# Fire: A Constructive Prescription

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Fire is no stranger to our humble genus, Homo. This incendiary romance is 1.5 million years old and dates back to Homo erectus: the first species whose use of fire is confirmed by archaeological excavations (Stephen Pyne, 2003). More recently, Homo sapiens started using fire for agricultural purposes in the early Holocene (10,000-7,000 BP) during the Neolithic Revolution, or the first agricultural revolution. During this period, human behavior became increasingly sedentary as hunters-and-gatherers realized the nutritional benefits of cultivating crops on landscapes that could be exploited at predictable time-intervals. When dealing with infertile soil, growers often resorted to swidden agriculture: the process of burning a plot of land to stimulate plant growth. Swidden agriculture is still practiced today, concomitant with controversy due to its ostensibly destructive nature.

The centuries-old agricultural method of controlled-burning has been stigmatized by wildfires and other natural phenomena that wreak havoc on forests, private properties, and even human lives (Lightfoot and Parrish, 2009). Beyond their association with these destructive forces, controlled agricultural fires are also guilty of reprehensible CO2 efflux, inciting resistance from environmentalists. So how is such a flagrant agricultural method still in practice today? Slash-and-burn agriculture is a profoundly efficacious farming strategy, with the potential for both economic and biological growth that can, by itself, cultivate a diverse and healthy ecosystem. It thus becomes necessary to further understand this practice and its significant social and ecological role within modern-day agricultural societies.

To understand how Swidden agriculture can promote crop-growth, it is necessary to familiarize oneself with the process of slashing and burning. First, a plot of land is prepared by cutting down, or slashing, all of the vegetation. Next, the plot of land is set on fire. It is best to do this during the driest part of the year to ensure effective burning of the vegetation; this step rids the soil of pests, and releases the nutrients from all of the cut-down plants into the soil -- the ash is acting as fertilizer. Finally, the fertilized land is planted with crops of interest (e.g. seeds, rice) just before the rainy season begins, and the land plot blossoms once again.

Motives for practicing swidden agriculture can be subsistence or market-based. For the poor rural farmers that tend to practice slash-and-burn, land is often their only available resource, and crops are their only source of income. Unfortunately, this income is often insufficient to permanently raise their standard of living, tying these farmers inextricably to their land (Hauser and Norgrove, 2004). Similarly, California Indians subsumed swidden agriculture as a subsistence strategy, recognizing centuries ago that "fires can augment the growth and diversity of many economic plants, including roots, tubers, fruits, greens, nuts, and seeds" (Lightfoot, 2009).

So it is evident that slash-and-burn agriculture can yield crops that carry economic and nutritional value, but how does it affect floral and faunal populations? Early studies in Southeast Asia insist that swidden agriculture decreases biodiversity, basing their claims on a "commonly held belief that swidden agriculturalists are responsible for about half of Indonesia's annual deforestation" (Wil de Jong, 1997).

*"The prescribed use of fire actually fosters a more diverse ecosystem"*

However, there are numerous variations to the slash-and-burn method -- practitioners can be skilled or wasteful -- and claims like Wil de Jong's have a tendency to conflate all of these agriculturalists into a single group of swidden agriculturalists. More recent studies discuss these differences in farming techniques. For example, Hauser and Norgrove have probed the effective difference between a long and a short fallow period -- that is, the period where the land lies uncultivated: long fallow periods "reverse the degradative processes of cropping", such as soil fertility decline, weed buildup, crop pests, and crop diseases (Hauser and Norgrove, 2001). Long fallow periods improve soil quality, aboveground biomass nutrition, and soil-macrofaunal activity while combatting weeds, pests,

and diseases (Hauser and Norgrove, 2001). By avoiding premature cropping of the fallow land, farmers can set the stage for a vivacious suite of successive flora and fauna, thus optimizing their own yield. It is thus up to the farmers to calibrate their cropping techniques to ascertain the most lucrative balance between the fallow phases and cropping phases.

It may appear that burning an entire landscape decreases biodiversity by harming the flora and fauna of the landscape, but longitudinal studies prove these ecological injuries to be merely temporary: The prescribed use of fire actually fosters a more diverse ecosystem. Burning a landscape creates new land plots for successor species to colonize. Plant and animal succession occurs in waves, producing a mosaic of ecosystems that offer a variety of resources and, thus, spawn diverse populations of organisms. When fire spreads, the land is unevenly affected; burns will be more intense in some spaces than in others, leaving behind residual organisms where the fire wreaked less havoc (Turner and Baker, 1998). In 1992, Martin and Sapsis defined this phenomenon as pyrodiversity, specifically referring to "landscape heterogeneity and diverse biota that result from various stages of plant succession as those plants recolonize burned areas".

In a longitudinal study spanning three years (1998-2000), Wang Zhijun and Stephen Young studied bird diversity at two sites in China, both sites occupied by swidden agriculturalists (the Hani and Jinuo people). Due to a growing population, the farmers in the Jinuo region have become commercial agriculturalists and, consequently, have begun practicing shorter fallow periods to maximize their revenue. The Hani region, however, still exercises long fallow periods, ranging from 6 years to 40 years. Using a line-transect identification, the researchers counted the number of bird species from 33 different bird families and there were salient numerical differences between the two sites: in total, the researchers counted 267 bird species at the Jinuo site, and 467 bird species at the Hani site, supporting the theory that longer fallow periods are conducive to greater biodiversity. This study provides a clear example of the potential for agriculturalists to restore biodiversity by allowing longer fallow periods; environmentalists, thus, should push for sustainable agricultural techniques rather than condemn the entire culture of slash-and-burn, which could jeopardize scores of farmers' livelihoods.

Moving across the Pacific we can see more examples of ecologically savvy populations: the California Indians. Recognizing California's vulnerability to large-scale fires, the native peoples sought ways to benefit from this natural feature of their environment. Hunter-gatherers were interested in enhancing

**Figure 1. Slash and burn agriculture in Madagascar**

the growth of diverse resources that would "augment the availability of a variety of plant foods . . . and the availability of economic resources [raw materials for baskets]" by creating environmental mosaics (Lightfoot and Parrish, 2009). Lightfoot and Parrish propose that the California Indians practiced small, frequent, low-severity fires to foster these mosaics that were essential in maintaining staple foods, such as acorns and large game. By preemptively prescribing small fires, the natives avoided the large, natural fires that were more damaging. Controlled burning produces "edges or transitions between different habitat types" that greatly enhance biodiversity (Lightfoot and Parrish, 2009). These farming practices provide great insight into non-commercial fire usage systems, revealing human receptiveness to the environment; over centuries of adjustment, hunter-gatherer populations have managed to optimize their use of fire to create florally diverse environments on which their villages can subsist, while cultivating the raw materials necessary to spur economic exchange relationships -- social complexity fostered from biodiversity.

Fire has been a pivotal element for agricultural innovation. Such a paradoxical complex -- destroying land to create new resource opportunities -- is reliant on proper execution by agriculturalists to ensure the consequent increase of biodiversity resulting from secondary succession. Through careful experimentation, it is evident that swidden agriculture has the capacity to create mosaic environments that promote floral and faunal diversity while stimulating economic growth, justifying the short-term destruction of unproductive landscapes.

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