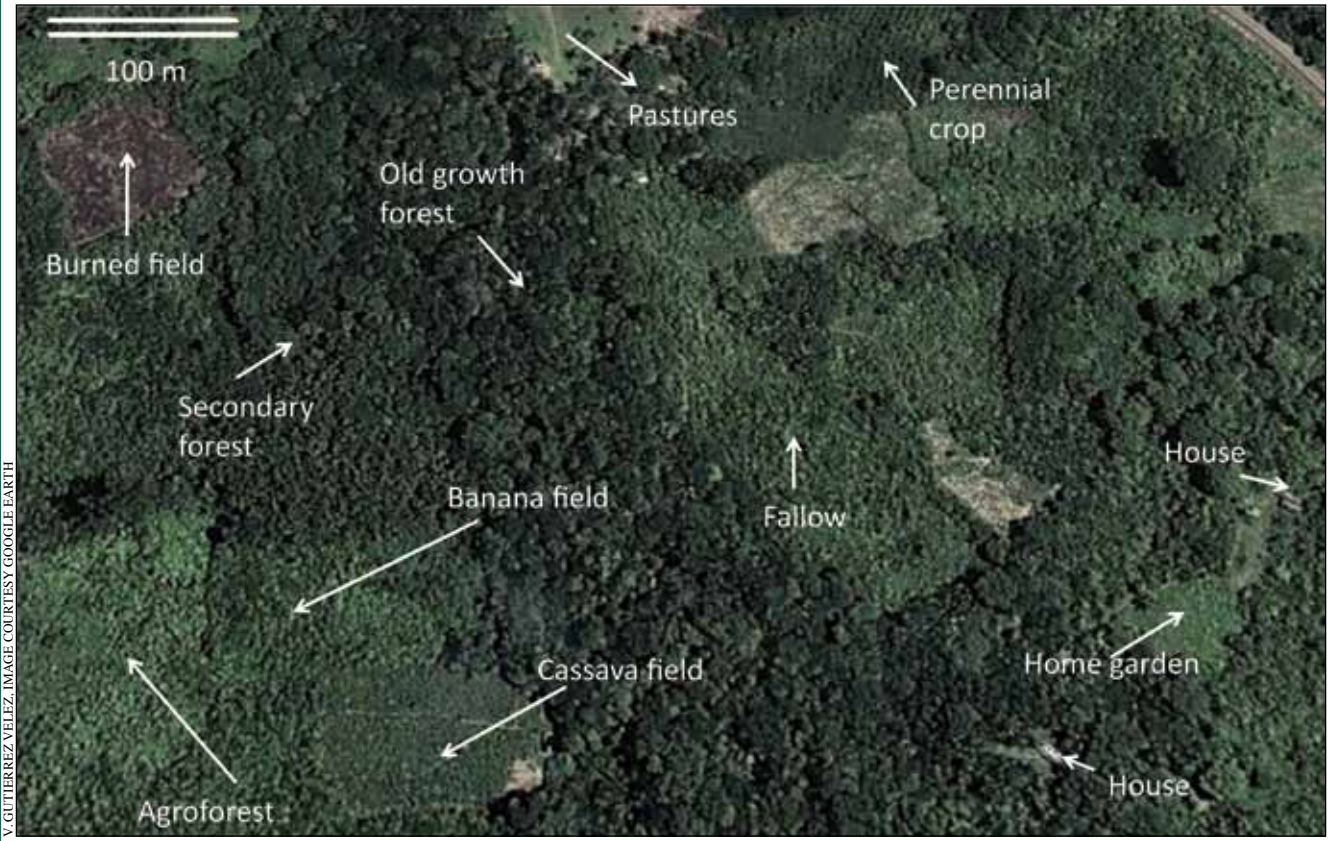

V. GUTIERREZ VELEZ, IMAGE COURTESY GOOGLE EARTH

Managing landscapes for greater food security and improved livelihoods

C. Padoch and T. Sunderland

The research and development community should focus more effort on reintegrating food production and conservation in smallholder-managed landscapes.

The "sustainable intensification" of agriculture is being advocated as the optimum means to advance and reconcile two pressing global issues: the need to protect ever-decreasing forest lands, and the imperative to feed the growing human population. The sustainable-intensification paradigm has come to dominate the discourse of many institutions devoted to economic and agricultural development, including the research centres of the CGIAR[1] (Pretty, 2009).

The interpretation of sustainable intensification appears to differ considerably depending on the programme, but invariably it involves the goal of producing more food without clearing new areas of natural vegetation or further degrading the environment. At first glance this goal seems laudable and compelling, yet a number of important issues arise concerning the assumptions and meaning of sustainable intensification (Rudel *et al*., 2009; Collins and Chandrasekaran, 2012). In this article

Above: A diverse smallholder landscape in the Amazon, Brazil. Approaches that maintain or increase the diversity of land uses and land users in landscapes offer an alternative to "sustainable intensification" in achieving food security, but they need more attention from researchers

[1] CGIAR, of which CIFOR is a member, is a global partnership aiming to unite organizations engaged in research for a food-secure future. The name CGIAR comes from the acronym for the Consultative Group on International Agricultural Research.

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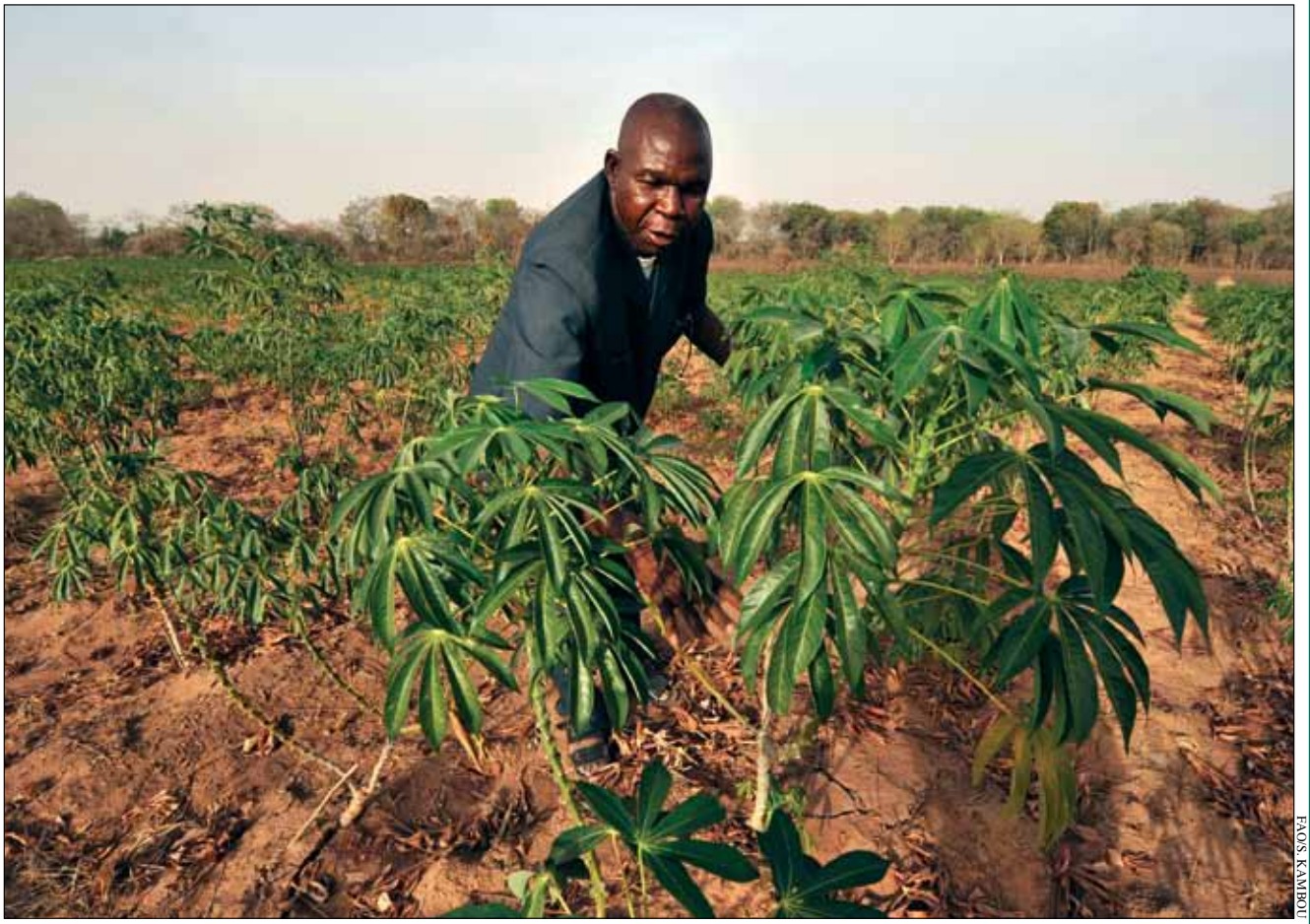

FAO/S. KAMBOU

A farmer inspects the foliage of a cassava plant in an intensive agricultural approach in Niamy, Chad. In many parts of the world, large increases in production have been achieved per unit area using a suite of modern technologies and tools, but there are doubts about a sole focus on this approach in efforts to achieve global food security

we ask why the intensification of agricultural production – or, for that matter, any single solution – is being championed as the only pathway to meeting sustainable production goals for agriculture. And we explore an alternative paradigm that could lead to improved outcomes.

QUESTIONS ON SUSTAINABLE INTENSIFICATION

The intensification of production is hardly a new idea; it has been an important – indeed dominant – trend in agricultural development for many decades (Tilman *et al*., 2002). Large increases in grain production per unit area have been achieved using a suite of technologies and tools, such as high-yielding planting materials, increased irrigation, and large quantities of synthetic fertilizers and pesticides – the very essence of the Green Revolution (Evenson and Gollin, 2003). The use of these technologies have greatly boosted food supplies in many – but not all – regions of the world, but it has also led to a broad range of environmental ills, such as reduced biodiversity and increased carbon and nitrogen pollution (Godfray *et al*., 2010; Collins and Chandrasekaran, 2012).

Some important questions about sustainable intensification remain to be answered. Will the same technologies and approaches employed in the previous intensification era continue to be used in "new" efforts to achieve sustainable intensification? Is it possible to deploy them in more environmentally benign and effective ways?

Doubts about an overemphasis on sustainable intensification are fuelled by empirical evidence that does not always support the seemingly logical notion that increased production per unit area will spare natural ecosystems, including forests, from further encroachment and conversion (Pinstrup-Andersen, 2013). On the contrary, more production per unit area sometimes appears to lead to more areas being cleared for production, due to lower labour inputs and greater yields and the associated increase in profitability (Angelsen and Kaimowitz, 2001; Barretto *et al*., 2013; Chappell *et al*., 2009; Perfecto and Vandermeer, 2010).

There are also questions about those regions in which intensification technologies have until now led to few benefits.

Solutions to the apparently complex and multiple reasons why the Green Revolution bypassed some of the poorest regions of, for example, sub-Saharan Africa continue to confound those who have attempted to raise yields and benefits for local producers in such areas. Producers continue to be challenged by the high costs and unreliable availability of the inputs required and the limited capacity of government extension agencies (Evensen and Gollin, 2003).

Many of the questions being asked about sustainable intensification, however, address the fundamental assumption that it is the production of more food, especially more calorie-rich grains, that should be our major focus in achieving global food security (Sayer and Cassman, 2013). Arguably, the objectives of obtaining more equitable access and distribution of what is already produced, as well as reducing waste, are equally or more important (Tscharntke *et al*., 2012). We also need to know whether the estimated 842 million people who suffered from chronic hunger in 2011–2013 (FAO, IFAD and WFP, 2013) did so mainly because of inadequate quantities of food or because they could not access the food that was actually produced (Rocha, 2007). If the problem is largely one of access to, rather than the total supply of, food, how will sustainable intensification, and a focus on production, resolve that? Moreover, the quality of food may be just as important as its quantity: in the view of many nutritionists and others, the provision of more nutritious food rather than simply more calories is the most pressing global challenge (Welch and Graham, 1999; Brinkman *et al*., 2010).

LAND-SPARING VERSUS LAND-SHARING

The way in which most proponents of sustainable intensification have presented their plans conforms to what has been labelled a "land-sparing" approach to reconciling production and conservation priorities, in which a greater yield is achieved on a smaller area of land, thus "sparing" the conversion of natural systems.

There are alternatives, however (e.g. Phalan *et al*., 2007), such as land-*sharing* approaches in which environmental and production functions are more closely

Behind these huts in Song Thanh, Viet Nam, the hills show the complex mosaic landscape typically created by shifting cultivation in a land-sharing approach, with fields under active annual cropping interspersed with areas in various stages of regrowth and with older forest on the hilltops

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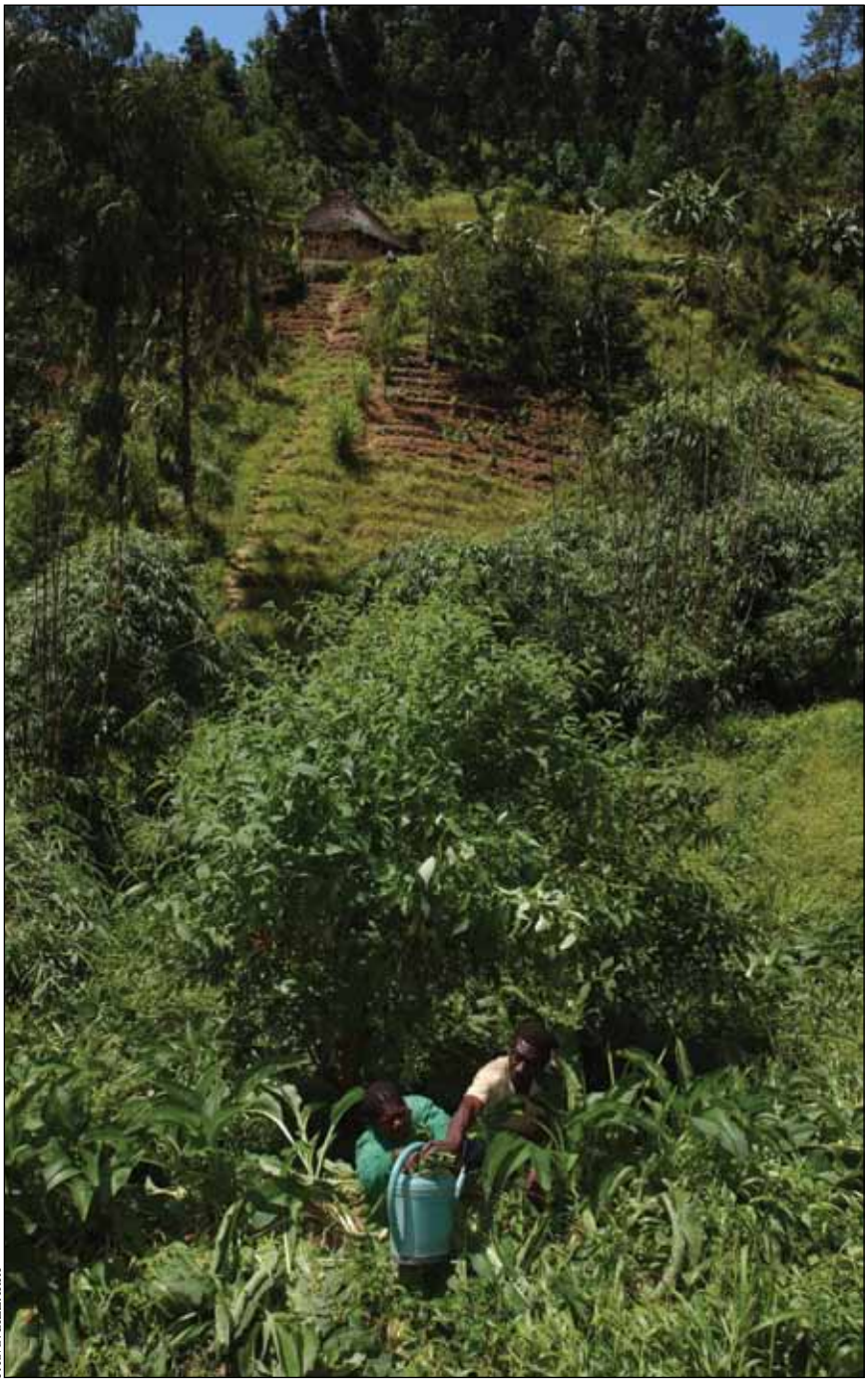
integrated at the landscape scale. Using both ecological theory and empirical data, a number of researchers have suggested that land-sharing may generate better food-production and conservation outcomes than approaches that aim to isolate and intensify both production and conservation. In addition to arguing that integrating production and conservation can improve the outcomes of both, Perfecto and Vandermeer (2010) pointed out that land-sharing often allows for a greater diversity of both land uses and land users.



FAO/G. BIZZARRI

A farmer collects leaves of the kibembeni tree to make an organic insecticide in the village of Msewe, the United Republic of Tanzania. Diverse, locally adapted production and resource management systems tend to increase the resilience of rural households

LANDSCAPE APPROACHES

Landscape-scale approaches that embrace a land-sharing philosophy have recently gained traction in debates as an alternative to the more conventionally imagined sustainable-intensification pathway (Sayer *et al*., 2013). Producing food in diverse, multifunctional landscapes challenges dominant agricultural development paradigms, but it also presents issues and difficulties. For example, many types of integrated landscape approach have not been studied by scientists, and the existing research and policy framework may be insufficiently integrated to improve either agricultural production or environmental protection in such diverse landscapes (Tilman *et al*., 2011).

The lack of rigorous research is concerning and needs to be addressed. A central problem for advancing landscape approaches may be that they combine agricultural production and environmental conservation in ways that are unfamiliar to specialized scientists, who have made many of the recent advances in agronomy and conservation; the unfamiliar is rejected or, more likely, ignored (Sunderland, Ehringhaus and Campbell, 2008). But the farming of diverse landscapes has long been the dominant smallholder paradigm. There is much practical experience to build on, therefore, in both management practice and governance.

Addressing access and diversity

Even if landscape approaches are less of a sure thing for directly increasing the global supply of familiar commodity crops, they have great potential for resolving other issues that are central to the food security of some of the world's most vulnerable people. Landscape approaches are already known by many of the people who tend to

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A mosaic of more and less traditional land uses in a landscape in northern Thailand. Realizing the promise of integrated landscape approaches requires the willingness and ability of researchers to work across sectoral, academic and ideological boundaries

be the targets of development programmes, especially those who have benefited little from previous initiatives. They offer promise for solving some food-related problems that have proved to be more intractable than the basic task of producing more calories – such as improving access to food and nutrition through the provision of a diversity of products, and thus improving diets (Scherr and McNeely, 2008).

More effective in marginal lands

Landscape approaches, especially those that are developed locally, are often more suitable for lands where previous agricultural intensification has been unsuccessful, for example on sloping lands and in other areas that are marginal for conventional approaches. The diverse production activities that such systems comprise are often well adapted to the panoply of environmental, demographic, social, political and economic changes that is sweeping across much of the less-developed world. Diverse, locally adapted production and resource management systems tend to increase the resilience of rural households in the face of such changes (Scherr and McNeely, 2008).

Reorienting research

Realizing the promise of integrated landscape approaches, however, requires the willingness and ability of researchers to work across difficult sectoral, academic and ideological boundaries. Working to improve existing locally developed and locally adapted production systems to increase incomes and improve nutrition rather than "reinventing" landscape approaches to fit the constructs and preconceptions of the research and development community will require a reorientation of research ideas, ideologies and priorities.

While the challenge is undoubtedly complex, making use of existing experience will help. It is estimated that 40 percent of all food in the less-developed world originates from smallholder systems, and many of these depend essentially on diverse landscapes (Godfray *et al*., 2010). Smallholder farmers worldwide and throughout history have managed landscapes for food and other livelihood needs. Forests, woodlots, parklands, swidden-fallows and other tree-dominated areas are integral parts of many smallholder landscapes and household economies (Agrawal *et al*., 2013).

Smallholder-managed landscapes are, of course, variable in spatial extent, complexity and management, among other things. One of the few generalizations that can be made about them is that they tend to be diverse, complex and dynamic, which is the main source of their strengths and also of their weaknesses (van Vliet *et al*., 2012).

Amazonian floodplain farmers

On the Amazonian floodplains, smallholder farmers have created heterogeneous, mosaic landscapes characterized by high levels of ecosystem and species diversity at different spatial scales (Padoch and Pinedo-Vasquez, 2000; Sears and Pinedo-Vasquez, 2004). To manage the natural variation of complex floodplain environments, farmers in these agro-ecological landscapes integrate strategies of production, use and conservation to serve multiple objectives, and they adapt their management to seasonal or even diurnal (in the estuary) fluctuations in water level. Their plots are not randomly arranged, and nor are they "primitive" or "unproductive" versions of modern or industrial-scale farm fields. Smallholder strategies of land use and resource management are often based on the concurrence of intensive and extensive activities that simultaneously minimize risk and maximize labour opportunities while allowing for adaptation to opportunities and problems as they emerge.

The adaptive management practised by Amazonian floodplain farmers results in multifunctional farming systems in which the production of a diversity of goods and services is integrated and the particulars of the system are attuned to biophysical, social and economic conditions that vary, often dramatically, over time and space. This multipurpose management is one of the characteristics that best distinguishes smallholder systems from the simplified practices of large-scale agriculture and industrial farming and forestry.

Transformations resulting from farming and other resource-use activities often lead to increased habitat diversity as well as to increased levels of connectivity and mobility within forest–field landscapes (Pinedo-Vasquez *et al*., 2001). Farmers, who simultaneously are also foresters, fishers and hunters, transform and manage these landscapes, often making them more ecologically diverse and thus providing favourable habitats for fish (Goulding, Smith and Mahar, 1995), wildlife (Bodmer and Pezo Lozano, 2001), trees (Pinedo-Vasquez *et al*., 2002) and fruit trees (Hiraoka, 1992).

The diverse patches of smallholder mosaics provide ecosystem services in ways that are poorly understood. Such services may include, for example, microclimatic effects that make agricultural production possible or more profitable in times when extremes in temperature or humidity would otherwise prevent farm production. Among the many ecosystem services that small forest stands supply to agricultural fields and the families who manage and share the space are a reliable supply of water, shade and forage for livestock; refuges, food and breeding sites for fish; and a variety of valuable forest products to support farmer families in times of climatic stress.

The effects of diverse patches on seed availability for the restoration of forest species and hence of soil fertility may often also be among the crucial but hidden benefits of diverse, smallholder-developed and -managed landscape mosaics. Typically, several of the patches in a given human-modified landscape on the Amazon floodplain will comprise highly diverse agroforests that include timber trees and other economically valuable trees and herbaceous species. There will also be multistoried and fruit-rich homegardens in and around human settlements, which are particularly valuable for food security and nutrition. Institutions and non-governmental organizations devoted to landscape approaches to agricultural development often promote agroforests and homegardens as being particularly valuable (Sayer *et al*., 2013; Scherr and McNeely, 2008).

SHIFTING CULTIVATION

In most discussions of successful landscape approaches, however, there is a conspicuous omission. Shifting cultivation, also known as swidden or slash-and-burn agriculture, is an integral part of many, if not most, tropical forest landscapes crucial for biodiversity conservation and watershed protection, including those in the Amazon Basin, Borneo and Central Africa (Ickowitz, 2006; Padoch *et al*. 2007; Mertz *et al*., 2009; Schmidt-Vogt *et al*., 2009). But this manner of managing forests and landscapes for food and other human needs has been criticized, condemned and in some cases criminalized (Fox *et al*., 2009; Mertz *et al*., 2009).

Few of the features of shifting cultivation seem to fit into any conventional category of sustainable production or landscape management. The cutting of trees, the burning of fields, the comparatively low production of staple crops and the apparent abandonment of fields after a year or two of cropping – all highly visible features of many such systems – are largely regarded worldwide as primitive, wasteful and destructive. Efforts to eliminate such practices have been central to many national and international conservation and development programmes (Cramb *et al*., 2009; Fox *et al*., 2009).

But beyond the smoke and the prejudices inherent in a term like "slash-and-burn", it is clear that many shifting cultivation systems could be valuable components of a landscape approach to agricultural production in forested regions. Including them would require a willingness to reject the lure of simplicity that alternative solutions offer.

Shifting cultivation is complex on several levels (van Noordwijk *et al*., 2008; Padoch *et al*., 2007). The biodiversity of some of these systems is almost legendary. When the shifting cultivation systems of the Hanunoo people of Mindoro island in the Philippines were studied more than half a century ago (Conklin, 1957), they were found to involve more than 280 types of food crop and 92 recognized

rice varieties, with several dozen of these usually showing up in any one field. More recently, research in the upland rice fields of Southeast Asian farmers has commonly identified some 30 species of staple crops, 30–40 species of vegetables and 25 species of herbs and spices (Anderson, 1993; Sutthi, 1995; Dove, 1985; Colfer, Peluso and Chung, 1997).

The above figures are only for crops in farm fields: the landscapes of the Hanunoo shifting cultivators also included extensive areas of forest of various ages and with significant levels of biodiversity (Rerkasem *et al*., 2009). Although such areas in these landscapes are commonly referred to as fallows, many are managed intensively for economic and other products, including such nutritionally valuable products as wild meat. Forest fallows also often provide ecosystem services that are less easily perceived and measured, such as pollination and the maintenance of water quality and supply. Recent research has determined that forest–field mosaics such as those of the Hanunoo often sequester high levels

Hillside swiddens in Nam-Et Phou Louey, northern Lao People's Democratic Republic

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A hillside subject to shifting cultivation in the Lao People's Democratic Republic

of carbon, especially in the soil (Zeigler *et al*., 2012). This may surprise many researchers and policy-makers because slash-and-burn is widely condemned as a particularly environmentally damaging form of agriculture.

The greatest obstacle to including shifting cultivation in the new landscape paradigm, in the eyes of both development professionals and conservationists, is not, we suspect, the illegibility of its patchy landscapes (see below) or the complexity of its management, but its inherent dynamism. Change is what defines a system as shifting cultivation: annual crops are moved from plot to plot every year or two; and as forests regrow in one sector, they are felled in another. Can so much dynamic change be tolerated in a "sustainable" landscape? Can shifting cultivation be sustainable if it includes slashing and burning woody vegetation?

Many shifting cultivation systems worldwide have adapted successfully to larger human populations, new economic demands and the directives of anti-slash-and-burn policies and conservation prohibitions. Such adaptation has taken a large number of pathways, of which the more active management of fallows has perhaps been the most important. Examples include the management of rich mixtures of marketable fruits and fast-growing timbers in Amazonia and the production of rubber and rattans in Southeast Asia (Sears and Pinedo-Vasquez, 2004; Cairns, 2007). These adaptations suggest that the sustainability of shifting cultivation systems emerges when it is seen at broader spatial and longer temporal scales: shifting cultivation, in common with many smallholder-influenced landscapes, is constantly mutable.

Negative impacts of replacing shifting cultivation

An important new study (Castella *et al*., 2013) analysed changes in the patterns of forest–field landscapes that occurred as environmental and socio-economic change transformed the territories of seven villages in the northern uplands of the Lao People's Democratic Republic over a period of 40 years. In this region, where a

tradition of shifting cultivation had created intricately patterned landscapes of forests, fallows and farms, such landscapes are now being radically altered by policies aimed at increasing forest cover and promoting intensive commercial farming. Shifting cultivation, with its complex landscapes, is deliberately being replaced with a land-sparing model of agriculture. This is because the segregation of land uses is perceived as most efficient for achieving multiple objectives in the context of a growing population, and shifting cultivation is widely viewed as "primitive" by government and other institutions.

Based on extensive field research, however, Castella *et al*. (2013) found that by imposing strict boundaries between agricultural and forest areas, interventions in the name of land-use planning have had significant negative impacts on the well-being of rural communities and especially on their ability to adapt to change. Farm and forest products that previously were "intricately linked at both landscape and livelihood levels, are now found in specialized places, managed by specialized households" (i.e. the domestication of non-wood forest products) and are collected by specialized traders. The authors argued that "this trend may have negative consequences for the resilience of the overall landscape as it reduces its biological and socio-economic diversity and therefore increases vulnerability to external shocks" (Castella *et al*., 2013).

Productive, complex and dynamic landscapes in the Lao People's Democratic Republic and elsewhere lend flexibility to household economies and contribute to appropriate responses to climatic and economic perturbations. Programmes of directed change, such as the one promoted by the Lao Government, attempt to create distinct zones for agricultural intensification and forest conservation. Up to now, however, they have not led to more sustainable resource management, and the simplified, intensified agro-ecological systems that have been advocated have not benefited local people.

TRADITIONAL APPROACHES ARE A VALUABLE RESOURCE

We do not suggest that existing smallholder practices, no matter how diverse, complex and dynamic, are invariably ideal or well-adapted to rapidly changing conditions. We do suggest, however, that this potential resource of knowledge, practice and products should not be ignored.

Efforts at agricultural development and biodiversity conservation (e.g. "social forestry") have often failed to take advantage of the resource that existing patterns and practices offers. There are many reasons for this failure, including a misunderstanding of the diversity that characterizes such patterns and practices, and their dynamism. Public policies tend to be sector-oriented and unsuited to managing integrated systems. Such systems are essentially "illegible" to outsiders (Scott, 1998), and local landscape management systems are therefore often ignored, denigrated or criminalized by government actors and policies. As in the Lao People's Democratic Republic, development efforts have led to specialization that often limits the capacity of smallholders to cope with risk and uncertainty.

Landscape research should build in traditional systems

What is urgently needed is research that builds on these traditional systems, that values what these patterns and practices provide and achieve, and that succeeds in improving them to provide the additional food, feed, shelter, income and resilience that smallholders need in a rapidly changing world and to which they have an intrinsic right. It remains to be seen whether agricultural and forest research institutions can respond successfully to this challenge. Reforms to landscape governance are also imperative to allow systems that embrace landscape complexity, dynamism and multiple objectives and engage all stakeholder groups in collectively managing diverse, multifunctional landscapes.

We echo the conclusions of Castella *et al*. (2013) in calling for "more integrative planning and design processes grounded in improved multistakeholder negotiation mechanisms to enhance landscape multifunctionality and thereby increase the capacity to respond to unforeseen change". The challenge to improve food security in the face of great global uncertainty is too big for the resource offered by traditional systems to be ignored by research institutions (Opdam *et al*., 2013), including the centres of the CGIAR. The challenge is also too complex to be met solely by following the pathway of sustainable intensification. ◆

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