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MULTIFUNCTIONALITY: ENVIRONMENT VERSUS RURAL VIABILITY IN SOCIAL OPTIMA*

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Abstract
We examine policy implications of including rural viability to the notion of multifunctional agriculture. We assume that rural viability refers predominantly to the number of people living in rural areas to keep the infrastructure and living conditions at good state for a good life. The economic core of viability is employment in agriculture and agriculture serving sectors. Viability benefits are modelled with the help of a viability valuation function. We demonstrate that rural viability entails adjusting fertilizer tax and buffer strip subsidy below their environmental first-best Pigouvian levels to reflect the direct and indirect employment effects of agricultural production. Moreover, when non-agricultural land use is present, an additional, non-agricultural instrument is needed to adjust the amount of land allocated to agriculture to its socially optimal level. Thus, inclusion of rural viability creates distortions in multifunctional policies. Theoretical results are illustrated with Finnish data to examine how the inclusion of rural viability to multifunctionality relates to the true socially optimal agri-environmental multifunctionality. We also assess welfare loss from promoting rural viability in the case where there is no base on viability benefits.

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1. Introduction

The OECD (2001) provides the standard definition of multifunctional agriculture. The fundamentals of multifunctionality are defined by i) the existence of joint production of commodity and non-commodity outputs and ii) the fact that some of the non-commodity outputs exhibit the characteristics of externalities or public goods (OECD, 2001: 13). Non-commodity outputs include the impacts of agriculture on environmental quality, such as rural landscape, biodiversity and water quality but also socio-economic viability of rural areas, food safety, national food security and the welfare of production animals together with cultural and historical heritage.

As for a research strategy, OECD emphasizes that in developing the notion of multifunctional agriculture, it is useful in the first phase to focus predominantly on positive and negative agricultural environmental non-commodity outputs; we call this *agri-environmental multifunctionality* in what follows. In the second phase, rural viability and other non-public good items could be introduced to the framework, although it is acknowledged that including food security and rural viability to multifunctionality is disputed and they do not fit well with the framework of multifunctionality (OECD, 2001: 31).[1]

Almost without exceptions, agri-environmental multifunctionality has been the starting point of the sparse academic research made on multifunctionality. Boisvert (2001), Romstad et al. (2000), Guyomard et al. (2004), Anderson (2002), Paarlberg et al. (2002), Vatn (2002), Peterson et al. (2002) and Lankoski and Ollikainen (2003) focus on the properties and policy design of multifunctional agriculture either in a closed economy or in an inter-

[1] Implications of multifunctionality on agricultural trade have raised this notion to the forefront in the international debate. Some countries fear that further reductions in and constraints on domestic support would reduce the ability of governments to pursue their domestic non-commodity objectives, whereas other countries consider that multifunctionality is being used as a pretext for maintaining high levels of production-related support (see e.g. Burrell 2001). Hence, the concept of multifunctionality and its use as a basis for concrete policy interventions has raised conflicting views among the WTO members. Among the developed country WTO members there may be more consensus with regard to agri-environmental multifunctionality, so that environment has been listed as one of the legitimate non-trade concerns.

national trade framework. All these studies approach multifunctionality with the help of the theory of joint production.

Boisvert (2001) exemplifies the qualitative role of both public goods and public bads by focusing on two agricultural commodities and two non-commodities produced with a land input and a purchased input. Land allocated to both commodities produce landscape amenities and the use of purchased input creates environmental residual. Using similar approach, Peterson et al. (2002) provide a comprehensive analysis of multifunctionality. Policy instruments include taxes and subsidies on output, land and non-land inputs. They show that, although commodity intervention may be part of the optimal policy-mix, it is not necessary, since a set of input taxes and subsidies can internalise all externalities in the absence of commodity intervention. Moreover, the optimal policy necessarily consists of a mix of instruments including input subsidies, taxes or regulations, used in perfect synchrony.

Vatn (2002) argues that there is a trade-off between the precision of instrument design and its transaction costs. If targeted instruments imply high transaction costs, it may be reasonable to pay for the provision of non-commodity properties by supporting the commodity output. Thus, it may not be rational to have free trade for commodity outputs while paying separately for non-commodity outputs. Lankoski and Ollikainen (2003) allow for spatial heterogeneity and endogenous land allocation between two crops. This modifies the previous findings of Boisvert (2001) and Peterson et al. (2002) to reflect heterogenous conditions and suggests the use of differentiated corrective instruments to attain the socially optimal multifunctionality. They also analyze the social welfare of using second-best, undifferentiated instruments[2]. Romstad et al. (2000) and Guyomard et al. (2004) in turn focus on alternative policies towards multifunctionality.

[2] Implications for trade policy can be summarized as follows. Paarlberg et al. (2002) show that multifunctionality never justifies intervention to trade. It can be promoted by production related subsidies or taxes provided that the level of externality is linked to commodity output levels. Peterson et al. (2002) and Latacz-Lohmann (2000) have analysed the trade and welfare implications of agri-environmental policies. Peterson et al. (2002) show that results very much depend on whether the country in question is large or small. Latacz-Lohmann (2000) shows that government intervention to internalize environmental externalities increases domestic social welfare even though it may affect the quantities produced and traded.

Havlik et al. (2005) focus on beef production and grassland biodiversity when beef price is uncertain and farmers are risk-averse. Their simulation results based on French data show that joint commodity and non-commodity production is almost independent of the degree of farmers' risk aversion. Moreover, commodity production coupled policy instruments promote poorly public goods. Brunstad et al. (2005) focus on the complementarity between landscape preservation and food security. Using Norwegian data they show that due to a high degree of cost complementarity between these two public goods, it is more efficient to support land-extensive production than production *per se*.

None of previous papers has focused on the rural viability aspect of multifunctional agriculture. The reason is evident. Pareto optimality requires that all positive and negative externalities should be internalized, giving thus a firm theoretical basis to the concept of agri-environmental multifunctionality. The OECD (2001) notifies that in some occasions or from certain angles rural viability can be interpreted as public good. However, it is acknowledged that rural viability cannot entirely be subsumed into the category of public goods. The same is argued for instance by Anderson (2002). Therefore, providing justification for the inclusion of rural viability to multifunctional agriculture is a complicated issue. Without going into the details of this discussion, we will present in this paper our interpretation of what economic meaning can be given to rural viability.

The OECD (2001) lists various aspects of rural viability, which relate to agriculture's contribution to economic and social viability of rural areas and communities. Rural viability is linked to the attractiveness of life in rural areas for both rural and urban population. This attractiveness includes especially income levels, possibilities for employment and income creation, physical infrastructure, social capital and quality of the environment. Also, OECD lists some ways rural viability aspects may generate costs or benefits to society that justify its inclusion to the concept of multifunctionality. (OECD 2001:45 and 74-75). For related discussion see also Sinabell (2008).

A number of empirical studies have measured the linkages and multiplier effects of the agricultural sector to the wider economy and to rural communities by using Input-Output or Social Accounting Matrix (SAM) methodologies. The basic finding is that multiplier effects (income and employment) of agricultural sector are important in rural areas (for overview see OECD 1998).Farm sector has the largest income and employment multipliers in both predominantly rural and significantly rural areas. However, the contribution of agriculture to rural communities depends on many factors, such as the structure of the sector, farm types, the size of the region, as well as market structure of upstream and downstream sectors (OECD 1998).

We take the dimensions of rural viability suggested by OECD as given and interpret the meaning of rural viability as follows. Rural viability refers to the economic and social viability of rural areas and communities that depends crucially on the number of people living in rural areas. Following the strategy of analysis outlined in OECD (2001), we include rural viability into the framework of multifunctionality as one of its dimensions. Our aim is to investigate what the economic implications of including rural viability to the frame of agri-environmental multifunctionality are[3]. The research questions of this paper are the following. How should one incorporate rural viability into agricultural frameworks? What implications does rural viability induce to agri-environmental policies? How does rural viability modify our understanding of multifunctional agriculture? Note that we deliberately omit here other possible government policies impacting rural areas, such as general employment and regional policies, which often target other rural industries and activities than agriculture.

In line with OECD (2001), we describe the core economic content of rural viability by employment in agriculture and in the rural sectors serving agriculture. We introduce a rural viability valuation function in the social welfare function. This reflects the idea that, not conventional labor market or related effects, but the more general benefits and costs to society are valued in the concept of rural viability. We neglect here the trade policy aspects, because our primary purpose is to examine the optimal design of multifunctional agriculture, which inherently is a domestic policy question, even though has important connections to trade policy, as Anderson (2002) points out. Finally, given that the role of rural viability is somewhat disputed, we discuss in the empirical application the case where social benefits from rural viability are absent in reality but society devotes resources to promote rural viability.

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[3] Like us, Hediger and Lehman (2003) provide a welfare theoretical analysis of multifunctional agriculture in a small open economy framework. Their focus differs from ours in many ways. They assume homogenous land, which can be allocated between agriculture, forestry and manufacturing. Labor and land are inputs in production and environmental quality depends on land use and emissions.

The rest of this paper is organized as follows. Section 2 provides a theoretical model of multifunctional agriculture and develops the first-best policies to address it. These results are then contrasted with our interpretation of rural viability. Both analytical results are illustrated by using Finnish data in section 3. The concluding section 4 ends the paper.

2. Multifunctional Agriculture: Towards a General Framework

A natural framework for multifunctional agriculture is a model which emphasizes heterogeneity of land quality and spatial aspects to allow choice of crops and entry and exit of land to agriculture. Therefore, we incorporate rural viability in the agri-environmental multifunctionality model by Lankoski and Ollikainen (2003), where biodiversity and runoff damages represent externality and public goods aspects of crop production.

2.1. Basic framework: Agricultural production, rural viability and the environment

Consider agricultural production when land quality varies and arable land can be allocated to alternative land-use forms. The production units, parcels, are normalised to the size of one hectare and the overall fixed amount of arable land is *G*. The land quality is assumed to be uniform in each parcel but it differs over parcels, and land quality is ranked by a scalar measure *q*, $0 \le q \le 1$ (see Lichtenberg, 1989). Thus, $G = \int_0 g(q)dq$ is the cumulative distribution of *q* (acreage of having quality *q* at most) and *g*(*q*) is its density that is assumed continuous and differentiable, $G'(q) = g(q)$.

The arable land can be allocated between two cereal crops, crop 1 and crop 2, and some of the land may be allocated to non-agricultural uses. The shares of land devoted to crop 1 and 2 are defined as $L_1 = \int_{\hat{q}} g(q)dq = G(q\ ) - G(q)$

and $L_2 = \int_{q^c} g(q)dq = G(1) - G(q^c)$, where $G(1) = N$ and denotes the total amount of land. The share devoted to non-agricultural land use is defined by $L_{NA} = \int_0 g(q)dq = G(\ddot{q}) - G(0)$. Profits from non-agricultural use are by assumption independent of land quality and the return to it, r_{NA}, is exogenous.

For crop production we assume constant returns to land of any given quality, but decreasing returns with respect to inputs and land quality. The production function of crops 1 and 2 in each parcel is a function of land quality *q*, and fertilizer intensity, l_i, $y^i = f^i(l_i;q)$ with conventional assumptions concerning the partial derivatives: $f^i_{l_i} > 0$, $f^i_{l_i l_i} < 0$.

We assume that cultivation requires a constant amount of labor input (measured in working hours) and capital, and denote them by n_i and k_i, respectively. Capital intensity may differ between the crops and higher capital intensity requires more labor input (working hours). The profit function of crop *i* per parcel is defined as the difference between the revenue and input costs. We also allow for a possibility that the farmer establishes buffer strips to prevent runoff and promote biodiversity:

$$\pi^i = (1 - m_i)\left[p_i f^i(l_i;q) - cl_i - wn_i\right] - rk_i\,, \tag{1}$$

where m_i denotes the buffer strip, and p_i refers to the prices of crops and *c* to the fertilizer price, *w* to wage and *r* to the cost of capital. In accordance with the actual practice, we assume in (1) that the wage cost per parcel is fixed (as working hours are fixed) and depends on the actually cultivated share of the parcel. Capital cost is another fixed cost term but independent of the size of the buffer strip. This is natural, as machinery and equipment related capital costs, such as depreciation, accrue irrespective of the size of the buffer strip. Both fixed cost terms affect our analysis: the size of the buffer strips is dependent on labor costs, and both labor and capital will affect directly land allocation and, hence, the social optimum.

Following the research strategy outlined by OECD (2001), we describe rural viability via employment in agriculture and in those sectors that agriculture supports. However, viability benefits are not identical to wage earnings in those sectors. This would not capture the social benefits of viability discussed above. Therefore, we include the rural viability valuation component to the social welfare function. This modeling choice is in line with the justifications given above. Moreover, even if they would not be valid, this modeling helps us to trace the consequences of viability to multifunctional policies.

Denote the overall amount of labor related directly or indirectly to agricultural production, by *N*. This total amount consists of two streams of labor: labor used directly in agriculture (direct employment) and indirect employment created by agricultural activities. The total actual direct use of labor in agriculture, denoted by N^a, is defined by $N^a = \int_{\hat{q}} \sum_{i=1} (1-m_i) n_i L_i g(q) dq$. The second, indirect employment effect emerges in agriculture serving intermediary sectors, such as retailers of fertilizer and capital, and services related to the use of capital. We denote this indirect labor by N^I and assume that it is a function of the actual use of fertilizers and capital via commerce and services. The actual use of fertilizer and capital is defined as $l = \int_{\hat{q}} \sum_{i=1} (1-m_i) l_i L_i g(q) dq$ and $K = \int_{\hat{q}} \sum_{i=1} k_i L_i g(q) dq$, Using these we have $N^I = \sum_{i=1} N_i^I (l, K)$, with $N_l^I > 0$ and $N_K^I > 0$. Finally, we also account for the (exogenous) employment in the non-agricultural land use and denote it by N^{NA}.

One could introduce explicitly the agriculture serving sectors into the model and define the agriculture-dependent employment there, but this is not necessary for our theoretical treatment. As pointed out in OECD (2001), conventional market effects from agriculture to the employment of sectors serving it do not provide a cause of including rural viability into multifunctionality, rather it is the special emphasis given by the society to rural viability in the form of employment. Therefore, we next introduce the social valuation of rural employment calling it rural viability valuation function, B, and define it as $B = B(N)$, where $N = N^a + N^I + N^{NA}$. We assume that the *marginal viability effect* increases in *N*, but in a decreasing fashion, i.e., $B'(N) > 0$ and

$B''(N) < 0$. Thus, for changes in the use of inputs we have, $B_{l_i} = B'(N)N^I_{l_i} > 0$, $B_{K_i} = B'(N)N^I_{k_i} > 0$, and for the change in the size of the buffer strip $B_{m_i} = -B'(N)N^I_{m_i} < 0$.[4] We would like to emphasize, again, that although we model viability function as if such inefficiency would prevail in the labor market, we do not argue here that such inefficiency exists in the European labor market. Our assumption is instrumental for our intention to investigate the content of multifunctional policies in the presence of non-public goods aspects.

We finally link environmental aspect to the set-up. Choice of fertilizer input, the size of the buffer strip and land allocation affect the environmental quality of our rural landscape. Assume that the society regards biodiversity and surface water quality as the most important non-commodity outputs in our agricultural landscape. We refer to Lankoski and Ollikainen (2003) as regards to the general discussion of these aspects. We express the valuation of biodiversity as a function of aggregate land use of each typeincluding also non-agricultural use. Runoffs depend on the use of fertilizer and size of the buffer strips. For simplicity, non-agricultural land use does not cause pollution.

$$\Omega = \Omega(L_1, L_2, L_{NA}, M), \tag{2}$$

$$Z = \int_{\hat{q}} \sum_{i=1}^{2} v_i\left[(1-m_i)l_i(q), m_i(q)\right]L_i g(q)dq, \tag{3}$$

where $M = \int_{\hat{q}} \sum_{i=1}^{2} m_i(q)L_i g(q)dq$, L_1, L_2 are defined above, $v_i(\cdot)$ denotes the runoff from parcels devoted to crop 1 and crop 2, with $v_{l_i} > 0, v_{l_il_i} > 0$, where $l_i = (1-m_i)l_i$ and $v_{m_i} < 0, v_{m_im_i} > 0$. Given Z, the society's monetary valuation of runoff damages defines a damage function, $D(Z)$, which is assumed to be convex ($D'(\cdot) > 0$ and $D''(\cdot) > 0$).

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4 From the definition of N^I we have for the derivatives: , $N^I_{k_i} = dN^I/dk_i = L_i \frac{\partial f_i}{\partial K} > 0$ and $N^I_{m_i} = dN^I/dm_i = -l_i \frac{\partial f_i}{\partial \hat{l}} L_i < 0$.

2.2. Socially optimal agri-environmental multifunctionality and rural viability

We assume that the government maximizes the sum of the producers' and consumers' surplus, but augments the social welfare function by the extra weight given to the rural viability. Thus, the social welfare function reads now,

$$W = \int_0^1 (L_1\pi_1^*(q) + L_2\pi_2^*(q) + L_{NA}\pi_{NA}^*)g(q)dq - D(z) + \Omega(L_1, L_2, L_{NA}, M) + B(N) . \qquad (4)$$

The first-best optimum is solved by choosing first the use of inputs and then allocating the land to its best use. The choices of inputs are characterized by

$$W_{l_i}^i = p_i f_{l_i}^i - c - D'(Z)Z_{l_i} + B'(N)N_{l_i}^I = 0 \qquad (5a)$$

$$W_{m_i}^i = -\frac{}{(1-m_i)} - D'(Z)Z_{m_i} + \Omega_M + B'(N)N_{m_i}^I = 0 , \qquad (5b)$$

where $Z_{l_i} = (1-m_i)\frac{}{\partial l_i} > 0$ and $Z_{m_i} = \frac{}{\partial m_i} - l_i \frac{}{\partial l_i} < 0$.

From (5a), fertilizer intensity in each parcel is chosen so that the value of the marginal product of fertilizer equals its unit cost adjusted with the sum of the marginal social costs and marginal viability benefits of fertilizer application. According to (5b) the size of the buffer strip in each parcel is socially optimal when the net loss of income due to decreased production equals the marginal benefits from runoff reduction and the constant marginal benefits from biodiversity production minus the marginal decrease in rural viability due to lowered employment. Given that the land quality varies over parcels, the socially optimal l_i and [illegible] will vary over parcels as well.

A comparison of this outcome with agri-environmental multifunctionality entails setting $B'(N) = 0$, that is, assuming that rural viability does not matter. This comparison is condensed to

Proposition 1. The use of agricultural inputs under rural viability

Relative to agri-environmental multifunctionality, the effect of including rural viability is to moderate the policy towards public goods and bads, because now the society trade-offs public goods aspects with viability aspects. Thus, fertilizer intensity is higher, buffer strips are smaller and employment in agriculture is higher than under agri-environmental multifunctionality.

Proposition 1 implies that now socially optimal policy shifts away from the first-best Pigouvian policy due to employment considerations. The reason for this distortion from optimality is to favour the population in rural areas.

Next, the social planner allocates land to crops 1 and 2 taking into account the effects of land allocation on diversity, nutrient runoffs and rural viability. To facilitate the land allocation, we make the following assumptions. First, there is some land quality level for each crop, denoted by q_i, for which the social rent is zero. Without a loss of generality, we assume that this marginal land quality is lower for crop 1 than for crop 2. Second, the social returns are higher for crop 2 on the land of highest quality. Third, the social returns as a function of land quality increase more rapidly for crop 2 across parcels. Fourth, by assumption, profits from non-agricultural land use are constant and independent of land quality. Moreover, non-agricultural land use is more profitable than crop production only on the lowest qualities of land. Under these assumptions, the critical switching land quality, q , and the marginal land quality q_i become uniquely determined, and the whole area of arable land is divided into a unique, compact ranges of land qualities for both crops and non-agricultural land use.

The critical switching land quality, $q^{\cdot}$, and the marginal land quality $\hat{q}$ are defined by

$$\pi_1^* - D'(\cdot)v_1 + \Omega_{L_1} + B_{L_1} = \pi_2^* - D'(\cdot)v_2 + \Omega_{L_2} + B_{L_2} \tag{6a}$$

$$\pi_1^* - D'(\cdot)v_1 + \Omega_{L_1} + B_{L_1} = \pi_{NA}^* + \Omega_{L_{NA}} + B_{L_{NA}} \tag{6b}$$

Assuming, again, for a moment that $B'(N) = 0$, allows us to trace the land allocation under agri-environmental multifunctionality. Now the condition (6a) for the switching land quality becomes: $\pi_1 - D'(\cdot)v_1 + \Omega_{L_1} = \pi_2 - D'(\cdot)v_2 + \Omega_{L_2}$, which is the same as in Lankoski and Ollikainen (2003). It simply requires land allocated between the two crops so that the social returns from both crops in terms of profits, runoff damages and biodiversity benefits are equal. From (6b) we have a new condition for the marginal land quality $\pi_1 - D'(\cdot)v_1 + \Omega_{L_1} = \pi_{NA} + \Omega_{L_{NA}}$. This requires that land is allocated to agriculture up to the point where the social return from agriculture equals the social return of the land allocated to non-agricultural use.

Allowing now $B'(N) > 0$ reveals how rural viability changes land allocation relative to agri-environmental multifunctionality. We collect these findings in Proposition 2.

Proposition 2. Land allocation under rural viability
Relative to agri-environmental multifunctionality, the inclusion of rural viability changes land allocation: a) within agriculture towards the crop which entails higher use of labour within agriculture and b) between agricultural and non-agricultural land use towards land use which entails higher use of labour.

Proposition 2 implies that if the labour intensity is higher in the production of more polluting crop 2, some additional land will be allocated to it via marginal viability effect. Interestingly, inclusion of rural viability has implications to the marginal land quality as well. Marginal land quality may increase or decrease depending on whether the land in crop 1 or in the non-agricultural land use has higher marginal viability effect. Ceteris paribus, if non-agricultural land use has higher marginal impact on rural viability, more land is allocated outside agriculture and vice versa. This means that the concept of rural viability should be applied outside of agricultural sector as well and thus it has broader implications to general regional policy. Hence, rural viability cannot be restricted only to agriculture and thus it can hardly be regarded as a genuine part of multifunctional agriculture.

2.3. The design of multifunctional policy instruments when rural viability counts

We next ask how does rural viability affect the design of multifunctional policy? Recall Propositions 1 and 2. They imply that one needs instruments within agriculture to affect the use of inputs and land allocation between crops. Moreover, as the marginal land quality is a function of social returns to non-agricultural land use, an additional instrument is needed to ensure the achievement of optimal allocation of land between agricultural and non-agricultural use. In what follows we establish these findings in a more rigorous way.

Note first that the privately optimal solution, extracted from equations (5a) - (5b), entail $\pi^i_{l_i} = p_i f^i_{l_i} - c = 0$, $\pi^i_{m_i} = -\left[p_i f^i(l_i;q) - cl_i - wn_i\right] \leq 0$. Thus, while the use of fertilizer is higher, the size of the buffer strips is smaller than in the social optimum. In fact, without any socially-induced incentives, the privately optimal level of buffer strips is zero due to net loss of profits. Hence, it is optimal to choose a tax/subsidy to handle the (positive or negative) externality of each input.

Postulate now a crop specific unit tax τ_i on the use of fertilizer (the after-tax unit price is $c_i = c(1+\tau_i)$) and a buffer strip subsidy is $b(m_i)$ with $b'(m_i) < 0$. Inserting these instruments into privately optimal conditions and setting them equal to the socially optimal conditions (6a) and (6b) allows us after some subtractions to define the optimal tax and subsidy rates from the following two equations system: $-c\tau_i = -D'(Z)\frac{\partial Z_i}{\partial l_i} + B'(N)N^I_{l_i}$ and $c\tau_i l_i + b'(m_i) = -D'(Z)\frac{\partial Z_i}{\partial m_i} + \Omega_M + B'(N)N^I_{m_i}$. Solving this system for fertilizer tax and buffer strip subsidy gives:

$$\tau_i^* = D'(Z)Z_{l_i} - B(N)N^I_{l_i} \tag{7a}$$

$$b'(m_i)^* = -D'(Z)(Z_{m_i} + Z_{l_i} l_i) + B'(N)(N^I_{m_i} + N^I_{l_i} l_i) + \Omega_M \tag{7b}$$

The implications of rural viability on the use of agri-environmental policy instruments become evident in (7a) and (7b). In the absence of rural viability, the optimal effective fertilizer tax (l $\quad l$) would reflect the social costs of fertilizer use only. When rural viability is present fertilizer tax is decreased from its environmentally first-best Pigouvian level to reflect the employment effects of fertilizer use. Similarly, if $B'(N) = 0$, the optimal marginal buffer strip subsidy would reflect only its environmental effects, that is, the constant marginal biodiversity effect, its direct effect of reducing runoffs and indirect effects of allowing for a slightly higher fertilizer intensity. Accounting for rural viability effect would clearly decrease its size, because buffer strips tend to decrease the direct and indirect labour.

Proposition 3. The design of policy instruments under rural viability
The multifunctional agriculture promoting rural viability under heterogeneous land quality requires the use of differentiated instruments on fertilizer and buffer strips inputs, set below their environmentally first-best levels because of the trade-offing of the rural viability effect via employment with promoting public goods and reducing negative externalities.

Equations (7a) and (7b) and Proposition 3 entail that the switching land quality between crops 1 and 2 becomes determined in a socially optimal way (to ascertain this, insert the optimal instruments in private land allocation condition to see that they become identical with the socially optimal one). They do not, however, define the marginal land quality, which partly depends on the social returns on non-agricultural land use. To see how rural viability affects the use of policy instruments between agricultural and non-agricultural land use, re-express condition (7b) governing marginal land quality as a private solution where policy instruments are used in agriculture but no instruments are used in non-agricultural land use: $\pi_1 - B'(\cdot)N_1 + \Omega_{L_1} + b_{L_1} = \pi_{NA}$. Comparing this with (7b) immediately reveals that too much land is allocated to agriculture, because agents in non-agricultural land use do not account for their positive contribution to biodiversity and rural viability. Hence, rural viability implies that

Corollary. Policy targeted to non-agricultural land use
If rural viability is included in the notion of multifunctionality, one should subsidize non-agricultural land use according to its biodiversity and rural viability effects so as to ensure optimal land allocation between agricultural and non-agricultural land use.

Hence, not only the concerns of viability but also design of policies will go beyond the limits of agriculture. Reasoning behind Corollary is the following. Tax and subsidy policies within agriculture adjust the input intensities and land allocation between two crops to the social optimum. Any attempt to correct land allocation between crop 1 (cultivated on the lower quality land) and non-agricultural land use by using agri-environmental instruments would distort land allocation between crop 1 and crop 2. Hence, affecting profitability of non-agricultural use by subsidies is the only way of adjusting the marginal land quality to its socially optimal level without distorting land allocation within agriculture.

Armed with our two models of multifunctionality and their characterizations we next go on to empirical illustration by using Finnish data.

3. An empirical illustration of environmental and viability aspects of multifunctionality

In this section we illustrate our framework of agri-environmental multifunctionality and rural viability with Finnish agriculture. We develop a parametric model comprising all parts of our theoretical model using wheat and rape as our alternative crops.[5] We examine quantitatively how much the inclusion of rural viability affects the design of agricultural policy as compared with agri-environmental multifunctionality and farmer's private optimum in the absence of government intervention. Also, we enlarge our theoretical analysis by assessing potential welfare losses in a case where the actual social benefits from promoting rural viability turn out to be non-existent.

[5] Wheat is the most important bread grain in Finland. The land area devoted to wheat was 167,900 hectares in 2007, making 8.6% of the cultivated land area. Rape seed is the most important oil seed crop in Finland and cultivated area of rape was 90,200 ha making 4.6% of total cultivated area.

3.1. Parametric model of multifunctional agriculture

The parametric model consists of a quadratic nitrogen response function, rural employment and viability valuation function and environmental parts (damage function from nitrogen run offs, agrobiodiversity valuation function). Other parts than viability aspects have been described in detail in Lankoski and Ollikainen (2003). The private profits from the agriculture in the absence of government intervention are

$$\pi^i = (1-m_i)\left[p\left(a_i + \alpha_i l_i + \beta_i l_i^2\right) - cl_i - wn_i\right] - rk_i \quad \text{for i =i,2,} \tag{8}$$

where the quadratic nitrogen response function has been estimated for rape (crop 1) and spring wheat (crop 2) in clay soils by Heikkilä (1980) and Bäckman et al. (1997), respectively. The land quality is incorporated into the response function through the intercept parameter a_i and slope parameter α_i by calibrating the nitrogen response function to reflect actual yields in clay soils in Southern Finland in years 2000-2002.

$$\begin{aligned} a_1 &= e_0 + e_1 q \qquad & \alpha_1 &= \mu_0 + \mu_1 q \\ a_2 &= h_0 + h_1 q \qquad & \alpha_2 &= \eta_0 + \eta_1 q \end{aligned} \tag{9}$$

All prices and costs are from year 2002 (see Appendix, Table 1 for parameter values). For the estimation of labor and capital costs we have developed a standard activity set for field operations: primary tillage, seedbed tillage, planting, herbicide application.[6] Labor cost is based on estimated hours/ha for different operations and farmer's wage rate per hour. Capital cost is based on machinery required for aforementioned field operations and machinery expense per hectare (which is measured by depreciation cost).

Besides rents from agriculture, π^i, the social welfare function contains runoff damages, agrobiodiversity benefits, and rural viability benefits. While other components are generally similar to Lankoski and Ollikainen (2003), rural viability benefits are the new component of the model. We assume that rural

[6] We assume here that machinery is same for both crops but the number of tillage operations (e.g. seedbed tillage by harrowing) may differ between crops.

viability valuation is a linear function of direct and indirect labor effects of agriculture. In defining the indirect effects of agricultural production on labor, we utilize regional input-output tables for Uusimaa region in Southern Finland, which is a representative area for crop production in Finland (Knuuttila 2004). According to Knuuttila (2004) the direct employment in agriculture was 7790 years and the overall indirect effect was 379 years. This suggests that one hour of work in agriculture causes a 0.0487 hour's increase in the indirect employment. Given that farmers spend 6.57 working hours in actual cultivation per hectare, we obtain an 0.32 hour as the indirect employment effect per hectare from the agriculture. We assume somewhat arbitrarily that the indirect employment effect from this work can be imputed to capital and fertilizer inputs in shares 0.6 and 0.4. Thus, we can define the overall employment (direct agricultural employment plus indirect employment) with the help of the following expression $N = N^a + N^I = \int_{\hat{q}} \sum_{i=1} 6.57 * (1 - m_i) + (0.0013933 k_i + 0.0009288(1 - m_i) l_i)$.

From a recent study by Yrjölä and Kola 2004, we have as the marginal valuation of rural viability 5.4 €, so that rural viability valuation is given by 5.4N.

The social welfare function for agriculture can now be expressed as

$$SW = \int_0^1 \sum \pi^i - 3.57Z + 54M^{0.0977} + 5.4N \qquad (10)$$

In the second term, Z denotes the nitrogen runoff and the social value of marginal damage (3.57) which is estimated on the basis of Yrjöläand Kola (2004). The nitrogen runoff function is $z_i = [1 - m_i^{0.2}]\phi\, e^{-0.7[1-0.01(1-m_i)l_i]}$. The first term in bracket represents nitrogen uptake by buffer strips, and the second term represents nitrogen runoffs from crop i generated by a nitrogen application rate of l_i per hectare when buffer strips take up a share of land m_i. The parameter ϕ calibrates runoff to reflect 100 kg nitrogen applied per hectare. We set the parameter ϕ at 15 kg N/ha.[7]

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[7] We postulate constant marginal runoff damages and viability benefits. This is a simplification reflecting the fact that we have only point estimates of the citizens' willingness to pay for viability and nutrient runoff. In our case this simplification does not distort the analysis, as the aim of the analysis is to compare our two model specifications.

The third term denotes the agrobiodiversity valuation. We link the buffer strip areas to species diversity with the help of a study by Ma et al. (2002). They describe the relationship between floral species richness and buffer strip area by [illegible], where ψ_α (ψ_β) is an estimate for the average change in species richness due to an increase in the length (width) of the area while keeping the width (length) of the area constant ($\psi = 1.6331$, $\psi_\alpha = 0.0009$, $\varphi_\beta = 0.0977$). Our estimate for agrobiodiversity valuation function is given in terms of buffer strip hectares and it is derived from Yrjölä and Kola (2004), who originally suggest €54 as average WTP per hectare for biodiversity.

The non-agricultural land use form in the empirical application is forestry. This is an obvious choice, as forests are the natural cover of the Finnish landscapes. Moreover, the border between agricultural fields and forests has varied across time. We assume that if a parcel of forest is converted to agriculture, there is a lump sum conversion cost, but the yields obtained from this converted land will reflect typical agricultural yields. If a previous cultivated land is forested, it will take a long time for this parcel to produce regular forest income. From Finnish studies, we have an estimate of € 47.8 per ha annual forest income over one rotation period of trees in reforested agricultural land. Hence, we set $\pi = 47.8$ €. According to Statistical Yearbook of Forestry (2001) employment effects of agriculture are 4.5 times to those of forestry when measured by the employment effects of an increase of €10 million in final demand for agricultural and forestry products. We will apply this employment information when solving the land allocation between agriculture and forestry. Finally, given that forests are so plentiful in Finland, we do not impose any special biodiversity value on changes in the forest land.

Other parameter values for our parametric model are reported in Appendix, Table A1. The arable land area is assumed to be 40 hectares (the width of the field area, that is, the distance from the water border to the other edge of each parcel is 200 m and the length, that is, border along the waterway is 2000 m so that the length of each parcel is 50 m). The base case of our parametric model represents the private market solution (without taxes and subsidies) for cereals and oilseeds in Finland in 2002.

3.2. Results: Environment versus viability and social welfare

We develop from equation (10) three basic solutions: the privately optimal agricultural production (in the absence of government intervention), socially optimal agri-environmental multifunctionality (AE-MF) and the agri-environmental multifunctionality with rural viability (RV-MF). The results are reported in Tables 1 and 2. We start with Table 1 that reports average use of inputs per parcel.

TABLE 1. Average input use per parcel (bold) under alternative solutions (range in parentheses).

	Fertilizer use Crop 1 (kg)	Fertilizer use Crop 2 (kg)	Buffer strip Crop 1 (share)	Buffer strip Crop 2 (share)
PRI-OPT	**80.3** (80.2-80.5)	**122.8** (120.3-125.4)	-	-
RV-MF	**71.2** (69.8-72.8)	**115.7** (114.4-117.0)	**0.0417** (0.0357-0.0477)	**0.0384** (0.0330-0.0438)
AE-MF	**72.2** (71.4-73.0)	**116.2** (115.0-117.4)	**0.0491** (0.0438-0.0544)	**0.0484** (0.0399-0.0569)

In accordance with our theoretical analysis, the fertilizer intensity increases and the size of the buffer strips decreases in land quality over all parcels. (Note that for fertilizer use, the first figure in parentheses is the lowest land quality cultivated under that crop, and for buffer strips, the first figure is the highest land quality cultivated under that crop.) Relative to the social optimum, the private input use is too high for fertilizer and too low for buffer strip (in fact, no buffer strips are established in private solution). Our model reveals some interesting features concerning the average input use in RV-MF and AE-MF. Although one could expect that the average fertilizer intensity is higher in RV-MF than in AE-MF, this feature does not show up in Table 1. The explanation is, however, obvious. With regard to land allocation results in Table 2 we see that under RV-MF, more land of lower quality is allocated in agriculture. Thus, under AE-MF, both crops are cultivated in higher quality parcels with higher fertilizer intensity than under RV-MF. Restricting attention only on the same parcels cultivated both under AE-MF and RV-MF reveals that our expectation is actually true. Within this range of qualities, the average fertilizer use under RV-MF is higher. While the mean rates of fertilizer application are 68.66 kg/ha (crop 1) and 110.57 kg/ha (crop 2) under AE-MF, we have for

RV-MF 69.02 kg/ha (crop 1) and 111.28 kg/ha (crop 2). Finally, in accordance with our theoretical model, the size of buffer strips is larger under AE-MF than under RV-MF.

The optimal use of inputs determines land allocation, profits, nitrogen runoff damage, biodiversity benefits, viability benefits and social welfare. They are collected in totals in Table 2. Biodiversity benefits (BB) refer here only to benefits provided by buffer strips, measured by floral species richness (other field edges remain the same in all solutions, so that these benefits are not included). Two SW concepts are provided. *SW I* includes social welfare only from agricultural land use, while *SW II* includes also social returns from parcels allocated to forestry.

TABLE 2. Social welfare results.

Policy	Land allocation (NA: C1: C2)	Profit, €	Runoff damage €	BB, €	Viability benefits €	SW I, €	SWII, €
PRI-OPT	17 : 3 : 20	2056	1397	-	854	1514 / 660	2463 / 1472
RV-MF	2 : 25 : 13	2115	865	1577	1350	4178 / 2828	4290 / 2923
AE-MF	12 : 15 : 13	1922	633	1608	988	3885 / 2897	4554 / 3471

Table 2 reports value components of the social welfare functions. The crucial figures behind the values are the following. Amounts of crop 1 (rape) and crop 2 (wheat) produced in the private optimum are 4431 kg and 78 682 kg, respectively. The corresponding figures in the RV-MF are 33 279 kg for crop 1 and 49 561 kg for crop 2 and in the AE-MF 20 647 kg (crop 1) and 49 111 kg (crop 2). Total nitrogen runoff is 391 kg in the private optimum, 242 kg in the RV-MFA, and 177 kg in the AE-MFA. Buffer strips provide 83 floral species in both socially optimal solutions. The number of working hours describes labour input for those field operations that we defined in the model (primary tillage, seedbed tillage, planting, and herbicide application). This entails 158 hours in the private optimum, 250 and 183 in the RV-MFA and AE-MFA, respectively.[8]

[8] Note that the farmers' overall labor input or working hours per ha for cereals and oilseeds is estimated to be 12 hours per ha. This estimate includes, for instance, machinery maintenance and repair, grain drying, hauling of harvest. Thus, our set of standard field operations, that requires 6.57 hours/ha labor input, covers roughly 50% of the total labor estimate per ha.

Table 2 reveals some striking features of the social optimum (AE-MFA). First and in line with the discussion in Lichtenberg (2002), we find that the social optimum entails new land entering into agriculture relative to the farmer's private solution, and yet runoff damage is lower and biodiversity benefits are higher than under farmer's private optimum. Land allocation under RV-MF is driven by the fact that agriculture has higher viability value (recall, 4.5 times higher) than forestry. When rural viability is not accounted for, AE-MF entails much more land allocated to forestry.

Starting with the components of social welfare, agricultural profits are higher in RV-MF than in private solution, since more land is allocated into agriculture. However, socially optimal AE-MF entails lower profits than the private solution due to lower fertilizer use and establishment of buffer strips (although agricultural land area is 5 ha higher). The size of buffer strips and biodiversity benefits under RV-MF and socially optimal AE-MF are close to each other. As expected, viability benefits under RV-MF are clearly higher than in the private optimum and socially optimal AE-MF solution.

Social welfare in the private solution is clearly inferior to socially optimal AE-MF under both welfare measures. To facilitate comparison between socially optimal AE-MF and inclusion of rural viability (RV-MF), we report social welfare for both solutions in two different ways. The first (second) figure includes (excludes) rural viability benefits for both notions. Clearly, from the viewpoint of agricultural production only (SW I), RV-MF produces highest welfare in the presence of rural viability. This is natural: if social benefits from promoting rural viability really exist, including these benefits raises social welfare. If we exclude rural viability, then the social welfare for RV-MF is below that of AE-MF.

Recall, SW II includes social returns also from parcels allocated to forestry. Now, AE-MF provides highest social welfare also when rural viability benefits are included in the social welfare. Thus, the higher share of non-polluting forestry under AE-MF makes it the best solution for the society as a whole. Economic intuition to this result is the following. Viability promotion is restricted to agricultural land use only. This favors agricultural land-use relative to forestry, even though this has much lower runoff. Increased nutrient runoff damages outperform increased viability benefits leading to lower social welfare than under AE-MF. Hence, the outcomes and trade-offs between AE-MF and RV-MF are non-trivial. If rural viability is to be promoted, that should be done in other rural land-use forms as well to prevent distortions. This finding is in full accordance with the Corollary provided in the theoretical part of this paper.

Consider, finally, a possibility that social benefits from rural viability are absent in reality but viability is promoted by multifunctional policies. Then the question rises: what is the social welfare loss frompursuing rural viability in the absence of social benefits? We approach this question from two separate angles. We first consider the marginal costs of public funds of promoting rural viability and then discuss possible distortions in rural labour market.

Recall, optimal multifunctional policies always require internalization of externalities. Thus, by internalizing externalities a corrective Pigouvian policy increases social welfare despite the fact that Pigouvian taxes are distortionary. If social benefits from rural viability are absent but viability is promoted using public funds collected by taxing citizens, corrective mechanisms are absent and RV-MF-policy entails just a social cost of public funds (marginal cost of taxation). In Finland, the marginal cost of taxation has been estimated to be at least 10-30% of government payments. Correcting the social welfare estimate by a marginal cost of taxation of 10, 20 and 30% yields as the corrected social welfare estimate (SW I) for RV-MF € 4043, € 3908 and € 3773. This implies that the welfare loss from running for viability benefits is € 135, € 270 and € 405, respectively. For SW II the welfare loss is precisely same (and the respective actual social welfare SW II estimates are € 4155, € 4020, and € 3885).

Another angle to evaluate the possible social welfare loss from promoting viability is to assess the distortion caused to labour market from promoting employment. To this end, we determine what the farm wage rate should be, so that social welfare level of RV-MF could be achieved without viability valuation in the case of SW I. Original wage rate per hour is € 11.35 per hour. The required labour input subsidy to farm labour would be € 5.62 per hour for crop 1 and € 5.66 per hour for crop 2. The labour cost accruing to the farmer in the presence of this subsidy would be now € 5.73 for crop 1 and € 5.69 for crop 2. This would increase labour demand in rural labour market leading to a pressure towards higher wages. The welfare loss due to increased equilibrium wage rate would be the area below the new labour demand function defined by the new and original wage rates.[9]

[9] Unfortunately, we do not have reliable estimates of the demand for and supply of

4. Conclusions

We examined economic and policy implications of including rural viability to the framework of multifunctional agriculture. Following OECD, we regarded employment as the economic core content of rural viability. To facilitate analytical treatment of rural viability, we introduced a viability valuation function to the social welfare function. This function reflects the viability benefits accruing to society beyond those effects emerging via market parameters, such as wages or sales income.

In the theoretical model, we demonstrated that introducing rural viability entails adjusting fertilizer tax and buffer strip subsidy below their environmentally first-best Pigouvian levels to reflect the social benefits from direct and indirect employment effects of agricultural production. Moreover, we showed that when non-agricultural land use is present, an additional, non-agricultural policy instrument is needed to adjust the amount of land allocated to agriculture to its optimal level. Inclusion of rural viability leads to distorted agri-environmental policies. It cannot be restricted only to agriculture but it should impact all rural industries. Thus, from theoretical angle, rural viability is not a genuine feature of multifunctional agriculture.

In a parametric model calibrated to Finnish agricultural conditions, and valuation of agri-environmental amenities and rural viability, we assessed how the socially optimal provision of non-public good multifunctionality relates to private optimum and socially optimal agri-environmental multifunctionality. Moreover, we examined separately the case where policy intervention to promote rural viability turns out not to be justified on efficiency reasons. For this case we defined the potential social welfare loss by using marginal costs of taxation and distortions in the labour market.

In sum, our findings reveal that there are potentially many challenges to design rural viability policies. When all land use forms are included, promoting viability just by using agricultural policy instruments and not giving emphasis on viability aspects in non-agri-agricultural land use results in social welfare losses. Thus, policy instruments used to promote rural viability should be

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labour in rural labour market segment, so that we cannot provide an assessment of the welfare loss via labour market distortion.

extended to non-agricultural activities as well. In case rural viability benefits are absent, viability policies entail welfare losses. Depending on the marginal costs of taxation, welfare loss from viability policies may be low or high. Welfare losses measured via rural labour market distortions depend on the actual state of unemployment. If structural unemployment is high wage effects are, naturally, negligible, whereas under full employment they may turn out to be great.

To our knowledge, this paper is the first to focus on rural viability in the framework of multifunctional agriculture. Our choice was to emphasize the number of people in rural areas (via employment), because a critical mass of people is needed to sustain services, schools and shops in rural areas. To capture this idea, we introduced rural viability in the multifunctionality framework with the help of viability valuation function, which conveniently refers to social benefits that do no show up via market parameters. While other avenues for modeling rural viability were possible, our model strategy was the closest to the fundamental ideas of the OECD.

Our modeling strategy was instrumental to reveal that the concept of rural viability extends beyond agriculture. It became evident that agricultural instruments impacting land use must be synchronized to those impacting other land use forms. While there are pros of including rural viability in the concept of multifunctional agriculture, there are obvious cons as well. Much empirical research is needed to ascertain that restricting rural viability to multifunctional agriculture alone does not lead distortions between land use sectors. Namely, from the efficiency angle, the inclusion of rural viability to multifunctionality frame is not generally well-grounded but requires further empirical justification. Empirical work should focus on many issues, such as possible inefficiencies in rural labor market and other markets, and the role of indivisibilities and thresholds in the provision of social services. Whether the empirics provide justification for the inclusion of rural viability to the multifunctionality concept or not is a very interesting task of future research.

Appendix

TABLE A1. Parameter values in the numerical application.

Parameter	Symbol	Value
price of rape	p_1	€ 0.255/kg
price of wheat	p_2	€ 0.13/kg
price of nitrogen fertilizer	c	€ 1.2/kg
basic level of response for crop 1 basic level of response for crop 2 slope of the response change for crop 1 slope of the response change for crop 2	μ_0 η_0 μ_1 η_1	9.72 30.8 0.01 0.05
parameter of quadratic nitrogen response function	β	-0.0324 for rape -0.094 for wheat
initial level of productivity for crop 1 initial level of productivity for crop 2 slope of the productivity change for crop 1 slope of the productivity change for crop 2	e_0 h_0 e_1 h_1	700 680 10 23
nitrogen leakage at average nitrogen use farmer's wage rate per hour farmer's labor input per hectare capital cost	ϕ w n rk	10-20 kg/ha € 11.35/h 6.57 h/ha € 144/ha

Notes: All prices and costs are from the year 2002. The price of nitrogen is calculated on the basis of a compound NPK fertilizer.

References

Anderson, K. 2002. Agriculture's 'multifunctionality and the WTO. *Australian Journal of Agricultural and Resource Economics* 44: 475-494.

Boisvert, R. 2001. A note on the concept of jointness in production. Technical annexes (Annex 1 pp. 105-123 Annex 2 pp. 125-132) in Multifunctionality: Towards an analytical framework. 159 p. OECD, Paris.

Brunstad, R.J., Gaasland, I. and Vårdal, E. 2005. Multifunctionality of agriculture: an inquiry into the complementarity between landscape preservation and food security. *European Review of Agricultural Economics* 32: 469-488.

Burrell, A. 2001. Multifunctionality and agricultural trade liberalisation. Paper presented at: 77th EAAE Seminar/NJF Seminar No. 325, August 17-18, 2001, Helsinki.

Bäckman, S.T., Vermeulen, S. and Taavitsainen, V.-M. 1997. Long-term fertilizer field trials: comparison of three mathematical response models. *Agricultural and Food Science in Finland* 6: 151-160.

Guyomard, H., C. Le Mouel and A. Gobin. 2004. Impacts of alternative agricultural income support schemes on multiple policy goals. *European Review of Agricultural Economics* 31: 125-148.

Havlik, P., Veysset, P., Boisson, J-M., Lherm, M. and Jacquet, F. 2005. Joint production under uncertainty and multifunctionality of agriculture: policy considerations and applied analysis. *European Review of Agricultural Economics* 32: 489-515.

Hediger W. and B. Lehman. 2003. Multifunctional Agriculture and the Preservation of Environmental Benefits. Proceedings of the 25th International Conference of Agricultural Economists (IAAE). Durban South Africa, August 16-22. 2003.

Heikkilä, T. 1980. Economic Use of Nitrogen Drawing on Field Experiments. The Agricultural Economics Research Institute, Finland. Research Reports No.70. In Finnish.

Knuuttila, M. 2004. Elintarvikesektorin työllisyysvaikutukset − Panos-tuotosanalyysi maakunnittain. Maa- ja elintarviketalous 56. MTT Taloustutkimus, Helsinki.

Lankoski, J. and Ollikainen, M. 2003. Agri-environmental externalities: a framework for designing targeted policies. *European Review of Agricultural Economics* 30: 51-75.

Latacz-Lohmann, U. 2000. Beyond the Green Box: The economics of agri-environmental policy and free-trade. *Agrarwirtschaft* 49(2000), Heft 9/10.

Lichtenberg, E. 1989. Land quality, irrigation development, and cropping patterns in the Northern High Plains. *American Journal of Agricultural Economics* 71:187-194.

Ma, M., Tarmi, S. and Helenius, J. 2002. Revisiting the species-area relationship in a semi-natural habitat: floral richness in agricultural buffer zones in Finland. *Agriculture, Ecosystems and Environment* 89: 137-148.

OECD. 1998. Agricultural policy reform and the rural economy in OECD countries. 312

p. OECD, Paris.
OECD. 2001. Multifunctionality: Towards an analytical framework. 159 p. OECD, Paris.
Paarlberg, P., Bredahl, M. and Lee, J. 2002. Multifunctionality and agricultural trade negotiations. *Review of Agricultural Economics* 24: 322-335.
Peterson, J., Boisvert, R. and de Gorter H. 2002. Environmental policies for a multifunctional agricultural sector in open economies. *European Review of Agricultural Economics* 29: 423-443.
Romstad, E., Vatn, A., Rorstad, P.K. and Soyland, V. 2000. Multifunctional agriculture: implications for policy design. Agricultural University of Norway, Department of Economics and Social Sciences. Report No. 21. 139 p.
Sinabell, F. 2008. To what extent is rural development a joint product of agriculture? Overview and Policy Implications. Pages 17-46 in Multifunctionality in Agriculture: evaluating the degree of jointness, policy implications. OECD, Paris.
Vatn, A. 2002. Multifunctional agriculture: some consequences for international trade regimes. *European Review of Agricultural Economics* 29(3): 309-327.
Yrjölä T. and Kola, J. 2004. Consumer preferences regarding multifunctional agriculture. *International Food and Agribusiness Management Review* 7(1).

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