



Analysis

The economic relevance of sustainable agroforestry practices – An empirical analysis from Tanzania



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ABSTRACT

This paper investigates the economic relevance of sustainable behavior of agroforestry practices for smallholders using the example of firewood exploitation in rural Tanzania. Three questions are addressed: (1) To what extent do households behave sustainably regarding firewood extraction from agroforestry? (2) Which factors determine the likelihood of households practicing sustainable agroforestry? (3) Are sustainably behaving households better off in terms of income compared to households practicing unsustainable agroforestry? The analysis is based on cross-sectional data of 314 households. A sustainability indicator shows that the share of sustainable households varies between 14 and 41% depending on the underlying wood growth rate. The results of the logistic regression indicate that property rights regarding the ownership of agricultural land and environmental awareness increase the likelihood of sustainable firewood extraction. Empirical evidence from the quantile regression reveals that poorest households generate higher income if they extract firewood unsustainably. The opposite is true for households of upper income percentiles. Thus, the poor are likely to increase environmental degradation to generate more income causing a 'downward spiral' of the poverty–environment trap resulting in income losses in the long run. Households with a per capita income of 524 TZS or more manage their tree stocks sustainably.

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1. Introduction

Deforestation is a predominant problem in Tanzania (Godoy et al., 2012; Hall et al., 2009). Between 2005 and 2010, forest losses amounted to one percent per year (World Bank, 2011), which is very high compared to other African countries (Godoy et al., 2012). To counteract this trend, the Tanzania Forest Act emphasizes priority on conserving and managing natural forests (United Republic of Tanzania, 2002). The protection of forests aims at ensuring the mitigation of deforestation and simultaneously improving carbon sequestration and storage, and is also promoted by international frameworks such as the United Nations Programme on Reducing Emissions from Deforestation and Forest Degradation (UN-REDD) (Sedjo, 2012). Currently, Tanzania is one of nine pilot countries for the UN-REDD Programme (Burgess et al., 2010).

Furthermore, a World Bank Study emphasized the importance of forest income for the rural poor (Vedeld et al., 2004). Monela et al. (2001) reported for Tanzania that forests contribute up to 70% of the annual household income (see also Kimaro and Lulandala, 2013; Schaafsma et al., 2011). In order to cushion smallholders' income losses arising from forest protection, agroforestry is promoted to complement the national reforestation strategy of the Tanzanian

government (Sonwa et al., 2011). The National Agroforestry Strategy initiated in 2004 promotes agroforestry technologies contributing to improve the livelihoods of resource-poor households (NASCO, 2006). In fact, agroforestry has increasingly become part of the production portfolio of many small-scale farmers in the last decade (Mercer, 2004; Pretty, 2008).

Agroforestry comprises various benefits for farmers such as firewood, timber but also supplementary income possibilities due to tree crops (Nair, 2007b). In addition, it is a promising solution to alleviate soil erosion on agricultural plots and hence helps to stabilize or even improve yields (Gebreegziabher et al., 2010; Nair, 2007a, 2007b). However, these positive effects only persist if agroforestry is preserved over a long time period (Mercer, 2004). Overutilization of agroforestry systems, associated with the decline of tree stocks, may weaken the positive impact on soil fertility, food production, firewood and timber availability, and thus farmers' income in rural areas. Some studies solely promote the implementation of agroforestry as a sustainable system (Kang and Akinnifesi, 2000; Tambula and Sinden, 2000). For Tanzania, however, Schwartz et al. (2002) raised serious concerns about the long-term viability of tree systems given current tree harvest rates from the perspective of natural sciences. The number of empirical socio-economic papers on sustainable agroforestry practices is still small (Schoolman et al., 2012). The value added of this paper is thus to investigate the relevance of sustainable agroforestry practices for smallholders from an economic perspective. The analysis is based on a unique data set on households' tree properties (species, age and number) in relation to their firewood extraction from private agroforestry, public sources or

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from the market. Three questions are addressed: (1) To what extent do households behave sustainably in terms of firewood extraction from their own agroforestry? (2) Which factors determine the likelihood of sustainable firewood extraction? (3) Are sustainably behaving households better off in terms of income as compared to households practicing unsustainable agroforestry?

The remainder of this paper is structured as follows: the second section reviews the theoretical and empirical literature on sustainability and the adoption and impacts of sustainable behavior in agroforestry. Based on this, key hypotheses are derived for empirical testing. Section 3 briefly describes the underlying data and the econometric models used in this study. The empirical results are discussed in Section 4, and Section 5 finally concludes.

2. Review of the Literature

There are three different strands of relevant literature and they relate to (Section 2.1) the concepts of sustainability, (Section 2.2) the adoption of sustainable behavior, and (Section 2.3) its impact on households' welfare.

2.1. Theoretical Concepts of Sustainability

The concept of sustainability is particularly discussed in interdisciplinary papers (Schoolman et al., 2012). The most comprehensive definition of sustainability is given in the Brundtland report (Owens, 2003). It defines sustainability as meeting “the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987, p.40).

Hence, the concept of sustainability relates to the maintenance of a given capital stock (Pearce and Atkinson, 1998; Webster, 1999). A capital stock includes man-made capital (e.g. produced goods), human capital (e.g. knowledge, skills), social capital (e.g. relationships between individuals and networks) and natural capital (e.g. trees, land, clean air and water) (Pearce and Atkinson, 1998). If the overall capital stock is maintained, although there is substitution between the different capital components, sustainability is defined to be weak (Mori and Christodoulou, 2012; Pearce and Atkinson, 1998). In other words, if e.g. natural capital is exploited, then this is consistent with weak sustainability as long as an appropriate investment is made in the form of another type of capital (e.g. man-made capital) (Pearce and Atkinson, 1998) and as long as the reinvestments are substitutable with natural capital (Ayres and van den Bergh, 1998). However, some authors emphasize that e.g. man-made and natural capital are complementary (Daly, 1990) and hence very difficult to substitute. In the case of a very small degree of substitution, the concept of strong sustainability becomes relevant whereby each capital component is maintained individually (Ayres and van den Bergh, 1998; Mori and Christodoulou, 2012).

The importance of the concept of strong sustainability is often highlighted with respect to natural resources. This is especially true for developing countries, where the rural poor highly depend on natural resources and only few substitutes may exist (Daly, 1990; Pearce and Atkinson, 1998). In this paper, the environmental dimension of sustainability is solely considered. With respect to agroforestry, it is reasonable to maintain the existing tree stock since it has a multipurpose function which is difficult to substitute in the rural areas. The overexploitation of firewood is usually associated with the decline of tree stocks. As a consequence, the regenerative capacity of the trees is reduced and thus the aforementioned positive effects. Against this background, the strong concept of sustainability in terms of firewood extraction is applied in this paper.

2.2. Adoption of Sustainability

Compared to conventional farming practices, the adoption of sustainable farming systems is assumed to be more complex due to their

various benefits to smallholders (D'Souza et al., 1993). D'Souza et al. (1993) proved that human capital and environmental parameters such as farmers' awareness of the importance of natural capital for production activities are very important determinants of the adoption decision. Another example is the duration of such an investment. Sustainable agricultural practices such as agroforestry are naturally long-term investments and may take several years until they generate a consumable output (Caviglia-Harris et al., 2003). In contrast, poverty is reported to lead more to short planning horizons preventing poor small-scale farmers from investing in long-term conservation measures to protect their natural resources (Holden et al., 1998; Mink, 1993). Therefore, unsustainable short-term agricultural practices such as slash-and-burn cultivation are often their only option (Caviglia and Kahn, 2001; Caviglia-Harris et al., 2003). Other important factors comprise knowledge, property rights as well as access to credit (Calkins and Thant, 2011; Lal and Israel, 2006; Nath and Inoue, 2009).

Calkins and Thant (2011) differentiated between intentional and actual sustainable behavior. They found that intentional behavior is mainly influenced by intangibles such as awareness, knowledge, or subjective and moral norms by the individual households. In turn, intentional behavior influences the actual sustainable behavior together with tangible factors such as age, gender, education, land access, food and health conditions as well as households' wealth status.

Hai et al. (2010) confirmed the importance of age, gender, occupation, social status and knowledge in influencing sustainable development. However, the awareness of sustainable behavior is discussed critically. Hai et al. (2010) found out that some households did not understand the need of sustainable behavior in general. In contrast, Brocklesby and Hinshelwood (2001) stated that the poor perceive environmental quality as an important determinant of their health, productivity, and energy supply; however, they often do not have the capacity to invest in a sustainable environment. Caviglia and Kahn (2001) highlighted the importance of property rights and the need of information on sustainable practices for farmers in order to implement these measures properly.

2.3. Welfare Impact of Sustainable Behavior

A central statement of the Brundtland report is: “The environment and development are not separate challenges; they are inexorably linked” (WCED, 1987, p. 37). In developing countries such as Tanzania, environmental sustainability is considered to be a central approach to generate farm income based on the capital endowment of households (Nix, 1990). Rural households are highly dependent on natural resources to generate income for subsistence and cash crop production (Shiferaw and Holden, 1999).

The central issue is to understand the link between sustainable behavior with respect to the environment on the one hand, and poverty on the other hand. This link is controversially discussed in the context of the poverty–environment trap (Dasgupta et al., 2005; Duraipappah, 1998) which can be characterized by a chicken-egg problem in terms of causality. The predominant idea is that poverty causes environmental degradation (Duraipappah, 1998). This is in line with the observation that “poor families often have to meet urgent short-term needs, prompting them to ‘mine’ natural capital through, for example, excessive cutting of trees for firewood and failure to replace soil nutrients” (The World Bank, 1992, p. 7). In consequence of this depletion of natural resources, the rural poor may find themselves in a downward spiral by further reducing their income in the long run (Dasgupta et al., 2005). Households, who are in such a trap, have to consume their natural capital in an unsustainable manner to generate enough income to survive.

Research can be done from both perspectives if the robustness and causality of the model can be proved (Dasgupta et al., 2005). Case studies at the household level provide an adequate possibility to assess whether environmental degradation has an impact on the poor, but empirical models are rare (Dasgupta et al., 2005). If a downward spiral for poor households can be identified, the deduced question is whether

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