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Background Research Paper

**Environmental Impacts of Trade Liberalization in the
Bio-diesel Sector of the Lao PDR**

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To inform the *Rapid Trade and Environment Assessment* for Lao PDR, seven background papers covering nine key economic sectors were commissioned by the RTEA Expert Advisory Panel, a body consisting of key government and private sector stakeholders established to provide overall guidance to the assessment process. These papers provided vital background information and illuminated key sector-specific policy recommendations for the main assessment and are seen as a valuable contribution to the growing body of in-country research focusing on the complex dynamics between trade and the environment in Lao PDR.

This research exercise was coordinated by the Science, Technology and Environment Agency and IUCN – The World Conservation Union in Lao PDR.

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Environmental Impacts of Trade Liberalization in the Biodiesel Sector, Lao PDR

by Phaychith Sengmany*

Introduction

The Lao People's Democratic Republic (Lao PDR) is a landlocked country in Southeast Asia that borders with China, Myanmar, Vietnam, Thailand and Cambodia. Lao PDR is one of the 42 least developed countries in the world. With limited natural mineral and oil resources, Lao PDR relies on imports of fuel for transport and industry. The recent rise in crude oil prices and the rapidly growing demand for oil in China have highlighted the importance of developing an efficient energy policy, including alternative energy sources. Given that Lao PDR is landlocked, it is particularly vulnerable to dependence on external energy sources. In this context, the need to explore new and environmentally-friendly alternatives to external energy sources has become even more important.

The production of biodiesel in developed and developing countries has been increasing in recent years and is likely to continue expanding at a rapid rate through the end of this decade as planned capacity comes on stream (Steenblik 2006). A recent Organization for Economic Cooperation and Development (OECD) analysis of biofuels notes that "in many cases the choice of feedstock, particularly oils from tropical plants, available to developing countries means that they can produce biodiesel at lower cost than the fuel can be produced elsewhere" (Steenblik 2006). The OECD analysis outlines that domestic government policies are necessary to contribute to a faster rate of substitution of a relatively clean-burning fuel for petroleum diesel and ensure that environmental safeguards are in place.

Trade and environment are intrinsically linked and no less in Lao PDR where trade is highly dependent upon the country's wealth in natural resources. Lao PDR has recently joined the Association of Southeast Asian Nations (ASEAN) and consequently has taken on commitments to liberalize its economy through the ASEAN Free Trade Area (AFTA). The Government of Lao PDR (GoL) is also preparing for accession to the World Trade Organization (WTO), which includes myriad requirements to increase economic efficiency and open up the economy to competition as the country integrates into the multilateral trading system.

This paper provides an overview of the biodiesel sector in Lao PDR in light of increasing trade liberalization with its key trade partners. It seeks to explore the potential positive and negative environmental effects of trade liberalization in this sector, with the aim of flagging key environmental impacts that should be considered in trade negotiations. It should be noted from the outset that one of the primary purposes of switching to locally-produced biofuel sources in Lao PDR is to reduce dependence on imports of oil. For example, as tariffs on fuel imports are reduced through trade liberalization, the domestic biofuel sector will have to be increasingly efficient in order to compete with cheaper fuel imports.

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Section 1:

Overview of the biodiesel sector

1.1 What is biodiesel?

Biodiesel is defined by the World Customs Organization (WCO) as “a mixture of mono-alky esters of long-chain (C16-18) fatty acids derived from vegetable oils or animals fats, which is a domestic renewable fuel for diesel engines.” The GoL plans to designate approximately two million hectares of land for the development of biofuel feedstock plantations in an effort to produce sufficient biofuels by 2020 to replace the contribution of imports to the country’s total fuel consumption (GoL 2004). There are many types of plants that can be used to produce biofuels, for example the original diesel engine was operated on peanut oil. A number of crops are grown in Lao PDR that would be suitable as a potential source for biodiesel, including jatropha, soybean, palm and coconut. Corn, rice and coffee are also used for ethanol biodiesel production. Each of these raw materials has advantages and disadvantages in being used as a source of biodiesel, some of these are discussed below:

- **Coconut** - Coconuts grow well in Lao PDR and have a high yield of 2,400 litres per hectare. The problem is that in plantations, coconut trees are at high risk of yellowing, a disease that kills trees with no known prevention or treatment. Thus, growing coconuts in large quantities is a high-risk endeavour with longer-term guarantee of supply difficult to ensure.
- **Jatropha Curcus** (physic nut) - Jatropha is easy to grow and is commonly used as a shrub by farmers. Depending on the cost of buying jatropha from the local farmers, this crop represents the most viable potential as biodiesel in Lao PDR at present. However, if Lao PDR were to produce jatropha, it would be as a “single use” oil, which is not suitable for human consumption or animal feed. Jatropha projects are currently being developed in Khammuan province to provide a projected yield of 2,100 to 2,800 litres of oil per hectare.
- **Soybean** - Soybean is being grown with great success as a short-term crop with a variety of uses, such as in food, medicines, soaps, detergents, skincare creams and biofuel. The residual material from processing can be used for soymilk or animal feed. The waste materials can also be used as a flour substitute for celiac sufferers, or as a milk substitute for lactose-intolerant people. Soybean produces 500 litres of oil per hectare with little waste material.
- **Palm** - Palm nuts produce large volumes of oil per acre but the oil tends to solidify at a high temperature. Biodiesel made from palm oil also tends to cloud or gel at a higher temperature than oil from other sources. For example, palm kernel oil is difficult to handle below 30°C (86°F) and palm oil would be difficult to handle below 40°C (104°F). This should not inhibit their use but producers must be prepared to put significant energy into maintaining the temperature at a high enough degree to keep it liquid. Palm nuts produce 5,950 litres of oil per hectare.
- **Corn** - Corn is presently grown for animal feed in and around Vientiane. The quality varies. Corn is generally used for ethanol production; the main disadvantage of corn for biodiesel is its low yield of oil. It produces only 70 litres per hectare, the lowest yield of the crops examined in this paper.
- **Rice** - Rice is a significant crop in Lao PDR, with a higher yield of oil than corn, at 335 litres per hectare. Pilot projects to test the viability of this crop as a fuel source have been undertaken in recent years. There are concerns that allocating rice for fuel will impact on rice availability for local consumption. However, pilot projects are overcoming this issue by concentrating on using inedible rice for this process, which also produces higher-quality ethanol (Vientiane Times 2006a).
- **Coffee** - Coffee is increasingly being cultivated in Lao PDR, with rising sales for domestic consumption and export. Coffee produces 186 litres per hectare. The main problem with coffee is the independent crop value far outweighs the cost of refining this expensive crop for biodiesel. It is

not an economical use of the crop, particularly considering the gains in the world coffee price over the last few years.

While a formal policy on biodiesel has yet to be developed (see Section 1.3) the overall policy of the GoL is to promote the commercial production of appropriate crops and to substitute imports to strengthen Lao PDR's trade position (GoL 2004). As a result, these policies are directly linked to the promotion of biodiesel. Therefore, the GoL has proposed to support Lao businesses by cultivating crops of jatropha, soybean and coconut to process raw vegetable oil through the process of "transesterification" into biodiesel. In the initial phases, demand for biodiesel is likely to be driven by government policies. Demand for renewable energy sources has been shown to be significantly impacted by tax incentives, regulations on the share of biofuels in transport fuel, and government procurement policies (Steenblik 2006). Lao PDR is not alone in the region in its recent drive to stimulate biofuel production. For example, Thailand has recently put in place a three percent target share for biodiesel by 2011. Biodiesel production from jatropha is being studied, given that this large, fast-growing, drought-resistant perennial shrub yields seeds that produce 2,700 kilograms of raw oil per hectare (Steenblik 2006). Moreover, biofuel production generally does not require complicated proprietary technologies.

1.2 Environmental concerns in the sector

By using vegetable rather than mineral-based oil, there is approximately 80 percent less net release of carbon dioxide and a dramatic reduction in sulphur dioxide. There is an increase of nitrogen oxides of between 10-15 percent if pure biodiesel is used. Biodiesel is considered safe to handle and transport because it is as biodegradable as sugar. It is ten times less toxic than table salt and has a high flashpoint of about 300°F compared to petroleum diesel, which has a flashpoint of 125°F.

The rationale for the GoL's plans to increase the production and use of biofuels is based on the premise of potential positive environmental and social impacts, notably the mitigation of climate change through greenhouse gas abatement, conservation of fossil fuels, security of energy supply and maintaining employment in the agricultural sector. The environmental impacts of diverting land to biodiesel crops depend on several factors, including yield, water consumption, chemical inputs, watershed and soil management, and biodiversity conservation.

There are real concerns about the environmental and social impacts associated with some feed stocks. In broad terms, the main environmental impacts are as follows:

- Conversion of natural forests to mono-crop plantations;
- Conversion of land for food crop production for biofuels;
- Expansion of biodiesel crop cultivation into areas with rich biodiversity and endangered species;
- Use of land clearing techniques such as slash and burn to establish new biofuel crop plantations;
- Soil erosion and increased sedimentation;
- Water pollution from the use of fertilisers and pesticides;
- Pollution from oil mill effluents;
- Potential use of genetically-modified crop varieties to increase yields; and
- Use of land targeted for alternative purposes, such as nature conservation.

1.3 Policy and regulatory framework for the biofuels sector

At present, Lao PDR does not have specific decrees or regulations to manage the broadly defined policy to increase production and use of biofuels. Recently, the Lao National Council of Sciences was requested by the Prime Minister to draft a biofuels policy for the consideration of the GoL.

Given the linkages of biofuel production to a range of other areas, such as agriculture, forestry, water

and waste management, and environmental protection, the following policies and regulations are relevant to this sector:

- Notice of the Prime Minister's Office No. 09/PM dated 25/05/2006 to save on imported fuels due to price increases.
- Environmental Protection Law No. 02/NA dated 03/04/1999.
- Decree on the Implementation of the Environmental Protection Law No. 102/PM dated 04/06/2001.
- National Science and Technology Policy to 2010 No. 09/PM dated 27/11/2003.
- National Strategy on Environment Education and Awareness to 2020 and Action Plan for 2006-2010 No. 01101/STEA-PMO dated 05/06/2004.
- Forestry Law No. 01/NA dated 11/10/1996.
- Land Law No. 01/NA dated 12/04/1997.
- Agricultural Law No. 01/NA dated 10/10/1998.
- Water and Water Resources Law No. 02/NA dated 11/10/1996.
- Industrial Processing Law No. 01/NA dated 03/04/1999.
- Business Law No. 03/NA dated 18/07/1994.

Currently, government research as well as foreign direct investment (e.g., from Thailand and Korea) are focused on the potential of jatropha as a biofuel in Lao PDR. Jatropha has been identified as the plant with the most biodiesel potential in Lao PDR because the jatropha fruit yields seeds with high oil content. Jatropha oil can be extracted and used as fuel for operating internal combustion engines. There are more than five associations that have partnered with private companies to carry out research and pilot projects for jatropha, including the Sustainable Tree Plantation and Livestock Promotion Association; Lao Promotion Biological Products Association; Lao Agricultural and Artisanal Promotion Association; Community and Environment Development Association; and Lao Organic Farmers Association. To date, it is estimated that more than 50,000 hectares of jatropha have been planted in Lao PDR (Sunlabob 2007).

Section 2:

Trade-related environmental impacts and national experiences in improving environmental sustainability in the sector

The GoL is making an effort to reduce its dependency on petroleum imports and to address a prolonged trade deficit through promoting trade-led growth and attracting foreign investment. Initiatives are being put in place that will increase production to meet the needs of the domestic market and boost exports, especially in key sectors such as agriculture, construction materials and light manufacturing industries. Increasing production and exports will require a solid energy policy to underpin economic growth and ensure that it goes hand-in-hand with sustainable development in Lao PDR.

2.1 Analysis of the impacts of increased trade in the biofuels sector

There have been many studies carried out at the international level on the environmental impacts of substituting biofuels for fossil energy sources (Steenblik 2006). There are many compelling reasons for promoting the production of biofuels, as well as important constraints. The National Environment Performance Assessment (EPA) undertaken by STEA sets out several environment indicators of relevance to the development of biofuels: forest resources; water resources; threat to biodiversity; land degradation; and climate change (STEA & UNEP 2006). Given the GoL's commitment to a forest policy to protect existing forests, the EPA states that "shifting cultivation and inappropriate farming practices in the uplands" have contributed to a dramatic decline in forest cover in the past three decades (STEA &

UNEP 2006:12).

Thus, it is vital to note that the agriculture sector is by far the largest consumer of water resources, at 82 percent of total freshwater withdrawals in 2000, compared with 10 percent for industry and 8 percent for domestic use (STEA & UNEP 2006). As a direct result, the extent to which biodiesel development impacts on forests, water, biodiversity and land policies will have to be taken into consideration. The EPA highlights that there was a marked decrease in the 1990s with respect to land degradation through slash and burn farming due to the GoL's policies. Notably, agriculture ranks as the largest contributor to greenhouse gas emissions, accounting for 86 percent of methane emissions and 81 percent of CH₄ emissions mainly through slash and burn practices (STEA & UNEP 2006). This percentage does not take into account the loss of absorption capacity of forests that have been destroyed to make way for agriculture. Potential benefits of using biodiesel and possible associated environmental impacts are summarized below; importantly, the extent of these impacts will be shaped by the policy and regulatory framework put in place by the GoL.

Positive impacts of biodiesel

- Empowerment of a slowly-developing country by reducing its dependence on external sources of mineral oil products, thereby reducing the current trade deficit;
- Contribution to environmental protection on a large scale through a potential reduction in greenhouse gases resulting from a switch from fossil fuels to alternative biofuels;
- Contribution to environmental protection on a smaller scale by using renewable resources for biofuels produced by domestic labour.
- Economic benefits to the macro and micro economy of the country by using domestic labour and resources in the production and distribution of energy;
- Use of land that would otherwise not be suitable for cultivation of other crops; and
- Efficient use of biodegradable outputs from industry, agriculture, forestry and households, such as straw, timber, manure, rice husks, sewage, and biodegradable waste.

Negative impacts of biodiesel

- Unsustainable land use changes as a result of a shift from, for example, rice paddies to plantations for biodiesel production;
- Loss of natural forests to mono-crop plantations for biofuels;
- Food security concerns resulting from a shift from food crops to production for biofuels, as well as rising prices for staple crops for food;
- Loss of biodiversity and endangered species;
- Land-clearing fires to establish new biofuel plantations; and
- Water pollution (ground water and watershed areas) from the use of chemical fertilizers and pesticides.

With the developing interest in biodiesel as a sustainable alternative to fossil fuels in Lao PDR, it is important to recognize that the potential benefits may be undermined if forests are cleared for biodiesel crops, for example. This is likely to be less the case for jatropha, which can grow on marginal land, but potentially the case for other crops, such as palm and soybean. Given that Lao PDR has a significant forest cover - with approximately 40 percent of the country covered in forests (STEA & UNEP 2006) - the temptation may be to cut prime forested areas for biofuel cultivation. As a direct result, the environmental benefits of biodiesel as a non-CO₂ emitting alternative to fossil fuels may be undercut by the loss of forests for carbon absorption. These inter-linkages will have to be further studied to allow for a complete assessment, on a case-by-case basis, of the impacts of biodiesel development in Lao PDR.

2.2 Case study of Jatropha: an integrated approach to rural development

There is significant interest in the production of biofuels from the fruit of the jatropha tree, with jatropha cultivation and resulting biodiesel production increasingly being established in Lao PDR (Vientiane Times 2006b). This industry may prove economically viable due to the country's low population density and large areas of available land suitable for jatropha cultivation. Positive impacts of developing the jatropha biodiesel sector include:

- Jatropha does not require large quantities of water to grow and can grow in areas where land is poor and degraded.
- Jatropha is suitable for use as a revegetation and erosion prevention species as the plant's roots grow close to the ground's surface, anchoring the soil and effectively reducing surface run-off during heavy downpours, thus causing more water to penetrate the soil. The jatropha tree has been used to create shrub fences around the Nam Theun 2 dam to reduce wind erosion and help to control soil erosion.
- Jatropha is commonly used for hedges, for example around cotton plantations or to fence-in livestock, while also improving soil fertility.
- The processing of jatropha results in a "press cake" after oil extraction, which has proved to be effective organic manure.
- Jatropha hedges are used in cotton production and rotation to ensure improved fallow, whereby jatropha hedges keep out cattle when the cotton fields are sown with legumes to improve soil fertility protect cotton fields.

It is important to keep in mind that if pesticides are used in the production process for jatropha, there is an increased potential for pesticides to run-off into the local hydrology system.

The Lao PDR Ministry of Agriculture and Forestry has been working with farmers in Saythany district and Vientiane municipality to cultivate 2.5 million trees on approximately 1,000 hectares of land, where trees can reach maturity within two to three years and have the capacity to produce up to 5 million litres of biodiesel per year (GoL 2004). In addition to local initiatives, there has been Thai investment in jatropha plantations in Vientiane and Savannaket provinces, and Malaysian investors have applied to the GoL for concession areas for jatropha and palm oil plantations.

There has been considerable attention given to the potential of jatropha as a biodiesel in Lao PDR to provide energy sufficiency and to build an integrated approach to rural development. Various research and development projects have been defined by the GoL as well as the private sector to establish and encourage biofuel programs.

Non-government organizations have also been attracted to this sector. For example, a Lao company, Sunlabob, in cooperation with the Lao Organic Farmers Association, is exploring the viability of jatropha oil through participating in research and development projects for propagation, village level decentralized production and processing of oil, and the use of oil for fuel in rural areas for machinery such as tractors, trucks, pumps and generators (Sunlabob 2007). Sunlabob is developing jatropha to generate electricity for remote villages that are not connected to the main electricity grid. Biofuel-operated motors for electricity generation have the potential to provide rural villages with an efficient energy source. Providing rural communities with electricity has obvious development benefits, such as enhancing productive capacity for grain mills, sawmills, carpentry, food processing and packaging, distillation of essential oils, and enhancing communication. The intention is also to stimulate village income and make agricultural processes less energy intensive and more energy efficient.

Section 3:

Conclusions and strategic policy recommendations for the biofuels sector

3.1 Conclusions

- The GoL will continue to focus on the development of biofuels to replace imports and to contribute to meeting the country's total fuel consumption needs. Increased production of biodiesel as a reliable domestic energy source can contribute to meeting the needs of the domestic market and to underpinning trade-led economic growth in Lao PDR. Lao PDR has significant land on which to cultivate plantations of jatropha and soybean, which are the plants with the most biodiesel potential.
- While many government policies and regulations indirectly govern the biodiesel sector, a cohesive national policy on biofuels does not exist at present and will require coordination between government ministries and provincial authorities.
- Biodiesel has many environmental benefits and should be promoted; however, the production of this fuel source also raises the environmental concerns outlined above. There are also social issues such as the labour involved in biodiesel crop cultivation and production and the impacts of transferring productive food crops to fuel crops.
- There are a growing number of examples of private/public partnerships, such as the Sunlabob/Lao Organic Farmers Association, which are promoting the production and use of biodiesel and directly contributing to the GoL goals of growth and poverty reduction.
- There is a shortage of experts and technicians to help to monitor the quality of biodiesel produced and make sure the equipment operates efficiently and with the best available technologies. There is a lack of training in rural areas to ensure efficient crop cultivation, processing and use of biofuels.
- There is a lack of in-country materials, research and expertise in biofuels in Lao PDR.

3.2 Strategic policy recommendations

The objective of the GoL is to increase the domestic supply of energy to provide an alternative to high-cost petroleum imports. To do this in a sustainable manner will require integrated planning, assessment of potential impacts with a strategy for mitigating negative impacts, and a forward-looking national energy strategy that realistically includes biofuels within the overall energy context of national development. In formulating a national biodiesel policy, it is recommended that the GoL consider:

- **Mainstreaming environmental considerations into biodiesel policy and regulation development processes, through:**
 - ▶ including a strategic environmental assessment (SEA) of the national biofuel policy in coordination with the ministries and provincial authorities concerned, which clearly outlines environmental and social policies and is integrated with, and included in a national energy production and management plan;
 - ▶ conducting environmental impact assessments of jatropha as well as other biofuels in order to promote environmentally sustainable and integrated rural development as part of developing a national policy;
 - ▶ drafting the government's "Master Plan" for the utilization of land, encouraging biodiesel plantations to integrate crop rotation with other crops, such as rubber and rice, and to incorporate natural resource-use considerations;
 - ▶ establishing a centralized institution to address current gaps in knowledge, skills, equipment and capital to carry out integrated planning and management of a standard biodiesel program. One possibility would be to develop a training program on the environment and social aspects of the

industry. This training curriculum could then be expanded to include other educational institutions, such as the National University of Laos; and

- ▶ establishing a government-supported system to check the quality of biofuels produced and to ensure the equipment is operated efficiently during production and delivery.

■ **Encouraging the private sector to adopt best practices, through:**

- ▶ strengthening the strategic environmental assessment process to ensure the private sector addresses environmental and social issues of their operations in Lao PDR;
- ▶ providing incentives to attract investment from both domestic and foreign sources to develop suitable biodiesel crops in line with SEA findings; and
- ▶ providing incentives for, and investor preferences to those investors with a proven environmental and social track record.

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