SCOPE OF BIODIESEL IN INDIA

Pravin M. Kinge*

Prof. B.R. Kharde**

ABSTRACT

Biodiesel is a hot topic internationally as well as in India. Since the beginning of the 2000s, the Government of India and, to a greater extent, various state governments have promoted the production and consumption of biodiesel. Proponents of biodiesel point to the potential of oilseeds as a substitute for fossil fuels, underlining their ability to reduce India's energy dependency and bring down greenhouse gas emissions. They also highlight opportunities for greening the countryside and creating rural employment and income. This report shows that biodiesel production in India is a special case which has much more positive development effects than biodiesel production elsewhere. India is different because there is far-reaching consensus there that biodiesel production will only be promoted on the basis of non-edible oil seeds on marginal lands. Hence the risks of driving up prices for edible oil or crowding out food production are relatively low. In addition, cultivating tree-borne oilseeds on degraded lands stabilizes soils and creates carbon sinks, and production requires low inputs, which serves to further improve the carbon balance. Even within India, however, the development effects of the biodiesel industry vary greatly, depending on how the value chain is organized.

*Lecturer, Mechanical Dept., NIT Polytechnic , Nagpur, M.S., India

**Production Dept., Amrutvahin college of Engg., Sangamner, M.S. India

INTRODUCTION

This study identifies no less than 13 different ways of organizing the value chain, ranging from cultivation on large plantations to contract farming arrangements, farm-based production for rural electrification, and social forestry projects. Between these different types of value chains, there are marked differences in terms of income generation, participation and empowerment, food security, natural resources management and climate change, and economic sustainability.

BIODIESEL IN THE GLOBAL CONTEXT

From 1971 to 2005, the world's final consumption of oil rose from about 2000 million tonnes/year to almost 3500 million tonnes/year. correspondingly, the price for crude oil on the world market went up from 20 US$/barrel in the 1990s to over 145 US$/barrel in July 2008. Although prices fell below 100 US$/barrel again in October, when this study was finalized, most analysts expect higher oil prices in the long term. In view of rising prices and the environmental – and primarily climate-change – concerns that result from increased global energy consumption, countries all over the world have launched biofuel programmes to develop alternatives to conventional fuels. While the share of biofuels in overall global fuel consumption was still marginal in 2006 (less than 1 %), the growth rate of biofuel production is enormous. Between 2000 and 2005, worldwide production of bioethanol rose by 95 % and biodiesel output even grew by 295 %. 1 Bioethanol and biodiesel need to be distinguished when we speak of liquid biofuels.2 Bioethanol is derived from starch and sugar, making maize and sugar cane – or the waste products produced during their processing – the most important feedstock used for its production. In contrast, biodiesel is obtained from any kind of vegetable oil like rapeseed, soybean, palm or sunflower oil, for example. With 28.3 billion litres, global production of ethanol is about six times as high as biodiesel production and therefore more relevant on the global scale. Demand for biofuel is rising especially due to mandatory blending requirements adopted by large energy consumer countries. In order to contribute to energy security and to abide by the requirements of the Kyoto protocol, many have developed ambitious plans to further substitute biofuel for fossil fuel. In 2003, for example, the EU set targets for blending biofuel in the transport sector at a rate of 2 % by 2005 and 5.75 % by 2010. In addition, several European countries support the use of biofuels through tax reductions or higher 1 The driving countries in bioethanol production are mainly Brazil and the United States, while especially Germany and France are engaged in producing biodiesel. Germany, with a share of about 40 %, is the world's largest biodiesel producer

(Worldwatch Institute 2007, 7). 2 Since any kind of motor or generator can also be designed to run on gas, gas can also be considered a fuel in a broader sense. This study, however, only refers to bioethanol and biodiesel when it speaks of biofuels. Tilman Altenburg et al. 14 German Development Institute blending requirements (Worldwatch Institute 2007, 283 ff.). The United States set – in the Energy Policy Act of 2005 – the target of blending 28.4 billion litres of biofuel by 2012. It is estimated that these measures will create demand for an additional 9.2 million tonnes of biofuel worldwide (ibid., 9). The international public debate on biofuel, though, has shifted from euphoria to increasingly critical and sceptical voices. In this sense, the OECD asks in a discussion paper on biofuels whether “the cure is worse than the disease” (Doornbosch / Steenblik 2007). The criticism mainly regards two aspects: a) concerns about the impact of biofuel production on **food security**, and b) doubts about the overall positive **net carbon balance** of those fuels. Both points of criticism will be discussed briefly in the following. With regard to worldwide **food security**, two questions arise about the effects of biofuels: First, it is unclear how big the impact of biofuel production is on the rise of food prices. Second, it is disputed whether a rise in food prices increases or decreases food security, especially of the world’s poor. The fact is that food prices have been rising, especially in the last few years. There are three reasons why biofuel production has some kind of impact on this rise of food prices. First, the raw material used for biofuel production – mainly maize, sugar cane, rapeseed and palm oil – does not enter the food market, and therefore food supply is reduced.

BIODIESEL IN INDIA

The Indian biodiesel sector is different from biofuel activities in many other countries of the world because it is based on the use of non-edible oils derived from oil-bearing trees that can grow on less fertile land. This renders it more positive because risks of food crop replacement can be avoided, many small farmers and landless cultivators can generate additional income and the plants can serve for greening barren lands.Tilman Altenburg et al. 18 German Development Institute This study focuses exclusively on *biodiesel* programmes in India. While the country is already the world’s 7th largest ethanol producer, with an annual production of 200 million litres of ethanol (Worldwatch Institute 2007, 6), biodiesel production started only a few years ago. The following chapter portrays the biodiesel sector. Chapter 3.1 first describes the biodiesel value chain in India, laying special emphasis on the feedstock and – resulting from this – the type of land needed for production. The potentials for development will be depicted in Chapter 3.2. These are manifold, but certain risks remain that food crops may be displaced. However, the biodiesel sector in India is still in a nascent state, which is mainly due to a lack of economic viability for almost all activities related to the sector. Reasons for this general barrier to the development of biodiesel production in India will be specified in Chapter 3.3. 3.1 The biodiesel value chain in India The following chapter describes some general aspects of the biodiesel value chain in India. This will help to better understand and assess the developmental impacts of biodiesel production and consumption. For example, at the cultivation stage the type of land and type of plantation have important impacts on socioeconomic and environmental effects. Different ways of processing the raw material imply different cost structures and require different technical capacities. Not all of them are suitable for the same conditions. Different end-products are consumed by different people at different levels – local or more distant – and have different developmental impacts. Moreover, the use of by-products allows people to earn additional income. As not all crops generate the same by-products, some crops may be more economically viable than others. The chapter is divided into separate sections on the three steps of the value chain – cultivation, processing, and consumption – and a last section on different alternate uses and by-products of straight vegetable oil (SVO) and biodiesel that may generate additional income sources. The following figure presents the simplified value chain of biodiesel in India. It breaks down into three steps: cultivation, processing, and consumption.

Cultivation

SVO, the raw material for biodiesel, can be extracted from many different plants. Seeds of certain plants (e.g. rapeseed, soya, sunflowers) have a high oil content and are, in some countries, used for biodiesel production. In India, SVO is derived almost exclusively from oil-bearing trees. Several tree species can be selected for biodiesel production. More than 300 different species of oil-bearing trees exist in India. All of them are naturally growing wild species that have not yet been cultivated and harvested systematically for oil production on a larger scale.4 Some of the seeds have been traditionally collected by poor people for lighting. In small quantities, TBOs are used for commercial purposes in the paint, lubricant and soap industries. According to the National Oilseeds and Vegetable Oils Development Board of the Indian Ministry of Agriculture (NOVOD s.a.[d]) there are about ten species with economic potential for biodiesel production, including Jatropha curcas, Pongamia pinnata, Simarouba glauca,5 Azadirachta indica (Neem) and Madhuca indica (Mahua). Proponents of biodiesel in India focus almost exclusively on Jatropha and to a lesser extent on Pongamia. Other species have not received much attention. The focus on Jatropha is justified mainly on the basis of two arguments: First of all, Jatropha is a shrub, i.e. it does not grow into a tree. Therefore, it is easier to harvest than large trees and has a much shorter gestation period. Since the time span between investment and return is shorter, more people could be willing to start cultivating this crop. Second, the seed collection period of Jatropha does not coincide with the rainy season in June-July, when most agricultural activities take place. This makes it possible for people to generate additional income in the slack agricultural season (Negi et al. 2006, 34). Pongamia has become the second most important feedstock of the Indian biodiesel sector for the reason that this tree is tradition- 4 It is estimated that only 10 % of the seeds from natural plantations are been collected (Ghasias 2006, 217). 5 Simarouba glauca is a promising oil-bearing tree, which was only recently introduced in India. Simarouba oil is edible, but its consumption for cooking is not habitual in India (Joshi / Joshi 2007, 99 ff.). Therefore, the tree is promoted for the production of biodiesel by some supporters, although the general Indian consensus is not to use edible oil for fuel production. Biodiesel in India German Development Institute 21 ally planted in several states and therefore well known to people. Being a multipurpose plant that is a source not only of oil but also of animal feed, manure, fire wood and substances with medicinal uses, farmers already integrate Pongamia into their farming systems. Pongamia is also systematically planted on public land such as forests or along roads, and it already is common practice for people to collect and sell the seeds – provided they find a market (Int. Ramakrishna, Samagra Vikas). The most important characteristic that distinguishes oil-bearing trees from other cash crops is the fact that they require very few nutrients to survive and therefore can also be grown on less fertile land. To survive, Jatropha, for example, only needs a minimum of around 600 mm of rainfall per year and temperatures that do not go below about 3°C (GTZ / TERI 2007, 7; Jongschaap et al. 2007, 18). However, it is an input-responding plant, meaning that fertile land, fertiliser and pesticides as well as better irrigation will lead to much higher oilseed yields (Jongschaap et al. 2007, 15- 16). Under favourable conditions, a yield of up to 2.5 kg/plant can be achieved There are three ways of cultivating oil-bearing trees. First, they can be grown as boundary plantation, e.g. around fields or along roads, railways and canals. Second, they can be planted in monoculture as block plantations. Third, oil-bearing trees can be cultivated through inter-cropping with other species, which is likely to happen when it is used for afforestation, but also possible when it is grown on fields. Boundary plantations of oil-bearing trees, especially of Jatropha and Pongamia are already common in India, even if the seeds are not used for SVO or biodiesel production. There remains a certain range up to which this kind of cultivation can be extended, but the amount of oilseeds produced will still remain marginal compared to the amount that could be reached through cultivation on regular plantations, either through monoculture or inter-cropping. These plantations can, in turn, be set up on three types of land: regular agricultural land, regular forestland as well as un- or underutilised land (often called “wasteland”). The first possibility, plantations on regular fertile agricultural lands, implies competition with other crops that can also be grown here. In India, most farmers are not willing to plant oil-bearing trees on fertile lands because yields and prices are considerably lower than those of food crops such as rice, wheat or sugar at this point in time. Changing cultivation patterns on already used fertile agricultural lands will only take place if the revenues from the cultivation of oil-bearing trees exceed those from food crops, which would presuppose either considerably higher demand (e.g. through higher prices of conventional fuel) or extraordinary increases in productivity The second possibility, to grow oil-bearing trees on forest land, mainly refers to afforestation. Regenerating degraded forest areas for ecological reasons and sustainable use of resources is desired in many forest regions of India. Pongamia – like any other tree – can serve this purpose very well. Jatropha, in contrast, is a shrub rather than a tree and it is therefore less useful for afforestation. India strongly promotes joint forest management (JFM) programmes in order to combine the benefits of afforestation and income generation for lower casts and tribal people . The third possibility – and the one most favoured in the public discussion in India – is the use of un- or underutilised land for cultivation of oil-bearing trees. Such land that is not suitable for any other crop because of its low fertility is called “wasteland” in day-to-day parlance. The Wastelands Atlas of India, a satellite-based land survey by the Indian Ministry of Rural Development, identifies 553,000 km² of the 3.3 million km² of total land area in India as wasteland (MoRD 2005, 12). Considerable parts of India’s degraded forest land (108,000 km²), land with scrub vegetation (151,000 km², ibid.) – together amounting to more than 8 % of the total geographic area in India – as well as certain other lands6 could serve for plantations of oil-bearing trees. Although more recently, the Government of India reduced its estimate of land reserves that are suitable for biofuel crop cultivation to 72,000 km², even this potential is enormous (Shankar 2006, 94). More drought-resistant than most other crops, oil-bearing trees can contribute to the rehabilitation of unutilised land by stabilizing soil, improving manure cover and bringing degraded land back into productive use.

However, the term wrongly suggests that all of this land lies waste and is not used by anybody. In reality, even unsuitable degraded land is still often used illegally by the poorest parts of the population for subsistence agricultural production or – even more commonly – for cattle husbandry. Claims of 13.4 million ha of available land for TBO cultivation

(Planning Commission 2003) therefore need to be looked at with care. Bringing much of this land under Jatropha or Pongamia plantation would certainly imply the displacement of marginalised groups of the population.

Processing

Once the fruits have been harvested, the first step in processing is extracting the oil. Only the seed of the fruit contains oil, so it is necessary first to separate the seed from the fruit hull. The seed itself also consists of a shell and a kernel. Before the oil is expelled, it is more efficient to remove the seed shell from the kernel in order to improve the extracted SVO. If this is not done, sediments of the shell will remain in the SVO. After hulling, the kernels are ground. There are two methods of extracting the oil from the ground kernels. First, the kernels can be pressed, using hand-powered pressing machines or mechanized equipment. When small-scale hand-powered pressing machines are used, only around 60 % of the total extractable oil can be expelled. More mechanized expellers such as animal-powered so-called *ghanis* can expel about 75 % of the oil content. Further advanced pressing machinery can obtain up to 90 % of the 6 Other relevant categories of wastelands with potentials for the cultivation of oil-bearing trees include 37,000 km² of land without scrub, 16,000 km² of shallow/moderately gullied or ravenous land and 9,000 km² of land with slight or moderate saline or alkaline values (MoRD 2005, 12; Shankar 2006, 94). Tilman Altenburg et al. extractable oil. Second, the more efficient way to expel the oil from the kernel is to use a chemical solvent that can extract almost 100 % of the oil (Jongschaap et al. 2007). This requires a highly sophisticated industrial oil extraction process, since the solvent needs to be handled with care and also must be removed from the oil after processing. The two methods, pressing and solvent extraction, can also be combined. The second step in processing is the transformation of SVO into biodiesel. This process is called transesterification. Depending on the final use of the fuel, transesterification may prove worthwhile. Transesterification requires three raw materials: SVO, alcohol (usually methanol is used), and an alkaline catalyst (e.g. sodium or potassium hydroxide). A two-stage chemical reaction first separates the SVO into free fatty acids and glycerol and then merges the free fatty acids with the methanol, generating fatty acid methyl ester, which is the chemical term for biodiesel. The glycerol remains as a by-product of the procedure. Transesterification units can have a large range of processing capacities, from small-scale biodiesel units to largescale transesterification plants. Handling and storage of biodiesel, however, require certain professionalism, since it is toxic and inflammable.

Consumption

Both SVO and biodiesel are suitable for final consumption. SVO can be used for lighting (replacing petroleum in lamps) and cooking (in specially designed cooking stoves). It can also replace conventional diesel in engines (e.g. electricity

generators or water pumps). Since SVO has very high viscosity, however, fuel injection pumps need to be modified, otherwise engines will abrade much faster. Hence, operational and maintenance costs of engines running on SVO are higher than for those running on conventional diesel. The fuel properties of biodiesel, on the other hand, are a lot better than those of SVO. Thus, replacing diesel with biodiesel instead of SVO reduces operational and maintenance costs. Some projects aiming at rural energy security use SVO for their machines and electricity generators, while others first transesterificate and use biodiesel for the same purposes. The advantages of the latter are better fuel properties, leading to more efficient fuel combustion and less pollution. There are, however, economic and safety issues associated with the process of transesterification. Additional technology and equipment as well as other inputs (methanol, catalyst) are needed to process SVO into biodiesel. This means additional costs both for investment and maintenance. Also, qualified personBiodiesel in India nel has to be trained to operate the complicated transesterification process. These issues, however, could be resolved with careful planning and implementation. One solution to this problem of viscosity is to blend diesel with either SVO or biodiesel. An SVO-diesel blend, though, still requires a modification of the engine for proper functioning in most cases. The characteristics of the SVO may vary a lot due to differences in seed quality and extraction methods. Therefore, the percentage up to which a blending of diesel with SVO is possible depends in large measure on SVO quality and engine type. By contrast, the characteristics of biodiesel are rather consistent because of the standardized chemical reaction processes during transesterification. Blending diesel with biodiesel is therefore much more efficient. Depending on the study consulted, blending of up to 50 % is possible without any major operational difficulties for engines (Jongschaap et al. 2007, 15). *By-products and alternate uses of SVO and biodiesel* Several by-products have economic value. Oil-bearing trees not only produce seeds/fruits, their leaves, latex and wood can also be used. Leaves of some oilbearing trees can serve as valuable organic fertiliser,7 and both leaves and latex of some species are used for medicinal purposes. When trees or bushes are pruned, branches can be used as firewood or – like any other biomass – for biogas production. Furthermore, fruit hulls may serve for all the possible uses mentioned above – as organic fertiliser, for burning, for medicinal purposes as well as for biogas production. Two other important by-products of

SVO/biodiesel production emerge during further processing: seed cake and glycerol. After the oil is extracted, what remains is the particulate material of the kernel, which is called seed cake. It can be used as an organic fertiliser. Since yields increase substantially when fertiliser is applied, the seed cake can be taken back to the field and used to facilitate cultivation. In addition, it is also possible to produce biogas from the seed cake. Theoretically, seed cake could also serve as fodder for animals. However, Jatropha seedcake has to be detoxified, and detoxification has proven successful only in the lab (Jongschaap et al. 7 In the case of Jatropha, the leaves have toxic properties and its effects on soil fertility have not yet been properly researched. The process – if applied in the field – would currently be very expensive, so that Jatropha seed cake as fodder would not be able to hold its own in the market. Glycerol (glycerine) is removed from the SVO during transesterification. It is an important ingredient for many kinds of cosmetics, soaps and pharmaceutical products. If the market demand for glycerol is high and the by-product can be sold at a good price, biodiesel production can become a lot more cost-efficient. However, this is not an important issue in India (yet). During the course of the field research for this study, glycerol did not play a role in any of the cases examined. Compared to the various by-products, the opportunities for alternate uses of SVO or biodiesel are very limited. The single most important mode of consumption is use as some kind of fuel. Biodiesel, in fact, can only serve as "petrol." On the other hand, some SVO can – depending on the plant of origin – be consumed as food, but Jatropha and Pongamia-based SVO is non-edible. One alternate use of the oil, however, is for soap production. A soap of good quality is produced from Jatropha-based SVO, in some countries (e.g. in Mali and Haiti). Some projects promote this kind of processing in order to generate income for poor rural families. In India, however, the production of soap from tree-borne oilseeds is not common.

BIODIESEL POLICIES IN INDIA

The following chapter gives an overview of Indian biodiesel policies at the central and state level. We use the term "biodiesel policies" in a broad sense, including comprehensive policy initiatives that are explicitly framed as 'biodiesel policy' as well as programmes that are of a general nature but may be used to promote biodiesel, such as afforestation and rural employment programmes. The first part of the chapter discusses the rationale for policy-makers to intervene in the biodiesel market. It shows that market failures are relevant and justify government support in principle. However, India's government has a long history of overregulation of the economy. Until the late 1980s, distorted incentives and red tape hampered investment and productivity growth. Against this background, several policy reforms and remaining weaknesses (e.g. related to rural development, forest management, and decentralization) are addressed that are directly related to the biodiesel industry. Following 21 One successful example for improving the productivity of plant material through R&D is the mycorrhiza technology developed by TERI. Applying this fungus to the roots of Jatropha shortens the gestations period and increases yields by up to 30 % (Adholeya / Singh 2006, 144).

Rationale for policy intervention

As the previous chapters have shown, biodiesel bears strong potentials – but also risks – with regard to India's simultaneous challenges of energy security, climate change mitigation, and rural development. Despite its potentials, a biodiesel market has not yet fully developed in India. This is due to a series of market failures. Biodiesel cannot yet compete with fossil fuels, as the prices of the latter do not reflect the negative environmental externalities which they cause. If these costs were internalised, biodiesel would be more competitive as it causes far lower environmental costs. At the same time, positive externalities of R&D efforts in biodiesel and of processes of self-discovery cannot be fully appropriated by investors and farmers. The vast part of this knowledge will consist in nonpatentable incremental innovations that can be freely appropriated by anyone. The same applies for the positive social externalities which biodiesel production may imply for rural development. A number of market failures specifically prevent the poor in remote areas from benefiting from the opportunities of the sector. Most importantly, since TBObased biodiesel production is a new activity, poor potential cultivators lack information about cultivation methods and required inputs, expected yields, available support measures and the development of the market. Such information is especially important because TBO-based biodiesel production is a risky business: First, because markets are not yet established; second, because of the long-term nature of investments – most TBOs have very long gestation periods; and third, because some of them can only be used for the production of non-edible oil and are thus worthless if the biodiesel market does not take off ("asset specificity"). However, access to information is often lacking in remote areas. Where consultancy services are available, poor farmers often underestimate the value of such services. Particularly as regards strategic and long-term activities, the final outcome of consultancy services is unpredictable for farmers, so that small farmers are usually not willing to spend money for consultancy services to obtain the knowledge and information they need. Another impediment is a lack of access to credit markets and to land. Vertical and horizontal coordination failures furthermore create barriers:

Cultivators will be reluctant to enter into biodiesel production without linkages to processors. In order to establish such vertical linkages, horizontal coordination among cultivators is required, as processors depend on the availability of a critical amount of oilseeds to operate at an economically viable capacity. This may be obstructed by high transport and transaction costs in remote areas. All of these market failures justify and call for state intervention. However, policy-makers should consider two more factors. The first one relates to the risk of government failure. Heavy government intervention is prone to the problems of lacking information about market dynamics, high costs of acquiring such information, opening up spaces for rent-seeking, and distortion of markets. Until the late 1980s, India relied on centralised policy planning and implementation and on strong regulation of the private sector, all of which was intended to correct real or perceived market failures. This policy, however, produced inefficiencies, market distortions and rent-seeking activities, and ultimately slowed down India's economic development. Secondly, policy-makers should consider that all subsidies have opportunity costs. Each rupee spent on subsidising biodiesel cannot be spent for other useful purposes, e.g. other poverty-alleviating programmes or other renewable energies. Policy choices thus need to be based on a comparison of cost-benefit ratios of development alternatives – a task that falls outside of the ambit of this study. In sum, there is a case for subsidising biodiesel, but subsidies should not be excessive and should be reduced as economic actors develop more viable business models. India, from independence to the late 1980s, imposed many heavy-handed regulations that engendered red tape and corruption rather than spurring growth and reducing poverty. Policy-makers must therefore be careful not to increase costs by adopting highly complex policies that exceed the implementing capacities of government bureaucracies and create space for intransparency and rent-seeking. Incentives must be set that put entrepreneurs and bureaucrats alike under pressure to make biodiesel production as competitive as possible under existing conditions. In practical terms, Indian society and policy-makers may, for example, decide to make biodiesel blending compulsory, or to make TBO plantations eligible for government funding. With these measures to correct existing market failures, investments should then be economically viable without further subsidies. Furthermore, monitoring and evaluation mechanisms, conditionality and sunset clauses should be integrated into all policies to ensure efficient and sustainable implementation.

The following section briefly presents some policy reforms that are relevant for developing biodiesel value chains in a way that benefits rural development in India. It shows that despite considerable efforts at deregulation and decentralisation, ineffectiveness and distorted incentives are still a major concern. Reforming the policy environment for biodiesel production – achievements and remaining challenges Since the 1980s, India has made considerable efforts towards deregulation and decentralisation. As regards economic deregulation, industrial licensing requirements have been significantly relaxed.

The government adopted a more pro-business attitude aimed at easing the supply- and demand-side constraints faced by private entrepreneurs (Kohli 2006a, 1253). Subsequently, GDP growth accelerated to 5.8 % per annum between 1980 and 1990 (ibid., 1254). At the beginning of the 1990s, India abolished or reduced numerous other regulations and restrictions on economic activities, including restrictions on the inflow of foreign capital and technology transfer; moreover, import tariffs were reduced and service provision liberalized (ibid., 1361). With the constitutional recognition of the three-tier Panchayati Raj system and the Joint Forest Management policies of many states, India has also made considerable efforts at decentralisation. Yet despite these noteworthy efforts and achievements, reforms remain largely incomplete. This is especially true for land market, agricultural and forest policies, which remain much more regulated than the manufacturing and urban service sectors. While there are good reasons to regulate these areas in consideration of the need to protect the livelihoods of the rural poor, existing regulations are often inefficient, hold back investments and slow down productivity growth, and in some cases even turn out to be directly anti-poor. With regard to biodiesel value chains, we have identified five areas where reforms have been initiated to correct government failure, but much remains to be done:

1. political decentralisation,
2. land ownership,
3. forest management,
4. marketing of agricultural and non-timber forest products,
5. provision of agricultural extension services.

The following section gives a brief account of these reforms as well as their shortcomings.

Provision of agricultural extension services:

Different state departments have extensive administrative setups for service provision. The Department of Agriculture in Chhattisgarh, for example, currently has 650 posts for Agriculture Development Officers operating at district level and 3375 posts for Rural Agricultural Extension Officers, operating at block level. Apart assessing the input requirements of farmers and communicating the numbers to the district level, the latter are mainly involved in providing extension services free of cost to farmers. One officer is responsible for 800 to 1000 farmers. There is no system of independent monitoring and evaluation or mechanism for gathering and feeding back the farmers' opinion of the services delivered. Chhattisgarh only very rarely funds private service suppliers such as NGOs, and if so, this happens at the discretion of the respective district official, following no defined tendering procedure (Int. Kridutta, Agriculture Department). Acknowledging that public service provision suffers from a lack of outreach, lack of professionalism, top-down planning and implementation and absence of performance- based monitoring, the Policy Framework for Agricultural Extension issued by the Ministry for Agriculture in 2000 recommended a number of far reaching reforms, including contracting out of services to private suppliers and private co-financing of some services. Since agriculture is a state matter, it remains to be seen to what extent states will adopt these recommendations. These examples of enduring government intervention in India show that although policy intervention to correct market failures in the rural economy is justified and necessary, it does not always work in favour of the well-being of the target groups. Policies designed to empower rural people have not gone far enough and their effects are often offset by interference of government officials, by local corruption, or by contradictory policies. These risks of government intervention have to be considered when policies for promoting new activities such as biodiesel production are recommended.

National Policy on Biofuels and other Union policies

India is a federal state with relative autonomy for the federal states. Among other things, agricultural and land policy, managements of forests, and the rules for local government are all state matters. The states thus set most of the conditions for the production of biodiesel. However, the Union also has important competences, e.g. with regard to taxes and fiscal incentives. Demandside policies, such as mandatory blending of diesel with biodiesel reltive taxation of fossil and biofuels are Union matters. Moreover, the Union has a key role in economic and social planning, and it uses a great number of centrally- sponsored Schemes to influence policymaking in the states. Likewise, one of the crucial gaps that needs to be addressed – R&D – is mainly in the hands of the central government. In 2002, the Government of India set up a committee on the development of biofuels under the chairmanship of the Planning Commission. The final report was presented to the Prime Minister's office in July 2003. The Ministry of Rural Development (MoRD) was to become the nodal agency to implement the recommendations of the report (GTZ/TERI 2005, 21). Consequently, the ministry commissioned the Energy and Resource Institute (TERI) to prepare a Detailed Project Report. A draft Project Report was submitted in September 2004, discussed by various ministries, and submitted to the Planning Commission for in-principle approval by February 2005 Since 2004, more than seven ministries and the Planning Commission debated the biofuel policy until it was finally approved in September 2008. The stalemate of the overall process created considerable uncertainty in the four years between publication of the draft biofuels policy and its final approval. Farmers and corporate investors had no reliable information as to whether compulsory blending of fuels would be decreed, what tax incentives would be available, and which crops to select. One major feature of the draft policy of 2004 was its focus on Jatropha curcas as the preferable plant to be promoted by the government. Apart from having some other advantages, it was assumed that Jatropha can be grown on low-fertility marginal, degraded, and wasteland with rainfall requirements of only 200 mm (Planning Commission 2003, 111 f.). The plant was to start producing seeds two years after planting. Information about yields was highly vague, stating that they range from 0.4 to 12 tonnes/ha (ibid.). However, experience made in the past few years by research institutions and practitioners has shown that these assumptions were far from reality, and that yields in fact remain at the lower end of the given range. The focus on Jatropha was thus chosen even though research results on the agro-climatic and soil conditions, inputs and maintenance activities that are necessary to obtain economically viable yields from Jatropha were still miss See also http://biospectrumindia.ciol.com/content/BioBusiness/10511111.asp. Indian Council of Forestry Research and Education (ICFRE), Forestry Research Institute (FRI).

Moreover, research findings on the environmental and social impacts of Jatropha plantations were and are still missing. This can be considered a significant flaw of the draft National Biodiesel Mission. Such unsubstantiated assertions and recommendations – even though still in the form of a draft - may have long-term repercussions, if they give wrong information to implementing agencies and ultimately to farmers, who are highly dependent on the economic viability of the crops they plant. According to NOVOD, the lack of reliable information on the economics of Jatropha cultivation was one reason for holding back the launching of the new policy (Int. Kureel, NOVOD). In September 2008, a "National Policy on Biofuels" was finally approved, and it was decided to set up a National Biofuel Coordination Committee, chaired by the Prime Minister, and a Biofuel Steering Committee, chaired by the Cabinet Secretary. The Ministry of New and Renewable Energy has been given responsibility for the National Policy on Biofuels and overall co-ordination. The Panchayati Raj Ministry would also be included as a member of the Steering Committee. The National Policy on Biofuels reaffirms that biodiesel production will only be promoted on the basis of non-edible oil seeds on marginal lands. The focus would be on indigenous production of biodiesel feedstock, and import of oil from other crops (e.g. oilpalms) will not be permitted. Biodiesel plantations on community and government lands will be encouraged, while plantation on fertile irrigated lands will not be encouraged. The new policy establishes a number of demand-side support mechanisms and emphasizes the need for more research. In addition, a range of supply-side incentives have been set for the cultivation of TBOs, although most of these are not formally part of the National Policy on Biofuels.

Demand-side policies

The National Policy on Biofuels sets the target of raising blending of biofuels (bioethanol and biodiesel) with petrol and diesel to 20 % by 2017. Moreover, a *Minimum Support Price* for biodiesel oil seeds will be announced to provide a fair price to the growers. The details of the minimum support price mechanism will be worked out subsequently and considered by the Biofuel Steering Committee. The price will be revised periodically. Also, a *Minimum Purchase* See Satish Lele (http://www.svlele.com/biodiesel_in_india.htm) and The Financial Express, Sept. 12, 2008(http://www.financialexpress.com/news/Biofuel-policy-gets-Cabinet-nod/360218/).

Price for the purchase of biodiesel by the Oil Marketing Companies will be established, and it is to be linked to the prevailing retail diesel price. Although a target for blending fuels has been set, there are no provisions to make blending compulsory. Mandatory blending would have been a strong signal to encourage investments in fuel crop cultivation and transesterification plants. Under the new policy, it remains to be seen whether the minimum purchase price will be sufficiently high to encourage production. Already in October 2005, the Ministry of Petroleum and Natural Gas proclaimed a biodiesel purchase policy that came into effect in January 2006. According to that policy, oil marketing companies were to purchase biodiesel at a price of now 26.5 Rs./l at currently 20 purchase centres in 12 states. Suppliers had to be registered with the state-level coordinators and meet the specifications of the Bureau of Indian Standards. The oil companies, for their part, were to blend conventional diesel with biodiesel at a maximum of 5 % at the purchase centres. So far, these purchase centres have not been able to procure any biodiesel (Int. Choudhary, Indian Oil Corporation Ltd.), as large quantities of seeds and biodiesel are not yet available and the purchase price offered is much too low for the industry (Int. Ganguly, Confederation of Indian Industries; Int. Gulati, Biodiesel Association).

Research and Development

The new policy stipulates the establishment of a sub-committee under the Steering Committee comprising the department of biotechnology as well as the Ministries of

Agriculture, New and Renewable Energy, and Rural Development, to support research on biofuels. Already in 2004, the National Oilseeds and Vegetable Oils Development Board (NOVOD) had established a "National Network on Jatropha and Karanja" to contribute to the development of high yielding varieties (NOVOD 2008, no page number). The network consists of 42 public research institutions – the State Agricultural Universities, Indian Council of Agricultural Research (ICAR), Council of Scientific and Industrial Research (CSIR), Indian Council of Forestry Research and Education (ICFRE), Central Food Technology Research Institute (CFTRI), Indian Institute of Technology (IIT) and The Energy Research Institute (TERI). Research is financed for issues such as identification of elite planting material, tree improvement to develop high yielding varieties with better quality of reliable seed source, inter-cropping trials, development of a suitable package of prac- 30 Local name for Pongamia pinnata.

The Department of Biotechnology (DBT) of the Ministry of Science and Technology has initiated a "Micromission on Production and Demonstration of Quality Planting Material of Jatropha" with the aim of selecting good germplasm and developing quality planting material. Under the Micromission, 500,000 ha of plants of superior material have been produced in a nursery. Furthermore, the Department of Biotechnology supports programmes for testing the potential of other TBOs, including Pongamia (DBT 2007, 129 f.). Research seems to be concentrated on Jatropha as the most suitable TBO for biodiesel production, with 25 institutes participating in NOVOD's Network on Jatropha, and only 8 institutes participating in the Network on Karanja (NOVOD 2006, 4 f.). Current figures suggest that in order to reach economic viability, Jatropha must yield 2 kg of seeds per plant without investments in irrigation and fertilisers (Int. Kureel, NOVOD), whereas actual yields under these conditions tend to be well below 1 kg (NOVOD 2007, 11).

This highlights the urgent need for more research not only on the plant material but also on the agro-climatic and soil conditions, inputs, and maintenance activities necessary to increase the productivity of TBOs. Achieving higher yields is a necessary condition to make the industry viable and to increase rural income. Higher yields also lead to a greater substitution of fossil energy carriers and lower greenhouse gas emissions (Reinhardt et al. 2007). Furthermore, there is a lack of knowledge on the environmental impacts of TBOs. According to the Forestry Research Institute in Uttarakhand, the environmental impacts of Jatropha cannot yet be foreseen (Int. Negi, Forestry Research Institute). Currently TERI seems to be the only institution that has commissioned a social and environmental impact assessment on Jatropha with respect to its own plantation project in Andhra Pradesh (Int. Adholeya, TERI).

Lastly, there is a lack of research on breeding drought-resistant varieties of different oil-bearing tree species that give acceptable yields. At present, the assumption that Jatropha and other oil-bearing tree species can be grown profitably on land that is unsuitable for agriculture does not hold (Int. Kureel, NOVOD). Hence there is a real threat that food crops may be crowded out. At current market prices very few farmers are abandoning food production for TBOs. But this may change if fuel crop prices rise faster than food prices and if high-yielding fuel crops become available (Int. Ramakrishnaia, MoRD; Int. Adholeya, TERI; Int. Shukla CREDA/CBDA). If drought-resistant high yielder were available they would provide farmers additional income that would generate resources to be invested in increased food production on fertile lands.

Supply-side policies

The New Biofuels Policy confers ‘declared goods status’ on biodiesel and ethanol. This implies that both will attract a uniform central sales tax or VAT rate rather than the varied sales tax rates prevalent in the states, and movement of biofuels within and outside the states will not be restricted. Already in 2006, the government gave them the status of a ‘non-conventional energy resource’, meaning that biodiesel was fully exempted from excise duty (S. No. 53A of the Notification No. 4/2006). At the current purchase prices, this ‘non-conventional energy resource’ status reduces the price for biodiesel by about 4 Rs./litre (Int. Choudhary, Indian Oil Corporation Ltd.). This does not, however, outweigh the benefits that conventional diesel enjoys from heavy subsidies. In addition, biodiesel is not recognised as a renewable energy source according to the legal definition, which would allow investors to obtain additional tax benefits. As another measure to encourage the supply of biodiesel, NOVOD initiated a back-ended credit-linked subsidy programme specifically for TBOs. The program provides subsidies for a) nursery raising and commercial plantation, b) establishment of procurement centres, and c) installation of pre-processing and processing equipments. It can be extended to governmental organisations, NGOs or individuals. Interviewees in Karnataka and Andhra Pradesh stated that NOVOD recommends using these funds for Jatropha nurseries only. Nonetheless. both states have also used the funds for Pongamia plantations (Int. Varma/Kanwerpal, Forest Department; Int. Nirmala, Department of Panchayati Raj and Rural Development). Loan assistance by the Rural Infrastructure Development Fund of the National Bank for Agriculture and Rural Development (NABARD) can also be used to fund biodiesel plantations. In addition, there are a large number of centrally-sponsored schemes that can be and are used for biodiesel plantation. In the four states under examination, we found that the

● National Rural Employment Guarantee Scheme (NREGS)

● Watershed Development Programme

● Swarnajayanti Gram Swarozgar Yojana

See http://www.novodboard.com/nb-schemes.pdf.

● Village Energy Security Programme

● National Afforestation Programme

are being used for biodiesel plantation, with NREGS being the most important one. Centrally-sponsored schemes are a core element of biodiesel policies. It is therefore necessary to briefly discuss their main strengths and weaknesses. Using these schemes for biodiesel plantation is a convenient way to kick-start the supply of TBOs on a large scale. This takes due account of the fact that the uncertainties related to TBOs and their economic viability as well as their long gestation period prevent farmers and other people in rural areas to enter into biodiesel planting without any such support. Moreover, as biodiesel plantations aim to contribute to achieving certain public goods such as afforestation and inclusion of marginalised people, using these governmental support schemes is fully justified.

However, it has long been recognised that these schemes are beset by a number of problems as regards their effectiveness, efficiency, sustainability and outreach. For example, the guidelines given by the line ministries are often rather inflexible, and the planning process of the individual projects under the schemes is often very top-down, lacking participation by the respective communities implementing projects in their villages. As Saxena and Ravi note, "[m]ost often the Pradhan/Sarpanch selects the project which suits his needs or for which he is pressured by the dominant castes/clans. Participation of the poor especially women is missing" (Saxena / Ravi s.a. [b], 2). Similar problems pertain to their implementation. In 2004 an Impact Assessment of Watershed Development Schemes asserted that government departments implemented projects with very little interaction with the people, especially not with women (Planning Commission 2006, 256). Programmes furthermore have problems in reaching their respective target groups and disbursing funds to them without leakages and delays (MoRD 2006, 2). Rural employment programs have often focussed on construction activities with little focus on institutions and capacity building, leading to non-sustainability of the assets created (Planning Commission 2006, 256). 32 The planning process within NREGS, in contrast, is a bottom-up planning process, starting at the level of the Gram Panchayat (MoRD 2006, 9 f.).

ABBREVIATIONS

CBDA Chhattisgarh Biofuel Development Authority

CREDA Chhattisgarh Renewable Energy Development Authority

DBT Department of Biotechnology

MoRD Ministry of Rural Development

NOVOD National Oilseed and Vegetable Oils Development Board

OECD Organisation for Economic Co-operation and Development

REFERENCES

1. Arghiris, R., and Leonardi, R., 2008 Nicaragua Footprint:Bath
2. Bdpedia, 2006a Advantages of Biofuels and Biodiesel, The Biodiesel WWW Encyclopedia http://www.bdpedia.com/re/be/adv/adv.html
3. Bdpedia, 2006b Biodiesel History, The Biodiesel WWW Encyclopedia http://www.bdpedia.com/biodiesel/history/history.html
4. Davids, K., 2006 Nicaragua Cup Of Excellence, http://www.coffeereview.com
5. energyportal.eu, 2006 The Advance of Biofuels – a boon for the climate? Http://www.energyportal.eu
6. http://effectivepapers.blogspot.com/2010/11/research-paper-on-biodiesel.html