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SWIDDEN CULTIVATION: A REVIEW OF CONCEPTS AND ISSUES

Amalendu Jyotishi*

Encroachment of forest lands for cultivation occupies a central position in the debate on tropical deforestation. Though swidden (shifting cultivation) is one of the primitive forms of agriculture in the forest-farming continuum in the tropics, some scholars consider it as an agent of degradation of forest. Shifting cultivation still covers a fairly significant part of the forestlands in tropical countries. Some estimates even suggest that the global share of swidden in deforestation is between 45 per cent (UNEP cited in Angelson, 1995) and 60 per cent (Myers, 1995).

It is claimed that shifting cultivation as a major contributor to deforestation gives rise to two major problems on the environmental front viz., loss of biodiversity and increased soil erosion. Apart from this, the climate changes due to forest loss have also been an important fallout. The study of shifting cultivation as an ecological problem is crucial as the change in the natural balance has direct as well as indirect effects on human life. Most often factors like poverty, population growth and migration into the forest by the swiddeners are cited as the most important causes of deforestation. Such an inference is not only superficial but also undermines the underlying institutions that manifest these factors. More so, universalising the problem of deforestation due to the presence of such factors may be misleading. While studying the role of shifting cultivation in deforestation, property rights structures, state administration, culture, and different market and non-market forms of integration are some of the important institutional structures that have been neglected. Swidden is also considered as an inefficient form of cultivation, where production is not economical, the technology used is obsolete and labour intensive, the land is used uneconomically and the yield does not even meet the consumption demand of the cultivating households (Mohanty, 1986; Bohidar, 1974; Mohapatra and Debi, 1973). Hence, it is important to understand the forces that compel the existence of the swiddeners. It is also essential to understand the genesis of the phenomena of shifting agriculture and its transformation as institutional, economic and ecological consequences. This paper is an attempt in that direction, in order to improve our conceptual scheme to understand shifting cultivation as part of the spectrum of land use in different farming systems through a critical review of the available literature.

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Problems in Defining Swidden

It is difficult to attempt a systematic approach to define shifting cultivation because of the various heterogeneous factors involved in this form of cultivation including topography, agro-climate and institutional factors. But, as generally observed, it is a form of agricultural practice, especially in the forested and hilly tracts where plough agriculture is difficult. It involves the clearing and cultivation of patches of forests in rotation. The individual plots are burnt and cultivated for a few years and left fallow for an extended period, to allow the vegetation and soil to rejuvenate and recover the lost nutrients. Cultivators then move on to the next plots, abandoning the earlier area, especially when the production starts declining, normally after one or two years (Gadgil and Guha, 1992). Conkline (1961) defines shifting cultivation as a continuing agricultural system in which an impermanent field is cropped for a shorter period in years than fallowed. Such definitions, if not wrong, are oversimplistic and do not necessarily distinguish between the fallow systems and shifting systems. A relatively simple and appropriate criterion is the relationship between crop cultivation and fallowing within the total length of one cycle of land utilisation. Shifting cultivation can be modelled as follows. Let t be the year in the cropping-and-fallow cycle. While $t=1$ is the year of initial clearing and first year of cropping, where t' is the final year of cropping; and t'' is the final year of fallow of the crop-fallow cycle. Based on the above several alternative definitions are possible. **Allan's** land use factor $\mathbf{L = t''/t'}$ (Dvorak, 1992); **Ruthenberg's** R value i.e. $\mathbf{R = (t'/t'') \times 100}$ (Ruthenberg, 1976); and **Boserup's** land use intensity i.e. t'/t'' (Dvorak, 1992) are most commonly known. Allan defines shifting cultivation as the practice when $L > 10$, Ruthenberg uses $R<33$ to distinguish shifting cultivation from semi-permanent farming. For semi-permanent farming he takes $33<R<66$. However, such definitions are also not free from ambiguity. Firstly, because these definitions do not consider factors like the cropping pattern, crop mixture, type of vegetation and canopy cover, rainfall, soil quality, method of production and migration systems, etc. Secondly, the difficulty arises in operationalising such definitions, particularly while deciding from what angle the land use system should be observed. For example, the 'L' or 'R' value will differ if the land use system is observed from a regional, cluster or household point of view. As the shifting cultivation system is spread all over the tropics, the practice varies from region to region, community to community, and climate to climate. The variations can be marked in the cropping pattern, crop mixture, selection of area, dependency on such form of cultivation, and also rotational cycle. Hence, drawing conclusions from the rotational cycle alone without a proper understanding of other aspects may lead to a bias against shifting cultivation.

Deforestation and Swidden

Another issue of concern is related to the determination of the level of deforestation due to swidden. There is neither a clear definition of deforestation nor a reliable estimate of its extent nor of swidden being the primary cause of deforestation. One source of definition provided by WRI (World Resource Institute) is: *The term deforestation describes a complete change in land use from forest to agriculture- including shifting cultivation and pasture or urban use. It does not include forest that has been logged and left to regrow, even if it is clear-cut (WRI, 1996 and Angelson, 1995).*

The definition entails a contradiction since forest opened by shifting cultivation often would be secondary forest, previously used for the same purpose and then left fallow. Thus, temporary clearing by logging is not classified as deforestation, whereas temporary clearing by shifting cultivation is included. Much confusion arises because a proper distinction is not made between permanent and temporary conversions, between conversions and alterations, or between deforestation and forest degradation. FAO distinguishes deforestation and forest degradation as follows: 'Deforestation... refers to the transfer of forest land to non-forest uses and includes all land where the forest cover has been stripped and the land converted to such uses as: permanent cultivation, shifting cultivation, human settlements, mining, building dams, etc.' Degradation, on the other hand, refers to 'reduction in the extent and quality of forest cover due to such factors as: indiscriminate logging, inappropriate road-making methods, forest fires, etc.'(Rao, 1989 cited in Fox et al, 1999). It is notable that FAO defines deforestation both as a change in land cover (i.e., loss of forest cover) and a change in land use (i.e., converted to other permanent uses). Studies show that traditional swiddening does not entail permanent conversion but only temporary use of forestland (Fox et al, 1999; Xu et al, 1999, Angelson, 1995). Hence, to include the cleared area that regenerates into secondary forests after shifting cultivation as deforestation will lead to an overestimation of deforested area. In fact, some estimates suggest that the swidden area is more or less stagnant even after 40 years and the share of shifting cultivation in deforestation is negligible (Fox et al, 1999; Xu et al, 1999). However, land cover change has been observed from a fairly homogeneous forest cover (closed and open canopy) to a highly heterogeneous and fragmented cover of secondary vegetation. If a substantial portion of forest is regenerating into forests, the rate of felling of primary forest is an over estimate of the overall net rate of change in forested area. Hence, there is every chance that such tainted observation (unclear definition and uncertain estimates) will widen the scope of biases against the practice of shifting cultivation.

Biodiversity and Swidden

In recent times, ecological evolutionary biologists and conservationists have focused increasingly on tropical rain forests. Although tropical rain forests cover only 7 per cent of the earth's land area, they harbour more than half the species of the world's biota. So, any damage of those forests would result in endangering, and in some cases, the extinction of a large number of species, many of which are not even catalogued or understood by tropical biologists (Ramakrishnan, 1992). But biodiversity consequences also vary depending on the type of change in land use. Estimates of biodiversity loss are often based on species-area curves with an elasticity of the number of species with respect to area. Such crude measures are not dependable for at least two reasons. First, overall figures of deforestation do not account for the categorisation of the forestland, thereby misleading the impact of biodiversity. Second, there are significant differences in defining biodiversity across different land use systems (Angelson, 1995). Field study by Xu et al (1993) cited in Xu et al (1999) in Mengsong, China shows that plots classified as grass, bamboo, bush and open canopy often have more number of species and higher diversity when compared to mature and closed canopy secondary forests. Similar studies in Kalimantan, Indonesia (Lawrence et al, 1998; Padoch and Peters, 1992 cited in Xu et al, 1999), have shown that while diversity of both plant and birds was lower in swidden areas than in the primary forests, some sites have 50–80 per cent of the diversity of comparable natural forests. These studies have concluded that while swiddening may cause a significant loss of biodiversity, the impact is less than that of the major alternative land uses (plantation forestry and commercial agriculture).

Another common belief is that swiddening reduces not only the diversity of species but also the number of valuable species. But swidden cultivators typically favour species they value most and preserve those during slashing, burning and selective weeding and later replanting the useful species when abandoning the land to fallow (Xu et al, 1999). Beside this, another outstanding feature in shifting cultivation is the variety of crops grown. In the Philippines, Harold Conklin listed some 77 types of crops cultivated among the Hanunoo shifting cultivators (Hong, 1990). Among the Lua' hill farmers in northwestern Thailand, 84 plant varieties are cultivated in the swidden field of which 70 are food species and at least 13 are grown for medicinal purpose. The Lua' recognise and use some 482 varieties of plants in the fallow swiddens for use as food, animal feed, medicine, construction, weaving and dying, decoration, fuel, poison, fencing, and insect repellent among others (Kunstadter, 1978 cited in Hong, 1990). Among the Kantu in Kalimantan in Indonesia, Michael Dove found that each year an average Kantu household grows about twenty one different plants in its swidden (Dove, 1985 cited in Hong, 1990).

The multiple cropping or mixed crop culture not only enriches the *in situ* biodiversity but is also found more scientifically-oriented in forest and mountain farming continuum. Ramakrishnan (1992), in a study in northeastern India observes that sequential harvesting of crops is an effective way of managing up to 35-40 crop species over both time and space. Thus, after harvesting the early maturing species such as maize, rice gets more space at the peak of its growth period. Successive harvests of cereals create additional space for the remaining perennial crops, which in turn receive humus and nutrients. The crops being planted at various times in the swidden cycle, they mature or ripen at different periods and thus provide the farmer with a steady supply of food. This also means that ground cover is protected and soil erosion is minimal. We will discuss this issue of soil erosion pertaining to swidden elaborately in the following section. Multiple cropping also discourages pests and diseases unlike monoculture or single crop cultivation and the diversity of crops grown also helps to keep down weed growth (Hong, 1990).

Soil Erosion and Swidden

Shifting cultivation is also commonly cited as a cause for soil erosion. But swidden being one of the primitive practices of the land use system, it is an established fact that the long-term success of the shifting cultivation system depended on the maintenance of soil fertility. If the nutrients lost or were displaced during the cultivation phase of the cycle, their balance is maintained by those replaced during fallow, and the system continues in practice indefinitely (Xu et al, 1999; Ramakrishnan, 1992; Hong, 1990). In fact, the first monsoon rains of the season certainly cause some erosion from the newly cleared swidden fields. Moist tropical forests, however, are impressively resilient and vegetation quickly covers the ground and reduces the erosion throughout the rest of the monsoon. Evidence from field survey suggests that topsoil loss under grass or bush cover was about 0.9 ton/ha in contrast to 1.78 ton/ha under a well-terraced tea garden (Xu et al, 1999). Some other researchers observed that swiddening is the most efficient system of cultivation in the forest and hill slopes compared with other modern agricultural systems (Hatch, 1980; Padoch, 1980; Nye and Greenland, 1960; cited in Hong, 1990). This may be because of the method of practice involved in swidden cultivation, where soil is not disturbed beyond a few centimetres in planting and weeding. Forest cover due to its root system is crucial for mass erosion. Soil erosion is minimal in mixed crop farming than monocrop farming (Ramkrishnan, 1992). It is because mixed crop farming often has trees strategically placed to check erosion (Nadkarni and Govindaru, 1995). As soil is impoverished in humid tropics, the main sources of nutrients are found in living vegetation. Swiddening makes use of these resources, as firing the vegetation decomposes and releases the nutrients into the soil through ash formation. With ash deposition, the availability of nutrients would increase. Increased soil pH would also decrease the microelement toxicity like aluminum and manganese (Ramakrishnan, 1992; Hong, 1990). Swiddening involves optimisation of production by capitalising upon the limited soil fertility in a highly transient ecosystem. Crop placement on a given slope, with more nutrient-use efficient species being placed at the top of the slope under the shifting system, represents a finer level of appreciation of plant soil interaction by the farmer (Ramakrishnan, 1992). Legume intercropping, minimum tillage agriculture and agroforestry systems are all essential ingredients of the swidden system. Building up on these concepts not only would help to conserve soil fertility at a relatively low economic cost, but would also conserve and strengthen natural bio-chemical processes in the soil (Ramakrishnan, 1992).

Issues Pertaining to Economics of Swidden

Economics of shifting cultivation is an interesting as well as an analytically complex issue to handle. It needs to be considered from various points of view. It includes economics of land use, production methods, and productivity both in energy and monetary terms. The arguments advanced against the economics of shifting cultivation always state that it is a sub-optimal method of cultivation, output is low, and labour intensity is very high. We have already discussed that shifting cultivation is ecologically a suitable method in fragile humid tropics. This implies that swidden is a sustainable method in comparison with alternative land uses. It plays a positive role in the conservation of biodiversity, erosion control, recycling of soil nutrients, regeneration of forests and preservation of useful species. If all these roles of swidden are included in the long-term sustainable use of land resource, it will indicate a positive impact on the economy as compared with alternative methods of cultivation.

a. Economics of factors of production use in swidden

Since shifting cultivation involves a rotation of fields, forest regeneration is an integral part of the system. This recycling of land use is a form of conservation practice, which prevents land wastage. Many researchers have observed that swiddening can be a stable system with minimal cutting of new forests. A study in the Philippines reveals that out of a total of 48 new swiddens cleared, only four were cut partly from the primary forest. This amounted to less than 10 per cent of the total area cleared (Hong, 1990). Similarly in Sarwak, Malaysia, Leach found that in most normal circumstances, the total amount of virgin forest cleared in any one year is almost infinitesimally small (Leach, 1950 cited in Hong, 1990). Xu. et al, in their study in Yũnan, China during 1965-93 found that the extent of the active swidden fields through the period remained stable at 2 per cent of the total area (Xu. et al. 1999). Fox et al in their study in northwestern Vietnam also found a similar result, where the swidden land cover has increased about 10 per cent of the total land cover during the period 1952 to 1995. They also observed that this complex indigenous land use system thus maximises the stability of food production and the percentage of the landscape dominated by secondary vegetation. Their research suggests that perhaps too much emphasis has been placed on changes on land cover, and insufficient attention is paid to the stability of swidden agriculture as the main land use system in that region (Fox et al, 1999). Cutting of primary forest where the tree growth is substantial needs a very high labour force, and the output is not convincingly higher than from that of a well-grown secondary forest. Hence, except in the worst condition, people normally do not prefer to cut primary forest for the purpose of shifting cultivation.

It is also argued that shifting cultivation has been a more labour-intensive method of production, which is considered to be a sign of underdevelopment. But, this is a method of cultivation where hardly any capital is used other than on some implements like hoe and axe. So, the intensity does not make any sense. In fact, in shifting cultivation, seeds are the only input besides manual labour. Generally it appears that a plough system minimises the labour input due to the technology involved as compared with the traditional slashing and burning method. But one important point to be noted here is that the ploughing system involves the labour of oxen, and equal labour is needed to attend to these animals. These animals also require enough grazing land or more intensity in the cropping where fodder has to be grown. So, it is not effective in land utilisation. More so, due to intensive cultivation, the quality of soil deteriorates, thereby requiring additional fertiliser input on the land for retaining productivity. On the other hand, in the swidden system, labour use is minimum and well spread over the season. Swiddening involves burning which is a very effective method of weed control. So, the labour use for weeding is negligible for swidden, which is proportionately very high in other forms of cultivation. The swidden system not only makes sustainable use of land, but productivity in swiddening is also very high compared with the alternative systems.

b. Economics of production in swidden

Although researchers have arrived at different estimates to determine self-sufficiency among swidden cultivators, the general conclusion is that they are able to feed themselves adequately. The swidden household (depending on its size) would require between 1203 kgs of food grains (Freeman's estimates for an average family size of 5.7 members) and 1935 kgs of food grains (Chin's estimate for an average household of 9 members) to meet its yearly consumption. Dove, in one of his case studies, found that the average yield per household is about 4270 kgs (Dove, 1989 cited in Hong, 1990). Chin, in another study, found that the average yield per household per year is 2300 kgs (Chin, 1984 cited in Hong, 1990) which is far above the consumption needs. Ramakrishnan (1992) has also studied the average yield of grains and seeds, leaves and fruits, and tuber and rhizomes under different shifting cycle in the northwestern part of India. The results shown in table-1 also reveal that the yield is higher than the needs of an average household size, even produced in a short cycle of 5 years. But the average yield alone does not reveal the economic efficiency of the shifting system, unless the output-input ratio is very high (both in energy as well as monetary terms) as compared with alternative systems of agriculture.

c. Energy use efficiency in swidden

Shifting agriculture systems have been upheld as models of productive efficiencies where 5 to 50 units of food energy is obtained for each unit of energy expended (Rapport, 1971; Steinhart and Steinhart, 1974 cited in Ramakrishnan, 1992). In fact, the alternative agricultural systems may be efficient in terms of human labour and time, but are highly inefficient from an overall energy equation point of view. Other systems require higher energy input for the production of a single unit of food energy. Ramakrishnan, in a comparative study in northeastern India, concluded that shifting cultivation has survived all these years chiefly because of the high energy efficiency of the system associated with longer cycles, where the only energy input is in the form of manual labour provided by the farmer, a major fraction of which goes for the slash-and-burn operation (Ramakrishnan, 1992; also see table-2). Table-3 gives the energy output-input ratio of shifting cultivation of different cycles in northeastern India vis-à-vis terrace and valley cultivation. The results suggest that the output-input ratio of swidden of any cycle is much higher than terrace and valley cultivation systems. Similar results are also observed in table-5, when a 10-year cycle swiddening is compared with various other plantations and cash crops.

d. Output efficiency in swidden

The output-input ratio in swidden is also more favourable when compared with terrace and valley cultivations (Banerjee, 1995). A study by Ramakrishnan in Meghalaya, India, which is shown in table-4, reveals the story. A similar study by Dove (1984) in Kalimanthan, Indonesia, also shows the efficiency of swidden in terms of net return. A comparison of swidden with modern logging Dove (cited in Banerjee, 1995) concludes that not only are net returns higher than commercial logging, but shifting cultivation also supports more than three times as many people. For a developing economy, larger subsistence support would be a more important criterion for choice of land use.

Institutional Aspects of Swidden

Swidden cultivation being an age-old practice in the forested and hilly tracts of the tropic, and being primarily practised by indigenous groups, it has developed under institutional set-ups different from the mainstream society. There are few different aspects, which underscore the institutional face of swidden. Swidden was guided by the community rules and norms till it was intervened by other forms of cultivation, market forces, or state or any other institution. When these forces entered into the lifestyle of the swiddeners, the norms were diluted and their effects can be seen in the practice of swidden. The property right structure as a community holding also has undergone changes. Similarly, the forms of relation within the community also have undergone changes from reciprocity and redistributive forms to market forms of exchange. State intervention into the forest also affected the swiddeners in various ways. The state policies of the colonial government towards the shifting cultivators also underwent changes. All these institutional facets of swidden are discussed in this section.

a. Property right structures and customary institutions

Swidden is a use of forestland, where, property rights are ill-defined; mostly because, it is in the encroached forest area where the state claims the ownership right. But the prevalence of swidden suggests that these cultivators have established their users' right over the land. Though in practice the land is used by individual households, the community decision plays an important role in choosing the part of the forest that has to be cleared and cultivated, and also in assigning different plots to different households of the community. Singh (1996) observes the role of the village council of Mizoram for allotment of plots through the lot system. She also observes that importance of collectivity is embodied in the mandate of the village council to regulate shifting cultivation. The village council restricts the individual decision-making, which may lead to degradation of land as well as forest. Xu et al (1999) recognise the importance of customary institutions for the sustainable management of land resources. In a study in Yunan, China, they observe that these customary institutions structured the attitude of the villagers, the social relationships, and even technology in such a way as to ensure secondary generation of the fallow fields, to protect forests from over exploitation, and to secure in cultivating swidden fields through labour exchange.

The traditional swiddening and the customary institutions associated with it are undergoing drastic changes due to the intervention of market forces on the one hand and development projects on the other. In many parts of India, particularly in the Western ghats where shifting cultivation was prevalent, is now being replaced by plantation crops like arecanut, coffee, tea, rubber etc. These transformations have changed many swiddeners into meagre agricultural labourers in these fields. In some other areas (specifically Orissa and central India) various development projects like dam construction, mining, industry etc., displaced these swiddeners from their original habitat and made their life even worse (Pathy, 1992).

b. State policy and its impact on swiddeners

Most of the tropical countries where shifting cultivation is practised were also under colonial rule at a particular period of their history. The state policy evolved very systematically by the colonial governments in a similar fashion. In fact, most of the colonial governments in Africa and south Asia have considered swidden as unplanned, aimless, nomadic, unproductive, and uneconomical in the utilisation of land and labour and destructive of environment (Whittlesey, 1937). One of the important driving forces to stop swidden may be to ensure timely and efficient tax revenue collection. Swidden was generally practised by scattered, extended family groups, with members living in temporary shelters near their fields as harvest approached. In the eyes of the colonial officers, swidden encouraged tax evasion; or at least, it made collection more difficult and time consuming[1]. So, one of the state policies evolved was to settle the swiddeners near major transportation routes. The other driving force was to ensure and procure the necessary labour force for logging, for the timber needs for ship-making and building railway tracks. The intention was clear - i.e. to enhance trading of the valuable commodities to the colonising countries.

The attitude of the colonial government in India towards shifting cultivation is clear from the Royal Commissions Report, 1928. It is stated that all shifting cultivation should be brought under control with a view to the practice being entirely stopped, whenever it is productive of harmful results (Madan and Smith, 1928). Hong (1992) observed that the despoliation of their physical environment and the negative attitude towards these shifting cultivators have threatened their very existence. In many regions of Southeast Asia, shifting cultivators have been displaced in their natural environments deprived of their livelihood and they suffer extreme deprivation and cultural alienation. European administration reinforced and extended the systems of

1 Similar observations are also stated by Jarsoz (1993) about Tavy in Madagascar; Rangarajan (1996) about *Bewar* in central India; Pouchepadass (1995) about *Kumri* in south Kanara district of South India; and Saldhana (1990) about *Rab* and *Dalhi* in Tahna district of Maharashtra, India.

private ownership of land and state control of the public domain. The incompatibilities between the loosely administered pre-European land systems and shifting cultivators land systems were greatly increased and made more emphatic. The results have often been the restriction of territorial ranges of shifting cultivators' societies to the point where maladjustment becomes severe and shifting cultivation began to exhibit all the faults that are commonly ascribed to it as a system (Spencer, 1966).

Conclusion

We tried to see various concepts and issues involved in swidden. These include various ecological, economic and institutional aspects. Though swidden is suggestive towards the sustainable use of land as compared with the alternative land use, the results are not very conclusive. An important issue posed here is that the consequences of failure to anticipate the ecological and social facets of land use changes may lead to short-term economic gains. However, sustainability of such changes in the long-run is questionable. Failure to recognise secondary regeneration of forest in the swidden fallow has led to overestimation of the extent of deforestation partly because swidden is not a homogeneous practice and partly because of the inaccuracy involved in various estimations. Failures to account for the effects of landscape heterogeneity may also mean the significant effect of land cover change is not recognised. In such an instance, a more efficient and humane policy would be to invest in research on methods of maintaining the ecosystem associated with swidden, while increasing their productivity and soil sustaining properties. It is also important to generate base line data for comparing how local resource management systems are changing in the wake of widespread regional landscape transformation.

Table-1: Mean Yield under Different Shifting Cycles of Different Tribal Communities at Meghalaya

Shifting cycle	Crop category: Grains and seeds	Leaves and fruits	Tubers and rhizomes	Grand total
20-years				
Garos	2,188(± 174)	370(± 27)	872(± 68)	3,430(±238)
Khasis	1,920(± 168)	290(± 22)	452(± 40)	2,662(±189)
Mikiris	1,244(± 104)	74(± 6)	468(± 37)	1,786(±154)
10-years				
Garos	1,625(± 131)	349(± 31)	988(± 81)	2,962(±211)
Khasis	1,007(± 96)	401(± 29)	859(± 56)	2,267(±169)
Mikiris	807(± 67)	141(± 11)	411(± 33)	1,359(±133)
5-years				
Garos	953± (71)	374(± 22)	1,307(±97)	2,634(±178)
Khasis	642± (43)	495(± 37)	453(± 32)	1,590(±128)
Mikiris	583± (32)	403(± 34)	-	986(±76)

Notes : i) Yields are mean yields in kgs per hectare

ii) Figures in brackets are standard errors of mean

Source: Ramakrishnan (1992)

Table-2: Energy Inputs under Different Shifting Cycles of the Garos in Meghalaya

Agricultural operation	30-yr cycle	10-yr cycle	5-yr cycle
Labour input (total)	1,641	1,176	494
Clearing understorey vegetation	274	331	78
Felling trees and bamboos	583	319	-
Collection of debris and burning	51	35	5
Terrace preparation	-	-	-
Dibbling broadcasting and transplanting	40	43	43
Hut construction	23	24	24
Weeding	63	76	87
Guarding the field from animals	71	70	64
Rearing caterpillars	123	-	-
Harvest	187	198	173
Transportation	21	13	8
Threshing	77	25	5
Shelling	128	42	7
Seed input	24	15	16
Fertilisers	-	-	-
Total energy input into the System	1,665	1,191	510

Notes: The figures refer to energy input in MJ/ha/year

Source: Ramakrishnan (1992)

Table-3: Comparison of Energy Input/Output Ratio in Swidden, Terrace and Valley Cultivation Systems

System	input	output	output/ input ratio
Swidden of 30-yr cycle	1,665	56,766	34.1
Swidden of 10-yr cycle	1,181	56,601	47.9
Swidden of 5-yr cycle	510	23,858	46.7
Terrace	6,509 (8,003)	43,602	6.7 (5.4)
Valley (I and II crops)	2,834	50,596	17.8

Notes: i) Figures for inputs and outputs are in MJ/ hectare/ year

ii) Values in the parentheses indicateivalues for the first year of terrace cultivation.

iii) The value of both crop I and II of the same year is taken together

Source: Banerjee (1995).

Table-4: Input-Output Ratio in Swidden, Terrace and Valley Cultivation

	Swidden			Terrace	Valley		
Indicators	30-yrs cycles	10-yrs cycles	5-yrs cycles		Crop I	Crop II	Crop I & II
Input	2,616	1,830	896	2,542 (4,544)	2,602	2,241	4,843
Output	5,586	3,354	1,690	3,658	2,820	2,745	5,565
Net gain/loss	2,970	1,524	794	1,116 (-886)	218	504	722
Output/input	2.13	1.83	1.88	1.43	1.08	1.22	1.14

Notes: i) Figures for input and output are in Rupees.

ii) Values in parentheses indicate the values for the first year of terrace cultivation.

Source: Banerjee (1995)

Table-5: Plantation/Cash Crop System Compared with Swidden under 10-Year Cycle at Nayabunglow, Meghalaya.

	Coffee	Tea	Pineapple Mixed cropping	Ginger	Jhum 10-yr cycle
Input	8,855 (2,754)	19,425 (14,314)	973 (3,096)	1,3854 (18,854)	1,302 (1,830)
Output	8,450 (4,560)	18,1310 (37,125)	17,085 (12,090)*	33,392 (42,435)	56,655 (3,354)
Output/ input ratio	0.95 (1.66)	9.33 (2.59)	17.56 (3.90)	2.41 (2.25)	43.51 (1.83)

Notes: i) figures are in MJ/ha/yr
ii) figures in the parentheses are in terms of Rupees
* 9,095 Rupees for pineapple and 2,997 Rupees for rhizomes and tuber crops

Source: Ramakrishnan (1992)

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