Memo: Follow-up BUS report
By: Marieke Meeusen and Frank van Tongeren
Date: May, 12 2005

UNDERSTANDING THE FACTORS WHICH DETERMINE BIOMASS AVAILABILITY

1. Reason for this study

Many studies have been devoted to understanding the potential amounts of biomass present at various levels. Several BUS tickets have been worked out in order to determine which portion of this potential biomass actually becomes available. These tickets make it clear that economic factors must also be taken into account in order to understand the amount of biomass that can actually be expected to become available. The BUS tickets that have been worked out also make it clear that the result of the economic analysis differs per biomass flow, per region etc. This is largely due to the alternative application of the biomass flow and the (economic) objective of the (potential) provider of the biomass. It is therefore clear that - if we are to obtain any real insight into the amount of biomass available - the already existing studies must be expanded to include economic factors. In addition, the amount of potentially available biomass should also be evaluated within the context of renewable/sustainable energy policy. After all, the ultimate goal of using biomass as a source of energy is to contribute to a sustainable society. In other words, we need to obtain a better understanding of the factors which determine whether, and to which extent, the potential amount of biomass can become available: a) practically speaking, and b) in a socially responsible fashion.

2. Goal

This paper answers the following questions:

- Which factors influence the availability of biomass? The factors considered do one of two things: a) they determine social support/acceptance for describing the biomass as being a 'sustainable' source of energy b) they determine the economic feasibility. Both types of factors differ per flow of biomass.
- Which (economic) models and studies can be used to supplement the existing studies in order to obtain more insight into the conditions which determine whether the potentially available biomass actually becomes available?

The follow-up results in a phased plan or checklist, which lists the factors that can provide insight into the actual availability of 'socially responsible' biomass, per biomass flow and per region. The checklist makes it possible - on the basis of a potential quantity of biomass - to (quickly) find out which part of that biomass will actually become available. The checklist is generally applicable for all biomass flows in all regions of the world. The checklist also contains tools which can be useful in further working out these issues.

The checklist focuses on several types of biomass flows, namely:

1. biomass cultivated specifically for bioenergy;

2. the residual flows which become available (at the production level) during the production of biomass (e.g. straw as a by-product of grain production);
3. the residual flows which become available (at the processing level) while processing biomass (e.g. flakes, cacao shells).

Other flows - such as wood, residual materials which become available during tree farming and aquatic cultivation of biomass - are not dealt with in this paper.

3. General approach: relevant themes

The availability of 'socially responsible' biomass demands a broad-based approach. This issue involves new applications in new markets, with regard to which sustainability is often a very important factor. When discussing the position of biomaterials, it therefore makes sense to emphasise the 'sustainability' factor. A second factor which determines the actual availability of biomass for bioenergy is its competitive position compared to other applications and the motives/considerations involved in that comparison. Finally, the prices and demands set by the market will also influence the economic feasibility. We are therefore dealing with three themes when it comes to determining the actual availability of sustainable biomaterials within the context of the bioenergy market.

- Social support/acceptance and sustainability;
- Market analyses;
- Economic analyses.

These three themes are not independent of each other but are rather interconnected.

4. Social support

4.1. Introduction

The bio-based economy is driven by developments on the supply side. In the Netherlands, for example, the sale of residual flows in existing markets (in particular for cattle feed) is running into limitations. These limits are determined by the requirements related to food safety and the (diminishing) size of the livestock. At the same time, there are developments on the demand side which determine the demand for bio-based products. The major issue in that respect is the assumed contribution to a sustainable society. The demand for bio-based products is stimulated by such factors.

Two important aspects must be kept in mind when considering the position of sustainable products:

- Sustainability alone is usually not enough to ensure access to a (large) market. It should be emphasised that such products must (also) score well with regard to the 'normal' quality requirements (ease-of-use, functionality, etc.). The sustainability factor must be an added benefit compared to the alternative and cannot replace the normal requirements.
- The marketing of sustainable products requires social support. When is a product considered to be sustainable? Such questions can only be answered via feedback from and interplay with social forces. Within the context of the bioenergy discussion, we have seen that a one-sided focus on the CO2 contribution is not sufficient to elevate bioenergy to the role of a 'sustainable' source. In other words, the import of bioenergy must certainly be viewed within a broader sustainability perspective. The 'people' component of sustainability also needs to be considered. A stakeholder analysis and dialogue

can be very helpful for obtaining insight into the relevant issues regarding sustainability and the positioning of various products. This provides insight into the issues considered relevant by stakeholders. In this way, social support can be mobilised for the strategy that needs to be followed, which will minimise the risk of market failures.

4.2. Tools, checklist methods

In determining social support, the first step is the stakeholder analysis, followed by the stakeholder dialogue. In this paper, the stakeholder analysis is worked out further.

A large variety of stakeholders are involved in sustainability issues. Four different groups can be differentiated in this regard, each with its own role, responsibility and importance:

- The business world, focused on organisational continuity and the (financial) profit required to ensure continuity;
- Government, focused on the interests of its citizens and the shared interests of society;
- Nongovernmental organisations, focused on the (sub) interests of a specific group of members of society;
- Knowledge oriented institutes and bodies, focused on contributing to the social debate with facts and knowledge.

Of course, it is impossible to involve all the stakeholders in the decision-making process related to all the (strategic) sustainability issues. A selection must be made. In making a selection, two criteria can be of help:

- The degree to which the stakeholders can influence matters;
- The degree to which the stakeholders have an interest in the matter.

	Little influence	Much influence
Little interest	A	B
Much interest	C	D

Figure 1: Positioning of stakeholders with regard to influence and involvement

Cell A includes stakeholders who do not have much interest in the subject and also have little influence. The stakeholders in cell B also have little interest but do have considerable influence. The stakeholders in cell C have much interest in the subject but only limited influence. Cell D includes stakeholders who have a considerable interest in the matter as well as influence. It should be evident that the stakeholders in cells B, C and D - in particular - are important. Their opinions and wishes should also be taken into account.

The stakeholders selected are then asked under which conditions they would consider biomass for bioenergy to be a sustainable solution, which underlying problems they think can be solved in this manner, and in which areas solutions might be found for possible bottlenecks. In selecting the relevant sustainability issues, the checklist used by Ten Pierick and Meeusen (2004) may serve as an aid. This checklist is included as annex 1. It includes all the sustainability issues which - from the Triple P viewpoint - could play a role in sustainable agrofood chains. The stakeholder analysis provides a description of the limiting conditions under which biomass for energy could really be considered to be 'socially responsible'. An example for imported biomass has been worked out further in the box below.

Planet (environment)
- CO_2 emission throughout the entire chain (C cycle).
- Other emissions to air, water and soil throughout the entire chain.
- Other activities with environmental impact throughout the entire chain.
- Biodiversity.
- Use of space.

This implies that the entire chain - from production up to and including consumption - must be improved with respect to all the various environmental themes. Attention should also be paid to the use of crop protection agents, artificial fertiliser, water and energy in the production phase. In doing so, one must consider not only the environmental effects on a local scale but also the effects on a global scale.

People (social-cultural)
- Development of rural areas and employment.
- Transparency and validation of information throughout the chain.
- The personal responsibility of citizens and businesses with regard to climate change and emissions.

With regard to the people-based component, the contribution to the development of rural areas, in particular, is mentioned. Bioenergy becomes an attractive option when it contributes to employment both quantitatively and qualitatively.

Profit (economic aspect)
- Price of energy.
- Security of supply.
- Incomes and living standard for links in the chain.
- Developing and expanding knowledge.
- Innovation.

Profitability is taken into account for all links in the chain. Bioenergy is an attractive option only if it contributes to the profit of actors in the chain and preferably contributes *more* than other activities. At the same time, the goal is to keep supply costs as low as possible in order to be able to offer the consumer energy at a price not much greater than normal. In this respect, consideration must also be given to the impact on other parts of the world. With regard to the profit aspect, for example, the development of knowledge for the Dutch economy is also a factor to be taken into account. Innovation and new technologies which can lead to knowledge export are also considered positive.

Box 1: Example of a list of limiting conditions under which stakeholders consider the import of biomass to be 'socially responsible'

5. Market analysis

5.1. Introduction

A farmer can utilise his land for various products, as he can choose from a wide range of crops to cultivate. These crops can also be sold in various markets. The same is true for the owner of residual flows. He can also choose from various applications. Quite often, a selection is made from several 'F applications': farma, food, feed, fuel. The various markets differ in many ways: size, sale price, quality specifications desired, supply amounts desired, continuity desired etc. An evaluation of the various options based on these aspects determines which application and which market provide the most attractive possibilities for the biomass produced or - in case of residual flows - the biomass for sale.

By obtaining an external perspective on the opportunities and threats concerned, one can obtain insight into the attractiveness of a particular market. At the same time, it's also necessary to obtain an internal perspective with regard to strengths and weaknesses in order to evaluate whether, and to what degree, it will be possible to benefit from or deal with opportunities and threats. Ideally speaking, the producer will compare the various options for his biomass flow and choose the option which best fits his company strategy. For the purchaser of biomass, this means that he should be aware of the fact that the farmer's production factors (land, capital and labor) can be used for a variety of applications, of which bioenergy is just one out of many. The same is true for the owner of residual flows. He also has a range of options for selling his residual flows, of which bioenergy is also just one option out of many.

The following question then becomes very relevant: how does bioenergy score in comparison with other markets? Economic attractiveness (see below) is thereby a very important factor. To a great degree, the behaviour of economic actors is determined by the economic attractiveness of one alternative compared to another alternative.

5.2. Tools, checklist methods

The objective of a SWOT analysis is to provide insight per application area into the opportunities and threats, on the one hand, and the strengths and weaknesses, on the other hand - thereby making it possible to choose the most attractive market option. In the first place, the SWOT forms the basis for a set of Critical Success Factors, which must at the very least be complied with in order to successfully utilise the application in a given market. A company can then ask itself whether it is able and willing to go down that particular road.

The external environment analysis (opportunity and threat analysis) includes the macro-environment forces (demographic, economic, technological, political-legal and social-cultural) and significant micro-environment actors (customers, competitors, distributors, suppliers) that affect its ability to earn profits. The analysis results in two matrices: an opportunity matrix and a threat matrix:

High success probability High attractiveness	Low success probability High attractiveness
High success probability Low attractiveness	Low success probability Low attractiveness

Figure 2: An opportunity matrix
Source: Kottler, 2003

In the opportunity matrix the best marketing opportunities are listed in the upper-left cell; management should pursue these opportunities. The opportunities in the lower-right cell are too minor to consider. The opportunities in the upper-right cell and lower-left cell should be monitored for any improvement in attractiveness and success probability.

High probability of occurrence High seriousness	Low probability of occurrence High seriousness
High probability of occurrence	Low probability of occurrence

Low seriousness	Low seriousness

Figure 3: A threat matrix
Source: Kottler, 2003

The threats in the upper-left cell are major threats, because they can seriously hurt the company and have a high probability of occurrence. To deal with these threats, the company should prepare contingency plans that spell out changes it can make before or during the threat. The threats in the lower-right cell are very minor and can be ignored. The threats in the upper-right and lower-left cells do not require contingency planning but need to be monitored carefully in case they become more serious.

Once management has identified the major threats and opportunities facing a specific business; it can characterise that business's overall attractiveness. The following options are possible:

- An ideal business is high in major opportunities and low in major threats;
- A speculative business is high in both major opportunities and threats;
- A mature business is low in major opportunities and low in threats;
- A troubled business is low in opportunities and high in threats.

It is one thing to identify attractive opportunities but quite another to be able to take advantage of them. An internal environment analysis helps a business to do the latter. To carry out such an analysis, a business needs to evaluate its internal strengths and weaknesses. Figure 5 gives a checklist for performing a strengths/ weaknesses analysis.

The market orientation analysis reveals: (a) which application options are available for the product (b) the opportunities, threats, strengths and weaknesses per application. For example, a given residual flow may have two different potential applications, which differ with regard to market size, price and quality requirements. On one side of the scale, we find a market large in size and low in price, which requires a company to 'do little work'. On the other side of the scale, we find a market which is smaller in size, offering a higher price, which requires a company to invest time and energy in analyzing and developing the opportunities for unlocking the value of the residual product in order to provide a valuable new product for the purchaser (i.e. product development). It should be clear that the first market referred to will require a minimum investment of time and energy but will also provide the least reward. The latter market offers a more attractive pricing point, but requires the provider to invest time and energy in thinking about and developing new networks with new customers. The choices involved for a company are strategic ones: does the company wish to enter into new and less familiar markets with new networks, and is it prepared to invest the necessary time and money to do so?

Box 2: An example of a SWOT for residual flows

	Performance	Importance
Marketing • Company reputation • Market share • Customer satisfaction • Customer retention • Product quality • Service quality • Pricing effectiveness • Distribution effectiveness • Promotion effectiveness • Sales force effectiveness • Innovation effectiveness • Geographical coverage		
Finance • Cost or availability of capital • Cash flow • Financial stability		
Manufacturing • Facilities • Economies of scale • Capacity • Able, dedicated workforce • Ability to produce on time • Technical manufacturing skill		
Organisation • Visionary, capable leadership • Dedicated employees • Entrepreneurial orientation • Flexible or responsive		

Figure 5: A checklist for performing strengths/weaknesses analysis
Source: Kottler, 2003

6. Economic feasibility

6.1. Introduction

Once a (provisional) choice has been made regarding a market and application, the question of economic feasibility becomes very relevant. To answer this, a cost/benefit analysis is done. What costs are involved in marketing and selling the biomass flow and what are the benefits provided in return? Ideally, this analysis is carried out for the various application options, after which the economically most attractive option can be selected. The party requesting the biomass should be aware that he is also in competition with other possible purchasers for the same biomass.

A characteristic of biomass that deserves specific attention is the fact that it consists of several components, each of which may be interesting for specific markets. Ideally, a solution is found which optimises the potential for all the components from a particular residual flow or from a particular crop. However, as it turns out, this aspect is not yet always taken into account in actual practice. Generally speaking, the economic player (the producer, processor) bases his economic actions primarily on the returns provided by the main product. The economic player remains focused on his core business. For him, the by-product is literally a by-product: it is something that is also produced on the side. For the potential purchaser of by-products, it is therefore also important to keep abreast of market developments for the (related) main products. After all, it is these main products that determine whether the by-product will or will not become available.

Generally speaking, the greater the purity of a product, the more interesting it will be for a specific application. However, the cost of obtaining the (pure) product will also increase with the degree of purity. A cost/benefit analysis is therefore definitely relevant here. Another related aspect is the mutual interdependence of the market potential for the various component products. In the final analysis, one strives to realise an optimum combination of market potential for all the component products that can be derived from the biomass. For example, if there is an option of realising a pure biomass flow, which also provides a large amount of residual product with (much) lower market potential, the initial rosy perspective becomes much less attractive. It should be emphasised that the market potential for the various component products must be evaluated while taking into account the mutual interdependencies. The risk factor is also relevant here. If an entire array of biomass flows is dependent upon a single promising market - which is considered a risky one - then the perspective is less attractive than would be the case in a 'more secure' market. As a result, a choice is often made to deal with unlocking the value of a limited number of biomass flows.

6.2. Tools, checklist methods

The model 'Unlocking the Value of Organic Residual Flows' is a useful tool for evaluating which processes for unlocking the value of residual flows are the most attractive from an economic viewpoint. This involves an integrated evaluation of all the costs and benefits involved in processing the materials as well as the (various) resulting products. In doing so, the model identifies the conditions under which processes are economically the most attractive as well as the related sensitivity to pricing and the economic breakeven point.
The following illustration is an example of how the model can be helpful. It involves a comparison of two different options for unlocking the value of residual flows. The first option, A, involves a process which costs € 2 per unit of residual flow and which provides two products in a particular ratio. The second option, B, involves a more expensive process, which costs 5 € per unit of residual flow and which provides four products in a different ratio. The products from option B command a different price than the products from option A. The evaluation involves a comparison of costs and benefits for both options, whereby all flows are taken into account.

Table: Net benefits from unlocking the value of 100 kg of residual flow in € per ton

	Option A	Option B
Costs	200	500
Benefits	Fibre: 20 * 11 = 220 Protein: 10 * 12 = 120 Wastewater effluent: 70 * -	Fibre A: 10 * 2 = 20 Fibre B: 30 * 3 = 90 Protein: 40 * 1 = 40

	1 = -70	Colouring agent: 5 * 150 = 750 Wastewater effluent: 15 * -5 = -75
Total	70	325

It's clear that in the final analysis process B, although more expensive, is more attractive than process A, as long as there is a market for colouring agent B. If the market for colouring agent B disappears, then process A becomes more attractive than process B. This illustration shows how risky a particular choice can be and how great the influence can be of the sales opportunities for a particular product. In the model 'Unlocking the Value of Organic Residual Flows', the user has the option of evaluating the possibilities provided by various products and processes (economically speaking) in greater detail. The model also makes it clear that the price of a product depends on market size: pricing elasticities are built into the model.

For the potential producer of biomass for bioenergy, the following question is central to the economic evaluation: how can I generate as much added value as possible with my (scarce) production factors (land, labour, capital). For the potential provider of residual flows for bioenergy, a different question is central to the economic evaluation: how can I market the residual flows as attractively as possible? The answer will differ from company to company, depending upon the particular company strategy chosen. An economic analysis therefore requires an overview of all the costs and benefits for the player involved per alternative. For the producer, this means that various crops and marketing options must be compared with each other. For the owner of residual flows, this means that various marketing options for the residual flow are compared with each other.

7. An integrated approach: GTAP

An integrated global economic approach, differentiated per region

In the comparison between the various applications, economic attractiveness plays a decisive role. Production and consumption of biomass are driven by technical as well as economic considerations. Technical feasibility does not imply that new developments are actually taken into production, and long-term projections based purely on technological potential have time and again proven to be off-mark. The utilisation of biomass potential for (bio)energy depends on a number of factors, including:

1. Agronomic features, including land availability and growing conditions
2. (supply) response of farmers, i.e. the decision to grow bioenergy relevant crops
3. Technical substitutability of biomass energy for conventional energy sources
4. Economic substitutability of biomass energy for conventional energy sources
5. National and global policies
6. Social considerations
7. Environmental considerations

Economists and economic models have something to say about items 2, 4 and 5 on the above (non-exhaustive) list. Agronomic, biophysical and technical aspects are typically included in these models in a cursory fashion. Agricultural economists, however, have a tradition of including agronomic production features in their models, and recent developments in the EU attempt integrated modelling of economic, agronomic, environmental, climatic and social issues. (e.g. SEAMLESS and SENSOR, which are both so-called integrated projects sponsored by the FP6 of the European Union).

Key to fruitful long-term projections of biomass issues is a proper modelling of the supply side of biomass and a proper representation of the demand side for bio-energy. In both demand and supply, technical and economic considerations play a role, and therefore a multidisciplinary approach is warranted.

However, additional actions on the theme of 'bioenergy' remain necessary
The GTAP model is a global economy-wide model that covers worldwide production, consumption and trade. It is a general equilibrium model, based on the micro-economic foundations of production- and consumption behaviour. It captures backward and forward linkages within each of the regional economies through an input-output structure. In the general equilibrium structure, both prices and quantities are endogenously determined as outcomes of the model after a perturbation of exogenous variables, such as policies, technological changes, taste changes etc.

Since its inception in 1992, the explicit aim of the GTAP project has been the lowering of entry barriers to global trade analysis. Much of the focus of GTAP is directed towards the analysis of agricultural policy and trade, but there are also applications in non-agricultural trade-related issues as well as environmental policy analysis. More recently, database development and modelling have also expanded in the direction of energy usage and climate change. Therefore, the GTAP modelling framework is a potentially useful starting point, but it would need to be adapted for the specific issues at hand (See Annex X)

The project is now supported by a consortium of 18 national and international agencies and provides financial support as well as guidance to the Center of Global Trade Analysis at Purdue University (USA). The consortium includes some of the major players in global trade analysis (World Bank, WTO, UNCTAD). The GTAP website provides more information on the consortium, conferences, courses and other activities and is a repository of resources: http://www.gtap.org/. The current version of the database (version 6) has coverage of 87 regions, 57 commodity groupings and 5 primary factors (Land, Skilled and Unskilled Labour, Capital and Natural Resources), and is benchmarked to 2001 US dollar values. See Annex X for a country and commodity listing.

The main components of the database consist of bilateral trade, transport and protection matrices that link the country/ regional input-output (IO) databases. Although the commodity coverage has a deliberate agricultural bias with 12 primary agricultural sectors (8 food processing sectors, 1 forestry sector and 1 fishing sector), within the remaining commodity groupings, there is significant disaggregation of manufacturing, services and fossil fuel sectors. The database contains energy use data for 5 energy commodities (coal, oil, gas, petroleum commodities, electricity), and a special model version (GTAP-E) is geared towards modelling energy and climate issues (this model has been used extensively in the IPCC context).
Given its current low share in global energy use, the database does not include separate information for biomass energy.

Box: Further notes on GTAP

8. Phased plan

1. Determine which sustainability issues are relevant

- Select the stakeholders who have influence on and an interest in the themes of sustainability, agrofood chains and bioenergy
- Be aware of the complex and inclusive nature of sustainability within the framework of the discussion on agrofood – biomass – bioenergy. Use a checklist (Ten Pierick and Meeusen, 2004, for example)
- Together with the stakeholders, select the factors which determine the social support base for the use of biomass for bioenergy.

Result: a list of sustainability issues which determine the social support base for the biomass-bioenergy chain to be selected

2. Determine the critical success factors which determine whether the primary producer will or will not cultivate biomass for bioenergy

- Try to put yourself in the shoes of the potential provider of the biomass, in other words the farmer with land at his disposal on which he can cultivate various crops for various applications, which will provide him with various net yields;
- Determine the potential applications for the available production factors;
- Determine the strengths and weaknesses per application;
- Determine the opportunities and threats per application;
- Put yourself in the shoes of the farmer and choose the application you think he will choose;
- Determine what additional things you need to do, as a player on the demand side of the biomass equation, to make the bioenergy market (more) attractive for the farmer.

Result: insight into the critical success factors which you, as a potential purchaser of biomass, can influence in order to make the bioenergy market more attractive for the primary producer

3. Determine the critical success factors which determine whether residual flows - at the level of the producers and processers - will or will not be utilised for bioenergy

- Put yourself in the shoes of the potential provider of the biomass: the owner of the residual flows (farmer or processer), who has products available which he can try to sell in various markets, each of which involve varying levels of investments and net returns;
- Determine the potential applications for the residual flow;
- Determine the strengths and weaknesses per application;
- Determine the opportunities and threats per application;
- Putting yourself in the shoes of the residual flow owner, choose the application you think he will choose;
- Determine what additional things you need to do, as a player on the demand side of the biomass equation, to make the bioenergy market (more) attractive for the owner of residual flows.

Result: insight into the critical success factors which you, as a potential purchaser of biomass, can influence in order to make the bioenergy market more attractive for the primary producer

4. *Determine whether, as a potential purchaser of biomass, you wish to positively influence the critical success factors on the supply side in order to ensure that the potential biomass actually becomes available.*

Sources

Kottler, P. (2003) Marketing management, Prentice Hall

Annex 1: List of sustainability issues

Figure B.1.1 gives an overview of all categories, aspects, sub-aspects and indicators.

Dimension	Category	Aspect	Sub-aspect	Indicator
People	Working conditions	Health and safety of workers	Safety	Reducing the number of worker accidents.
			Health	Reducing the number of sickness-related and other types of absenteeism related to working conditions.
		Secondary terms of employment	Training and education	Average number of hours spent on training as a result of this project.
			Worker facilities	An increase in the number of employees making use of (not legally mandated) facilities for realising a better fit between their roles as private persons and as employees (for example via child care, parental leave, care leave etc.). An increase in the number of employees making use of (not legally mandated) facilities for assisting them in developing career opportunities or ending their active work career.
	General social themes	Norms and values	Emancipation	Reduction in number of complaints regarding unequal treatment.
			Human rights	Decrease in number of complaints regarding non-compliance with human rights. Reduction in number of complaints regarding forced labour and child labour.
		Transparency	Labelling and hallmarks	Increase in number of products with a label and/or hallmark.
			Reporting	Increase in number of GRI indicators included in annual report.
	Agro-specific social themes	Animal welfare	Animal health	Decrease in average number of days that animals are sick or wounded. Decrease in wastage percentage.
			Natural behaviour	Increase in average number of days that animals can display natural (species specific) behaviour.
			Accommodations	Increase in average space available per animal.
			Care	Decrease in number of instances in which animals are hungry and/or thirsty. Decrease in number of instances in which animals suffer from fear and/or stress.

Dimension	*Category*	*Aspect*	*Sub-aspect*	*Indicator*
People (continued)	Agro-specific social themes (continued)	Animal welfare (continued)	Care (continued)	Decrease in number of animals that undergo an amputation or other treatment for the sake of simplifying maintenance of the animals involved.
		Quality of local environment	Historic buildings	Increase in number of historic buildings and/or monuments which are restored to and/or maintained in good shape.
			Recreation	Increase in number of visitors to recreational facilities.
			Noise nuisance	Decrease in number of complaints regarding noise nuisance.
		Food safety	Food safety	Decrease in number of complaints regarding health and safety issues.
				Decrease in number of punishments and size of penalties imposed.
				Decrease in number of product recalls.
Planet	Compartments	Soil	Use of land	Decrease in amount of land used for production activities and mining/exploitation activities.
			Soil quality	Decrease in emissions of heavy metals.
				Decrease in emissions of other substances which impact the environment.
			Soil erosion	Increase in cover percentage.
		Air	Air quality	Decrease in emissions of greenhouse gases.
				Decrease in emissions of gases which negatively impact the ozone layer.
				Decrease in emissions of other substances which impact the environment.
			Odour nuisance	Decrease in emissions of odour-causing substances.
		Water	Water use	Decrease in water usage.
				Decrease with regard to groundwater and surface water.
				Increase with regard to recycled and reused water.
			Water quality	Decrease in emissions of substances impacting the environment.
				Decrease in unintentional emissions of substances impacting the environment.

Dimension	*Category*	*Aspect*	*Sub-aspect*	*Indicator*
Planet (Continued)	Environmental themes	Waste	Waste	Reduction in amount of waste.
				Reduction in amount of waste through waste prevention.
				Increase in waste processing.
				Increase in recycling of waste or materials.
				Reduction in amount of hazardous waste.
		Biodiversity	Biodiversity	Decrease in number of animal and plant species (IUCN Red List).
				Increase in amount of land in accordance with natural category target.
				Stopping activities in nature areas.
				Starting activities in nature areas.
		Energy	Energy consumption	Reduction in energy consumption (excluding fuel for transport).
			Energy produced by players themselves	Increase in use of energy produced by players themselves.
			Sustainable energy	Increase in use of sustainable energy.
		Crop protection agents	Emissions of crop protection agents	Decrease in number of locations negatively impacting the environment.
				Decrease in amount of crop protection agents.
		Raw materials, additives and other materials	Raw materials, additives and other materials	Decrease in amounts of raw materials, additives and other materials.
			Renewable raw materials	Increased use of renewable raw materials.
		Minerals	Mineral emissions	Reduction in degree of saturation.
		Transport	Transport	Reduction in fuel consumption for transport.
				Reduction in number of transport kilometres
	Other	Environmental awareness	Environmental awareness	Increase in overall amount spent on the environment.

Dimension	*Category*	*Aspect*	*Sub-aspect*	*Indicator*
Profit	Competitive strength	Ability to adapt to market conditions	Service	Increase in customer satisfaction regarding service.
			Responsiveness	Reduction in number of days between start of product development and market introduction.
				Number of product introductions.
		Efficiency	Employee productivity	Increased turnover per fulltime equivalent.
			Price/quality ratio	Increased customer satisfaction regarding price/quality ratio.
		Chain harmonisation	Information exchange	Increased number of contacts between chain partners.
				Number of complaints regarding information exchange.
				Number of complaints regarding timeliness of information exchange.
			Cooperation	Increased formalisation of agreements between chain partners.
		Strategic potential	Flexibility	Reduction in number of days between the last possibility for a purchaser to change specifications and order delivery.
			Financial health	Increase in ratio between company net capital and total capital.
			Innovativeness	Number of patents filed.
			Absorption potential	Reduction in age of machinery.
	Costs and returns	Returns	Turnover	Increase in net turnover (per organisation submitting; inside and outside the Netherlands).
		Costs	Costs	Costs (per organisation submitting; inside and outside the Netherlands; in developing countries).
	Employment	Quantity of employment	Quantity of employment	Increase in number of full-time equivalents (per organisation submitting; inside and outside the Netherlands; in developing countries).
		Quality of employment	Quality of employment	Increase in employee satisfaction regarding work content.
	Other	Competition	Competition	Reduction in number of complaints regarding non-compliance with competition laws.

Figure 1: An overview of the categories, aspects and indicators

Annex 2: Questionnaire for stakeholder analysis

Taking stock of the parties involved
- Which parties play a role with regard to the import of biomass and which of these are the most important ones?
- What are their standpoints with respect to the discussion on the import of biomass?

Exploration of success factors
- What is needed to ensure that the discussion on the import of biomass is successful?
- What is needed to ensure that the developments with respect to the import and use of biomass are successful?
- Which conditions does the result have to comply with?

Exploration of problems
- Which problems arise with respect to the import and the use of biomass?
- *(may include standpoints of political parties, insufficient insight into risk factors, high financial risks run by business persons, support from environmental organisations, involvement of private parties, public involvement, insufficient trust between various parties, insufficient linkage between the various parties (cultural differences)*
- How would you order your own priorities regarding the list of problems?
- What consequences does that have regarding the progress made?

Exploration of expectations of stakeholders
- What expectations do you have regarding the import and use of biomass?
- What expectations do you have regarding the use of biomass as a source of energy?
- What specific expectations do you have regarding a possible pilot?
- What expectations do you have of the different parties in the various phases?

Determining responsibilities

- What is the objective of your contribution to the discussion surrounding the import and use of biomass; what are you interested in?
- What do you see as your responsibility in this area?

Exploration of possible solutions to the problems mentioned

- Which solutions do you see for the problems mentioned?
- Which parties play a role in the above?
- Are there any parties presently involved who you think should (be allowed to) have hardly any or no involvement at all?

Taking stock of 'missing pieces' with regard to supporting the process
- What is your opinion of the process surrounding the discussion on the import and use of biomass? Do you think there is an organised stakeholders' dialogue?
- Are any aspects of the process receiving too little attention?
- Which aspects of the entire process should receive more attention?
- Which players could take the initiative with regard to the above?

Main role

In your opinion, which party is doing most of the pushing when it comes to developing biomass applications?

- Which party or person would you prefer to see pushing the development of biomass applications?

Taking stock of questions regarding actions and knowledge
- Which actions are needed to achieve a sensible resolution of the discussion regarding the import and use of biomass?
- Which information (knowledge) is needed to support these actions?

Figure: example of a questionnaire

Annex 3: An example "Unlocking the value of residual flows"

The following illustration is an example of how different options for unlocking the value of residual flows can be compared with each other. The first option, A, involves a process which costs € 2 per unit of residual flow and which provides two products in a particular ratio. The second option, B, involves a more expensive process, which costs 5 € per unit of residual flow and which provides four products in a different ratio. The products from option B command a different price than the products from option A. The evaluation involves a comparison of costs and benefits for both options, whereby all flows are taken into account.

Table: Net benefits from unlocking the value of 100 kg of residual flow in € per ton

	Option A	Option B
Costs	200	500
Benefits	Fibre: 20 * 11 = 220 Protein: 10 * 12 = 120 Wastewater effluent: 70 * -1 = -70	Fibre A: 10 * 2 = 20 Fibre B: 30 * 3 = 90 Protein: 40 * 1 = 40 Colouring agent: 5 * 150 = 750 Wastewater effluent: 15 * -5 = -75
Total	70	325

It's clear that in the final analysis process B, although more expensive, is more attractive than process A, as long as there is a market for colouring agent B. If the market for colouring agent B disappears, then process A becomes more attractive than process B. This illustration shows how risky a particular choice can be and how great the influence can be of the sales opportunities for a particular product. In the model 'Unlocking the Value of Organic Residual Flows', the user has the option of evaluating the possibilities provided by various products and processes (economically speaking) in greater detail. The model also makes it clear that the price of a product depends on market size: pricing elasticities are built into the model.

Annex 4: GTAP region and sector detail

GTAP v6 commodity breakdown

Primary agriculture
- Paddy rice
- Wheat
- Cereal grains nec
- Vegetables, fruit, nuts
- Oil seeds
- Sugar cane, sugar beet
- Plant-based fibers
- Crops nec
- Cattle, sheep, goats, horses
- Animal products nec
- Raw milk
- Wool, silk-worm cocoons

Natural resource based activities
- Forestry
- Fishing
- Coal
- Oil
- Gas
- Minerals nec

Processing agriculture and food
- Meat: cattle, sheep, goats, horse
- Meat products nec
- Vegetable oils and fats
- Dairy products
- Processed rice
- Sugar
- Food products nec
- Beverages and tobacco products

Manufacturing
- Textiles
- Wearing apparel
- Leather products
- Wood products
- Paper products, publishing
- Petroleum, coal products
- Chemical, rubber, plastic prods
- Mineral products nec
- Ferrous metals
- Metals nec
- Metal products
- Motor vehicles and parts
- Transport equipment nec
- Electronic equipment
- Machinery and equipment nec
- Manufactures nec

Services
- Electricity
- Gas manufacture, distribution
- Water
- Construction
- Trade
- Transport nec
- Sea transport
- Air transport
- Communication
- Financial services nec
- Insurance
- Business services nec
- Recreation and other services
- PubAdmin/Defence/Health/Educat
- Dwellings

GTAP v6 regions (87)	Member regions (226)
Austria	Austria
Belgium	Belgium
Denmark	Denmark
Finland	Finland
France	France
Germany	Germany
United Kingdom	United Kingdom
Greece	Greece
Ireland	Ireland
Italy	Italy
Luxembourg	Luxembourg
Netherlands	Netherlands
Portugal	Portugal
Spain	Spain
Sweden	Sweden
Bulgaria	Bulgaria
Cyprus	Cyprus
Czech Republic	Czech Republic
Hungary	Hungary
Malta	Malta
Poland	Poland
Romania	Romania
Slovakia	Slovakia
Slovenia	Slovenia
Estonia	Estonia
Latvia	Latvia
Lithuania	Lithuania
Rest of Oceania	American Samoa
	Cook Islands
	Fiji
	French Polynesia
	Guam
	Kiribati
	Marshall Islands
	Micronesia, Federated States of
	Nauru
	New Caledonia
	Norfolk Island
	Northern Mariana Islands
	Niue
	Palau
	Papua New Guinea
	Samoa
	Solomon Islands

	Tokelau
	Tonga
	Tuvalu
	Vanuatu
	Wallis and Futura
India	India
Rest of Free Trade Area of the Americas	Antigua & Barbuda
	Bahamas
	Barbados
	Dominica
	Dominican Republic
	Grenada
	Haiti
	Jamaica
	Puerto Rico
	Saint Kitts and Nevis
	Saint Lucia
	Saint Vincent and the Grenadines
	Trinidad and Tobago
	Virgin Islands, U.S.
Rest of the Caribbean	Anguilla
	Aruba
	Cayman Islands
	Cuba
	Guadeloupe
	Martinique
	Montserrat
	Netherlands Antilles
	Turks and Caicos
	Virgin Islands, British
Rest of South African Customs Union	Lesotho
	Namibia
	Swaziland
Malawi	Malawi
Tanzania	Tanzania, United Republic of
Zimbabwe	Zimbabwe
Rest of Southern African Development Community	Angola
	Congo, the Democratic Republic of the
	Mauritius
	Seychelles
Madagascar	Madagascar
Uganda	Uganda
Rest of Southeast Asia	Brunei Darussalam
	Cambodia
	Lao People’s Democratic Republic

	Myanmar
	Timor Leste
Bangladesh	Bangladesh
Rest of South Asia	Afghanistan
	Bhutan
	Maldives
	Nepal
	Pakistan
Mozambique	Mozambique
Zambia	Zambia
Rest of Sub-Saharan Africa	Benin
	Burkina Faso
	Burundi
	Cameroon
	Cape Verde
	Central African Republic
	Chad
	Comoros
	Congo
	Cote d'Ivoire
	Djibouti
	Equatorial Guinea
	Eritrea
	Ethiopia
	Gabon
	Gambia
	Ghana
	Guinea
	Guinea-Bissau
	Kenya
	Liberia
	Mali
	Mauritania
	Mayotte
	Niger
	Nigeria
	Reunion
	Rwanda
	Saint Helena
	Sao Tome and Principe
	Senegal
	Sierra Leone
	Somalia
	Sudan
	Togo
Brazil	Brazil

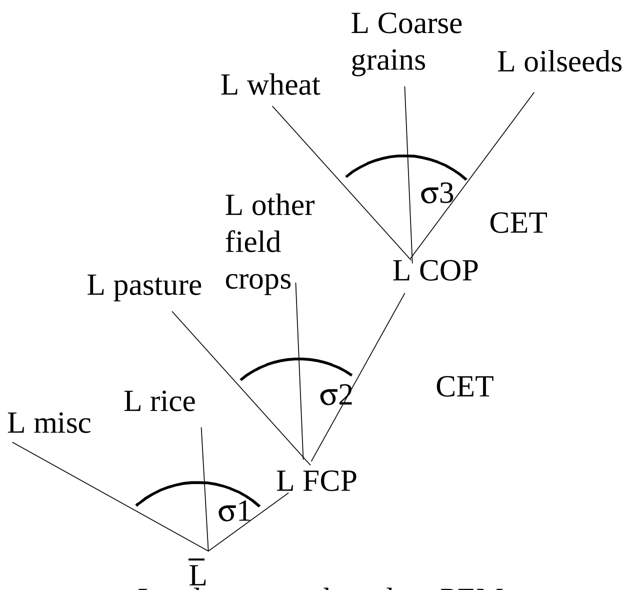
Botswana	Botswana
South Africa	South Africa
United States of America	United States of America
New Zealand	New Zealand
Japan	Japan
Korea	Korea, Republic of
Canada	Canada
Mexico	Mexico
Switzerland	Switzerland
Rest of EFTA	Iceland
	Liechtenstein
	Norway
China	China
Russian Federation	Russian Federation
Turkey	Turkey
Rest of Middle East	Bahrain
	Iran, Islamic Republic of
	Iraq
	Israel
	Jordan
	Kuwait
	Lebanon
	Palestinian Territory, Occupied
	Oman
	Qatar
	Saudi Arabia
	Syrian Arab Republic
	United Arab Emirates
	Yemen
Morocco	Morocco
Tunisia	Tunisia
Rest of North Africa	Algeria
	Egypt
	Libyan Arab Jamahiriya
Indonesia	Indonesia
Australia	Australia
Thailand	Thailand
Hong Kong	Hong Kong
Taiwan	Taiwan
Rest of East Asia	Macau
	Mongolia
	Korea, Democratic People’s Republic of
Malaysia	Malaysia
Philippines	Philippines
Singapore	Singapore
Viet Nam	Viet Nam

Sri Lanka	Sri Lanka
Rest of North America	Bermuda
	Greenland
	Saint Pierre and Miquelon
Colombia	Colombia
Peru	Peru
Venezuela	Venezuela
Rest of Andean Pact	Bolivia
	Ecuador
Argentina	Argentina
Chile	Chile
Uruguay	Uruguay
Rest of South America	Falkland Islands (Malvinas)
	French Guiana
	Guyana
	Paraguay
	Suriname
Central America	Belize
	Costa Rica
	El Salvador
	Guatemala
	Honduras
	Nicaragua
	Panama
Rest of Europe	Andorra
	Bosnia and Herzegovina
	Faroe Islands
	Gibraltar
	Macedonia, the former Yugoslav Republic of
	Monaco
	San Marino
	Serbia and Montenegro
Albania	Albania
Croatia	Croatia
Rest of Former Soviet Union	Armenia
	Azerbaijan
	Belarus
	Georgia
	Kazakhstan
	Kyrgyzstan
	Moldova, Republic of
	Tajikistan
	Turkmenistan
	Ukraine
	Uzbekistan

Annex 5: Further notes on GTAP

Modelling the supply side of biomass

A crucial aspect of modelling the supply of biomass crops is the allocation of land. In conjunction with the OECD secretariat, LEI has undertaken to model the agricultural supply side in GTAP in a specific way that allows us to capture the limited substitutability of land across alternative crops (and livestock for feeding purposes). In a nutshell, the land allocation is driven by relative returns that can be earned, while taking into account the fact that not all crops can easily be grown on alternative soils. The following figure illustrates the concept:



Land structure based on PEM

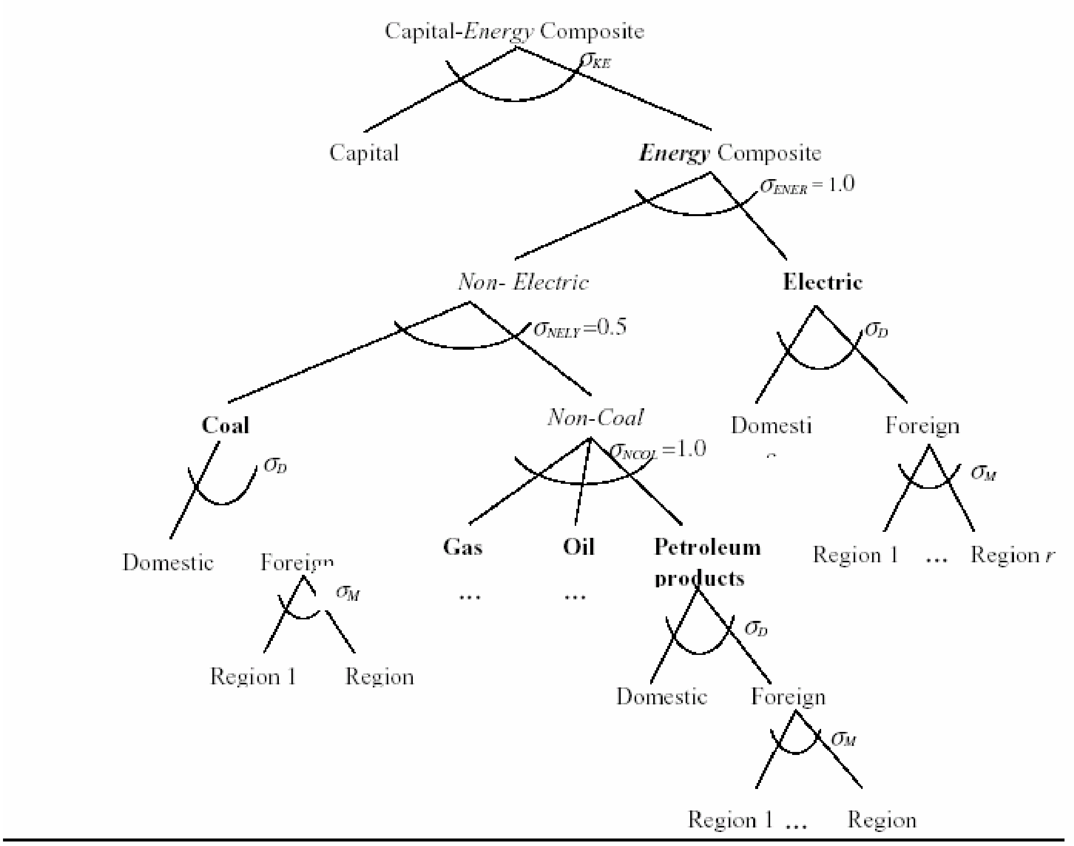
Total available land L is allocated over 3 broad 'nests'. Within each nest, the allocation is guided by constant elasticities of transformation σ_1, σ_2, σ_3. For example in the upper nest, land can easily be transformed between wheat, coarse grains and oilseeds (the COP complex), but it will require big shifts in relative returns to move land out of COPs and into pasture. In this way, alternative crops can be seen to be competing for the available land resources. The relative returns of alternative uses depend on market returns and the policy chosen.

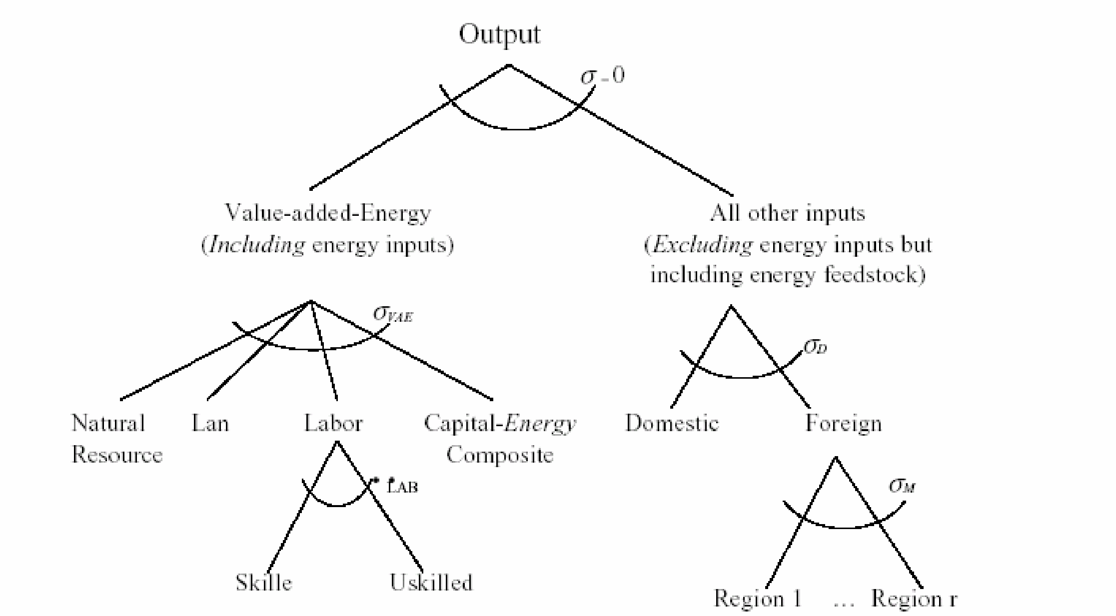
Issues concerning trade-offs between biomass and food security can easily be analyzed within this framework. The demand for food crops is derived from estimated demand functions that include relative prices and income and allow for varying expenditure shares as income grows.

Modelling the demand side for bio-energy

Energy modelling in GTAP already has a tradition, and as mentioned above, we have a consolidated (i.e. consistent) database of conventional energy use. For energy modelling the substitution possibilities in demand amongst alternative energy sources are very important. This can be done in a variety of ways. The GTAP-E model proposes the approach pictured in the figure below, where the various σs here indicate elasticities of substitution. The users of energy decide on their mix of sources on the basis of relative prices, including the domestic/foreign price ratio. If, for example, foreign electricity becomes cheaper relative to domestic electricity, more will be imported. If this cheaper electricity import also leads to falling composite electricity sources, more electricity will be demanded relative to non-electric sources.
For bio-energy modelling, the biomass component would have to be folded into this structure.

Figure: Production structure GTAP-E





N.B.
Land
Skilled
Unskilled