ELSEVIER

Ecological Economics 32 (2000) 169–173

ECOLOGICAL ECONOMICS

www.elsevier.com/locate/ecolecon

COMMENTARY

On the use value of land in agricultural production

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Received 26 April 1999; received in revised form 9 September 1999; accepted 9 September 1999

Abstract

The evaluation of agricultural land is an area that has received little attention within natural resource economics compared to the evaluation of other ecosystems such as forests or wetlands. A recent attempt by Alexander et al. (1998) (Alexander, A.M., List, J.A., Margolis, M., d'Arge, R.C., 1998. A method for valuing global ecosystem services. Ecological Economics 27, 161–170) considers one of the functions performed by agricultural land, i.e. agricultural production, and it is based on the mathematical difference between monetary value of output and production expenses. This approach is discussed in relation to the different treatment provided by the market to agricultural and industrial products, to the correctness of the arithmetical procedure, and to the issue of upscaling data from lower to upper levels of the ecosystem hierarchy. Such an approach needs much refinement before the results provided are meaningful.

Keywords: Agricultural systems; Ecosystem services; Land evaluation; Land use

1. Introduction

The search for a land evaluation methodology, particularly in relation to agrarian systems, is a long-standing issue within Soil Science. From the land capability classifications, first developed in the 1920s, to the FAO Framework for Land Evaluation of the late 1970s, there have been continuous attempts at putting into perspective the role of land, and soils in particular, in those systems. But for some excellent exceptions, such as that of Smit et al. (1981), no coherent methodology has been established as yet (Olarieta, 1996).

On the other hand, standard reference books in natural resource economics (Pearce and Turner, 1990; Azqueta and Ferreiro, 1994; Romero, 1997) seem to concentrate on examples of the evaluation of ecosystems such as forests or wetlands, but not on agroecosystems. The extensive literature on the evaluation of soil degradation under agriculture may serve as a surrogate, but the assumptions and methodologies are not convincing (Olarieta, 1994).

In this context, Section 3 of the paper by Alexander et al. (1998) is particularly welcome even

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PII: S0921-8009(99)00128-7

though it only considers the valuation of ecosystem services to agricultural production. Nevertheless, there are some issues that I believe are not properly addressed in this paper. In Section 3 the authors propose a methodology for valuing ecosystem services to agricultural production based on the following relation:

$$\text{Ecosystem value} + \text{production expenses} = \text{value of output} \qquad (1)$$

I will discuss this approach in relation to three main points. First, how these three different items are valued in the market. Second, what requirements need to be met in order to be able to add up ecosystem services and human-made inputs. And in third place, the issue of upscaling results from the farm to the global scale.

2. The relation between the prices of agricultural output and production factors

Pietilä (1997) considers that the 'cultivation economy' and the 'industrial production' are two distinct components of human economy. Furthermore, and as Georgescu-Roegen (1976) (p. 89) had already suggested, the former cannot be accommodated into the latter or into economic science, as this is based on the logic of industrial production. So, in principle, we should not mix agricultural and industrial products as Eq. (1) intends.

Nevertheless, in order to work with it, Alexander et al. (1998) make the common assumption of many monetary analyses. Presuming a perfectly competitive behaviour of markets allows equalling the societal value of an item to its market price. For such a central assumption, some effort should be invested in attempting to prove it, but this is not the case. Are there any criteria upon which to say whether a certain market is competitive or not? If the answer is yes, then just apply those criteria to your market and see whether they fit or not. But I am afraid that there are no such criteria, and that the assumption is simply wishful thinking. And from then on, the use of market prices sounds very much like getting a number, whatever the number, in order to be able to work around with it.

Although it is not used by Alexander et al., I do not believe that the common recourse to the deduction of taxes and subsidies to overcome supposed 'inefficiencies' solves the problem. We know about these supposed 'inefficiencies' and we can put a number on them; and we do know about the inefficiencies created by economic pressure groups (Bromley, 1985; Naredo, 1987; Chan, 1992), but we cannot put a number on them. The common way out of this seems to be to only consider the former and forget about the latter. But it sounds like a dubious methodology.

And in particular reference to the USA agricultural markets, not everybody seems to agree with Alexander et al. that these are free of inefficiencies. Actually, Vogeler (1981), (cited by Blaikie and Brookfield, 1987, p. 80) gives exactly the opposite idea:

> Given the high costs of supplies, the low market prices farmers receive, and the monopolization of the farmers' market, the choice is often between signing with a corporation or going out of business.... Once contracts are signed, processing companies usually make all the technical and market decisions....

Related to this is the assumption that there is no bias in the market pricing towards either agricultural produce or factor inputs. In a world dominated by industrial societies at the expense of non-industrial societies (Naredo, 1987, p.192) this assumption does not hold. Indeed, as we move along the industrial chain, an unequal market exchange takes place where finished products are 'rewarded' with higher prices than the resources required to produce them even though energy and materials are dissipated in the process. And this bias in favour of increasingly manufactured products is precisely what allows the industrial sectors of world society to subsist (Hornborg, 1998).

In fact, the approach used by Alexander et al. (1998) clearly reflects such distortion. They present data from the state of Florida where soybean production yields excess rents close to zero. Following Eq. (1), the obvious interpretation is that the value of ecosystem services is also close to zero in this case. But this makes no sense. In all probability the services provided by the ecosystem in Florida are different to those provided in Iowa, where such rents are highest in the US. But there is surely some sun providing radiation, some clouds providing rainfall, and some soil providing, at least, physical support and some porosity to retain water and oxygen for the soybean plants. These services have a positive value. The problem then is an under-pricing of soybean or an over-pricing of man-made inputs. Or maybe the problem is, taken to the absurd, that the whole system yields zero production in Florida. But this is not a failure of the ecosystem not providing services, but of society applying certain inputs where they should not be applied. Thus, in that case human-made inputs should have a negative value, rather than ecosystem services having a zero value.

Once again, the authors let figures dictate how to conduct their work. They do have figures for human-made inputs and for value of output but they do not have a figure for ecosystem services. Their way forward is to work with the former to obtain the latter regardless of whether it makes much sense or not.

3. Adding up numbers

Eq. (1) implies that the unknown term is 'value of output'. In fact, what is really meant and actually applied is:

$$\text{Value of output} - \text{production expenses} = \text{ecosystem value} \qquad (2)$$

Mathematically, Eqs. (1) and (2) are equivalent, but in real terms, the results are completely different, as we have seen in the previous section.

Nevertheless, Eq. (1) should fulfill two requirements at least. In the first place, each production cost should result in an equivalent increase in the value of output. And the intersection and interaction between ecosystem services and human-made inputs should be zero. None of these conditions are met by Eq. (1).

In relation to the first requirement, there is evidence, for example, that pesticide sales increased tenfold from World War II to the late 1970s with no concomitant decrease in crop losses due to pests (Edens and Haynes, 1982). Similar figures could be shown in relation to fertilizers.

The second requirement is impossible for a system, like agriculture, to meet. A system is an assembly of components and linkages that *interact synergistically* to perform a given function (Edens and Haynes, 1982). So, by definition, ecosystem services and human-made inputs cannot be added, because necessarily there are interactions between them, whether to improve or to worsen the result. We know that some factor inputs do act not only increasing production but also limiting the services provided by land. Increased levels of phosphate fertilizer limit the relative activity of mycorrhizal fungi (Barea, 1991), and increased use of nitrogen fertilizer decreases symbiotic nitrogen fixation (Frame and Newbould, 1986). Some forms of fertilizer have an acidifying effect on soil (Moody and Aitken, 1997). Modern crop varieties have been selected to be responsive to fertilizers by increasing yield and not total primary production (Ryszkowski, 1984). As a result, inputs of plant litter to soil are decreasing, and so is carbon content in agricultural soils and the functions it performs for agricultural production. A similar effect results from soil cultivation, which not only improves soil physical conditions for plant growth, but also increases humus decomposition rates.

Such interactions could also lead to double counting in favour of human-made capital. Pimentel et al. (1987) (cited by Cleveland, 1994) suggest that about 50% of the fertilizer applied to US farmland simply replaces the nutrients lost in soil erosion. This soil erosion is, partly at least, a result of some of the production expenses, e.g. the above-mentioned decreases in soil organic matter, and the loss of soil cover related to weeding.

In some ecosystems, such as forests, wetlands, or natural parks, human intervention in the reproduction of the services provided may be negligible, making them more attractive to this type of analysis searching for 'ecosystem value'. But in agricultural systems, isolating ecosystem services from human intervention is probably an impossible task.

4. About spatial scales

An important question related to the analysis is the definition of system boundaries. Eq. (1) is solved by Alexander et al. (1998) at a farm scale, and the results extrapolated at a global scale. But this is not right. According to system analysis, each scale has to be analyzed in its own right, and the behaviour of one level cannot be inferred from the behaviour of lower levels (Conway, 1984). Components, processes, and key-variables of systems change with scale.

The authors first extrapolate the farm results to the US scale on the assumption that in all arable land of the US the services provided by ecosystems are similar to those provided in land used for maize and soybean. I would argue that the rest of the arable land in the US is not of the same quality, but probably worse from the point of view of agricultural production, as that devoted to these two crops, as these have special environmental requirements.

At least, the results in an industrialized country should not be extended to non-industrialized countries, because the different production strategies involved in the two situations. As Edens and Haynes (1982), Giampietro et al. (1992) suggest fossil fuel and technology are inputs which have been made to be relatively inexpensive and abundant compared to human labour in industrialized countries, while the contrary holds for non-industrialized countries.

Finally, some of the inputs to agricultural production, like potash and phosphorus, may be considered to be manufactured inputs at the farm scale. But certainly at a global scale these are, partly at least, land-related inputs extracted from earth.

5. Conclusions

Land evaluation for agricultural production based on the mathematical difference between monetary value of output and production expenses presents various problems. Market prices for agricultural and industrial products are qualitatively different, and thus hardly comparable. Such approach probably results in underestimating ecosystem services. Nevertheless, given the interactions between these services and human-made inputs, this kind of exercise should not be attempted in the first place. And finally, a global value for land services in agriculture should be developed from concepts and data at the global scale and not from those developed at the farm scale. On the basis of this discussion, I believe that the results of such an approach are difficult to interpret and need much further refinement.

Acknowledgements

I would like to thank two anonymous reviewers for their comments, which, among other things, have brought new ideas to me.

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