Intensification of Upland Agriculture – Development or Degradation?

Bruun, Thilde Bech; Hepp, Catherine Maria

Publication date:
2018

Document version
Publisher's PDF, also known as Version of record

Citation for published version (APA):
Bruun, T. B., & Hepp, C. M. (2018). *Intensification of Upland Agriculture – Development or Degradation?*. Poster session presented at The Lao Uplands Conference
, Luang Prabang, Lao People's Democratic Republic.

FACULTY OF SCIENCE
UNIVERSITY OF COPENHAGEN

Intensification of Upland Agriculture – Development or Degradation?

Thilde Bech Bruun[1] and Catherine M. Hepp[2]
[1]*Department of Geosciences and Natural Resource Management, University of Copenhagen, Øster Voldgade 10, 1350 Copenhagen, Denmark*
[2]*Department of Plant and Environmental Sciences, University of Copenhagen, Thorvaldsensvej 40, 1871 Frederiksberg, Denmark*

The large scale conversion of extensive swidden agriculture to intensive market oriented production of maize in upland areas of South East Asia is a cause of concern – both in relation to the environmental and socioeconomic impacts. This study investigates (1) the drivers behind intensive maize cultivation in an upland area of Northern Thailand (2) the effects of this intensification on soil quality; (3) the potential of Permanganate Oxidizable Carbon (Pox-C) as a fast, low cost indicator of soil quality and (4) the socio-economic impacts of maize cultivation.

Study Site

A series of field studies were carried out in Nan Province in Northern Thailand between 2010 and 2012. Nan is the second largest maize-producing province in Thailand and the area under maize in this province tripled between 2005 and 2009. We focused on the village of Ban Huai Puk, which has 160 households and 540 inhabitants mainly of Khamu ethnicity. The area is dominated by hilly landforms, typically with slopes between 15° and 25°.

Results

The area under active fields more than tripled from 2002 to 2010 (Figure 1). This development mainly took place in areas that used to be under old fallows. In 2002 all respondents cultivated upland rice in a fallow-based system, while maize was cultivated by less than 25%. In 2010, 50% of the respondents cultivated upland rice, whereas maize was cultivated by 90%. The total area under maize was more than five times larger than the area under upland rice.

Maize cultivation: CP888 was the most popular type of maize seeds used in the area. Fertilizers and herbicides were used by all respondents and 90% relied on loans to purchase these inputs. 80% of maize production from Nan was sold to the Charoen Pokphand Group (CP).

Causes of Land Use Changes

The observed land use changes are driven by a combination of economic and political factors.

Maize prices tripled from 2005–2011, and the favorable prices were mentioned as an important reason for cultivation of maize by all of the respondents. Governmental support programs, such as maize pledging schemes were also mentioned as important incentives for focusing on maize cultivation. However, lack of alternative low investment cash crops capable of growing on the infertile upland soils was also frequently mentioned as a reason for the sole focus on maize.

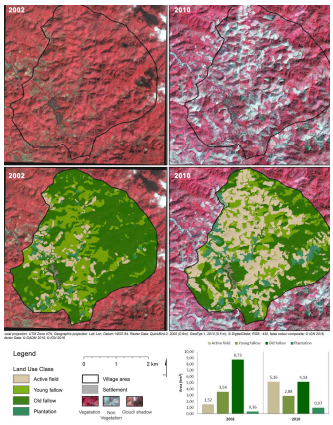

Figure 1: Land Use Changes 2002-2010. Young fallows are < 10 years, Old fallows are > 10 years.

65% of the respondents started to cultivate maize after 2001 when the Thai Government launched a set of micro-credit programs. In 2011, almost 90% of the maize growing farmers relied on short term loans from the Bank for Agriculture and Agricultural Cooperatives (BAAC), and many stated the possibility of obtaining credit for maize cultivation as an important reason for continuing to grow this crop. The loans from BAAC had to be repaid after harvest - with interests rates of 8–12% yr^{-1}

50% of the farmers reported accumulating maize-related debt due to harvest failure and decreasing prices. However, at the time of the study they all planned to continue maize cultivation due to the absence of alternative agricultural income sources, and the need to repay debts.

Methods

Surveys, Interviews and Participatory Mapping: Questionnaire surveys about agricultural activities, and perceptions of soil fertility were carried out in 2010 and 2011 (n=60). In 2012, households were revisited and interviewed about maize yields and constraining factors. Qualitative data was generated from in-depth interviews (n=20) and ranking exercises focusing on maize production, including information about indebtedness. Information about land use changes was acquired from participatory mapping and group interviews. Land use classification was done based on two high resolution, multi-spectral and pan-sharpened images from 2002, and 2012.

Plot selection and soil sampling: To investigate the effects of maize cultivation on soil quality, sampling plots were selected to represent a chronosequence of maize cultivation intensity (n=16). Soil samples were collected from four depths of three replicate profiles (60 cm) per site. Samples were analysed for soil texture, pH, concentrations of soil organic carbon (SOC), Total N, Permangenate Oxidizable Carbon (Pox-C), plant available P, exchangeable base cations, iron and aluminium (hydr-) oxides, and for Cation Exchange Capacity (CEC).

'The good thing about maize is that you get money – the bad thing is that you get debt'

The abandonment of the traditional swidden agriculture system has also been driven by a tightening of land use policies and an increased penalties for violating these. Over the recent decade, different Thai governments have increased efforts to eradicate the system that is blamed for causing deforestation. Since early 2000, the farmers in Ban Huai Puk have experienced increased inspections by government officials and recently by soldiers. Farmers have been fined for open burning or sent to prison accused of forest encroachment after being caught when clearing what they perceived as their older fallows. The enforcement of the ban on open burning and the different opinions about what constitutes a fallow and a forest means that farmers are afraid of leaving their land fallow and thereby risk being accused of open burning or of forest encroachment when clearing it.

Pox-C and soil quality

The Pox-C concentration of the 0–5 cm soil layer is positively and significantly correlated with all investigated indicators of soil quality, and with a few exceptions, this is also the case in the 10-20 cm layer (Table 1). A close relation was found between farmers' perception of soils as good and concentration of Pox-C ($p=0.038$, paired t-test). These patterns suggest that concentration of Pox-C represents an integrative measure of soil quality in these depleted Ultisols. Combined with low acquisition and operating costs, and its applicability in the field, the method has potential for application by extension services.

Effects of maize cultivation on soil quality

A strong negative correlation between land use intensity measured as 'years under maize' and concentration of Pox-C in the upper 5 cm of the soil is found (Figure 2). On average, the concentration of Pox-C in the upper 5 cm of the soil declines with 40 mg yr^{-1} under-maize^{-1}. Based on these findings, we conclude that concentration of Pox-C in the upper 5 cm of the soil is sensitive to the land use intensity in the investigated system.

55% of the respondents stated that the soil in their active maize fields was either 'bad' or 'very bad'. More than 70% ascribed low yields in the 2011–2012 cropping season to low soil quality, which was in most cases ascribed to successive maize cultivation.

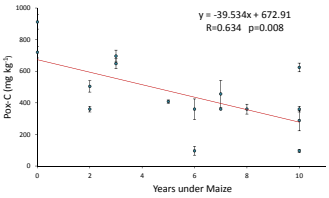

Figure 2: Correlations between land use intensity and Pox-C concentration in the upper 5 cm of the soil.

	SOC	N	pH	CEC	Mg	Ca	K	Bases	Plant available P	Al and Fe (hydr-) oxides
0-5 cm										
Pox-C	0.546**	0.668**	0.347**	0.582**	0.378*	0.545**	0.446*	0.540**	0.509*	-0.154
SOC	1	0.835**	-0.063	0.375	0.267	0.290	0.470*	0.341	0.214	-0.389
N	x	1	0.156	0.442*	0.298	0.389	0.392	0.410*	0.191	-0.371
pH	x	x	1	0.733**	0.578**	0.702**	0.246	0.741**	0.267	0.180
10-20 cm										
Pox-C	0.593**	0.493**	0.145	0.612**	0.540*	0.457	0.339	0.545*	0.734**	0.125
SOC	1	0.855**	0.036	0.281	0.162	0.195	0.451*	0.218	0.187	-0.144
N	X	1	0.032	0.238	0.085	0.238	0.436*	0.197	0.202	-0.164
pH	x	X	1	0.566**	0.451*	0.711**	-0.273	0.642**	0.425*	0.419*

Table 1: Correlations between selected indicators of soil quality.

- We document a widespread change from swidden agriculture to intensive maize cultivation resulting mainly from economic and political drivers: Farmers have been forced out of swidden agriculture due to policies aiming to eradicate the system, and simultaneously drawn into maize cultivation by high maize prices, and policies ensuring plentiful credit opportunities.
- Concentration of Pox-C in the topsoil of the maize fields is closely related to common indicators of soil quality, and to farmers' perceptions of soil quality.
- Maize cultivation has a negative effect on soil quality and this effect is captured by Pox-C. We conclude that Pox-C is a sensitive indicator of effects of land use intensity on the soil.
- Farmers in Ban Huai Puk are faced with declining maize yields, indebtedness, beginning soil degradation, heavily enforced restrictions on leaving land fallow and limited room for maneuver.
- We suggest that extension efforts should focus on finding integrated solutions that acknowledge the production realities of smallholders in upland areas and that extension efforts should build on the knowledge of local people as well as on established research-based knowledge. We call for a more demand driven extension service approach, which pays attention to farmers' knowledge instead of the current top-down approach.

Based on: Bruun, T.B., Neergaard, A., Burup, M.L., Hepp, C.M., Larsen, M.N., Abel, C., Aumtong, S., Magid, J., Mertz, O. (2017): Intensification of Upland Agriculture in Thailand: Development or Degradation? Land Degradation and Development, 28, 83–94.