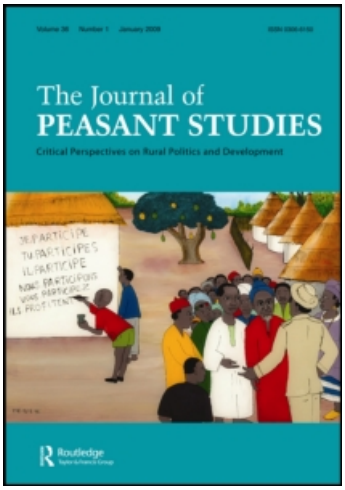

Journal of Peasant Studies
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713673200

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Online publication date: 23 September 2010

To cite this Article Ariza-Montobbio, Pere , Lele, Sharachchandra , Kallis, Giorgos and Martinez-Alier, Joan(2010) 'The political ecology of *Jatropha* plantations for biodiesel in Tamil Nadu, India', Journal of Peasant Studies, 37: 4, 875 — 897
To link to this Article: DOI: 10.1080/03066150.2010.512462
URL: http://dx.doi.org/10.1080/03066150.2010.512462

The Journal of Peasant Studies
Vol. 37, No. 4, October 2010, 875–897

Routledge
Taylor & Francis Group

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

Pere Ariza-Montobbio, Sharachchandra Lele, Giorgos Kallis and Joan Martinez-Alier

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 analyse 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 fieldwork on *Jatropha* plantations in the state of Tamil Nadu to show how *Jatropha* cultivation favours resource-rich farmers, while possibly reinforcing existing processes of marginalisation of small and marginal farmers.

Keywords: biofuels; political ecology; marginalisation; India; *Jatropha*

Introduction

Global production of biofuels has grown three-fold between 2000 and 2007, although it still accounts for less than two percent 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

We wish to thank the many people who helped us in the course of designing and executing this research. Smriti Das gave useful advice at several stages. Ignatius Prabhakar contributed valuable insights in the field. Anand, Yokesh and Sreenivasan provided translation support. Dr. Paramathma gave valuable suggestions in the agronomic assessment. David Chackrawarthy helped in a variety of ways. Francisco Zorondo, Viky Reyes, and Ivana Logar helped with data processing and editing. The anonymous reviewers provided helpful comments. Most of all, this research would not have been possible without the unconditional cooperation extended to us by the villagers of Thiruvannamalai and Coimbatore. The first author also thanks the staff of the Centre for Interdisciplinary Studies in Environment and Development (CISED – now merged with ATREE) for their friendship and help. The first author's contribution to this study is supported by the research project SEJ2006-15219 and the second author's contribution is supported by an institutional grant from the Ford Foundation.

ISSN 0306-6150 print/ISSN 1743-9361 online

DOI: 10.1080/03066150.2010.512462
http://www.informaworld.com

reports warn on 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, hence reducing 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. Eighty-seven percent of the land under *Jatropha* cultivation is located in Asia, with India, China, and Myanmar as leaders (GEXSI 2008b); 12 percent in Africa, especially central and southeast Africa (Henning 2008); and two percent in Latin America, especially in Brazil and Mexico, where this species comes from (Martínez 2007, Consejo Agropecuario del Sur [CAS] 2009).

With about 300,000 ha, India is a leader in *Jatropha* plantations and also its research and development (IARI [Indian Agriculture Research Institute] 2007). The official rationale is that the crop best fits the diverse agro-climatic conditions of the country and has a shorter gestation period than other oil-bearing trees. *Jatropha* is promoted both as a potential solution to the energy demand-supply deficit that the growing economy of India is facing (Government of India 2006) and as a suitable crop for marginal land reclamation and rural development (Government of India 2003). The National Biofuel Policy, launched in December 2009, building upon the National Biodiesel Mission of 2003 (NBM2003), aims at blending bioethanol and biodiesel with gasoline and diesel, respectively, at a proportion of 20 percent by 2017. The biodiesel target is planned to be met through the cultivation of 13.4 million hectares of 'wastelands' with *Jatropha*. The south Indian state of Tamil Nadu is one of the leaders in biodiesel promotion, with a goal of reaching 100,000 ha of *Jatropha* between 2007 and 2012 (Government of Tamil Nadu 2007c, Government of Tamil Nadu 2009).

This paper investigates the political, technical, and social construction of *Jatropha* as a solution to India's energy, agriculture, and poverty problems 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 interviews 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 being pro-poor, the pattern of cultivation of *Jatropha* is generating upward redistribution, the big farmers being the only ones who benefit from it, if at all.

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 benefits and burdens of socio-environmental change (Martinez-Alier 2002, Heynen *et al.* 2006). Socio-environmental change comes from increased social metabolism (Martinez-Alier 2002, 2009), meaning larger flows of energy and materials, and is unevenly distributed, i.e. '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, and 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 contextualised knowledge of local actors, those who work the land (e.g. St. Martin 2001), and of those who conduct critical interdisciplinary studies. Macro discourses implicitly assume a priority for 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 'marginalisation', referring to social and environmental degradation due to production at the margin in economic terms from socially marginalised 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 the local agro-ecology, often reducing landscape and productive diversity. Changes in social relations caused by commodification of exchange and redistribution and increasing dependence on cash can result in processes of further marginalisation and *proletarianisation (or semi-proletarianisation)* of the

already marginalised rural poor (Kay 2006). However, some studies (e.g. Grossman 1993, Moreno-Peñaranda and Kallis 2010) urge for caution in assuming *a priori* that export-oriented or commercial crops have negative social effects, and argue for careful, locally 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 the 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 to the changing political economy of India.

'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 liberalisation-globalisation in the last two decades has witnessed the interlinked phenomena of industrialisation 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 and 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 recently started to lose self-sufficiency in food produce (Jasani and Sen 2008) and is facing a 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 (Government of India 2006).[1] Second, there is a reference to the opportunity to rehabilitate degraded or dry lands,[2] the so-called 'wastelands',

[1]India is meeting 70 percent of its increasing oil needs by imports and is the fourth major oil importer after the 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 50 percent of oil consumption (Government of India 2006).

[2]K.C. Pant, Deputy Chairman of The Planning Commission of India, Foreword, Report on the Committee on Development of Biofuel (Government of India 2003).

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] 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 , 7)

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 utilise 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, 28)

Where is *Jatropha* being planted? Is 'wasteland' rehabilitation discursively used to build legitimacy around *Jatropha*, irrespective of 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, when 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; 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 underutilised 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 ha, a staggering 37 percent of the country's land area![5] The National Remote Sensing Agency was then charged with producing a

[3]D.N. Tewari, Member of the Planning Commission of India, Preface, Report on the Committee on Development of Biofuel (Government of India 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.

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 percent 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 percent of the total available wastelands: 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, when 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 'commercialisation' 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.[6]

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 (Government of India 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 (3m ha), protective hedge around agricultural fields (3m ha), farmlands under agroforestry (2m ha), fallow lands (2.4m ha), wastelands previously covered under various watershed projects (2m ha), and tracks of public lands along railways, roads, and canals (1m ha). That farmlands under agro-forestry are considered wastelands or suitable for *Jatropha* shows the extreme malleability of the concept! Malleability makes it difficult to estimate what kind of land use and land cover types are really being converted to agrofuels, under which property rights they exist, and to whom they are being given. Such unaccountability allows the government and corporations to

[5]Table 12.1 in Yadav (1989).

[6]Depending on their actual land cover and land use, the so-called 'wastelands' provide diverse environmental services, such as carbon sequestration and biodiversity and water conservation.

legitimise the promotion of agrofuels in favour of their interests. Thus, in practice, *Jatropha* plantations are promoted through three different models.

The first approach consists of 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 rule on 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 ha 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 could 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 2m ha of government wasteland and involves 30-year leases to the corporate houses, for which a 'normative' ceiling of 400 ha 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 of 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* on their own private lands, as a monocrop on leased or transferred 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 the rural poor. For instance Tamil Nadu 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.[7] 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 improvement of social equity through employment creation and more equal income distribution (United Nations Development Programme 1996). The 'pro-poor' discourse goes along with 'the equity-growth-efficiency argument' that is already present in the debates about land reforms (Srivastava 2006).

[7]While about 2m ha of wasteland have been transferred to eligible people in Andhra Pradesh, about 150,000 ha in Karnataka, and 180,000 ha in Kerala, the wasteland distributed in Tamil Nadu is less than 100,000 ha (Viswanathan 2003).

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 and consistent scientific consensus on the maturation period (Achten *et al*. 2008) and the farmers' lack of knowledge about this new crop have allowed private companies and the government to announce shorter maturation periods than even those achieved in research stations. While research stations claim it takes three to five years before the yield stabilises (Rao 2006, Paramathma *et al*. 2007), the NBM2003 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, which enables employment at different periods than for the rest of the crops (Biswas *et al*. 2010). Such characteristics should benefit the poor, especially small or marginal farmers and the landless, who will have more income opportunities. Finally, the pro-poor discourse includes arguments that highlight the potentialities of 'decentralised energy production for local use'. By-products (such as the seed-cake) can be used as green manure or as feed for cattle (Openshaw 2000). Small-scale decentralised oil mills can improve the 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 the village level. Under contract farming, the by-products are kept under private companies' control in industrial centers, and the oil extraction is highly centralised.

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 and 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-mentioned arguments, especially the 'pro-poor' discourse. We draw on the interpretation of empirical field data about the actual performance of *Jatropha* contract farming in Tamil Nadu.

A political ecology reading of *Jatropha* failure and the risk for increasing small farmers' marginalisation

The results of a field-level assessment of the performance of *Jatropha* plantations on private agricultural lands in the 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 the 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 process. First, researchers (6), NGOs representatives (2), government officials (9), private companies' managers and field staff (6) were interviewed.[8] Research institutes and

[8]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

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 centre of *Jatropha* research and development. We surveyed 79 plantations (21 in C and 58 in T) and in each we collected data on the 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[9]) 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 very briefly outlining the evidence of *Jatropha* failure, we explain its uneven causes and consequences and its broader meaning.

Jatropha development in Tamil Nadu state of India: the context

The Tamil Nadu policy: actors, roles and interactions

Tamil Nadu state in southern India is one of the leading 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 percent input subsidies (for saplings and drip irrigation).

Under the State Agricultural Department as a nodal office, but with the involvement of the Forest Department and the Rural Development Department, nurseries have been built, saplings have been planted on the degraded edges of forest, 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 from each farmer and supervises the legal documentation needed for the subsidy component. Tamil Nadu Agricultural University (TNAU) provides quality seeds to government and private nurseries, which it monitors and inspects. 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 farmers under contract farming.

Field setting: ecological and socio-economic conditions of production

Coimbatore is, after Chennai, the second most urbanised and industrialised district of Tamil Nadu, with 66 percent of its population living in urban areas. Forty percent of the district's approximately 7500 sq km land area is under agriculture. The main crops are cereals and millets and coconut. In contrast, Thiruvannamalai is among the

accompanied company field staff and government officials to the field to understand and observe their work.

[9]The reason for the lopsided sample for in-depth interviews is that the plantations were clustered in T, while in C, plantations were scattered, limiting the extent of data collection.

districts with the highest fraction of rural land, about 80 percent. Although less industrialised, Thiruvannamalai has, like Coimbatore, 40 percent of its approximately 6300 sq km under agriculture, the main crops being cereals and millets and oil seeds, especially groundnut. Coimbatore and Thiruvannamalai form part of the inland belt, which together with the southern and northern coastal areas constitutes the 'dry' agrarian ecotype of Tamil Nadu. The average annual rainfall is 690mm and 1040mm, respectively.

The 'dry' areas historically have had a less inegalitarian structure, with peasant proprietorship as the dominant mode (Krishnan 2003). Thiruvannamalai follows this expected trend towards the marginalisation of holdings. Seventy percent of the agricultural land is held by small or marginal landholders (holding size 2 ha or less), who constitute 94 percent of farmers. The other 30 percent of the land is held by big landholders (holding size greater than 2 ha), who constitute six percent of the farmer population (Government of India 2001). Coimbatore, however, has historically reflected less of a trend towards marginalisation of holdings than Tamil Nadu as a whole and the rest of 'dry' areas (Krishnan 2003). Thirty percent of the total agricultural land is held by marginal or small farmers, who represent 70 percent 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 characterised by a prevalent water and agricultural labour scarcity. Overexploitation of ground water is widely reported in both districts (Palanisami and Venkatram 2008a, 2008b). Water scarcity limits the production from the land and constrains households in terms of the land that they can actually cultivate, forcing them to flexibly allocate labour to 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 that damage the crops at night also shapes the ability of the household to allocate labour.

In Thiruvannamalai, farmers usually follow a crop pattern of one or two seasons of irrigated cash crops 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 also combine 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 maintains soil fertility (Palanisami and Venkatram 2008a). Moreover, diversified livelihood strategies and short-term crop rotation help the households cope with climatic shifts and fluctuations in the semi-arid tropical environment, as well as the prevalent rural poverty, characterised by short-term needs, that endangers daily subsistence.

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 labourers either in the building and manufacturing sector or in commercial agriculture. However, nowadays such migration 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 characterised 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 for farmers. Wage increases in the building and manufacturing sector attract agricultural labourers. In the case of Coimbatore, the establishment of industrial complexes and multinational companies attracts people from agriculture towards industry and promotes rural-urban migration. In both districts farming is in the grip of an agrarian crisis that is characterised or triggered by increased input costs, poor credit availability, labour problems, and low prices for agricultural produce (Palanisami and Venkatram 2008b).

Jatropha plantations in Coimbatore and Thiruvannamalai districts

Coimbatore and Thiruvannamalai are leaders in *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 has implemented the NWDPRA project through more than 70 watershed committees and has achieved about 350 ha under *Jatropha* plantations, mostly on farmers' private lands. There are several private companies promoting *Jatropha* in the district, including D1 Mohan Bio Oils Ltd.,[10] the biggest company promoting *Jatropha* in Tamil Nadu. By 2007, the company had reached 12000 ha all around Tamil Nadu, about the 25 percent 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 on two clusters of plantations. One consisted of a group of plantations promoted under the NWDPRA scheme, some under contract farming with AGNI-NET Biofuels Ltd. Another cluster of plantations originated through 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[11] plantations. Shiva Distilleries had reported planted around 1200 ha all around Tamil Nadu, covering eight districts and involving around 500 farmers,[12] 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. A price of 5–10 Rs/kg is assured, although it is linked to the market prices. A buy-back agreement is arranged. While the company promises to buy the produce, farmers promise to sell

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

[11]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 for 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/)

[12]Interview with the manager of Shiva Distilleries' privately owned plantation, at Gudimangalam, 17 June 2008.

Table 1. Summary of results of agro-economic analysis of Jatropha cultivation under different cultivation scenarios.

	Cultivation scenarios		
	Irrigated plot		
Economic parameters	Electric pumpset, own well (N = 11)	Diesel pumpset (N = 4)	Rainfed plot (N = 23)
Field data (Ariza-Montobbio & Lele in press)			
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)	−2,222	−3,601	−216
Total initial investments, if yield starts in year 3[1]	23,927	28,137	13,410
Plots not getting yield at all	5	3	18
Plots which stopped irrigation prematurely[2]	–	3	–
Experimental station data (Paramathma et al. 2007)			
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[3]	9,722	11,101	4,716
Net returns, ignoring initial investments (Rs/ha/yr)	65,278	63,899	20,284

[1]Initial investment figures differ across cultivation scenarios simply because of statistical variation. Figures are in Indian rupees (66 INR = 1€ in May 2008). Not including any interest burden.
[2]Thereby incurring high initial costs, but low yields.
[3]Assuming same costs as sample farmers, although actually input costs are likely to be higher.

by agreeing to pay back the loans with part of the harvest. A loan is given in three instalments. Out of approximately 15000 Rs/ha, two-thirds are given the first year and the other third is given in the next two years, in two instalments. The companies' *Jatropha* promotion strategy is to convince farmers village by village through an active field staff who provide the technical assistance needed as part of the farming contract. Company officials visit the villages in 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' plot conditions and the associated need for assistance.[13] The recurrent visits are also useful for the field officers to try to convince disappointed farmers that had entered before into *Jatropha* cultivation through government programs (such as NWDPRA) or other companies' buy-back agreements but have not been adequate to meet farmers' needs. Promises are made to convince farmers to shift to an improved version of contract farming; mainly for the provision of loans for improving irrigation infrastructure and technical assistance for intercropping or apiculture.

Summarising 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

[13]For a matter of private confidence and privacy respect, none of the interviewees are named.

(in press), are summarised in Table 1 below. They show how yields of *Jatropha*, as reported by farmers, and the yield related agronomic parameters observed by us in the field are far lower than the expected yield and agronomic performance according to 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 (three-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 favours 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 subsidised. If farmers were to get the expected yields the crop could become profitable at the current level of costs. However, the need for more inputs to reach such an increase in yield makes it 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 labour and land. Facing low productivity and the associated economic loss, 30 percent of the interviewed households have already dropped out of *Jatropha* plantations, uprooting the plants and shifting back to the previous cultivation. About 45 percent have left the plants without maintenance, waiting for better institutional frameworks to develop *Jatropha* or for good conditions to shift back to previous cultivation. Finally, 25 percent are keeping the plantation, absorbing the losses with the production from the rest of the landholding.

Uneven consequences of Jatropha failure: distributive livelihood impacts and marginalisation

Despite *Jatropha* being presented as a 'pro-poor' crop, the results show a bias towards big farmers with irrigation infrastructure. This bias is present from the beginning in terms of who adopts the crop. Although in Thiruvannamalai, 70–80 percent of farmers are small or marginal in the *Jatropha* cultivators' villages,[14] small or marginal farmers and big agriculturalists were equally represented in our sample (50 percent each), which included all *Jatropha* cultivators in each selected village.[15] It shows, therefore, that *Jatropha* tended to be adopted more often by big rather than small farmers. In Coimbatore, *Jatropha* cultivators were mainly big farmers (88 percent) scattered in different villages. Given that irrigation is essential for higher yields, there is an entry barrier that makes it impossible for small and marginal farmers to have enough infrastructures for *Jatropha* cultivation. Although nowadays *Jatropha* is not profitable for any kind of farmer, *Jatropha* would be, potentially, a

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

viable option only for those who control groundwater, land, and capital, not for the rural poor. For this reason, those plantations that continued, even in the absence of direct and short-term benefits, were managed by big farmers with electric pump sets (85 percent), most of them in Coimbatore (64 percent). The field staffs of the companies and the managers of their field stations are starting to acknowledge that the crop is more suitable for big farmers with good irrigation infrastructures.[16] The crop adoption has different livelihood impacts on small and marginal farmers than on 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 percent of farmers planted *Jatropha* as a substitute for food crops. Only 18 percent used barren land or sacrificed non-food commercial crops. Of those planting in barren land, most were in Coimbatore (63 percent), and most were big commercial agriculturalists (80 percent). In Thiruvannamalai, groundnut was the most frequently foregone crop (77 percent of the farmers). Fifty-six percent of the respondents reported they were affected by loss of edible oil, needing to purchase it from the market. Groundnut oil accounts for 20–25 percent of the edible vegetable oil produced in India,[17] and it is therefore the most important edible oil crop (Damodaran and Hegde 2005). The discourse of the government in favour of non-edible oil crops for biodiesel is based on the argument of avoiding competition with food crops and, especially, not worsening 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. Fifty percent of the sample reported that their access to fodder was directly reduced by the shift to *Jatropha*, while the other 50 percent 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 percent of the cases), there was also a reduction of the firewood available to the household.

Thirty-three percent of households were increasing their off-farm activities as wage labourers or coolies[18] during the period of *Jatropha* cultivation. Sixty-six percent of those who reported an 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 labour in agriculture, building, and manufacturing. *Jatropha* does not yield by-products for the household and requires a long gestation period with no income from the land. Good maintenance of the crop requires the household to dedicate labour to this activity. However, there is in the meantime the need to get income from other sources to compensate for the long period with no productivity from the land. There is then a trade-off as to whether the household prefers to allocate labour to improve *Jatropha* performance or to ensure income from off-farm activity while the crop is still not mature. Framing this

[16]Interview with Shiva Distilleries' privately owned plantation manager, at Gudimangalam, 17 June 2008.
[17]According to data from the Solvent Extraction Association of India (2008).
[18]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'.

discussion we raise here an important contradiction in the discourse in favour of *Jatropha*. *Jatropha* is presented by the government as a source for employment generation in rural areas. Meanwhile, companies convince farmers to adopt *Jatropha* as a good way to cope with the reduced availability of agricultural labourers. This contradiction seems to ignore the diversity among farmers and their livelihood strategies. The role that land and on-farm activities perform in a small or marginal farmers' (who are closer to being peasants) livelihood strategy is different from that of big farmers, who are closer to being capitalist cultivators.

Small or marginal farmers' households allocate a greater share of their own labour time to the land, while big farmers tend to hire wage labourers. The small or marginal holders are both agriculturalists and the labour force for other activities. Big farmers, meanwhile, have more access to capital and their diversification tends to come from managing small businesses. In the present scenario, a failed *Jatropha* crop contributes to changes in 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 favours rural capitalists as it eliminates small peasants as competitors in agricultural production and transforms them into cheap labour that capitalists can employ (Kay 2006). In the case of *Jatropha*, the land does not produce for a long period. Production, when it comes, is not substantially more remunerative than 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 to 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 *proletarianisation* of small and marginal farmers. *Jatropha* also reduces access to household-produced food, increasing the need for money for market access to food.

The politics of Jatropha promotion

Company officials, in our interviews with them and even in newspaper articles,[19] 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 cannot 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 with regard to growth and yield due to the higher than expected need for irrigation and fertilizers, such difficult circumstances are reinforced by the lack of government involvement and the non-fulfilment of company promises in contract farming.

[19]Interview with AGNI-NET Biofuels Ltd. Manager in Pondicherry, 3 July 2008, and statements of Credit Carbon Farming (CCF) manager in Milmo and Wasley (2010).

Government officials at the district level agree with the idea that *Jatropha* is not the most suitable crop for rural poor. However, they are guided by 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'.[20] However, complying with the targets has not meant, in practice, ensuring that farmers will receive assured markets and advice during the period of cultivation. The hard sell and ambitious targets of the government promotion contrast with how the policy is implemented at farm level. During the official first year of program implementation (2007–08) only 20 percent of the annual target was achieved (Government of Tamil Nadu 2007c). Although the Government of Tamil Nadu was supposed to give 50 percent subsidies for saplings and drip irrigation, through facilitation by companies, no farmer received the latter subsidy and 16 percent did not receive the subsidised saplings. Contract farmers get a loan that should cover the long period of investment that *Jatropha* cultivation implies. In practice, companies were not paying the instalments 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 percent of the households were appealing to the locally called *kaymathu* (asking cash from the neighbours without interest) more than relying on *tandals*[21] or pawnbrokers.[22] Seventy percent of them were small or marginal farmers. Even if farmers get the required amount of credit and at the proper time, it is still very difficult for them to repay a loan without increasing their off-farm work due to the long 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. Other cropping systems, such as groundnut cultivation rotated with cereals, require only short-term credit as the farmer harvests the crop in three months. This does not work with *Jatropha*. The abandonment by the companies reached its peak, in Thiruvannamalai, when the few that were able to get yields (23 percent) were not able to sell the produce to them. Why did companies step into biodiesel production, sign agreements with the government and contracts with farmers, but then not deliver 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 Tamil Nadu government.

The Tamil Nadu biodiesel policy set favourable conditions for industrial biodiesel processors. According to the policy, the oil extraction and transesterification (the main process of biodiesel manufacturing, that consists into reacting the vegetable oils catalytically with a short-chain aliphatic alcohols [typically methanol or ethanol]) have to be undertaken only by the biodiesel manufacturers. The need for extraction units with modern machinery make the local operators inefficient. Oil extraction by local operators leads to poor quality of raw oil and affects the conversion process and biodiesel standards (Government of Tamil Nadu 2007a). Furthermore, it is argued that the detoxification of the cake to be used as fodder is impossible at the local level and should be done by industrial processors, and the

[20]Interview with Assistant Directorate of Agriculture in Thiruvannamalai, 21 May 2008.
[21]A *tandal* is a broker who takes interest from the beginning, delivers some cash, and then expects a fixed weekly repayment of the loan.
[22]The pawnbroker provides cash after assets are left as a deposit. The assets are returned when the cash is repaid in full.

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[s] 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' (Government of Tamil Nadu 2007b). 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 a 50 percent subsidy for planting material for *Jatropha* and other biofuel crops will be given and extends the subsidy available to the agro-processing industry to bio-fuel and bio-diesel extraction plants (Government of Tamil Nadu 2007d).

Companies can enter into agrofuels ventures because of the long-term subsidies and the pro-industrial environment of the policy. Big corporations and multinational companies are able to wait for some years to recover their investment due to their other multiple-sector benefits. *Jatropha* plantations are a small fraction of their operations as big corporate groups. Pro-industry rather than pro-farmer policies have created a framework in which companies have *a priori* substantially more to win than to lose, and even what they can lose is still a small fraction of what they gain. Their time frames are long and their risks are low. Meanwhile the risk and uncertainties for farmers are substantially higher and the timeframes 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 into agrofuels ventures, 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. The 'Promotion of *Jatropha* cultivation in Tamil Nadu' program is implemented by the TNAU Center for Excellence on Biofuels working in partnership with 11 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 that there are 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 which to get growing and breeding material or to test which 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.[23] After evaluating the unsuccessful experience of small-scale plantations managed by farmers, D1 Mohan Bio Oils Ltd. has withdrawn from Thiruvannamalai and has shifted south to Tiruchirapalli district. Not finding it

[23]Interview with an ex-field staff worker of D1 Mohan Bio Oils Ltd, Thiruvannamalai, 30 June 2008.

convenient to collect from farmers' scattered plots, it is in search of government wasteland to lease for planting *Jatropha* on a large-scale.[24]

The pro-industrial approach of the policies is clearly in contradiction with the 'pro-poor' rhetoric. None of the announced benefits are present in the current implementation of contract farming. Although it failed, contract farming was designed to favour the export of the seeds from the rural areas to be crushed in industrial poles. Even if *Jatropha* performed 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 newly introduced crop is remunerative to cultivate on previously uncultivated 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 a Minimum Support Price (MSP) that could only go to the poor or be used on marginal lands would be needed for the 'low-input' crop to be genuinely 'pro-poor'.

Conclusions

This paper has tried to elucidate the main causes and consequences of the failure of *Jatropha* plantations 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 visited on farmers' livelihoods, reinforcing processes of marginalisation. Furthermore, the interaction of the actual performance of *Jatropha* with already existing structural factors of rural Tamil Nadu's 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 could 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 of active engagement with 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 up a framework that allows government and corporations to easily get available lands for agrofuel development. Under the guise 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 legitimise the real implementation of the crop as contract farming, as with other commercial crops. The 'pro-poor' discourse is also used as a means of building

[24]Ibid.

'consensus' that local rural development is compatible with growing agrofuels for industrial economic growth.

A political ecology approach, however, calls on the analyst to contrast the discourses at the national and state levels with the actual political processes and outcomes at local and regional levels 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, and the yield of the crop one-tenth of the expected according to research stations experiments. The impact on livelihood strategies showed how the crop was a poor fit with the ecological and socio-economic conditions of production in the study area. The conversion of the land to a monocrop of *Jatropha* suppressed crop diversity and eliminated the benefits of 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 more severely affected small and marginal farmers. The long gestation period of *Jatropha* – three to five years – makes the crop unsuitable for farmers' temporal frameworks, in which short-term cash rotation allows them to cope with fluctuations in socio-environmental conditions of production and with the short-term needs recurrent in conditions of poverty. The high credit requirement generated dependency. The non-fulfilment of farming contracts, due to the lack of proper advice, and the failure to provide loans at the expected and needed times, combined with the agronomic and ecological factors to drive the failure of *Jatropha* plantations.

Political ecology helps to analyse the dynamics of knowledge at local levels, in particular how the introduction of a new crop that had not been well studied was shaped by uneven relations of knowledge transfer in which farmers depended on companies not only for growing material but also for technical expertise. Farmers then supplied new knowledge free of charge to companies, at the cost of crop failure. In a political ecology analysis the uneven distribution of risks and uncertainties and the timeframes of economic processes engaged in by different actors are very helpful for understanding actors' interactions and their final outcomes. We contrasted the local farm reality to the motivation of companies, which are driven by generous subsidies in the industrial side of the policy. Companies and government have low risks, high incentives, longer timeframes, and broader options and strategies for their own reproduction. Farmers have high risks and high incentives but are very much conditioned by their limited room for action and agency and their short-term timeframes and narrowed options for survival. Such circumstances allowed companies to benefit from the experiences 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 can afford the failure of the current model of contract farming and the low performance of the varieties of *Jatropha* cultivated presently. Farmers, however, require immediate success with what is being implemented currently.

The political ecology analysis of *Jatropha* plantations has allowed us to reveal the incongruence of the approach for smallholders. 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 understand the long-term consequences of *Jatropha* promotion in terms of *proletarianisation* or *deagrarianisation*. Time-use surveys of small and marginal farmers (adopting *Jatropha* and not 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 contextualised within the labour dynamics and the political economy of the region. Interviews with big farmers, landless workers, and building and manufacturing entrepreneurs would help in 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 prioritise the development of *Jatropha* on a 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 in order to get more energy out. The current situation shows the contradiction of trying to get the 20 percent blending target through low input cultivation in marginal lands. The environmental and social impacts and resource competition with food production will be still in place, and will 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 decentralised renewable food and energy production for meeting local needs first.

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Pere Ariza-Montobbio holds a Masters Degree in Environmental Studies from University Autonomous of Barcelona (UAB). His research experience is based on fieldwork in Tamil Nadu, South India. He has done research on the social perception and the multi-functionality of rainwater harvesting systems as ecosystems for decentralised water management. Current PhD research focuses on land-use conflicts related to the energy system and rural-urban metabolism. Email: pere.ariza@uab.cat

Sharachchandra Lele is Senior Fellow, Centre for Environment and Development, Ashoka Trust Research for Ecology and the Environment, Bangalore. He has a PhD in Energy and Resources from the University of California, Berkeley. His research interests are analyses of institutional, economic, ecological, and technological issues in forest, energy, and water resource management, conceptual issues in sustainable development and sustainability, and methodology of interdisciplinary research on the environment. Email: slele@atree.org

Giorgos Kallis completed a Marie Curie International Fellowship at the Energy and Resources Group of the University of California, Berkeley, in 2008. His research focused on socio-environmental coevolution, adaptive co-governance in large river basins, and droughts and social adaptation. His current research focuses on the political-economic roots of environmental degradation, particularly in relation to water resources, and an exploration of the idea of sustainable de-growth, i.e. a smooth socio-economic downscaling to a sustainable future where we can live better with less.

Joan Martinez-Alier is an ecological economist and full professor at the Universitat Autònoma de Barcelona in the Department of Economics and Economic History. He is a founding member of the International Society for Ecological Economics and a member of the Scientific Committee of the European Environment Agency. He is the author of *Ecological economics: energy, environment and society* (with Klaus Schluepmann) (Oxford: Basil Blackwell, 1987); *Varieties of environmentalism: essays north and south* (with Ramachandra Guha) (Lodnon: Earthscan, 1997); and *The environmentalism of the poor: a study of ecological conflicts and valuation* (Cheltenham: Edward Elgar, 2002).