**Working Papers on Environmental Sciences**

# The political ecology of Jatropha plantations for biodiesel in Tamil Nadu, India

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***Date:*** *08-04-2010*

Refer to as:

P. Ariza-Montobbio, S.Lele, G. Kallis, J. Martínez-Alier: The political ecology of Jatropha plantations for biodiesel in Tamil Nadu, India, *Working Papers on Environmental Sciences*

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# ABSTRACT

*Jatropha curcas* is promoted internationally for its presumed agronomic viability in marginal lands, economic returns for small farmers, and lack of competition with food crops. However, empirical results from a study in southern India revealed that Jatropha cultivation, even on agricultural lands, is neither profitable, nor pro-poor. We use a political ecology framework to analyze both the discourse promoting Jatropha cultivation and its empirical consequences. We deconstruct the shaky premises of the dominant discourse of Jatropha as a "pro-poor" and "pro-wasteland" development crop, a discourse that paints a win-win picture between poverty alleviation, natural resource regeneration, and energy security goals. We then draw from field-work on Jatropha plantations in the state of Tamil Nadu to show how Jatropha cultivation favors resource-rich farmers, while possibly reinforcing existing processes of marginalization of small and marginal farmers.

***Keywords:*** biofuels, political ecology, marginalization, India, Jatropha.

# 1. Introduction

Global production of biofuels has grown three-fold between 2000 and 2007, although still accounting for less than 2% of global final energy consumption (Howarth et al. 2009). The dramatic rise of prices for basic food staples in 2008 was arguably related in part to farmers switching from food crops to biofuels (Mitchell 2008). A growing number of studies have been questioning the ecological-economic sustainability of biofuel energy (Pimentel and Patzek 2005, Pimentel et al. 2007, Russi 2008, Giampietro and Mayumi 2009), and even EU reports alert about the environmental damage of agrofuels (Harrison 2010). The EU, the US and other countries have kept, however, their targets for agrofuels production. The development of agrofuels in the South has boomed and can dramatically affect agrarian conditions and rural livelihoods.

*Jatropha curcas* (hereinafter Jatropha) is a hardy shrub claimed to be drought-tolerant and with the ability to reclaim land, prevent erosion and respond better to organic manure compared to chemical fertilizers (Francis et al. 2005). Jatropha is promoted on the basis of its suitability for marginal lands and its multiple uses, reducing hence competition with food crops and offering income alternatives to farmers. A global market study of Jatropha (Global Exchange for Social Investment (GEXSI) 2008a) has estimated the existence of about 1,000,000 ha around the world in 2008, comprising nearly 250 projects. The 87% of the land under Jatropha cultivation is located in Asia, with India, China and Myanmar as forerunners (Global Exchange for Social Investment (GEXSI) 2008b), 12% in Africa, especially central and southeast Africa (Henning 2008), and 2% in Latin America, especially in Brasil and Mexico, where this species comes from (Martínez 2007, Consejo Agropecuario del Sur (CAS) 2009).

With about 300,000 ha, India is a forerunner in Jatropha plantation and also its research and development (IARI (Indian Agriculture Research Institute) 2007). The official rationale is that the crop fits best the diverse agro-climatic conditions of the country and has a shorter gestation period than other oil-bearing trees. Jatropha is promoted as a potential solution to both the energy demand-supply deficit that the growing economy of India is facing (Government of India 2006) and as a suitable crop for marginal lands reclamation and rural development (Government of India 2003). The National Biofuel Policy, launched in December 2009, building upon the National Biodiesel Mission of 2003, aims at blending bioethanol and biodiesel with respectively gasoline and diesel at a proportion of 20% by 2017. The biodiesel target is planned to be met through the cultivation of 13.4 millions of hectares of "wastelands" with Jatropha. The South Indian State of Tamil Nadu is one of the leaders in biodiesel promotion, the goal being to reach 100,000 ha of Jatropha between 2007 and 2012 (Government of Tamil Nadu 2007c, Government of Tamil Nadu 2009).

This article investigates the political, technical and social construction of Jatropha as a solution to India's energy, agriculture and poverty problems, taking place at the national and state political levels, and contrasts it to the actual ecological, economic and social failure of the crop at the farm level. The field ecological-economic analysis is based on a study of plantations in two of Tamil Nadu's districts, Coimbatore and Thiruvannamalai. National, state and district level research builds on a review of policy documents and in-depth and informal discussions with actors involved in Jatropha promotion. The agro-economic results are reported in detail in Ariza-Montobbio and Lele (in press), who come to the conclusion that Jatropha cultivation on private agricultural lands has failed in the case-study area. In this paper, we explain, through a

political ecology approach, the causes and implications of this failure. We highlight the contrast or mismatch between the results in the field and the continued promotion of Jatropha by regional and national policy makers and researchers in India. We uncover the impact that the crop has in farmers' everyday life. Rather than pro-poor, the pattern of cultivation of Jatropha is generating upward redistribution, being the big farmers the only ones who benefit from it, if at all.

# 2. A Political Ecology of Jatropha plantations

Political ecology "combines the concerns of ecology and a broadly defined political economy" (Blaikie and Brookfield 1987, 17). Nature-society relationships are examined through an analysis of social forms of access and control over resources (Watts and Peet 2004) and the unavoidable conflicts in the temporal and spatial distribution of the goods and bads of socio-environmental change (Martinez-Alier 2002, Heynen et al. 2006). Socio-environmental change comes from increased social metabolism (Martinez-Alier 2002, Martinez-Alier 2009), meaning larger flows of energy and materials, and that it is unevenly distributed, i.e. that "one person's profit is another's toxic dump" (as Watts and Peet (2004, 9) put it). The consequences and the modalities of environmental change depend on the distribution of power in society which is unevenly distributed along lines of class, race, or gender (Swyngedouw 2004).

Political ecology traces causation of environmental degradation to broader systems rather than blaming only proximate and local forces. Causes of environmental degradation or impoverishment are searched through "chains of explanation" at multiple scales (Blaikie and Brookfield 1987). "External structures", such as state institutions, global markets, "peak oil" and the price of energy, frame the incentive structures that pressure national and local actors to act the way they do and serve to explain why for example, new policies, such as those promoting a new "eco-friendly" crop, fail. Political ecology offers both an understanding of socio-environmental change as well as a conceptual toolkit, consisting of a number of (hypo)theses (patterns of explanation) that have emerged through accumulated empirical studies (Robbins 2003). Two theses/insights from political ecology are relevant to our analysis here.

The first thesis concerns knowledge, values and power. Control of knowledge and of the forms of representing reality (scientific or discursive) is an important source of power. Power is not only exerted materially through control of the means of production or the control of political institutions. It is also exerted at the realm of ideas and discourses. Powerful "valuation languages", often the techno-economic discourses privileged by elites in power, suppress alternative forms of values, expressed often by local communities and indigenous groups in environmental conflicts (Martinez-Alier 2002).
Political ecologists have contrasted the technocratic simplifying systems and models of ecological knowledge promoted by scientific experts and "decision-makers" at macro-political levels, with the often detailed and spatially or culturally contextualized knowledge of local actors, those who work the land (e.g.(St. Martin 2001)) and critical interdisciplinary studies. Macro discourses implicitly assume a priority to economic values and the need to have new "clean" energy supplies for national economic growth, whereas local discourses place a value on household or community reproduction and employ a diverse and more plural set of values.

The second thesis concerns "marginalization", referring to social and environmental degradation due to production at the margin in economic terms from socially marginalized groups, producing and living in marginal ecosystems (Blaikie and Brookfield 1987). Ecology, economics and politics interact, when new economic activities such as cash crops change both, the local agro-ecology, reducing often landscape and productive diversity. Changes in social relations by commodifying exchange and redistribution and increasing dependence on cash can bring to processes of further marginalization and *proletarianization (or semi-proletarianization)* of the already marginalized rural poor (Kay 2006). Some studies (e.g.(Grossman 1993,

Moreno-Peñaranda and Kallis 2010) urge however for caution in assuming *a priori* that export-oriented or commercial crops have negative social effects, and argue for careful, local-based analyses of how new economic activities fit in and are appropriated/adapted in the livelihood systems of local populations, with due attention to consequences and their distribution.

We find both these theses relevant to the Jatropha experience in Tamil Nadu. National and state policy discourses about Jatropha simplify a complex local agro-ecological reality in a set of techno-economic indicators and accompanying maps, which render certain lands as "wastelands" amenable to biofuel plantations. The introduction of new technologies is done, in other cases, by constructing local practices as "inefficient" or "backward". Jatropha, a new agrofuel commercial crop, is introduced in the name of expanding energy needs, and the development of wasteland and rural poor, with the aim to produce fuel mainly, for national urban areas. Local ecological-economic and political-ecology studies are necessary to shed light on the precise socio-ecological changes that take place at the local level and link the micro to the macro level, and the two into the changing political economy of India.

# 3. "Pro-Wastelands" and "pro-poor" crops: A political ecology reading of the social construction of Jatropha in India and Tamil Nadu.

The Indian economy is immersed in a rapid structural transformation with an associated socio-ecological (socio-metabolic) transition (Fischer-Kowalski and Haberl 2007, Krausmann et al. 2008, Schandl et al. 2009), and energy demand is growing. The process of liberalization-globalisation in the last two decades has witnessed the interlinked phenomena of industrialization and rapid economic growth for the country as a whole, a slow down of agriculture, and an intensification of social conflicts (Walker 2008). The availability of land has been shrinking on account of population growth and the competing demands from various sectors (Government of India 2009b). The pressure is both on agricultural lands as well as non-agricultural lands (forests, grazing lands, etc). Simultaneously, within agriculture, the shift from food crops to non-food crops is a matter of concern. India has started recently to lose self-sufficiency in food produce (Jasani and Sen 2008) and is facing shortage of edible oils (Government of India 2003). Food prices have been rising rapidly in the past few years (Rahman 2008). In this context, any proposal to divert land for producing energy for vehicles is bound to be met with scepticism. How has the government managed to introduce the concept and expand the discourse in favour of cultivating agro-fuels?

The government seems to have used a three-pronged approach. First, there is the constant refrain of 'energy security', the need to become less dependent on foreign petroleum[1] (Government of India 2006). Second, there is a reference to the opportunity to rehabilitate degraded or dry lands[2], the so called "wastelands", without competing with food production. Third, there is an added concern that agrofuels 'could become in itself a major poverty alleviation programme for rural poor'[3](Government of India 2003).While the energy security discourse is applicable to all energy policy, and has come in for criticism elsewhere (Pimentel and Patzek 2005, Pimentel et al. 2007, Russi 2008, Giampietro and Mayumi 2009), we focus on the other two elements that are specific to the promotion of agrofuels in general and Jatropha in particular[4].

The National Policy on Biofuels states:

> 'Plantations of trees bearing non-edible oilseeds will be taken up on Government/community wasteland, degraded or fallow land in forest and non-forest areas. Contract farming on private wasteland could also be taken up through the Minimum Support Price (MSP) mechanism proposed in the Policy. Plantations on agricultural lands will be discouraged'.(Government of India 2009a , p. 7)

[1] India is meeting 70% of its increasing oil needs by imports and is the fourth major oil importer after USA, Japan and China (International Energy Agency 2009). Petrol and diesel use in transportation are growing rapidly with high economic growth since 1991 and the transport sector accounts for the 50% of oil consumption (Government of India 2006).
[2] K.C. Pant, Deputy Chairman of The Planning Commission of India, Foreword of the Report on the Committee on Development of Biofuel (GOI 2003).
[3] D.N. Tewari, Member of the Planning Commission of India, Preface of the Report on the Committee on Development of Biofuel (GOI 2003).
[4] We leave other elements aside such as the optimistic views on scarce water requirements, the very positive energy return on energy invested (EROI), and the avoided carbon dioxide emissions, that accompany pro-Jatropha discourse not only in India but across the world. They are used complementarily with the "pro-poor" and "pro-wasteland" discourses as supporting features.

An assessment by The Energy and Resources Institute (TERI), however, contradicts the above, pointing out that:

> 'The present strategy of the Central Government is to utilize wastelands for biodiesel plantations so as not to affect the food security of the country. However, several private industries and state governments are exploring the possibility of utilising agricultural land as well for biodiesel production' (The Energy and Resources Institute (TERI) 2005, p 28).

Where is Jatropha being planted? Is "wasteland" rehabilitation discursively used to build legitimacy around Jatropha, irrespectively the use and cover of the land where it is finally planted? To start with, it is useful to explore the concept of "wasteland":

The term 'wasteland' has very different connotations depending upon whether one is thinking in fiscal, social, or agro-ecological terms. The economic connotation originated during the colonial period, where the term was applied to all land that did not generate revenue for the British government (Gidwani 1992). Thus, even dense forests and productive grasslands were classified as 'revenue wastelands' or 'assessed or unassessed wastelands'. In terms of ownership, these lands were under either state ownership or local commons; although a much smaller portion of revenue wasteland was private land that could not be cultivated. Thus, socially speaking, most of these 'revenue wastelands' were crucial components of the livelihood system, and a large portion were agro-ecologically important.

The 1980s saw the re-emergence of the 'wasteland' discourse, this time in a technical sense of "degraded land that can be brought under vegetative cover with reasonable effort and which is currently underutilized land and land which is deteriorating due to lack of appropriate water and soil management or on account of natural causes" (Government of India 1989, Chopra 2001). A National Wasteland Development Board was set up in 1985, and it estimated the total area of wastelands in the country to be 123 million hectares, a staggering 37% of the country's land area! (Table 12.1 in Yadav 1989). The National Remote Sensing Agency was then charged with producing a Wasteland Atlas. The estimate was eventually revised downwards to around 55.3 million ha according the last edition (National Remote Sensing Agency 2005), which is still 17% of the land area. The mapping also used 28 categories, including permanent snow cover and permanent desert, which are not really lands degraded by human agency. Nevertheless, three categories account for more than 50% of the total available waste lands: degraded forest-scrub dominated land, land with scrub and land without scrub. Of course, the remote sensing approach is not able to indicate the property rights situation or de facto use of these lands, which assessed from local in-depth studies, gets highly more complex (Lele et al. 1998).

The technical approach thus sidestepped the fundamental point that the notion of 'degradedness' is necessarily value-laden and subjective, and methodologies of mapping are further biased in particular ways (Sarin 2003): grazing lands which are productive during the rainy season but 'barren' looking during the dry season routinely get classified as wasteland, while their socioeconomic value to local communities, particularly the poor, is actually high (Jodha 1990, Government of India 2009b). Attempts to 'regenerate' such common wastelands by planting commercially valuable species such as eucalyptus date back to the Social Forestry programmes of the 1980s; several analyses showed that this 'commercialization' of the commons benefited the paper and pulp industry while depriving local communities of subsistence uses (e.g., firewood and grazing) (Shiva et al. 1985). Thus, degraded how is related to degraded for whom, and regenerate how is related to regenerate for whom. But the simplistic

discourse on wastelands glosses over these multiplicities, and thereby creates the space for interventions that are one-sided, driven by a technical (productivity-oriented) or techno-economic (return-oriented) rationality, rather than a balance between these and social needs and ecological function[5].

The idea of wasteland is powerful because it renders debate almost impossible: how can anyone disagree with the propositions that 'wasteland' should be regenerated, that producing agrofuel out of unproductive wasteland is a good thing? Having mooted this, techno-econonomic missions then take liberties with even the technical definitions to suit their goals. Thus, the Biodiesel National Mission (2003), when estimating the extent of land suitable for Jatropha, includes categories that go beyond the above three most abundant wasteland categories. It includes understocked forests lands (3 mha), protective hedge around agricultural fields (3 mha), farmlands under agroforestry (2 mha), fallow lands (2.4 mha), wastelands previously covered under various watershed projects (2 mha) and tracks of public lands along railways, roads and canals (1 mha). That farmlands under agro-forestry are considered wastelands or suitable for Jatropha shows the extreme malleability of the concept! Malleability makes it difficulty to estimate what kind of land use and land cover types are really being converted to agrofuels, under which property rights they exist and who they are being given to. Such unaccountability allows government and corporations to legitimize the promotion of agrofuels in favour of their interests. Thus, in practice, Jatropha plantations are promoted through three different models.

The first approach consists on leasing out government lands to private companies and is being practised extensively in the state of Rajasthan. The State government has set up a "Rajasthan Land Revenue (Allotment of wasteland for biofuel plantation and biofuel based industrial and processing unit) Rules 2007". These rules permit wasteland to be leased out to private companies and government enterprises, for up to 20 years. Both, the maximum size of a plot that can be held by an individual or a company and the ban on the sale of tribal lands, have been abolished. It is now possible for a special government committee to approve up to 1,000 hectares of land to be given to private companies for Jatropha plantations (GRAIN 2008). Most of *Orans* (Village Commons) and *Gauchars* (Grazing lands) legally fall under the "cultivable wasteland" category and would be snatched away from pastoralist communities (Navdanya 2007, National Consultation 2007). Tamil Nadu has also included a leasing component in its Comprehensive Wasteland Development Programme (CWP), launched in 2003. It targets 2 million hectares of government wasteland involving 30 year leases to the corporate houses for which a "normative" ceiling of 400 hectares has been fixed. Wasteland would be developed for orchards, medicinal and aromatic plants, horticulture and other types of commercial agriculture (Government of India 2009b). However, there has been no clear definition as to the kind of wastelands to be developed. Grazing lands, excluded at the beginning, were finally included.

The distribution of wasteland to the rural poor constitutes the second model of Jatropha promotion. The National Watershed Development Program for Rainfed Areas (NWDPRA) aims at increasing productivity of wastelands in rainfed areas. In doing so, the program, as part of other activities, brings government wasteland under cultivation through distribution of land to small farmers for cultivation of "pro-poor" crops such as Jatropha. However beneficiaries of NWDPRA are being convinced to plant Jatropha in their own private lands, as monocrop instead on public wasteland. State governments, in their above mentioned schemes, add to the target area allotted to companies a share to be allotted to cooperative societies of rural poor. For instance Tamil Nadu

[5] Depending on its actual land cover and land use, the so called "wastelands" provide diverse environmental services, such as carbon sequestration and biodiversity and water conservation.

CWP distributes two acres of government wastelands to landless households. However, among the southern States, Tamil Nadu remains at the bottom in the matter of wasteland transfer[6] (Viswanathan 2003). Wasteland transfer, although being discursively "pro-poor" finally prioritises agri-business entrepreneurship.

Finally, the cultivation of Jatropha on private lands is the third model of Jatropha promotion. It uses the "pro-poor" discourse to "sweeten" the actual contract farming between Jatropha farmers and private companies. This discourse is in favour of small farms, due to the social efficiency of resource use and the improving of social equity through employment creation and more equal income distribution (United Nations Development Programme (UNDP) 1996). The "pro-poor" discourse, goes in line of "the equity-growth-efficiency argument" that is already present in the debates about land reforms (Srivastava 2006).

The "pro-poor" discourse is articulated among three main arguments: the short maturation period of Jatropha, its "low-input crop" characteristics, and the associated promotion of "small-scale decentralised energy production". The lack of clear experiences on the maturation period (Achten et al. 2008) and the lack of farmers' knowledge about this new crop have allowed private companies and the government to announce shorter maturation periods that even those achieved in research stations. While research stations claim for three to five years before the yield gets stabilized (Rao 2006, Paramathma et al. 2007), the NMB2003 reports it as two years. Another argument in favour of the poor has been that less water, fertilizers and labour are required for Jatropha cultivation. Part of the harvest season coincides with the non-agricultural season being able to provide employment at different periods than the rest of crops (Kumar Biswas et al. 2010). Such characteristics should benefit the poor specially small or marginal farmers and landless that will have more income opportunities. Finally, the pro-poor discourse includes arguments that highlight the potentialities of "decentralized energy production for local use". By-products (such as the seed-cake) can be used as green manure or as feed for the cattle (Openshaw 2000). Small-scale decentralized oil mills can up-grade rural off-farm sector (Francis et al. 2005). However, to do so, the oil extraction and by-products should be extracted and detoxified by small-scale industries located at village level. Under contract farming, the by-products are kept under private companies control in industrial poles, and the oil extraction is highly centralized.

Summing up, the two discourses, the "pro-wasteland" and the "pro-poor", operate together as a way to get either common or private lands for Jatropha. They involve starting with fuzzy concepts, stretching them in various ways, selective use of data and transgressing in practice boundaries that were laid down in earlier policies (such as not leasing out commons and forest lands, investing in rainfed lands, etc.) through obfuscation. The next section deconstructs the above presented arguments, specially the "pro-poor" discourse. We draw from the interpretation of empirical field-data about the actual performance of Jatropha contract farming in Tamil Nadu.

[6] While about 2 mha of wasteland has been transferred to eligible people in Andhra Pradesh, about 150000 ha in Karnataka and 180000 ha in Kerala, the wasteland distributed in Tamil Nadu is less than 100000 hectares (Viswanathan 2003).

# 4. A political ecology reading of Jatropha failure and the risk for increasing small farmers' marginalization

The results of a field-level assessment of the performance of Jatropha plantations on private agricultural lands in Tamil Nadu state of India, using a sample drawn from two districts in the state, have been reported elsewhere (Ariza-Montobbio and Lele, in press). We look at causes and consequences of Jatropha failure and their distributive impacts to elucidate whether Jatropha cultivation is really "pro-poor" or if it can, on the contrary, increase social differentiation.

Our empirical material comes from a two level data collection. First, researchers (6), NGOs representatives (2), Government officials (9), private companies managers and field staff (6), were interviewed[7]. Research institutes and experimental stations were visited from March to July 2008. Second, our field study was based on a nested approach to data collection in two districts of Tamil Nadu. Thiruvannamalai (T) is the leading district in Jatropha area coverage. Coimbatore (C) is a center of Jatropha research and development. We surveyed 79 plantations (21 in C and 58 in T) and in each we collected data on main agro-economic characteristics of the farm and socio-economic features of the farm-owning or managing households. Out of the surveyed plantations we selected 45 households (6 in C and 39 in T[8]) for conducting in-depth interviews about Jatropha adoption and its livelihood impacts. An agro-economic assessment was also performed for 14 selected plantations (9 in C and 5 in T) that were older than 2.5 years. We begin with a short overview of the state-level policy and field context. We follow with the description of Jatropha plantations in Coimbatore and Thiruvannamalai. After outlining in very brief the evidence of Jatropha failure, we explain its uneven causes and consequences and its broader meaning.

## *4.1 Jatropha development in Tamil Nadu state of India: the context*

### 4.1.1 The Tamil Nadu policy: actors, roles and interactions.

Tamil Nadu state in southern India is one of the forerunner states in Jatropha development with a well articulated Biodiesel Policy (Government of Tamil Nadu 2007a, Government of Tamil Nadu 2007b, Government of Tamil Nadu 2009). This policy, launched in 2007-08, was built upon a pilot scheme launched in 2006, and has set a target of promoting 100,000 ha of Jatropha plantations over a period of five years, with district-wise differential targets. The policy involves providing 50% input subsidies (for saplings and drip irrigation).

Under the State Agricultural Department as a nodal office, but with the involvement of Forest Department and Rural Development Department, nurseries have been raised, saplings on degraded edges of forest have been planted and watershed development programs have been undertaken. However, the greatest effort has been put into developing contract farming on private lands to grow Jatropha. The State Agricultural Department collects planting area details of each farmer and supervises the legal

[7] Interviews were conducted in Tamil Nadu Agricultural University (TNAU), Forest College Research Institute (FCRI), Bannari Amman Group factory main plantation site and R&D Branch plantations, D1 Mohan Bio Oils Ltd. R&D Branch plantations, District Collectorate, District Watershed Development Agency, and District Forest Office, among other government agencies. Some interviews were conducted in the field itself as we accompanied company field staff and government officials to the field to understand and observe their work.

[8] The reason for the lop-sided sample for in-depth interviews is because the plantations were clustered in T, while in C, plantations were scattered, limiting the extent of data collection.

documentation needed for subsidy component. Tamil Nadu Agricultural University (TNAU) provides quality seeds to government and private nurseries to whom is monitoring and inspecting. TNAU also provides training and technical advice to farmers and entrepreneurs. Eleven companies are identified by the Agriculture Department for supplying planting material to the farmer under contract farming.

### 4.1.2 Field setting: ecological and socio-economic conditions of production.

Coimbatore is, after Chennai, the second most urbanized and industrialized district of Tamil Nadu with 66% of its population living in urban areas. 40% of the district's ~7500 sqkm land area is under agriculture. The main crops are cereals and millets, and coconut. In contrast, Thiruvannamalai is among the districts with highest rural fraction, about 80%. Although being less industrialized, T has, like Coimbatore, the 40% of its ~6300 sqkm under agriculture, the main crops being cereals and millets and oil seeds, especially groundnut. Coimbatore and Thiruvannamalai form part of the entire inland belt, which together with the southern and northern coastal areas constitute the "dry" agrarian ecotype of Tamil Nadu. The average annual rainfall is 690 mm and 1040 mm respectively.

The "dry" areas have had historically a less unegalitarian structure with peasant proprietorship as the dominant mode (Krishnan 2003). Thiruvannamalai follows this expected trend towards the marginalization of holdings. 70% of the agricultural land is held by small or marginal landholders (holding size 2 ha or less) who constitute the 94% of farmers. The rest 30% of the land, is held by big landholders (holding size >2 ha) who constitute the 6% of farmers' population (Government of India 2001). Coimbatore, however, has historically reflected a lower trend towards a marginalization of holdings than Tamil Nadu as a whole and the rest of "dry" areas (Krishnan 2003). 30% of the total agricultural land is under marginal or small farmers' holdings that represent the 70% of landholders in Coimbatore (Government of India 2001).

The ecological, bio-physical and socio-economic conditions of production constrain livelihood systems. As repeatedly reported by interviewed farmers, the study area is characterized by a prevalent water and agricultural labour scarcity. Over exploitation of ground water is widely reported in both districts (Palanisami and Venkatram 2008a, Palanisami and Venkatram 2008b). Water scarcity limits the production from the land and constrains households, in terms of the land that they can really cultivate, forcing them to flexibly allocate labour in off-farm activities. Timely sowing, planting, weeding and harvesting in dry land are major problems due to labour and water scarcity. The existence of wild pigs, cattle and other wild animals damaging the crops at night also shapes the possibility of the household to allocate labour.

In Thiruvannamalai, farmers usually follow a crop pattern of one or two seasons of irrigated cash crop during the rainy season (sown in June-July and harvested in September-October), according the water availability, followed by a season of short term crops more oriented to subsistence. They combine also multiple crops through intercropping. The main cash crops are groundnut and rice and more subsistence oriented crops are pulses such as green gram, black gram, horse gram and pigeon peas. The main cropping system (paddy- groundnut, paddy –pulses) followed in the district enriches the soil and maintain soil fertility (Palanisami and Venkatram 2008a). Moreover, the diversified livelihood strategy and the short term crops rotation help the household to cope with climatic shifts and fluctuations in a semi-arid tropical environment. It allows confronting also the prevalent rural poverty that endangers daily subsistence characterized by short-term needs.

After the agricultural season, landless labourers and small and marginal farmers usually migrate to nearby towns or to other states or districts to work as daily wage laborers either in building and manufacturing sector or in commercial agriculture. Such migration, however, nowadays is particularly affected by broader political economic processes. Both districts are affected by a structural economic transformation. The structural transformation of the rural economy as an indirect consequence of local and regional industrialisation is formed by (i) a growing non-agricultural sector in rural areas, (ii) seasonal migration and (iii) pluriactivity (Djurfeldt et al. 2008). Such transformation diminishes the availability of agricultural labour available for farmers. Wage increases in building and manufacturing sector in respect to agriculture attract agricultural labourers. In the case of Coimbatore, the establishment of industrial complexes and multinational companies attracts people from agriculture towards industries and promotes rural-urban migration. In both districts farming is in the grip of an agrarian crisis that is characterized or triggered by increased input cost, poor credit availability, labour problems and low prices for agricultural produce (Palanisami and Venkatram 2008b).

### 4.1.3 Jatropha plantations in Coimbatore and Thiruvannamalai districts

Coimbatore and Thiruvannamalai are forerunners of Jatropha plantations. Coimbatore is a centre of *Jatropha curcas* research and Thiruvannamalai is the leading district in Tamil Nadu in terms of area under Jatropha (3,876 ha in 2007) (Government of Tamil Nadu 2007c). In Thiruvannamalai, Assistant Directorate of Agriculture extension work and the contract farming developed by companies coexist. The District Watershed Development Agency have implemented NWDPRA project through more than 70 watershed committees and has achieved about 350 ha under Jatropha plantations, mostly in farmers' private lands. There are several private companies promoting Jatropha in the district, including D1 Mohan Bio Oils Ltd.[9], the biggest company promoting Jatropha in Tamil Nadu. By 2007, the company had reached 12000 ha all around Tamil Nadu, about the 25% of them in Thiruvannamalai district. Apart from D1 Mohan Bio Oils Ltd, other small companies, such as AGNI NET Biofuels Pvt. Ltd and AHIMSA, are forming farmers clubs and clusters of farmers' plantations in the district. Our fieldwork in Thiruvannamalai is focused in two clusters of plantations. One consisted of a group of plantations promoted under NWDPRA scheme, some under contract farming with AGNI-NET Biofuels Ltd. Another cluster of plantations originated from the aggressive promotion by D1 Mohan Bio oils ltd. In Coimbatore, plantations are more scattered, and, although the public agricultural extension system works, farmers are mostly contacted by private companies that offer farming contracts. Our fieldwork focused in Shiva Distilleries-BAG[10] plantations. Shiva Distilleries had reported planted around 1200 ha all around Tamil Nadu, covering eight districts, involving around 500 farmers[11], of which 700 ha had been planted in Coimbatore district alone (Government of Tamil Nadu 2007c).

The farming contract developed by the companies mentioned is as follows. Saplings are given to farmers for free. During and after the plantation establishment there is technical guidance, twice monthly, by the company's field staff. Assured price at 5-10

[9] D1-Mohan Bio Oils Ltd. is a joint-venture (at 50:50) between D1 Oils plc, a UK-based multi-national company, and Chennai-based Mohan Breweries & Distilleries Limited (http://www.d1plc.com/)

[10] BAG is one of the largest Industrial Conglomerates of South India with a wide spectrum of manufacturing and trading (sugar, alcohol, ethanol, biodiesel, liquor, granite, cotton yarn), distribution (automobiles and related accessories of renowned brands), and financing activities. The group is involved in the service sector through wind power energy, IT services, education, health care and real estate. (http://www.bannari.com/)

[11] Interview with Shiva distilleries privately-own plantation manager, at Gudimangalam,17th June 2008.

Rs/kg is provided, although it is linked to the market prices. A buy-back agreement is arranged. While the company promises to buy the produce, farmers also promise to sell when agreeing to pay back the loans with part of the harvest. A loan is given in three installments. Out of about 15000 Rs/ha, two thirds are given the first year and the other third is given in the next two years, in two installments. The strategy of companies for Jatropha promotion is to convince farmers village by village through an active field staff that should provide the technical assistance needed as part of the farming contract. The companies' officials visit the villages through cycles, coming back to the same village on a regular fortnightly to monthly basis. While coming back to the villages, companies' field staff has a registered tracing of farmers. The recurrent visits are used as well for trying to convince disappointed farmers that had entered into Jatropha through government programs or other companies' buy-back agreements. Promises are made to convince farmers to shift to an improved version of contract farming. Promises are mainly the provision of loans for improving irrigation infrastructure and technical assistance to do intercropping or apiculture.

## *4.2 Summarizing the low performance of Jatropha in the field*

Despite the publicity given to Jatropha as a "miracle crop", our empirical data show a great distance between its expected performance and the actual one. The agro-economic results of our research, described in detail in Ariza-Montobbio and Lele (in press), are summarized in Table 1 below. They show how yields of Jatropha, as reported by farmers, and the yield related agronomic parameters as observed by us in the field, are far lower than the expected yield and agronomic performance according research agricultural stations i.e., TNAU. While the expected yield according TNAU (Paramathma et al. 2007) and other research stations (Rao 2006), should be 7500 kg/ha under irrigated conditions and 2500 kg/ha under rainfed conditions, reached by the third year of cultivation, the maximum yields reported by farmers in our sample were 750 kg/ha under irrigated conditions and 450 kg/ha under rainfed conditions for similarly aged (3-year old) plantations. The reported yields, thus, are nearly one tenth of that expected from agricultural stations.

Furthermore, agronomic performance indicators collected as proxies to yields, such as crop survival and number of nuts per plant, showed that the average number of nuts per plant was twice as high in irrigated plots as compared to rainfed ones and the survival percentage was significantly higher in irrigated plots. This shows how continuous irrigation favors and is indeed necessary to achieve high productivity. This finding completely contravenes the idea of undertaking plantations in marginal lands with no irrigation infrastructure. The low agronomic performance made the crop economically unviable (see Table 1) even in the current situation, in which the electricity for irrigation is fully subsidized. If farmers were to get the expected yields the crop could become profitable at the current level of costs. However, the need for raising inputs to reach such an increase of yield makes difficult to predict the final economic and energetic balance. However, the balance could hardly be positive, even with subsidies and without counting the opportunity costs of labor and land. Facing the low productivity and the associated economic loss, 30% of the interviewed households have already dropped out of Jatropha plantations, uprooting the plants and shifting back to the previous cultivation. About 45% have left the plant without maintenance, waiting for better institutional frameworks to develop Jatropha or for good conditions to shift back to previous cultivation. Finally, 25 % are keeping the plantation absorbing the losses with the production of the rest of the landholding.

**Table 1**

Summary of results of agro-economic analysis of Jatropha cultivation under different cultivation scenarios

| Economic parameter | Cultivation scenarios | | |
|---|---|---|---|
| | Irrigated plot | | Rainfed plot (N=23) |
| | Electric pumpset, own well (N=11) | Diesel pumpset (N=4) | |
| ***Field data(Ariza-Montobbio & Lele)*** | | | |
| Best yield at 3 yrs (kg/ha/yr) | 750 | 750 | 450 |
| Best gross returns (Rs/ha/yr) | 7,500 | 7,500 | 4,500 |
| **Best net returns, ignoring initial investments (Rs/ha/yr)** | **-1,902** | **-3,281** | **-578** |
| Total initial investments, if yield starts in year 3 [a] & [d] | 23,927 | 28,137 | 13,410 |
| Plots not getting yield at all | 5 | 3 | 18 |
| Plots which stopped irrigation prematurely [b] | - | 3 | - |
| ***Experimental station data (Paramathma et al)*** | | | |
| Yield at maturation stage (3 yrs) (kg/ha) | 7,500 | 7,500 | 2,500 |
| Gross returns (Rs/ha/yr) | 75,000 | 75,000 | 25,000 |
| Annual costs in yielding yrs Rs/ha/yr [c] | 9,402 | 10,781 | 5,078 |
| **Net returns, ignoring initial investments (Rs/ha/yr)** | **65,598** | **64,219** | **19,922** |

[a] Initial investment figures differ across cultivation scenarios simply because of statistical variation.
[b] Thereby incurring high initial costs, but low yields.
[c] Assuming same costs as sample farmers, although actually input costs are likely to be higher.
[d] Not including any interest burden.

## *4.2 Uneven consequences of Jatropha failure: distributive livelihood impacts and marginalization*

Despite Jatropha is presented as a "pro-poor" crop, the results show a bias towards big farmers with irrigation infrastructure. It comes right from the beginning in terms of who adopted the crop. Although in Thiruvannamalai, 70 to 80 % of farmers are small or marginal in the Jatropha cultivators' villages[12]. Small or marginal farmers and big agriculturalists were equally represented in our sample (50% each), which included all Jatropha cultivators in each selected village[13]. It shows, so, that Jatropha tended to be adopted more by big rather than small farmers. In Coimbatore, Jatropha cultivators were mainly big farmers (88%) scattered in different villages. Given that irrigation is essential for higher yields, there is an entry barrier that makes impossible for small and marginal farmers to have enough infrastructures to carry out Jatropha plantations. Although nowadays Jatropha is not profitable for any kind of farmer, Jatropha is a viable option for those who control groundwater, land and capital, not for the rural poor. For this reason, those plantations maintained, even if no direct and short-term benefits are coming, were managed by big farmers with electric pump sets (85%), most of them in Coimbatore (64%). The field staffs of the companies itself and the managers of their field stations are starting to acknowledge that the crop is more suitable for big farmers

[12] Records of Village Administrative Officers (VAO)
[13] There were few exceptions due to farmers' migration, unwillingness to answer, illness or death.

with good irrigation infrastructures[14]. The crop adoption has differential livelihood impacts on small and marginal farmers than in big landholders. These two types of cultivators follow distinct livelihood strategies.

Expecting to get the promised loans, technical advice and profits promised by the companies, 82% of farmers planted Jatropha substituting for food crops. Only 18% used barren land or sacrificed non-food commercial crops. Of those planting in barren land, most were in Coimbatore (63%), most of them being big commercial agriculturalists (80 %). In Thiruvannamalai, groundnut was the most frequent foregone crop (77% of the farmers). The 56% of the respondents reported to be affected by loss of edible oil, needing to purchase it from the market. Groundnut oil accounts for the 20-25% of the edible vegetable oil produced in India[15] and, it is therefore the most important edible oil crop (Damodaran and Hegde 2005). The discourse of the government in favor of non-edible oil crops for biodiesel is based on the argument of avoiding competing with food crops, and specially to not worsen the shortage of edible oil that India is already facing. The reality however, shows that Jatropha is displacing groundnut. The food trade-off was accompanied by a shortage of fodder for feeding the cattle. 50% of the sample reported that their access to fodder was directly reduced by the shift to Jatropha, while the other 50% either did not own cattle or were able to obtain fodder or grazing from other lands (private and/or common). Where Jatropha replaced pigeon peas or cotton (20% of the cases), there was also a reduction of the firewood available to the household.

The 33% of the households were increasing their off-farm activities as wage laborers or *coolies*[16] during the period of Jatropha cultivation. The 66% of those who reported to increase in off farm activities were small and marginal farmers. Jatropha cannot be in the current context, the only cause of households' increase in off-farm activities and the consequent reduction of their agricultural work. However, groundnut is also a commercially oriented short-term crop whose by-products and direct contribution as food kept by the household allows greater complementary with the wage labor in agriculture, building and manufacturing. The new plantation introduced did not leave by-products to the household and had a long gestation period with no income from the land. A good maintenance of the crop requires the household to ensure labor to such activity. However, there is meantime, the need to get income from other sources to compensate the long period with no productivity from the land. There is then a trade-off as to whether the household prefers to allocate labor to improve Jatropha performance or to ensure income from off-farm activity while the crop is still not mature. Framing this discussion we raise here an important contradiction in the discourse in favor of Jatropha. Jatropha is presented by the government as a source for employment generation in rural areas. Meantime, companies convince farmers to adopt Jatropha as a good way to cope with lower availability of agricultural laborers. This contradiction seems to be ignoring the diversity among farmers and their livelihood strategies. The role that land and on-farm activities performs in a small or marginal farmers' livelihood strategy who are closer to be peasants, is different from that of big farmers who are closer to be capitalist cultivators.

Small or marginal farmers' households allocate a higher share of their own labor time to the land, while big farmers tend to hire wage laborers. The small or marginal holders are both agriculturalists and labor force for other activities. Big farmers meantime, have more access to capital and their diversification tends to come, usually, from managing

[14] Interview with Shiva distilleries privately-own plantation manager, at Gudimangalam,17th June 2008.
[15] According Solvent Extraction Association of India data: http://tinyurl.com/seaofindia-com
[16] The term "*coolie*" is applied to the class of daily wage workers. This term is often used pejoratively. In Tamil *kuli* means *"wages"* and in Hindi *qūlī* means "(day-)labourer".

small businesses. In the present scenario, a failed Jatropha crop contributes to changes of livelihood strategies that are increasingly based on off-farm activities. The increase in off-farm activities cannot be considered as prejudicial for farmers getting out of poverty *per se*. Becoming building and manufacturing workers increases the wages of small and marginal farmers. However, losing income and all the other non-monetary benefits coming from the land, reduces the capacity of the small and marginal farmer to keep his or her own piece of the land. This process favors rural capitalists as it eliminates small peasants as competitors in agricultural production and transforms them into cheap labour which capitalists can employ (Kay 2006). In the case of Jatropha, the land is not producing for a long period. Production when it comes is not substantially more remunerative than for other crops. Farmers lose farm income and the multiple benefits from other crops. While the big farmer can still maintain the income from the rest of the farm, the small and marginal landholder suffers more in proportion from a failed crop. He must resort to off-farm opportunities. Keeping on this strategy for the whole period of Jatropha maturation and, thereafter due to its failure, can potentially contribute to processes of increasingly permanent *deagrarianisation* (Bryceson 2000) or *proletarianization* of small and marginal farmers. Jatropha also damages access to household produced food, increasing the need for money for market access to food.

# 5. The politics of Jatropha promotion

Company officials, in our interviews with them and even along newspapers websites[17], explained away the failure or poor performance of Jatropha in these districts as stemming from 'lack of required inputs' or 'inadequate management' by the farmers. But our analysis above shows that this bland assertion hides the failures of the "pro-poor" and "pro-wasteland" development benefits that Jatropha claims to have. Our results can not be explained simply in terms of farmers' incompetence, since even the best, big, irrigated farmers, in Coimbatore, are getting poor yields. While the crop experienced difficulties to grow and yield due to the higher than expected need for irrigation and fertilizers, such difficult circumstances get reinforced by the lack of government involvement and the non-fulfillment of companies' promises in contract farming.

Government officials at district level agree with the idea of Jatropha not being the most suitable crop for rural poor. However, they are guided for targets fixed at higher bureaucratic levels: "*We have to comply with the targets from the Central Government, even if we know that it is not a good crop, profitable for farmers"*[18]. However, complying with the targets has not meant, in practice, to ensure that farmers will get assured markets and advice during the period of cultivation. The hard-sell and ambitious targets of the Government promotion contrast with how the policy implements at farm level. At the officially first year of program implementation (2007-2008) only 20% of the annual target has been achieved (Government of Tamil Nadu 2007c). Although the Government of Tamil Nadu was supposed to give 50% subsidy for saplings and drip irrigation, through companies' facilitation, no farmer got this last subsidy and 16% did not get the subsidized saplings. Contract farmers get a loan that should cover the long period of investment that Jatropha cultivation implies. In practice, companies were not giving the installments at the promised time and in some cases the loan did not arrive at all. As mentioned, the long gestation period makes it difficult to face the costs without proper financial resources. There is no income from the land for at least three to five years.

Facing this circumstance, 30% of the households were appealing to the locally called *kaymathu* (asking cash from the neighbors without interest) more than relying on *tandals*[19] or *pawn brokers*[20]. 70% of them were small or marginal farmers. Even if farmers would get the required amount of credit and at the proper time, there is still a great difficulty for farmers to repay a loan without increasing the off-farm work, due to the long time period with no income from agriculture. Given the already heavily indebted situation of Indian farmers, and the high input costs (if Jatropha is to have high yields), opting for Jatropha cultivation will lead to still greater indebtedness than before. Other cropping systems, such as groundnut cultivation rotated with cereals, require short-term credit only as the farmer harvests the crop in three months. This does not work with Jatropha. The abandonment by the companies arrived at its extreme, in Thiruvannamalai, when the few that were able to get yield (23 %) were not able to deliver the produce to them. Why did companies step into biodiesel production, sign agreements with the government and contracts with farmers, but then not deliver

[17] Interview with AGNI-NET Biofuels Ltd. Manager in Pondicherry, 3rd July 2008 and statements of Credit Carbon Farming (CCF) manager in http://tinyurl.com/independent15feb2010
[18] Interview with Assistant Directorate of Agriculture in Thiruvannamalai, 21st May 2008.
[19] Tandal is a kind of broker that taking an interest from the beginning is delivering some cash, and then asks weekly for a fixed constant part of the loan.
[20] The pawn broker gives some amount of cash after some assets are left as deposit. The asset is returned when the amount is repaid.

the technical support and buyback that they had promised? The answer lies in the pro-investor, rather than pro-farmer and pro-poor, approach adopted by the TN government.

Tamil Nadu Biodiesel Policy set favourable conditions for industrial biodiesel processors. According to the policy, the oil extraction and transesterification have to be permitted only to the biodiesel manufacturers. The need of extraction units with modern machineries make the local operators inefficient. The oil extraction by local operators lead to poor quality of raw oil and affect the conversion process and biodiesel standards (Government of Tamil Nadu 2007a). Furthermore, it is argued that the de-toxification of the cake to be used as fodder is impossible at local level and should be done by industrial processors, and the small-scale batch type of etherification plant cannot produce uniform and constant fuel standards to meet the BIS/Euro III norms. All by-products should be commercially valuable. Thus, the policy prioritises the industry and 'defer purchase and sales tax for a period of five years to the bio diesel industry to encourage and sustain the business being an agro industrial project involving farmers' interest'. The Tamil Nadu Industrial Policy (2007) has declared that Jatropha seeds will be exempted from purchase tax and Jatropha Oil will be exempted from VAT for a period of 10 years from the date of commercial production. Industrial policy as well, states that 50% subsidy on planting material for *Jatropha* and other biofuel crops will be given and extends the subsidy available to agro-processing industry to bio-fuel and bio-diesel extraction plants (Government of Tamil Nadu 2007d).

Companies can enter in the agrofuels venture because of the long term subsidies and the pro-industrial environment of the policy. The big corporations and multinational companies actually, have as well the ability to wait for some years to recover the investment due to their other multiple-sector benefits. Jatropha plantations are a small fraction of their operation as big corporate groups. Pro-industry rather than pro-farmer policies, have originated a framework were companies have *a priori* substantially more to win than to lose, and even what they can lose is still a small fraction of their benefits. Their time frames are long and their risks are low. Meanwhile the risk and uncertainties for farmers are substantially higher and the time frames are driven by the short-term needs of the poor. The real Jatropha policy seems to rely on big farmers and companies, and the "pro-poor" rhetoric is acting as window dressing.

The uneven distribution of risks among producers and buyers, allowed the companies to enter in the agrofuels venture, and benefit from the experience the small farmers have offered at their own cost. While big farmers were able to cope with the associated risks of a Jatropha trial, small and marginal farmers faced higher risks. "Promotion of Jatropha cultivation in Tamil Nadu" program is implemented by TNAU Center for Excellence on Biofuels working in partnership with eleven biofuel companies. The research institutions have an important role on the development of new varieties and the generation of the fittest germplasm for Jatropha development. The R&D programmes capture a substantial amount of funds for biofuels development to the extent of the creation of companies exclusively dedicated to R&D, such as D1 Plant Science Ltd. The relation between companies and researchers is another fundamental point for understanding the distance between the enthusiasm for Jatropha promotion and its results in the ground. While for farmers the failure of Jatropha has become a loss, the R&D branches of the companies and the research institutions (i.e TNAU) learn from farmers' experiences, using them as multi-location trials from where to get growing and breeding material or to test what are the best varieties. For instance, D1 Mohan Bio Oils Ltd and Bannari Amman Group have been exchanging seeds at a considerable higher rate than the one paid to the farmers. Seeds collected from

farmers have been provided to TNAU and FCRI[21].After evaluating the unsuccessful experience through small-scale plantations managed by farmers, D1 Mohan Bio Oils Ltd. has withdrawn from Thiruvannamalai and has shifted down to the South, in Tiruchirapalli district. Not finding convenient to collect from farmers' scattered plots, it is on search of government wasteland to lease for planting Jatropha at a large-scale[22].

The pro-industrial approach of the policies is clearly in contradiction with the "pro-poor" flavor. Any of the announced benefits have existed in the current implementation of contract farming. Although it failed, the contract farming was designed for favoring the export of the seeds from the rural areas to be crushed in industrial poles. Even if Jatropha would perform better in agronomic terms, it would not benefit the poor. Apart from the already mentioned causes, there is a lack of clear agricultural policy measures to ensure that Jatropha will benefit the poor on a priority basis. If a new introduced crop is remunerative to cultivate on previously uncultultivated land, then the crop is going to be even more remunerative on fertile farmland. Farmers with fertile land will get more profit than those with marginal (previously uncultivable) land. Subsidies for drip irrigation and land improvement and Minimum Support Price (MSP) which only can go to the poor or be used in marginal lands would be needed for the "low-input" crop really becoming "pro-poor".

[21] Interview with an ex field staff worker of D1 Mohan Bio Oils Ltd in Thiruvannamalai on 30 June 2008.
[22] Ibid.

# 6. Conclusions

This paper has tried to elucidate the main causes and consequences of Jatropha plantations failure in Tamil Nadu, through a political ecology approach. We analysed the social construction of Jatropha plantations (as pro-wasteland and pro-poor) and its contrast with the uneven disruption that the crop has originated on farmers' livelihood, reinforcing processes of marginalization. Furthermore, the interaction of the actual performance of Jatropha with already existing structural factors of rural Tamil Nadu transformation, would seem to push small and marginal farmers to *proletarianise*, accelerating land ownership concentration and *deagrarianisation*.

Through the case study of Jatropha plantations in Tamil Nadu we have tried to develop and illustrate how political ecology helps us to understand the politics of agrofuels and explain its boom. The original impulse came from an attempt to supply a new source of energy for transport given the increased social metabolism of the Indian economy in parallel to economic growth, and given the expectation that biofuels substitute for fossil fuels and are "carbon neutral". At a more local level, as agrarian policy, Jatropha came together with "pro-wasteland" (or pro-environment) and "pro-poor" discourses because of its promotion through active engagement of small and marginal farmers in the so called "wastelands", rather than through large-scale monocultures (such as the case of palm oil or soybean).

The unclear classification of "wastelands" and the ambiguity of Indian agrofuel policies set a framework that allows government and corporations to flexibly get available lands for agrofuel development. Under the intention of developing "wastelands" there is a unique economic rod of valuation that denies the multi-functionality of land use. The "pro-poor" discourse linked to Jatropha presents the crop as multi-functional and suitable for all the diverse agro-climatic zones of India. Jatropha is small and marginal farmer friendly. It needs little water and labour. This discourse is used to legitimize the real implementation of the crop as contract farming as other commercial crops. The "pro-poor" discourse is used as well as a mean to build "consensus" that local rural development is compatible with growing agrofuels for industrial economic growth.

A political ecology approach, however, calls the analyst to contrast the discourses at national and state level with the actual political processes and outcomes at local and regional level that drive environmental change to be unevenly distributed. The field agro-economic analysis of plantations performance shows how Jatropha irrigation inputs were higher than expected, being the yield of the crop one tenth the expected according to research stations experiments. The impacts on livelihood strategies showed how the crop was unfitting with the ecological and socio-economic conditions of production in the study-area. The conversion of the land to a monocrop of Jatropha, suppressed the crop diversity and the multi-functionality of the other crops through the provision of food for self-consumption, fodder, firewood and cash. The loss of diversity increased farmers' vulnerability and affected more severely small and marginal farmers. The long gestation period of Jatropha, of three to five years, makes the crop unsuitable for farmers temporal frameworks for whom the short-term cash rotation allows them to cope with fluctuation of socio-environmental conditions of production and with the short term needs recurrent in conditions of poverty. The high need for credit requirement generated dependency. The non-fulfilment of contract farming due to the lack of proper advice and the non- provision of loans at the expected and needed time combined with the agronomic and ecologic factors that drove the failure of Jatropha plantations.

Political ecology helps to analyse the dynamics of knowledge at local level and how the introduction of a non-well studied new crop was shaped by uneven relations of knowledge transfer where farmers depend on companies for growing material but as well for technical expertise. Farmers then supplied new knowledge free of charge to companies, at the cost of crop failure. Along a political ecology analysis the uneven distribution of risks and uncertainties and the time-framing of economic processes by different actors are very helpful to understand actors' interaction and the final outcome of it. We contrasted the local farm reality to the motivation of companies, driven by generous subsidies in the industrial side of the policy. Companies and government have low risk, high incentives, longer time-frames and broader options and strategies for their own reproduction. Farmers have high risk and high incentives but are so much conditioned by their limited room for action and agency and their short-term time frames and narrowed options for survival. Such circumstance allowed companies to benefit from the experience of small farmers as part of their experiments to generate better varieties of the crop with higher yield and oil content. Companies can wait and afford the failure of the current model of contract farming and the low performance of the varieties of Jatropha cultivated nowadays. Farmers however, are bound to immediate success of what is being implemented currently.

The political ecology analysis of Jatropha plantations have allowed us to reveal the incongruence of the approach on small-holders that Jatropha proponents claimed. It was too good to be true and this is borne out by the fact that only rich farmers are actually able to adopt it (if at all). In the current context of agrarian crisis, further research is needed to approach the long term consequences of Jatropha promotion in terms of *proletarianization* or *deagrarianisation*. To do so, time use surveys of small and marginal farmers (adopting Jatropha and non-adopting Jatropha) would have to be collected during several years to see the evolution of household land-time budget decisions (Grunbuhel and Schandl 2005).This information will have to be contextualized within the labour dynamics and the political economy of the region. Interviews with big farmers, landless workers and building and manufacturing entrepreneurs would help conducting the research.

The current experience can then have implications for future agrofuel developments and for renewable energy and rural development policies in India and other parts of the World. On the one hand, it can push Jatropha promoters to prioritize the development of Jatropha at large-scale through company-owned block plantations in government "wasteland" or enclosed peasant or pastoralist lands, with associated irrigation infrastructures development to ensure its better performance. While the "pro-poor" or "pro-farmer" model is not performing, the large-scale cultivation could become economically profitable although its Energy Return On Investment (EROI) would be probably very low. The energy input will have to increase for getting more energy out. The current situation shows the contradiction of willing to get the 20% blending target through low input cultivation in marginal lands. The environmental and social impacts and the resource competition with food production will be still in place, even increase. On the other hand, the current experience can be used as a lesson to focus more on rural development based on small-scale decentralized renewable food and energy production for meeting local needs first.

# Acknowledgements

Thanks go to Smriti Das for their useful advices during the research work. Thanks also to CISED-ATREE staff and its warm environment. Thanks to Ignatius Prabhakar for his

insights and help in our fieldwork. Thanks to Anand, Yokesh and Sreenivasan for their fieldwork translation. Thanks to Jesús Ramos Martín for his comments and suggestions. Thanks to all the people interviewed, from government officials to the companies staff. Thanks to the farmers interviewed who taught us what can not be found in books and papers. Thanks to Dr. Paramathma for his suggestions in the agronomic assessment. Thanks to David Chackrawarthy for his unconditional help whenever and wherever. Thanks to Francisco Zorondo, Viky Reyes and Ivana Logar for revision and help in data processing.

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