

NEWS FEATURE:

A new climate for grazing livestock

Colombia's sustainable cattle ranching programme restores degraded land while boosting livestock production and making farmland more resilient to climate change.

Lisa Palmer

For cattle rancher Carlos Hernando Molina, growing trees in his pastures while raising cows has boosted his income and restored the degraded soil. Over the past 20 years, he has been replacing his 130 hectares of grasslands in southwestern Colombia with special varieties of leguminous trees, shrubs and grasses (Fig. 1). The plants provide dense layers of food for grazing, doubling the milk and meat production per hectare while reducing the amount of land needed to raise the cattle.

Molina's move to agroforestry is part of a global trend to sustainably improve agricultural production on each hectare while reducing the need for chemicals and fertilizers. Agroforestry is a science-based method for cultivating trees alongside food crops or livestock, while farmers make use of the trees' ecological and economic benefits. Across Colombia, cattle ranchers are making the switch¹. Conventional treeless pastures are slowly becoming forested, creating intensive 'silvo-pastoral' systems that don't use chemicals and fertilizers but increase biodiversity and resilience to climate change. It is part of an ambitious programme to boost farmers' incomes while restoring forests and soil fertility.

Livestock and their food production take up 30% of land globally². In Colombia, where the country's 25 million head of cattle occupy 80% of agricultural land³, conventionally grazed pastures have contributed to severe soil degradation, deforestation and, in dry areas, have hastened desertification, according to Julián Chará, a researcher at the Center for Research in Sustainable Systems of Agriculture (CIPAV) in Cali, Colombia. However, a new paradigm is emerging. Land conservation is happening alongside livestock production.

Colombia's national strategic plan for cattle ranching is poised to reduce the area of cattle production by 26%, down to 28 million hectares, while increasing cattle numbers from 25 million to more than 40 million head, says



Figure 1 | Farmers in Colombia combine grazing and agriculture with tree cultivation to yield more food per hectare, restore degraded landscapes and help them contend with the effects of climate change.

Chará. The project, Mainstreaming Sustainable Cattle Ranching in Colombia (<http://go.nature.com/vqDHR3>), had an initial budget of US\$42 million, but an additional US\$22 million from the United Kingdom's International Climate Fund has extended the project's reach⁴.

Agriculture has been the main driver of deforestation, loss of wetlands and conversion of grasslands. Worldwide, agriculture has cleared 70% of grasslands, 50% of savannas, 45% of temperate deciduous forests and 27% of tropical forests⁵. The expansion of crop and pasture yields is one of the biggest challenges in sustainably meeting the world's future food needs. "To meet projected demands for milk and animal protein, without expanding pasture, production will need

to grow by more than 80% by 2050," says Timothy Searchinger, lecturer at Princeton University, New Jersey, and a senior fellow at the World Resources Institute. "Intensive silvo-pastoral systems show good promise of getting close to this output in tropical regions."

Olimpo Montes, who farms 45 hectares in the northern Cauca Valley of Colombia, made the switch to agroforestry almost overnight. He jokes, "I went to bed wanting to be a coffee producer and woke up a cattle rancher." Coffee had failed to produce a profit, he said. Landslides occurred, as did soil erosion. So, beginning in 2002 with the help of a Payment of Environmental Services — compensation he received following changes he made as a participant in a project funded by

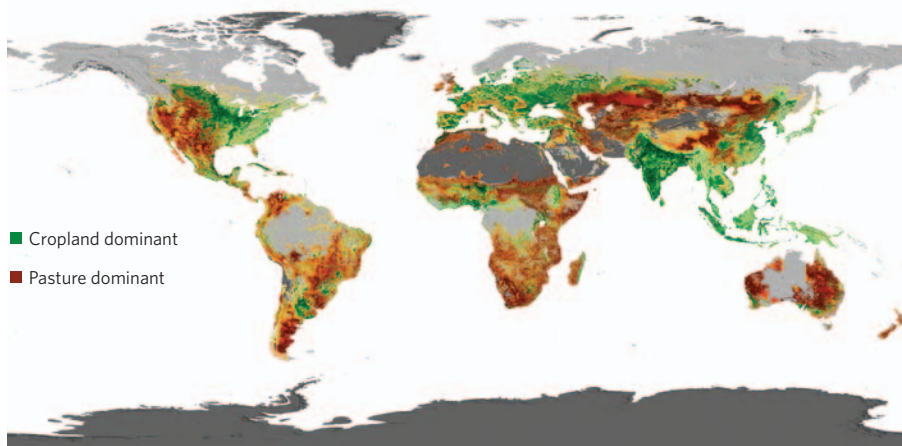


Figure 2 | Distribution of the world's croplands and pastures. Figure reproduced from ref. 8, © 2008 AGU.

the Global Environment Facility and administered by the World Bank — he transformed his formerly treeless land into pastures filled with forests. He started with 100 head of cattle on 45 hectares, but now raises a herd the same size on 25 hectares. On the rest of his land he produces traditional shade-grown coffee, plantains, pepper, vanilla and high-value timber.

Molina's and Montes' brand of 'sustainable intensification' is the favoured agroforestry practice for livestock production in Colombia. Molina has trained cattle producers from other parts of Colombia, as well as Mexico and Costa Rica. Additionally, producers in Nicaragua, Panama, Brazil and Rwanda (and more developed countries like New Zealand and Australia) are using intensive silvo-pastoral practices to increase climate resiliency and increase livestock production while conserving land.

Transforming a pasture into a virtual plant nursery is not the first thing that comes to mind when thinking about sustainable livestock production, says Searchinger. However, he calls it "the ultimate system". Rangeland improvements are critical because they comprise such a large portion of agricultural land globally (Fig. 2), he said. And rangeland is poised for further growth. Beef production is expected to increase by 80% by 2050. "Changes in land use to support that increase in production is supposed to come equally from grassland as from cropland," he said.

The tropics have the unique ability to support the growth of biomass for cattle feed and increase the amount of carbon held in the landscape, Searchinger says. "Increasing the number of trees in pastures on a large scale in a scientific way, as a

method of increasing production while absorbing carbon, is new," he says. "The question now is, how can you expand it at a really rapid rate? With intensive silvo-pastoral systems, we've identified the magic bullet, but we don't yet know how big this bullet must be to solve the problem."

Production under intensive silvo-pastoral systems can be 70% higher than otherwise well-managed and fertilized pastures, said Searchinger. "Grazing produces half the world's animal feed. That's a big deal," he said. "If everybody would do it, if every livestock producer in Latin America shifted to silvo-pastoral systems, it would solve a lot of land-use problems."

In Carlos Molina's pastures, native trees like mahogany and *Samanea*, are strung with electric wire to form a natural enclosure for cattle. Inside the pen, *Leucaena* shrubs grow in hedgerows on an east-west axis to minimize shading. Three types of plant grow underneath and between the *Leucaena* rows, including African guinea grass, star grass and peanuts. The Molinas rotate the cattle between pens daily, and each pen is allowed 30–45 days to regrow and recover.

Intensive silvo-pastoral systems provide multiple benefits to the land, water systems and cattle, says Enrique Murgueitio, executive director of CIPAV. Trees absorb carbon, add humidity to the canopy and their root systems help the soil retain moisture. In addition, dung beetles draw animal waste underground, which enriches the soil; in open pasture, animal waste frequently remains on the surface, attracting flies. Because the animals eat better-quality forage, they gain weight more quickly, produce more milk, and produce less methane. "The advantage to this system is that the benefits to the environment

and to production occur simultaneously," Murgueitio says.

Other types of silvo-pastoral systems include the use of fodder bank trees, or a 'cut and carry' method, in which farmers grow fields of trees and shrubs, such as the Mexican sunflower, and distribute the fresh cuttings to cows in the forested pastures. But the *Leucaena* is the strength of the silvo-pastoral system. Its shoots, leaves and seed-pods pack protein. It grows quickly and can withstand hefty browsing by cattle. And, its feathery leaves allow sunlight to reach the grass under the plantings. *Leucaena* also 'fixes' nitrogen up to three feet underground, which helps to fertilize the soil naturally. While conventional pastures require expensive applications of fertilizer and herbicides, silvo-pastoral systems thrive with no chemical additives or irrigation. Furthermore, dense vegetation reduces weed growth and retains soil moisture.

In Colombia, planting a silvo-pastoral system costs between US\$1,000 and US\$2,000 per hectare, depending on the combination of trees and shrubs used (7,000 shrubs; or 5,000 shrubs and 500 trees, respectively). For farmers seeking an economic return, one of the immediate benefits of silvo-pastoral grazing is increased milk production. Within four months of establishing plants and fodder shrubs in her fields, Estella Dominguez said her cows were able to be milked twice a day for the first time. And, with fewer inputs, she achieved more financial gains because she didn't have to pay for fertilizer or herbicides on grazing land. Like Dominguez, most farmers demonstrate a return on their investment in two years.

Science-based solutions like silvo-pastoral systems are only now beginning to see their potential because the climate risks are becoming clearer, Murgueitio says. Extreme weather events, such as those associated with La Niña in 2010 and 2011, led to yield losses in the agriculture sector, but producers using silvo-pastoral systems were better able to cope with the changes.

Even though the science that supports the benefits of silvo-pastoral grazing has become clear, high up-front costs have posed a barrier, in addition to the expertise needed to plant and maintain the trees. Historically, cattle ranching required few resources for land management, aside from fertilizers to help the grass grow and herbicides to keep the weeds down, says CIPAV researcher Chará. Trees and pastures are not typically thought to be compatible with ranchers, Chará adds.

Although scientists have demonstrated that silvo-pastoral systems have benefits for forest ecology and natural systems, can

increase climate change resilience and can improve a farmer's income, economic and policy barriers add another hurdle. Most land ownership in Colombia is informal, Timothy Searchinger said. Because small holders do not register titles, banks cannot grant them loans for planting the trees and improving pastures. A main benefit of intensification for farmers is increased milk production. Dominguez can have her cows milked twice per day because her farm is near a metropolitan centre. Milk is collected once a day from cattle producer Fabiola Vega's cattle on the northern edge of the Cauca Valley because her farm in the former coffee region is too far from the dairy infrastructure. With new improvements in infrastructure and loan incentives, Vega hopes to achieve an economic return on her investment.

Some people may frown at the sustainability innovations in cattle production

because emissions from ruminants are one of the largest sources of greenhouse gases. Yet silvo-pastoral systems represent a more environmentally efficient approach to livestock. As cattle can digest the forage more easily, methane emissions are reduced by 20% (refs 6,7). In addition, silvo-pastoral systems increase carbon sequestration in both trees and soils and reduce the use of fire for pasture management. Intensive grazing may seem an unlikely partner in sustainable land management; however, proven benefits for rural economics and food security, and even more so for environmental services and reforestation, might persuade ranchers of the advantages. □

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Corrected after print: 8 May 2014

Correction

In the News Feature 'A new climate for grazing livestock' (*Nature Climate Change* **4**, 321-323; 2014) Olimpo Montes's source of funding was incorrectly stated. He received a Payment of Environmental Services as compensation for changes he made as a participant in a project funded by the Global Environment Facility and administered by the World Bank. This has now been corrected in the HTML and PDF versions after print 8 May 2014.