

INTEGRITY



Mixed crop-ruminant livestock systems around the world were characterized

Mixed crop-ruminant livestock production systems are incredibly different around the world. Production systems may vary according to the agro-climatic and socio-cultural region where they are established. Since, nutrient circularity could be improved in these systems, farm typologies in each region need to be studied. For this reason, researchers of INTEGRITY project conducted an investigation to describe representative mixed crop-ruminant livestock systems in their home countries. This activity is part of Work Package N°1, which aims to investigate different management practices at diverse agricultural systems to enhance nutrient circularity, production efficiency, and reduce C footprint. Data to characterize representative mixed crop-ruminant livestock systems was obtained from different national bodies, local or regional statistics sources, and directly from stakeholders using a multi-stakeholder and expert participatory approach. Description per mixed crop-ruminant livestock system considered in the present study included biotic and abiotic factors, management practices, historical management and time-sequence for the crop and pasture rotations. Other practices such as tillage, fertilization (rates, sources, timing), weed and pest control, herd management (breeding, calving, weaning), stocking rate, grazing management, supplementation (type, level, management), among others were also identified. Main results per country are presented as follows:

Argentina:

The representative mixed crop-beef production system in the Southwest Pampeana region is a complete-cycle system, including the cow-calf, rearing, and finishing phases. The typical crop rotation of this region consists of 60% fodder crops such as oats, grain production for both animal feeding (mainly corn) and cash crops, and 40% sown pastures. The livestock production is characterized by a grazing cow-calf system that has a low-input and technological level for 8 months (weaning age). The forage base has around 80% native grassland and 20% cultivated pastures, with a typical animal stocking rate of 0.6 heads ha⁻¹. The rearing phase has a duration of 12 months, with cattle directly grazing winter fodder crops such as oats for 180 days, and alfalfa-based pastures during the other 180 days in the summer. The finishing phase occurs under confinement (i.e., feedlots) for 60 days supplemented with grains until reaching 420 kg of live weight. In northwestern Argentina's sub-humid and semiarid rangelands, is predominant beef cattle production with Brahman crossbreds (e.g. Braford, Brangus) and farmers operate cow-calf, fattening, and whole production systems with high rainfall variability. These systems are forage-based with introduced pastures such as guinea grass, buffelgrass, and Rhodes grass with a growing phase during the summer (rainy season) and deferred pastures during winter (dry season). Usually, during winter protein or energy-protein supplementation is required to achieve suitable animal performances. The most common supplements are whole cottonseed, soybean expeller, soybean meal, and DDGS.

Argentinian typical dairy farms also are mostly located in the Pampas Region, with an average stock of 160 cows, reaching 1.4 cows ha⁻¹, mainly with Holstein animals producing about 5,900 L.cow⁻¹ yr⁻¹. Dairy systems are mostly mixed crop systems, with part of the rotation under crop production and the other part with perennial pastures. Most of the production systems are pasture-based with partial mixed ration, with cows grazing all year round in predominantly non-irrigated land. A favorable milk-to-concentrate price ratio (over 1.5) provides farmers an opportunity to incorporate large amounts of supplements and by-products into their diet. Milk production in Argentina has remained stable over the last 20 yr.

Brazil:

Beef cattle livestock is characterized by different production systems, from extensive production (low inputs and low productivity) to intensive production (feed supplementation, feedlot, and high productivity). Regardless of the system type, there is a predominance of forage-based systems, with more than 95% of the beef production systems based on pasture. Meat production (carcass weight) is on average 65.5 kg ha⁻¹ year⁻¹ and 10.32 tons equivalent carcass year⁻¹. The predominant cross-breed for beef production is Nellore (*Bos taurus* x *Bos indicus*). The most used forage as pasture is *Brachiaria brizantha* (52%) and native pasture (38%). A representative crop-ruminant livestock system for the selected region of Brazil for beef production is managed to complete the full cycle of production: breeding, rearing, and finishing with Nellore breed. Soybean is used as cash crop and *Brachiaria brizantha* as pasture for livestock. Between October and February, soybean is cultivated and the remaining area is used for cattle maintenance. After harvesting soybeans, the whole farm is turned into livestock production. The pasture remains for periods from 3 to 4 years. The beef production is characterized by a grazing cow-calf phase that has a high technological level with an animal stocking rate of 2.0 head ha⁻¹. The rearing phase has a duration of 240 days. The finishing phase being in pasture supplemented with mineral salt until reaching 555 kg during 4 months.

Finland:

The average herd size in the national milk recording scheme (covering 73% of all herds) was 53.3 and the mean annual milk yield/cow was 10073 kg in 2021. Predominant breeds are Nordic Red and Holstein. The growing season in Finland is short (125 - 180 days) and the snow cover period is long which causes the need for a long indoor feeding period and quite intensive production. Most Finnish agricultural land is located above latitude 60° N. The climate is under a mixture of continental and maritime influences due to the location between the Eurasian continent and the Atlantic Ocean. Grass silage is the main feed contributing 55-60% of dietary DM and grasslands covers over 30% of agricultural land. Grazing contributes to only ~6% of annual dry matter feed intake of dairy cows. Many of the dairy farms are mixed dairy and crop systems where grass silage and cereals are produced on the farm and additionally commercial concentrates (most often rapeseed-based protein supplements) are used. The most common cereal crops grown for cattle feed are barley and oats. The proportion of commercial feeds in the average dairy cow diet was 31% in 2021. The farm represented is a mixed dairy and cereal farm where cereals are produced for animal feed and cattle is grazing during the summer.

Guadeloupe:

Guadeloupe is a French insular archipelago located in the Caribbean Sea. Guadeloupe encompasses a broad diversity of farming systems engaged at various stages in the agro ecological transition process. Guadeloupean agriculture is mainly based on small MCLS farms, which represent 80% of the farms, with an average size of 4.1 ha. Much of Guadeloupe's agricultural land cover (31,400 ha) is sugarcane and banana, two highly subsidized export crops that represent 45% and 8% of local arable farmland, respectively. Pasture and fallow currently account for close to half of the arable land of the island. Food crops (vegetables, tubers, and plantain), ruminants (mainly cattle, goats, and sheep) and small livestock (poultry, pork, and rabbit), which are less subsidized and oriented to the local market, are often produced along with one or both of the two major exports crops. Farms also include market gardening, orchards, or tuber and fruit outputs. Products destined for the local market do not cover local demand, and so the island is exposed to strong dependence on external sources. The agricultural trade balance shows a large deficit, as 80% of food comes from imports. Moreover, both crop and livestock activities are heavily reliant on increasingly expensive imports of feed concentrates and mineral fertilizers.

Ireland:

Beef production is the most common type of farming in Ireland, with 78,800 (56.4%) of farms falling into this category. Specialist dairying (15,600) and specialist sheep farms (15,000) were the next most prominent types of farming. Beef production in Ireland is characterized by having an array of different production systems. Grasslands contribute substantially to Irish agricultural production systems providing a large proportion of the feed requirements of ruminant livestock. Grassland in Ireland accounts for approximately 92% (3.91 million hectares [ha]) of the agricultural land area. Rough grazing includes grazed unreclaimable bogland, and grazed mountain and lowland partially covered in scrub, bushes or rock. The average proportion of the total grass silage area (1.066 million ha) harvested for first, second and subsequent silage harvests is 78%, 21% and 1%, respectively. The use of other crops, such as maize silage and beet, has declined in recent years. Irish grassland can produce some of the highest non-irrigated herbage yields (12–16 t dry matter (DM)/ha per annum) in Europe. In recent years there has been significant interest in the use of legumes (white and red clover) and forbs as part of mixed species swards.

New Zealand:

Canterbury is the largest region in New Zealand by Regional Council boundaries, and it is of significance to New Zealand's agricultural production. The region comprises a diverse mix of intensive dairy, sheep and beef, and cropping operations on the plains, to extensive sheep and beef farms on high country. The region comprises up to 85% and 63% of the total area in wheat and barley, respectively, and half of New Zealand's area in grain seed and fodder crops is in Canterbury. In the region, the area in wheat dropped to 34,000 ha in 2017, from a high of 47,800 ha in wheat in 2012. In contrast, dairy cattle numbers in Canterbury continue to rise (the region currently carries 20% of the national herd), compared with a relatively steady trend in New Zealand's dairy herd numbers. Canterbury accounted for almost two thirds (478,000 ha) of the total consented water volume for irrigation (Ministry for the Environment and Statistics NZ, 2017). Almost 95% of irrigation in Canterbury is under a spray system.

Peru:

The lowland humid tropics is the largest ecoregion in Peru, found between 80 and 1,000 meters above sea level (masl). The region has an average temperature of 31°C, high relative humidity (higher than 75%), and a yearly rainfall of approximately 1,000 mm. Soil in this province reports on average an acid pH (4.8), high organic matter content (4.3%), low phosphorus (2.36 ppm) and low to medium potassium (114 ppm) levels. Some by-products such as: broken rice, rice polishing, coffee pulp, cacao husks and coconut cake are used by farmers as a complementary source of energy and protein. Traditional animal production systems in the Peruvian Amazon region are based on monoculture of grasses, with seasonal variation in forage availability, lack of fertilization and inadequate grazing management, resulting in high rates of land degradation and soil erosion. Cattle production is based on low capital investment and is viewed by farmers as a low-risk activity compared with crops that are subject to price volatility. However, poor land management has led to overall low productivity, low economic feasibility, vulnerability and extensification of livestock systems and rural poverty and malnutrition, increasing the need for farmers to continue deforesting while trying to benefit from the temporal higher fertility of recently open land. Predominant livestock types in the Peruvian Amazon region are Zebu hybrid-mixes. The land area of livestock farms in the Amazon region is on average 25.4 ha/farm, with a herd size of 10.6 animals/farm, production per lactating cow of 8.0 kg milk/d, and an average carcass weight per beef animal (more than 2 years of age) of 134.3 kg. These traditional livestock production systems are currently being improved by the implementation or conservation of silvopastoral systems (SPS), defined as the intentional integration and management of grass, livestock, and trees.

United Kingdom:

The representative mixed crop-ruminant livestock system in the United Kingdom for sheep production is characterized by a stratified three-tier breeding structure. The overwhelming purpose is to produce meat (mainly lamb), with wool as a co-product. The system combines different breeds to develop hybrid vigor and make best use of available land at different altitudes. Hill farms produce ewes that are sold to upland farms where they are crossed with high genetic merit rams to produce ewes that are, in turn, sold for breeding to lowland farms and crossed with a terminal sire breed to produce crossbred lamb for meat. Most male lambs on lowland farms can be finished before the end of summer, whilst lambs from upland and hill farms must be sold to lower land farm to be grown and finished over winter, or kept as stores at maintenance rations until being finished the next spring. The breeding season starts in autumn, when rams and ewes will remain together for 6 to 8 weeks. Around 40 or 90 days of gestation, ewes are scanned and usually split into groups according to the number of lambs they are carrying to make sure of getting the right management and diet for their needs. Between 8 and 14 weeks of age, lambs are weaned from their dams and grazed on pastures of good quality. In the UK, sheep grazing management target opening covers of 2,200 kg per hectare and aim to graze down to 1,600 kg per hectare. Over the summer, lambs growth between 0.10 and 0.19 kg/d, for hill and lowland farms respectively. Lambs for the meat market are generally sent to slaughter at five to eight months of age, which will depend of the weather and quality of grass over the summer. Generally, lambs sent into the food chain weight around 40 kg.

Uruguay:

In Uruguay, the dairy production sector is made up of 3,300 dairy farmers, of which 73% send their production to the dairy industry and the remaining 27% produce artisan cheese on their own farms. The sector employs, directly and indirectly, a total of 20,000 people (INALE, 2019). Family labor predominates on dairy farms, while in manufacturing industry most workers are hired on a permanent basis. Dairy cattle graze pasture outdoors all-year-round and belong to breeds with internationally recognized genetics, predominantly the American-Canadian Holstein breed (78%), the New Zealand Holstein breed (13%) and the Jersey breed (3%) (INALE, 2019). More specifically, the Holstein breeding is characterized by 1178 days of lactation producing a total of 22,998 kg of milk. This production is organized around 4 breedings, the cow being culled 1 month after the 4th breeding (MU, 2019). Unlike beef cattle production systems that predominantly graze on native grasslands, the Uruguayan land use management of dairy systems is characterized by a four years of temporal pasture followed by annual winter pastures (e.g. oat) and 2-3 years of cultivated grain-crop for silage (e.g. sorghum/maize) (DIEA, 2019). It is important to note that 100% of the livestock is registered and under a traceability system. The farm selected as representative of Uruguay mixed crop-ruminant dairy livestock system is characterized by having 150 milking cows on an area of 250 hectares with a production of 18 L of milk per cow per day (INALE, 2019).



Finland: Dairy farm production



Peru: Silvopastoral system in the Amazon region



United Kingdom: Livestock system for sheep production



Argentina: Beef production system in the Northwestern region