

Agriculture Beyond Food

...exploring the potential of biomass...



*A frame-work for international scientific collaboration,
based on a joint vision and strategy of
Indonesian and Dutch scientific institutions.*

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1 Executive summary

The world faces an enormous increase in demand for biomass for purposes other than food. This demand both poses threats and offers opportunities for the agricultural sector. It is a challenge for both governments and parties linked to the agricultural sector to capitalize on the opportunities while avoiding the threats. To achieve this, a concerted action between the scientific community and stakeholders is imperative. The current note builds on this challenge and aims to mobilize the best research on Agriculture beyond Food in order to explore and exploit the potential of biomass.

2 Biomass for mankind

Rationale

Plants are at the base of all life and are exploited by mankind to their benefit from pre-history on. The recent exciting scientific developments in plant sciences increase the potential of plants enormously. These new possibilities respond to the growing demand for agriculture products by modern society, generally referred to as the bio-based economy. This bio-based economy is a term which encapsulates a vision of a future society no longer wholly dependent on fossil fuels for energy and industrial raw materials. The concept also responds to a variety of global trends, such as growing global demand for healthy and sufficient food, produced according to ethically acceptable environmental standards, and growing risks of food-related diseases, posing a challenge to researchers from many disciplines to find solutions to make a bio-based economy possible. It is also a challenge for governments to design policies that enable adoption of techniques supporting developments toward such a future society. In the bio-based economy, agriculture will expand widely beyond its main current function: the production of food. The challenge to date is to develop a sustainable agriculture *beyond food*.

Discussion of the future of bio-based products and the competition between food and fuel is now ongoing worldwide among scientists, politicians and policy makers and in the media. The new developments in the field of biofuels are considered both a threat in terms of sustainability and food security, and an exciting new option for agricultural development. Many developing countries, well suited for the production of biomass for the bio-based economy, face the challenge of enduring profit from economic possibilities of the renewed interest in biomass. It is important to be aware of the consequences of this major development of agriculture. Scientific insight in possibilities and opportunities, threats and limitations are needed to judge the future of an agriculture *beyond food*. It is imperative that in this discussion technical, social, economic, environmental and legal scientists cooperate and that all domains of the production chain are considered (figure 1).

¹ This programme document has been prepared by scientists of the universities of Wageningen (WUR), Leiden (RUL), Groningen (RUG), Twente (TU) and Utrecht (UU)) and the Indonesian Institute of Sciences (LIPI). It serves as a document that may be used by different funding organizations and stakeholders to design new subsidy programmes and to formulate research proposals. Editor: Dr Huub Löffler (WUR)

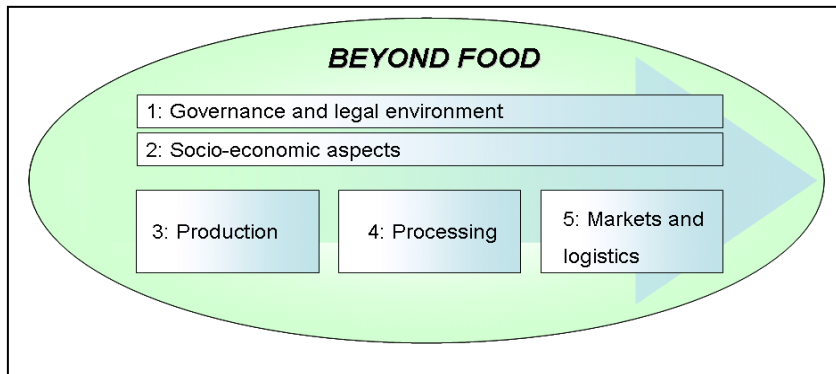


Figure 1: Proposed domains of the scientific Beyond Food program

In June 2007, the new Dutch government published their strategic objectives for the coming years in their policy statement 'Samen werken, samen leven'². One of the specific policy goals is assisting developing countries to cash on the opportunities that bio-energy offer. 'Agriculture Beyond Food' builds on this objective. The program fits perfectly in the recently published policy statement on the Bio-based Economy³ of five Dutch ministries, led by the Ministry of Agriculture, Nature and Food Quality (LNV). Two of the main recommendations in this report are the internationally sustainable production of biomass and the biorefinery concept, topics that are both addressed in this initiative.

3 Vision and Strategy

Mission

...collaboration with developing and upcoming economies for the sustainable exploitation of opportunities arising from Agriculture Beyond Food...

...

Objective

The ultimate goal is to obtain a solid, scientifically well founded, innovative program in which developing and upcoming economies and the Netherlands collaborate for the sustainable development and exploitation of bio-products. The program will focus on capacity building, research and utilization of results. The program will address technical, socio-economic, environmental and ecological and legal aspects in a concerted way and will be to the benefit of society, economy and environment of the involved countries. The program will be a joint responsibility of involved countries.

Strategy

The initiative will stimulate scientific research, capacity building, scientific education and utilization of results. Although the initiative is a concerted program, different stake-holders may be interested in the different domains or objectives. To serve all stakeholders, the program is designed as an 'a-la-carte' program, where different stakeholders can choose to participate in only part of the program at wish. The governance structure (see later) is chosen such that this approach is optimally accommodated.

4 Indonesia and the Netherlands

Many developing countries are touched by the bio-based discussion. Among them, Indonesia is a country with a specific ambition to enter the bio-based economy and to become a super-power in

² Beleidsprogramma Kabinet Balkenende IV 2007-2011

³ Overheidsvisie op de Bio-based economy in de energietransitie: 'De keten sluiten'

the field of biofuel. The government stimulates this development actively and allocates considerable funding to promote the sustainable production and use of biofuels⁴. Recently, an independent national Team for Biofuel Development was installed, with the goals to alleviate poverty, to create jobs, and to encourage economic development. The team coordinates activities of ministries, the private sector, and NGO's to stimulate the development of biofuel. The current initiative fits this Indonesian policy.

In view of a long-standing scientific collaboration between The Netherlands and Indonesia, both countries are logical partners in the Agriculture beyond Food program. Building on the policies of the Indonesian and Dutch governments, the Joint Working Committee on Scientific Cooperation Indonesia-The Netherlands recommends scientific cooperation in the field of Agriculture beyond Food. Cooperation with Indonesia on the production and use of sustainable energy is a priority target in the budget for international cooperation mentioned in the statement '*Samen werken, samen leven*'. Indonesia and the Netherlands as focal point of '*Agriculture Beyond Food*' addresses this objective.

5 The research and education program

As indicated in figure 1, the program involves five domains, both technically and non-technically. The different domains and its focal points are summarized in the following paragraphs.

Domain 1: Governance and legal environment

The Agriculture Beyond Food technical research on production and processing will result in new ways to reach the goal of sustainable biomass use for bio-energy and bio-based products. Yet, whether these new techniques will contribute to a sustainable bio-based economy depends on how they are implemented and what the effects on people, profit and planet will be. Sustainable use of natural resources also requires an effective legal system within a proper governance regime. Such a regime is required for balancing protection of the environment, social justice and economic growth. Social sustainability comprises protecting human rights and enforcement of the law by an independent judiciary. Research in this domain focuses on the legislation process, implementation of laws and policies and protecting local rights, and on socio-legal and governance aspects of future scenarios for a bio-based economy.

Focus 1: Biofuel production within the rule of law

Governments in many development countries currently prioritize large scale agriculture for biofuel production because they are facing pressing issues caused by rising fossil fuel prices and growing populations. They designate 'biofuel' as a new policy sector and support production targets with enabling legislation, however without providing legal safeguards to ensure that this new sector does not damage social sustainability. The speed of this on-going process causes gaps between the new biofuel legislation and 'rule of law'. The concept 'rule of law' refers not just to legal certainty regarding enforcement or contractual obligations, but also comprises clear rules, accountability, implementation, equity and fairness. Research will (a) identify those gaps, (b) investigate the (informal) practical process of legislation and policy making, and (c) indicate ways for linking biofuel legislation and policies with existing national and international legislation for protecting rights of people and planet, and for fair distribution of profits.

Focus 2: Governance along the value chains between global forces and local rights

The value chains of agriculture beyond food stretch from consumers, governments and companies in the developed countries to the very poor in the producing areas of the world. This chain runs through many legal systems and the corollary legal pluralism

⁴ Presidential Regulation 5/2006 on National Energy Policy, consideration a, and article 3.2
faolex.fao.org/docs/pdf/ins64284.pdf

creates room for negotiation. Research into the practices of various actors linked in one value chain will show how legislation and government policies are implemented or side-tracked, and identify what is required to protect small-holder rights and interests in developing countries. Research will also include the effect of this new sector of large (inter)national commercial and economic interests on the power relations between local, regional and national levels of government. It will look at how various stakeholders influence processes of application of law, adjudication and law enforcement. How do international trade regulations of WTO, regional trade organizations such as ASEAN and multilateral environmental agreements, such as CBD (Convention on Biodiversity) exert impact on production and trade of bio-fuels in upcoming economies?

Focus 3: The legal and governance context of future scenarios for a bio-based economy

Technical research on plant production and process technology will lead to alternative future scenarios for a bio-based economy. A well-functioning legal system, harmonious adoption of innovations in society and supporting governance are required to enable implementation and make investments commercially viable. The (technical) scenarios situated in particular areas of developing countries are the point of departure for research to identify the legal and governance characteristics of those scenarios. New developments in bio-based industry will put more pressure on regional government. Since administrative decentralization has created more regional autonomy it is of crucial importance that a sustainable administrative structure strengthens good governance in order to control various political interest groups.

Domain 2. Socio-economic aspects

This domain concentrates on the broader social impact of Agriculture beyond Food on 'people, planet and profit'. The bio-based economy may serve as an ideal model of a human society in which people will have access to healthy and sufficient food, and use renewable instead of fossil resources for the production of energy and raw materials. Current biomass production speeds up the pace in long-standing agricultural change processes:

- *centralised regulation* required for high-technical expertise and knowledge chains, financing, and planning,
- *commercialisation* of agriculture through the introduction of cash crops in subsistence areas and the development of agricultural cooperatives. This has effect on land prices, land title disputes, shifts in local food and energy markets, development of infrastructure, and effect on urban-rural and intra-rural inequalities.
- *intensification* of agriculture in ecologically marginal areas,
- *(potential) proletarianisation* in rural areas through increasing landlessness, agricultural casual labour, migrant labour.

Research on social and economic aspects of agriculture beyond food will evaluate current practices against lessons from the past, indicate the gaps between current practices and standards for social sustainability, build economic (simulation models) so as to provide basis for an exploration of potential scenarios of bio-based economies as developed in technical sciences.

Focus 1: Lessons from history

The 'new' biofuel policies in developing countries recall images of past large scale programs for commercial agriculture for domestic use and global commercial purposes. In the past, some effects on local populations were so negative that similar policies have to be avoided. In other respects biofuel policies might benefit from earlier experiences. This research position current biomass production into the long-standing change processes mentioned above, and will present an overview of lessons from experiences with regard to social and economic impact of 19th century colonial interventions for large scale commercial agriculture, the Green Revolution and plantation agriculture as far as these can be translated to the current situation created by the boom in biomass production for

energy. Additionally lessons form experiences with smallholder plantations could indicate whether and how proletarianisation can be avoided.

Focus 2: Social sustainability

A prerequisite for a viable bio-based economy is 'social sustainability'. Urban and rural populations need access to a secure supply of affordable food and fuel. Research will examine 'social sustainability' in the context of this food-fuel competition. At the level of primary producers of biofuel crops research will analyze the impact of current practices on income, on local labour issues – including effects of immigrant work force – and impact on environmental and health issues. Social sustainability also depends heavily on knowledge and information, access to technology and value chains. This subject will be addressed by research concerning the sources and flows of information to (and from) actors at various levels of the value chain, about crops, techniques, prices, laws and opportunities. Research will also study the role of consumers and other end-users in constituting the demand side of markets for biomass products and the mechanisms by which their influence manifests itself.

Focus 3: social and economic aspects of future scenarios of a bio-based economy

Technical research on plant production and process technology will lead to alternative future scenarios for a bio-based economy. The viability and sustainability of these scenarios will depend on impacts on land and food prices, on tenure security and income opportunities for local producers, on food security and effects on the environment. This research includes macro economic modelling and simulation analyses, starting with general equilibrium models to analyze how new technologies will affect prices and the allocation of production factors across various uses. Throughout we focus on the generation and distribution of income, as well as qualitative research on social impact.

Domain 3: Production

The Agriculture beyond Food program focuses on a sustainable use of biomass for bio-energy and bio-based products. The first step to reach these goals is the actual production of biomass in sufficient quantities and of sufficient quality. Because of the limited possibilities to open up new areas of production, focus will be on increasing the production of biomass per unit area and/or of its essential components. Increasing the total biomass production and essential components holds great promise since many crops, and especially new crops, are still far away from their maximum yield potential. The Agriculture beyond Food program focuses on the latter strategy: a high productivity of existing or new crops. To increase this productivity, ABF identifies the following three focal points.

Focus 1: Improve the performance of existing and new agro-systems.

Productivity can be enhanced by optimizing agronomic conditions of those crops already in use for Agriculture Beyond Food purposes. Inputs in agro-systems may be suboptimal in terms of sustainable production. Models exist and can be expanded that connect relevant variables to productivity. These models can be used to optimize the system. Productivity also depends on socio-economic conditions and the scale of operation. The possible trade-off between productivity and socio-economic effects like direct benefits and employment must be acknowledged in this respect, and will be elaborated in coming paragraphs.

Focus 2: Choose and adapt crops to meet the traits imposed by the bio-based economy

Plants currently in use for bio-based purposes are often not optimized for the new functions they must fulfil. A large genetic variation for the desired traits, be it biofuels or bio-based products, may still exist and may be exploited. Oil-content of various crops like *Jatropha* may be genetically improved and directly increase the productivity of this crop. This can for instance be achieved through changing the plant architecture for more effective light interception or improved harvesting possibilities, changing the harvest index (ratio useful part/total), or improving the yield as such. Alternatively, growth

characteristics may also be altered to create genotypes that are better adapted to the specific conditions (drought, acid-sulphate soils, salinity), or better withstand pests and diseases. The rapidly expanding knowledge of genomics and metabolomics offer valuable tools to achieve these goals. Besides known crops, other, hitherto unknown or under-utilized crops, may better serve the needs of the AbF. New processing technologies and especially the bio-refinery concept elaborated in next paragraphs, may call for valuable traits in plants not yet recognized. Also, plants may be present that combine various components such that the overall economic value of these plants largely exceeds those of plants now in use for uni-functionality.

Focus 3: Ecological sustainability.

Any production for biofuels may jeopardize environmental sustainability. Therefore research is needed for regions where the ecological environment is likely to be most affected by biomass production for bio-fuels. In this respect, upgrading marginal or degraded areas is a major challenge to counteract the necessity for new agriculture soils. Further, small-scale production systems may prove to differ in sustainability from large-scale systems. Also the impact of biomass production on biodiversity needs to be clarified. In short, an interdisciplinary assessment of ecological sustainability is needed before high-impact decisions are made..

Domain 4: Processing

Current biomass production facilities predominantly focus on a single product outlet and byproducts are either applied for low tech applications or discarded. Both from an economical and environmental point of view, utilisation of all components of the biomass source is highly desirable. This may be achieved by applying the Bio-refinery concept. It involves fractionation of biomass into intermediates. These are subsequently converted through biological, (bio-)chemical and/or thermo-chemical routes to high value products for the food and non-food sector. Application of this concept will lead to cheaper, more (energy) efficient and sustainable processes. The following focus areas have been identified:

Focus 1: Biomass pre-treatment and primary fractionation.

In this focus area, novel technology will be explored for the pre-treatment of biomass to enable efficient primary fractionation into its prime components (cellulose, hemi-cellulose, lignin, proteins, vegetable oils, minerals) to increase the component yields and reduce energy costs, reduce season dependency and enable recycling of minerals and reduce undesired transports of plant components. Furthermore, existing primary fractionation technology will be improved.

Focus 2: Efficient conversion technology for primary products to high value products

In the second focus area existing technology will be improved and novel technology will be developed for the efficient conversion of primary bio-refinery products via biological/biochemical and chemo-catalytic routes followed by suitable separation technology to high added value products in the food, feed and non-food sector. Special attention will be given to the development of processing technology to upgrade bio-refinery waste streams to energy carriers (syngas, pyrolysis oil, bioethanol)

Focus 3: Development of small and flexible production facilities.

Flexible, small scale production facilities have, particularly for developing countries, a number of (economic) advantages. In this focus area flexible and robust concepts for primary fractionation of biomass combined with further processing steps will be identified and explored.

Domain 5: Markets and logistics

In the production (3) and processing (4) domains research and development areas have been defined that focus on efficiency improvement of existing crops, on the development of genetically

adapted and on the use of new hitherto unknown crops. At the same time new processing technologies and a more efficient use of all biomass fractions (*via* the biorefinery concept) will be explored. However, these important elements of the total supply chain from biomass production to biomass processing and refining, to the manufacture of commercial biomass-based consumer and industrial products need to be considered in an integrated way. Likewise, the socio-economic aspects of local or regional biomass conversion against the logistic requirements from harvest location to selling new and existing products in consumer markets need to be balanced. The following focus areas have been identified:

Focus 1: Market analysis and product identification.

As part of the study, currently grown crops will be evaluated for a more efficient and full scale bio-refining approach with the option to design and develop new added-value products using discarded residue or upgrading current low tech end-uses. In this approach, consumer and industrial markets will be analyzed and segmented to identify the need for new products including their product performance requirements. Data from this analysis also will be applied to direct crop selection and crop optimization. Part of research on market analysis focuses on industrial organization with particular focus on monopsonic tendencies at the level of primary production. Technical aspects of processing, economic considerations and organizational characteristics within the value chain (connecting international companies to local businesses and trade) will be investigated to analyze price-making forces.

Focus 2: Logistics and planning of refining capacity in relation to biomass production locations

The protection of biomass against any form of degradation (i.e. oxidative and/or biodegradation) and its proper storage and pretreatment prior to the bio-refining processes are considered as critical factors in the current proposal. Therefore, the first part of the chain from "biomass as harvested" to "refined intermediate product" will be considered to create the optimum pathway from production location, to refining facility, to intermediate product storage facilities.

Focus 3: Logistics and planning from primary processing to secondary conversion and final markets .

As for the early part of the supply chain (Focus 2), the second part of the supply chain, i.e. logistics to secondary conversion units or to final product markets, will be considered in an integrated pathway. All focus areas, i.e. market analysis and product identification, upstream logistics and downstream logistics will be considered in a coordinated fashion such that it will be aligned with all other domains in the research program. Coupling of small scale (pre)processing units with central factories is a way to build market power based on small scale units operated by smallholders.

6 Organization and structure

The Netherlands Organisation of Scientific Research (NWO) and the Royal Netherlands Academy of Arts and Sciences (KNAW) have decided to jointly set up an Agriculture beyond Food subsidy programme focused on Indonesia with an initial budget of M€ 2.5 for five years, addressing the scientific issues exemplified in this document. Within NWO the program will be executed within the framework of the theme Sustainable Earth. Within KNAW Agriculture Beyond Food resides under the umbrella of the Scientific Programme Indonesia – Netherlands (SPIN)

NWO and KNAW have installed a Steering Group consisting board members of all funding organizations. The Steering Group (with a broader mandate than AbF) will install an AbF Programme Committee responsible for a Call for Proposals, peer review of applications, evaluation and monitoring. Peer review will involve a scientific assessment (leading criterion) as well as a separate appraisal of economic and societal relevance. The Programme Committee advises the Steering Group on the final selection of research proposals. The Steering Group is mandated to take decisions on behalf of the funding organizations.

KNAW and NWO will solicit a Programme Coordinator who will form a scientific coordination team with the principal investigators of the selected research applications. This coordinator is responsible for reporting about progress and achievements to the AbF Programme Committee. Further organizational details will be announced in a Call for Proposals.

KNAW and NWO welcome other partners to join their AbF-Indonesia programme. Its governance structure is open to participation by other funding organizations as to enlarge the programme, complement the scientific component with industrial, economic and societal elements, or to further expand towards other countries like Brazil, India, China. Other organizations may also decide to set up their own (complementing) programmes.