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Grazing Animal Husbandry Based On Sustainable Nutrient Management

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Abstract:
According to per capita intake of animal protein is predicted to extend globally through 2050, and therefore the rate of increase are going to be more in developing or emerging economies than in developed countries. Global meat consumption between 1980 and 2050 is projected to extend from 133 million to 452 million tons, and 86% (279 million tons) of the rise will occur in developing countries. Animal-based agricultural systems occupy 45% of the worldwide acreage and contribute an outsized proportion of agricultural emissions. Additionally to being a serious source of nitrous oxide (N_2O), methane (CH_4), and other greenhouse gases (GHGs), livestock also use 8% of the worldwide water withdrawal. The animal sector is dominated by resource-poor and little landholders of developing countries. Adverse effects of livestock on the environment are caused by the way farming is practiced, in no small part because animals aren't integrated with other agricultural and forestry-based practices. Incorporating pastures/forages within the rotation cycle along side controlled grazing, called ley farming, and agroforestry, like alley cropping, are samples of integrated farming systems. Other strategies of reducing the environmental footprint comprise the following: reducing enteric fermentation by precision feeding and matching dietary protein to animal need, processing CH_4 and N_2O emissions for other uses, and managing manure and other animal waste prudently. Other important considerations are adopting multiple GHG perspectives and minimizing gas swapping, reducing wastage of animal products, decreasing the utilization of antibiotics, and restoring rangeland for sequestration of atmospheric CO_2 as soil organic matter.
Keywords: *Grazing animal husbandry, nitrous oxide, methane, greenhouse gases, farming systems.*

I. Introduction

Over millennia, the cultivation of crops was closely integrated thereupon of raising livestock. Since the mid-twentieth century, however, the separation of raising livestock from the growing of crops has caused environmental issues like the degradation of soil health, eutrophication of water, emission of greenhouse gases (GHGs) into the atmosphere, and loss of biodiversity (Peyraud et al., 2014).

Raising livestock separately might not be a sustainable option (Broom et al., 2013) economically, pedologically or ecologically. In sight of the various demands of the growing and increasingly affluent human population, achieving food and nutritional security is seemingly at odds with the need of reducing the negative environmental footprint of agriculture. a crucial explanation for this dilemma could also be the simplification of agro-ecosystems, and therefore the attendant decline in diversity of farming systems at the soil scape, landscape, and therefore the farm scale (Lemaire et al., 2014). The adverse effects of livestock on the environment are attributed to the way during which the animals are raised, and such issues are often addressed (Dalibard, 1995). In some climates and landscapes, separating livestock from crops and trees is a crucial explanation for the decline in diversity at the farm scale, with the attendant adverse impacts on the environment. Such a simplification and loss of biodiversity also results in decoupling of the cycling of carbon (C) from those of water (H_2O), nitrogen (N), phosphorus (P), and sulfur (S) (Lal, 2010). Cycles of N and C, closely connected to livestock's role in land use and land use change (Steinfeld et al., 2006), could also be decoupled by this simplification of the farming system. Emission of GHGs (i.e., CH_4) is exacerbated when ruminants are concentrated, which tends to uncouple the C and N cycle by releasing the digestible C as CO_2 and CH_4 and digestible N in waste as N2O (Soussana and Lemaire, 2014).

II. Objectives

The objectives of this paper are to discuss: (1) the potential and challenges of accelerating food and nutrition for the growing human population by raising livestock, (2) the livestock sector and therefore the Sustainable Development Goals (SDGs) of the United Nations , (3) the conceptual basis of integrating livestock with crops and trees to extend the biodiversity of farming systems, (4) the choices for sustainable management of grasslands for food and climate security, (5) the potential of integration of livestock with crops and trees to sequester carbon and reduce gaseous emissions, and (6) improved management of livestock within the tropics.

III. Challenges of accelerating Food and Nutrition

Fears of widespread famine were aggravated by the rapid increase during the 1950s and 1960s (Ehrlich, 1968). The human population of 2.56 billion (B) in 1950 increased to three .04 B in 1960, 3.71 B in 1970, and 4.34 B in 1980 at the 10-year rate of growth of 18.9, 22.0, and 20.2%, respectively. The fears of widespread famine were averted by the spectacular increase in yields of cereal crops, achieved through the revolution during the 1960s (Pingali, 2012). However, the planet population has increased to 7.8 B in 2020 and is projected to be 9.8 B by 2050 and 11.2 B by 2100 (UN, 2019b). Whereas 820 million people are susceptible to undernourishment (FAO, 2017), about 2 B are affected by malnourishment due to deficiencies in protein, micronutrients, and vitamins (Ritchie and Roser, 2019). However, the livestock sector can play a crucial role in eliminating hunger and malnourishment.

The strong nexus between livestock and anthropogenic global climate change can neither be denied nor ignored. Indeed, livestock impact global climate change , and therefore the rapidly changing climate is additionally impacting livestock. it's precisely during this context that integrating livestock with crops and trees can play a crucial role in re-greening of the earth (Janzen, 2011). Harnessing the positive effects of livestock-based farming systems (e.g., nutritious food, eliminating hunger and hidden hunger) can cause sustainable management of crops and trees and reduce the environmental footprint of farming (Herrero et al., 2009). additionally , sustainable management of rangelands by adopting ecologically based principles of farming can strengthen the provisioning of ecosystem services (ESs) from these fragile and ecologically-sensitive but economically important ecoregions (Havstad et al., 2007).

IV. Livestock Sector and Sustainable Development Goals of the United Nations

The highly dynamic livestock sector is rapidly changing in response to the ever-increasing demands of the growing population, especially in developing countries. Thus, judicious management and eco-intensification of livestock-based systems also can address the daunting challenge of advancing the SDGs of the United Nations (Figure 1) because site-specific integration of crops with livestock is critical to advancing several SDGs. Specifically, prudent management of livestock can advance SDG #1 (No Poverty) by improving income of small landholders also as that of economic farmers. For little landholders in developing countries, livestock aren't only a source of nourishment, they're also a source of renewable energy through draft animals, use of dung as household fuel, and also a source of manure as an amendment for crops. Additionally to addressing the vulnerability of 820 million under-nourished people, most of them concentrated in South Asia and Sub-Saharan Africa, judicious production and use of animal-based diet also can alleviate malnutrition (hidden hunger) affecting 2 B people globally. Thus, livestock are critical to advancing SDG #2 (Zero Hunger).

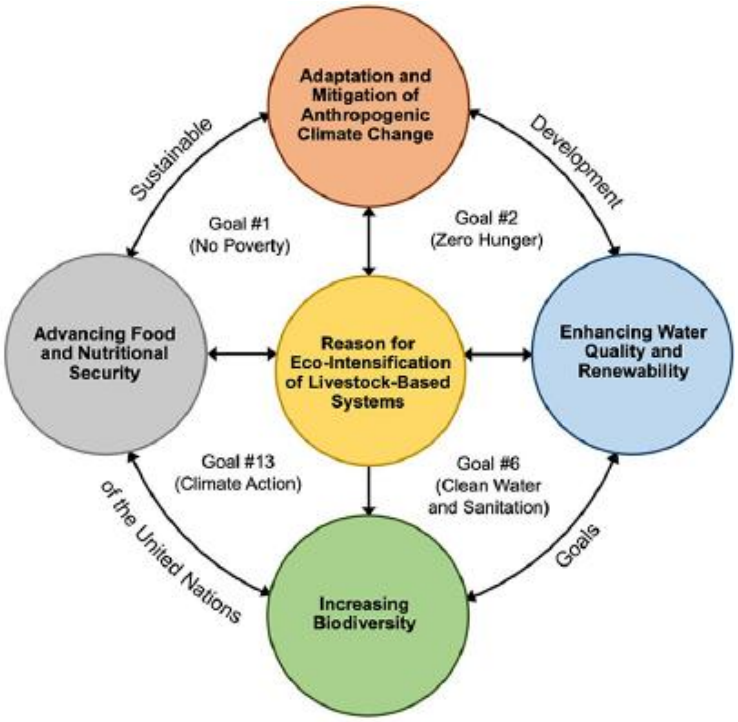

Figure 1 : Eco-intensification of livestock-based systems to advance the Sustainable Development Goals of the United Nations.

The livestock industry, which consumes 8% of the worldwide water system (Schlink et al., 2010), features a strong impact on SDG #6 (Clean Water and Sanitation). Livestock production involves the utilization of both blue and green water (Falkenmark, 2003). Nearly one-third of the entire water footprint of agriculture within the world is said to animal products (Mekonnen and Hoekstra, 2012), and beef features a larger water footprint than poultry and pork (Gerbens-Leenes et al., 2013). Therefore, reducing the water footprint of livestock, a crucial consideration of eco-intensification of livestock-based systems (Doreau et al., 2012), can advance SDG #6. Judicious management of livestock and rangelands is critical to improving the standard and renewability of water through buildup of soil organic matter content which will enhance soil water storage and denature and filter pollutants.

V. Conceptual Basis of Integrating Livestock with Crops and Trees

Livestock use 30% of the Earth's entire land surface as permanent pastures; 33% of arable land is employed to supply feed for the livestock (FAO, 2006), and thus livestock have an outsized environmental footprint (Smith et al., 2013). Pelletier and Tyedmers (2010) projected that the livestock sector will even more strongly impact the environment by 2050 with regards to 3 issues: (i) global climate change , (ii) reactive nitrogen mobilization, and (iii) appropriation of plant biomass at a worldwide scale. Pelletier and Tyedmers also predicted that the livestock sector alone may overshoot humanity's "safe operating space" by 2050 in each of those three domains. While (FAO, 2006) estimates within the report "Livestock's Long Shadow" are strongly debated, emissions of GHGs from the livestock sector, especially that of CH_4 and N_2O, are often reduced and managed by adapting the integrated systems presented herein. It's also pertinent to carefully choose site-specific sustainable livestock production to scale back or mitigate emissions, and to develop policies that promote global climate change adaptation and mitigation options. Some concerns about the impacts of animal-based diet (Pitesky et al., 2009; Gerber et al., 2013b; Eshel et al., 2014; Hedenus et al., 2014) are often addressed through a judicious integration of crops with livestock. The latter can cause a rise within the quantity and quality of food production and economic returns while also reducing pressure ashore and water resources (Franzluebbers, 2007).

Integrated system	Description
Sod-based	2–10 years of sod rotated with 1–8 years of cropping, or sod-inter-cropping
Cover crops as forage	Cover crop grazing by livestock to accomplish both production and soil conservation objectives
Ley farming	The growing of grass or legumes in rotation with grain crops as a soil conservation measure and to enhance soil fertility
Pasture cropping	Land management system that integrates cropping with pasture production and allows grain cultivation as a part of perennial agriculture
Dual purpose cereal crops	Growing of cereals (i.e., wheat, rye) as pastures from late autumn to early spring and then harvesting for grains
Agroforestry	Intentional integration of trees, forages, crops, and livestock with specifically designed spatial arrangements
Alley cropping	Planting rows of trees at wide spacings and on contour with grain crops grown in the alleyways between the rows. Trees are specifically chosen for fodder, biological nitrogen fixation, fuel wood, or fiber.

Table 1 : Examples of integrated livestock systems with crops and trees (Compiled from Kang et al., 1990; Leakey, 1996; McCown, 1996; Bajracharya et al., 1998; Garrett et al., 2004).

Most emissions from the cattle area arise in commodity (meat, milk) manufacturing or the supply-aspect. However, gaseous emissions also are suffering from the demand-aspect, or the purchaser population, which isn't simplest developing in numbers however is likewise present process a vitamins transition in prefer of the animal-primarily based totally diet. Therefore, numerous research have advised that simply addressing the supply-aspect emissions from the cattle area can be inadequate to restriction the temperature upward thrust to

<2°C, and addressing the demand-aspect is likewise necessary. Indeed, demand-aspect mitigation measures—which include options for a plant-primarily based totally diet, at the side of consuming extra fowl and fish than purple meat, or grass-fed in place of grain-fed meat – have a more ability to lessen emissions (1.5–15.6 Gt CO_2-eq /yr) (1 Gt = gigaton = billion ton) than do supply-aspect measures (1.5–4.3 Gt CO2-eq/yr) (Smith et al., 2013). An included and sensible control of plants and cattle might also additionally mitigate a number of the terrible environmental influences at the supply-aspect whilst plants are grown one after the other from that of elevating the cattle (Herrero and Thornton, 2013).

Models are wished for simultaneous quantification of C and N flows and the way they're suffering from exceptional cattle-crop-tree control structures. Several whole-farm primarily based totally fashions have attempted to estimate gaseous emissions (Snow et al., 2014), however there may be a want for extra facts on nutrient and C flows at the sphere level (Snow et al., 2014).

VI. Options for Sustainable Management of Grasslands for Food and Climate Security

Site-precise alternatives are wished for sustainable intensification of cattle structures in numerous socio-monetary and biophysical areas vulnerable to weather extrade. For instance, cattle-primarily based totally structures occupy 45% of the worldwide land area; grasslands/savannas appropriate for grazing cowl 37% of Earth's floor area (NAS, 2015). These ecosystems are fairly numerous and arise withinside the seasonally dry tropical to sub-tropical equatorial areas. Savanna ecoregions, open-cover and hearthplace-established biomes, also are vulnerable to weather extrade that can modify phenology, root-water get right of entry to and hearthplace dynamics. Principal environmental drivers affecting biomass/feedstock productiveness in savanna areas are water and nutrient availability, vapor strain deficit, sun radiation and hearthplace (Devi Kanniah et al., 2010). Therefore, knowledge those controls and their control via eco- intensification is essential for boosting internet number one productiveness (NPP) beneathneath the converting worldwide environment (Kanniah et al., 2013). Important controls encompass restoring soil functions, retaining water to reduce the dangers of drought, and adopting advanced species of forages and meat of higher dietary best (Herrero and Thornton, 2013).

VII. Integrating Livestock with Crops and Trees to Sequester Carbon and Reduce Gaseous Emissions

Restoration and sustainable control of grasslands can play an essential position in variation and mitigation of weather extrade (Lal, 2008). Technical ability of C sequestration in worldwide savannas, via land healing and included control of cattle with plants and timber, may be as plenty as 2.55 Gt C/y (Table 2). Pertinent animal feeding strategies (e.g, use of flax seeds, protein-extensive forages) can lessen enteric CH_4 and NH_3 emissions. Above all, carbon sequestration in grass—via way of means of planting species with excessive biomass manufacturing and organic nitrogen fixation, together with timber like Acacia albida and Leucaena leucocephala in west Africa (Kang et al., 1990; Pieri and Gething, 1992; Soussana et al., 2010)-is an essential choice to lessen internet emissions from the cattle area. In addition, recycling of cattle manure in a whole-farm perspective (Petersen et al., 2007) can lessen enter of fertilizers in croplands.

Ecosystem	Area (10^6 km^2)	Estimated carbon sink (Gt C/y)	Average carbon sink (ton C/ha·y)
Tropical savannas and grasslands	27.6	0.39	0.14
Temperate grasslands	15.0	0.21	0.14
Tropical forests	10.4	0.35	0.34
Boreal forests	13.7	0.47	0.34
Mediterranean shrublands	2.8	0.11	0.38
Crops	13.5	0.20	0.07
Deserts	27.7	0.20	0.07
Total	149.1	2.55	—

Gt = gigaton = billion ton.

Table 2 : Global land area under grasslands and the estimates of C sequestration (Adapted from Grace et al., 2006; Lal, 2008).

Adaptation and mitigation of weather extrade withinside the farm animals quarter calls for translating of technology into motion via way of means of coverage interventions that take away obstacles to imposing validated technology (Smith et al., 2007). Appropriate coverage interventions are mainly essential in growing international locations for reaching sustainable control of rangeland due to ecologically fragile and climatologically harsh environments. In India, for instance, general annual CH_4 emissions, anticipated at 9–10 Tg (Tg = teragram = 1 million ton) from enteric fermentation and animal waste (Sirohi and Michaelowa, 2007), may be decreased via way of means of suitable coverage interventions inclusive of bills for provisioning of atmosphere services.

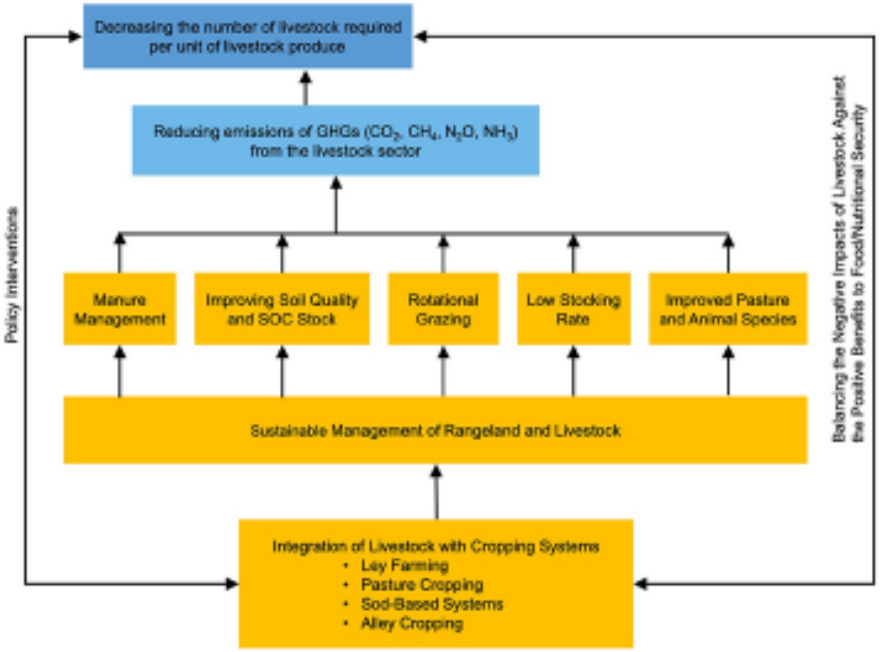

Figure 2 : A flow chart depicting the integration of livestock with arable land use for decreasing the number of livestock required (SOC, soil organic carbon; GHGs, greenhouse gases).

The schematic in Figure 2 depicts the pathways of reducing the environmental footprint of farm animals products. Conceptually, selecting a farm animals product with a decrease emission footprint for a weight loss plan might lessen the general poor effect on weather and the environment. The environmental footprint of a nutritional product may be expressed in 3 ways (de Vries and de Boer, 2010): (i) according to kg of product, (ii) according to kg of protein, and (iii) according to kg of common every day consumption of every farm animals product. Based at the lifecycle analysis (LCA) of sixteen research performed in OECD (Organization for Economic Cooperation and Development) international locations, de Vries and de Boer (2010) decided that the land and power use and the GWP for 1 kg of product observed the order of beef > pork > fowl. This order turned into primarily based totally on variations in feed efficiency, enteric CH4 emission, and replica rates. Similar traits had been suggested via way of means of (Eshel et al., 2014).

Emissions of all gases (CO_2, CH_4, N_2O) are used to compute CO_2 equivalents (Lal, 2004). Direct emissions of CH_4 and N_2O withinside the farm animals quarter should be decreased. In this context, a couple of GHG attitude should be adopted (Figure three) due to the fact CH_4 has a GWP of 21 and N_2O of 310. Because of the excessive GWP of CH_4 in each constrained and grazing structures, steps should be taken to broaden credible techniques of measuring CH_4 emission via way of means of ruminants, and to lessen enteric fermentation via way of means of ruminants. Precision feeding, matching feed consumption with the want of the animal (Gerber et al., 2013a), and the selection of forages also can lessen the gaseous footprint. For instance, the mixture of noticeably digestible foragesthat incorporate secondary compounds inclusive of tannins also can reuce methane emissions. The couple of GHG attitude is an essential method that could deal with the capability pollutants swapping-a discount in a single fueloline can result in emission of some other (Gerber et al., 2013a). Thus, a complete accounting of all GHGs is required (Soussana et al., 2007).

VIII. Improved Management of Livestock withinside the Tropics

Livestock are an essential issue of agroecosystems withinside the tropics and adopting progressive farm animals/farming strategies can beautify manufacturing and decrease environmental footprints. Judiciously combining vegetation with farm animals in the equal panorama has severa co-blessings (Gil et al., 2015). For

instance, ley farming (Carberry et al., 1996; McCown, 1996), related to mild grazing of legumes grown in rotation with vegetation, is a pertinent method for integrating vegetation and farm animals. Built at the idea of ley farming, pasture cropping is a farmer-initiated idea of sowing a winter-lively cereal right into a summer-lively local perennial pasture (Millar and Badgery, 2009). Self-regenerating annual legume pastures (Puckridge and French, 1983) can beautify soil fertility and boom cereal yield, along side extra forage for sheep and livestock manufacturing. Ley farming, advanced in Southern Australia because the 1930s, is likewise applicable to comparable areas in Sub-Saharan Africa, South/Central Asia, and the Caribbean. However, soil/webpage unique alternatives of legumes and grazing patterns/depth should be identified.

The severa blessings of ley farming include (Bell et al., 2010): (i) improving soil N for the following crop, (ii) sequestering SOC and off-placing emissions, (iii) controlling weeds and different pests, (iv) minimizing dangers of runoff, soil erosion, and deep drainage, (v) growing farm animals manufacturing, and (vi) maintaining crop yield. However, numerous demanding situations exist. Successfully imposing ley farming consists of a crucial appraisal of the following (Bell et al., 2010): (i) addressing problems with pasture establishment, (ii) suppressing/getting rid of pasture flowers earlier than seeding vegetation, and (iii) decreasing opposition for water and a few plant nutrients. Site-unique preference of pasture species is crucial.

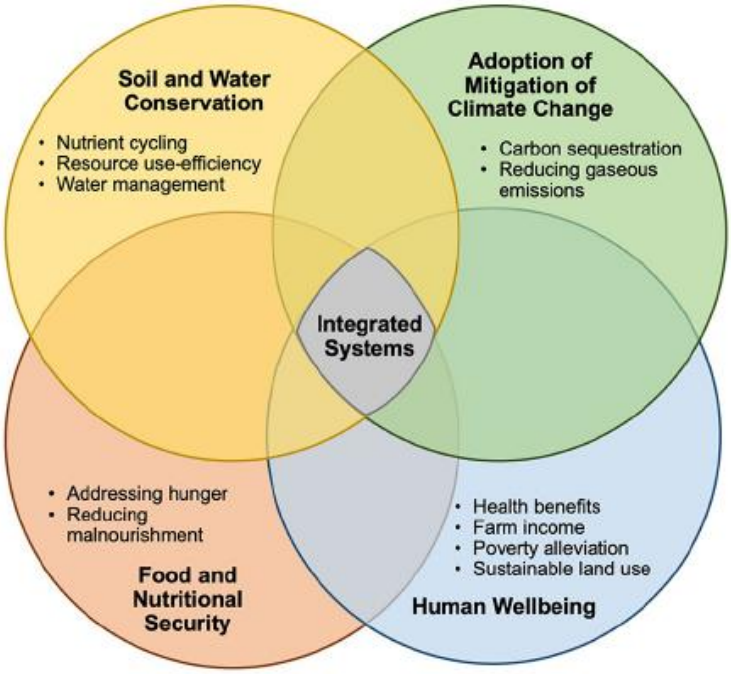

Figure 3 : Ecological and socio-economic benefits of integrating livestock with crops and trees.

Successfully integrating vegetation with farm animals has severa monetary, ecological, and different blessings (Figure 3), mainly in growing international locations of the tropics (Herrero et al., 2013). Important amongst those are: (i) developing some other earnings circulation for farmers and assuaging rural poverty (De Haan et al., 2001), (ii) growing a protection internet for the bad and mainly girls farmers, (iii) improving belongings for farmers, and (iv) assuaging malnourishment (Figure 3). However, farm animals want extra land, water, nutrients, and forage resources. Therefore, really appropriate control of the increase of this quarter is crucial, mainly for decreasing environmental footprints. These technical dimensions should be objectively taken into consideration in the context of institutional support (market) and the human dimensions (Tarawali et al., 2011).

IX. Conclusions

Intensive farming, that's designed to provide big quantities of financial meals to satisfy the needs of the developing and an increasing number of prosperous human populace via way of means of the use of excessive inputs on small areas, has its deserves and demerits. Intensification of vegetation and cattle structures have substantially improved according to capita meals manufacturing for the reason that 1960s. However, the environmental footprint of cattle zone need to be decreased via way of means of lowering soil degradation, growing water and nutrient use efficiency, lowering eutrophication of water, lowering pollutants of air, and minimizing the dangers to international warming.

These efforts may be more suitable via studies priorities recognized via way of means of The Committee on Consideration for the Future of Animal Science Research (NAS, 2015). They include: (1) figuring out suitable mixes of intensification and extensification required to concurrently boom manufacturing and decrease environmental footprints in specific areas for the duration of the world, (2) improving sustainability of medium- and smaller-scale producers, (3) growing coverage interventions to optimize call for animal products, and (four) comparing environmental influences of numerous cattle-primarily based totally manufacturing structures.

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