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A fresh look at shifting cultivation: Fallow length an uncertain indicator of productivity

Ole Mertz [a,*], Reed L. Wadley [b], Uffe Nielsen [c,1], Thilde B. Bruun [a], Carol J.P. Colfer [d], Andreas de Neergaard [e], Martin R. Jepsen [a], Torben Martinussen [f], Qiang Zhao [g], Gabriel T. Noweg [h], Jakob Magid [e]

[a] Department of Geography and Geology, University of Copenhagen, Øster Voldgade 10, 1350 Copenhagen K, Denmark
[b] Department of Anthropology, University of Missouri-Columbia, 107 Swallow Hall, Columbia, MO 65211, USA
[c] Department of Food and Resource Economics, University of Copenhagen, Rolighedsvej 25, 1958 Frederiksberg C, Denmark
[d] Center for International Forestry Research (CIFOR), P.O. Box 6596, JKPWB, Jakarta 10065, Indonesia
[e] Department of Agricultural Sciences, University of Copenhagen, Thovaldsensvej 40, 1871 Frederiksberg C, Denmark
[f] Department of Natural Sciences, University of Copenhagen, Thovaldsensvej 40, 1871 Frederiksberg C, Denmark
[g] Department of Mathematics, Texas State University, 601 University Drive, San Marcos, TX 78666, USA
[h] Centre for Applied Learning, Universiti Malaysia Sarawak, 94300 Kota Samarahan, Sarawak, Malaysia

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Abstract

Shifting cultivation is practiced by millions of farmers in the tropics and has been accused of causing deforestation and keeping farmers in poverty. The assumed positive relationship between fallow length and crop yields has long shaped such negative opinions on the sustainability and environmental impact of the system, as population growth is believed inevitably to lead to its collapse. Empirical evidence for this assumption is scarce, however, and a better understanding of system dynamics is needed before discarding shifting cultivation as unsustainable. With cases from Malaysia and Indonesia, we show that fallow length is a weak predictor of crop yields, though interactions with fertilizer inputs may increase its importance. Other factors such as drought, flooding, and pests are more important determinants of yields. The implication is that when using natural fallow as the only means of nutrient supply, there is no need to cut old fallow vegetation. Moreover, there is no evidence of system collapse, even at short fallow periods. We conclude that shifting cultivation should be accepted as a rational land use system and that earlier calls for bringing a "Green Revolution" to shifting cultivators are still relevant to achieve intensive and sustainable production.

Keywords: Borneo; Fallow; Kalimantan; Land use; Rice production; Sarawak; Southeast Asia; Upland rice

1. Introduction

Despite rapid economic development in many tropical countries, millions of people, particularly in the humid tropics, still practice some form of shifting cultivation (swidden or slash-and-burn agriculture). Exact figures on the areas under shifting cultivation worldwide do not exist, but there is an estimated 850 million ha of secondary forest in tropical Africa, America and Asia (FAO, 2005) of which shifting cultivators occupy an important part. Figures for the number of people depending on this system are also uncertain and range from 40 to 500 million (Russell, 1988; Goldammer, 1988; Kleinman et al., 1996; Sanchez et al., 2005). There is no doubt that despite rapid change and conversion to other land uses (Padoch et al., 2007),

* Corresponding author. Tel.: +45 3532 2529; fax: +45 3532 2501.
E-mail address: om@geogr.ku.dk (O. Mertz).
[1] Present address: Danish Economic Council, Amaliegade 44, 1256 Copenhagen K, Denmark.

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shifting cultivation remains important in many tropical countries, and even though it has generated a relatively large literature, aspects of the system are still poorly understood.

Shifting cultivation is a resource management strategy involving the shifting of fields rather than crop rotation and reliance on fallow to exploit the nutrients of the vegetation and soil (McGrath, 1987; Brookfield, 2001). A variety of crops are grown in almost all shifting cultivation systems, but upland rice is the most common in Southeast Asia and parts of humid West Africa. In many parts of Latin America and sub-humid Africa, maize and other cereal crops are more common, whereas bananas and tuber crops dominate in Central Africa, the Amazon and the Pacific region. Fallow lengths may range from 20 to 30 years or more in areas with low population density to short fallow periods in areas with more intensive farming. Often, a combination of fallow lengths is found within one system, and shifting cultivation practices are usually mixed with more or less permanent cultivation of tree crops or other cash crops. This has caused considerable problems in classifying such complex systems ranging from Ruthenberg's (1980) *R*-factor indicating the average amount of land under cultivation at any given time to classification systems attempting to describe different variants of the system by its various components (Fujisaka et al., 1996). Shifting cultivation is often practiced by the poorer segments of a population, but this does not make it an unprofitable system. Several studies have demonstrated the rationale of the system in the past (Kunstadter et al., 1978; Dove, 1985) and the profitability in terms of labour productivity was shown in a recent study (Nielsen et al., 2006).

A review suggested that certain conventional understandings of shifting cultivation have a slim empirical basis, particularly with respect to the importance of fallow length, which is normally assumed to correlate positively with crop yields (Mertz, 2002). Most of the studies (Toky and Ramakrishnan, 1981; Roder et al., 1995; Silva-Forsberg and Fearnside, 1997) cited in the review provide very interesting but limited data to evaluate completely the effect of fallow length on yields, leading to a paradox in decades of research: since Greenland's (1975) call for "bringing the Green Revolution to the shifting cultivator", many studies have focused on the need to improve the system, especially with fallow management (Kettler, 1997; Cairns and Garrity, 1999), without first testing the basic assumption that crop yields decline when fallow periods are shortened (Boserup, 1965), all other factors being equal. Based on this assumption alone, shifting cultivation has been considered a system on its way to collapse under population pressure despite little empirical evidence of such a pathway (Colfer, 1993; Mertz, 2002).

A recent study (Bruun et al., 2006) provides detailed analyses of the fallow–yield relationship in Sarawak, Malaysia, where farmer-managed test plots showed a positive correlation between fallow length and rice yields with plant-available nitrogen (N) as the main limiting nutrient for yields. While providing some of the first data on the fallow–yield relationship in Southeast Asia, the limitation in that study is a relatively small sample size in which few plots under long fallow tend to determine results. The research reported here takes a broader approach and combines *in situ* measurements and historical estimates of rice yields and other production factors. We combine two rather different data sets: direct measurement of all production factors influencing yields of upland rice in shifting cultivation in two areas of Sarawak, Malaysia; and studies of long-term change in production in four areas of East and West Kalimantan, Indonesia, using retrospective interview techniques. Both approaches attempt to overcome two problems in studying determinants of productivity in shifting cultivation (Conklin, 1957; Mertz, 2002): the temporal aspect of analyzing impacts of fallows that may be as long as 40–50 years and the large number of factors that influence crop yields, but which are difficult to control in farmer-managed fields.

2. Study areas and methods

The shifting cultivation practices in all study areas include planting of upland rice and vegetables in swiddens shortly after the fallow vegetation has been burned. Rice is usually farmed only 1 year before fallowing. Further description of the farming practices are given in earlier studies (Colfer, 1993; Wadley, 1997; Wadley and Mertz, 2005; Hansen and Mertz, 2006), and they are similar to other areas in Borneo (Padoch, 1982; Dove, 1985; Mertz et al., 1999) and wherever upland rice is the main component of the system (Cramb, 2005). An exception in Sarawak today is the more frequent use of herbicides and inorganic fertilizer (Nielsen et al., 2006).

2.1. Sarawak

In Sarawak, four communities in Niah Sub-District, north-eastern Sarawak, and Padawan District, south-western Sarawak (Fig. 1), were studied in the 2002/2003 farming season. Unless otherwise stated, the data refer to this season. The Niah and Padawan datasets were merged for the statistical analysis of this season. This is justified because the two areas are very similar in terms of farming practices, the variability in the topography of fields, and soil types. Average precipitation is higher in Padawan, but variability in the temporal and spatial distribution of precipitation is high in both areas. The Niah communities were also studied in the 2000/2001 and 2001/2002 seasons (Table 1). In each season, 15–20 households participated in the study in each community each year – note that the *n* in Table 1 refers to total number of households analysed in all seasons. The data presented represent a sub-set of these as data for some households were incomplete and had to be discarded; moreover, some households decided to leave the study. The observations listed in Table 1 represent the most reliable data sets.