Water: an eco-friendly and energy-efficient resource for milling in rural Arunachal Pradesh

Water is an essential natural resource for human and living organisms. We use water for various purposes like drinking, cleaning, agriculture practices, transportation, etc. It is the prime resource for the hydel power station, providing electricity for domestic, industrial and commercial purposes. Among the northeastern states, Arunachal Pradesh is endowed with vast natural resources because of its geographical location and climatic variation. The state has 26 major tribes and over 110 sub-tribes[1] whose lifestyle totally depends on natural resources[2–4]. This reliance has created an indivisible bond between the ethnic communities and the natural environment. Consequently, their cultural, spiritual and religious beliefs often influence the natural resources of the area where they live. The Monpas, one of the major tribes, inhabit the West Kameng and Tawang district of western Arunachal Pradesh. The region is well known for its glittering landscape. However, life in the remote villages of the hilly terrain is so harsh that most people depend on agriculture for their subsistence. Because of the terrain, inaccessibility and poor roads, the villagers totally depend on forest and other natural resources. Even today, many of the villages have no electricity and are deprived of modern facilities. These villagers use a water-powered mill called the 'chakki' for grinding agricultural crops like rice, maize, finger millet and papur, and making flour for daily use.

The chakki is built and maintained using locally available natural resources like wood and stone. Generally, the mill house (chuskur) is constructed near a water source using wood, stone and bamboo. Water is the prime resource which is led from the stream via an earthen channel, extending towards the mill house through a wooden chute (chorong) made up of a hollow tree trunk. A wooden vertical shaft (manginu) runs through the floor of the mill house and turns the top pair of grinding stones. The grinding stones are set on the floor of the mill house and have two parts: upper (bunnang) and lower (manggi), attached directly to the shaft. Water flows quickly down the chute (Figure 1 *a*) and hits the shaft having wooden blades (brow; Figure 1 *b*) attached at the tip, which start rotating automatically both the grinding stones and the shaft. A filter shield is used to prevent surface debris as well as regulate the water flow. Furthermore, a wooden barrier is used to block the water flow when the mill is not in operation. The upper grinding stone has a hole carved in its centre all the way through it. Grain is fed slowly into the hole though a tin funnel (ran; Figure 1 *c*) hanging above, and is ground between the pair of stones; the flour is collected from the sides. To keep the flour from spilling out on the floor, a wooden frame (jangpa) surrounds the grinding stones. According to the requirement, a wooden frame (sar) is used to make the flour coarse and fine.

This traditional water mill is an excellent alternative source of energy, where neither electricity nor diesel/machinery is required. It is also an eco-friendly, pollution-free, energy-efficient and low-cost indigenous practice. It entirely depends on naturally available water. Therefore, further studies are needed to make this indigenous technique more efficient for the benefit of the rural people. It also has a potential to generate income among the local people. Hence, remote villagers should be encouraged and provided with financial support for better management of this indigenous practice. The Government and non-governmental organizations should come forward to promote such practices for the benefit of the tribal people.

Figure 1. Traditional water milling. ***a***, Water flowing through the chute (chorong); ***b***, Rotating vertical shaft (manginu), and ***c***, Grinding to make flour.

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