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Surveys

Economic and ecological trade-offs of agricultural specialization at different spatial scales

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ABSTRACT

Specialization in agricultural systems can lead to trade-offs between economic gains and ecosystem functions. We suggest and explore a conceptual framework in which economic gains can be maximized when production activities are specialized at increasingly broader scales (from the household to the village, region or above), particularly when markets for outputs and inputs function well. Conversely, more specialization likely reduces biodiversity and significantly limits ecosystem functions. When agricultural specialization increases and moves to broader scales as a result of improved infrastructure and markets or other drivers, ecosystem functions can also be endangered at broader spatial scales. Policies to improve agricultural incomes may influence the level of specialization at different scales and thus affect the severity of the trade-offs. This paper takes Jambi province in Indonesia, a current hotspot of rubber and oil palm monoculture, as a case study to illustrate these issues. We empirically show that the level of specialization differs across scales with higher specialization at household and village levels and higher diversification towards the province level. We discuss ways to resolve trade-offs between economic gains and ecological costs, including landscape design, targeted policies, and adoption of long-term perspectives.

1. Introduction

For poor smallholder households that depend largely on the use of natural resources for their livelihood, increasing agricultural incomes is critical to escape poverty (Lipton, 2005; World Bank, 2007; Klasen et al., 2013). In an environment of well-functioning markets and infrastructure, a possible economic option to increase incomes is to specialize on the most profitable crop for given soil, climate, and weather conditions (Lambin and Meyfroidt, 2011; Ruiz-Perez et al., 2004).

At the same time, there are some costs and constraints to complete specialization which partly relate to land tenure, farm size, social capital stocks, and idiosyncratic decision making of farmers, and partly relate to the availability, access, and functioning of markets for inputs, outputs, labor, and credit. For example, complete specialization often requires highly seasonal labor demand which often cannot be procured locally; similarly, concentration on one crop exposes farmers to high risk against which they can only imperfectly insure themselves (Di Falco and Chavas, 2008; Abson et al., 2013); third, jointness in production can also lead to advantages of diversified production (Allen and Lueck, 1998; Ballivian and Sickles, 1994; Klasen and Waibel, 2012; Kurosaki, 2003).

However, the better labor, capital, insurance, input, and output markets function, the lower are these constraints to specialization. If, for

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example, seasonal labor demand can be met with migrant labor, farmers have access to insurance, and improved infrastructure promotes intra-regional and international trade in competitive input and output markets, these constraints to specialization at increasingly broader scales are much less serious and specialization at increasingly larger scales becomes an important route to improve farm incomes, also for smallholders (Kurosaki, 2003). In the extreme, this could lead to monocultures not only at the level of the individual household, but at the level of the village, or even region. Hence, the degree of specialization may change along spatio-organizational scales depending on market functioning (Fig. 1).

To be sure, this discussion so far focuses on the economic rationale for specialization of the individual farmer. Of course, other drivers of specialization can often also be operative and they often relate to politics and power. For example, large and politically well-connected land owners might push specialization through evicting subsistence farmers or specialization might be promoted by subsidies for particular cash crops, again benefiting particular groups of farmers (e.g. Pritchard, 2013; Binswanger and von Braun, 1991; Binswanger et al., 1995). Thus policies, politics, and power can also influence the degree of specialization either directly or indirectly via their influence on market functioning (Herath and Weersink, 2009). While these instances can be important drivers of specialization in particular circumstances, we want to focus here on the possible dilemma posed that improvements in the functioning of markets can provide increasingly powerful economic incentives for specialization even without such political interference by the powerful.

This can pose a dilemma since, at the same time, there can be substantial ecological and also socio-cultural costs in terms of reduced ecosystem functions and services if such monoculture agricultural systems emerge at the level of a village or an entire region. Ecosystem functions are the capacity of natural processes to provide goods and services that directly or indirectly satisfy human needs (De Groot et al., 2002). There might be losses in plant and animal biodiversity (Foster et al., 2011), but also reduction of pollination services (Priess et al., 2007) or biological pest control (Stamps and Linit, 1997) as well as hydrological functions (Comte et al., 2012; Nedkov and Burkhard, 2012; Ojea et al., 2012). Decomposition services and carbon sequestration may possibly be impaired, too. Furthermore, information functions or cultural services may be lost (Gasparatos et al., 2011; Millennium Ecosystem Assessment, 2005). These losses crucially depend on the level of scale at which specialization on monoculture crops occurs, with specialization at broader scales generating more problems. There can also be a mismatch on a temporal scale: In the short term, the progressive loss of ecosystem functions and associated services may only have a small impact on the profitability of specialized monocultures; in the longer-term, the sharp reduction or entire disappearance of important functions might, however, undermine the profitability of monocultures at broader spatial scales.

The economic, socio-ecological, and cultural consequences depend therefore, to a large extent, on the spatial scale at which specialization occurs. For example, specialization within a village at the level of an individual farm might already generate some benefits of specialization for the respective farmer with few ecological costs compared to broader-scale specialization if the diversity of crops remains high within a village. Fig. 1 illustrates this point by showing two scenarios: one where poorly functioning markets allow only specialization at the household level; economic benefits of specialization are low but ecosystem functions are high. In scenario two, well-developed markets allow specialization at the regional level generating higher benefits but specialization at this broader scale reduces ecosystem services (see also Timmer, 1997). This development of specialization can also be driven or exacerbated by policies, politics and power. For example, policies can actively promote monocultures through supporting and subsidizing the development of cash crops in particular regions; in the case of Indonesia discussed below, the promotion of the palm oil sector was supported by various policies of the government, including migration policies, land policies, or infrastructure (McCarthy and Cramb, 2009). In addition, however, policies aimed primarily at promoting growth and poverty reduction may also affect this trade-off between economic benefits and socio-ecological and cultural consequences of specialization. For example, policies to improve access and functioning of markets (e.g. through improved infrastructure, information systems) are likely to increase the economic benefits of specialization as they may increase the scope for specialization for poor producers, but such policies might cause harm from an ecological point of view as they push specialization to a broader spatial scale.

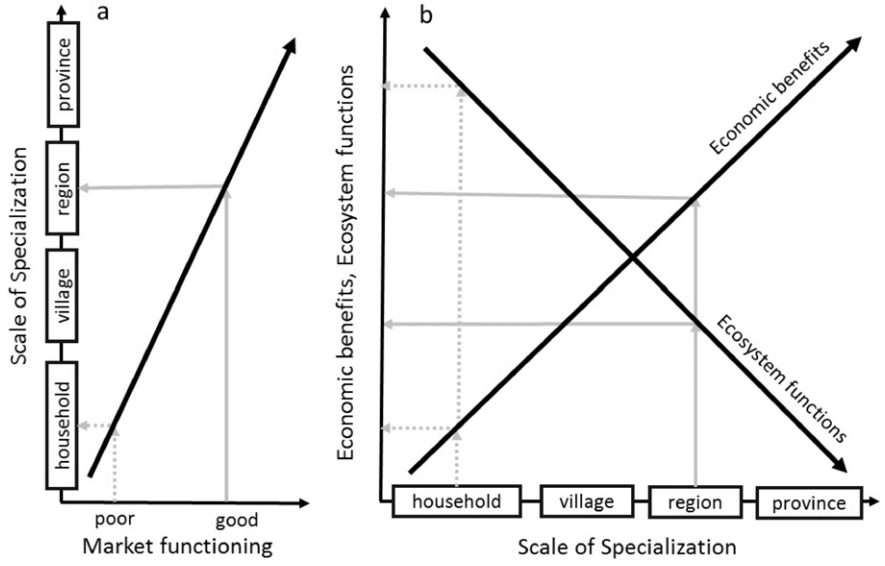

Fig. 1. Market functioning can drive the level of scale at which specialization occurs (a), which in turn drives economic benefits and ecosystem functions (b; black arrows). Other drivers (not depicted here) such as policies, politics and power may influence the scale of specialization either directly or via their influence on market functioning. Two scenarios are illustrated (grey arrows): In the poor market functioning scenario (dotted grey arrows), specialization is only possible at the household level (see a) which leads to low economic benefits and high ecosystem functionality (see b). In the scenario with good market functioning (solid grey arrows), specialization is possible at broader scales such as the region (see a). This leads to loss of ecosystem functions and high economic benefits compared to the poor market functioning scenario (see b). Note that in this illustration the location of the crossing of the arrows is arbitrary. The general message is that there is a scale-dependent trade-off between specialization and ecosystem functions driven by market functioning.