Shifting cultivation to sustainability – seeing beyond the smoke

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Shifting cultivation (SC) is a system of agriculture widespread in the tropical and subtropical regions of the world. In India, it is rampant in the East and North East states. SC has been overwhelmingly portrayed as a threat to ecosystems and climate, ignoring the ecological value of the fallow phase and secondary forests. Finding ways to manage the practice of SC without affecting agricultural productivity is essential for climate change mitigation, biodiversity conservation and the welfare of indigenous communities. This study analyses recent research on the impacts of SC with regard to ecosystem effects at different stages of the process.

Keywords: Ecosystem services, fallow, land sparing, secondary forests, shifting cultivation.

SHIFTING cultivation (SC) can be defined as a form of agriculture in which lands are cleared (typically by man-made fires) and cultivated for shorter periods than they are fallow[1,2]. This system of agriculture is prevalent in the tropics and subtropics of Asia, Africa, South America and Australia. It has been identified as a significant contributor to tropical deforestation, with almost 30% of fallow tropical forestland being a direct result of such activity, making it a major driver of carbon release and biodiversity extermination[3]. SC has also been interpreted as an economically inefficient form of agriculture[4]. Population pressure on limited land, policy formulation without local participation, poor levels of economic development and low education levels are all factors that perpetuate the practice of SC. The literature overwhelmingly paints SC as unscientific, leading to low productivity and economic unviability, while at the same time posing a threat to the stability of ecosystems and climate. This is despite the fact that, from a climate justice perspective, historically SC has emitted among the least fossil carbon into the atmosphere relative to other land uses[5].

SC regions encompass a range of ecological succession stages, from primary forests, cleared out for agriculture to fallow lands and then secondary forests. However, precise quantification of ecosystem services from SC landscapes is lacking. About 250–300 million hectares of land globally is under some form of SC, which can be best described as secondary forests or fallows in different stages of growth[6]. Secondary forests, along with the ecological services they provision, have been dismissed as an undesirable transitional category between agricultural land and primary forests. This is evidenced in the push for land-sparing approaches in order to reserve land for wild tracts, thereby reducing fragmented and successional landscapes. However, recent evidence points out that many forms of SC are indigenous systems of organic cropping, which are well adapted to local conditions and might not be as harmful to the environment as previously considered[7]. Finding a way to manage the practice of SC without affecting agricultural productivity is essential for climate change mitigation, biodiversity conservation and the welfare of indigenous communities in developing countries with large forested areas. There is also a need to understand the large 'grey area' between permanent agriculture and primary forests in which different phases of SC landscapes are categorized, in order to better formulate policies toward this end.

Shifting cultivation in India

In India, SC is most prevalent among forest communities of the east and North East regions. Locally known by names like jhum (states of the NE), podu (Odisha) and vevar (Bundelkhand), SC is a dominant mode of livelihood for many rural households. The practice of SC, and the community ownership and participation that come with it influence the social organization. The concept of 'sense of place' among tribal communities, i.e. connections with the natural environment and a dearth of alternative occupations have been purported to be factors that perpetuate the practice[8].

Among the Indian states, Odisha ranks first both in terms of land area under SC and the number of dependent people[9]. An estimated 85% of the agriculture in the states of NE India is through the practice of SC. Approximately 8500 km^2 area in NE India is reported under SC[10]. Different programmes focused on the management of SC have claimed reductions in both the area under cultivation and

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the number of households involved. However, the Indian State of Forests Report by the Forest Survey of India (FSI) reports large-scale deforestation and loss of forest cover in different states every year. Given this inconsistency in the data of various agencies, there is a pressing need for updated and authentic data.

The GoI has enacted forest laws to prevent SC, while attempting to ease the indigenous forest communities into a more 'sustainable' means of livelihood. Four targets have been highlighted towards this end: food security, commercialization of agricultural produce, economic stabilization for poverty reduction and sustainable forest management. However, for many indigenous communities, SC is a way of life that they have sustainably practised for several generations.

In contemporary times, SC is largely an outcome of poverty coupled with a lack of technical knowledge. Increasing requirement for land has led to a reduction of fallow periods, affecting the resilience of the ecosystem in many of these agricultural landscapes. In the present-day scenario, it is unsustainable due to rising population pressure and mostly interfaces with rapid economic development projects in the vicinity. Managing transformations in SC-dominated landscapes through a coordinated multi-ministry and agency approach is thus fundamental to sustainable agriculture and development in these regions.

Impacts of shifting cultivation – untangling the variables

The practice of SC has immense impacts on the environment. Deforestation and burning of biomass release large amounts of stored carbon. The loss of forests reduces soil fertility and habitat quality for many species. It also affects the quality and quantity of water flow which facilitates soil erosion. In an equilibrium scenario, the carbon released in the process of SC will be sequestered back into the secondary vegetation that comes up during the fallow period, thereby causing no net change in atmospheric carbon over a period of time. However, the shortening of fallow periods has led to a shift in this equilibrium, making the practice of SC a net carbon-emitter in many places. For example, a field study on SC practices of the Chepang community of Nepal revealed that the fallow period reduced to just about 2.5 years in the three decades between 1979 and 2009. Most of the Chepang farmers presently practice annual cropping instead of fallow in the SC land, due to erratic rainfall, in order to supplement their livelihoods[11].

How reliable are past studies on shifting cultivation?

The estimation of carbon emissions from SC is often complicated due to site-specific ecological processes, as well as system boundaries spanning over large spatial and temporal scales[12]. Carbon and other greenhouse gas (GHG) emissions depend on the degree of vegetation burned, flaming (which emits largely CO_2), burning efficiency, smouldering (which emits trace gases) and soil heating. Research on carbon fluxes due to SC has predominantly focused on accounting landscape carbon stocks on a plot-based scale. Such studies represent only a single snapshot of a small land area which is comprised within larger spatial and temporal dynamics of the overall socio-ecological system. A caveat with such studies is that not only do they provide an incomplete picture, but also one that might be contradictory to the dynamics of the whole. Theoretical approaches show that annual emissions of GHGs from biomass burning due to SC at the national and continental levels are likely to be overestimated in the literature[13]. These results were based on area burned, aboveground biomass, combustion completeness and emission factors. Belowground biomass in SC lands is also liable to under-estimation by 50–60%, because root biomass and stump resprouting are not accounted for in the estimation[14]. If this is the case in different studies, it amounts to a large stock of biomass carbon that is not accounted for in SC landscapes.

Importance of the fallow period

The fallow period represents the re-establishment of the initial conditions of the forest ecosystem prior to cropping. Ecological processes in this period are similar to the natural process of ecological succession, wherein there is an increase in organic matter, biomass and biodiversity in the soil.

Research from Mizoram, NE India singled out fallow period as the most important factor in the recovery of carbon stocks and vegetation. However, even 5-yr-old fallows had substantially fewer species, stem density, biomass carbon and soil organic carbon than old-growth forests. The recovery of carbon in aboveground biomass was quicker during the early successive years compared to mid-successive fallows[15]. As a result of SC, fallows currently occupy almost 30% of all tropical forest land and are expected to increase at the fastest rate relative to other forms of land-use change in the tropics[16]. In similar landscapes in NE India, 20-yr-old fallows show increased tree diversity, only about 20% lower than natural forests. Fallows of 15–20 years have almost three times the carbon storage compared to 5–8-yr-old fallows, but still only about half of the natural forests. The proportion of non-labile carbon stocks shows a positive correlation with the age of the fallow[17]. A long-term management system to enhance the ecological condition of degraded lands under SC is thus key to improving the livelihoods of shifting cultivators.

Importance of secondary forests

Secondary forests can be considered as equivalent to fallow vegetation. They are inferior to primary old growth forests, but superior to agricultural systems in carbon sequestration and biodiversity in most cases, while soil quality comparisons do not show a clear trend[18]. In the Brazilian Atlantic forests, there is empirical evidence for positive carbon–tree diversity co-benefits in the secondary forests. This suggests that even highly degraded and fragmented landscapes can play a role in the sequestration of carbon and act as corridors for biodiversity, connecting protected areas[19].

Studies from Mexico[20], Colombia[21] and the Brazilian Amazon[22] show that secondary forests stored almost half of the landscape carbon compared to old-growth forests within 30 years. Long fallow periods also help build up carbon stocks. The proximity of old-growth or mature secondary forest to fallow sites may help in faster seed dispersal where SC is of small-scale shifting mosaic nature[23], resulting in faster rates of forest recovery.

Impacts on forest soil

The practice of SC across different phases of conversion, planting and fallow alters the physical, chemical and biological properties of the soil. Burning of forests causes hardening of topsoil, which impacts the surface run-off and erosion. The composition of soil aggregates also changes, which affects water retention and nutrient absorption. Fires decrease the amount of soil organic carbon, but may increase mineral carbon. Soil moisture is maintained in slash and burn, which controls the severity of fires, and thus minimizes negative impacts on the soil structure[24].

SC is based on the availability of stored nutrients in the burned biomass, and hence external nutrient inputs are not needed[25,26]. Absorption of ash by the soil causes nutrient enrichment in it. The conversion stage, from the ecological point of view, has a net positive impact on chemical properties of the soil. Increasing the cultivation intensity by reducing the fallow period could, however, lead to a loss of soil resilience. The period for which the soil is left to rest is of great significance; at least ten years is considered essential to avoid soil degradation[27].

Way forward – looking beyond the prejudices inherent in 'slash and burn'

The question of how much SC contributes to carbon-based emissions relative to other land-use systems is complex to address. First, there is no general way to define a SC system, and thus the type of SC used as a proxy for comparison varies across studies. Second, natural undisturbed forests are often used as a baseline for comparison with SC, even though SC is more comparable to agricultural systems with integrated forest use[28,29]. Many studies overlook the people involved in SC and thus, compare a livelihood system with a natural forest.

Shifting agriculture must be separated from other forms that use fire for the establishment of permanent agriculture, ranging from small-scale forest clearance for permanent agriculture to large-scale forest clearance for the establishment of permanent industrial plantations. The term 'slash-and-burn agriculture', thus, sometimes becomes a misleading 'catch-all' category in policy and scientific research[30,31]. Empirical studies from Odisha have shown that distinct approaches are needed to ensure continued productivity of land that has been under SC even at the village level[32], suggesting that disaggregation of the present body of knowledge is key to effective policy-making.

To intensify or 'deintensify'?

Intensifying SC in a small area, while sparing old-growth regions has been suggested as an optimal strategy to ensure carbon sequestration and biodiversity goals in tropical forests. Intensification of agriculture assumes a binary view of landscapes (agriculture/forest) in order to optimize the allocation of resources[33]. Studies from tropical dry forests of Mexico demonstrated lower emissions from intensive crop production in a permanent cultivation system compared to SC, without considering energy inputs entailed in intensive crop production. Permanent forms of agriculture in small parcels of land would allow forest regrowth on former fallow areas, thus helping in the recovery of stocks[20,28].

An alternative strategy of 'deintensification' has also been proposed, wherein SC cycles are lengthened for improved environmental management[34]. In such a scenario, SC is carried over a large area, but fallow periods are longer allowing for building of carbon stocks in the intermediate phases. Intensification thus aims at increasing the average carbon stocks over a spatial scale, while deintensification aims at achieving the same over temporal scales. Depending on agroclimatic factors and population pressure on the land, one of these alternatives or a mix of both can be adopted to reduce carbon loss.

Responses of SC communities to pressures on their traditional practices have been categorized under two heads[35]. First, more 'effective' fallows where the biological efficiency of fallow functions is improved to achieve greater production benefits in a shorter time. Secondly, more 'productive' fallows, in which perennial species are used to add value without modifying the fallow period. Real scenarios see a combination of the above strategies for improvement, with varying degrees of biophysical and economic benefits.

Role of REDD+ in shifting cultivation landscapes

SC is intricately linked to deforestation and land degradation, in its impacts on carbon emissions and sequestration potential. Understanding these dynamics is key in the context of international policy on Reduced Emissions from Deforestation and Forest Degradation (REDD+). From an ecological perspective, an SC landscape can be considered a mosaic of forests of different ages or a continuum of forest succession. Reduction in SC cycles is usually correlated to lower average aboveground biomass[36]. However, cycles may be shortened due to population pressure and a need to bring a higher proportion of total area under cultivation according to the exigencies of time. If shortened cycles lead to complete abandonment of areas that were earlier a part of the cultivation cycle, it is possible that over the area as a whole, average carbon stocks will rise[20].

Depending on the length of cultivation–fallow periods and the growth rates of trees, SC may lead to an average carbon stock that is lower than that of an intact forest, instead of a continued decline in stocks. It does not lead to a permanent removal of tree cover (>20 years). Hence, for the purpose of REDD+, it is more justified to consider SC as a form of forest degradation instead of deforestation[37]. REDD+ mechanisms of avoiding deforestation, avoiding forest degradation, and enhancing carbon are all relevant in SC landscapes.

Can small agricultural holdings play a role in the new conservation paradigm?

The number of studies that argue in favour of sustainable aspects of SC has increased in the last decade[7,29]. Some studies have argued that certain types of forest ecosystems might have evolved under the influence of human interference, such as SC[38–40]. Studies from Bhutan show that certain species are particularly adapted to cycles of disturbance and banning SC to preserve forest cover would put their existence at risk[41]. The role of human interference in shaping forest ecosystems has also been argued for ecosystems in Brazil, Congo and Southeast Asia[42].

SC, despite the ill-repute in conservation debates, is still an integral part of tropical forests across the world[43,44]. Livelihoods in these regions also include agroforests, permanent plots and home gardens. A simple ‘agriculture/forest’ dichotomy is insufficient to distinguish desirable forms from destructive ones. The vast range of activities on an SC farm, often without a tightly regulated schedule, makes diversity and stock measurements on SC land a painstaking exercise. Conklin[45] documented 280 food crops, including 92 species of rice in Hanunoo community lands on Mindoro islands of the Philippines. Rerkasem *et al.*[46] listed 370 plant species within a single Karen village territory in northern Thailand. Based on this evidence, the major obstacle to integrating SC in broader conservation schemes is the inherent diversity and dynamism. Brush[47] predicted a collapse of SC livelihood systems due to shortening of the fallow cycles. However, SC systems around the world have adapted to larger populations and prohibitive policies, largely through a greater degree of management and diversification of farm activities, without compromising on the dietary diversity they provide to the communities. Sustainability of SC systems, thus, emerges when seen in larger spatial and longer temporal scales.

Addressing policy concerns around shifting cultivation – the case of India

Forest and environment laws in India have considered SC detrimental to the environment since colonial times. Post-independence laws also outlawed SC, pushing these communities to the fringes of various development programmes[48]. SC lands presently fall under the categories of ‘abandoned land’, ‘wastelands’ and ‘unclassed state forests’. SC falls under agriculture in the cropping phase, but under forests in the fallow phase. This subjects the same land to different regulations and management at different times, which may be contradictory, thereby affecting the farmers’ autonomy over such plots. There is an urgent need to assign SC to a distinct land-use category and review various legal frameworks to find solutions acceptable from ecological and livelihood points of view. Over time, fallow lands can regenerate into secondary forests and add to the forest cover. The positive aspects of SC must be recognized and given due credit while forming policies.

In the absence of consolidated central laws around SC, certain regional policies and schemes have considered the livelihoods of SC communities. In 1987, the Ministry of Agriculture, GoI, started a 100% central assistance scheme to restore ecological balance in the hilly regions and improve socio-economic conditions of SC communities by weaning them away from the practice. The SALT (sloping agriculture land technology) approach that was successful in South and Southeast Asia was introduced in NE India as an alternative to SC. This approach incorporates on-field soil conservation methods to enhance productivity and animal husbandry to support income. The Government of Odisha adopted a watershed unit approach to managing catchments in Koraput, Phulbani and Kalahandi districts, where SC is most prevalent. However, these initiatives were limited in their scale and impact.

The Northeastern Region Community Resource Management Project (NERCORMP) promoted home gardens, which has resulted in positive outcomes such as nutritional security and gender parity in incomes, while also reducing the dependence on SC. Presently, home gardens are not designated for land use, which hinders the allocation of funds through specific schemes. Among the strengths of SC is its diversity of produce, and there exists a market demand for these products, which are sourced for trade largely through the unorganized sector. Agricultural marketing institutions and Forest Development Corporations need to be leveraged to formalize the marketing of these products, and thus, involve the communities on a larger scale to address employment and economic security for them. SC communities have limited access to credit because they are cannot offer their land as a collateral without suitable land titles. Group guarantee schemes (on a village basis) could facilitate loans for SC communities.

Conclusion

SC systems are a storehouse of both biological and cultural diversity. Moving away from the business-as-usual scenario to include SC communities and blend their indigenous knowledge into policies that govern their own livelihoods is the need of the hour. Policies for the welfare of SC communities have mostly been synonymous with attempts to wean them away into settled forms of agriculture. The promotion of settled agriculture on fallows in the form of terrace farming and plantations has taken over lands that would have otherwise grown into secondary forests. The resultant land-use change from SC still leads to loss of vital ecosystem services, though the larger agricultural output is considered a compensation.

The new-age conversations around conservation that include food production as a matrix need to look at the bigger picture of livelihood systems. The current focus is on a few selected, simplified land-use systems. SC is a complex and, in some ways, a problematic management system because it is difficult to categorize, quantify and monitor. This has historically led to anti-SC policies across different rainforest landscapes. At the same time, it is a proven source of livelihood and a repository of biodiversity that has stood the test of time. SC is far from being an ideal solution and its position lies outside the conventional paradigms of conservation. However, with rigorous scientific studies and a region-specific approach, it can be integrated into the mainstream conservation dialogue. This would not only help preserve biodiversity, but also the cultural diversity that has been a part of SC communities since as early as the advent of agriculture.

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