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ABSTRACT:

Lessons from the OECD workshop on biomass and agriculture

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The economies of many OECD countries in the 19th century were based on coal, with the emergence of increasingly oil based economies over the 20th century. But the 21st century could see the switch from the fossil fuel to the biological based economy, where agriculture would be rejuvenated as a source of bioenergy and biomaterials, as well as fulfilling its traditional role in providing food and fibre. But is the birth of the so called "bioeconomy" a false dawn according to some sceptics?

Costs will clearly play a key role. Projected prices of fossil fuels over the next 30 to 50 years might be expected to ensure the dominance of the hydrocarbon economy over much of this century. Even so, the price of bioplastics is already competitive with petroleum based plastics at the top end of the market. Also, some biofuels, such as ethanol are easier to exploit for their market potential than fuel cells. Existing engines can use ethanol with little alteration, and the current fuel distribution infrastructure would not need major change.

This paper summarises the key lessons learned from an OECD Workshop on Biomass and Agriculture, held in Austria, 2003. The overall purpose of the Workshop was to:

- *examine the sustainability of producing biomass from agriculture* (including agro-forestry, but not commercial forestry *per se*), covering the economic, social and environmental issues;
- *review current policy approaches used by OECD Member countries* to promote biomass production from agriculture in terms of their economic efficiency and environmental effectiveness;
- *explore possible policy options and market led approaches* to address policy and market failure in agricultural biomass markets.

LESSONS FROM THE OECD WORKSHOP ON BIOMASS AND AGRICULTURE

Kevin Parris[1]

1. Introduction[2]

There is growing interest by both governments and the private sector, across OECD and many non-OECD member countries, in developing markets for bioenergy and biomaterials produced from agricultural biomass. Within this context the OECD organised a Workshop**,** hosted by the Austrian government and held in Vienna, June 2003, which drew together a wide range of stakeholders representing agricultural, environmental, industrial and energy interests from government, the private sector, International Governmental Organisations and Non-Governmental Organisations. The Workshop's objective were to:

- ***examine the sustainability of producing biomass from agriculture*** (including agro-forestry, but not commercial forestry *per se*), covering the economic, social and environmental issues; and,
- ***review current policy approaches used by OECD member countries*** to promote biomass production from agriculture in terms of their economic efficiency and environmental effectiveness;
- ***explore possible policy options and market led-approaches*** to address policy and market failure in agricultural biomass markets, with recommendations to the OECD for possible future policy analysis in this area.

2. Agricultural biomass and bioproduct markets and their future potential

Bioenergy

Bioenergy and biomaterials (see glossary) ***derived from agricultural biomass currently contribute a very small share of the total OECD energy and raw material markets.*** But this OECD average statistic masks considerable variation within and across countries. The biobased economy is expected to grow rapidly in many countries over the next few years, in part due to new policies to promote or require greater use of renewable products, for example, bioenergy.

Bioenergy derived from agricultural biomass includes bioethanol and biodiesel which currently account for under 1% (energy basis) of the total EU and US vehicle fuel market. Regional variation within countries is highlighted by the example of the US where two states, Iowa and Illinois, supply over 50% of the US total agricultural biomass feedstock used in biofuel production.

The share of agricultural bioenergy in OECD heat and power generation is higher, accounting for about 7% of total heat and 1% of total electricity generated. In specific countries it ranges from over 10% of total consumer energy in Austria to under 1% in Japan. In developing countries the situation is different, with non-commercial biomass (firewood and animal dung) representing 25% of total energy demand, mainly derived from fuel wood, but agricultural by-products are also important.

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2. This paper is an edited extract from OECD (2004) publication ***Biomass and Agriculture: Sustainability, Markets and Policies*** (see the OECD website at: www.oecd.org/agr/env). The author wishes to thank OECD colleagues for their comments and assistance in preparing this paper. Any remaining errors in the paper are the responsibility of the author, and the views expressed do not necessarily reflect those of the OECD or its member countries.

Glossary of key terms used in this paper

Biomass: any organic material, of plant and animal origin, derived from agricultural and forestry production and resulting by-products, and industrial and urban wastes, used as feedstocks for producing bioenergy and biomaterials (only agricultural biomass was considered at the OECD Workshop).

Agricultural biomass: a subset of biomass produced directly from agricultural activities, including cereal grains; sugar crops; oilseeds; other arable crops and crop by-products such as straw; vegetative grasses; farm forestry (*e.g.* willow and poplar); and livestock by-products, for example, manure and animal fats.

Bioenergy: renewable energy produced from biomass when used to produce heat and/or power and transport fuels. Bioenergy produced from agricultural biomass includes ***biofuels*** such as bioethanol, mainly derived from cereal grains and sugar, and biodiesel from vegetable oils and animal fats; ***biopower*** in the form of electricity; and bioheat generated from processing mainly agro-forestry products (*e.g.* willow), crop and livestock by-products (*e.g.* straw and manure) and grasses (*e.g.* elephant grass).

Biomaterials: renewable industrial raw materials and derived processed products produced from biomass. Biomaterials produced from agricultural biomass mainly include ***industrial oils*** for paints, inks, etc. from oilseed crops; ***starch and sugar*** from, for example, cereals, potatoes, sugarbeet and sugarcane, used to produce polymers, detergents, paper, etc.; ***fibres*** from crops such as cotton and hemp; and ***high-value low-volume products*** derived from a variety of crops, and used in the production of, for example, cosmetics, flavourings, and healthcare products.

Bioproducts: includes both bioenergy and biomaterials.

Biobased economy: an economy that uses renewable biomass resources, bioprocesses and eco-industrial clusters to produce sustainable bioproducts and provide employment and income.

Biomass use in electricity generation is projected by the International Energy Agency (IEA) to be one of the fastest-growing primary energy sources in OECD countries, expanding at over 4% annually up to 2030, under current policy assumptions. As this growth is from a very low base, however, the market share of bioenergy derived from agricultural biomass will remain small, reaching only about 2% of total electricity generation by 2030. Government targets for production of bioenergy in many countries, for example the US and EU member states, aim to substantially expand production levels over the next 10_15 years, with bioenergy likely to become a major source of primary energy supplies in some localities and regions within OECD countries.

Biomaterials

For biomaterials derived from agricultural biomass current usage is very small compared with products derived from fossil fuel feedstock for most OECD countries. There are some exceptions, such as natural fibres (*e.g.* cotton, flax), vegetable oil-based products, and cereal/sugar-based starch mainly for the paper industry. Global trade in these products is in excess of USD 250 billion annually.

The potential for future growth of biomaterials derived from agricultural biomass is uncertain, because of the large diversity of feedstock and products, the complexity of technologies needed to transform the feedstock into industrial products, and the fact that most biomaterials are substitutes for fossil fuel based products. Even so, projections, although limited, would suggest that the growth in certain biomaterials could be substantial over the next 10 years.

These projections are underscored by the fact that some multinational chemical companies (e.g. Cargill-Dow, Bayer, Dupont) are rapidly increasing investment in biomaterial product development and processing plants, especially bioplastics derived from cellulosic plant material. Automobile manufacturers are also using more biomaterials in vehicle construction.

3. Biomass, agriculture and sustainability

The expanded production and use of bioenergy and biomaterials from agriculture is inextricably linked with the broader societal challenges and opportunities of contributing toward sustainable development. Sustainability is a complex and wide-ranging concept and is not linked to any one prescribed approach. But the basic objective for a sustainable agriculture is to optimise agriculture's net contribution to society, by making better use of physical and human resources. Sustainable farming systems are those that contribute to long-term welfare by providing food, raw materials and other goods and services in ways that are:

- **economically viable** – responding efficiently and innovatively to current and future demands for adequate, safe and reliable supplies of food and raw materials;
- **environmentally sound** – conserving the natural resource base of agriculture to meet the foreseeable needs of future generations, while maintaining or enhancing other ecosystems influenced by agricultural activities; and
- **socially beneficial** – meeting the wider values of society, such as supporting rural communities and addressing cultural and ethical issues, such as animal welfare concerns.

A key question for the Workshop was how and to what extent agricultural biomass production can contribute to sustainability? The following sections address this question by outlining some of the key issues that need to be considered in determining the contribution that biomass production from agriculture can make to sustainability.

Is agricultural biomass feedstock use economically viable?

The economics of biomass feedstock and use are dominated by considerations of costs relative to fossil fuel-based products. At present bioenergy derived from agricultural biomass feedstock in most situations (but with the notable exceptions of agricultural crop by-product and processing wastes) is usually competitive only where governments provide production subsidies, tax exemptions and other forms of support. Moreover, this support is against the background of the high level of support for the OECD agricultural sector, with the OECD (see the *Agricultural Policies in OECD Countries: Monitoring and Evaluation* report 2003), estimating that the total support cost to OECD farmers was nearly USD 235 billion in 2002, representing 31% of total farm revenue.

Market opportunities exist for biomass and bioproducts, particularly where using biological approaches can reduce production costs and environmental impacts. Even so, energy-based projections, such as the 2002 IEA *Energy Outlook*, indicate that changes in fossil fuel prices over the next 30 years are not expected to be large enough to drive widespread use of biomass for energy production.

Other options and opportunities will need to be found if the biomass feedstock and bioproduct industry is to become commercially viable and free of subsidies. But in making price comparisons between bioenergy and non-renewable energy sources it will also be important to make a critical analysis of the negative externalities and subsidies received by the coal, aviation fuel, oil exploration and nuclear power industries in some OECD countries.

Improved technologies and economies of scale, however, are narrowing the price gap between biomass and competing fossil fuel based products, especially through greater efficiencies in both biomass feedstock delivery to processing plants and also biomass conversion technologies. But this is only part of the solution to bridging the price gap. There is a need to develop longer-term strategies that recognise local/regional resources and potential and move toward multi-feedstock production and multi-product bio-refineries. Such complexes would be capable of producing both energy and materials, with emphasis on optimising the use of all agricultural biomass feedstocks, including recycling farm by-products, as well as using grains, oilseeds, sugar and other crops.

The economics of agricultural biomass could also be altered, vis-à-vis fossil fuels, by establishing markets for carbon offsets (i.e. bioenergy) and carbon sinks (i.e. for certain forms of biomass feedstock, such as agro-forestry). Furthermore since the supply chains for agricultural biomass are poorly developed, these could be improved through vertical and horizontal integration of the biomass industry to exploit synergies across different activities, such as agriculture, forestry, and municipal waste all supplying biomass feedstocks, and to develop institutional infrastructures for research and development, transport, marketing and sales networks.

Is agricultural biomass feedstock use environmentally sound?

The net balance between costs and benefits of biomass products compared with fossil fuel alternatives depends critically on how the environmental benefits and costs (*i.e.* externalities) ***are valued***. But few, if any benefits, have a suitable market in which to establish their price, and there remains a lack of information and agreement as to how to measure environmental externalities. Frameworks and assessment tools are being developed that will help improve measurement of externalities, such as life-cycle analysis (LCA). The use of LCA and other assessment tools, however, is not widespread throughout industries using bioprocesses or developing bioproducts. Hence, use of the LCA tool should be encouraged to identify the most efficient approaches in developing the bio-economy.

Some recent LCA studies indicate that compared to the use of cereal grains and sugar crops, the use of cellulosic plant material, such as grasses or woody crops for bioethanol production, result in substantial net economic and environmental benefits when all externalities are taken into account and valued. The use of cellulosic crop by-products, such as straw, can also reduce waste and involves using the whole plant crop and not just the grain, while using perennial grasses and woody crops can reduce fertiliser and pesticide use compared to arable crops. Processes using cellulosic materials as both the feedstock and the process fuel could potentially eliminate the use of fossil fuel process energy, yielding much improved carbon balances compared to the current use of cereal grains and sugar crops.

A critical issue concerning the future environmental sustainability of agricultural biomass relates to the interaction with other land uses. The availability of marginal land that could be used to produce woody crops is in some areas much greater than the limited cropland available to grow arable crops for non-food purposes. But large-scale changes in land use to produce biomass feedstock, may not always be appropriate or desirable as they could have adverse impacts on food production, soil quality, marginal and fragile land, biodiversity and landscape either within OECD countries or more globally.

The land requirements for biomass will in part depend on substitution with agriculture cropping and other land uses, improvements in yields of the principal biomass crops, and the extent to which agricultural by-products are utilised. These issues require further assessment, especially the consequences of increasing agricultural biomass production on food production and prices, effects on biodiversity, and the impact on soil quality and nutrient status from the removal of crop by-products for biomass feedstock instead of incorporating them back into the soil. Moreover, all these factors need examining in the light of reform of the existing agricultural support framework.

Is agricultural biomass feedstock use socially beneficial?

Assessing if agricultural biomass production is socially beneficial is probably the least well understood and most difficult dimension of sustainability to quantify. Estimating the social benefits and costs of expanding biomass production and products may require complex modelling of the net effects on farm incomes, rural employment and the economy as a whole. There are also difficulties of gauging public perceptions of biomass when there is a lack of knowledge of the industry. This highlights the importance of engaging local and regional communities into biomass projects to improve understanding of the industry and its potential benefits, and also to attract investors so that communities have ownership of projects.

4. The objectives for policy intervention in agricultural biomass markets by OECD countries

Most OECD countries are implementing measures to develop the markets for the use of agricultural biomass, with current emphasis on bioenergy. A range of policy tools are employed and many countries have adopted a policy strategy that seeks to bridge the price gap between biomass and bioproducts with fossil fuel alternatives rather than providing incentives and information for processors and consumers. Given cross-country differences in natural resources, industry, infrastructure, policy approaches and mixes towards developing a biobased economy, no one policy solution will fit all cases, but sharing experiences can help.

Government rationale for policy intervention in the agricultural biomass and bioproduct markets in most OECD countries is usually focused on three main objectives to:

- meet the broader goals of sustainable development linked to the vision of moving toward a biobased economy and recycling society;
- support the development of an "infant industry" as it moves down the experience chain; and to,
- ensure the provision of environmental and health benefits.

Vision toward a biobased economy and creation of a recycling society

Within the context of broader national goals of sustainable development and sustainable agriculture, ***a number of governments have articulated a vision for the biobased economy as an engine of growth and market innovation.*** The goals of this vision mainly include establishing sectoral contributions (*e.g.* agriculture, forestry), identifying directions for technology development, opening possibilities for export potential based on biobased technologies, developing business opportunities through carbon markets, and providing infrastructure and institutional frameworks.

The emphasis of this vision differs across countries. Some focus upon meeting renewable energy targets, others on material production from growing agricultural biomass crops, and others still on the recycling of agricultural by-products and waste minimisation. Energy importers, for example, may value more highly bioenergy production for reasons of energy security than an energy exporter. While some localities and countries may place a higher value on using bioethanol to achieve clean air goals, than meeting other environmental objectives.

Policies have often been directed at maintaining and diversifying farm incomes through supporting the production of agricultural biomass, rather than targeting the development of the biobased economy that would address the industrial demand for agricultural biomass feedstock as well as broader environmental and social goals. This latter approach necessitates the development of a coherent and integrated biomass policy framework that cuts across traditional ministerial boundaries (*e.g.* environment, agriculture, transport, industry, science and technology), and also engages local communities as the prime drivers in biomass projects. Such a strategic approach may be more demanding in the short term, but is more likely to deliver greater benefits in the long term.

The creation of a recycling society in many countries, reflects changing values and improvements in the efficiency of energy and raw material use. Policies to expand bioproduct output from agricultural biomass feedstock in some cases target the increased use of farm by-products to help reduce costs of their disposal and to encourage the reduction in use and disposal costs of non-renewable products. Some countries, concerned with the reliability of oil supplies, are also adopting measures to increase the diversification and security of domestic energy and raw material supplies, including expanding bioenergy and biomaterial production.

Infant industry and market failure

Government support to the biomass market on the basis of the "infant-industry" argument emphasises that initial research and development costs can be prohibitive or involve too high a risk to be supported solely by the private sector. This rationale is weaker for some areas of agricultural biomass production and processing, such as the use of cereal grains and sugar to produce bioethanol which has a relatively long history. Other areas of biomass conversion processes and technologies are only at the research and development stage, for example, biomass gasification processes and developing biomaterials from plant cellulose feedstock, such as from perennial grasses and cereal straw, although depending on how research and development costs are supported can have implications for competitiveness and trade.

The market failure justification for governments to support the development of the use of biomass is based on cases where the market does not remunerate the environmental and social benefits (externalities) generated from biomass production and processing. Some countries are implementing measures that seek to stimulate rural and regional industrial development and employment through expansion of agricultural biomass feedstock for regional bioproduct processing plants. In some localities this may help to diversify farm income and rural employment opportunities, while the uptake of appropriate technologies at different local/regional scale, may maximise environmental benefits.

Environmental and health benefits

Governments are also adopting measures to develop agricultural biomass to help meet a range of environmental and health objectives, such as improving soil and water quality, and biodiversity conservation. Greater use of bioenergy, especially biodiesel, is also being encouraged by some governments to meet air quality and health objectives, such as using bioethanol in fuel blends to reduce road vehicle exhaust particulates, with resulting improved health effects, although burning bioethanol can result in higher emission levels of other pollutants, such as nitrogen oxide.

Whether agricultural biomass production can meet environmental objectives depends on the current farming system that biomass production replaces, and the extent to which production displaces valued farming habitats or results in the intensification of land use and resulting harm to soil, water and biodiversity resources. Over the longer term the method of producing and harvesting biomass from agriculture can also affect soil and water quality, water resources and biodiversity conservation.

A key environmental objective for most countries is the commitment to reduce greenhouse gas emissions under the UN Framework Convention on Climate Change. Bioenergy provides a source of renewable energy with zero or low carbon dioxide (CO_2) emissions compared to fossil fuels. But this is highly variable between different bioenergy feedstocks, with cellulosic feedstocks such as perennial woody crops normally with lower net CO_2 emissions compared with cereal grains, sugar crops and oilseed crops which require higher energy inputs. Carbon certification schemes offer a way of establishing the net impact of biomass systems on emissions and ensuring that biomass technologies deliver carbon savings compared to fossil fuel or other renewable technologies.

5. Policy instruments and market approaches used by OECD countries to develop agricultural biomass markets

Financial incentives

Financial incentives are the most common policy instrument OECD countries have used to stimulate biomass markets. Typically this involves indirect production support for agricultural biomass crops, such as cereal grains, sugar and oilseeds, by reducing sales tax on bioethanol and biodiesel fuel blends; the use of set-aside land for energy and raw material crops; grants and other investment subsidies for developing biomass processing technology and capacity, especially bioenergy plants; higher tariffs for biopower fed into the national power grid (*i.e.* "feed-in tariffs"); and excise tax credits for using biofuel blended fuels instead of fossil fuels.

The emphasis of many financial incentive measures tends to be on closing the gap between production costs and market prices for biomass products relative to those based on fossil fuels. Instead policies should be more focused on maximising environmental benefits, encouraging innovation and reducing technology costs in the utilisation of biomass to stimulate the industry. Payments or low-interest loans granted to reduce risks of biomass projects, if not provided as a lump sum or gradually reduced over time, can introduce market distortions and long-term market dependence on subsidies.

Indirect production support for agricultural biomass feedstock can also lead to production, trade and price distortions with other food and raw material commodity markets. In some cases, the use of trade barriers to protect agricultural biomass feedstock producers may further exacerbate these market distortions. For example, sugar production is one of the most highly supported and protected agricultural commodities across OECD countries. Also, the loss of previously uncultivated land or land managed for conservation to intensive biomass cultivation, such as for land under diversion schemes, could have a negative impact on biodiversity.

Market-based approaches

More recently some countries have explored the development of market-based approaches to stimulate the biobased economy. A number of governments are establishing carbon markets which provide credits to biomass producers for fossil fuel displacement and GHG sinks. As opposed to providing subsidies, creating a market for carbon places a monetary value on the external benefits of reducing GHG emissions. Creating carbon markets will in future be sensitive to the GHG accounting and trading schemes that result from the process of international greenhouse policy negotiations.

Good practice guidelines, research and communication strategy

Good practice guidelines have been developed by some countries to assist different stakeholders involved in developing commercial biomass projects (*e.g.* landowners, feedstock producers, transporters, processors). In only a few cases have governments developed standards and labelling specifically for biomass projects. Guidelines and standards could greatly help a newly created biomass industry. For example, by enhancing vertical and horizontal integration to improve feedstock supply reliability, and guarantee product quality, especially by certifying carbon savings and environmental benefits and providing international standards for traded biomass feedstocks and bioproducts.

Improving biomass research and development, education and public awareness is an area requiring a greater policy response than at present for many countries. Targeting research and development on innovation and market-focused projects, such as large-scale pilot testing, can yield rapid results. A better understanding of the external benefits and costs of biomass use and bioproducts, and of those fuels and materials they compete with is necessary.

A clear communication strategy is needed for technology and feedstock providers and potential users, including across different government agencies with responsibility for the biomass industry, such as agriculture, environment, energy, and industry. This strategy should be extended to improve public education, awareness and understanding of the biomass sector. Such a strategy would be beneficial in the local communities where projects are established, as an important prerequisite to gain local acceptance and involvement in biomass projects. This strategy might be further developed by OECD countries to improve interactions and exchange of biomass information and technologies with developing countries.

6. Future Research Challenges

The OECD Workshop concluded that countries need to (forestry was outside the scope of the Workshop):

- ***evolve a new policy strategy for biomass production*** that works with markets in facilitating a balance between stimulating demand for bioproducts and developing appropriate feedstock supply, and addresses those cases where fossil fuel and derivate product industries are favoured through subsidies;
- ***promote targeted policy options and market approaches*** that encourage industry innovation and provide maximum long-run benefits to society, (such as using feedstocks and implementing processes with very low net greenhouse gas emissions), rather than continuing with a policy strategy that just seeks to close the gap between production costs and market prices for biomass versus fossil fuel products;
- ***ensure that biomass and bioproducts are produced to appropriate international standards***, especially in view of increasing international trade in these feedstocks and products, and that there are codes of best practice in place to ensure that carbon savings are delivered and wider environmental benefits are maximised;
- ***improve assessment of the costs and benefits of using agricultural biomass feedstocks and related bioproducts*** to meet economic, trade, environmental and social objectives in the agricultural, energy, and industrial sectors in the context of sustainable development;
- ***establish clear lines of communication between technology and feedstock suppliers***, processors and potential users, and also across relevant government agencies responsible for the bio-economy, especially agriculture, environment, energy, industry, science and technology; and,
- ***develop public education, awareness and understanding of the biomass sector*** and its contribution to the biobased economy.