by switching from direct payments on the indicator variables may justify a loss in precision.

### 6.3.4 Input and Production Method Subsidies

The rationale for subsidizing certain inputs or production methods from an environmental perspective is that there exists strong linkages between the input used or the production methods applied. Examples of such payments include per hectare payments for certain productions, additional supports for ecological farming or payments per head of certain animals (like grazing sheep and cattle). Again, reduced transaction costs need to be compared with any losses in precision in the policy.

Per hectare payments for certain productions or production methods increase their relative profitability. Whenever it is technically difficult or prohibitively costly to directly observe the environmental attributes, indirect payments like acreage schemes may be justifiable. Clear
parallels exist to the issue of nonpoint source pollution in agriculture, where the costs of monitoring nutrient runoffs from individual farm fields render taxes on perceived polluting inputs or on polluting agronomic practices viable policy options.40

Payment per head of grazing animals is a particular type of support aimed at increasing the amount of grazing in marginal areas when grazing is presumed to have a positive effect on biodiversity or the public's perceptions of the landscape. It should be noted that there is a marked difference in per head payments and price supports on the amount of meat produced from grazing animals. The environmental performance of this policy is strongly linked to how well targeted these payments are. Alternate, and in some cases more direct schemes, include subsidies for fencing of abandoned pastures and meadows, thereby reducing the costs of utilizing such areas again.

A common feature of all these schemes is that they change the costs associated with certain physical production possibility sets. This increases the likelihood that farmers adopt agricultural practices or expand activities where the production of some public goods is enhanced.

6.3.5 Index Payments

Index payments come in various forms. The basic idea behind index payments is that one chooses a set of observable indicators and assigns weights to these points. The payment received by the farmer is then directly linked to the index score. Nuppenau (1999) has investigated the applicability of such payment schemes. His preliminary results indicate some promising features, provided that sufficient clear incentives can be linked to such schemes.

The primary difficulty with such schemes is that if only the total number of points matters, and not their allocation along the various attributes, unfortunate mismatches between individual agents' cost structures and environmental objectives (the point scheme) may lead to unintended effects on resource allocation. This is of particular concern when goods are relational (cfr. Section 4.2).41 One way of safeguarding against this type of partial fulfillment is to

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40 Braden and Segerson (1993) contains a theoretical discussion. Several articles in Romstad, Simonsen and Vatn (1997), and Vatn et al. (1997) contain assessments of costs and environmental performance of such schemes, and suggestions for alternative solutions.

41 This corresponds superadditivity that has been observed in willingness-to-pay responses when several environmental objectives where met at once (Bergland, 1994; Klynderud, 1994).
provide additional points if several objectives are met. We will return to this issue in Section 6.4, where relational and complex goods are analyzed more specifically.

6.3.6 Lump Sum Transfers
A lump sum transfer is the least cost way of maintaining the profitability in a sector where reduced profitability may cause agents to exit production. However, such payments provide no incentives for changing the production methods, nor do they change the costs of the production possibility sets. Unless linked to some condition that the land is to be farmed or maintained, such payments are unlikely to provide any supply responses in terms of the provision of public good attributes.

In a multifunctional setting one may also question if there exist neutral lump sum transfers, i.e., payments that have no allocative effects. This follows directly from the participation constraint. Such effects are reinforced if farming, in addition to being a job, is a life style. Consequently, income effects cannot be ruled out.

6.3.7 Cross Compliance Payments
Cross compliance payments are contingent on certain physical measures or practices being followed. Farmers can choose to participate in such programs or not. Any farmer choosing to participate voluntarily subjects him-/herself to a set of regulations for which he/she receives a compensation.

From a theoretical perspective cross compliance has some interesting properties. Those who voluntarily subject themselves to a cross compliance scheme do so because their expected profits from participating exceeds the expected profits from not doing so. Conversely, if the expected profits from non-participation exceed the profits from participation, the farmer chooses not to participate. This implies that the farmers with the least costs of complying with the regulations are more likely to sign up. The parallels to menu based systems are clear, with one equivalent result – separating equilibria. Under certain conditions separating equilibria are welfare enhancing (see Rotchild and Stiglitz (1976) for an overview). In particular, note the condition that for separating equilibria to be sustainable, there can be no more than one principal.
Consequently, cross compliance may be a cost reducing strategy to meet certain policy targets. Cross compliance programs can easily be tailored to specific regional needs, or designed to induce that a minimum level of some public good attributes is provided. Flexible and targeted compliance programs fall on the borderline between policies for the everyday landscapes and landscape preserves, utilizing contracts. This opens up for a wide array of policy options, including auctions to make farmers provide the desired public goods at the least costs. The disadvantage with such schemes is that the transaction costs may exceed the gains from having the least cost providers sign up.

6.4 Relational Goods, Complexity and Coordination Issues

6.4.1 General Aspects
So far we have to a large degree simplified the analysis by assuming no interrelationships between the value or quality of various public goods – be it different goods produced by the same farmer or the same good from different farms. We shall now explore cases where such connections exist.

Many of the public goods attached to agriculture are relational – i.e., the value of one good or element depends on the level and form of another. This type of superadditivity is observed in contingent valuation experiments where several environmental objectives were met simultaneously (Bergland, 1994; Klynderud, 1994). It poses some extra problems for policy making – both related to defining and demarcating the good and to find appropriate policy instruments. The challenges involved here are in our mind especially important for landscape issues.

Concerning the definition of this class of goods, we have earlier distinguished between biological diversity, cultural heritage, amenity values, recreation and scientific or educational aspects. First of all, the value of each of these goods depends to a greater or lesser extent on the quality of the other. Second, each group is in itself composed of various elements that gain some of their value through the specific mix with other elements within the same group. When formulating policy instruments one must thus take into account effects at different scales and the high complexity that these interrelationships imply.
In principle we encounter three problems in this field when formulating a policy. First, it will be more or less impossible to formulate a payment scheme for each element and secure consistent incentives across all combinations of good configurations. Second, since many of the landscape values are created or appear at a higher level than the farm, coordination between farms is needed. Third, we do not work in a fixed setting. What is considered a nice landscape, etc. will change over time. Thus, one also needs to secure incentives for the more innovative aspect of the problem that do not obstruct desired changes. Otherwise, the policy will get an increased character of mere conservation as time passes. Conservation is an important aspect of landscape management, but not the only one.

As previously pointed out, a system of index payments with additional points if more objectives are met simultaneously, may be a way to handle this, at least at the level of the individual farm. Still, there are problems with such point schemes since the relational aspects are not so much linked to the amount of various elements as it is related to the specific mix or physical combinations. Further, the huge degree of local variation – which may be a goal in itself to conserve or develop – may also limit the value of this method. This implies that what is a good solution for one farm or a specific part of that farm, is of little value under other conditions.

6.4.2 Management Contracts and Education

In situations like those described above, it seems appropriate to consider policy packages containing one or both of the following elements:

(a) a management contract
(b) an educational package, including activities promoting local dialogue.

As indicated above, we find these types of measures most relevant for landscape values. They may – however – also play some role in securing goals attached to food safety and food security – i.e., in achieving certain standards concerning production method, food quality, etc.

The idea behind the contracts is to define a set of goals or rules concerning landscape conservation and development, agronomic practices, etc. that the farmer must abide by to get a certain payment. This payment can be formulated as a separate premium following directly from the contract – i.e., a kind of direct compensation for public goods provision (in that
respect parallel to the proposal in Section 6.3.2). It may also take the form of a cross compliance scheme (section 6.3.7) – i.e., that the attainments of other supports are dependent on the fulfillment of the contract. This may in principle be both acreage supports, per animal supports, price supports or per farm supports.

The costs of this system – i.e., transaction costs – depend on the degree of detail that is or has to be put into the contract and the subsequent need of control. An accompanying educational package and the creation of local fora for landscape development will reduce the needs concerning both detail and control. The idea is to create a process where farmers learn about the values involved. This includes:

- awareness on what is considered good practices,
- awareness of their own attitudes, and
- participation in the development of a management plan for the public good resources of their own farm that forms one of the bases of the final contract.

To the extent that certain agronomic practices are important and/or simplify the attainment of public goods provision – such requirements could be formulated. They are important in reducing the transaction costs. Creating increased understanding for the challenges involved and creating new norms or ideals may directly facilitate the process in itself and reduce the need for external control.

In Section 6.3.7 on cross compliance we focused on the system of voluntary cross compliance schemes and their capacity to create separating equilibria. If the quality of public goods depend on the choices of farmers as a group – i.e., those being part of the same landscape – the menu of contracts that farmers are offered need to take account of this.42 Whenever the value of the project increases the more farmers who sign up for it, this needs to be mirrored in the formulation of the contracts. The punishment or payment necessary for reaching the required participation can take different forms. A strong measure is to require management contracts for getting the right to farm.

It is the complexity of the goods and their relational character that form the basis for the problem studied here. Thus, it is again a reasoning around the trade-off problem between

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42 This complicates the specification of the menu of contracts.
precision and transaction costs. We see no way to obtain necessary precision at an acceptable level of transaction costs that do not in some way involve the active participation and commitment from the farmers' societies. Creating this social environment thus becomes crucial, and will most probably limit the available policy options.

6.5 Other Behavioral Assumptions

Expanding the analyses to other behavioral assumptions, the reasoning will be more general than the ones conducted under the assumption of profit maximization. We will just highlight some possible policy implications of changing the behavioral assumptions.

6.5.1 Utility Maximization

Let us reformulate the farmer's objective function to the following utility optimization problem:

\[ U = U(k, z) \]  \hspace{1cm} [6.15]

subject to:

\[ p_y y + p_z z - p_k k - C(y, z) = 0 \]  \hspace{1cm} [6.16]

where: \( U \) denotes the farmer's utility

\( k \) is ordinary consumption good(s)

\( z \) is public good produced by the farmer

\( p_y \) is price on the private good

\( y \) is the private good produced by the farmer

\( p_z \) is the price (payment) for the public good produced by the farmer

\( p_k \) is the price on the consumption good

\( C(y, z) \) is the cost function of producing \( y \) and \( z \) for the farmer

The farmer's utility depends on consumption good(s) and the quality of the public good the farmer herself produces. The budget constraint [6.16] restricts expenditures such that they are equal to incomes. To simplify, the private and public goods are competing in resource use. The results to be shown here are (mainly) independent of the assumed relationships concerning jointness, complementarity, etc.

The above formulation represents a gross simplification, but still it provides some useful insights on changes caused by modeling a farmer's decisions based on utility instead of
profits (Appendix I contains a more complete model). Elaborating on the above model, we obtain the following expressions:

\[ \frac{\partial U}{\partial k} - \lambda p_k = 0 \]  
\[ \frac{\partial U}{\partial z} + \lambda \left[ p_z - \frac{\partial C}{\partial z} \right] = 0 \]

[6.17] is equivalent to standard consumer theory; in optimum the (scaled) marginal utility of the consumer good equals the price. What is important here is [6.18]: In the optimum derived from profit maximization we have that marginal profit equals zero, i.e.:

\[ p_z = \frac{\partial C}{\partial z}, \quad \frac{\partial \pi}{\partial z} = p_z - \frac{\partial C}{\partial z} = 0 \]

If the farmer's marginal utility of the public good is positive when profit maximum is reached, [6.18] demands this marginal profit to become negative. It must further equal the (scaled) marginal utility of consuming \( z \) in absolute terms. This is intuitively easy to see. If the farmer obtains utility from consuming the public good, she will produce more of it than we would expect from a profit maximizing model. The opposite also holds, i.e., if the farmer does not like to consume the good she is paid to produce, she will produce less of it.

Continuing with the case where the farmer gains utility from the public good, we also find (with reasonable assumptions) that the supply of \( z \) will increase (decrease) with an increase (decrease) in income, i.e., the income elasticity is positive. Appendix I also shows that the total effect on supply is larger for an increase in \( p_z \) than an increase in production independent income.

Farmers and the general public may value various public goods differently. As already indicated, some goods that are highly valued by the public are not valued positively at all by the farmers or the farmers' communities\(^{43}\). If negatively valued, the effect will be the opposite of what is expressed above.

Living in the country side, the farmers not only consume the public goods like the landscape they produce on their own farm. They also have interests in what other farmers do. If the public good is relational, in the meaning that the actions of one farmer influence the value of the choices of another, this mutual interdependency increases. We believe this to be an important force behind the development of local norms concerning what is perceived as good

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\(^{43}\) The reintroduction of large predators in parts of Norway is a prime example of such a value conflict.
landscape conservation, nice buildings, etc. By emphasizing this we move ourselves into a "third landscape", that of norm based behavior.

6.5.2 Norm Based Behavior

As emphasized in Section 5.3.2 behavior is also driven by considerations concerning what is appropriate behavior. Within this understanding, conduct is a result of social processes where identification plays an important role. Following the terminology from Section 5.1, this implies that the participation constraint is expanded (from only containing income or utility) to embody certain qualitative aspects of the occupation in mind. This may also have important implications for policy evaluation.

In general, the literature on "crowding out" shows that if the policy instruments used do not fit people's own understanding of the problems at hand or their values, they may tend to follow what they consider right rather than what pays the most (Frey and Oberholzer-Gee, 1997). Being in such a conflict, they may also turn to other arenas, other things to do, etc. Certainly, the reaction will be conditional on the size of the discrepancy and the type of problem involved.

Farming communities have been strongly oriented towards food production. This focus has actually increased over the last 50 years as food production has become a more specialized undertaking. These societies have developed a lot of identities and norms related to what it is to be a "good" farmer. High yields, good standing of the crop, and animal care are examples of attributes of a "good farmer" (Vedeld et al., 1998). These are agronomic values that have a strong position in the farming communities, even though the focus may vary substantially even across a country like Norway. We know the very "productivist" orientation of the Jæren farmer, while the farmer of the mountain regions of central Norway has a different attitude with less emphasis on high yields and large production (Vedeld, 1997).

In a situation with strong professional identities, it may not be simple to change farmers' behavior from mainly being a food producer to becoming a producer (also) of public goods – at least if these goods do not conform well with the existing way of producing food and fiber. Let us use direct payments for landscape goods as an example.
The point is that farmers may react negatively to the implicit change in identification. More specifically, such a policy change conflicts with farmers' notions of what it is to be a farmer. The partial effect of this is that they will deliver poorer public goods than otherwise expected. Certainly, being a good farmer may involve some claims on landscape conservation – especially related to some types of resource conservation and aesthetic aspects. Thus, the conflict may only be partial. Still, it is easy to imagine ridiculing or sarcasm over certain policy objectives in the list of public goods presented here. The same will be the case with certain types of payments. We believe that the more bureaucratic forms of payment that are used – i.e., involving much paper work and control – the lesser the acceptance.

Two different strategies can be utilized to counteract this. First, one can try to offset the expected delayed response by strengthening the orientation of the policy even more towards the public goods than otherwise thought necessary. Second, one can look at certain mitigating strategies.

We view the first solution alternative as difficult – it just increases the basic problem of identification. It is not at all certain that strengthening the external signals reduces the negative reactions. The effect may instead be opposite. Issues related to appropriateness is difficult to overcome just by instrumental measures – i.e., just by paying enough (the "crowding-out effect").

The second option may consist of at least two elements that may even reinforce each other. First, the kind of processes proposed in Section 6.4 around the establishment of management contracts – information and local engagement processes – may help both explaining the values involved to farmers and change identifications. Second, we find that there are many possibilities to integrate production of private and public goods better. These options should be utilized to ease the transformation. What we have in mind here, is that the conflicts between the various good components as described in Chapter 3 will vary substantially between practices and intensities. Thus, it should be possible to restructure farming towards becoming a business focusing on the integration of producing both private and public goods. This may start as a compromise with the existing farmers' societies and values, and end with a considerable change in identification of what it actually is or has become to be a farmer.
The potential inherent in this integrative perspective depends on the degree of conflict between the different goals and the technological solutions available to find good compromises. To evaluate this, one needs insights into both production possibilities and costs that go far beyond what can be studied in an analysis like ours. Still, it is an important field for future research.

Given existing knowledge and the character of the problem, it is difficult to be very precise about the use of instruments to obtain integration. This perspective adds two dimensions to the previous analyses of instrument use: Partly it is a question of technological research that can help reduce the conflicts between private and public goods provisioning. Partly, one will need some types of restrictions on the types of practices that are allowed - restrictions that represent good compromises between the various goods involved. Again the management contract seems to become crucial. Complexity and transaction costs make it improbable that reasonably good solutions can be reached only through the use of prices or payments.

### 6.5.3 Recruitment

The above discussion also pertains to the recruitment issue. This is a concern about expected income, type of payment and various job characteristics. The latter two are both related to the identification processes involved when one enters a certain sector. Ceteris paribus, higher income will yield higher recruitment. This follows from all the behavioral models we have explored (as long as income does not have negative marginal utility). We shall thus not explore that aspect further.

Concerning the role of identification, the arguments made in Section 6.5.2 need to be even more emphasized. You may stay in an occupation even after a perceived negative change in the job characteristics just because you have few alternatives or because it is the best way to secure the value of past investments. In the case of recruitment, the person has more options, and if the person does not identify with agriculture, he will look somewhere else. Thus, recruitment may be much more vulnerable to changes than the adaptations of existing farmers.

This, however, does not necessarily imply that a change towards public goods provisioning will ceteris paribus result in huge recruitment deficits. What is crucial is to what degree potential new farmers hold the values of the existing farmers' communities or socialize
themselves with the values inherent in the new regime. Again this can be influenced by the measures used. Our previous comments on information and integration between private and public goods are even more important in this case. Certainly, one may believe that the more bureaucratic the policy becomes (the more control it involves) the less interesting it becomes to enter the business. Still, we believe that it is foremost the status of the occupation and its various products in society at large that counts the most for the identification.

6.6 Public Finance Impacts and Implications

Payments for public goods generally comes out of public funds. From the literature on public finance it is well known that the marginal costs of public funds (MCPF) exceeds one (see Goulder, 1997, for more details). In some of the previous sections we have pointed to the efficiency losses caused by indirect instruments for providing public goods. This particularly relates to paying for the public good, \( z \), through the prices on the private good, \( y \), as this causes distortions in the secondary markets. From such a perspective, direct payments – whenever possible – for the public good are preferable.

However, in deciding between the cost of using policies (distortions in secondary markets, imperfect incentives, etc.) one must also consider the inefficiency wedge that is created by using public funds when the MCPF exceeds one. In principle, the cost efficient policy mix occurs where the marginal social costs of all policies are equal. There are also fixed costs tied to using some policies, these fixed costs are added to shift the marginal social costs of policies. Figure 6.3 provides an illustration.

\[\text{In a presumed well organized society like Norway the marginal costs of public funds is around 1.3, i.e., it costs 1.3 NOK to produce public services worth 1 NOK. If the administrative structure is less efficient – as is commonly assumed about developing countries – the marginal costs of public funds could be much higher (2-3 is not an unusual estimate).}\]
The curves, $MSC_A$, $MSC_B$ and $MSC_D$ depict the marginal social costs of using the respective policy. The vertical shift along the marginal social cost axis on policy $D$ denotes the fixed costs of starting to use that particular policy. The horizontal line, $MC$ shows the targeted level of marginal costs. At the levels of the policies $A^*$, $B^*$ and $D^*$ the marginal social costs of the three policies are equal, i.e., a candidate for the optimal mix of policies.

As there are sizable fixed costs of using policy $D$, the overall costs of using this policy is the total of the two areas. The question is if policy objectives still can be reached and cost savings can be achieved by not using policy $D$. Suppose that a small increase in the extent of polices $A$ and $B$ makes policy $D$ redundant. Figure 6.4 depicts this situation.
In Figure 6.4 a minor increase in the use of policies $A$ and $B$ makes policy $D$ redundant, i.e., the optimal extent of policy $D$ is $D^{**} (= 0)$. The increase in the use of policies $A$ and $B$ increases their marginal costs from $\overline{MC}$ to $\overline{MC}^*$. This increases the total costs of these policies by the light shaded areas $A^*$ to $A^{**}$ and $B^*$ to $B^{**}$, but saving all of the shaded areas in $D$.

To sum up: the \textit{marginal costs of public funds} makes it optimal to use other policies (like tariffs) that do not increase public expenditures to the extent that the $MCPF$ exceeds the marginal social costs of other distortions.
7 Discussion and Conclusions

This report deals with issues related to simultaneous production of private and public goods from agriculture, the so called *multifunctional agriculture*. The concept of multifunctionality incorporates many goods or aspects. Further, the relationships between the various goods, and between the production of different public goods and agricultural commodities are diverse. Note the following two interrelated trade-offs:

(A) First, we have the trade-off between public goods that are complementary or competing with the production of private goods, versus relationships that are joint.

(B) Second, we have the trade-off between precision and transaction costs.

Point (A) concerns balancing the use of price supports for private goods and securing the desired supply of public goods that are jointly produced together with the market commodities. This includes taking into account the potential negative effects of price supports on the attainment of other public goods. These tradeoffs are particularly important in countries where the domestically produced agricultural commodities are not internationally competitive. More specifically, increasing the production of public goods by increasing commodity production through commodity price supports tends to increase input intensity. Increased intensity tends to increase the level of pollution, and may also have adverse effects on the capacity to provide public goods.

Figure 7.1 (next page) illustrates this trade-off problem. The upper panel (I) shows marginal costs for producing the private good \( y \). Panel (II) shows a public good \( z_1 \) (like food safety) that is jointly produced with \( y \). In panel III the production possibility frontiers for a good \( z_2 \) (like a landscape good) exhibit complementary or competing relationships with the private good. Finally, panel IV shows a situation for a good \( z_3 \) that is competing with the private good in the whole range (e.g., water quality caused by pollution). *Figure 7.1 only highlights the principal effects. To draw any conclusions regarding the magnitudes involved, one needs data that currently are not available.* Remember also that the \( z \)'s are measured in different physical units.
In the figure direct payments for $z_2$ are kept constant (at a low level). Starting out with a low product price $p_l$ – for example the world market spot price – the corresponding levels of the public good are $z_1^l$, $z_2^l$, and $z_3^l$. To increase the supply of $z_1$ one may raise the price of $y$ to $p_h$, implying an increase in the supply of $z_1$ to $z_1^h$. Reduced levels of $z_3$ is the price one has to pay for obtaining increased supply of $z_1$. The effect on $z_2$ is more complicated to assess since it depends on the relative magnitude of the income and substitution effects. This magnitude may vary from one situation to another.\textsuperscript{45} Still, paying for $z_2$ through direct payments will generally result in the desired effects as the substitution and income effects work in the same direction. That also has to be taken account of in the total evaluation.

Concerning the trade-off problem between $z_1$ and $z_3$ (Panel IV) a theoretically well merited solution is to combine price supports with environmental regulations like emission taxes. Such a multiple instrument would create the incentives for the farmers to produce the private good ($z_1$) with less negative impacts on the public good ($z_3$). Finding the desired solution entails considering the net effect of the two, not just by considering the negative externality.

\begin{figure}[h]
\centering
\includegraphics[width=0.8\textwidth]{figure7_1.png}
\caption{Various relationships between commodity production and public goods.}
\end{figure}

\textsuperscript{45}Panel III depicts a situation where the substitution effect is less than the income effect. Hence, the amount of $z_3$ may not increase even though the relative price ratio becomes more favorable in terms of producing $z_2$. 

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The problem emphasized in (B) concerns targeting – i.e., the costs associated with keeping a high level of precision. Our study points to two issues in this connection. First, we have the problem of finding good "proxies" to which public good payments could be attached. This is the problem of information costs, monitoring and enforcement issues, etc. These factors may cause high transaction costs. Moreover, the difficulties related to monitoring (verifiability) may reduce the legitimacy of such payment forms from the public's perspective. From the farmers' point of view the administrative work and controls deemed necessary by the public may make such instruments less legitimate. Second, the relational character of many goods produces extra challenges on the payment schemes. One has to account for the mix of different goods produced at each farm as well as the heterogeneity across farms.

The analyses undertaken here have thus yielded two important lessons:

- All interrelationships involved make it necessary to think in systems. Piecemeal strategies are doomed to fail.
- It seems important to try to formulate policies where the conflicts between producing public and private goods are reduced.

Developing an agriculture with larger synergies across different good categories may turn out to be very important in a "landscape of goal conflicts", in particular if high transaction costs are attached to many solutions. This implies a redirection of agricultural practices to make providing public goods a more or integrated part of the business of agriculture itself. Moreover, this requires a focus not only on each good, but also on the production methods themselves – i.e., methods that represent good compromises between the different goods involved. This form of integrating private and public goods may imply changes in the basic perception and role of agriculture.

A policy package to obtain a balanced production of private and public goods when commodity production is not competitive at the international level, will from our analysis need to include:

1. Payments for public goods or positive externalities and taxes (or other regulations) to reduce the extent of negative externalities.
2. The use of regionally differentiated product prices including some import levies.
3. The use of management contracts to further secure the provisioning of public goods.
Concerning the major challenge is to balance high precision with keeping transaction costs down. In some cases it will be possible to pay directly for the public good. However, in many of these instances it will be necessary to find "proxies" (indicators) for the public good or bad to which such payments or taxes can be attached. The use of measures under (1) must be evaluated in close connection with the other aspects we have listed.

Point (2) implies the use of price supports, both budgetary and in the form of import levies. To the extent that the public good is jointly produced together with the private commodity, price supports may have several advantages as long as production costs and public good values vary between locations. The effect of different financial instruments on efficiency and the potential for reduced transaction costs using such an administratively spoken simple measure is also part of our argument. Two lines of reasoning are developed in this study concerning import levies:

− First, if imports themselves inhibit the attainment of a public good, import levies are justifiable even though such levies may create distortions in secondary markets.  
− Second, payments for the collective goods (directly or indirectly) over public budgets instead of import levies or other policies that do not require payment over public budgets, entail additional costs whenever the marginal costs of public funds exceeds one.

Concerning transaction costs, whenever the private and public goods are mainly complementary, indirect payments via the private good may entail less administrative and information costs than paying directly for the public good(s) in question. Again, this will depend on the inferred loss of precision caused by the indirect payments. The relative magnitudes of these "inefficiencies" constitute an empirical matter that is likely to vary from one setting to another.

The proposed use of management contracts in (3) is very central to the above solution. Contracts are likely to be a central instrument to induce production methods or management practices to facilitate public goods provisioning. Thus, the management contract has to define the core features of these methods. Second, it may be difficult to attain the desired precision.

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46 A total evaluation on the use of import levies or other corrective policies also includes secondary market distortions (see Chapter 6 or Haakonsen, 1999).
through the use of type 1 or type 2 measures, in particular when the relationship between the public and private good is multifaceted and complex. Thus, some kind of contract is necessary, especially to define the qualitative aspects of goods paid for under (1).

The final element – the informative part – is important in creating the necessary commitments, insight and positive attitude to the whole redirection of agricultural policy. We do not believe that it is possible to direct all choices in farming with the use of economic, judicial or other technical instruments. Complexity and local variation are far too great for that. Thus, information and the creation of an atmosphere for compliance are important.

The changes in agricultural practices to achieve the desired levels of the public goods may be substantial. Moreover, there will be many possibilities for farmers to circumvent the rules if they want to. Thus, it is very easy to get into a kind of "hide and seek" game between farmers and the authorities. There exists a great potential in the farming communities for redirecting behavior as long as one is able to establish resemblance between farmers' insights and visions, and the goals of public policy. This is maybe the greatest challenge for the future, not least for the farmers' society.

In terms of regulatory policies for obtaining the desired provision levels of public goods from agriculture the following is worth noting:

- Based on the relevant economic theory, any incorporation of positive (or negative) externalities in a multiproduct framework will have impacts in the commodity markets.\(^{47}\) This is even the case for neutral instruments like *conditional lump sum transfers* as most of these transfers lead to changes in economic agents' resource allocation.

- It is not easy to find "optimal" policies when there is geographical variability in the productive capacity of agriculture or when *public goods are site specific*. The primary reason for this is that regulations capturing these effects must vary among regions. Such regulations could therefore have impacts on trade patterns. There are two difficulties involved here:

\(^{47}\)Secondary market effects are often termed distortionary. Regulations that internalize externalities generally cause secondary market effects. In that sense it is somewhat striking that one rarely hears that the term *market distortions* is used when corrections are made for negative externalities. For example, fertilizer taxes reduce nonpoint source pollution as well as commodity production levels.
- defining a legitimate rights structure – i.e., what is legitimate to do for one country taking the interests of other countries into consideration, and
- balancing the optimization of domestic provision levels of public goods vis-a-vis the need for transparent rules for international trade.

The policy challenges in this area are many. At the micro level, multiple and complex relationships, as well as difficulties in observing important public good attributes, like biodiversity, pose a major challenge to natural scientist in terms of providing a better understanding of these issues. The wide extent of relational goods further complicates matters. Insufficient data on how different farmers perceive the notion of public goods makes their response to regulatory policies aimed at public goods uncertain. Together, these factors open for adverse selection and moral hazard problems.

At the national level lack of knowledge, particularly related to the value of several public goods may create problems with regard to policy legitimacy, domestically as well as internationally. On the international arena agreeing on a set of fair and equitable principles for international trade with agricultural commodities is by itself no minor undertaking. The need to incorporate public goods linked to agriculture in this framework pose additional challenges. A failure to do this could result in important public amenities being lost for generations to come.
Appendix 1 The Effects of Utility Maximizing Behavior Compared to Profit Maximizing

As pointed out in the main text, farmers' preferences will affect the production of both private and public goods. Here, we will compare utility maximizing behavior to profit maximizing behavior.

The Effects on the Provision of Public Good

In order to ease the interpretation and exposition of the problem, we will start with a simple as possible model. If we assume that the farmer has preferences over only two types of goods: consumption goods (e.g., food) and some kind of a public good produced at the farm (e.g., cultural landscape, biodiversity, etc.), the objective of utility maximizing farmer may be written as:

\[
\begin{align*}
\max_{k,z} U(k, z)
\end{align*}
\]  

where \( k \) denotes the consumption good, and \( z \) denotes the nonmarketable good produced at the farm.

In addition to income from the production of the public good, the farmer has some exogenous income. This may be a lump sum transfer or it may be income that is not linked to the production of the public good in any way. We also assume that there is no link between production of the private and public good. This is a very restrictive assumption, but it will be relaxed later on. However, this assumption will not affect the conclusions drawn from this simple model, as will be shown later. Given this, income, \( M \), may be written as:

\[
M = p_y y + L_s
\]

where \( L_s \) is a production independent income (lump sum), e.g., acreage support, \( p_y \) denotes the price of the privat good, and \( y \) denotes the private good.

Equation [A1] is maximized subject to:

\[
M + p_z z - C(z) - p_k k = 0
\]

where \( p_k \) denotes the consumption goods price, \( p_z \) denotes the price for the public good, and \( C(z) \) denotes the cost of producing \( z \).

The Lagrangian for this problem

\[
L = U(k, z) + \lambda [M + p_z z - C(z) - p_k k]
\]  

where

\[
\lambda
\]

is the Lagrange multiplier.
First-order conditions for [A3] becomes:

\[
\begin{align*}
\frac{\partial L}{\partial k} &= \frac{\partial U}{\partial k} - \lambda p_k = 0 \quad \text{[A4]} \\
\frac{\partial L}{\partial z} &= \frac{\partial U}{\partial z} + \lambda \left( p_z - \frac{\partial C}{\partial z} \right) = 0 \quad \text{[A5]} \\
\frac{\partial L}{\partial \lambda} &= M + p_z z - C(z) - p_k k = 0 \quad \text{[A6]}
\end{align*}
\]

By solving [A4] to [A6] we may obtain the optimal choice functions \((k^*(p_k, p_z, M), z^*(p_k, p_z, M))\) and \(\lambda^*(p_k, p_z, M)\). Before we go into details about the interpretation of the first order conditions it is worthwhile to give an interpretation of the Lagrangian multiplier \(\lambda\).

At optimum the value of the objective function (the utility function) must equal the value of the Lagrangian. This since the income constraint ([A6]) must hold as an equality. This means that:

\[
U(k^*(p_k, p_z, M), z^*(p_k, p_z, M), \lambda^*(p_k, p_z, M)) = L(k^*(p_k, p_z, M), z^*(p_k, p_z, M), \lambda^*(p_k, p_z, M))
\]

If we now differentiate both sides with respect to \(M\), we get:

\[
\frac{\partial L(k^*(p_k, p_z, M), z^*(p_k, p_z, M), \lambda^*(p_k, p_z, M))}{\partial M} = \lambda^*(p_k, p_z, M)
\]

\[
= \frac{\partial U(k^*(p_k, p_z, M), z^*(p_k, p_z, M))}{\partial M}
\]

In other words, the Lagrangian multiplier \(\lambda\), may be interpreted as the marginal utility of income. In principle it is not possible to sign \(\lambda\), i.e., \(\lambda\) might be negative, zero or positive. However, if we assume that marginal utility of consumption is everywhere positive, then \(\lambda\) must also be positive by [A4]. Positive marginal utility means that \(U\) is non-decreasing in \(k\).

We now interpret the first order conditions: The intuition behind equation [A4] is that the agent will consume \(k\) up to the point where the marginal utility from consumption equals the marginal cost. The marginal cost is the product of the marginal utility of income times the price of the good. The costs represents, loosely speaking, the loss in utility by buying an additional unit of \(k\) via a reduction in income.

Equation [A5] may be interpreted in the same way: marginal utility equals marginal cost. If the farmer is not paid for providing \(z\), i.e. \(p_z = 0\), and there are constant unit costs of production, i.e., constant marginal costs, the interpretation of [A4] and [A5] are identical.

The last first order condition [A6] is just to insure that the constraint holds: cost must equal income.

One of the aims of this appendix is to compare the model above with a model where the farmer is maximizing profit. The objective of a profit maximizing farmers is:

\[
\{\text{Max}_{z}\} \pi = p_z z - C(z) \quad \text{[A7]}
\]

The first order condition:

\[
\frac{\partial \pi}{\partial z} = p_z - \frac{\partial C}{\partial z} = 0 \quad \text{[A8]}
\]
If we now compare [A8] to [A5] we see that [A8] is equal to the term in the brackets in [A5]. If this term is zero in [A5] this means that the marginal utility also must equal zero. This may be the case, either by coincidence or if the farmer has no preferences for \( z \). Normally, the marginal utility of \( z \) is non-zero and [A8] does not hold in the case of utility maximizing behavior. The production of \( z \) can therefore not be the same in the two situations. If we use [A8] in [A5] we end up with:

\[
\frac{\partial u}{\partial z} + \lambda \frac{\partial \pi}{\partial z} = 0
\]  

[A5']

If the marginal utility, the first term, is positive then marginal profit must be less than zero. On the other hand, if marginal utility is negative then marginal profit must be larger than zero. This implies that a farmer that has, loosely speaking, positive preferences for the public good, will provide more \( z \) than a profit maximizing farmer. A farmer that has "negative" preferences for the public good will provide less. Mathematically this is due to the fact that marginal profit is downward sloping in \( z \) (from the second order conditions). See figure A1.

**Figure A1:**
Optimal production of \( z \) under different assumptions. Subscripts denotes partial derivatives, while signs denotes sign of the marginal utility with respect to \( z \).

**Effects of Changes in Income and Price of the Public Good**

Above we showed how preferences affected the optimal choices, but it is also interesting to look at how the supply of \( z \) changes with changes in income (exogenous) and changes in the price of the public good. In the case of profit maximizing, income does not enter into the problem, so the comparative static with respect to income does not exist. Regarding an increase (decrease) in \( p_z \) it follows from the second order conditions that the supply of \( z \) will increase (decrease).

In the case that the farmer is not maximizing profit, these comparative statics are not so straight forward. However, if we now evaluate the first-order conditions at optimum, assuming the second-order conditions hold, and differentiate with respect to \( M \), we may use Cramer's rule to get the following comparative static for the provision of the public good (subscripts on functions denote partial derivatives):
\[
\frac{\partial z}{\partial M} = \frac{U_{kk} \pi_z + p_k U_{kz}}{D}
\]  
\[\text{[A9]}\]

where \( D \) denotes the determinant of the second partials of the Lagrangian with respect to, \( k, z \) and \( \lambda \). From the second order conditions \( D > 0 \).

In order to get an unambiguous sign on this, the two terms in the nominator must have the same sign. From the second order conditions we know that \( U_z < 0 \) and we know that \( p_k > 0 \). Therefore \( \pi_z \) and \( U_{kz} \) must have opposite signs for \([\text{A9}]\) to have an unambiguous sign. It is reasonable to assume that a person that has "positive" preferences for \( z \) and \( k \) has \( U_{kz} > 0 \). As shown above for this person \( \pi_z < 0 \), hence \([\text{A9}]\) will be positive. In other words, an increase in exogenous income will lead to higher supply of \( z \). On the other hand, if the farmer has "negative" preferences for \( z, \pi_z > 0 \) and \( U_{kz} \) must be less than or equal to zero for \([\text{A9}]\) to be negative.

The comparative static for a change in \( p_z \) looks similar to the one for \( M \):

\[
\frac{\partial z}{\partial p_z} = \frac{U_{kk} \pi_z + p_k U_{kz}}{D}
\]

\[\text{[A10]}\]

Since the first term is positive, we are only able to sign this expression when the last term is positive. The terms in the brackets equals \([\text{A9}]\), thus if the farmer has "positive" preferences for \( z \), \([\text{A10}]\) will be positive. In the case of "negative" preferences \([\text{A10}]\) may be positive or negative.

If we compare \([\text{A9}]\) and \([\text{A10}]\) we see that it is reasonable to believe that \([\text{A10}]\) is larger than \([\text{A9}]\). If \( z > 1 \) this will definitely be the case, and for small values of \( z, \lambda \) will be large offsetting the effect via the small \( z \). This is a rather weak proof, but if it holds it tells us that if the aim is to increase the supply of \( z \), the most effective way to do so is by increasing the price of \( z \), i.e., a targeted approach is the best way every thing else held constant.

**Production in a Production Sets Framework**

Above we assumed that there were no links between production of private and public goods. Most of the conclusions above do not rest on this assumption, but in a majority of cases there is a link in production of the two types of goods. The model above will therefore be extended to include also production of a private good. A model for the case of profit maximizing behavior is presented in 2.3.3. The problem of a utility maximizing farmer may be expressed as:

\[
\left\{ \begin{array}{c}
\text{Max} \\
 k, y, z
\end{array} \right\} U = U(k, z)
\]

\[\text{[A11]}\]

Income must equal cost, so \([\text{A11}]\) is maximized subject to:

\[
p_y y + p_z z - C(y, z) - p_k k = 0
\]

\[\text{[a12]}\]
In addition, as in section 2.3.3, costs are assumed to be constant, i.e., the production possibilities are defined by the cost function. This gives the second constraint:

\[ C(y, z) = \bar{C} \quad \text{[A13]} \]

This gives the following Lagrangian:

\[ L = u(k, z) + \lambda [p_y y + p_z z - C(y, z) - p_k k] + \gamma [\bar{C} - C(y, z)] \quad \text{[A14]} \]

Solving [A11] we get:

\[ \frac{\partial L}{\partial k} = \frac{\partial U}{\partial k} - \lambda p_k = 0 \quad \text{[A15]} \]

\[ \frac{\partial L}{\partial y} = \lambda \left[ p_y - \frac{\partial C}{\partial y} \right] - \gamma \frac{\partial C}{\partial y} = 0 \quad \text{[A16]} \]

\[ \frac{\partial L}{\partial z} = \frac{\partial U}{\partial z} + \lambda \left[ p_z - \frac{\partial C}{\partial z} \right] - \gamma \frac{\partial C}{\partial z} = 0 \quad \text{[A17]} \]

In addition, [A13] and [A14] must hold.

If we manipulate [A16] and [A17] we get:

\[ \frac{\partial C}{\partial y} = \frac{p_y}{p_z + \frac{\partial U}{\partial z}} \quad \text{[A18]} \]

Assuming that it is possible to solve [A13] for \( z \), it is possible to show that:

\[ \frac{\partial C}{\partial y} = \frac{\partial C}{\partial z} = -RPT_{yz} \quad \text{[A19]} \]

i.e., the slope of the production possibility frontier. If we put these two together:

\[ RPT_{yz} = -\frac{p_y}{p_z + \frac{\partial U}{\partial z}} \quad \text{[A20]} \]

If we now compare this to the optimality condition obtained for profit maximizing behavior in section 2.3.3:

\[ RPT_{\pi z} = -\frac{p_y}{p_z} \quad \text{[A21]} \]

we see that [A20] must be less (larger) than [A21] if marginal utility of \( z \) is larger (less) than zero. Since \( RPT_{yz} \) is decreasing in \( y \) (from the second order conditions), utility maximizing will lead to production of more (less) \( z \) if marginal utility is greater (less) than zero. This is the same conclusion we reached for the case with no link in production of \( y \) and \( z \).
This holds for all combinations of $p_y$ and $p_z$ along the frontier. It is pointed out earlier that a dramatic shift in the prices may lead to a shift to another production frontier. However, given at set of prices the property pointed out above still holds. Utility compared to profit maximizing behavior is shown in figure A2.

Let us now assume positive marginal utility of $z$ and that utility is concave in $z$, i.e. that marginal utility decreases in $z$. It is then obvious from [A20] that "utility effect" is largest for low values of $z$. As $p_y$ increases, holding $p_z$ constant, we move down along the frontier. This indicates that the "utility effect" is largest for policies favoring the production of the private good. However, from this we can not conclude that the difference between profit maximization and utility maximization is larger for policies favoring $y$ with respect to production of $z$ and $y$.

Now consider two polices, one favoring the production of the private good (policy a) and one favoring the production of the public good (policy b). Both polices imply the same total cost, i.e., the optimal choice is on the same frontier in both cases. The question is then: under which policy would utility maximizing imply the largest shift with respect to provision of $z$ compared to profit maximizing behavior? The two situations are shown in figure A3.

If we now once again manipulate [A16] and [A17] we get:

$$RPT_{zy} = \frac{\partial y}{\partial z} = -\frac{pz}{p_y} + \frac{\partial U}{\partial z}$$

We see that this is the reciprocal of [A20]. For the case of profit max. we have:
While we above expressed the first order conditions in the y,z-space, we here look at it in z,y-space. The result will of course be the same.

From the properties of the frontier we know that the left hand side of [A22] and [A23] is falling in z. The right hand side of [A22] is increasing in z via the marginal utility (becomes less negative), while the right hand side of [A23] is constant. This gives figure A4 to the left.

The distance between $U^\max$ and $\pi^\max$ depends on the vertical distance between the two hatched lines and the curvature properties of $yz$ (partial derivative of $y$ with respect to $z$). Regarding the first:

$$\Delta RPT = \frac{p_z}{p_y} - \frac{p_z + \frac{\partial U}{\partial z}}{p_y} = \frac{\frac{\partial U}{\partial z}}{p_y}$$

In general we are not able to compare $\Delta RPT_{zy}$ for different policies since both the nominator and the denominator may change. We know that large $p_y$ would imply large marginal utility, since this would mean a high production of $y$ and low production of $z$, but we do not know which effect is largest. In one special case we may say something definite about [A23]. If $p_y$ is constant, i.e., "policy b" has a higher $p_z$ than "policy a", then [A23] would be highest for "policy a", since marginal utility is larger under "policy a".

Even if we were able to compare $\Delta RPT_{zy}$, the difference in $z$ also depends on curvature of $y_z$. We can not say anything about the sign of $\Delta RPT_{zy}$, from the necessary and sufficient conditions, since this depends on the third partial derivative with respect to $z$. If we return to the special case, where $p_y$ is constant, "policy a" would have a larger difference in $z$ if $y_z$ is concave (including linear) in $z$. However, this is a special case.

In general, we are not able to tell if the "utility effect" would lead to a larger, equal or smaller change in production of $z$ if a policy favoring production of $z$ is compared to a policy favoring production of $y$. 
Literature


Blekesaune (1999): Agriculture's Importance for the Viability of Rural Norway, Centre for Rural Research, Norwegian University of Science and Technology, Trondheim, Norway.


Norges lover 1997


Field Margin Provision in Ecological Main Structures, Working paper, Department of Agricultural Economics, University of Kiel, Kiel, Germany.


**Personal communications:**


Olsson, Gunilla A. (1999), Department of Botany, Norwegian University of Science and Technology, Seminar at Asgårstrand, Norway, September 1999.