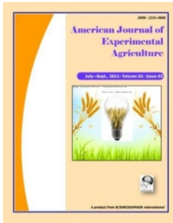

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Challenges Facing Pasture In The Context of Agricultural Multifunctionality In Brazil

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Authors' contributions

This work was carried out in collaboration both authors. Both authors read and approved the final manuscript.

Review Article

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ABSTRACT

The concept of multi functionality of agriculture, of European origin, is an expanded form of addressing agriculture in relation to the traditional perspective, which in turn, focuses on the economic aspect, the production of food and fiber for the market, whose values are regulated based on market transactions. When talking about multi functionality takes into account that agriculture today, not only provides agricultural products (basic function), but also performs other functions, such as environmental or ecological, social and territorial. In this context, the rationalisation of land use is necessary and strategies of use leading to greater economic improvement that respect the environmental medium are necessary to ensure the sustainability of farmers. Among the alternatives for developing competitive, sustainable livestock with minimal environmental impact are crop-livestock integration, silvopastoral systems, agrosilvopastoral systems, integrated systems of cattle-sheep-goat production, rural tourism, organic crop and livestock technology, cooperation systems and most recently, the international burden for carbon sequestration by pasture. There are differences formed by agricultural multi functionality with the emphasis on sustainability of livestock through tropical grazing, and the rational use of different values from Brazilian agricultural properties to generate savings and subsistence for both producers and the environment.

Keywords: Agricultural products; environmental; livestock; sustainability.

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1. INTRODUCTION

The vision of agricultural multi functionality began in France in the twentieth century, and has spread across Europe [1]. Issues that have arisen include war, famine, xenophobia and most recently, the European idea that agriculture is a different industry from others on account of its multi functionality from some arguments commonly made by producers and national governments developed in defence of the idea of auto-sufficient food.

The notion of agricultural multi functionality is a form extended from considering agriculture in relation to the traditional perspective, which in turn was central to the economic aspect, in food and fibre production for markets, where values are regulated by merchant transactions [1].

When talking about multi functionality, it takes into account that nowadays agriculture not only provides agricultural products (basic function), but also performs other functions to the ecological, territorial and social environments [2]. The environmental function is related to the production of public goods that do not abide by market rules, such as shaping the rural landscape, conserving soil, sustainably managing natural resources and preserving biodiversity. The social function, another type of agricultural product, relates to the contribution for socioeconomic viability in rural areas, notably the creation of jobs and the maintenance of the rural social fabric [3,2].

The theme has taken different dimensions and has been debated by the international community, in which proponents claim that these attributes are positive components of agriculture, deriving the argument that the sector deserves greater support and protection [1,4]. In addition, it is evident that no producer can act as an environmental or landscape guardian, without the knowledge of its importance and a minimal salary for this. In a general sense, the salary earned by the animal product sales generated is low in the case of livestock. Importantly, even if they know the importance of the native systems in ecological ecosystem maintenance in determining Brazilian territorial regions, it must be admitted that the economic pressure for transforming biomes can only be reversed if there are economical alternatives which ensure the permanence of the established livestock industry.

In this context, the rationalisation of land use is necessary and strategies of use leading to greater economic improvement that respect the environmental medium are necessary to ensure the sustainability of farmers [5]. Among the alternatives for developing competitive, sustainable livestock with minimal environmental impact are crop-livestock integration, silvopastoral systems, agrosilvopastoral systems, integrated systems of cattle-sheep-goat production, rural tourism, organic crop and livestock technology, cooperation systems and most recently, the international burden for carbon sequestration by pasture.

This review’s purpose is the establish practical implications on the multi functionality of tropical agriculture based on livestock grazing as a mainstay in the basis of production process.

2. IMPORTANCE OF PASTURE SUSTAINABILITY

Within the concept of agricultural multi functionality, it is evident that sustainable management of the pasture ecosystem is the first step to establish rational farming with good subsistence.

The concept of sustainability is broad, dynamic and holistic, including concepts of ecological character, economics and human equity. In general, this consists of the rational use of natural resources to satisfy the necessities of the present generation without compromising the ability of future generations to satisfy theirs [6].

In this concept, grazing has to be properly introduced to the production system. Production systems are however very complex and dynamic with seemingly many diverse interacting farm system factors such as soil, plants, animals, the climate and human intervention. It is normal that changes in these components generate outer modifications. Within this context, forage supply systems need to be established in order to make farming socio-economically competitive and interesting [7,8].

It must be kept in mind however that sustainable production implies that the exploitation of natural resources is done in a balanced manner whilst preserving, and that the production obtained is adequate in quantity and quality, thus benefiting society. The rational use of pastures in Brazil is very important because of the vast area (approximately 180 million ha) and resulting production and social benefits [9].

The actual pasture generation has used the natural resources in rates without precedents; historically these same resources had been degraded and spoiled on a global scale [10]. There has been an increased awareness of this problem and preoccupation in relation to the future, which has generated changes in attitudes by all sections of the community against this process, causing pressure for the development of appropriate technologies for potential use and conservation of these resources for human advantage [11,12].

Literature showed that correct management of pastures excels sustainability, having a direct benefit on production of meat, milk and wool, as well as the environment. As cited by [13] stated that for watershed systems, where pastures were managed adequately and made to conserve soil in the entire area of Paraná state, the turbidity index was 30 in treatment stations, when only in 50% and 5% of the area the indices were 70 and 90, respectively. Aside from an effect on water quality, there was siltation reduction in rivers and dykes.

Tropical pastures constituted of grasses and legumes had the potential to be extremely efficient in utilising and conserving resources, including the natural fertility and addition of nutrients to the existing systems, particularly a strategy for low input agricultural areas or areas of poor soil fertility in the tropics [14]. In this context, the author emphasised the importance of legumes as components of tropical pastures for the maintenance of the level and improvement of litter quality, favouring the recycling of nutrients [15,13,16,17,11,12,18].
In a simulation study, [19] mentioned that for Tropical pastures producing 3 to 2; 2 T DM ha per year require from 15 to 158kg N ha per year, by the medium of biological fixation, indicating that under these conditions, legumes yielding 20 to 45% dry matter of pasture can provide productive and sustainable systems.

3. CROP-LIVESTOCK SYSTEM

Crop-livestock integration is an multifunctional alternative for more sustainable agricultural production in many regions of Brazil, with greater utilisation of nutrients, machines and labour breaking the cycle of invasive species, decreasing the cost of pasture regeneration and increasing the cash flow, generally well divided between the producer and the nation, with more appropriately used environmental resources, particularly when the direct planting system is used.

Crop-livestock integration can be defined as a system which integrates the two activities with the objectives of rationally maximising land use, infrastructure and labour, diversifying and completely integrating production, minimising costs, diluting risks and aggregate values of crop and livestock production, by features and benefits that provide an activity to others. Within this concept, the cropping areas support the livestock by providing feed for the animals in the form of grains, silage and hay from direct pasture; increasing the capacity of property support; permitting the sale of animals in the off-season; and increasing the proportional distribution of yearly revenue [20,5].

Regarding pasture regeneration, the integration of crops and livestock permit the production of supplementary feed for cattle in critical moments and generate revenue through the diminished regeneration costs, the use of fertilisation materials, the control of invasive species and increased efficiency of machine and implement use coupled with the rationalisation of manual labour jobs [21-24].

From this, crop-livestock integration can contribute to the sustainability of agricultural land in a general sense through biological and financial benefits. Despite all the possible advantages of the integrated crop-livestock system, some implications exist which must be taken into consideration including the choice of culture and linked pasture combinations to the production system used, the detailing of crop and animal management practices, the increases in system complexity requiring greater preparation of techniques and products involved, and the acceptance of livestock activity by traditional crop farmers and vice versa [25-27].

This technique adds to the many benefits generated as cited previously, with one particularly important indirect benefit being the recuperation of degraded areas, generating an increased use of land and indirectly avoiding the deforestation of new areas for pasture establishment [20].

Integrated crop-livestock systems (ICLS) out-compete specialized livestock systems but do not show competitive rates of return in comparison to specialized soybean systems. The high demand for capital in ICLS, particularly for the acquisition of growing animals for fattening, explains ICLS' lower return rates and is perceived as a major constraint on the widespread adoption of mixed systems. The design of innovative financing mechanisms will be essential to foster and speed large‑scale adoption of the technology [28].

Some examples of synergistic integration crop-livestock are presented in Table 1. So properly quantify the interactions' between components pasture and crops, giving them values monetary, priority step is to check the actual economic performance of the ICLS specialty [28].

Evaluated the animal performances on renewed pastures [29], substituted despite the use of associated crops corn (RC) or rice (RR), renovated directly (RD) and areas without renovation (TT), in rotational stocking systems and 7% base pasture pressure in Barreirão systems. The authors observed weight gains in Nelore cattle at nine months of age at the commencement of the experiment of 670, 593, 596 and 356kg live weight ha year, respectively for treatments RM, RR, RD and TT. This occurred as a response to the increased carrying capacity during the wet season of the first three treatments. The authors concluded that the renovation strategies shown were able to significantly increase the carrying capacity and earnings per animal and per hectare.

Table 1. Examples of synergistic effects in crop-livestock integration

Benefices	Agronomic effect	Economic impact[1] (US$ ha)
	for livestock farming	
Use efficiency fertilizers	Prevents loss of 800kg ha of soybeans	264.31
Use efficiency fertilizers	Gain 87-1075kg ha of soybeans from 65.00 to 785.00	286.34 a 341.81
White mold (*Sclerotinia sclerotiorum*)	Prevents loss of 394kg ha of bean seed	202.64
White mold (*Sclerotinia sclerotiorum*)	Reduced fungicide applications	87.70 a 167.40
	For livestock farming	
Efeito residual	Residual effect is equivalent to 394kg of nitrogen to the pasture	299.55

[1]A estimated economic impact considered US$ 19.82 per bushel of soybeans, there is US$ 30.83 per bag of beans cost of fungicide application of US$ 83.70 and US$ 374.44 ha of urea. Adapted from [28]

4. SILVOPASTORAL SYSTEM

Similar to crop-livestock integration, the silvopastoral system permits greater rural production in order to maintain families on the field and obtain rational and sustainable dividends. Silvopastoral systems consist of a natural combination or a deliberate association of one or many woody components (trees and/or shrubs) within a pasture of grass or legume (herbaceous or cultivated) species, and their utilisation with ruminants [30,31].

In general, the principal objectives of integration of ruminants to silvopastoral systems are: 1) To produce animal protein without incorporating new areas into the production system; 2) To reduce the costs of control of invasive plant species in the forest understorey via palatable pasture species or damage and trampling of non-palatable species; 3) To reduce the risk of fires by preventing the accumulation and drying of herbaceous vegetation; 4) To accelerate the cycle of biomass nutrients via deposition of urine and faeces; and, 5) To provide additional income via increasing land productivity [32].

Here, the trees that compose the silvopastoral system maintain or increase the chemical and physical characteristics of the soil by the following processes: 1) Increasing the inputs (organic matter and atmospheric nitrogen fixation by legumes and nutrient absorption); 2) Reducing the losses (organic matter and nutrients through recycling and erosion control); 3) Improvement of the physical properties of the soil, including water retention capacity; and, 4) A beneficial effect on the biological processes (nodulation and *Mycorrhization*) [32].

In summary, the trees can influence the quantity and availability of nutrients within the actuation zone of the radical system of associated cultures, principally by the possibility of recovering nutrients below the radical system of pastures and reducing the losses by leaching and erosion, consequently increasing the availability of these nutrients by the increased quantity of organic matter deposited in the soil and by the process of nutrient recycling [33,34,31].

[35] concluded this assumption, stating that the management of the Eucalyptus forests for multiple uses in agroforestry systems with annual crops between the tree lines, during the

first year of forest installation, perennial pastures were later installed for the fattening of beef cattle, presented as a potential alternative to amortisation of initial implantation and forest maintenance costs, permitting a continuing cash flow for long-term forest maturation and hence providing additional income.

[36] experimented with silvopastoral system treatments consisting of three *Eucalyptus saligna* Smith, with 816, 400 and 204 trees per ha with spacing of 3.5 x 3.5, 5 x 5 and 7 x 7 m, respectively. Animal capacity, stocking rate, mean live weight of animals, mean daily weight gain of animals, live weight gain per hectare, rate of increase, total dry matter yield and mean residual forage at 81 days of pasture were measured (Table 2).

It was concluded that the mean forage yield is reduced by the increase in tree density. This forage yield determined the animal capacity and stocking rate, with a decreasing relationship of these variables with an increase in the number of trees per ha. The presence of animals controlling the consumption of understorey herbage through grazing was efficient in reducing the accumulation of vegetative biomass in the understorey, thereby reducing the risk of fire.

Table 2. Effect of three densities of eucalypts on the capacity, stocking rate (SR), mean live weight (MLW), mean daily weight gain (MDG), live weight gain per hectare (G/ha), rate of increase (RI), total dry matter yield (TDMY) and mean residual forage (MRF)

	Density (trees ha)		
	816	**400**	**204**
Capacity (animals ha)	262.91	483.92	558.23
SR(kg ha day)	309.2^{B}	586.2^{A}	698.5^{A}
MLW (kg animal)	27.61	28.64	30.37
MDG (g animal day)	-2.93	-18.33	8.63
G/ha (kg ha)	-7.83^{B}	-7.27^{B}	4.66^{A}
RI (kg ha day DM)	5.92	31.99	28.15
TDMY(kg ha DM)	175	767	675
MRF (kg ha DM)	1212	2148	2613

Values with the different letters in the same line are significantly different P<0.05
Adapted from [36]

5. AGROSILVOPASTORAL SYSTEM

The agrosilvopastoral system is another multifunctional alternative to rational land use, constituting crop integration of forest species with agricultural species and pasture for bovine production, incrementally over time [29,25,18,37]. [38] Described agrosilvopastoral systems as particularly important for the cultivation of eucalypts by showing greater biodiversity over time, providing greater improvement of both horizontal and vertical resource buildings and applying inputs to improve the efficiency of the forest and agricultural plants and animals. Further, from an economic point of view, the producer can obtain important intermediate revenue from the rebate of forest clearing costs (if performed).

A further possibility is to integrate bee cultures to improve the tree flowerings, provide an additional income for the family and generate a positive impact to the environment [36,26]. In this scenario, as the trees do not receive fruit tree pesticides, the honey from eucalyptus flowers and other trees in silvopastoral and agrosilvopastoral systems can frame performance in apicultural ecology.

[39] stated that traditional and conventional apiculture always results in areas with large pesticide applications, whether orchards are temperate or tropical. The apiculture products produced in these areas may store and conserve these pesticides. It is possible, however, to create ecological beekeeping and products free from toxic contamination; for this certain characteristics of bee management should be observed, as well as for the production of organic honey, including: 1) The vegetation, suppliers of the primary material to the bees, should be native and agriculture ecological and traditional; 2) Both the trees planted as practical cultures and exotic species cannot be supplied as bee pasture; 3) Exotic bee pasture is only allowed when practical cultures for feeding and subsistence until after analyses have been performed to ensure there is no toxic substances, areas containing plants that produce or are subjected to toxic systems should be eliminated; 4) The beekeeper must intervene to change the period and increase the production of existing vegetation or crops.

Facing this multi functionality the producer can produce beyond those products extracted directly from the agrosilvopastoral system (cereal grains, wood and meat), including organic or traditional honey depending on the system, add value to the product and the possible establishment of a brand for value addition.

The work of [40] showed some examples of agrosilvopastoral systems in Brazil, evaluating the increase and the development of paricá (*Schizolobium amazonicum*), tatajuba (*Bagassa guianensis*) and eucalyptus (*Eucalyptus tereticornis*) in combination with corn and Marandu grass (*Brachiaria brizantha*). In this experiment, the trees were planted in tracks formed by three planting lines (space of 3 x 3 m), with a 12m distance between the tracks. The author did not observe differences in the survival of the trees on the day post-planting between the monoculture and agrosilvopastoral systems, however a gain by more than 110% of total dry matter in the tree line of the agrosilvopastoral system was observed. This gain occurred due to the improvement in the fertilisation residues applied to the corn, with the corn productivity being 1086, 738 and 335kg ha^{-1}, respectively, for the first, second and third years; planting and tree maintenance costs of 21 and 64% of the total Marandu grass pasture DM productivities however affected total productivity in the first and second years, respectively. Twelve months pre-sowing, DM productivity was 9029kg ha^{-1}, a value within the mean range of the region. The author found that the sowing of Marandu grass had been anticipated for the second year with grazing to commence in the third year due to the lower yield of corn.

In accordance with Oliveira and [41,35], the establishment of cropping rows should be maintained with a minimal distance of 1m between eucalyptus lines to facilitate the crop treatments and ameliorate the competition so that the boundaries of each 200ha module are made by the utilisation of proper trees. In this system, mean cattle weight gain was 625g day^{-1}, which before three years corresponded to approximately 16 arrobas. The productivity of farming was not very good (25 bags of rice and 18 bags of soybean per hectare) compared to the monoculture means in the region, but helped to reduce the costs of tree planting and soil preparation for the introduction of better pastures (*Brachiaria spp*, Tanzania and Mombasa grasses) [42].

In relation to the economic analysis of agrosilvopastoral systems, [42-45] concluded that implanting agrosilvopastoral systems with eucalypts in the Cerrado region is a viable economic option, provided that less than 5% of wood produced is used for sawmiiling and the reminder for energy or another purpose where value is equal to or greater than the market value. Some situations that can result from the agrosilvopastoral system with implanted eucalypts are: discount rates greater than 11.45% per year; price of land above

US$200.96 per hectare; eucalypt productivity below 20.86 stone per hectare per year; price of beef arrobas less than US$16.75; price of sawmill wood below US$5.24 per stone; price of rice and soybean bags less than US$6.34 and US$5.96, respectively; and a simultaneous increase of more than 5.38% in total costs of production.

6. MULTIPLE OR COMBINED GRAZING SYSTEM

The multiple grazing system is a form of agricultural multi functionality because there is a possibility of adding value through the activity of creating different animal species. From this, comparative marketing goals and animal sales can be established when the price is favourable, in the case of an exclusive creation this would be an aggravating factor.

This system consists of the use of more than one type of grazing animal, expanding the consumption of different forage species and control of excess mass. Beef cattle and sheep prefer grasses, while goats prefer woody species. The consortium of beef cattle and sheep in the Amazon, for example, permit better pasture control in the wet season, because the sheep can degrade the pastures.

The fact that various herbivorous species utilise the same pasture simultaneously and in the same season does not mean that they occupy the same niche and are in direct competition for the same forage resources; this constitutes what is called multiple or combination grazing. It is fundamentally practical that the botanical composition of the pasture vegetation is diverse (primarily native), that there are differences in diet and in animal grazing habits to facilitate the access to and movement in the area as a function of its topography. Cattle, sheep and goats exhibit striking differences in their botanical diet composition and grazing habits, as found in the botanical composition and forage availability, season of the year, pasture intensity and animal morphological factors. There is superposition in the botanic composition of ruminant diets which can be exacerbated in situations of low botanical diversity of the pasture vegetation and in times of forage shortage [46,47].

Northeastern caatinga is an example of this type of pasture permitting value addition through a base of consortium creation between sheep, goats and cattle. More than 90% of cattle, sheep and goat production in northeastern Brazil is associated with native caatinga. The production and productivity indices of both pasture and animals are much lower due to random combinations and inadequate pasture management.

Traditional ruminant farming in northeastern Brazilian hinterlands uses combination pastures. Studies from this region have recorded a mean property size of 500 ha and mean total animal size of 64 cattle, 67 goats and 107 sheep. The mean animal load is 4.4 ha AU (Animal units) year, a much lower value compared to 12.5 ha AU year recommended from the native caatinga beneath the pasture combinations. The three animal species did not receive the same care, principally concerning their feeding. When feeding necessities occurred, the cattle were attended to first, followed by sheep and finally goats [47].

In order to improve these indices and promote greater rational and sustainable use of this consortium, [46] evaluated the pasture combination of native Caatinga (control), lowered Caatinga and thinned Caatinga fed to the different combinations of cattle, sheep and goats. Results from this study are published in Table 3, and varied in function due to the Caatinga pasture management; native Caatinga management did not result in significant differences in weight gain between cattle when combined with sheep, with goats and when alone; in lowered and thinned Caatinga however, weight gain was greater when cattle grazed these pastures alone. These results also showed that combination grazing supported production better when on native Caatinga pastures.

Table 3. Effect of combinations of species x caatinga pasture manipulation on weight gain (g day) of cattle in a combination grazing system

Combination	Native caatinga	Lowered aatinga	Thinned caatinga
Cattle	55.9^a	227.3^a	219.8^b
Cattle+Goats	35.3^a	108.2^b	147.8^b
Cattle+Sheep	60.4^a	100.8^b	241.2^b
Cattle+Goats+ Sheep	87.8^a	110.0^b	301.6^a
Mean	59.9	136.5	304.7

Means followed by different superscripts in the same column are significantly different (P<0.05)
Adpated from [46]

According to [46], the mean weight gain of cattle increased when grazing alone, throughout the year, on native caatinga to around 60g day^{-1}. Combining the cattle with sheep and goats did not significantly alter the weight development. Goats, however, gained on average, 16g day^{-1} in the same conditions and did not exhibit performance alteration when combined with sheep and cattle. Sheep gained up to 31kg ha^{-1} day^{-1} on native caatinga without suffering negative effects when combined with goats and cattle. Considering the production of animal weight, the greatest increase has been made when combining cattle, sheep and goats with a production of 13.8kg ha^{-1} year^{-1}, followed by sheep and goats with 12.1kg ha^{-1} year^{-1}, then goats alone with 11.9kg ha^{-1} year^{-1}. These results compare satisfactorily with the 5.6kg ha^{-1} year^{-1} obtained by cattle grazing alone on native caatinga, thus favouring combination grazing for animal weight gain.

7. ORGANIC LIVESTOCK

The farming of beef cattle is an important economic activity in Brazil. Standards of geographical space occupation have been established in Brazilian culture, and relate with many environmental impacts in most regions. Knowing this, the organic livestock certification program commenced a search for more environmentally sustainable alternative production systems, and at the same time provided the equilibrium between socio-economic factors and the well-being of animals. Organic livestock certification thus presented itself as an alternative to be encouraged [48]. As an aspect of multi functionality, it can provide meat with characteristics that increase production value with a view to price differentiation beyond its proportional environmental benefits through the preservation of the livestock production equilibrium.

Organic beef production is a system based on a holistic vision that is combined with the principles of agroeconomic system sustainability, with two essential global focus components: Environmental and social. This system has the objective to produce maintaining the ecological agroeconomic equilibrium while satisfying human needs, both directly and indirectly. In other words, organic production is the introduction to seeking new environmental and social sustainability values for production systems, with rural properties viewed as balanced in all aspects [48]. Organic management aims to develop economic production systems which do not pollute, degrade or destroy the environment while valuing humans as the principal process integrator [49].

Organic meat-producing livestock in Brazil is a relatively recent activity, with the first livestock herd in the country certified organic in 1999 (Eldorado Farm – Pantanal de

Paiaguás - Corumbá municipality – MS). The Pantanal wetland was chosen as the basic area of organic beef cattle production because the production system peculiarities to be adopted there were considered “inside out”, where natural conditions prevail and have little utilisation of exogenous inputs. A typical farming region, the Pantanal does not utilise intensive farming techniques as a result of the degradation of its fragile ecosystem [50]. The profitability of the region’s livestock has thus become more dependent on meat of increased value (such as organic meat) farmed using intensively applied technology, causing constant degradation to the applied land.

It is important to not confuse organic beef with “green beef”. Despite both utilising pasture and being ecologically sustainable systems, the similarities end here. The farming of “green beef” uses synthetic soluble fertilisers, antibiotics and allopathic medications when permitted. Feed supplementation is restricted to plants (e.g. corn, sugar cane) originally found in conventional production systems. Table 4 provides the main viewpoints differing between the two production systems.

Table 4. Differences between the production of organic beef vs. green beef

Organic beef	Green beef
Permits only green fertiliser	Permits green and synthetic fertilisers
Prohibits urea use	Uses urea liberally
Supplements exclusively with vegetation, of which 80% must be organic	Supplements exclusively with vegetation, descended from conventional cultures
Disease treatments restricted to herbal and homeopathic products	Disease treatments restricted to allopathic products
Prohibits use of fire for pasture management	Permits the use of fire for pasture management
Prohibits embryo transfer	Permits embryo transfer
Official vaccinations mandatory	Official vaccinations mandatory

In organic production systems, nitrogen limits production and thus can be only introduced in its organic form or via biological fixation since chemical fertiliser is not permitted by international legislation for utilisation in organic systems [51,52]. The need to fertilise pastures, coupled with the increased costs of chemical fertilisers have caused farmers to rethink towards maximum improvement of the existing natural resources on rural properties.

As an alternative to organic fertilisation to forage crops, [53] researched the importance of bovine manure use as a source of nitrogen to coast-cross, Tifton-85, Swazi and Transvaal grasses and noted linear responses from using bovine manure as a nitrogen source on the root and shoot growth (Figs. 1 and 2). This type of study shows the capacity of internally produced input used on the property and that the rational use of these inputs increases the flexibility of the production system and the more appropriate use of waste products [54].

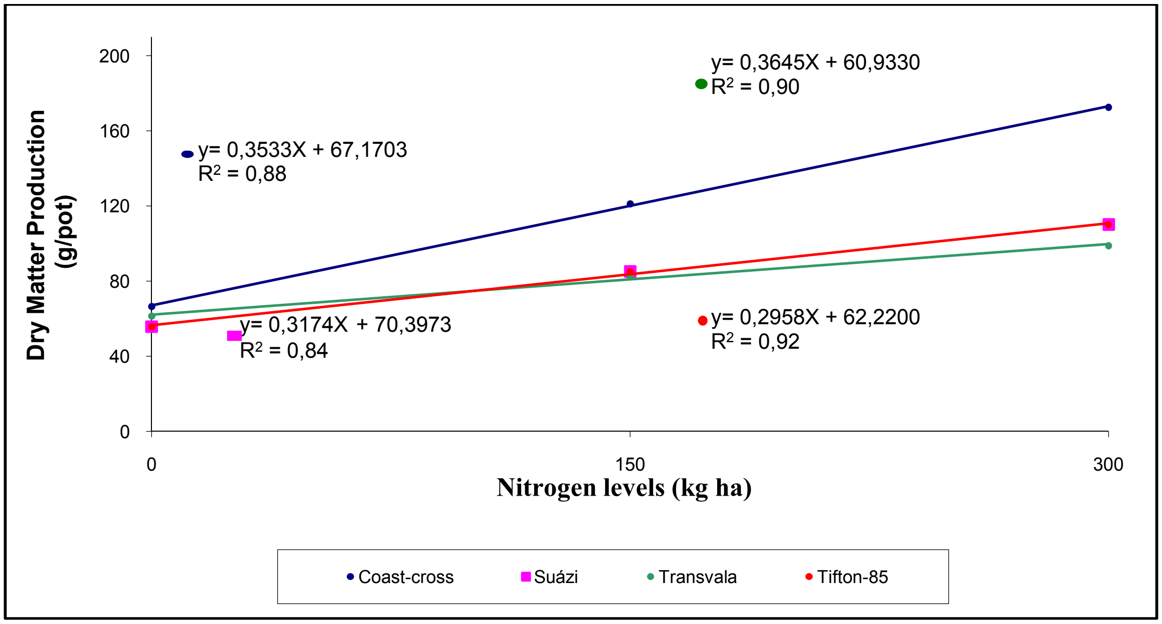

Fig. 1. Linear regression from total root dry matter production of Coast-cross, Swazi, Transvala and Tifton-85 grasses as a function of nitrogen doses in manure form
Adpated from [54]

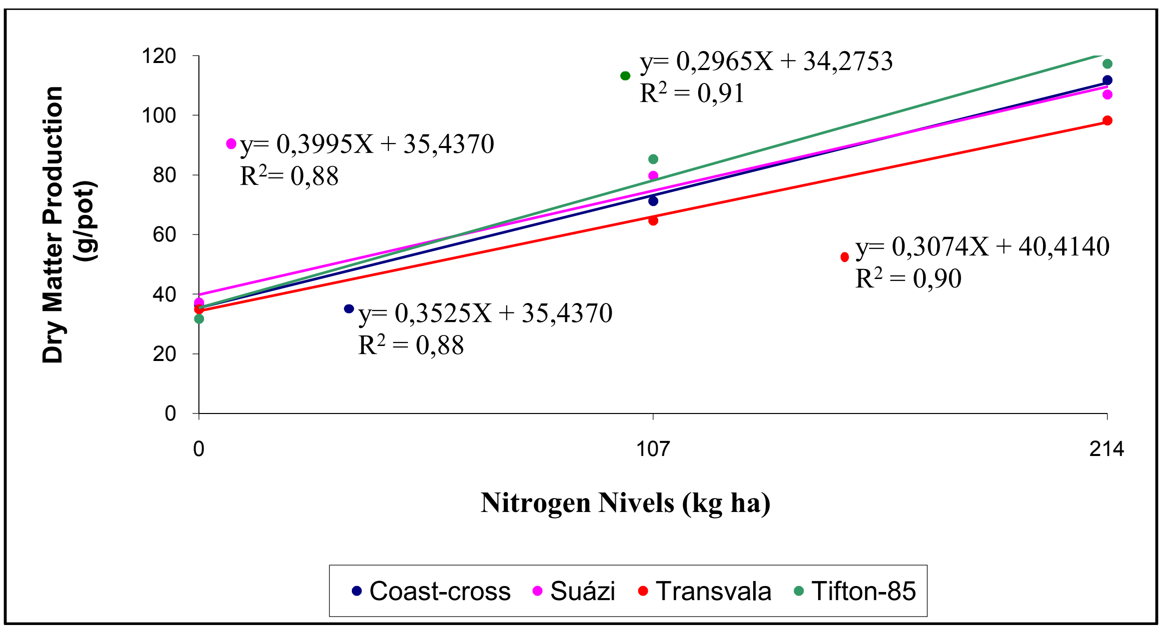

Fig. 2. Linear regression from total air dry matter production of Coast-cross, Swazi, Transvala and Tifton-85 grasses as a function of nitrogen doses in manure form
Adpated from [54]

8. RURAL TOURISM

In the literature was found that the year 1980 marked the initial exploration into rural tourism in Brazil. In 1990, with the intensification of rural activities and with the increasing value of nature, tourism practices in the rural environment had expanded [55]. In reality, rural and/or ecological tourism provides a principal function for value addition to multifunctional agriculture; by this, the producers, particularly those that produce multi functionally, have a privilege to directly sell products and services to the consumer, resulting in genuine economic gains for their family and consequently, to the environment [1].

According to Embratur, rural tourism is defined as the conjunction of practical tourist activities in rural areas committed to livestock production, adding value to products and services in order to rescue and promote the natural community and culture [56].

Rural environment tourism consists of activities offering services, equipment and products such as: hospitality, convenience living in the countryside, visits to rural properties, typical cooking and commercialisation of local products. These activities provide an alternative for sales areas for farming families, complementing their income, reinforcing the combination nature of work in the agricultuiral workforce and inserting in the production process. Rural tourism in Brazil is not free from problems, however, as pointed out by [57] that issues in the planning and management arise from the lower population economic capacity and difficulty of information access in rural areas. It is thus necessary to improve the professional capacity and political stimulation to make rural tourism more practical in Brazil [58,3].

9. CARBON SEQUESTRATION OF PASTURES

The concentrations of gases can affect the greenhouse levels in the atmosphere, especially carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), with these increasing in recent years with increased human activity. Greenhouse gases alter the energy balance of the Earth's surface and can lead to global warming. Preoccupation with climatic alteration scenarios has arisen due to the increase in greenhouse effect, resulting in the signing of the Kyoto Protocol, which have the objective of reaching a 5% mean reduction in emissions by industrialised countries by 2008-2012, from the reference year of 1990. This protocol was signed in effort to reduce the incidence of drastic climatic changes resulting from greenhouse gas emissions [59,56].

A viable alternative to decreasing the aggravation of this process consists of atmospheric carbon storage from reforestation, silvopastoral systems and pasture cultivation. In this situation, Brazil will be able to benefit from the Clean Development Mechanism (CDM), with projects which substitute polluting energy sources and agro forestry projects, with agricultural multi functionality precisely inserted to directly drive profitability from grazing as carbon sequestering, primarily in degraded areas.

[60] Highlighted that from this new market, Brazil can play an important role, because in addition to soil and a favourable climate, there is technology available to optimise alcohol as a combustion source and biomass as an electrical energy source. Recent estimates Demonstrated that the international commercialisation of carbon sequestration credits from CO_2 emission reductions can reach an annual demand of US$20 billion when this market is fully regulated.

In a country such as Brazil, a large sequester of carbon, the use of credit sales can be used to concretise the socio-economic development [60]. For Brazil, the internal volume of business carbon credits is estimated at US$60 million per year, after ratification from the Kyoto Protocol [61].

[58,62] Stated that induced agronomic systems with the final goal of obtaining carbon credits require a green label certification. In Europe two concurrents systems exist for this, being: 1) PEFC (Pan European Forest Certificate, also known as European Certificate) – certified from a European cooperation of many forest owners (private, community and state); and 2) FSC (Forest Steward Councilship) – certified from a global organisation that has the subsidy of organisations such as Greenpeace and World Wildlife Fund, as well as Green political parties.

Vegetation is used in its photosynthetic capacity to fix atmospheric CO_2, biosynthesised in the form of carbohydrates and found in plant cell walls. This process is considered carbon "sequestration" [63]. The accumulation of carbon in soil from grazing is increased by the pasture by residuals of forage, roots and faecal returns. In ryegrass pastures, the soil carbon content was superior by 10T ha^{-1} when grazing compared to when cut after four years [63].

Researchers from the International Centre for Tropical Agriculture – CIAT, and from Embrapa Agrobiologia, observed that grasses from the *Brachiaria* genus have the capacity of storage of significant quantities of carbon in soil, because the rate of carbon accumulation due to dead grass root decomposition is higher, with consequent reduction of carbon gas generation.

In experiments conducted out in these institutions, an increase in soil carbon contents was verified when implanted with *Brachiaria spp.* grasses, particularly when intercropped with *Stylosanthes guianensis* legumes, resulting in an increase of 20 to 30 tonnes of dry matter per hectare per year, in comparison to grass monocultures. The authors indicated that with appropriate management of the sustainable product and lucrative beef cattle, the extensive *Brachiaria spp.* pasture area present in the country can accumulate an appreciative quantity of carbon in the soil.

In the Cerrados region, the accumulation of carbon in the soil of well-managed *Brachiaria* pastures is between 1 and 2 tonnes of carbon per ha per year [64,65]. [62] Also observed this tendency in Atlantic Forest conditions and found that the presence of a legume species (*Desmodium ovalifolium*) in *Brachiaria humidicola* pasture doubled the accumulation rate of carbon in soil. [66] Observed that the quantity of roots in *B. dictyoneurra* were 4.2T ha^{-1}, in *B. dictyoneura* x *Centrosema acutifolium* 3.9 T ha^{-1}, and only 1.8T ha^{-1} in native savannah; this indicated that the more productive a pasture is for grazing, the higher its atmospheric carbon fixation is. According to [67,68,64], pastures established in forest areas exhibited a decrease in soil organic matter following deforestation and burning, but could regain soil carbon after some years. The author also related that Amazon forest soil contained 90 T of carbon per ha on commencement of *B. humidicola* pasture grazing, after two years the quantity had dropped to 68.8 T of carbon per ha but after eight years of grazing the quantity of carbon had superseded the original, reaching 96T ha^{-1}.

In the existing view of a possibility of good income and sustainability of global human environmental activity, in this scenario the producer has to seek to comply with this activity and base their livelihood in deforested areas rather than deforesting new areas. The awareness of this market allows projects to be inserted into areas devalued many times by degradation and make them productive and economically viable by having their finances based on recently proposed activities.

10. RURAL COOPERATION

Rural cooperation fits the multi functionality model not as a productive aspect, but more as a planning aspect worth knowing for commercial production. Within this logic, the rural producer organisation may provide sustainability to the productive system; by this the stimulus of association can be the difference between the fixation of farmers or rural exodus. Cooperation has been expanded by many countries, since the creation of primary cooperation in England in 1843. Since its initiation, it has been the protagonist of a doctrine which defined the possibility of reducing social distortion through economic development of cooperatives. This correction was made possible by the formation of cooperative associations that function in a self-help system [59]. In view of this improved social economy, governmental organisations and financial agencies have been the principal developers of cooperation, primarily in developed countries [69,70]. In Brazil, in particular, this practice has been stimulated [71,70].

Evaluated differences in rural cooperation [71] concluded that it would be more adequate to implement a cooperation that had the transformation of fruits into sweets or cassava root into flour, as principal activities from the collective production of fruits and cassava. In this case, both increase the product value when it is possible for each member to exercise controls of its proper work and its proper production. The two work in conjunction when the project appears to require excess production with an increase in scale, which would be impossible to obtain individually, but instead in a form where each has control of its work contributions and results and thus avoiding unnecessary conflicts.

In the dairy segment, cooperatives have significant participation in some countries in order to dominate the production chain. Cooperative production provides producers with better price negotiation conditions from input industries, as well as increased gains in product sales. Cold raw milk sold in bulk is one milk product which can benefit from increased value. [69,28], in a survey of diverse dairy cooperatives, describes the relevant potential of milk cooperatives in São Paulo to improve their results and increase their perceived cooperative gains. Between 23 dairy cooperatives studied, cases of diverse success were verified with some potentially inferred by experiences of successful integration between their different operations.

11. CONCLUSION

Agricultural multi functionality consists of recognising that the role of agriculture is not to simply produce raw materials and food, to liberate manual labour for urban activities, to generate foreign exchange and to transfer capital to other economic sectors, but to also highlight its other functions which are social, human equity, aesthetic and recreational/educational.

Multi functionality also exhibits environmental functions that are not defined by the market rules such as shaping the rural landscape, promoting soil conservation, sustainably generating natural resources and preserving biodiversity.

There are differences formed by agricultural multi functionality with the emphasis on sustainability of livestock through tropical grazing, and the rational use of different values from Brazilian agricultural properties to generate savings and subsistence for both producers and the environment.

In practice, farmers should understand and exploit agricultural resources in a context of multi functionality, and organize in the form of rural cooperatives to add value to their products and provide quality of life for your family.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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