Short Rotation Crops in the World: IEA-Bioenergy Task 30 Organization and Priorities[1]

Plantações de Curta Rotação no Mundo: IEA-Bioenergy Task 30 Organização e Prioridades

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Abstract: IEA Bioenergy is an International collaborative R&D agreement, with the aim to accelerate the use environmentally sound and cost-competitive bioenergy on a sustainable basis, to provide increased security of supply and a substantial contribution to future energy demands. By means of a Task on Short Rotation Crops, IEA-Bioenergy acquires, compiles and transfers theoretical and practical knowledge of sustainable short rotation biomass production systems with the aim to enhance market development and large-scale implementation in collaboration with the various sectors involved. Four SRC - High Priority Areas, presently under review by the *Task on Short Rotation Crop*s, are presented here together with its recent developments and future plans. SRC are land-use effective biomass production systems, due to use of species and management leading to relatively small differences between gross and net productivity, and optimal resource allocation to harvestable fractions. Due to their biological properties, SRC may play a key role in water and nutrient management and soil rehabilitation. These functions, together with the suitability to deliver other co-products, play an important role in the developments needed to overcome the economic constraints of the system as a stand along crop for bioenergy purposes. The main barriers to large scale implementation of the system are of non-technical nature and do require awareness creation and extension activities as well as a progressive use of policy instruments to be overcome and to accelerate the use of bioenergy. IEA-Bioenergy will be running a new Task on SRC during 2004-2006. This Task will have a strong focus on improving production system efficiencies, reducing negative environmental impacts from SRC systems, applying SRC systems for specific environmental purposes, identifying co-product opportunities that could facilitate SRC uptake, accelerating deployment of SRC systems and identification of barriers to large-scale implementation.

Key words: IEA Bioenergy, short rotation crops, biomass, bioenergy.

Resumo: IEA-Bioenergy é um acordo de colaboração em R&D (Pesquisa e Desenvolvimento) que visa acelerar o uso sustentável de bioenergia ambientalmente limpa e de custo competitivo, para propiciar uma oferta mais segura e substancial à demanda de energia futura. Por meio de uma *Task on Short Rotation Crops*, a IEA - Bioenergy adquire, compila e transfere conhecimento teórico e prático sobre sistemas de produção sustentável de biomassa, através de rotação curta, visando melhorar o desenvolvimento do mercado e a implementação em larga escala, em colaboração com os vários setores envolvidos. Quatro áreas de alta prioridade em plantações de curta rotação (SRC), estão atualmente sob revisão pela *Task on Short Rotation Crops*, são apresentadas neste trabalho, em conjunto com os recentes progressos e os planos futuros. SRCs são sistemas efetivos de produção de biomassa para uso agrícola, devido às diferenças relativamente pequenas entre produtividade bruta e líquida, e alocação

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ótima de recursos em frações coletáveis, alcançadas através do uso de espécies e do manejo. Devido às suas propriedades biológicas, as SRCs podem desempenhar um papel importante no manejo da água e nutrientes e na recuperação do solo. Estas funções, associadas com a possibilidade de produzir outros subprodutos, desempenham um importante papel no desenvolvimento necessário para a superação das limitações econômicas do sistema de cultivo para fins bionergéticos. Os principais obstáculos a implementação do sistema em larga escala são de natureza não-técnica, exigindo atividades de conscientização, criação e extensão, como também o uso progressivo de instrumentos de política, visando a superação e aceleração do uso de bionergia. IEA-Bionergy estará introduzindo uma nova task em SRC durante 2004-2006. Esta task enfatizará o aperfeiçoamento das eficiências dos sistemas de produção, reduzindo os impactos ambientais negativos causados pelos sistemas SRC, aplicando sistemas SRC para fins ambientais específicos, identificando oportunidades de co-produtos que possam vir a facilitar a difusão (absorção e aceitação) de SRC, acelerando a distribuição de sistemas SRC e identificando as barreiras à implementação em larga escala.

Palavras-chave: IEA Bioenergy, plantações de rotação curta, biomassa, bioenergia.

INTRODUCTION

When discussing the development of the global human population in relation to its biogeophysical environment, we notice how we continue to put increasing demands on an ever shrinking natural resource base on which we all depend. There is a growing awareness that our production of goods and concurrent exploitation of natural resources is causing a degradation of our environment, to such a degree that available supplies of pure water, uncontaminated soils and even of fresh air are severely limiting a huge part of our population, and is putting populations of other species at risk.

Consequently, the notion of sustainable development is increasingly dominating our ways to produce goods, food, and suitable energy carriers. Research and implementation efforts are going on world-wide with regard to renewable energy and most of us realize, whether we like it or not, that it will not take too many generations before the last barrel of fossil oil is pumped up at a competitive price, which - by the way - will be higher than today's oil price. We urgently need renewable sources to derive our energy from, and global energy use projections predict that biomass will be an important component of primary energy sources and a main source of renewable energy in the coming decades. Short-rotation crops (SRC) will be a major component of this biomass.

People who on a daily basis work with SRC are confronted with a large number of questions and concerns. To identify the particular groups in our society that are posing questions and to assess the nature of the particular concerns they put forward, we may ask the legitimate question: Why are you concerned, instead of: What is your particular question? By systematically proceeding that way, four groups can be identified:

1. Those who are concerned with sustainability, environment, the needs of future generations (comprising a substantial part of the general public).
2. Those who have a strong (long-term economic) interest in - potentially competing - land based systems (land-owners, foresters, farmers etc.).
3. Those who intend to make a living on the relatively new SRC-systems, the people who are prepared to take a certain risk by managing the uncertainties associated with the development of new systems.
4. Those who currently are making profit on traditional (fossil fuel based) energy systems.

The major message that IEA-Bioenergy Task 30 wants to mediate here consists of good news for groups one, two and three. I also want to acknowledge the sometimes very strong counter-lobby initiated by group four: Its counter-actions are comforting us because concerns of this group proves that we are under way to develop alternatives that are going to give the traditional energy industry a severe match. The fossil fuel industry obviously seems to realize that once fossil fuel projects are being asked to pass the same high level of scrutiny as is required today for biomass to energy projects, their dominant role in the energy sector will be over. Alternatively, representatives of group four may pick up some ideas here on where to invest their money in the near future.

I will discuss the role of Short Rotation Crops, especially for energy use, as outlined in the current work done in high priority areas, as identified by IEA-Bioenergy Task 30, and show you some of the recent Task 30 initiatives. Prior to that, I will introduce you to IEA-Bioenergy and shortly introduce you to the other IEA Tasks that are active in the field of bioenergy.

IEA Bioenergy

IEA Bioenergy is an International collaborative R&D agreement, with the aim to accelerate the use environmentally sound and cost-competitive bioenergy on a sustainable basis, to provide increased security of supply and a substantial contribution to future energy demands. It started in 1978 with 4 countries, and from January 2003 there are 20 member countries.

Major activities include:

- co-operative R&D
- information exchange
- national experts sharing info & work
- industrial involvement
- workshops and seminars
- handbooks and models

Based on the needs and priorities of the member countries, the programme of IEA Bioenergy is organized by tasks that run on a 3-year cycle. The new cycle for the SRC-task starts in 2004. Current Tasks (2003) are:

Task 29: Socio-Economic Drivers in Implementing Bioenergy Projects

Task 30: Short Rotation Crops for Bioenergy Systems

Task 31: Conventional Forestry Systems for Sustainable Production of Bioenergy

Task 32: Biomass Combustion and Co-firing

Task 33: Thermal Gasification of Biomass

Task 34: Pyrolysis of Biomass

Task 35: Techno-Economic Assessments for Bioenergy Applications

Task 36: Energy from Integrated Solid Waste Management Systems

Task 37: Energy from Biogas and Landfill Gas

Task 38: Greenhouse Gas Balances of Biomass and Bioenergy Systems

Task 39: Liquid Biofuels

Organisation and participants od Task 30, SRC for bioenergy.

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Task Secretary: Nils-Erik Nordh, SLU, Sweden.

The Task is organized with 'National Teams' in the participating countries. The contact person (National Team Leader) in each country is listed below:

Country	National Team Leader	Institution
Australia	Don McGuire	South Australian Forestry Corporation
Brazil	Laércio Couto	Federal University of Vicosa
Canada	Andrew Gordon	University of Toronto
Croatia	Davorin Cajba	University of Zagreb
Denmark	Uffe Jørgenson	Danish Institute of Agricultural Sciences
New Zealand	Ian Nicholas	Forest Research Institute
Sweden	Theo Verwijst	Swedish Univ. of Agricultural Sciences
UK	Keith Richards	TV Energy
USA	Bryce Stokes (alternate- John Stanturf)	USDA Forest Service

You will realize that there are a number of differences between the participating countries in our Task, with regard to social settings, legislation, climate, and also with regard to the actual crops used in different corners of the world. These differences are overruled by the similarities at process level when it comes to biomass production, by the coherence in the questions asked in different places and also by a resemblance in the final applications and solutions found to particular problems.

Consequently, the remainder of this talk will illustrate several aspects of our activities across the participating countries.

In this current Task 30 on SRC, we put emphasis on four 'High Priority Areas'. These are:

1: Sustainable SRC-Systems: Biomass production and technical aspects.

2: Sustainable SRC-Systems: Environmental and economic externalities.

3: Full-scale implementation of SRC-systems: Assessment of technical and non-technical barriers.

4: The use of Policy instruments - incentives, regulations, legislation to boost bioenergy, and assessment of their effectiveness.

We conceive 'sustainability' as a directional rather than absolute measure and include biological, economic and social aspects in its applicability.

The first High Priority Area (HPA) gives an answer to the questions: What are SRC, how do they function, how do they compare to other crops?

The second one has its focus on their benefits, others than biomass for energy, and show that SRC can be conceived as multi-purpose systems that may combine production and environmental goals in a very efficient way.

The third HPA shows that 'Sustainable SRC-Systems' do have strong economic and social dimensions that need to be accounted for if they are to be implemented successfully.

This means that 'SRC-Systems for energy' are subject to political decisions and actions, and that the way policy instruments are devised and used may be crucial for the deployment of SRC in our society. Assessment of policy instruments consequently is our fourth HPA.

Sustainable SRC-Systems: Biomass production and technical aspects.

Short rotation crops are plant biomass production systems, used in short rotations. Their energy is derived from the sun, as a result of photosynthesis, and stored in the organic matter as chemical energy.

If we trace the 'losses' of solar energy all the way from the solar constant in space to the energy fixed in a harvestable annual biomass increment of about 10 tons of dry matter per hectare and year, we find that about 0.5% of the solar energy was fixed in the harvest of 10 tons, that we obtained. Most of the solar energy never reached our site, due to the earths geometry and scatter in the atmosphere. Only half of the incoming radiation has the proper wavelength to be used in photosynthesis, and the quantum use efficiency of photosynthesis is relatively low. In other words, there are lots of losses that we cannot do anything about.

However, the harvest we obtained (10 tons of dry matter), went along with a carbo-hydrate production of above 30 tons/ha/yr. Where is the other 20 tons? In many vegetation types, the majority of the energy, incorporated by the photosynthetic process, is used for maintenance respiration, or allocated to other parts of the plant than those we intended to harvest. Our ideal SRC has a minimal difference between gross and net productivity and allocates a maximum of its resources to easily harvestable plant parts. And these are the major factors that we have been working on, when improving the productivity of SRC-systems, either by plant breeding and choice of varieties, or by managing the site in such a way that respiration and allocation patterns are changed in the wanted direction. And for the different systems, we do have estimates on what gains can be made, and at what rates, when improving management practices such as site preparation, fertilization, etc, and by efforts in plant breeding.

By far most of our agricultural crops are SRC and you may obtain a picture of their efficiency if you see that 90% of the worlds food production is performed on only a few percent of the available land area. Many of these crops play an important role as ‘non-dedicated energy crops’, meaning that the residuals of the crops, originally grown for something else that biomass for energy, do form a great resource base for the energy industry (straw, sugar cane- bagasse , rice husk etc.) while providing an additional income to farmers. We would be able to increase the overall biomass production of such crops, but we do not because the breeding goals for these crops have a different focus (protein-, starch contents, high grain to straw proportion, etc.).

Developments in global forestry give the same picture as in agricultural crops with regard to land-use efficiency: Less than 5% of the worlds forests consist of plantation forests, and these now are producing more than 25% of the global industrial round-wood, and generating a huge amount of residuals that can be used in the energy sector.

Dedicated SRC for energy consist of plantations of Eucalypt, Poplar, Robinia, Willow and some other woody species, and also comprise a number of annual and perennial crops such as Switchgrass, Reed canary grass and Miscanthus. In all these systems, substantial progress has been made in the last decade with regard to productivity and with regard to positive effects on the environment. Management, logistics and harvest of these systems differ widely and incorporate elements of traditional agriculture and forestry, depending on the systems resemblance with those two categories.

In terms of net biomass productivity, SRC is 10 to up to 20 times more productive than most of our natural and extensively managed forests, an in many instances is matching our very best traditional agricultural production levels. We need SRC, not only for the production of biomass, but also to counteract watershed damage, erosion, pollution and other adverse aspects of traditional agriculture and forestry which in many aspects have been far from sustainable.

Sustainable SRC-Systems: Environmental and economic externalities

SRC are tremendous biomass producers as you have seen, but they are useful in a number of other ways too.

Given the current low price for energy, as a stand-alone crop for energy, SRC is marginal as an economic crop in many regions. But due to their biological properties SRC may play a key role in water management, nutrient management and soil rehabilitation. In other words, SRC exhibit a number of functions, the need for which only is increasing, and for which the society is willing to pay a price. And thereby the economy of SRC is viable in many cases.

In the USA, in Europe and in the Australian and Asian regions, we have examples of SRC systems used to produce biomass, and functioning as recipients of wastewater. These systems simultaneously produce biomass and fresh water, in many cases suitable as drinking water.

SRC also can be used in the form of buffer strips to avoid nutrient runoff from nearby agricultural sites. In ongoing trials in Sweden, nutrient rich surface water from an agricultural area is collected and pumped through a willow SRC, resulting in a tremendous biomass production and in a clean water discharge to small rivers and lakes.

Organic waste, different kinds of sludge and also ash have been deposited in landfills in many instances. We realise now that we should not conceive this waste as a burden for society, but as a fertiliser for our SRC. Sludge and ash certification systems are on their way, to avoid soil contamination by heavy metals, as once occurred while using artificial fertilisers. Actually. Several SRC species and varieties do have the potential to actively take up heavy metals, and thereby it is possible to use some SRC to remove fertiliser induced cadmium contamination from sites, enabling the production of food again. Such special applications of SRC, often performed by willow and poplar species, go under the term 'phytoremediation', and are becoming important business in several places.

A growing SRC industry also is finding its way into markets for co-products. I refer to the Australian oil mallee industry having options to produce activated coal and leaf oils, Eucalypt SRC in Brazil producing charcoal to feed the pig-iron industry, and willow SRC in Sweden, Denmark and Belgium entering markets for gardening and construction of green space in urban areas.

In summary, we see that the environmental and ecological benefits of the system may be applied for a variety of special purposes which should act as a catalyst for the developments needed to overcome the economic constraints of the system.

Full-scale implementation of SRC-systems: Assessment of technical and non-technical barriers

Why has the renewable energy industry, and particularly the bioenergy industry such a small fraction of the energy market, and why is this industry growing only slowly, in many countries?

We use to distinguish between technical and non-technical barriers to large-scale implementation, and the increasing knowledge base that is building up in our Task work on SRC suggests that main barriers to large scale implementation of SRC are of non-technical nature. We are learning rapidly to produce large amounts of biomass in a land-use efficient and environmental friendly way, we are on our way to press the costs of bioenergy to such a degree that the systems are or shortly will become competitive with other land-use options.

In Sweden, for example we have developed the commercial system of willow SRC within only a few decades to such a degree that it is truly competitive with wheat-growing under current agricultural legislation. From the point of production system development, this is a real success, but still many people denounce the system as a complete failure, because they had expected to see 200,000 hectares of that particular SRC at this stage, instead of the current 15,000. Technical barriers, such as;

1. Variability in harvest season length, concurring need to over-dimension harvest capacity,
2. CHP-operators not used to tune equipment for use with high proportions of SRC-derived material,
3. Harvest equipment not suitable in deep snow, causing very high moisture contents at terminal,
4. Narrow genetic base in breeding material, increasing risk for pest/diseases, etc.

Mostly have been solved for the particular system. The same is true for many of the technical hindrances of the SRC-systems employed in other parts of the world. But what about the following 'non-technical barriers'?

1. Confidence in the system among farmers and foresters (takes years to build, can be lost in a fortnight).
2. Awareness and knowledge of the general public.
3. Confidence in renewable energy among general public.
4. Effects of counter-lobby from fossil fuel industry and from traditional land based industries.
5. Effects of 'Alliances' between fossil fuel industry and politicians in power.
6. Effects of legislation in agriculture and forestry, once based on a very profitable and unsustainable practice.

If you analyse the above 'non-technical barriers', you may come to the conclusion that 'large-scale implementation of bioenergy' is more or less equivalent to: 'Challenging well established power and capital in force in many nations', and that this has to be performed by means of informing and educating the public, stakeholders, all people who by virtue of the democratic system they live in, have some power to influence decisions that will affect their lives an those of next generations.

Someone here told me that in this part of the world 'bioenergy is one of the better kept secrets of all renewable energy sources'. If there is some truth in that statement, we may well ask some critical questions about the role of the media, radio, television, newspapers etc. As an example, this issue just shows how complicated and intricate the non-technical barriers for large scale implementation of bioenergy can be. Even more complicated, especially on an international level, is the development of policy instruments - incentives, regulations -, legislation to boost bioenergy, and assessment of their effectiveness.

The use of policy instruments - incentives, regulations -, legislation to boost bioenergy, and assessment of their effectiveness

You may have sensed some criticism in my statements with regard to the influence of 'well established power and capital' and of politics in finding solutions to our energy/environment problems. While my concerns seem to be confirmed by the developments around the Kyoto protocol, I acknowledge that the entire Kyoto protocol process has been and still is of great help for the creation of public awareness in many places of the world. We see private initiatives coming up in line with parts of this protocol, we even see regional and national legislations adapting accordingly.

In other words, actual progress also is being made by means of policy instruments.

The development of SRC in Sweden was a political initiative, has survived, and spread to other countries, by means of political support. A country report from Australia, presented in the framework of our SRC-task, clearly shows that the community is responsive to political incentives to promote bioenergy. Green electricity schemes have been adopted in several parts of the world, with help of incentives, and in many cases there is some support for land-owners to invest in systems that may produce biomass for energy purposes.

When designing subsidising systems to promote SRC in Sweden, we learned that planting grants may have a devastating effect in the long run, if they just are released to plant, instead of to produce something. It appeared that 90% of willow stands, once established under a planting grant scheme, never received any fertilisation, and their concurring low productivity in later years was used as an argument against the whole system.

Synchronisation of legislation between regions or nations also is of importance: Swedish willow SRC now has to compete with 'building waste wood', imported from nearby countries where it is considered as risk-waste and forbidden to incinerate. Such 'holes in the law' may be temporary, but may cause a developing industry to vanish from the scene rapidly.

One of the major challenges for politicians in the near future is to integrate forestry and agricultural policy into one coherent 'biological natural resource policy'. It seems to be part of human nature to categorize land based biomass production systems into either agriculture or forestry. These traditional categories are associated with different perceptions, prejudice and with a substantial bulk of category specific legislation and regulations, often preventing a sound, ecologically and economically justified development of SRC. In several places where people only a short while ago were allowed to cut down forests to start an agricultural enterprise, people now are asking why they are not allowed to plant a tree crop for bioenergy purposes. This is a legitimate question in itself, and only becomes stronger when agricultural crops are failing due to the absence of a tree cover in the watershed.

The premises for biomass production for energy on 'agricultural soils' differ widely from those for biomass production for energy by means of 'forestry' in many countries and yet, the production systems are addressing the same market.

If we intend to put out a new clonal variety of Poplar, Willow or Eucalypt in our forests, we may be severely questioned by some 'green organisations'. I would agree with them that extensive, nature based forestry should be based on the use of native trees, and/or use of provenances. We even see advantages in developing SRC based on native species. But we should have the legal right to cultivate SRC, even woody SRC, in the same way as we have bread and grown carrots, wheat and other intensively grown crops. If we look at out land base and adopt a 'triad concept', instead of a traditional classification in forestry and agriculture, we acknowledge the need for natural reserves, for extensively used areas and for areas designed for environmentally friendly but intensively managed sites for production of biomass. And SRC definitely belongs to the latter category.

Recent developments initiated by Task 30

To increase the impact of our Task-30 work, we have under the running task period developed a website: <www.shortrotationcrops.com>, through which you can obtain updated information on our organisation, participants and ongoing work in the participating countries. Task reports and country reports can be downloaded directly from this site. The site now also is updated with presentations given during the Task-30 conference in Denmark 2001, and includes presentations displayed during the international workshop 'Sustainable Bioenergy Production Systems: Environmental, Operational and Social Implications' that we organised together with Task 31 in Belo Horizonte, Brazil 2002. By means of this site, we announce future events undertaken in the framework of our Task, and provide links to a number of relevant organisations in the respective member countries.

We also publish a biannual newsletter reporting, among others, our latest activities, and this new-letter can of cause be downloaded from our website.

Reviews of our High Priority Areas, as described in this paper, also will be published on our website shortly. The first review to be out is the one on ‘Environmental and Economic Externalities of Sustainable SRC Systems’, compiled by Ian Nicholas, Laercio Couto and Don McGuire, and has a strong focus on Eucalypts. Only a few years ago, Eucalypt was poorly represented in our Task work, but due excellent Task work performed in Australia, Brazil and New Zealand, the importance of Eucalypt as a SRC now becomes fully displayed internationally by the IEA-Bioenergy Task 30 window.

During the current Task period, we have formulated a new proposal for a Task to be run during 2004-2006. During the next period, our work will have a strong focus on:

1. Improving production systems efficiencies
2. Reducing negative environmental impacts from SRC production systems
3. Establishing and managing SRC systems for specific environmental benefits
4. Identifying co-product opportunities that could facilitate SRC uptake.
5. Accelerating deployment of SRC systems and identification of barriers to large-scale implementation.

We will continue the ongoing technology and information transfer by means of:

- Annual workshops
- Website development
- Newletters
- Revision of SRC Handbook (by 2006)

We realise that the sustainable production of biomass is the basis for a further development of the bioenergy industry and acknowledge that the generation of biomass resources only is a first step in a value chain that leads to the desired end- products. That is why we in our task continue to integrate research themes across the entire value chain, and foster intensive cooperation with other IEA-Bioenergy Tasks.

In the next Task period, we will have a joint workshop with Task 29, on socio-economic aspects of bioenergy, and we have an ongoing information exchange with the Task on conventional forestry systems. Finally, we have an interaction with several IUFRO Task groups and with the International Poplar Commission (FAO).

If you feel that you can and want to contribute to our Task work on SRC within the framework of IEA Bioenergy, you are welcome to take up contact with your National Team Leader, to be found at <www.shortrotationcrops.com>.

ACKNOWLEDGEMENT

This presentation is based on the experience and work of many of our active participants in Task 30. Thank you for your input!