

Sustainable Livestock Production for Mexico and Beyond

Southeastern Mexico is in the midst of a rural revolution and CIAT is helping to supply the ammunition. But this particular upheaval isn't about politics or constitutional reform. And it doesn't have any masked militants marching on Mexico City. Rather, its foot-soldiers are traveling agricultural technicians, often seen wearing white baseball caps emblazoned with a green butterfly. And they are armed with nothing more than a few bags of grass seed. Their campaign is nevertheless aimed at empowering poor rural communities—and making a reasonable profit in the process.

This "quiet" revolution is about environmentally and economically sound production of milk and meat, based largely on highly productive forage grasses of African origin. The latest addition to this genetic arsenal is the world's first commercial hybrid of Brachiaria grass, developed by CIAT and marketed under the varietal name Mulato. The tiny seeds of this superior cattle forage are grown and sold by a dynamic young Mexican-based company known as Papalotla, which means "butterfly," in the indigenous language Nahuatl.

Mulato and other improved CIAT forages offer small-scale livestock producers, in Mexico and elsewhere in the tropics, a chance to not only survive but also thrive in today's highly competitive, globalized market. They are key ingredients of the biological capital needed for sustainable rural livelihoods.

CIAT has developed the world's first hybrids of the widely cultivated tropical forage grass Brachiaria. Based on three key species of African origin, this scientific achievement results from more than a decade of breeding and evaluation by Center scientists, with financial support from the Colombian, Japanese, and other governments. It offers major financial and ecological benefits to livestock producers, small and large, in tropical countries.

The region with the most to gain, at least initially, is Latin America. Half of its nearly 600 million hectares of pasture land, particularly in Brazil, has become degraded in recent decades. The hybrids' main advantages for farmers are their high tolerance of infertile acid soils, excellent productivity and nutritional quality, and improved resistance to a major pasture pest, spittlebug.

One of the hybrids, CIAT 36061, is now on the market under the varietal name Mulato. It was released in 2000 by the Mexican company Semillas Papalotla for demonstration purposes, but the firm is now moving ahead with full-scale seed production and marketing in Mexico. Distribution is also

expected to start soon in other countries. Under an agreement with CIAT, Papalotla has exclusive world rights to produce and sell Mulato seed. CIAT will receive funds to support the Brachiaria breeding program, together with a small royalty on sales.

As this hybrid is a unique product of CIAT research rather than a conserved sample of an unimproved variety, it is not part of the germplasm collection the Center holds in trust as international public goods for the United Nations Food and Agriculture Organization (FAO). CIAT can therefore license it and allow Papalotla to apply on its behalf for plant variety protection under the laws of the countries where it operates.

Completing the R&D Loop

CIAT's decision to license the hybrid stems from the lack of public-sector capacity for distribution of Brachiaria seed. In keeping with its mandate to fight poverty in the tropics, CIAT saw partnering with a private firm as the most direct way to get new germplasm to small-scale livestock producers.

Working with even fewer resources than it had in the late 1980s when it began its Brachiaria breeding, CIAT "doesn't have the marketing expertise and infrastructure to distribute the seed to the enormous potential market," says CIAT livestock economist Federico Holmann.

Hence the need to give the inside track to a firm like Papalotla which is willing to make the necessary investment, support farmers with technical advice, and promote environmentally sound production practices. "It's a monopoly," says Holmann. "But without it, the Brachiaria hybrid seed would never get delivered. This is the only way to get things moving." CIAT's science park director, Aart van Schoonhoven, concurs: "Without Papalotla, it would be impossible for us to reach large numbers of farmers."

Papalotla, which began operations in 1992, is just one player in a network of research, production, and marketing. It works with Nestlé Mexico, a major buyer and processor of fresh milk, and is in regular contact with researchers at CIAT and Mexico's National Institute for Forestry, Crop, and Livestock Research (INIFAP). Papalotla supplies farmers with forage seed and technical advice throughout the pasture and cattle production cycle. For its part, Nestlé buys the milk from participating farmer groups and provides credit to cover the costs of cooling tanks installed at rural collection points around the country. Farmer cooperatives repay the capital cost of the tanks through a per-liter "check-off" on milk production. Similarly, Papalotla makes its profit from 20 seed payments by each farmer, deducted from milk revenues.

The multipartner arrangement thus completes the research-to-development cycle. In addition, the financial risk to farmers is low, since credit repayment schedules are directly linked to milk production. "What more could you want?" asks van Schoonhoven. "That's a golden deal. And the private sector is more efficient in delivering it than the public sector."

Out of Africa

About 100 species of *Brachiaria* grass grow naturally in the tropics. About two-thirds are found in Africa, the rest in Australia, Asia, and Latin America. Several species are thought to have made their way to Latin America from Africa via the hay bedding used on slave ships. Unlike the slaves, though, *Brachiaria* grass received a warm welcome in the New World. It adapted, thrived, and spread quickly.

"It's just everywhere," says CIAT breeder John Miles, whose manipulation of three African *Brachiaria* species gave rise to Mulato. "Every little vacant space that isn't mowed is *Brachiaria*. It's amazing how it's been naturalized in tropical America despite these acidic soils. Almost all the grasses you see along the roadsides of tropical America are African species."

Thanks to the research of Miles and his colleagues, Mulato is the latest addition to Papalotla's growing portfolio of improved forages, which also includes a pasture legume promoted by CIAT, *Arachis pintoii*, and several nonhybrid *Brachiaria* grasses. "We should be listening very closely to these private seed companies," says Miles. "They're the vehicle by which we can turn an experimental line into a product for farmers. They have their ear to the ground."

A perennial that grows vigorously, Mulato outyields other *Brachiaria* cultivars by about 25 percent. Compared with many other forage grasses, it has a strong tendency to send out runners, or stolons, whose buds grow into new plants that quickly cover and protect the soil. Major benefits for cattle are its high protein content (12 to 16%) and digestibility (55 to 62%). And, as seen in the aggressive browsing behavior of cattle presented with Mulato, the animals love the taste.

CIAT experiments showed that cows fed Mulato produced about 2 liters more milk per day than those grazing commercial nonhybrid varieties of *Brachiaria*. The reason is the elevated protein content and high proportion of leaf matter. In southeastern Mexico, farmers have also observed the positive effects in their herds. While on-farm milk increases aren't as dramatic as those seen by CIAT, producers are clearly impressed.

Breakfast of Champions

One of those farmers is 63-year-old Miguel Cruz. For more than 45 years, he has worked the land in the State of Veracruz—initially as a young, landless sugarcane cutter, with ambitions of one day buying his own farm. Under Mexico’s land reform program, he was eventually able to purchase 50 hectares. After several years of growing beans, chilies, and maize, he tried cattle production, beginning in 1970. Today, the veteran producer and his family have combined holdings of 83 hectares, 60 of which are in pastures. At the moment there are 50 cows in Tronco’s herd of 90 animals.

Nine years ago he began reseeding land with higher quality forages, including a popular nonhybrid *Brachiaria* variety called Basilisk (*Brachiaria decumbens*). Recently, he went a step further and planted a hectare of Mulato, using free demonstration seed provided by Papalotla. His experience reveals a dramatic trend of increased milk production. On the old native grass pastures he used to get only 3 liters of milk per cow per day. Later, with new *Brachiaria* and other more productive species, production rose to 4.4 liters. And in his recent tests with Mulato involving 27 cows, average production leapt to just over 5.6 liters a day.

In the old days, says Cruz, the rare cow that gave 5 liters of milk was considered “a champion.” Now most if not all his milk cows are champions. And as a small bonus, Mulato can be grazed by horses and donkeys, crucial forms of transport in these parts. (These beasts of burden, notes Cruz, generally turn their noses up at Basilisk.)

“Little by little I’ll be adding Mulato *Brachiaria*,” says the farmer, who particularly likes the stolon-producing behavior of the grass. “I need to produce more milk to increase our income.” On Papalotla’s advice, he’s planning to reseed four hectares of older pasture with the new hybrid. “It’s generally difficult to get farmers to switch varieties,” adds Alejandro Bravo, Papalotla’s district manager for Veracruz. “Don Miguel, though, is always curious to look at new varieties.”

Another of Bravo’s clients is Victorico Alarcón. With his father and grandfather, he manages a herd of 187 animals, including 45 milk cows. The 100-hectare farm supports 15 family members, including Alarcón’s wife and three children. Their introduction of selected *Brachiaria* grasses 7 years ago, he says, helped boost the herd size and increase overall daily milk output to 200 liters.

Now the family has its eye on another ambitious goal: to more than double that output so they can join the elite ranks of “key producers” under the

Nestlé umbrella. “We’re going to plant 5 hectares of Mulato this year as an experiment since we’ve heard it’s a better forage,” Reyes tells a group of visitors to his milking station. “We trust what Alejandro has told us. We expect to reach the 500-liter-per-day target in 3 years.”

Part of the expansion and intensification strategy is to improve the herd’s genetic makeup with the introduction of new breeds. And eventually, adds Reyes, he may mechanize milking to reduce labor. A nearby cow, in the process of being relieved of her daily milk quota, suddenly kicks over the pail, as if to reinforce—or maybe challenge—the mechanization plan. Everyone bursts into laughter. No one here, it seems, cries over spilt milk, least of all Alarcón, who is too busy planning for the future of his farm and young family. Already, the financial gains made from adopting Mulato’s nonhybrid *Brachiaria* parent varieties have helped pay for Alarcón’s sister Edith to pursue studies in pharmacology.

Meeting Internal Demand

The income of thousands of Mexican farmers, many of whom raise both crops and livestock, is increasingly affected by the economics of international trade. Under the North American Free Trade Agreement (NAFTA), for example, many Mexican growers of maize, a traditional staple, can no longer compete against their counterparts in the highly efficient U.S. Corn Belt. And recently, pineapple prices have fallen dramatically as cheap imports pour in from Thailand. This has dealt a severe blow to production in southeastern Mexico, and many farmers are converting land to pasture.

“There’s a huge internal market for milk,” Holmann points out with enthusiasm. “Mexico is the biggest importer of milk powder in the world.” Switching to milk and meat production, or enhancing existing production, is thus an attractive alternative. But given the current low world price for milk, in part due to hefty subsidies for European Union farmers, production needs to be more efficient. Here, new hybrids like Mulato have much to offer.

The milk-and-meat option based on improved forages is exactly what’s on the minds of many small farmers today in Quintana Roo, Mexico’s flat, dry coastal state that forms the eastern flank of the Yucatan Peninsula. Poverty is widespread here and the state government is keen to identify economic options for farmers. That’s why it has asked Papalotla to serve as an intermediary, in the hope of convincing Nestlé to install a network of milk-cooling stations.

Although dairying here is largely undeveloped, demonstration plots of improved forage grasses, including Mulato, are now being planted with seed and advice supplied by Papalotla. Earlier efforts by some farmers to raise cattle failed when they ran out of high-quality forage during the long dry season. Now, farmers are required to establish productive pastures before being eligible to receive animals under the state-supported program.

"I really believe in this project," says Papalotla President Eduardo Stern. "There are communities in this region with very few resources, although compared with other parts of Mexico, they do have a lot of land. The impact will be social, economic, and ecological. Some other seed companies want to sell fast and easy. So they deal only with the larger farmers. To get off the main road and serve the smaller producers requires something more."

Among the small-scale farmers gearing up for cattle production is Mario Jiménez. His extended family, which includes 13 children, owns a total of 53 hectares. "We don't have experience with cattle," says Jiménez. "But I'm confident that milk and meat production will work for our family."

Besides growing crops such as beans, cabbage, and maize, this Mayan family also runs a village carpentry workshop. So far, nine hectares of improved pasture grasses have been planted, including two sown to Mulato. Seven more hectares are ready for planting. "Little by little we have opened up our land," says Jiménez's son Wilbur, a trained agricultural technician, as he guides visitors through a plot of Mulato bordering the jungle.

At the moment, the Mulato is intercropped with maize and beans. Once the food crops have been harvested and the *Brachiaria* has spread out to cover the soil, wire fencing will be erected. The fence posts are already piled and ready for installation. Next year [2002], Wilbur will launch the cattle operation with four or five head.

In the meantime, the Jiménez family is planning an age-old spring celebration – 56 hours of praying for rain punctuated by a grand feast called a *pib*. As Mario Jiménez explains, the family is as committed as ever to its Mayan heritage. The addition of cattle is simply a new option to give added economic security to an otherwise traditional indigenous lifestyle.

First Seed Harvest: Sold Out

In Mexico Papalotla's seed production of Mulato and other improved forages is concentrated in the state of Chiapas, several hundred kilometers southeast of Veracruz. Like the neighboring states of Tabasco and

Campeche, this too is an area where small-scale milk and meat producers could use an economic shot in the arm from new forage technology and technical assistance.

"A few of the farmers working under the Nestlé scheme are pretty well off," says Papalotla's regional manager for Chiapas, Adolfo Chávez Chena. "But about 80 percent are small producers with an average of only 10 hectares of land. They may have three or four cows, producing as little as 5 liters of milk per day, total. The really poor dairy farmers make up about half this group of small producers."

Papalotla's first season of Mulato Brachiaria seed production here, on several plots totaling about 100 hectares, was its first attempt at large-scale cultivation of any type of Brachiaria seed. The operation began in May 2000, with starter seed supplied by a contract grower. It was a learning experience and not everything went to plan. During field preparation, the ground was not adequately leveled, making for difficult mechanized harvesting in early 2001. As seed is collected only after it falls to the ground, along with stems and small amounts of soil, the uneven ground prevented the harvest of some seed.

"Before, we only had experience with experimental grazing plots," says Victor Hugo Torres who supervises seed production. "Except for some work in Brazil, we didn't know much about producing Brachiaria seed." But the bugs, he says, are now being worked out with the help of two Papalotla staff. And as of April 2001, the company had about 100 tons of seed composite safely stored in its warehouse and had begun sieving it. Soybean cleaning equipment, specially adapted to handle forage grass seed, allows technicians to reach final seed purity of 80 to 90 percent.

To Papalotla's delight, its earlier demonstration work with livestock producers is about to pay off: the entire Chiapas harvest of Mulato seed is already spoken for. Says Rene Lagunes, an expectant client in Veracruz: "For me there's no question or hesitation. I want to plant more Mulato and I have ordered 30 kilos of seed."

The farmer, whose 80-hectare farm supports a family of eight, is keen to ensure a secure supply of forage for his cows. In the past, he often had to move animals long distances during the dry season in search of green fodder. Now, with Mulato and other improved grasses, he can avoid that extra hassle. "At first I didn't believe claims about the increased production," says Lagunes. "But once the comparative experiment was done, I was convinced. I had the numbers right in front of me!"

Healthier Agroecosystems

Although rice, wheat, and maize are the world's premier food crops for people, that distinction belies the pervasiveness of cattle and other livestock in the landscape. Livestock occupy 3.4 billion hectares of grazing land and animal feed is produced on about one-quarter of crop land. All told, more than two-thirds of our planet's agricultural land area is devoted to animal production.

Food economists have long been predicting that global demand for animal products will skyrocket in the 21st century. Current trends suggest the developing world's annual demand for meat, for example, will grow from the current 206 million tons to 275 million tons, and perhaps more than 300 million tons, by 2020.

How can farmers meet this growing demand while protecting the local and global environments? This complex issue, involving multiple tradeoffs, so far lacks comprehensive, definitive solutions. Nevertheless, the use of hybrid *Brachiaria* grasses like Mulato offers tropical livestock producers a promising avenue for boosting production sustainably, namely with long-term improvements to the health of the agroecosystem. This is why CIAT researchers often refer to tropical forages as a "multipurpose genetic resource."

First, the growth habits of these African grasses, adapted over centuries to the presence of large grazing mammals, make for thick vegetative cover. The plants resist trampling and heavy grazing, suppress weeds, and help retain soil moisture and fertility. In contrast, pasture lands covered by native grasses, which still account for 60 to 70 percent of Latin American cattle production, evolved without heavy grazing pressure. In many areas, especially Brazil, introduced grasses have become severely degraded due to spittlebug attacks and poor management strategies, including overgrazing and lack of fertilizer amendments. The new grasses, properly managed, provide a powerful biological tool for pasture rehabilitation, especially when combined with fertility-enhancing legumes.

"The Brazilian farmers don't want to plant the same material that contributed to pasture degradation in the first place," says Carlos Lascano, leader of CIAT's project on tropical grasses and legumes. "They want something that responds to the improved fertility created by fertilizer application."

A second factor is the potential for improved *Brachiaria* grasses to slow global warming—an environmental service of benefit to all people. The

robust root systems of these grasses allow for significant buildup of organic matter deep in the soil compared with temperate grasses and native Latin American grasses. This effect, not well understood until quite recently, is enhanced by the addition of legumes such as *Arachis pintoii*, a wild member of the peanut family. In effect, *Brachiaria* grasses, including the new hybrids, are powerful “carbon sinks.” They capture and sequester vast amounts of carbon dioxide that otherwise would be recycled to the atmosphere. Since much of the carbon is stored below the penetration level of a typical plow, periodic planting of pastures to other crops does not disturb the stored carbon.

Third, and perhaps most important, the higher yields of these forage grasses, along with resistance to spittlebug, tolerance to acid soils, and good protein content and digestibility, allow for agricultural intensification, even on lands of low fertility. The resulting increases in production and production efficiency by both small and large farmers should translate into lower consumer prices for milk and meat products. At the same time, they should free up more favorable growing environments for food crops and reduce current pressures to extend production into adjacent forest land.

With improved forages, says Papalotla’s Eduardo Stern, “You need less land to produce more. So the pressure on the jungle is alleviated. These alternatives will eventually let people produce sustainably in an open world economy and competitively with industrialized countries.”

Taking the Hybrid Road

Responding to a clear need for better animal forage on Latin America’s vast pasture lands, CIAT launched its hybrid grass breeding program in 1988. It was a scientific gamble but now, 13 years later, elite germplasm capable of transforming livestock production in tropical countries is beginning to emerge.

During the 1970s and 1980s, millions of hectares of land in tropical America were sown to a highly promising African grass, *Brachiaria decumbens*. A big improvement over native grasses, it’s highly productive, tolerates the region’s acid soils, establishes itself quickly, and helps protect the soil. It’s also highly nutritious for cattle. But as many farmers soon found out, it’s very susceptible to spittlebug attack.

Gradually, a spittlebug-resistant species, *Brachiaria brizantha*, began to make commercial inroads as an alternative and complement to *B.*

decumbens. Unfortunately, it too has weaknesses, particularly its inability to persist on infertile acid soils.

In the mid-1980s, CIAT broadened its Brachiaria seed bank by collecting many samples in Africa. Unfortunately, in subsequent screening of the accessions, forage scientists did not find any suitable material that was as good as *B. brizantha* for spittlebug resistance or as tolerant of poor, acid soils as *B. decumbens*.

The only real alternative was to breed hybrids with the right mix of traits, based on the two commercial Brachiaria species. But scientists faced an uphill battle, the major hurdle being a peculiar reproductive habit called apomixis, typical of Brachiaria grasses. Plants with this trait produce seed asexually, that is, without egg cells first having to be fertilized by pollen. Thus, new plants grown from such seed are all clones, in other words, genetic duplicates of the mother plant. To cross the two apomictic Brachiaria species, a sexual parent was needed.

A major break came in 1988 when a researcher from the Brazil Agricultural Research Enterprise (Embrapa) provided CIAT with suitable sexual (nonapomictic) material in the form of *Brachiaria ruziziensis*. Also of African origin but bred by a researcher in Belgium, this germplasm had the right number of chromosome sets to allow it to serve as a female sexual bridge between *B. decumbens* and *B. brizantha*.

“Darwinian evolution is great stuff and we can control it,” says CIAT forage breeder John Miles. And control he did. The subsequent hybrid breeding program, based on the three parent species, focused initially on capturing good spittlebug resistance, and later on tolerance to acid soils and drought. At the same time, Miles and his colleagues began developing better methods for screening the new genetic material for these and other desirable traits.

The breeding effort has paid off. The resulting hybrid populations have good resistance to spittlebug, though in varying degrees. And currently the tolerance of some Brachiaria hybrids to high aluminum levels (typical of poor, acid soils) is 50 percent greater than that of the *B. brizantha*, but not as good as that found in *B. decumbens*.

One promising hybrid, CIAT 36061, although not fully resistant to spittlebug, has several good traits including high productivity, drought tolerance, and high nutritional value. Several years ago, it was taken by one of CIAT’s Mexican collaborators for evaluation in field trials in his home country. This germplasm is now being multiplied and marketed in Mexico and Brazil as

“Mulato” under a CIAT-issued license. Commercial distribution in other Latin American countries, and possibly in Asia, is expected soon.

In addition, an elite CIAT line of nonhybrid *B. brizantha* was released in 2000 by Costa Rica’s agriculture ministry under the varietal name Toledo and by a Brazilian seed company under the name MG-5 Vitoria. In the meantime CIAT’s forage scientists are designing even better screening procedures, so that the best hybrids can be further improved and then disseminated for use by livestock producers across the tropics.