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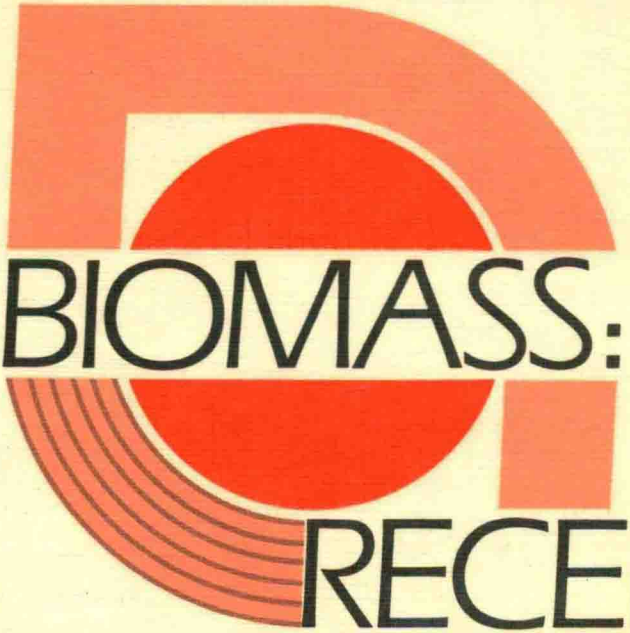

BIOMASS: RECENT ECONOMIC STUDIES

Edited by
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and
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INTRODUCTION

Since 1976, the EEC and its member countries have undertaken economic research projects to familiarize themselves with the microeconomics of producing energy from agricultural and forest by-products. Particular attention has been paid to producing energy via combustion of dry by-products and the use of methane produced by breeding and agribusiness by-products. These projects have shown that, except under specific well-defined conditions, energy costs are generally very high. This means that using dry by-products such as wood and straw as fuel is of interest, especially if they are used locally. However, their marketing, even on a small scale, means that prices are considerably raised owing to economic forces. The use of methane, upon which high hopes were based after the first oil crisis, is primarily limited to being an energy-saving purification process despite the increase in the price of oil.

Economists see no reason to re-examine these subjects, with the possible exception of regional approaches to the use of lignocellulose by-products. These are abundant and can only be used in limited quantities on farms or forest farms. Nonetheless, two fields seem worth investigating: the economics of non-food crop production and the methods used to aid government decisions.

These two subjects were singled out for study within the scope of the Community Energy and Agriculture programme and were studied by a working group of economists. They presented their work in Brussels in October 1985. This book contains the text of these presentations and describes the initial results of ongoing research.

What do these subjects entail and why are they so important?

The Economics of Non-food Crop Production

Some agricultural and forest farm crops can be used as raw materials for energy production and in industry. These are crops which have already been used as food and which could also supply new markets; this category

includes food plants, wheat and beets. Other crops, such as short rotation forestry, have been studied with a view to meeting industrial requirements.

Hope is being held out that such crops may help to absorb European agricultural surpluses or may enable efforts to valorize less favoured areas to continue. Whatever they may be, these crops should be a part of agricultural and forest production systems. For this to become a reality, the support of the producers must be obtained. Hence the importance of familiarity with price levels and subsidies which would give the producers the economic encouragement needed to change their crop orientation and introduce new crops, in any context.

First, a detailed analysis of the cost of such crops and those of competing crops is performed. It must be kept in mind that crop competition exists and that it varies with the region and the production system, thus causing opportunity costs to vary widely. Thus, a thorough knowledge is required to identify gathering areas. Even today, a statistical approach to this cost spread depending upon region and country has yet to be developed; the methodology is poorly understood. However, knowledge of costs cannot rest there; if it is to be genuinely useful to decision-making, the economic risks stemming from yield variations and price fluctuations must also be estimated. This is essential from the point of view of manufacturers who are not always able to take advantage of the flexibility of agricultural supply. In addition, increased productivity and cost changes caused by more expensive fossil fuels and future competitive food crop price variations must somehow be taken into account.

Production economics also requires that more methodological research be conducted parallel to practical application. Short rotation forestry is the ideal area for this. The first part of this book deals with this aspect of the subject and shows that European economists already possess a large body of data in this field.

Methodology Used for Government Decisions

It is not only private individuals who are affected by biomass valorization; governments and the EEC have as much at stake because of the external repercussions of such valorization. Public authorities are now heavily involved in creating and implementing innovations and must monitor the effects of innovation on larger macroeconomic balances (employment, balance of trade) and on lop-sided agricultural markets; their role is thus very important. The tools needed to make the correct decisions with regard to biomass are currently lacking.

The complexity of the problem means that an appropriate method cannot be defined. Three methodological approaches can be suggested, each dealing with a specific aspect of the problem.

First, dairy and cereals market surpluses are the subject of growing concern. One possible method of regulating them is producing biomass for non-food purposes. However, other markets may be indirectly disrupted if joined by-products come on to tight markets. This must be taken into account in economic analyses.

Second, it may also be possible to further widen the external repercussions of establishing a set procedure for different scales of production, each of which may have varying effects. Ethanol fuel, currently the centre of discussion, requires this type of analysis.

Lastly, the effects of technology on different macroeconomic scales can be widely divergent. One technique may encourage employment while creating higher private energy costs. Another may have favourable results with regard to agricultural surpluses but will create little employment. Public authorities implicitly refer to the 'social utility' of a technique when making decisions. A third possible avenue of research consists of trying to formalize the concept of social utility so as to achieve aggregation methods for macroeconomic criteria.

These are not the only possible avenues of research; the second part of the book shows that some of them have already been well examined.

The importance of methodology has been stressed in this introduction. It is in this area that economists have the most to contribute at the present time. In addition, standard application of these methods throughout Europe is important in order to facilitate later economic comparisons. These contributions extend beyond the framework of questions related strictly to energy.

We must take advantage of the current temporary respite on the energy markets to develop analysis methodologies. It should be remembered that these were found lacking after the first energy crisis. We cannot afford to be taken by surprise by any future oil market instability.

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CONTENTS

THE CULTIVATION OF RENEWABLE RESOURCES ON MARGINAL LAND

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ABSTRACT

One possibility of using contaminated agricultural land, which is not suitable for unrestricted food production any longer is the cultivation of renewable resources. To introduce a discussion about the economic possibilities and consequences of the production of renewable resources on such land an overview of the situation is given. In this context the legal regulations for pollutants contents in soils and plants, the plant uptake and the extent and distribution of contaminations are of importance. The investigation about the economic consequences of the production of renewable resources should be done with individual farm model calculations and the possibilities and restrictions for alternative land use systems there are described.

INTRODUCTION

When talking about the economic aspects of biomass cultivation it's competition for land and the high EEC spending on food surplus have to be taken into account. Another aspect must be considered as well: biomass cultivation can be an alternative for food production if the latter is restricted in some way or is not possible at all. Such restrictions may ermerge, when soil deteriorates like in the case of contaminations, or if requirements of nature and water protection forbid an intensive use of fertilizer and pesticides. Refering to this aspect the assessment of the profitability of biomass cultivation has to be different. In this case biomass cultivation must not compete economically with food crop rotations but with the remaining alternatives of land use.

The proposed research is mainly about the problem of contaminated agricultural land. The outline given will proceed as follows: first that portion of the contaminated land will be specified which can be called "marginal" because the food production is endangered by high contents of pollutants.

Second the acreage and the distribution of contaminated agricultural land will be evaluated and third the economic possibilities and consequences for the production of renewable resources on that land in comparison with other land use alternatives will be investigated.

DEFINITION AND SPECIFICATION OF CONTAMINATED AGRICULTURAL LAND

The quality of agricultural land is reduced by man-caused emmissions of pollutants. Some of these, like heavy metals and several organic chemicals, enrich irreversibly in the soil, pass to the crops and reach man either directly or indirectly with animal food-stuffs. Thus, land should not be used for food production any longer if the crops grown on it endanger human health by their content of pollutants.

To specify the effected land one has to look on some other factors besides the pollutants concentration in the soil. The uptake of the pollutants by plants is also influenced by the type of element and the form in which it is present in the soil; it depends on the kind of the plant as well as on the soil properties such as buffer capacity and pH value. For example lead is quite tightly fixed in soils whereas cadmium, zinc and thallium can be readily absorbed by plantroots. With lower pH values the availability of heavy metals generally increases. The concentration is higher in sands than in clay soils (Sauerbeck, 1985, S. 140).

Investigations in Nordrhein-Westfalen indicated a content of cadmium in wheat and oats three times that of rye and barley. On the other hand oats and barley showed the highest contents of lead - two times as high as that of wheat and rye.

Celery and spinach accumulate high amounts of cadmium, while green salad and kale accumulate large amounts of lead (König, 1985, S. 7).

Organic chemicals, which are often fat soluble, enrich in fat contending cells, so for example in the epidermis of carrots. As far as lifestock products are concerned, heavy metals are mainly found in livers and kidneys, organic pollutants in the milk as well. Another important aspect for the

specification of the concerned land are the legal regulations. They decide whether the agricultural use of contaminated land can be and will be actually restricted. In Germany the only possibility to enforce a restriction in land-use is provided in the food law. If the safety of consumers is endangered, the authorities can prohibit the cultivation of certain crops for this definite case. How to decide is the responsibility of the authorities for the law does not provide definite admissible limits for contamination of food-stuffs except for mercury in fish and nitrate in vegetables. For other substances like lead and cadmium there are only some recommended upper values for various food-stuffs, which the federal health department adopted from acceptable daily intake-values of the World Health Organisation. Both the values of the WHO and the recommended values of the federal health department are open to criticism. A regulation for fodder stuffs provides legally fixed limits for arsenic, fluorine, mercury and lead.

Legal fixed limits for heavy metal contents in soils are given in the regulation for the application of sewage sludges on agricultural land. These values are often used to assess the severity of a soil contamination. Although, exceeding these values does not mean the restriction of cultivation but the prohibition of more sewage sludge applications to this land. The limits of the sewage sludge regulation are controversal, because they refer to total amounts of heavy metals while the plant uptake is rather determined by the levels of the available (soluble) pollutants which depend mainly on soil properties.

Considering the inadequacy of legal regulations and the doubts about existing limits it seems to be inappropriate to specify that land which should no longer be used for unrestricted cultivation of food and fodder crops by comparison of heavy metals contents with any fixed or recommended values.

In the following chapter nevertheless some figures will be reported which describe the problem of contaminated soils by stating exceeded limits in soils and plants. These are the available data. Another approach would be to make inquiries about actual restrictions in agricultural land use. Such data

do not exist or are incomplete because most of the restrictions are recommendations only, not given by administration but by farm advisory services or regional agricultural journals.

THE ACREAGE AND THE DISTRIBUTION OF CONTAMINATED AGRICULTURAL LAND

Heavy metals concentrated in food-stuffs give an idea of the problem of contaminated agricultural land. The following table provides in addition to the averages of concentrations the 98-percentil value. The 98-percentile value marks that concentration that includes 98 % of all samples tested. If the 98-percentil is higher than the recommended limit, then the limit is considered to have been exceeded.

TABLE 1

	lead			cadmium		
	average	98-percentile	limit	average	98-percentile	limit
beef	0,045	0,408	0,3	0,10	0,067	0,1
porc	0,037	0,456	0,3	0,10	0,053	0,1
beef liver	0,458	3,0	0,8	0,123	0,6	0,5
porc liver	0,110	0,393	0,8	0,100	0,58	0,8
green vegetables	0,219	1,232	1,2	0,052	0,42	0,1
sprout vegetables	0,087	0,590	1,2	0,015	0,07	0,1
fruit vegetables	0,072	0,340	0,2	0,040	0,22	0,1
root vegetables	0,071	0,361	0,5	0,055	0,39	0,05
pome fruit	0,080	0,330	0,5	0,011	0,085	0,05
stone fruit	0,123	0,820	0,5	0,008	0,036	0,05
berries	0,089	0,810	0,5	0,008	0,037	0,05
rye	0,074	0,234	0,5	0,015	0,045	0,1
wheat	0,035	0,118	0,5	0,056	0,189	0,1
potatoes	0,078	0,218	0,2	0,047	0,17	0,1

(Umweltbundesamt '84, S.346 f.)

An indication of the distribution of contaminated land can be received by a list of the sources of pollutants.

TABLE 2 Sources of man caused contamination in the order of their importance

1. Ore mining and processing (local importance)
2. Emissions by industry (regional)
3. Industrial wastes (local)
4. Power plants and domestic heating (regional)
5. Domestic garbage (local)
6. River sediments (local)
7. Traffic (regional/local)
8. Agricultural chemicals (local/chemical)

(Sauerbeck, 1985, S. 120)

There is an often cited model, which estimates the effected agricultural land as follows: The areas within a 3 km radius of conurbations and industrial centres plus the strips along busier roads, which are presumed to be effected up to a distance of 50 m, add up to about 7 % of all agriculturally used land (Kloke, 1980, S. 24 ff.). According to a recent estimation of the same author the portion of agricultural land which is contaminated with heavy metals in excess of the recommended limits comes to 0,5 % (70.000 hectares) of the total at the most (Kloke, 1984, S. 113).

But also lower soil pollution levels can lead to critical plant contamination (see below), and pollution continues, especially in conurbations. As far as contaminations are accumulative, the amount of damaged land will increase with the continued emission of pollutants. Serious consequences for the farmer will occur, when the recommended limits for food-stuffs become law.

From published investigations of plant and soil contamination only one example is cited. It is taken from Ruhr Region and shows the special dangers to agriculture in conurbations. With different causes of pollution the heavy metal contents of soils were generally higher by 20 % compared with nationwide averages (König, Krämer, 1985, p. 51). One of the most important results of the study is that as far as cadmium is concerned the limits for grain are often exceeded although the corresponding soil contents are far below the limits of the

sewage sludge regulation.

Besides the general pollution of conurbations there are some areas known which are contaminated extremely by special causes and where agriculture is severly affected. Three examples:

- Two regions in the Rheinland (Mechernich and Stolberg), which cover areas of 3500 and 6000 hectares, in places with lead contents in soils over 10.000 ppm. Ore mining and processing caused the damage.
- Pasture grounds in the valleys of the rivers Oker and Aller. These rivers carried materials from ore mining for centuries and deposited it during flooding. These soils sometimes show extreme concentrations of several heavy metals and damage of crops and cattle has occured.
- Two regions near Darmstadt, where agricultural land was contaminated by industrial wastewater containing HCH (hexachlorocyclo-hexane) and heavy metals. The areas cover 230 and 150 hectares, the cultivation of vegetables is partly prohibited now, milk had to be withdrawn because of HCH contents for months until farmers used fodder crops from other regions.

Compared with the agricultural land in the Federal Republic in the whole the share of such extreme cases seems small. But for the region concerned and especially for the individual farmer it often is a severe problem. Looking at the recent investigations the most endangered crops are several kinds of vegetables (all kinds of heavy metals and organic chemicals), wheat and oats (cadmium), followed possibly by potatoes and sugar beet leaves used as fodder (lead, cadmium, org. chemicals). Of these, vegetables present a great risk to consumers if they consume mainly vegetables from one polluted area and wheat because it has a great share in human nutrition.

THE ECONOMIC POSSIBILITIES AND CONSEQUENCES OF THE PRODUCTION OF RENEWABLE RESOURCES ON CONTAMINATED LAND

It is proposed to investigate the possibilities and consequences of alternative land use systems with individual farm model calculations. An analysis of the adaption of a whole region to the contamination situation is more difficult. Data

mostly do not allow an exact conclusion from the measured values in specific localities to the extent of contamination of the whole area. Possibly one will end up with models as rough as the one cited above. Because regional production models can be only rough also, exspecially in conurbation regions, where agriculture may be very heterogeneous, the anticipated adaptation path may readily lead in some unrealistic directions. Adaptation path depends mainly on the conditions of the single farm for example on its size, its supply with labour and capital and the portion of its land that is contaminated. The farmer will choose one of several land use alternatives with regard to his special possibilities and to the effect the adaptation will have to his returns. Nevertheless regional studies are needed, on the one hand as a preliminary to find some typical, representative situations; on the other hand because regional characteristics and requirements may influence the action of the farm and the possibilities of adaptation. Thus, the analysis is proposed to include the following steps:

- an effected region is chosen
- a regional study shows the agricultural structure and the locational factors as far as they influence production systems
- some representative, "typical" farms are specified. Their production systems conflict with certain situations of soil contamination
- as a result of this, land use restrictions become necessary
- the possibilities for the farm to adapt to the situation, with special regard to the cultivation of renewable resources are analysed in their economic consequences for the farm.

An example shall illustrate the proceedure: Agriculture in conurbations is severly affected. A study shows that the share of agriculturally used land in conurbations in still considerable. In the Ruhr-region agriculture has a share of 36 % of all economically used land in the centres and 60 % at the edges of the centres. In the conurbations of Köln the corresponding share is 53 %, in the heavily populated areas of München, Nürnberg and Augsburg it is 38 %. Soils here are often of high quality because these are the places where people