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# Apatani paddy-cum-fish cultivation: An indigenous hill farming system of North East India

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The tribal communities of North East India have paddy-cum-fish farming along with shifting cultivation (*Jhum*). Paddy-cum-fish cultivation is practiced mainly by Apatanis, a progressive agricultural community of Arunachal Pradesh. The Apatani version of paddy cultivation is one of the most advanced cultivation practices. The main advantage from the practice is that, the land gives sustained yield year after year, unlike the *Jhum* system, that is under cropping only once in a few years of fallow interval, depending upon the *Jhum* cycle. The economic and energy efficiency of this agro-ecosystem is exceptionally high and rice is exported after meeting local needs. Rain fed cultivation of millet and mixed cropping contributes toward meeting the diverse needs of the people. Mithun, Swine and poultry husbandry are an important link with agro-ecosystems. Therefore, an understanding of this agro-ecosystem function becomes significant and it offers opportunities for redevelopment with additional scientific inputs.

**Keywords:** Agro-ecosystem**,** Arunachal Pradesh**,** Indigenous knowledge, Land management, Wet-rice cultivation, Jhum cultivation

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The tribal communities of North East region largely depend upon diverse agricultural practices ranging from a variety of shifting agriculture systems, fallow systems, home gardens and sedentary system such as wet-rice cultivation[1,2]. Ingenious indigenous farming systems developed by these tribal societies with long history and traditions are often energy efficient, and at the same time provide high economic returns to the farmers. The Apatanis of North East India, who practice only sedentary agriculture in the form of paddy-cum-fish cultivation in the valley lands, have elegantly linked this sedentary agricultural system with animal husbandry comprised of mithun (*Bos frontalis* Lam.), cattle, swine, and poultry. There is no reference of slash and burn (*Jhum*) cultivation in Apatani mythology. The practice of the terrace-wet-rice cultivation began with *Abotani,* the earliest ancestor of the Apatanis. The agriculture of the Apatanis is thus not only of interest, as the basis of an economy different from that of all surrounding population, but it provides an example of highly evolved indigenous farming systems. Therefore, an understanding of this hill agro-ecosystem function of the Apatanis becomes significant.

The North eastern region of India lies between 21°57′ and 29°28′N and 89°40′ and 97°25′E, comprising seven states namely, Arunachal Pradesh, Assam, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Recently Sikkim has also been included in this region. The North East region is home to about 39 million people from over 100 tribal groups. The State of Arunachal Pradesh is a mosaic of composite culture and tradition, having an area of about 83743 $km^2$ with a population of 10,91,117. Apatani valley in Lower Subansiri district of Arunachal Pradesh lies between Panior and Kamla rivers at an altitude of 1524 m. The tranquil valley originally consisted of seven large villages, viz. Hong, Biila, Dutta, Hija, Hari, Mudang-Tage and Michi-Bamin with 25000 persons (Fig. 1). Opposite village are the paddy fields, terrace after terrace following each other in uninterrupted succession (Fig. 2). The Apatani, a progressive agricultural community of Arunachal Pradesh has their own indigenous knowledge on land management. In Apatani valley, about 48.38% land is under paddy-cum-fish cultivation, followed by 32.64% clan forest, 16.41% bamboo forest and 2.75% home garden.

The Apatanis with a highly developed valley cultivation of paddy perfected over centuries has often been suggested to be one of the relatively advanced tribal societies in the North eastern region of India[3].

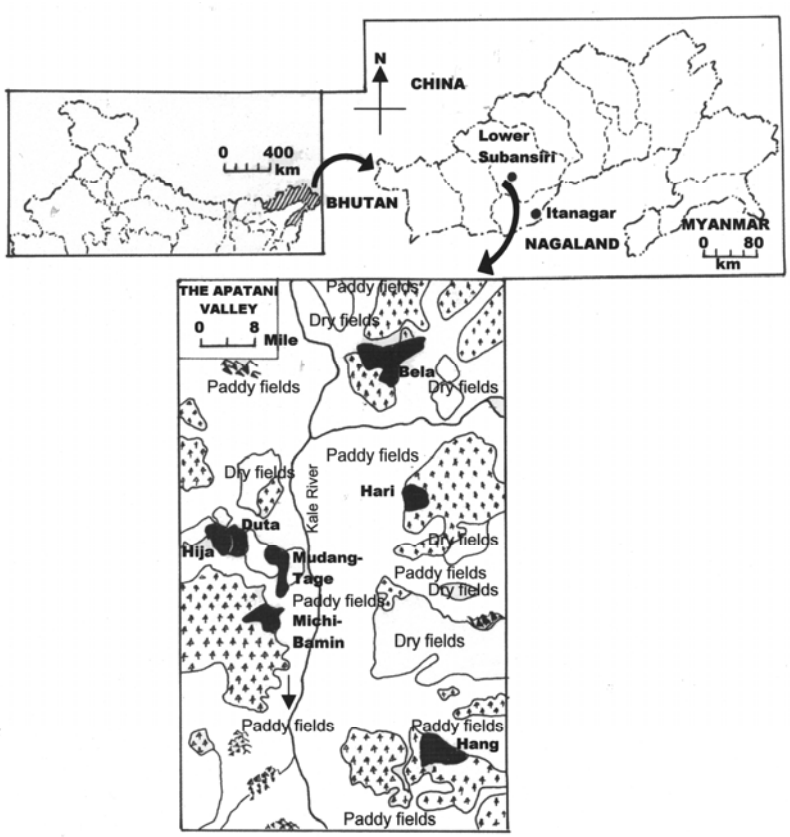


Fig. 1. Map showing location of Apatani valley in Arunachal Pradesh, North-East India.

Apatanis have evolved sedentary agriculture, chiefly in the form of wet rice cultivation in their extensive valley lands, using indigenous techniques. Their system of *Aji* cultivation, using a combination of paddy and fish together with millet on the bunds separating each plot, is thought to be one of the most productive and efficient agricultural systems of the region[4]. In this system, a small pit is dug in each terrace in a series of terraces where paddy is grown. Fingerlings are put in water in these pits. When water supply is sufficient in monsoon season, the whole paddy field is kept under shallow submergence of 5 to 10 cm and fishes come out of the pits and move around the whole submerged area of the terrace field. During water scarcity period, when water remains only in the pits, fishes run back to the pits and grow. In this system, fishes get better nutrition due to manuring of paddy fields and their growth is better due to availability larger surface area during full submergence of paddy fields. Thus, both paddy and fishes are produced together by proper management of rainwater.

The terrace paddy field is classified as *Jebi, Aane, Ditor* in accordance with availability of natural and artificial water supply. *Ditor* is fully dependent upon the irrigated water supply and the first two types of fields may have sufficient water supply from natural and rain water. The paddy-cum-fish agro-ecosystems of the Apatanis, like those of other tribes, is also dependent upon nutrient wash-out from the hill slopes. The house and granary sites are located on the higher level from the cultivated fields so that decayed and decomposed substances can easily be drained out to field. It is a good system from the hygienic point of views on one side and on the other side, the decomposed substances serve as good manure, which it helps yield of bumper crops of paddy. Recycling crop residues and use of organic wastes of the village for sustaining soil fertility, as also done by the Apatanis is an effective way of restoring soil fertility. Nearby the house and granary sites, the big plots are carefully tended by means of bamboo and pine groves and these bamboo and pinewood protect the soil erosion and landslide (Fig. 3). Nutrient wash-out from the hill slopes during the rains helps to sustain soil fertility, considerable quantities of nutrient are lost during harvesting[5,6]. The Apatanis, by both recycling crop residues and using the organic wastes of the village effectively sustain soil fertility[7]. The Apatanis,

Fig. 2. A view on Apatani paddy-cum-fish cultivation fields.

Fig. 3. Woon lining of primary irrigation channel in Appatani valley.

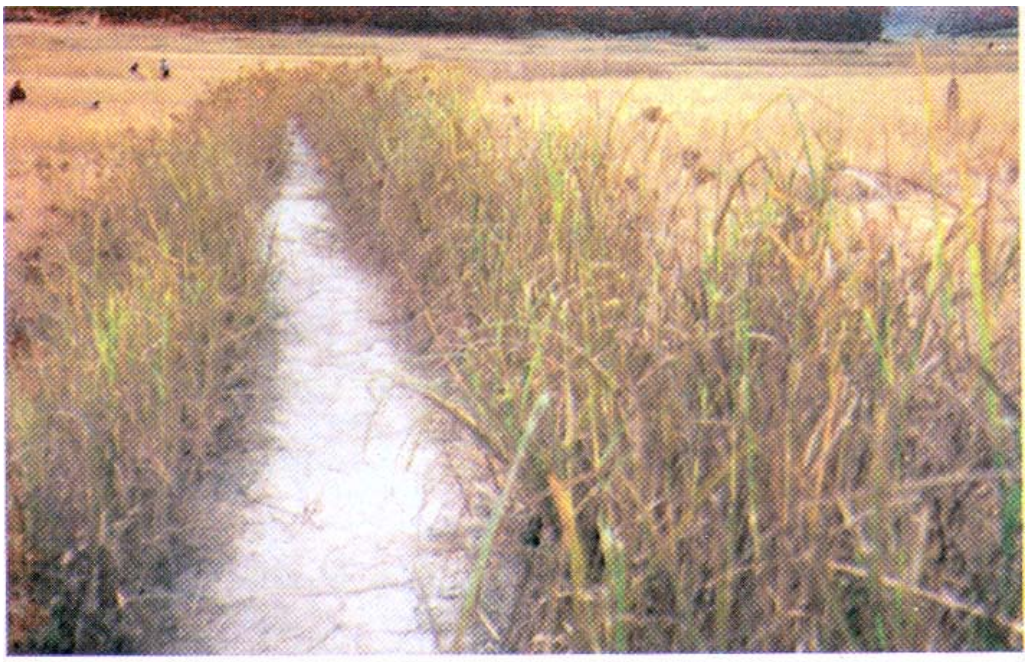

Fig. 4. Millet (Eleusine coracana) cultivation on elevated partition bunds between the paddy plots.

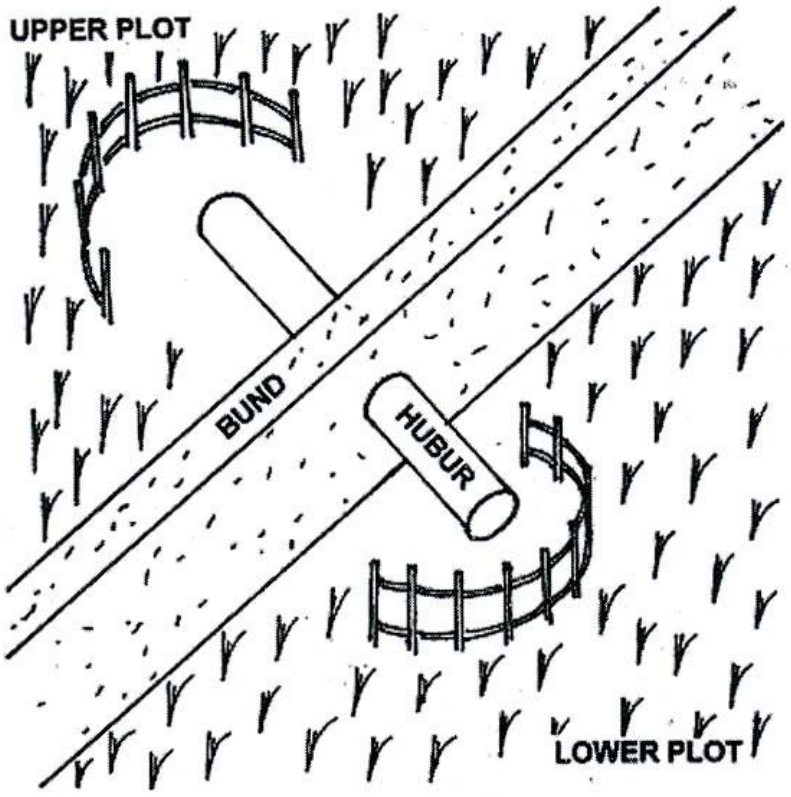


Fig. 5. Water management in Apatani valley of Arunachal Pradesh for paddy-cum-fish culture

however, recognize the need for preserving the fertility of the soil, and expand a great amount of energy on manuring. Throughout the winter and spring months, from the end of the harvest until the time for transplanting, women and men are to be seen daily carrying baskets of rice chaff, pig and chicken droppings, ashes and kitchen refuse to heap on their fields. If the yield of a field has not been upto standard, an Apatanis will carry out improvements before the next sowing season: divide a large field perhaps not perfectly watered into two terraces or conversely turn two terraces into one, gaining thereby the space of the dividing dam. For all such earth works as well as the repairing of embankments and the leveling of fields the Apatani shifts the soil from one area to another on large flat wooden trays, that are easily dragged over the slimy surface of the partially flooded ground.

The weeding of the paddy fields is done with great thoroughness, permanently flooded terraces are weeded two or three times and terraces less amply watered as much as five times. Millet is weeded twice, and women too do this with their bamboo hoes. Usually, millet is separately cultivated on the dry land called *Yapyo* and on the bunds of field (Fig. 4).

**Economic value**

With highly developed paddy-cum-fish cultivation, the Apatani economy is largely based upon agriculture alone. The arable land of the valley is enough and full of natural abundant soil, which result in yielding of crops every year. The agricultural operation is fully dependent upon the human labourers, not animal traction (ploughing). The paddy fields closer to the settlements were nutritionally richer than those farther away. The Apatani communities make effective use of their irrigated land by planting early and late ripening varieties of paddy. Early variety is sown farther away from the village where disturbance by animals and poor irrigation facilities could be major constraints. Closer to the village where conditions are more favourable, late variety is preferred. Fish culture done here synchronizes well with late ripening paddy variety. Further, paddy is supplemented with *Eleusine coracana* Gaertn. cultivated on elevated partition bunds between the rice plots. The early varieties of paddy had higher density but reduced basal area compared to the late varieties. Economic yield per plant and per unit area of the early varieties was significantly lower than the late varieties. The yield per hectare of *Eleusine coracana* grown on the partition bunds of paddy plots was high in plots with early varieties than in those with late varieties.

Based on farming systems performance, Apatani paddy-cum-fish agro-ecosystem is highly productive (400-500 kg $ha^{-1}$), 3 to 4 time of the average yield of the paddy in the state, economically viable, cost of cultivation being low with minimal external inputs making it a highly organic agriculture. The economic and energy efficiencies and the input/output ratio for individual crops are given in Table 1. With high labour, the input total for paddy + millet was higher. Inputs include only labour, organic manure and seeds; draft animal power is not used. However, the output from the system and the net return to the farmer was higher under paddy + millet + fish combination than paddy alone or with paddy + millet. The input/output ratios are also high in paddy + millet + fish than other two systems.

Widening plots by digging adjacent higher ground down to an irrigable level seems to be successful responses to population increase and new market opportunities. The net per capita monetary return through agriculture is high. As much as 40% of the rice produced is sold to the neighboring tribes such as Nyshi and the hill Miris. However, the agro-ecosystem of the Apatanis could be improved through appropriate crop rotation and productive utilization of

Table 1—Energy (MJ $ha^{-1}$ $yr^{-1}$) and monetary (Rs $ha^{-1}$ $yr^{-1}$) input/output pattern of paddy-cum-fish agro-ecosystem of Apatanis in northeast India[1]

| Production measures | Agro-ecosystems | |
|---|---|---|
| | Energy | Monetary |
| **Input total** | | |
| Paddy | 875.5 | 2579 |
| Paddy+millet | 908.10 | 2675 |
| Paddy+millet+fish | 906.6 | 2753 |
| **Labour** | | |
| Paddy | 741 | 2250 |
| Millet | 31.5 | 91.5 |
| Fish | 36 | 102 |
| Organic manure | 125 | 250 |
| **Seed** | | |
| Paddy | 9.5 | 79 |
| Millet | 1.1 | 4 |
| Fish | 0.4 | 100 |
| **Output total** | | |
| Paddy | 61325.5 | 8272 |
| Paddy+millet | 63218 | 8460 |
| Paddy+millet+fish | 68182 | 10062 |
| **Input: Output** | | |
| Paddy | 70.05 | 3.20 |
| Paddy + Millet | 69.62 | 3.16 |
| Paddy + Millet + Fish | 75.21 | 3.65 |

the land during the winter season. Inspite of these possibilities, the Apatani village ecosystem is a good example of economic self-sufficiency of a traditional agricultural society that practices ecologically sound sedentary agriculture in the north-east region of India.

**Ecological sustainability**

Apart from its high income value, this system provides an example of a high degree of ecological efficiency too. Land management practices revealed that terraces in the main valley are quite broad, perfectly leveled and provided with strong bunds. These bunds are made up of soil and supported by bamboo or a wooden chip at base, if the height of riser is more, there is a chance of erosion due to runoff. The size of bunds varies from 0.6 to 1.4 m in breadth and 0.2 to 0.6 m in height depending on the gradient of land and the size and shape of terraces. Perfect leveling of plots and well managed irrigation cum drainage channels, reduce the soil erosion to a negligible level. Plot size varies from 235 $m^2$ to 2740 $m^2$ and the size reduces towards the hills.

The Apatani tribal people have also developed an efficient system of water management for paddy and fish culture that has remained sustainable for centuries. The system involves people's participation for common works and the available water of natural streams is used judiciously in a planned manner for crop production. All streams coming out of surrounding hills are taped at the beginning of the valley, channelised and diverted through a network of primary, secondary and tertiary channels to paddy fields. At a short distance above the terraces, some water is allowed to flow in the first feeder channel through a diversion, while the stream continues on its course. The feeder channel branches of at angles to lead water to any terraced paddy field which can be flooded or drained as per need by blocking or opening of connecting ducts known as *Huburs* (Fig. 5). The cross section of the main and sub-channels vary in depth and width as per load of water. These channels are pitched with locally available stones and boulders especially at the entry point for checking erosion due to flow of water. By adjusting the height of the outlet pipes, the water level in the rice field is maintained. A 10 cm water table is maintained in the plot by adjusting the height of outlet bamboo pipes. The excess water from the fields is drained into the Kale river, which flows through the middle of the valley. The channel for irrigation also carries a lot of natural fertilizers of rotten leaves from the wooded land to the fields. The Apatnais with cooperative effort under the overall supervision of the village headman have optimized water use along with nutrient use in their paddy field.

**The Future Development**

The Apatani village ecosystem is a good example of economic self-sufficiency in a traditional agricultural society that practices sound sedentary agriculture. However, traditional agricultural systems need to be redeveloped through incremental rather than quantum change, based on traditional ecological knowledge; anything drastic may not find acceptance by the local communities. A few possibilities exist for redeveloping this system so that the farmer is able to obtain better returns: (i) mere transfer of technology from one tribe to another could be helpful. The Apatani system of farming is one of the most evolved and highly organized systems of paddy-cum-fish cultivation; (ii) introduction of early maturing and improved varieties of paddy would help in obtaining two or three harvests in a year; (iii) water is a major constraint outside the monsoon period. Rainwater harvesting and storage in tanks offers immense possibilities for irrigation; (iv) integration of modern scientific knowledge and proven eco-friendly techniques of conservation and utilization of natural resources using area specific tools, implements and agricultural practices as well as scientific management of cattle and fish. These indigenous systems can be made more economically viable.

Other important options would be introduction of agroforestry practices in the systems; agroforestry acts as a buffer and provides resilience to the system at the landscape level. Introduction of large cardamom cultivation in the area would be boon for the Apatanis because it is a perennial cash crop grown beneath the forest cover on marginal lands and well-adapted agroforestry system. Its cultivation is an example of how a mountain niche can be exploited sustainable. Ecological sustainability is even greater with cardamom when the Himalayan alder (*Alnus nepalensis* D. Don) is used as a shade tree. Ability of the alder tree in enhancing soil fertility has been fully exploited by the farmers of other northeastern states. Studies have shown that on an average about 100 to 125 kg N /$ha^{-1}$ is added to the soil by a well-developed alder tree, which is a non-leguminous tree that fixes large quantities of atmospheric nitrogen through nodules on the roots.

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