LOST HORIZON

Restored

As the UN marks the International Year of Mountains, innovative research techniques help make upland agriculture sustainable

Water buffalo and wiry farmers muscle plows through flooded rice paddies. Houses of rough planks and thatch cluster along a road that skirts the valley, tracing the line along which flat, intensively cultivated bottomland abruptly yields to steep hillsides displaying a patchwork of forest and upland fields. This scene in the northern Vietnamese province of Bac Kan, on the outskirts of Ba Be National Park, appears to exist outside of time, a classic image of tranquil, eternal Asia.

Appearances deceive. In recent decades, the way of life in rural Bac Kan has been buffeted by abrupt social transformations and squeezed by rapid population growth. Unable to grow enough food in their fertile but narrow valleys, farmers have increasingly resorted to tilling the surrounding hillsides. Runaway deforestation, soil erosion and loss of biodiversity now threaten to erase any hope that the people of Bac Kan will ever succeed in lifting themselves out poverty.

Since the 1960s, the Green Revolution has brought unprecedented gains in rice yields, allowing most Asian countries to attain self-sufficiency in this essential grain, even as their populations exploded. However, almost all of the gains so far achieved by IRRI and its partners have come in the irrigated lowlands, which produce 75% of the world's rice. Today, agricultural scientists are focusing more of their attention on fragile upland ecosystems. They aim to alleviate the grinding poverty that persists in these difficult environments and reverse the tide of environmental destruction that endangers the world's last vestiges of pristine wilderness, such as Vietnam's Ba Be National Park.

"A farm family's first priority is their own food security, which means growing enough rice to feed themselves from one harvest to the next," explains Jean-Christophe Castella, a specialist in agricultural production systems who works with IRRI. "They'll try to get rice sufficiency from the lowlands — which here in the mountains means the valley bottom. If their needs aren't covered, and they have labor available, they'll crop the uplands."

The catch is that upland fields don't last. After a few harvests of maize or upland rice (a dry-field crop like wheat), the soil is typically capable of supporting only the root crop cassava, then nothing. "Cassava is derided as a soil killer, because nothing can follow it," says Dr. Castella, adding that farmers must then clear new fields. "But cassava grows in infertile soil and is a good risk reducer, because you can harvest it in two years to feed the pigs, if the maize fails."

Dr. Castella heads a research project in Bac Kan that brings together IRRI, the Vietnam Agricultural Science Institute (VASI), Institut de Recherche pour le Developpement (IRD) and Centre de Coopération Internationale

This feature was developed for publication in the June 2002 issue of *The World & I* magazine as the last of six essays in the series *Struggle for Development*. It is concurrently published in *Rice Today* with permission from *The World & I*, a publication of The Washington Times Corporation.

The Samba method

Ecosystems won't wait to be saved. Change often outpaces the efforts of scientists to improve upland agriculture, and many square kilometers of forest have disappeared while researchers studied how to preserve them. This is one key reason the Mountain Agrarian Systems program developed the Samba method.

The method is a board game in which several farmer-players try to improve their livelihoods within the game by making the same sort of farm-management choices they face in real life. These include what to plant where, when to clear a new field, and whether or not to buy or sell a buffalo. Individual players draw cards defining their virtual farm household's initial conditions: how much paddy land their families own, how many mouths they have to feed, and how much labor they can muster.

Facilitator/researchers leave the rules, especially social ones, for the farmers themselves to work out in the course of play. As in real life, there is no single winner. Families fare well or badly depending on their strategy, how effectively they cooperate, and how vulnerable they are to such "chance" (facilitator-decided) factors as bad weather or livestock epidemics.

It takes a day to run the game to seven or eight cycles, or "years." Researchers spend the next three days interviewing participants to learn more about the strategies they adopted, meanwhile programming a computer model of how the game progressed. On the fifth day, researchers present the model to farmers for validation and to spur further discussion.

"The process is both a research tool and a training method," explains Dr. Castella. "It overcomes the problem of confidence between researchers and stakeholders. We and the farmers share a common experience — the game — which allows us to discuss and compare strategies and determine how closely the game resembles real life."

The Samba method also allows farmers to experiment with strategies, and to see the cumulative environmental impact of their decisions, without facing real-world consequences.

"The overexploitation of natural resources is commonly studied as biophysical phenomena, but the underlying causes and consequences are largely socioeconomic and institutional/political in nature," Dr. Castella observes. "A problem in integrated natural resource management is that research tends to be site specific. The challenge remains to make it capable of benefiting lots of farmers across large areas within reasonable time frames. The Samba method helps, because it's much faster than conducting anthropological surveys, and it can be used in different situations."

Trinh Thi Xuyen (*top*), Ma Ngoc Bich and Hoang Van Phoc follow up a Samba method exercise in Gnoc Phai, Bac Kan. SAM staffer Hoang Lan Anh (*below right*) facilitates a game.

en Recherche Agronomique pour le Développement (CIRAD). The aim of the Mountain Agrarian Systems program (shortened to its French acronym, SAM) is to help farmers progress from shifting, slash-and-burn agriculture toward sustainable, intensive systems that can improve their food security and livelihoods while preserving upland forests.

As this urgent need spans the highlands of Asia, Africa and Latin America, Dr. Castella and his colleagues are developing research methodologies that are broadly applicable to a range of local situations (see box at left "The Samba method"). At the same time, in partnership with other national and international research and development organizations, SAM is assembling a basket of solutions specific to Bac Kan, where lowland rice paddies provide only two-thirds of residents' basic caloric needs.

Filling the gaps

"The shortages occur in May and September, just before the rice harvests," Dr. Castella explains. "To fill the gaps, farmers rely on upland rice, maize and sweet potatoes. Agricultural researchers tend to think that upland rice and lowland rice are completely different systems, but here we see them side by side. And what happens in the lowland fields affects what happens in the uplands. When we understand the history of how the farming system developed, we can better see how we can make it sustainable."

Historically, people of the Tày ethnic group occupied the valleys and grew rainfed lowland rice. Tribal Dao people lived on the hillsides, where they practiced shifting agriculture and grew upland rice. In this subsistence economy, the Tày and Dao had little contact with each other or the outside world.

Lowland rice (*inset*) and upland rice in Gnoc Phai. The hillside in the foreground is in its first season, so seedlings are transplanted to take advantage of strong tillering. The hillside behind is in its second or third season and is already too depleted to support strong tillering, so seed is broadcast to achieve denser planting.

In 1960, the Vietnamese government collectivized agriculture in the area and banned cultivation on the slopes. The Dao moved to the lowlands, where they lived together with the Tày and newly arrived Kinh (mainstream Vietnamese) migrants. By late in the 1970s, lowland fields could no longer feed the growing population, so farmers began illegally clearing upland patches. Decollectivization brought two rounds of lowland reallocations, in 1982 based on how many mouths each family had to feed, and in 1986 according to how much labor families could muster. Then in 1991 the Tày reclaimed the ancestral lands they had contributed to the cooperatives, forcing other farmers back into the now-degraded uplands.

By this time, all accessible uplands even marginally suitable for agriculture had been exploited. As fallow periods shortened to two or three years, instead of the two decades or more that was typical before 1960, declining fertility and soil erosion became serious problems. Despite the ruggedness of the terrain, forest cover shrank from 80% in 1985 to 50% in 1998.

"The old slash-and-burn system has become unsustainable due to population pressure," says Dr. Castella, adding that the government's decision in 1993 to distribute forested uplands to individual households further rendered shifting cultivation unworkable. "The idea is to go from a shifting system to an intensive one. This will allow farmers to produce more food on less land. But to do this, we need to boost the fertility of existing farmland and reduce erosion. Our strategy is to combine increased productivity in the valley bottom with stabilization of hillside agriculture through eco-agriculture and improved fallow management."

"We face a diversity of situations and systems, so we have to offer a diversity of solutions," says Dr. Castella. "More broadly, we need to stop denying diversity, but rather use it to our advantage. And we need to integrate social aspects from the beginning"

One technique being studied by the VASI-CIRAD component of SAM Project — slow-burn trenches — mimics in existing fields the fertility-enhancing power of burning forest cover. Farmers bury shredded bamboo in trenches (for the trial plots, SAM salvages scraps from a local chopsticks factory) and set fire to the trenches, which smolder for two days. The process

Mountain Agrarian Systems head Jean-Christophe Castella (*second from right*), SAM interpreter/secretary Hoang Lan Anh (*third from right*), Dang Dinh Quang (*right*), Dr. Castella's counterpart in the Vietnam Agricultural Science Institute's Agrarian Systems Department, and SAM agronomist Hoang Hai Bac (*fifth from right*), interview Nguyen Van Quach, headman of Pac Cop village in Phong Huan, Bac Kan.

reduces soil acidity and aluminum toxicity and renders phosphorous in the soil more available to crops. It is a good first step toward reviving almost sterile soils in land-scarce areas.

SAM is also evaluating sustainable erosion-control techniques, such as planting contour lines of legume hedgerows or grass, or leaving strips of natural vegetation. The legumes are an effective nitrogen-fixing green manure, and both legumes and grass provide fodder for farm animals. Another option is sowing a cover crop that does double duty reducing erosion and providing mulch for upland rice, maize or cassava — combined, on slopes steeper than 35°, with mini-terraces for each row of the food crop. The mulch spectacularly boosts yields while sharply reducing the need to weed, a time-consuming chore that falls mostly to women and children.

"We face a diversity of situations and systems, so we have to offer a diversity of solutions," says Dr. Castella. "More broadly, we need to stop denying diversity, but rather use it to our advantage. And we need to integrate social aspects from the beginning."

Modern trends

Publicly funded agricultural research is sometimes derided as scientists handing down from their ivory towers "solutions" that are irrelevant to the problems of poor farmers. This caricature has never been wholly accurate or fair, and modern trends make it even less so.

"We are now using problem-driven delivery, rather than solution-driven delivery," explains Dr. Castella, citing a key principle of an emerging framework — called eco-regional integrated natural resource management (INRM) — for tackling agricultural challenges. By working closely with farmers and policy-makers, and by facilitating a mutual learning process, eco-regional INRM addresses issues linking agriculture and natural resource management beyond the field scale. It also aims to bridge the gap between this bottom-up approach and the top-down view of planners and policy-makers. Eco-regional INRM taps the full range of scientific assets that can be brought to bear, from laboratory-bound disciplines like biotechnology to such "soft sciences" as sociology. It also harnesses tools that facilitate the integration of diverse findings into analyzable packages (see box opposite "Geographic information systems").

Using this process, SAM researchers have discovered that the fundamental constraint to intensifying and diversifying upland agriculture in Bac Kan is not what most observers would guess. It is neither vegetable nor mineral, but animal.

"Success depends on developing better livestock management systems," Dr. Castella explains. "Rapid social and policy changes have so far prevented this from happening."

In Bac Kan, water buffalo provide most of the traction for land preparation. They are idle for much of the year but valued as "living capital" to sell in time of need. The upland-dwelling Dao assign a child or elder to keep buffalo

When not providing traction for land preparation, water buffalo are often left to graze unattended in the forests and meadows of the uplands, where they compact the soil and invade farmers' fields. Free-grazing animals are a major constraint to forest regeneration and agricultural intensification in Bac Kan

away from crops, as fencing a temporary field would be an impractical investment. However, since decollectivization and the distribution of buffalo to individual households in the early 1990s, the valley-dwelling Tày have allowed their buffalo to graze unattended in upland meadows and forests, where they often invade the fields of the Dao. In addition to causing crop loses and communal discord, the heavy buffalo compact the soils of the forests and meadows in which they graze.

"Free-grazing animals are a major constraint to forest regeneration, as well as to agricultural intensification," Dr. Castella observes.

Yet, if given the chance, agricultural intensification can solve the problem by supplying the fodder — cut from soil-stabilizing hedgerows and stands of grass — required for keeping buffalo corralled. Intensification thereby smoothes the way for further intensification, illustrating how the holistic eco-regional INRM approach, combining technological and social innovations, can replace the vicious cycle of environmental degradation with a virtuous cycle of self-reinforcing sustainability.

Ideally, most upland areas, in Bac Kan and around the world, would be preserved as wilderness, sustainably exploited for forest products. Accessible and suitable hillsides may be devoted to such perennial cash crops as fruit. The trick is to get from here to there, from how the uplands are used today to how they would be used best.

"After people cover their rice needs, they invest in livestock and fruit to sell," Dr. Castella says. "This is where access to market kicks in. Livestock is better if the way to market is long or difficult, because animals can walk and you have to carry fruit. For sustainability, though, fruit is the ultimate goal. But you can't get there all at once. You have to go through securing food needs first."

Farmers cooperating with the VASI-CIRAD component of the SAM project in Gnoc Phai try direct seeding of upland rice through dead mulch. This method controls erosion and spectacularly boosts yields while sharply reducing the need to weed, a time-consuming chore that falls mostly to women and children.

Geographic information systems

Eco-regional integrated natural resource management can be even more difficult to comprehend than it is to say. The volume and complexity of the data that go into an eco-regional INRM study — combining elements from an array of scientific disciplines — make synthesizing results almost as a great a challenge as communicating conclusions to nonscientists.

A valuable tool for such inter-disciplinary studies is map-making with geographic information systems (GIS), which allows scientists to layer wide-ranging data into compact, analyzable packages.

"GIS is a computer-based technology for integrating maps and data, both biophysical and socio-economic, from various sources," explains Suan Pheng Kam, IRRI's GIS specialist. Combining aerial photography, satellite images, existing statistical data, and field interviews on a single map can reveal patterns of interconnection that may otherwise escape the notice of researchers.

"GIS also makes it easier for scientists to present the results of complex models to local authorities," adds Dr. Kam. "This allows them to understand how their decisions affect what farmers can do with their land, water and other resources."

In Bac Kan, the Mountain Agrarian Systems program is experimenting with sketch maps and 3-D modeling, developed with the participation of farmers, to forge village- and watershed-level GIS tools that are easier to read than conventional maps. The goal is to find a common spatial language for scientists, farmers and other local stakeholders.