

# The Bontoc rice terraces: high and stable yields

**H**ow can the ancient Bontoc terraces continue to produce high and stable rice yields after so many centuries? Hilario Padilla tries to explain this classic example of ecological farming and to assess whether the indigenous LEISA techniques used in this mountainous area could find wider application.

## Hilario Padilla

The famous rice terraces of Northern Luzon are one of the wonders of the world. Many are astonished to see how the steep rocky mountains have been transformed into ricefields, like stairways to the sky, using only simple tools. The centuries-old terraces are believed to have been carved by "Indonesians" who came from Southern China sailing to Luzon in dugout boats. These migrants arrived with copper and bronze tools and the knowledge of building rice terraces (Scott 1975).

It is a wonder, too, that one of these terrace systems – Bontoc, at an altitude of over 1500 m – has maintained high yields through time under very difficult conditions. Omengan (1981) reported that the Bontoc rice paddies yield 6.2 t/ha without the use of modern cultivars, chemical fertilisers and pesticides. My sampling gave an average rice yield of 6.1 t/ha. Both measurements excluded the terrace borders, which produce more tillers, more filled grains and, hence, higher yields. In comparison, IRRI's long-term experiments with NPK fertiliser applications of 140-30-30 in the dry season yielded 7.3 t/ha (Chang 1975). The Philippine national average yield is about 2.5 t/ha. There is obviously much to be learned from the Bontoc farmers.

Unfortunately, their rice-growing system is now beginning to disappear without having been thoroughly investigated and documented. How do the Bontoc maintain their high yields without the use of "modern" techniques? Does it have anything to do with their cultural traditions? What makes this traditional system ecologically viable? Why has it not spread to other parts of the Cordillera with almost the same cultural traditions?

### The importance of tradition

Rice is central to the social, economic and religious life of the Bontoc people. It is the main dish on all festive occa-



sions and is also made into wine, which is highly valued for rituals. Rice production therefore demands utmost care, and the people live very close to the rice terraces. Rice is much more valued than the other main staple food, sweet potatoes. To have an abundant supply of rice is a status symbol.

The Bontoc have developed a very complicated sociopolitical system or Ato, centered on the council of elders who act as priests (mumba'i) during rituals. The Ato is the seat of all major decisions in the community. Without the Ato, the age-old rice production technology would have long been abandoned.

### Water as a tool in terracing

Terraces are built by the men, mainly for soil and water conservation. Areas are chosen where there is an ample water, regardless of slope, and a nearby source of construction materials. Slopes prone to landslides are avoided.

Terraces are usually built at times when water is particularly abundant, as water is an essential tool in construction. When terracing, the Bontoc never lift what water can move. Impounded water is used to transport tons of rocks, granules, debris and soil fill. Topsoil is carefully saved as the last filling material. Water is conveyed from its source by gravity flow and is sometimes diverted 1-4 km upstream. This hydraulic technology and the Bontoc's stonewalling skills are incredible feats of engineering. Terrace construction requires high labour input and is usually done through mutual assistance (obob-fo)

The sophisticated Bontoc terraces, like a stairway to sky, were terraced with river stones using only simple tools. The synergy between the forest as water source and the rice terraces indicates the intricate agro-ecosystem relationship. Photo: Hilario Padilla.

Paddy dikes and walls are religiously maintained. Seepage and weak points are immediately repaired, requiring constant field visits. A unique feature of the Bontoc terraces is their long curved walls of smooth stones (other terraces use angular broken rocks). The river-stone linings are said to conserve heat, and may indirectly influence nutrient cycling by crop uptake (Omengan 1981) or the activity of soil micro-organisms.

The long perimeters of the terraces are a Bontoc adaptation to increase yield, based on observations that the borders (paddy edges) produce more tillers and filled grains. This may be due to the effect of solar radiation.

### Soil puddling by foot

The women then clear and weed the terrace walls and immediate surroundings. Farmers are very particular about the cleanliness of terrace dikes and walls for fear of rat infestation. The weeds are not burned, but dumped in heaps for partial decomposition.

The women then puddle the soil with their feet. In some cases, if the terrain permits, animals are used to trample the mud. During puddling the partially decaying weeds cut from the surroundings and the weeds in the pond (especially the floating azollas and blue green algae) are treaded deep into the mud. The value of azollas had long been

recognised in the area even before scientists started investigating its potential as fertiliser. Nitrogen-fixing algae are thought to be a major source of N in the paddies.

In some parts of the pond where the water is shallow, weed vegetation is mixed with mud and formed into mounds that protrude above the water-table. They are used later to grow onions, garlic, legumes and other greens. As the women move forward, working the organic matter into the mud, they also gather fish, especially "yoyo", an eel-like fish the size of a pencil.

### Sowing with whole panicles

Two to five traditional varieties, usually long-season ones, are planted in a medium to large field. Seeding starts with the appearance of the "kiling" (*Erythrina hyperythra brunneiventris*), a migratory bird. Whole, unthreshed rice panicles are laid parallel to each other in the seedbed.

Little is known of the scientific significance of this practice. A new approach to raise the yield potential of rice is manipulating the weight of single grains. Increasing the number of high density (HD) grains increases yield, milling recovery and head rice recovery. Varieties differ in the number of HD grains. Within a panicle, certain spikelets invariably develop into HD grains. Most spikelets on the primary branches are HD grains. Leaves near the panicle are more important in grain filling. Removal of the 4th leaf from the top increased grain weight and number of HD grains (Vergara 1987). It is possible that the Bontoc's careful selection of panicles as seed source contributes to their high yields.

Seeding is done simultaneously in every community. This is related to a traditional holiday (tengao) which is declared before sowing. During this holiday, when it is taboo to go to the fields, seed is selected. Simultaneous sowing also helps prevent build-up of pests, especially rats (Valentin 1986), and allows re-utilisation of irrigation water and whatever nutrients it carries for other paddies.

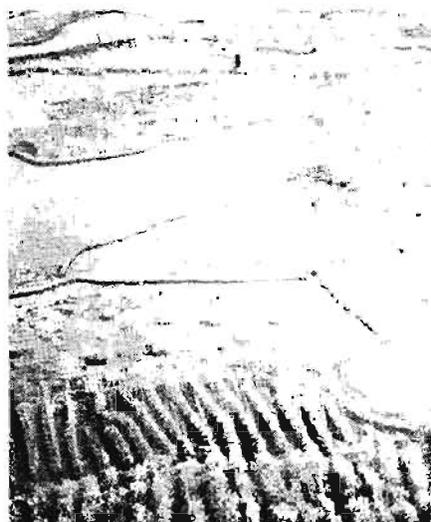
### Dense transplanting and little weeding

Rice seedlings are transplanted singly and randomly at a spacing which depends on variety, elevation and season. Generally, planting density is high, with a hill spacing of 8-12 cm. Seedlings are already very large when transplanted. The village agricultural priest (Tomona) declares when to transplant. The large seedlings and close spacing could be ways of controlling weeds. Plant are spaced more closely in poorer soils and during the rains, because



An old woman incorporating weeds, compost and azolla during land preparation. Simultaneously, she gathers yo-yo (an eel-like fish with the size of a pencil) and snails for food. Almost all farm work is done by women. Photo: Hilario Padilla.

Terraces are now being converted to vegetable gardens and farmers are drawn into the market system, leaving the delicate balance of the agro-ecosystem. This poses one of the great threats to the sustainability of the Bontoc rice terraces. Photo: Hilario Padilla.



tillering is slower in these conditions.

In many areas, transplanting is exclusively done by women. They also gather shell and mudfish at this time, and some transfer small mudfish to less-stocked terraces. At this stage of rice growing, the women work in many fields and become familiar with the soil conditions of each parcel and the agronomic response of the different varieties grown. After transplanting, no one enters a field for almost 4 days, another tengao.

Weeds are not a major problem. Often, only one weeding is enough, and the time is used again for collecting snails and weeds as food supplements. It is also a time for replacing missing hills.

### Communally managed irrigation

Irrigation water is maintained at 5-10 cm throughout the growing period. Farmers are very particular about water depth. After transplanting, a ritual is held to regulate the headwater source gate to avoid excess flow and thus lessen the nutrient loss due to water overflow. Irrigation water is usually stopped a week before harvest.

During dry periods, irrigation water is a common source of conflict. The role of the elders in settling such conflict is highly significant in the local management of the communal irrigation systems.

Omengan (1981) studied the nutrient content of water coming in and out of the fields and found that irrigation water contributes to the nutrient content of the paddies. She also found that significant quantities of P and N accumulate within the paddies. She inferred that the compost was the P source and probably nitrogen fixation from blue-green algae and azolla in the paddy was the N source.

Water quality differs from place to place. The occurrence of the disease "Lisao", the wilting and drying of seedlings 2-3 weeks after transplanting, could be related to water quality, as the disease occurs close to where the irrigation water enters the fields (Valentin 1986).

### Few pests and diseases

No major pests and diseases occur in the rice terraces, only minor ones like Lisao, which could be due to a zinc deficiency brought about by continuous flooding. This physiological disorder is manifested by red tops and rotten roots. In some areas, used batteries are ground and applied to the affected fields, as people claim it helps prevent Lisao. The Bontoc claimed that draining the fields also helps prevent this disease. This would correspond with experience at IRRI, where paddies were dried up to prevent zinc deficiency resulting from oxidation.

Rats are prevented by keeping the paddies clean. Birds are driven away by scaring and the ritual "felew". A large worm (tuwing) that causes paddy seepage is controlled using sunflower (*Thitania* sp.) and "paswek" (family Sapindaceae).

Another characteristic of the rice paddy system is the practice of "bangkag" or soil drying to prevent the occurrence of Lisao, to make the soil easier to manage during land preparation and to enhance the rooting of seedlings. Moreover, various scientific reports suggest that soil drying could enhance soil fertility by releasing some nutrients tied up in the soil organic complex.

### A classical integrated system

The Bontoc rice terraces give a classic example of a traditional farming system that is highly productive with proven sustainability. Elsewhere in the region, the cultural rites concerning rice and the terracing systems are quite similar, but the Bontoc have more advanced techniques to enhance soil fertility, make narrower terraces and use rounded river-stones for terrace walling.

They make maximal use of local resources and conserve water and soil. Soil life is maintained through nutrient recycling and the use of biomass like weeds and sunflower. The pig, already part of their tradition as a ritual animal, is an important part of the system's nutrient flow pattern, as it consumes byproducts like rice bran, and its dung, together with the bedding material cut from the grasslands, produces excellent compost. The Bontoc composting technique is worth emulating in other parts of the Cordillera, where pigs are free-roaming, but labour and cultural differences seem to constrain its diffusion. Other groups like the Kalinga regard the use of manure as a taboo.

The sociopolitical structure of the Bontoc and the careful work of the women are very important aspects in the perpetuation of this traditional rice-growing system. However, the increasing influence of "modern" culture and technology may push it into oblivion. The attraction of cash income from growing temperate vegetables is a major reason for the conversion of terraces into gardens. Some observers may regard diversification into vegetable growing as sound, because the farmers then have both rice and cash. But how long can they stand the pres-



Harvesting is done by panicle. My sampling gave an average rice yield of 6.1 tons per ha. The measurements excluded the terrace borders which produce more tillers, more filled grains and, hence, higher yields. Photo: Hilario Padilla.

sure that characterises the economy of commercial vegetable production, which is highly dependent on external inputs with unpredictable pricing and cash flow?

### Still room for improvement

As commendable as the Bontoc rice system is, it could be improved in certain aspects. For example, the women's task of using their feet to puddle the soil is very laborious. Some recommendations made by the Agricultural Sector Committee (in which I serve) for the Cordillera Comprehensive Development Plan on rice terraces are:

- Appropriate farm mechanisation, for example hand-operated puddler or carabao-drawn plough, should be encouraged wherever possible to replace soil puddling with the feet. Weeding tools like the rotary weeder could also be introduced to free women's labour time for other tasks and help reduce labour bottlenecks.

Sunflowers tying on the paddy. A large worm (hewing) that causes paddy seepage is controlled using sunflower (*Thlasia* sp.) and "paswek" (family Sapindaceae). Photo: Hilario Padilla.

- Crop rotation with legumes should be encouraged. Planting of "legume banks" in unused spaces near rice terraces should be promoted as a source of green manure. This could be an alternative source of fertiliser in parts of the Cordillera where there is cultural resistance to using manure.

- Modern rice-growing technology like that being promoted by the government, particularly the use of modern varieties, should be carefully studied in the light of existing cultural traditions, e.g. since harvesting is done by panicle, varietal characteristics such as resistance to panicle shattering should be considered.

- The Bontoc rice-growing technology, particularly the nutrient cycling practices, should be promoted in other areas. Building pig pens could be encouraged to facilitate manure collection.

- To permit self-sufficiency in rice, construction of more terraces should be encouraged.

- The irrigation system could be improved. The use of concrete channels to convey water from its sources up to 5 km away would greatly reduce current seepage problems.

The rice terraces, a national heritage, embody invaluable knowledge which is in danger of being lost under the pressure of "modernisation". Gaining insights into the wisdom of this traditional system could help us rethink current agricultural policies and learn about ecologically-oriented and productive farming. ■

### References

- Chang, S.D. 1975 *The utilization and maintenance of the natural fertility of paddy soils*. ASPAC Food and Fertilizer Technical Center, Extension Bulletin 71.
- Omengan, E.A. 1981. *Nitrogen and phosphorus cycles in a Bontoc rice paddy system*. MSc thesis, University of the Philippines at Los Baños.
- Prill-Brett, J. 1986. The Bontoc: Traditional wet-rice and swidden cultivators of the Philippines. In: *Traditional agriculture in Southeast Asia*, pp. 54-84. Marten G.G. (Ed). IT-Publications, 103-105 Southampton Row, London WC1B 4HH, UK.
- Valentin, P. 1986. Proceedings of DATC-MRDC workshop on rice production in the Cordillera. Organic Matters, April 1986.
- Vergara, B.S. 1987. Raising the yield potential of rice. IRRI, Los Baños
- Scott, W.H. 1975. Beyer's migration and Keasing's runaways. In: *History on the Cordillera*, Baguio Printing and Publishing Co. Baguio City, pp 45-6.

Hilario J. Padilla  
Aglalon, Nalsiran, Manaog  
Pangasinan 2428, Philippines

