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A case study of triple wins in milk and beef production in Colombia

This case study reveals one such solution: silvopastoral beef and dairy production.

In Colombia, cattle ranching has traditionally relied on extensive systems, with few animals per hectare raised on grass. While it has a range of benefits, this type of cattle ranching provides limited feed quality. It also often suffers from challenges during seasonal extremes of temperature and drought, due to limited shade, poor soil quality and access to water.

The world is facing major challenges developing sustainable livestock production systems that can deliver against growing demands for meat and milk production. These systems must also demonstrate environmental stewardship and ensure essential aspects of sustainability, including animal welfare and livelihoods, are properly respected.

Intensive silvopastoral systems have the potential to deliver much more feed from the land, through the planting of protein and mineral rich grasses and shrubs such as *Leucaena* (legume bushes). By growing plants, shrubs and trees, a three-dimensional feed source is created.

The quality and quantity of the feed source delivered in situ is greater. The additional plant matter, plus root density, and biodegradable material can increase soil quality and water retention, as well as increasing carbon retention in the soil.

By using animal breeds well adapted to tropical environments, the intensive silvopastoral system has the potential to achieve high levels of production from local feed sources in pasture-based environments. This maintains good health, natural behaviour and ease of animal management.

This project aimed to bring together measures of productivity, economics (and the potential for livestock-based livelihoods), environmental stewardship and animal welfare in one integrated assessment. It aimed to test the potential of a system, and its development over time to achieve sustainable livestock production.

The assessment was delivered as a partnership project. Partners included Colombian Cattle Ranching Association (FEDEGAN-FNG); the Centre for Research on Sustainable Agricultural Production Systems (CIPAV); global assessment network agri benchmark of the Thünen Institute of Farm Economics and World Animal Protection.

The farms assessed are pioneers in establishing intensive silvopastoral systems, delivered with the technical and scientific support of CIPAV. This has proved crucial for the development and dissemination of the systems.

The knowledge developed in these farms is used by the project Colombia Mainstreaming Biodiversity into Sustainable Cattle Ranching led by FEDEGAN-FNG in partnership with CIPAV research institute, The Nature Conservancy and Fondo Acción. The project is administered by the World Bank with funding from the Global Environment Facility and the United Kingdom's Department of Energy and Climate Change (DECC).

Delivering productivity gains through silvopastoral farming: a stepwise process

The analysis of the production system, productivity and economics, used the tools, methods and expertise of the global, non-profit agri benchmark Beef and Sheep Network.

For each of the farms, we first defined a reference situation (baseline) representing the status of the farm before introduction of intensive silvopastoral systems. Then, assisted by advisors and producers, the detailed, realistic pathway of introducing intensive silvopastoral systems and their implications on productivity, management and economics was assessed and modelled for 10 years. The introduction of the system is typically done step by step over 5-10 years.

Establishing silvopastoral systems involves investment in fence installation water lines and troughs, the seeding of grass (Guinea, star grass), Leucaena and, in the case of La Luisa, Eucalypt trees. Table 1 shows the investment and maintenance costs per ha for each of the farms.

More feed and more animals, profitability improved

The main impacts of intensive silvopastoral systems on productivity are:

- higher feed quantity and better quality (digestibility, nutrient contents)
- higher milk yields in cows, higher daily weight gains in finishing cattle, allowing the reduction of finishing periods and increasing the cattle numbers
- higher stocking rates and higher land productivity.

The results of this case study showed that:

- Intensive silvopastoral systems are more productive and profitable than cattle ranching systems. Their success is based on good management, extension and access to capital that builds farmers' long-term capacity to deliver efficient and increasingly productive beef and dairy production.
- Intensive silvopastoral systems deliver productivity that goes hand in hand with animal welfare.
- Intensive silvopastoral systems provide a clear investment in sustainable environmental management, with potential climate mitigation benefits.



The case study farms

La Luisa is a beef finishing farm in the Cesar valley with four groups of beef animals and a total of 500 cattle on the farm.



Petequí is a dairy farm in the Cauca valley with around 70 cross-bred dairy animals.



El Hatico is a dairy farm in the Cauca valley, rearing Lucerna breed animals. The herd is divided into five groups ranging from pre-parturition cows, high, medium and low lactation cows.





Table 1

Intensive Silvopastoral System: Investment and maintenance costs per ha

	La Luisa	Petequi	Hatico
Water and fences	648	648	492
Seeding and planting *	1,713	2,343	2,385
Advisory service	108	108	108
Maintenance	224	89	93
Total	2,692	3,187	3,079

* incl. soil preparation, fertilisation, plant protection, irrigation (Petequi/Hatico)

Figure 1 illustrates the significant increases in feed production and land productivity. It should be noted that the baseline of the farms used different levels of management. La Luisa used the least input and least productivity whereas the two others already had achieved a significantly higher productivity level.

Figure 2 shows the impact of the silvopastoral system on the returns and costs on whole farm level. It shows that a) the farms can significantly improve their profitability, b) that the first year(s) of establishment are characterised by investment and a reduced profitability.

Targeting investment to succeed

The results clearly show the benefits on productivity and profitability. Given this, why is the system not more widespread?

Reasons are mainly: a) the investment needs and the associated cash flow / profit challenges in the first years; b) the absence of access to affordable capital, especially for smaller producers, and c) lack of knowledge about the benefits of the system, its establishment and management. These issues can be tackled in the next project phase with a broader data base and a detailed analysis of implementation pathways and associated capital needs and risks involved. It is clear however, that with sufficient early investment the system can become highly productive and profitable in a relatively short timespan.

Figure 1

Feed Production and Land Productivity

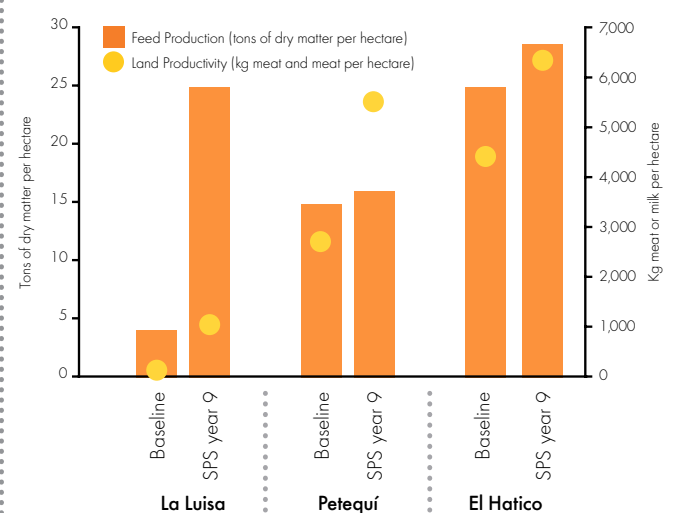
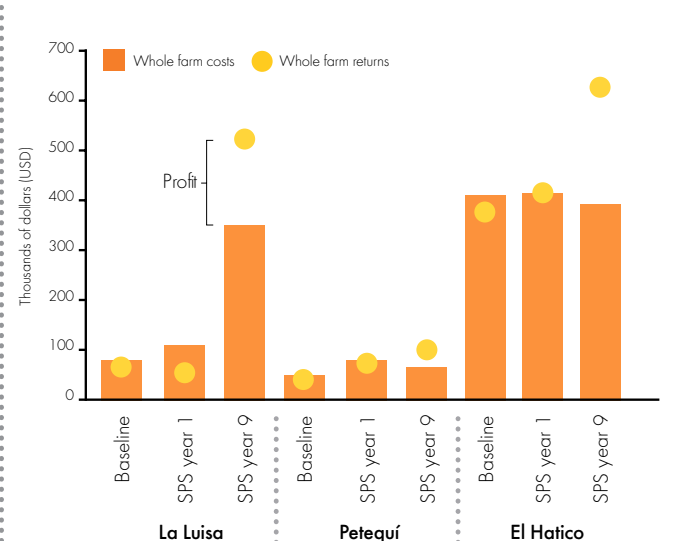


Figure 2

Profitability of Silvopastoral Systems



2. Integrating animal welfare in sustainable livestock production

Animal welfare is defined as the state of an animal in its attempt to cope with its environment (OIE, 2004). It can be measured both in terms of the farm's potential to deliver good welfare through resources provided - such as feed quality, veterinary care, access to exercise or resources to enable important behaviours and reduce stress -and the measurement of the welfare outcomes for the animal.

International consensus agreed among scientists, industry, and intergovernmental agencies including the World Organisation for Animal Health (OIE), maintains that animal welfare includes both the animal's health and behavioural / psychological welfare. Modern approaches to animal welfare focus on what the animal needs to have good welfare. This includes good feeding, good health, good housing, appropriate behaviour (see welfarequality.net).

World Animal Protection, agri benchmark and CIPAV scientists, working with Professor Donald Broom of Cambridge University, assessed cattle welfare on each of the three farms. This was alongside one comparable farm using standard cattle ranching systems. The assessment took direct measures of feed and water availability, behaviour, heat stress, body condition and evidence of parasites.

Intensive silvopastoral systems have high potential for good animal health and welfare. The environmental design of the system provides good quality green forage to meet animals' nutritional needs. Water is provided freely and trees and shrubs provide shade which is important for cow comfort and to prevent heat stress. Animals also have freedom of movement and can exhibit natural behaviours.

- ▣ On all three farms, animals had access to good quality, green forage for all of the day - consisting of grass and Leucaena which provides most of their nutritional needs.
- ▣ Animals on silvopastoral farms showed little heat stress.
- ▣ Water was available freely within the paddock and was clean and fresh.
- ▣ The animal breeds were suited to the local environment.
- ▣ Animals had freedom of movement and could exhibit natural behaviour. This included grazing, walking, lying down, ruminating, and showing positive interactions with other animals.
- ▣ Animals had the opportunity to choose their natural environment and were not subject to overcrowding or behavioural restriction.
- ▣ Animals were bright, alert and responsive.
- ▣ Animals were calm and showed no fearful response. Body condition was good, ranging from 3-4 on a five point scale (average 3.5).
- ▣ Animals were healthy and not lame.

The health and welfare of the animals in the three silvopastoral farms was higher than in the comparable cattle ranch. The animal-based measures provided evidence for good health and welfare in silvopastoral system. Animals were healthy and had good body condition, despite very high temperatures and dry conditions during the time of the assessment (34°C-41°C). Body condition was better on the silvopastoral farms compared to the control farm (3.5 vs. 2.5), reflecting the control farm animals' thinner, poorer condition. The cattle on the control farm were less calm and showed some fearful response to humans.

Cattle on the control farm showed a range of natural behaviour, but had less opportunity to change their environment.





Silvopastoral systems, disease and welfare – an overview

Professor Donald M. Broom, 2014

The role of health is important as a key part of welfare and for its economic consequences. Diseased animals very often have difficulty in coping with their environment, or fail to do so, hence their welfare is poorer than that of a healthy animal in otherwise comparable conditions. While this case study did not look in detail at animal disease, there is a body of scientific evidence showing the effect of intensive silvopastoral systems on animal disease.

Intensive silvopastoral systems alter the livestock environment in ways that affect disease, and hence welfare. In tropical and sub-tropical environments, some important disease-causing agents are carried to livestock by ticks. Others are carried by insects, such as the head-fly *Hydrotaea*.

In some areas, the most important causes of poor welfare are diseases caused by ticks or insects. Intensive silvopastoral systems have increased numbers of birds, lizards, large insects and other predators which consume ticks and harmful insects.

The more complex soil fauna in intensive silvopastoral systems may also encourage animals that reduce numbers of harmful insects. Livestock disease transmitted by ticks and insects has been demonstrated to be less in silvopastoral systems.

The consequences of poor welfare reduce resistance to disease. Poor welfare resulting from a wide variety of different causes may make disease more likely, often by initiating immunosuppression. This can be a consequence of an environment that is difficult, perhaps because the individual has little control over it, and this has further pathological consequences.

On the other hand, good welfare can help to protect individuals against disease. Positive behavioural and mental responses can increase the likelihood that the individual will succeed in coping.

Livestock in silvopastoral systems have better control of their immediate environment, more normal social interactions and hence have better welfare and more resistance to some diseases than animals in pasture-only systems.

This is a second reason for lower levels of disease reported in silvopastoral systems. The data supporting this come largely from tropical and sub-tropical countries, but all of the benefits, except that of predation on ticks, would also be likely to be important in temperate countries.

3. Resilient and sustainable environment

Intensive silvopastoral systems provide enhanced habitat and food resources for birds, mammals, and invertebrates due to the structural and biological complexity with several species of grass, shrubs and trees. Deep-rooted trees contribute to recover nutrients and water from deeper soil layers increasing tolerance to drought and biomass production and carbon sequestration both below and above ground.

Silvopastoral systems in the southwest of Colombia have five times as many bird species as pasture monocultures in the same region. Ant richness was 62% higher in intensive silvopastoral systems (Rivera et al., 2014). Dung beetle abundance and diversity were more than two times higher in relation to pasture monocultures (Giraldo et al., 2010). This increased diversity plays an important role in biological control of plant pests and cattle parasites. In El Hatico, bird and spider richness is higher in the intensive silvopastoral system than in surrounding land uses of the farm.

These farming systems also help in soil conservation and recovery. As observed in the case study at La Luisa, these systems can help in restoring degraded soils by reducing erosion, increasing soil fertility and resilience to drought.

Having fodder trees associated with pastures increases the content of organic matter and soil nutrients such as phosphorus. The presence of nitrogen-fixing legumes and other tree species and the continuous rotation of cattle also improves production and nutrient cycling and eliminates the need of chemical nitrogen fertilizers. The presence of trees could also lead to an increased soil humidity through reduced evaporation under the canopy, which increases grass growth and resilience to drought.

These systems produce more dry matter, digestible energy and crude protein per hectare. They also increase milk and meat production as observed in the case studies conducted. This leads

to lower methane emissions (per kg of milk and/ or beef produced) as the fodder quality has improved.

The intensive silvopastoral system also could play an important role in erosion control. It could protect the soil from direct effects of sun, wind and water by reducing rain impact, increasing infiltration and the stability of the organic matter. Silvopastoral systems can also give soil higher infiltration rates, improving its ability to retain water, reduce runoff, and contributes to the regulation of water cycle.

Intensive silvopastoral systems – delivering a triple win for economics, environment and animal welfare

The case studies provided evidence for the ability of intensive silvopastoral systems to create 'triple-win' solutions for sustainable livestock production: productivity and profitability gains; environmental improvements and animal welfare benefits. The uptake of silvopastoral systems has been limited by the level of investments needed, limited access to capital for smallholders and perceived investment risk.

As intensive silvopastoral systems are management-intensive, capacity building via extension and advisory services is a key component of successful delivery. Targeted investment early in establishment of the silvopastoral system, and an effective capacity building programme, tailoring knowledge development to individual farmers needs can provide increased potential for success.

The benefits for productivity and profitability from such investment are clear and this is an area where international and local policy mechanisms, donors and governments can play a crucial role.



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Project partners of the silvopastoral project



FEDEGAN-FNG

The Colombian Cattle Ranching Association - National Cattle Fund is a non profit trade association founded in 1963 that brings together regional and local cattle associations and other entities involved in cattle ranching activities



The Centre for Research on Sustainable Agricultural Production Systems, CIPAV is a not-for-profit research NGO based in Colombia with 28 years experience in research, teaching and dissemination of sustainable agricultural solutions for tropical and subtropical areas.



agri benchmark Beef and Sheep Network/ Thünen

agri benchmark Beef and Sheep is a project of the Thünen Institute in Germany. This global, non-profit and independent project, analyses production systems, their economics, drivers and perspectives around the globe.

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