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Short communication

Understanding marginal changes in ecosystem services from biodiesel feedstock production: A study of Hassan Bio-Fuel Park, India

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ABSTRACT

Small-scale biodiesel production with a high level of community involvement has been associated with a number of benefits. These include relatively low environmental impacts, lack of competition with food production, strong poverty alleviation effects and enhanced access to energy. This Short Communication provides a qualitative analysis of the effects of the cultivation of biodiesel oilseed tree crops (mostly *Millettia pinnata*, along with *Simarouba glauca*, *Azadirachta indica*, *Madhuca lungifolia* and *Jatropha curcas*) in such a small-scale project, the Hassan Bio-Fuel Park in Karnataka, India. This extensive ethnographic research and using the ecosystem services approach to synthesize the findings suggests that the changes in both the flows of ecosystem services and different constituents of human wellbeing are marginal. While the ecosystem services approach can be useful to synthesize various forms of knowledge on biofuels to inform policy, this particular case study highlights the importance of being open about the different, often implicit, priorities and values of research projects and the various kinds of actors involved in biofuel production. Finally, it is crucial to understand not just which impacts are generated but especially how those impacts are generated.

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1. Introduction

India's biofuel policy came out in 2009, 6 years after India's Planning Commission presented the National Mission on Bio-Diesel. The Mission kick-started national interest in biodiesel production, while arguing that biodiesel and ethanol will “contribute to energy security, climate change mitigation, apart from creating new employment opportunities and leading to environmentally sustainable development” [1]. The extent to which these claims can be materialized in the case of biodiesel production arguably depends on the organizational model that is deployed.

Firstly, there are large-scale block plantations that sell feedstock on national or international markets. However, this model has been associated with low environmental sustainability, employment opportunities for a limited number of people, and even land-grabbing [2–4]. Outgrower schemes, on the other hand, may face difficulties gaining farmers' acceptance and could impoverish those farmers that do not have good access to resources such as water, pesticides and fertilizers [2–7]. A third model are small-scale

schemes with high community involvement in growing/processing the feedstock and using the biofuel. In such schemes, biodiesel feedstock may be grown as hedges around the main cropland or other locations designated as suitable by the community [6–12]. It has been argued, particularly by the FAO and Energia, that such schemes have the potential to contribute towards rural development (especially for women), as well as improve local energy access [8,9]. In India, these projects include, among others, the Ranihedra rural village electrification initiative of Winrock international India and the biodiesel project in Mohuda, Ganjam district, Orissa, initiated by CTxGreEn and Gram Vikas. However, it is unclear whether this potential can be realized in practice.

This Short Communication presents and discusses the impacts of a small-scale biofuel scheme with high community involvement in the state of Karnataka, called Hassan-Biofuel Park. Besides being an illustrative example of a small-scale scheme with high community involvement, it also informs and legitimizes the Karnataka State Biofuel Policy [13]. This study adopts the ecosystem services approach as adapted for biofuels by Gasparatos et al. [13,14] and Stromberg et al. [15] from the ecosystem services conceptual framework of the Millennium Ecosystem Assessment [16]. This conceptual framework has been selected because it aims to

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generate a cohesive body of knowledge for policy-makers that links environmental change to human wellbeing [17].

2. Methodology

Hassan Bio-Fuel Park started in 2006 and promotes the small-scale production and use of biodiesel in Hassan district, Karnataka State, India (Fig. 1). It aims to encourage farmers to grow oilseed trees. Seedlings of various species, mostly *Milletia pinnata* (*Pongamia pinnata*, locally referred to as honge), *Simarouba glauca*, *Azadirachta indica* (neem), *Madhuca lungifolia* and *Jatropha curcas*, are offered to interested farmers free of cost.

By planting the seedlings around (rather than on) the main cropland, the researchers who run the project argue to avoid the food-fuel conflict and the diversion of agricultural inputs such as water, fertilizers and pesticides. So far, the project has reached out to half of Hassan district's 2593 villages and has interacted with approximately 100,000 farmers [18,19]. The project has its own oil expelling and transesterification facilities and supplies biodiesel to the Bangalore Metropolitan Transport Corporation at a maximum rate of 3 m³ per month (3000 L per month). Existing literature describes the project as potentially beneficial, particularly for women and rural poor [10,11].

Hassan Bio-Fuel Park's office and research station is located along a highway that connects the cities of Bangalore and Mangalore. The district headquarters are located in Hassan city, which is in the centre of the district and about 20 km west from Hassan Bio-Fuel Park office and research station. The villages participating in the Hassan Bio-Fuel Park project are located throughout the district.

This Short Communication offers a qualitative assessment of changes in ecosystem services due to the activities within the Hassan Bio-Fuel Park project, and the effect of these changes to key constituents of human wellbeing [12,14,16]. It draws primarily on ethnographic research spread across 14 villages (Table S1, Supplementary Electronic Material) carried out between September 2013–March 2014, and in October 2015. The actual names of the villages are not mentioned because some of the information discussed in this research is confidential and sensitive.

This ethnographic research consisted of informal, open-ended conversations with farmers (more than 200 in total) and participant observation while doing farm work or collecting and decorticating honge seeds. This fieldwork was documented on a daily basis, creating extensive ethnographic field notes [20]. In addition, the results presented in this Short Communication draw on over 1000 photos and about 100 short videos of farmers, fields and farming activities. The author also participated in a conference organized by the Karnataka State Biofuel Development Board (KSBDB) and carried out 10 expert interviews with policy-makers, scientists and activists (Table S2, Supplementary Electronic Material). Lastly, unstructured interviews were held with 13 traders of biodiesel oilseeds to understand the overall value chain as well as the current/past availability of these seeds.

Content analysis of this material was done manually and consisted of three rounds. During the first round, research data on specific ecosystem services and aspects of human wellbeing were identified and categorized following the categories proposed by Gasparatos et al. [12,14]. In addition, data on the impact of Hassan Bio-Fuel Park project that could not be categorized in the proposed categories, were collected in a separate file. The second round of analysis consisted of an iterative process during which factors that contributed to each of the impacts were identified in the field data. The third round consisted of analysing the interaction between all of the identified factors.

3. Results

3.1. Impact on ecosystem services and biodiversity

Tables 1 and 2 show that the Hassan Bio-Fuel Park project has very little impact on all the identified ecosystem services and constituents of human wellbeing. A marginal increase was found for cultural ecosystem services and biodiversity. With respect to human wellbeing, only rural development increased slightly due to increased knowledge among farmers. This was mostly related to the uses and marketing options of oilseed species that were already present in the area, particularly *Milletia pinnata* (*Pongamia pinnata*, or honge), and about the agronomic properties of some new tree species such as *Simarouba glauca* and *Madhuca lungifolia*. However, it should be noted that farmers considered collecting honge seeds, instead of doing more remunerative work, as a lack of rural development.

In addition to the changes documented in Tables 1 and 2, it should be noted that some farmers played a particularly active role, mediating relationships between the Hassan Bio-Fuel Park project field staff and their village. These farmers claimed that they benefitted from the Hassan Bio-Fuel Park project because it allowed them to widen their network, which they felt could be helpful in the future to access government support schemes or to join interesting agricultural programmes offered by companies in the area. This particularly applies for the villages that were identified as the most keenly participating by Hassan Bio-Fuel Park field staff (villages nr. 1 and 2, Table S1 of the Supplementary Electronic Material). Yet farmers in these villages were not particularly active collecting honge seeds in practice.

As argued in Section 3.2, the lack of impacts from the project (whether positive or negative) stems from the fact that there was barely any increase in the availability of oilseeds suitable for the production of biodiesel. Throughout the period of fieldwork, only 4 farmers (out of the more than 200 farmers who were interviewed) indicated that they had seedlings which survived the first year after planting. Some of these farmers could only be identified after specifically asking other farmers whether they knew anyone in the village whose biodiesel seedlings had survived. Furthermore, none of the farmers who were interviewed had started collecting more oilseeds as a result of their involvement in the Hassan Bio-Fuel Park project, though some sold their oilseeds directly to the project's field staff rather than to traders.

Traders and Hassan Bio-Fuel Park field staff offered farmers the same price per kg of oilseeds, which fluctuated between 0.17 and 0.21 € (Rs. 13–16 at a conversion rate of 1 € = Rs. 77) kg⁻¹ at the time of the research. To obtain oilseeds for the production of biodiesel, Hassan Bio-Fuel Park's field staff bought oilseeds from traders. However, all interviewed traders testified they would have sold the bulk of their seeds to soap producers if they had not sold them to the Hassan Bio-Fuel Park field staff.

3.2. Understanding the lack of significant impact on ecosystem services

To understand the reason behind the lack of significant impact on ecosystem services and human wellbeing (whether positive or negative), this section follows the process of biodiesel production. This includes all the different stages from the moment field staff from the Hassan Bio-Fuel Park project enter a village, until seeds reach the Hassan Bio-Fuel Park's biodiesel production facilities at the office and research station where they are processed into biodiesel. Doing so will particularly highlight the decisions farmers (including elderly and children) have to make at each stage and the considerations that they may entail. These findings are summarized

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