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1- A Ovelha Nativa Sul-Mato-Grossense "Pantaneira"

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Resumo

O estado de Mato Grosso do Sul possui animais de um grupamento genético Nativo Sul-Mato-Grossense que tem se mostrado altamente adaptado e com grande potencial produtivo e reprodutivo, esses animais apresentam uma combinação de alelos que se aproximam das raças lanadas do sul e deslanadas do nordeste, abrindo dessa forma caminho para a possibilidade da criação de uma nova raça. Os ovinos desse grupamento não apresentam estacionalidade reprodutiva podendo produzir até 1,5 cordeiros/ano. Possuem ainda o alto potencial produtivo, podendo ganhar até 350g/dia, proporcionando dessa forma animais precoces, abatidos com até 6 meses de idade com peso de 40Kg, podendo apresentar um rendimento de carcaça de 50%. Por serem animais lanados, a lã pode ser considerada um subproduto de grande importância. Assim, conservar as características desses animais é de suma importância, tanto para colaborar com a produção ovina regional, como para se oferecer uma opção a mais de raça a ser criada e utilizada em sistemas de produção de ovinos.

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Abstract

The state of Mato Grosso do Sul has a genetic origin of animals native Sul-Mato-Grossense that has been highly adapted and highly productive and reproductive potential, these animals exhibit a combination of alleles that are close to the south and tossed races wooless Northeast , thus paving the way for the possibility of creating a new race. The sheep of this group do not exhibit reproductive seasonality may produce up to 1.5 lambs per year. They also have high yield potential and can earn up 350g/day, thereby providing early animals slaughtered within 6 months of age weighing 40 kg and may have a carcass yield of 50%. Herd animals with wool, the wool can be considered a byproduct of great importance. So keep the characteristics of these animals is of paramount importance, both to collaborate with the regional sheep production, as if to offer an additional option to breed to be created and used in sheep production systems.

Introdução

Os ovinos foram introduzidos no Brasil por colonizadores europeus a partir do descobrimento. As raças inseridas no país foram primeiramente submetidas à seleção natural adaptando-se assim a ambientes diferenciados e condições edafoclimaticas adversas, sendo hoje conhecidas como animais crioulos, nativos, naturalizados ou locais (MORAIS, 2001).

O Mato Grosso do Sul possui privilegiada localização geográfica, condições climáticas favoráveis e perfil para produção de ovinos (PINTO et al., 2009). Na região, as criações de ovinos tem como objetivo principal a produção de carne, sendo que esta atividade é desenvolvida, geralmente, paralela à produção agropecuária, onde os outros produtos da ovinocultura como pele, lã e leite não são explorados comercialmente.

A falta de tradição na criação intensiva de ovinos no Estado leva à busca de animais e técnicas de produção em outras regiões do país. Verifica-se, portanto, a necessidade da utilização de animais adaptados às condições regionais de Mato Grosso do Sul, sendo necessário ainda validar e/ou ajustar os manejos às condições ambientais e regionais.

As raças ovinas naturalizadas ou nativas já identificadas se destacam pela rusticidade e capacidade de adaptação a regiões de clima semiarido, tropical e subtropical no Brasil. De acordo com Gomes et al. (2007) o grupamento genético de ovinos Nativos Sul-Mato-Grossenses, dentre os exemplares avaliados, apresentam uma combinação de alelos que se aproximam das raças lanadas do sul e deslanadas do nordeste, o que indica variabilidade genética e abre caminho para a possibilidade da criação de uma nova raça.

Todavia, para o desenvolvimento de uma nova raça, com base cientifica, é necessário o conhecimento acerca das características de desempenho zootécnico do material genético disponível. Assim, há a necessidade de nos ovinos nativos Sul-Mato-Grossense estudar possíveis características a serem utilizadas como critério de seleção em programas de melhoramento com a finalidade de obter animais com maior peso ao desmame visando menor período de terminação em confinamento ou a pasto (Vargas Jr. et al., 2011; Oliveira, 2012), não esquecendo do aspecto sanitário (Gonçalves, 2012).

De acordo com Egito et al. (2002) é fundamental a estruturação de programas de preservação e conservação dos grupos genéticos naturalizados, com intuito de utilização destes no sistema produtivo, agregando características de adaptação, que normalmente são de baixa herdabilidade e conseqüentemente pequena resposta à seleção. Para a condução do programa de melhoramento deste grupamento genético é indispensável à escrituração zootécnica do rebanho pelos produtores.

No entanto, o desconhecimento do potencial produtivo destes animais faz com que venham ocorrendo cruzamentos indiscriminados desses animais com raças exóticas, acarretando em perda destas características selecionadas naturalmente ao longo dos anos.

Características do Grupamento Genético

No ano de 2005, foi iniciado um estudo exploratório por pesquisadores da UNIDERP – CTO, EMBRAPA, UFMS e posteriormente a UFGD, afim de identificar e manter o grupamento genético. A principio foram adquiridos 300 animais "pantaneiros" (Figura 1) de criatórios do alto e baixo pantanal Sul-Mato-Grossense, os quais apresentavam características fenotípicas semelhantes entre si, mas distante dos padrões genotípicos das raças exóticas criadas no Brasil. Esses animais são encontrados em grande quantidade em fazendas isoladas na região, vivendo há anos sob qualquer tipo de seleção ou melhoramento genético, fato este que possibilita concluir que esses ovinos são adaptados à região Sul-Mato-Grossense (Vargas Jr. et al., 2011).

No aspecto reprodutivo os animais do grupamento genético nativo Sul-Mato-Grossense apresentam características que merecem destaque, pois apresentam comportamento reprodutivo distinto ao da maioria das raças ovinas criadas no país, as quais permitem a produção de apenas um cordeiro por ano, no sistema tradicional ou 1,5 corderiors por ano em sistemas mais tecnificados. Diferentemente, em estudos realizados por Martins, et al. (2008) foram identificados que as fêmeas Nativas Sulmatrogrossenses possuem desempenhos cíclicos e fertilidade favorável durante a época de adversidade de fotoperíodo, não apresentando dessa forma estacionalidade reprodutiva, favorecendo a produção de cordeiros durante o ano.

Nos reprodutores (carneiros) estas variações se alteram substancialmente em função da raça e demonstram a sensibilidade de cada animal ou grupo genético para fatores ambientais. Em regiões tropicais, no entanto, onde o fotoperíodo varia muito pouco, não se evidencia forte estacionalidade reprodutiva.

Embora os carneiros produzam sêmen o ano todo, um período de "esterilidade" ou reduzida eficiência reprodutiva ocorrerá por vários meses

(DUTT, 1960). A estacionalidade reprodutiva nos carneiros pode ser um fator limitante à produção constante durante o ano e em larga escala, pois impossibilita o cruzamento industrial, para obtenção de cordeiros precoces e com características de carcaça satisfatórias.

Figura 1. Ovinos do Grupo Genético Nativo Sul-Mato-Grossense. À esquerda são evidenciadas as ovelhas e à direita os carneiros.

Miazzi et al. (2008 e 2009) e Santiago Filho (2010) demonstraram que tanto carneiros Nativos Pantaneiros Sul-Mato-Grossenses jovens quanto os adultos, apresentaram performance reprodutiva semelhante e constante, salientando-se a ausência de supressão no período de maior luminosidade e que também não foram observadas variações sazonais na rotina do teste da libido destes, assim como também não houveram variações significantes na qualidades seminal durante o ano.

Estes estudos qualificam os ovinos nativos Sul-Mato-Grossenses a serem incluídos em sistemas intensivos de produção de cordeiros para corte, pois a ausência de fotoperiodismo reprodutivo permite que haja produção constante nas distintas estações do ano, diferentemente de animais lanados de origem europeia.

Os Cordeiros Nativos Sul-Mato-Grossenses nascem com peso vivo entre 2,5 e 3,5Kg em média, fato este que favorece muito a baixa incidência de partos distócicos, pois quando comparado com o peso ao nascer das demais raças estes são bastante inferiores.

Embora o peso ao nascer possa ser considerado inferior comparativamente, o desenvolvimento subsequente dos cordeiros deste grupo genético é bastante satisfatório conforme demonstrado por Pinto et al. (2009), e Lima et al. (2008). O ganho de peso médio diário, em confinamento oscilou de 200 a 350 gramas por dia, dependendo do nível nutricional da dieta, este fato proporciona a produção de cordeiros precoces sendo abatidos com idade entre 6 e 8 meses, com peso vivo entre 30 e 40 kg apresentando alto rendimento de carcaça oscilando entre 45 % e 50%. Outro importante aspecto a ser destacado é que machos e fêmeas apresentam desempenho e produção semelhante, bem como acabamento de carcaça uniforme.

Os ovinos nativos Sul-Mato-Grossenses, oferecem ainda como subproduto a lã, esse é um importante co-produto da ovinocultura de corte no MS. Em algumas raças especializadas este produto é bastante valorizado, devido à sua qualidade superior. Apesar de não ser ideal para vestuário, a lã deste Grupo Genético pode ser utilizada para trabalhos artesanais como tapetes, baixeiros, mantas entre outros produtos (BRAUNER, 2010), o que tem boa aceitação e comércio em regiões tradicionais em bovinocultura de corte, haja vista que os produtos têxteis oriundos da lã e couro ovinos são utilizados em montarias e apetrechos de fazenda para a lida de peões com o gado e outros animais de produção.

Conclusão

Os ovinos do grupamento genético Nativo Sul-Mato-Grossense apresentam grande capacidade produtiva e reprodutiva. Portanto, conservar as características desses animais é de suma importância, tanto para colaborar com a produção ovina regional, bem como para se oferecer uma opção a mais de raça a ser criada e utilizada em sistemas de produção de ovinos.

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*** The content of the texts and their spelling-grammar suitability are entirely those of the author.**

2- Advancements and New Options for Cattle Biodiversity Maintenance in EU – A Short Review

Enrico Zanetti[1], *Martino Cassandro*[2]

Abstract

The aim of this short review is to summarize the status of the cattle genetic resources in the European territory. Livestock biodiversity contributes greatly to food and agricultural production, and its decline is now source of concern, since specialization and globalization in animal breeding spread all over the world. In the European Union, cattle breeding programmes aim mainly to increase production and product quality, productivity and cost efficiency, but recently they have been modified to maintain genetic diversity and support the conservation of the genetic resources with *in-situ*, *ex-situ*, and *in-vitro* strategies. Detailed phenotypic characterization and several molecular genetics characterization studies have been undertaken, and recording of population sizes, animal identification and pedigree recording are generally well established for cattle. Research is extending from commercially relevant breeds and production systems of local breeds, that, due to their long adaptation, can potentially better respond to environmental triggers and threats in their habitat. To accomplish effective livestock biodiversity conservation strategies, strict collaborations between research scientists, policy makers, stakeholders, educational institutions and the general public are encouraged.

Keywords: Livestock, Cattle, Biodiversity, Conservation.

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Livestock Biodiversity

The aim of this short review is to summarize the status of the cattle genetic resources in the European territory.

Livestock biodiversity is referred to domesticated animal species and breeds that contribute to food and agricultural production (Hoffmann, 2011), but in this paper special emphasis is given to cattle. Livestock "genetic diversity" and options for its utilization are usually discussed in terms of diversity in the genetic components of a breed, but the term "breed" has more a social and conceptual dimension that a biological one, making a genetic characterization alone quite difficult (Boettcher et al., 2010). These breed populations represent unique combinations of genes for production and functional traits but also for the ability to adapt to local conditions (feed, water availability, climate, diseases, etc.). Livestock biodiversity has always been dynamic, changing during man history depending on society and environments modifications, but nowadays it is rapidly declining globally as specialization and globalization in animal breeding spread, all over the world.

Cattle Breeding in EU

Cattle breeding programmes for both beef and dairy cattle retain the highest priority and are implemented in all European countries, aiming mainly to increase production and product quality, productivity and cost efficiency. Only recently the same programmes have been modified to maintain genetic diversity, support the conservation and use of specific breeds and to consider animal welfare and sustainable systems of production, together with fertility, health and conformation related traits (FAO, 2007).

Development of livestock production and breeding activities in western European countries is largely influenced by the Common Agricultural Policy of the EU. Governments have generally withdrawn from active involvement in breeding activities and their role is now limited to the supervision. In eastern European countries, breeding activities are carried out through licensed farms under the control of research institutes. A common market for semen and breeding stock has been established, leading to extensive trade and international competition between breeding organizations (Gollin et al., 2008). Cattle breeding focuses mainly on single-purpose breeds, with the Holstein-Friesian being the dominant breed in most European countries. Beef production from specialized beef breeds (mostly French breeds) or from cross-breeds from suckler cows has gained remarkable economic importance. Intensive breeding programmes and the wide use of few highly selected sires have achieved significant genetic progress, but increased the problems related to inbreeding and loss of genetic diversity in the main cattle breeds. Such aspects are now taken into account, but difficulties remain in the case of rare local breeds with small population sizes (FAO, 2007, FAO 2009b).

The general trend sees breeding activities shifting from national cooperatives to international companies, able to select for products ensuring higher economic profit to livestock farmers.

Conservation Measures in EU

Because of the degree of human management, the conservation of livestock genetic diversity is strictly dependent on production systems. The major incentives for conservation are fundamentally based on the current and future potential use, and under utilization is a bigger threat than over utilization. This situation has lead many EU countries to give support, for in-situ conservation programmes, to a limited number of breeds, while most are involved in in-vitro and ex-situ programmes, such as gene banks and limited collections of animals (FAO 2007).

Despite that, throughout Europe there is a considerable awareness for conservation, as proved by the breeding and conservation plans established in its territory. Phenotypic characterization and several molecular genetics characterization studies have been undertaken. With some exceptions, recording of population sizes, animal identification and pedigree recording are well established.

In western and central Europe 27 countries have in vivo conservation programmes. A few EU countries (Ireland, Finland and Germany) base their conservation policy heavily on the effective population size. Through Europe, local breeds are becoming the object of low input small scale farming, where they are kept and used for the production of regional and typical products under quality labels in niche markets. Organic farming is often mentioned as an opportunity for the use of local breeds. Many private organizations play a decisive role in in-vivo conservation, but the genetic management of the populations under these programmes needs to be improved. In the Eastern Europe, the political and economical instability had a serious impact on livestock systems and related animal genetic resources. Many competitive breeds (and lines) were bred entirely separately from those of the Western Europe. These breeds and lines still exist, but are threatened by the introduction of Western genetic material. Most in vitro conservation programmes for cattle are found in western and central Europe, but in many cases this is restricted to the storage of semen from a limited number of breeds and only in few cases this conservation is extended to embryos, oocytes and tissue DNA samples in specific genebanks, that, however, needs to be further developed in the aspects of ownership and access, information and documentation, and optimization of the core collection and the ratio between gametes and embryos (FAO, 2007).

Reliable state indicators of endangered breeds are available from FAO through the “Domestic Animals Diversity Information System” (DAD--IS). It monitors breeds worldwide and classifies them into seven risk categories depending essentially on the number of available breeding males and females: extinct, critical, endangered, critical-mantained, endangered-mantained, not at risk and unknown status. The implementation of this dataset is a prerequisite for the adoption of the National Plan of Action for AnGR based on Strategic Priorities for Action grouped in four priority areas: a) characterization, inventory and monitoring of trends associated risks, b) sustainable use and development, c) conservation, d) policies, institutions and capacity building (FAO, 2007c)

In EU, the biggest level of livestock biodiversity protection, calculated as the percentage of the breeds that are involved into conservation and are included in the critical, endangered, critical-mantained, endangered--mantained status, is reached by Austria (87.9%) and Spain (80.4%). Belgium (68.4%), Greece (64.5%), Italy (64.4%), France (43.9%) are in the middle, while the lowest values of protection belong to Finland (35.3%), Sweden (30%), Germany (28.1%), Luxembourg and Portugal (25%) and Ireland (13%). For cattle, the European whole protection level is equal to 48% (DAD-IS; Signorello et al., 2003).

Cattle Conservation in Italy

Italy retains a considerable amount of biodiversity related to cattle breeds. The list of Italian cattle genetic resources described in the DAD-IS database is reported in Table 1 (DAD-IS; Bittante, 2011). A number of within breed varieties and populations exist, making difficult a detailed list. Many of them have good diffusion in the national territory, are particularly valuated in the market and associated to typical high popularity food products, others are considered endangered or already extinct.

In Italy, conservation is achieved mainly through annual payments made to farmers who, on a voluntary and contractual basis, raise local breeds at risk of extinction for a 5 year period, but many national institutions are often directly involved into the conservation measures. Funding is mainly made through allocation from the EU Rural Development Programme. On average the payment for cattle is around 200 euro/livestock unit. Some authors think, reasonably, that direct payments to farmers do not offer adequate support either to maintain the current population or to induce them to switch from higher yielding breeds to local ones because of a marked absence of profitability (Signorello et al., 2003; FAO, 2007b). This raises serious concerns about the eventual success of these livestock conservation programmes, that, far from being abolished, should be revised since most livestock keepers cannot afford and are not willing to safeguard local breeds without appropriate incentives (FAO, 2009).

Tabela 1 - List of Italian cattle genetic resources described in the DAD-IS database (adapted from Bittante, 2011)

Italian cattle breeds and populations		
Abruzzese (extinct)	Grigia Alpina	Podolica
Agerolese	Grigia di Val d'Adige (extinct)	Pontremolese
Bardigiana (extinct)	Grigia di Val di Fiemme (extinct)	Pugliese del Veneto (extinct)
Bianca Val Padana	Grossetana (extinct)	Pustertaler Sprinzen
Bruna Italiana	Jersey	Reggiana
Bruna Vecchio Ceppo	Limousin	Rendena
Burlina	Lucana (extinct)	Romagnola
Cabannina	Marchigiana	Romana (extinct)
Calabrese (extinct)	Maremmana	Sarda
Calvana	Modenese	Sardo Bruna
Camadona (extinct)	Modicana	Sardo-Modicana
Carniella (extinct)	Mölltal (extinct)	Siciliana
Charolais	Montana	Valdarno (extinct)
Chianina	Oropa	Val di Chiana (extinct)
Chianino-Maremmana	Ossolana (extinct)	Valdostana Castana
Cinisana	Pasturina	Valdostana Pezzata Nera
Demonte (extinct)	Perugina (extinct)	Valdostana Pezzata Rossa
Frisona	Pezzata Rossa Italiana	Valtarese (extinct)
Frisona Italiana	Piemontese	Varzese Ottonese
Friuli (extinct)	Pinzgauer	
Garfagnina	Pisana	

Research Needs and Future Options

Understanding the regulating mechanisms of biodiversity is a fundamental step to ensure biodiversity conservation. Research mostly focus on commercially relevant breeds and production systems, while many local breeds are not well characterized. Local breeds, due to their long adaptation, can potentially better respond to environmental triggers and threats in their habitat than high diffusion ones (Ludena et al., 2007). Hence, only by understanding these mechanisms of responses and interactions we will be able to adequately manage conservation of livestock diversity.

In a highly productive context such as the EU territory diversity is decreasing at high rate, but the inventory of breeds and local population is still far from completion, and in many cases we are losing high amounts of diversity without a comprehensive characterization in the micro and macro scale levels, i.e. integrating trait-based and molecular approaches to study both phenotypes and genotypes (De Meester et al., 2011). Besides that, there is an urgent need for comprehensive information on breeds and populations distributions. Long term monitoring can help to address the impact of the socio-economic global and local scale changes over time.

In the next years research will be driven to improve transparent, efficient and open access infrastructures where data, resources, analytical and modeling tools, knowledge and even expertises come together to drive conservation and rational exploitation of these animal genetic resources, but also to raise people and governments awareness, that is fundamental for the making of the right future policies. The recent innovative genomic techniques, together with related statistic and bioinformatic approaches, will presumably and hopefully help to improve the knowledge on many traits related to adaptation and environmental resistance (including diseases), shedding new light over important and under-known characteristics of these underestimated local breeds. In conclusion, although in EU different types of actions have been implemented, many others are required to accomplish effective livestock biodiversity conservation strategies, involving strict collaboration between research scientists, policy makers, stakeholders, educational institutions and, obviously, farmers.

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3- Advancements and new options for livestock biodiversity maintenance in a highly productive context

Enrico Zanetti[1]

Abstract

Livestock biodiversity contributes greatly to food and agricultural production, and its decline is now source of concern, since specialization and globalization in animal breeding spread all over the world. In the European Union, cattle breeding programmes aim mainly to increase production and product quality, productivity and cost efficiency, but recently they have been modified to maintain genetic diversity and support the conservation of the genetic resources with in-situ, ex-situ, and in-vitro strategies. Detailed phenotypic characterization and several molecular genetics characterization studies have been undertaken, and recording of population sizes, animal identification and pedigree recording are generally well established for cattle. In Italy, conservation is achieved mainly through annual payments made to farmers who raise local endangered breeds. Research is extending from commercially relevant breeds and production systems lo local breeds, that, due to their long adaptation, can potentially better respond to environmental triggers and threats in their habitat. To accomplish effective livestock biodiversity conservation strategies, strict collaborations between research scientists, policy makers, stakeholders, educational institutions and the

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general public are encouraged.

Keywords: Livestock, Cattle, Biodiversity, Conservation.

Liverstock Biodiversity

Agricultural biodiversity is a generic term that includes all components of biological diversity that constitute and sustain key functions of the agro-ecosystem: variety and variability of animals, plants and micro-organisms at the genetic, species and ecosystem levels, biotic factors and socio economic and cultural factors (Hoffmann, 2011). Livestock biodiversity is referred to domesticated animal species and breeds that contribute to food and agricultural production. In this paper special emphasis is given to cattle.

Livestock "genetic diversity" and options for its utilization are usually discussed in terms of diversity in the genetic components of a breed, but the term "breed" has more a social and conceptual dimension that a biological one, making a genetic characterization alone quite difficult (Boettcher et al., 2010). These breed populations represent unique combinations of genes for production and functional traits but also for the ability to adapt to local conditions (feed, water availability, climate, diseases, ...). Livestock biodiversity has always been dynamic, changing during man history depending on society and environments modifications, but nowadays it is rapidly declining globally as specialization and globalization in animal breeding spread all over the world.

Cattle Breeding in EU

Cattle breeding programmes for both beef and dairy cattle retain the highest priority and are implemented in all European countries, aiming mainly to increase production and product quality, productivity and cost efficiency. Only recently the same programmes have been modified to maintain genetic diversity, support the conservation and use of specific breeds and to consider animal welfare and sustainable systems of production, together with fertility, health and conformation related traits (FAO, 2007).

Development of livestock production and breeding activities in western European countries is largely influenced by the Common Agricultural Policy of the EU. Governments have generally withdrawn from active involvement in breeding activities and their role is now limited to the supervision. In eastern European countries, breeding activities are carried out through licensed farms under the control of research institutes. A common market for semen and breeding stock has been established, leading to extensive trade and international competition between breeding organizations (Gollin et al., 2008). Cattle breeding focuses mainly on single-purpose breeds, with the Holstein-Friesian being the dominant breed in most European countries. Beef production from specialized beef breeds (mostly French breeds) or from cross-breeds from suckler cows has gained remarkable economic importance. Intensive breeding programmes and the wide use of few highly selected sires have achieved significant genetic progress, but increased the problems related to inbreeding and loss of genetic diversity in the main cattle breeds. Such aspects are now taken into account, but difficulties remain in the case of rare local breeds with small population sizes (FAO, 2007, FAO 2009b).

The general trend sees breeding activities shifting from national cooperatives to international companies, able to select for products ensuring higher economic profit to livestock farmers.

Conservation Measures in EU

Because of the degree of human management, the conservation of livestock genetic diversity is strictly dependent on production systems. The major incentives for conservation are fundamentally based on the current and future potential use, and under utilization is a bigger threat than over utilization. This situation has lead many EU countries to give support, for in-situ conservation programmes, to a limited number of breeds, while most are involved in in-vitro and ex-situ programmes, such as gene banks and limited collections of animals (FAO 2007).

Despite that, throughout Europe there is a considerable awareness for conservation, as proved by the breeding and conservation plans established in its territory. Phenotypic characterization and several molecular genetics characterization studies have been undertaken. With some exceptions, recording of population sizes, animal identification and pedigree recording are well established.

In western and central Europe 27 countries have in vivo conservation programmes. A few EU countries (Ireland, Finland and Germany) base their conservation policy heavily on the effective population size. Through Europe, local breeds are becoming the object of low input small scale farming, where they are kept and used for the production of regional and typical products under quality labels in niche markets. Organic farming is often mentioned as an opportunity for the use of local breeds. Many private organizations play a decisive role in in-vivo conservation, but the genetic management of the populations under these programmes needs to be improved. In the Eastern Europe, the political and economical instability had a serious impact on livestock systems and related animal genetic resources. Many competitive breeds (and lines) were bred entirely separately from those of the Western Europe. These breeds and lines still exist, but are threatened by the introduction of Western genetic material. Most in vitro conservation programmes for cattle are found in western and central Europe, but in many cases this is restricted to the storage of semen from a limited number of breeds and only in few cases this conservation is extended to embryos, oocytes and tissue DNA samples in specific genebanks, that, however, needs to be further developed in the aspects of ownership and access, information and documentation, and optimization of the core collection and the ratio between gametes and embryos (FAO, 2007).

Reliable state indicators of endangered breeds are available from FAO through the “Domestic Animals Diversity Information System” (DAD--IS). It monitors breeds worldwide and classifies them into seven risk categories depending essentially on the number of available breeding males and females: extinct, critical, endangered, critical-mantained, endangered-mantained, not at risk and unknown status.

In EU, the biggest level of livestock biodiversity protection, calculated as the percentage of the breeds that are involved into conservation and are included in the critical, endangered, critical-mantained, endangered--mantained status, is reached by Austria (87.9%) and Spain (80.4%). Belgium (68.4%), Greece (64.5%), Italy (64.4%), France (43.9%) are in the middle, while the lowest values of protection belong to Finland (35.3%), Sweden (30%), Germany (28.1%), Luxembourg and Portugal (25%) and Ireland (13%). For cattle, the European whole protection level is equal to 48% (DAD-IS; Signorello et al., 2003).

Cattle Conservation in Italy

Italy retains a considerable amount of biodiversity related to cattle breeds, with at least six beef breeds (Chianina, Marchiggiana, Maremmana, Piemontese, Podolica and Romagnola), three high diffusion dairy breeds (Frisona Italiana, Bruna Italiana and Pezzata Rossa), and at least 24 double attitude local breeds (DAD-IS; Agraria.org). A number of within breed varieties and populations exist, making difficult a detailed list. Many of them have good diffusion in the national territory, are particularly valuated in the market and associated to typical high popularity food products, others are considered endangered or already extinct.

In Italy, conservation is achieved mainly through annual payments made to farmers who, on a voluntary and contractual basis, raise local breeds at risk of extinction for a 5 year period. Funding is made through allocation from the EU Rural Development Programme. On average the payment for cattle is around 200 euro/livestock unit. Some authors think, reasonably, that these payments do not offer adequate support either to maintain the current population or to induce farmers to switch from higher yielding breeds to local ones because of a marked absence of profitability (Signorello et al., 2003; FAO, 2007b). This raises serious concerns about the eventual success of these livestock conservation programmes, that, far from being abolished, should be revised since most livestock keepers cannot afford and are not willing to safeguard local breeds without appropriate incentives (FAO, 2009)

Research Needs and Future Options

Understanding the regulating mechanisms of biodiversity is a fundamental step to ensure biodiversity conservation. Research mostly focus on commercially relevant breeds and production systems, while many local breeds are not well characterized. Local breeds, due to their long adaptation, can potentially better respond to environmental triggers and threats in their habitat than high diffusion ones (Ludena et al., 2007). Hence, only by understanding these mechanisms of responses and interactions we will be able to adequately manage conservation of livestock diversity.

In a highly productive context such as the EU territory diversity is decreasing at high rate, but the inventory of breeds and local population is still far from completion, and in many cases we are losing high amounts of diversity without a comprehensive characterization in the micro and macro scale levels, i.e. integrating trait-based and molecular approaches to study both phenotypes and genotypes (De Meester et al., 2011). Besides that, there is an urgent need for comprehensive information on breeds and populations distributions. Long term monitoring can help to address the impact of the socio-economic global and local scale changes over time.

In the next years research will be driven to develop transparent, efficient and open access infrastructures where data, resources, analytical and modeling tools, knowledge and even expertises come together to drive conservation and rational exploitation of these animal genetic resources, but also to raise people and governments awareness, that is fundamental for the making of the right future policies. The recent innovative genomic techniques (i.e. the next generation sequencing tools and genomic selection), together with related statistic and bioinformatic approaches, will presumably and hopefully help to improve the knowledge on many traits related to adaptation and environmental resistance (including diseases), shedding new light over important and under-known characteristics of these underestimated local breeds. In conclusion, although in EU different types of actions have been implemented, many others are required to accomplish effective livestock biodiversity conservation strategies, involving strict collaboration between research scientists, policy makers, stakeholders, educational institutions and the general public.

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4- Animal Semen Freeze-Drying Process: Challenge for the Future of Animal Conservation

Calogero Stelletta[1]
Juri Vencato[2]

Introduction

Freeze-drying represent an alternative method for sperm preservation and could helps to overcome the limitations of the current cryopreservation method such as the high maintenance cost of frozen stock, the problems associated with transportation of frozen materials and the potential risk of total loss of the frozen stock.

The optimization of the process could increase the possibility to routinely perform two main activities: conservation of endangered species or breeds and semen commercialization reaching animal populations everywhere. Unfortunately very few works has been conducted about the conservation, if we refer to wild species (Czarny et al., 2009), while a lot of efforts were done for the mouse and rats genetic lines (Kawase et al., 2011; Li et al., 2009). This review consider the different aspects which have to be take into account for a good level of genetic damage exclusion and getting a safety production.

The main objective of research on sperm cell freeze-drying is to preserve motility and the fertilization capability therefore they could be used in artificial insemination or in vitro fertilization. Despite the changes in

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conditions of freeze-drying or storage were made, this objective has not been realized in any of the species studied. The mechanical and osmotic stress due to freezing and drying damages the spermatozoon membrane (including the acrosome) (figure 1) (Wakayama & Yanagimachi, 1998), resulting in motility loss and cell death. However, the lack of motility is no longer an obstacle to fertilization, since the microinjection of spermatozoa into oocytes is now routinely carried out in many equipped embryological laboratories (figure 2). However, the acrosomal loss could be consider a positive factor considering that it seems to exerts a negative effect on ICSI outcome. Conversely, the nuclear compartment of lyophilized spermatozoa is not affected by freeze-drying and re-hydration, as indicated by the observation that chromosomal abnormalities of blastocyst-stage embryos derived from freeze-dried sperm are comparable to those of mouse embryos obtained using fresh sperm. Since the first reports, many laboratories are working toward the optimization of protocols for freeze-drying spermatozoa.

Mature spermatozoa may be considered a kind of resistant cell, since they might be able to fertilize an egg after several days of permanence in the female reproductive tract. Moreover, their potential to participate in embryogenesis is not lost when the sperm cells die. Goto et al. (1990) published the first successful report about using non-viable spermatozoa for fertilization; in that study, bull spermatozoa were killed by several cycles of freezing and thawing without cryoprotection and then injected into metaphase II oocytes. Although only few of the injected oocytes developed into blastocysts (8%), two normal calves were born following transfer of such embryos into recipient cows (Loi et al 2011).

Principles of The Freeze-Drying Process

Freeze-drying or lyophilization depends on direct transition from a solid (ice) to vapor (gas) phase (sublimation phenomenon) contrary to conventional dehydration, which depends on an evaporation phenomenon, At sea level (where the pressure is equal to 1 atm), water molecules

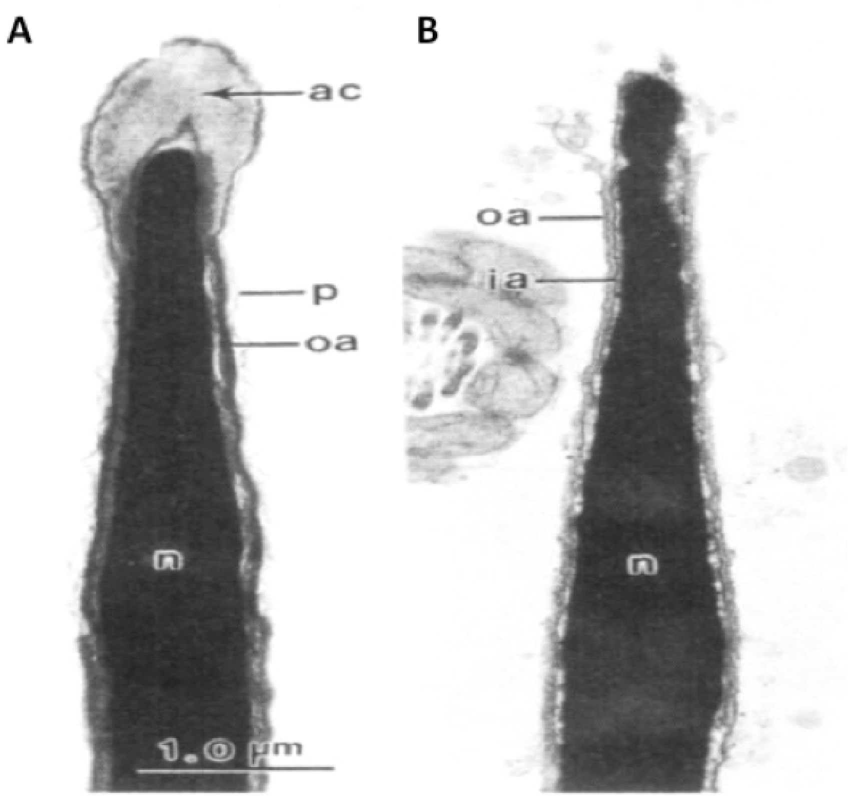

Figure 1. Longitudinal section of fresh (A) and Freeze-dried (B) mouse spermatozoa. (p) plasma membrane, (ac) acrosome, (ia) inner acrosomal membrane, (oa) outer acrosomal membrane and (n) nuceus. (Wakayama & Yanagimachi, 1998).

change from solid ice to liquid if their temperature is increased above the sea level freezing point (0°C) and then change to vapor (evaporation) if their temperature is increased above the sea level boiling point (100 C). If the water temperature is higher than the freezing point while the atmospheric pressure is maintained below 0.006 atm (6.1 hPa), the water molecules may be warmed enough to thaw. However, in the absence of enough pressure for liquid formation, the water molecules change directly to the vapor phase. The freeze-drying protocol has two different stages. During the first stage (main drying), latent heat is

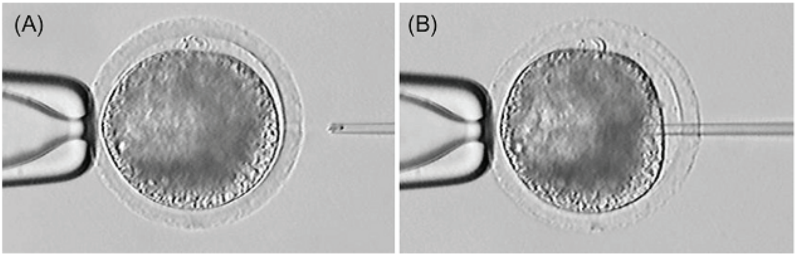

Figure 2. ICSI procedure in the bovine. (A) Single spermatozoon is immobilized and an oocyte is held with a holding pipette. The zona pellucida is drilled by several piezo pulses, and the spermatozoon is repositioned to the tip of the injection pipette. (B) The injection pipette is advanced mechanically deep into the center of the oocyte. The spermatozoon is gently injected into the ooplasm, and then the injection pipette is withdrawn. (Hoshi et al. 2011.)

supplied to the frozen product under low atmospheric pressure while keeping its temperature above the critical temperature. Reaching the temperature above this level results in undesired processing defects during freeze-drying, while maintaining the product temperature below the critical temperature may result in unacceptable slow progress of drying. Approximately 90% of the total water in the sample (essentially all of the free water and some of the bound water) can be removed by sublimation during this first stage. The remaining bound water, which limits the structural integrity of the product, can be removed during the subsequent second stage (final drying) when a higher temperature is applied to the freeze-drying material under lower atmospheric pressure than those typically used in the main drying stage.

Differences Between Rodents and Bovine Sperm Freeze-Drying Procedure: What We Have to Optimize

Physical Aspects

The conditions during the freeze-drying process, which were found effective in the rodent species, need to be optimized for bull spermatozoa. Mouse and rat spermatozoa were practically preserved at a refrigeration temperature (+4 C) for a long term (>6 months) after a two-step rehydration protocol for freeze-drying, with acceptable offspring rates. The freeze-drying protocol employed slightly reduced the ability of the bull spermatozoa to induce calcium oscillation, but it had no adverse effect on the active demethylation dynamics of the paternal genome and the microtubule assembly for formation of sperm-asters during the early stage after fertilization. However, freeze-dried bull spermatozoa participated very little in embryonic development to the blastocyst stage, even after improvement of blastocyst yield from ICSI oocytes by applying exogenous activation stimuli with ionomycin and ethanol. (Hochi et al., 2011)

Among different challenges, the most important point to optimize the freeze drying process is the evidence of damage absence during all the embryonic development phases.

Freeze-drying media, drying pressures, and all other conditions of the technique need further exploration and, above all, chromosome analysis after ICSI under various conditions which have to be investigated. It is essential to determine the level of DNA fragmentation of freeze-dried sperm before use.

The storage of freeze-dried mouse sperm at the commonly-used primary drying pressure (0.04 mbar) required temperatures lower than −80 C to withstand long-term preservation. Changing the pressure at primary drying from 0.04 mbar to 0.37 mbar significantly improved the developmental potential of mouse sperm with and without storage at refrigerator temperature after freeze-drying, the pressure at primary drying appears to be an important factor affecting time and temperature in the preservation of freeze-dried sperm. Freeze-dried sperm stored at −80 C with and without transportation can retain their ability to generate viable offspring after long-term storage (Kawase et al., 2011).

Sperm chromatin assessment is an independent measure of sperm quality that provides better diagnostic and prognostic capabilities for potential fertility than standard sperm parameters.

Over the past ten years, numerous reports have shown that freeze-dried mouse sperm are capable of producing normal embryonic development after injection into oocytes. Moreover, a lot of researchers have made various improvements to the practical aspects of the freeze-drying process, with beneficial effects on the embryo developmental rate. (Hoshi et al. 2011).

Chemical Aspects

The presence of decondensed sperm head, pronucleus and blastocyst formation after ICSI demonstrated that freeze-dried spermatozoa using EGTA solution and medium supplemented with FCS and trehalose were able to fertilized matured oocytes.

Disjoining of the tail from the head of the lyophilized sperm has been reported as a common finding in pigs, rabbits and in mice using different media. It is possible that bovine sperm has a greater stability in the connection region than other species and this could explain the low loss of tail after freeze-drying when compared to data found in the literature. Electron microscopy evaluation showed that in all treatments the mitochondria were structurally maintained after freeze-drying even if microtubules remained intact only in the media containing FCS and in the control group. Martins et al. (2007) hypothesize that the media with EGTA and trehalose, due to their hipertonicity, could affect microtubules integrity in higher extension.

Mammals sperm nuclei are very stable and highly condensed with an unique DNA organization, being 6 times more compact and having 40 times less DNA volume than somatic cells. This unique type of DNA packing is essential to protect the cell and minimize damages caused by exogenous agents before fertilization. It has been suggested that the bovine spermatozoa have a more stable nuclear packing than other species, which resulted in some difficulties for the sperm head decondensation in the ooplasm when bovine spermatozoa are used for ICSI. On the other hand, this nuclei characteristic makes the bovine sperm an ideal cell to be preserved by freeze-drying.

Sperm DNA can be damaged during freeze-drying and especially during storage if the adequate protection is not provided. It is well known that damages in DNA can be caused by activation of endogenous nucleases, which is always injured after freeze-drying.

Trehalose is a disaccharide of glucose found in many organisms that are able to survive under complete dehydration, a phenomenon known as anhydrobiosis. It is possible that during sperm freeze- drying process, trehalose binds to the sperm membranes and forms a stable component with low mobility, which would be responsible for the longer biological stability. Besides, trehalose could replace the water and cause stabilization due to the formation of hydrogen bridges with components of the cells when the water is removed. EGTA is a calcium chelator, it either prevents or decreases the activity of calcium-dependent endonucleases by limiting the availability of the circulating calcium. The use of EGTA is recommended to avoid chromosome breakage due to inhibition of the endonucleases.

Where and How the Freeze Dried Sperm Could Act Negatively

Oocyte Activation Induced by Sperm

Three hypotheses were offered to explain the sperm-induced oocyte activation in mammals: The conduit, or calcium bomb hypothesis, implicates the direct, sperm-generated injection of Ca ions into oocyte cytoplasm at fertilization. The receptor hypothesis maintains that the specific receptors on the sperm and oocyte plasma membranes activate the signaling cascade leading to the release of Ca from internal stores in oocyte endoplasmic reticulum. Finally, the oscillogen/SOAF hypothesis favors a soluble oscillogenic factor, presumably a polypeptide that is released from the sperm head into the oocyte cytoplasm at the time of gamete fusion. Recent studies seem to support the validity of SOAF hypothesis in mammals. The injection of sperm heads, but not sperm tails alone into oocyte cytoplasm induces activation. Factors released from the mammalian sperm head by freeze-thawing or by chemical extraction contain SOAF activity, and work across mammalian species and even in invertebrates. Since the sperm acrosome does not enter the oocyte cytoplasm during natural fertilization, SOAF activity should not be derived from the acrosomal content known to contain a complete calcium signaling system, which is also present in the oocyte cytoplasm and were implicated in the process of oocyte activation (Figure 3). Similar to the identity of SOAF, the actual mechanism, by which the spermatozoon introduces the oscillogenic molecules into the oocyte cytoplasm, is not known (Sutovsky et al., 2003).

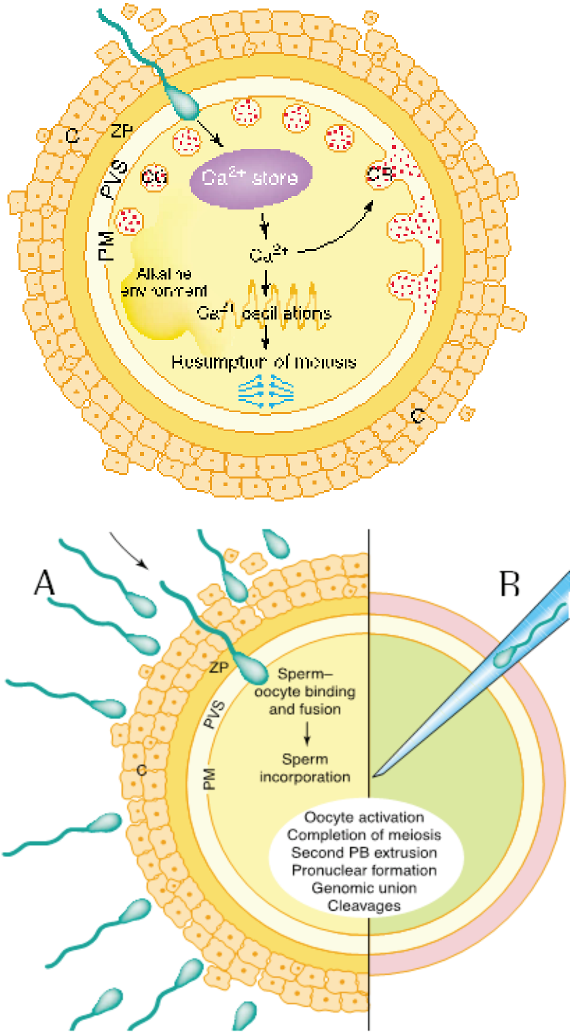

Figure 3. Graphic rapresentation of oocyte activation by sperm penetration during the natural fertilization and/or intracytoplasmatic sperm injection (Ben-Yosef et al., 2001).

Increasing cell biological understanding of the mechanisms regulating development of bovine preimplantation embryos leads to an increasing number of control step to evaluate the normality of embryos created by technological procedures. Unfortunately, cell biological analyses are still based on invasive procedures. Further advances in the molecular understanding of cellular function is expected to lead to development of new arrays of intravital markers, which, together with the developments in bioimaging may evaluate living embryos (Hyttel et al, 2003).

Epigenetic Reprogramming in Early Development

Normal development depends on a precise sequence of changes in the configuration of the chromatin, which are primarily related to the acetylation and methylation status of histones and the methylation of genomic DNA. These epigenetic modifications control the precise tissue-specific expression of genes. DNA methylation is also thought to play a crucial role in suppressing the activities of parasitic promoters and is thus part of the gene silencing system in eukaryotic cells. Previously, methylation was thought to be associated with silencing of a given gene, but an increasing number of genes is now found to be activated by methylation marks, specifically cancer suppressor genes and differentiation-associated genes. Epigenetic regulation is critical to realize the biological complexity of multicellular organisms and the complexity of epigenetic regulation increases with genomic size. During fertilization in most mammalian species, the centrosome brought into an oocyte by a spermatozoon plays a critical role in assembly of the microtubule network that brings both male and female pronuclei to the center of the newly formed zygote, as reported in humans, rhesus monkeys, rabbits, pigs and cattle. Interestingly, paternal inheritance of the MTOC (microtubule-organizing center) does not occur in the mouse and rat, and the microtubule network developed from multiple cytoplasmic asters, instead of a single sperm-aster, is involved in the migration of pronuclei.

Freeze-drying has been proposed as an alternative method to preserve mammalian spermatozoa, although freeze-dried (FD) spermatozoa after rehydration lose their motility and application of intracytoplasmic sperm injection (ICSI) technique is necessary. Rodent spermatozoa can be stored practically at refrigeration temperatures. However, in large domestic species, in vitro production of blastocysts derived from FD-ICSI is still considered to be a challenging endeavor. The freeze-drying protocol slightly reduced the ability of bull spermatozoa to induce calcium oscillations and that it had no adverse effect on the active demethylation dynamics of the paternal genome (Habdalla et al., 2009). In contrast, a harmful effect of the freeze-drying protocol was detected by chromosomal analysis and sperm chromatin structure assay in mouse spermatozoa, which may suggest the presence of species difference.

During early mammalian development, reprogramming of genomic DNA modifications is observed shortly before and after the formation of the zygote. The paternal DNA is actively and rapidly demethylated after fertilisation, whilst the maternal DNA undergoes passive demethylation, as shown in bovine, murine, porcine, rat and human zygotes. The embryonic DNA is increasingly remethylated between the two-cell and the blastocyst stages in waves, which correlate with the species-specific onset of transcription from the embryonic genome. These mechanisms ensure that critical steps during early development, such as the timing of first cell division, compaction, blastocyst formation, expansion and hatching are regulated by a well-orchestrated expression of genes. The application of assisted reproductive technologies, such as in vitro fertilisation and culture, is frequently associated with aberrant mRNA expression patterns in the resulting embryos, greater epigenetic disturbances and a higher risk of aberrant phenotypes (Niemenn et al., 2008).

Conclusion

The future approach to the study of freeze-drying processes both for the genetic resources conservation and commercialization have to take a specific sustainability vision. The differences among species, breeds and individual may influence the result of a reproductive technology application. It might be better to delve into the application after the complete evaluation of the hazard points and to have a clear definition of the risk assessment.

As reported for the animal cloning the weight of evidence approach consisted of four steps:

(1) Evaluation of the empirical evidence (i.e., data on molecular mechanisms, physiological measurements, veterinary records, and observations of general health and behavior) for the species being considered; (2) Consideration of biological assumptions predicated on our growing understanding of the molecular mechanisms involved in mammalian development; (3) Evaluation of the coherence of the observations with predictions based on biological mechanisms; and (4) Evaluation of the consistency of observations across all of the species considered, including the mouse model system. (CVM-FDA, 2008).

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5- Applications of Near Infrared Spectroscopy for the Assessment of Quality Traits of Livestock Products

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Massimo de Marchi

Introduction

In recent years consumers pay more attention to their diet and show high expectations on food and, indirectly, agro-food industry, that should guarantee the products quality. In view of this consideration, foodstuff companies need advanced analytical methodologies to evaluate the qualitative characteristics of food. In order to improve conventional ones, these methodologies must be rapid, cheap, reliable and it must be possible to integrate them into the manufacturing process. In that sense, today there is great interest in developing innovative analytical methodologies due to both the need of safeguarding consumers and the need of meeting the limits imposed by the regulations in force.

Near-infrared spectroscopy (NIR) is a valuable method for the qualitative and quantitative analysis of many agro-food industry's products. NIR spectroscopy is a physical analytical methodology based on the absorption of electromagnetic radiation whose wavelenght in the near-infrared goes from 12800 to 4000 cm'_1 (780-2500 nm) (Fig. 1).

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Compared to conventional analytical methodologies, this technique has a number of advantages: it is rapid (spectral sample acquisition needs from seconds to few minutes), not destructive (the sample can be reused after the spectral reading), not invasive (low energy radiation cannot transfer energy in the form of heat to the sample), and, remarkably, it does not need previous preparation of the sample can be analyzed “in raw”.

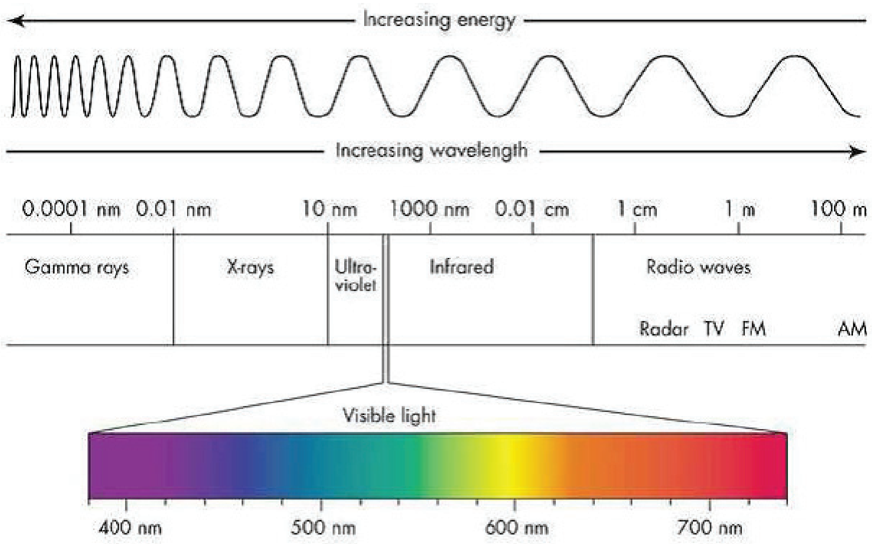

Figure 1. Electromagnetic spectrum (from Riovanto, 2011).

The analytical signal acquired by the instrument depends on the physical-chemical properties of the sample hit by incident radiation during the analysis. Such radiations can be absorbed, partly transmitted, partly reflected.

The obtained spectrum, that correlates the intensity of absorption with the wavelengths, is characterized by peaks that can be related to specific functional groups of the sample (Fig. 2).

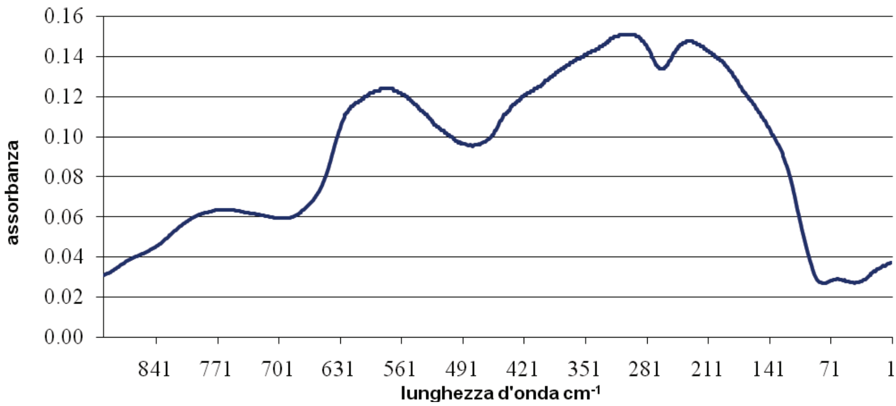

Figure 2: NIRS spectrum of the absorption of a Longissimus dorsi sample.

It follows that NIR spectroscopy is a very effective analytical technique to determine quickly and simultaneously many properties of the food products. In the NIR spectrum interval there are absorption bands due to overtones or to a combination of vibrational transactions of many bonds (C-H, N-H, OH, P-H, S-H). Hence, such a technique permits to make a quantitative analysis over the components that contain those bonds (water, proteins, lipids, carbohydrates).

Employing NIR spectroscopy to determine the chemical composition of food requires a calibration stage that comprise the individuation of representative samples and a statistic survey on chemical composition data and properties of the spectra. After chemometric analysis the instrument can predict the chemical composition of unknown samples with a margin of error which is defined by the statistical precision of the regression. Reliability of the prevision can be measured depending on the values of the determination coefficient (R2), of the standard error of the calibration (SEC) and of the standard error of the cross-validation (SEP) or prediction.

NIRS applications for beef quality

Near Infrared Reflectance Spectroscopy is one of the most promising technique for the large-scale valuation of beef quality (Geesink et el., 2003). NIRS has the potentiality of predicting rapidly and accurately different qualitative aspects of beef. It enables rapid and frequent mensuration and the preparation of the sample is also rapid and easy. It is suitable for being used in line for the without-contact determination of different spectra simultaneously (Prevolnik e coll., 2004).

The NIRS analysis can also be used to predict the chemical composition of samples that have not been subject to any preparation. In bibliography numerous evidences of the use of NIRS equipment on beef can be found. It has been used in research Institutes all over the world, on different livestock species, breeds, ages, feeding and production methods. Anyway, Ben Gera and Norris (1968) first showed the problems with the use of NIRS due to the high presence of water in fresh products and to the necessity of an accurate preparation and dehydration of the sample. The reason is the high absorption due to water that hides the information related to other components (Shenk e coll., 1992).

De Boever and coll. (1992) registered accuracy sufficient to predict the values of humidity and ethereal extract but a lower precision for the row protein. NIRS provides better data for the content of fat than that of proteins within freeze-dried veal meat (Sanderson and coll., 1997). Intramuscular fat proved to be one of the most foreseeable parameter (Prieto and coll., 2006).

Studies on rabbits provided high-precision prediction for grease content, gross energy, row protein and magnesium; medium-precision for the quantity of sodium, potassium and phosphorous; low precision for total ash, calcium and iron (Steverink and Steunenberg, 1991 and Masoero et al., 1994).

Through the statistic treatment of data it is possible to produce a classification and discrimination of age and weight at the moment of the slaughter for rabbit (Masoero and coll., 1994); of the diet of reared calves (Sanderson e coll., 1997); of the anatomical origin of many carcass muscles (Masoero e coll., 1994), of the technique of preservation (fresh, defrozen, defrozen and refrozen food) (Downey e Beauchene, 1997), and of breed origin of beef (Alomar et al., 2003).

Pla et al. (2007) predicted the composition of fatty acids on rabbit carcasses and distinguished the breeding system (conventional or organic), while McElhinney et al. (1999) distinguished among turkey and chicken meat.

Hoving-Bolink and coll. (2005) studied the quality of pork 1 and 24 hours post-mortem. As a result they registered complete accuracy on the prediction of intramuscular fat, though their study did not give any satisfactory results concerning the drip losses.

Shackelford et al. (2005) improved the methodology for the determination of the tenderness of the meat. On Longissimus toraci and Longissimus lomborum muscles, reading on fresh and frozen veal samples, Andre´s et al. (2007) registered a good accuracy for prediction of pH after 24 hours (0.97) and brightness (L*) at time zero (0.85) and after 60 minutes (0.82). Good potentialities have been measured about Warner-Bratzler shear force (0.65), while scarce prediction for cooking losses (0.20), for a* and b* parameters of colour (because of the freezing and defreezing) and for sarcomere length (0.16). Despite the latter, the study directed by Liu and coll. (2003) registered good correlations for parameters a* and b* of the colour (R2=0.90 and 0.78, respectively).

Ripoll and coll. (2008) tested NIRS on calf Longissimus dorsi muscle, showing good correlations for the myoglobin content (R2=0.91), the tenderness (0.98), the water holding capacity (0.82) and tWarner-Bratzler shear force (0.70). According to this study, NIRS is not suitable for the prediction of the protein because of the little variation of the values.

Prieto and coll. (2007) demonstrated that NIRS can successfully discriminate the minced beef samples depending on the kind of animal probably because of differences in the content of intramuscular fat and water. According to another study on Longissimus toraci of of calves, Prieto and coll. (2008) registered a good correlation for the parameters of brightness (L*) (R2=0.87) and of the yellow index (b*) (0.91). NIRS technology proved to be good for the prediction of colour: this is very important because the consumer mainly take this parameter into consideration at the moment of the purchase. The same good results have not been registered with regard to beef.

De Marchi et al. (2007) applied NIRS on Longissimus thoracis from of 17-20-month old Piemontese beef young bulls, which provided carcasses of about 400-450 kg. They registered better correlations on frosted and freeze-dried flesh than on fresh meat with regard to chemical parameters, except fatty acids, with correlation coefficients ranging from 0.86 to 0.99 for ashes, lipids and proteins. Little correlation for cholesterol and collagen was shown. For the fatty acids composition R2 values were very variable, 0.02 to 0.98 on frosted and freeze-dried meat. The most accurate parameters were the total of saturated and monounsaturated fatty acids, the palmitic, the stearic and the oleic acid. For the physical parameters correlations were instead low and unsatisfactory.

In one of their articles Berzaghi and Riovanto (2009) reviewed the most recent studies for the application of NIRS over meat quality. Table 1 shows a list of the examined parameters, the obtained correlation coefficient and the mathematical method used for the statistical treatment.

Table 1 - Applications of NIR spectroscopy on meat and meat products (Berzaghi and Riovanto 2009)

Traits	**R^2**	**RMSE**	**Scatter correction**
Ripoll e coll., 2008			
Fat	0.865	0.229	SNVD(3)
Moisture	0.928	0,220	None
Protein	0.332	1,047	MSC(4)
Myoglobine	0.947	0,287	None
WHC(1)	0.930	1.502	None
WBSF(2)	0.574	0.663	SNVD
Tenderness	0.621	0.370	SNVD
Prieto e coll., 2008			

pH	0.640	0.060	MSC o Log o None
L* colour	0.765	1.500	
a*colour	0.089	1.580	
b*colour	0.587	1.460	
press loss (%)	0.690	2.080	
drip loss (%)	0.508	0.360	
cooking loss (%)	0.371	1.610	
Sierra e coll., 2008			
SFA(5)	0.915	0.182	SNVD
BFA(6)	0.837	2.907	SNVD
MUFA(7)	0.923	0.140	SNVD
PUFA(8)	0.494	0.033	None
CLA(9)	0.766	1.613	None

(1) Water Holding Capacity; (2) Warner-Bratzler Shear Force; (3) Standard Normal Variate and Detrend; (4) Multiplicative Scatter Correction; (5) Saturated Fatty Acids; (6) Branched Fatty Acids; (7) Monounsaturated Fatty Acids; (8) Polyunsaturated Fatty Acids; (9) Conjugated Linoleic Acids.

Conclusions

Undoubtedly, NIR spectroscopy is playing and will play a central role in many industries and productive sectors to elevate food production chains to higher quality standard requirement. In animal production NIR analysis is considered as a suitable tool to implement frequent controls during the entire production chain, but the true potential of this technology is yet to be fully recognized or understood so that, presumably, many applications have still to be discovered. The main challenges for the future of this technology will be the development of applications for unspecialized personal management able to bring NIR spectroscopy, supported by low cost instruments, directly into the production processes (Berzaghi and Riovanto 2009).

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6- Carcass Weight and Value of Crossbreed Bulls and Heifers Using Belgian Blue Sires on Italian Dairy Cows

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Giovanni Bittante

Abstract

The aim of this study was to investigate the effect of four breed crosses progeny of Belgian Blue (BB) sires and four dam breeds [two dairy, Brown Swiss (BS) and Holstein Friesian (HF), and two dual-purpose, Simmental (Si) and Rendena (Re)] on carcass weight, carcass daily gain, and market value of young bulls and heifers reared in eight and one commercial fattening farms, respectively. Data on market value and carcass weight consisted of 1,530 males and 1,718 females slaughtered in one commercial abattoir from 2006 to 2009. Traits were analyzed by ANOVA procedure including the fixed effects of breed cross, fattening farm (only for young bulls), and the date of slaughter. All effects were significant ($P < 0.05$) in explaining the variability of the studied traits. The highest least squares means ($\pm$SE) for carcass weight and market value were found for young bulls and heifers from SI dams (369 $\pm$ 3.0 and 278 $\pm$ 1.2 kg, and 1,668 $\pm$ 13.9 and 1,541 $\pm$ 7.0 €/carcass, respectively), whereas animals from HF dams exhibited the lowest values of carcass weight (356 $\pm$ 3.1 and 272 $\pm$ 1.3 kg, respectively) and market value (1,599 $\pm$ 14.7 and 1,502 $\pm$ 7.8 €/carcass, respectively).

Keywords: Belgian Blue, young bulls, heifers.

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Introduction

Crossbreeding between beef sires and dairy dams is a common practice in Italy, especially in the Alps, where good fertility and longevity of dairy and dual-purpose breeds allow the use of beef semen on cows not destined to produce replacements. In Trentino-Alto Adige region (north of Italy) approximately 25 % of cattle is mated with beef sires and this results in higher income for farmers as crossbreds are much more appreciated by the market than purebreds. The vast majority of crossbreed calves in Italy are progeny of Belgian Blue (BB) sires (Dal Zotto et al., 2007 and 2009; Penasa et al., 2009). The use of double--muscling breeds in crossbreeding programs is increasing in Europe because animals are characterized by less bone, less fat, more lean and greater dressing percentages (Shahin and Berg, 1985; Hanset et al., 1987; Uytterhaegen et al., 1994; Güngör et al., 2003). Moreover, carcasses from crossbreed animals are more valuable than those from purebred dairy cattle (Wolfovà et al., 2007), and are characterized by better eating characteristics of meat (Davies et al., 1992). The production of beef calves from dairy farms in Italy is very important also as strategy to attempt the reduction of imported animals from foreign countries (Cozzi, 2007). The aim of the study was to assess the effect of four breed crosses on carcass weight and market value young bulls and heifers using Belgian Blue sire and four different breeds of dams.

Materials and Methods

Information recorded on each animal included carcass weight (kg), carcass price (€/kg), carcass value (€), breed of sire, breed of dam, date of birth, date of purchase, and date of slaughter of 1,530 young bulls and 1,718 heifers from crossbreeding between Belgian Blue sires and 4 dam breeds; 2 dairy (Holstein-Friesian, HF, and Brown Swiss, BS) and 2 dual-purpose (Rendena, Re, and Simmental, Si). Calves were collected weekly from 2006 to 2009 by the Breeders Federation of Trento province in the associated dairy farms and evaluated by a technician for market value. After weaning (approximately 5 months of age), calves were moved to fattening farms, and fed high-concentrate traditional cereal based diets. Heifers were slaughtered at approximately 14 months of age and 500 kg of live-weight, whereas bulls were slaughtered at approximately 20 months of age and 650 kg of live-weight. At slaughtering, carcass weight and carcass value (carcass weight x carcass price) were recorded. Young bulls and heifers originated from 8 and 1 fattening farms, respectively. The studied traits (carcass weight, carcass daily gain, defined from the division between carcass weight and slaughter age, carcass price, carcass value, added value, defined from the difference between carcass value and calf purchase value and daily value increase, defined from the division between added value and fattening time (slaughter age – age of calf at purchase), were analyzed using the GLM procedure of SAS (SAS, 2009). Fixed effects considered in the models were breed cross, the date of slaughter, and the fattening farm (only for young bulls).

Results and Discussion

Almost 75% of young bulls and heifers were progeny of BB sires and the two dairy dam breeds (BS and HF). Table 1 summarizes the descriptive statistics of the data for the studied traits. Young bulls were heavier and received higher carcass value at slaughter than heifers (366 and 266 kg; 1627 and €1536;). Furthermore, bulls exhibited also higher carcass daily gain and added value than heifers (0.59 and 0.51 kg carcass/d; 1145 and €1121/head, respectively). However, heifers received higher carcass price and daily value increase than bulls (5.56 and €4.44/kg; 2.79 and € 2.32/d, respectively).

Tabela 1 - Mean and standard deviation (SD) of traits analyzed for bulls and heifers

Trait	Bulls (N = 1,530)		Heifers (N = 1,718)	
	Mean	S D	Mean	S D
Carcass weight (kg)	366	43	276	24
Carcass daily gain[1] (kg/d)	0.59	0.07	0.51	0.05
Carcass price (€/kg)	4.44	0.35	5.56	0.45

Carcass value (€)	1,627	223	1,536	193
Added value[2] (€)	1,145	227	1,121	200
Daily value increase[3] (€/d)	2.32	0.46	2.79	0.47

[1] Carcass daily gain[1] = carcass weight / slaughter age.
[2] Added value = Carcass value – calf value.
[3] Daily value increase = Added value / fattening time.

Results from ANOVA for young bulls and heifers are in Tables 2 and 3, respectively. All the effects included in the model were significant ($P < 0.05$) in explaining the variability of the traits. The coefficients of determination were 0.55, 0.41, 0.92, 0.64, 0.65, and 0.66 for young bulls, and 0.42, 0.25, 0.98, 0.70, 0.71, and 0.67 for heifers for carcass weight, carcass daily gain, carcass price, carcass value, added value, and daily value increase, respectively.

Tabela 2 - Results from ANOVA of analyzed traits for young bulls

Trait	Effect			R^2	RMSE[1]
	Breed cross	Fattening farm	Date of slaughter		
Carcass weight (kg)	**	***	***	0.55	31.53
Carcass daily gain (kg/d)	***	***	***	0.91	0.06
Carcass price (€/kg)	*	***	***	0.42	0.11
Carcass value (€)	***	***	***	0.64	147.66
Added value (€)	***	***	***	0.65	147.38
Daily value increase (€/d)	***	***	***	0.66	0.29

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.
[1]RMSE = root mean square error.

Carcasses of young bulls and heifers from BB sires and SI dams were the heaviest (370 and 279 kg, respectively), whereas those from BB sires and HF dams were the lightest (357 and 273 kg, respectively); this is probably the consequence of the bigger size of Si compared to other breeds (Dal Zotto et al., 2009).

Tabela 3 - Results from ANOVA for analyzed traits of heifers

Trait	Effect		R^2	RMSE[1]
	Breed	Date		
Carcass weight (kg)	**	***	0.42	19.52
Carcass daily gain (kg/d)	**	***	0.25	0.05
Carcass price (€/kg)	*	***	0.98	0.07
Carcass value (€)	**	***	0.70	114.21
Added value (€)	***	***	0.71	116.39
Daily value increase (€/d)	***	***	0.67	0.29

*$P<0.05$; **$P<0.01$; ***$P<0.001$.
[1]RMSE= root mean square error.

Bulls and heifers from SI dams showed also the best carcass daily gain and the best carcass value (0.597 and 0.518 kg carcass/d, respectively, and 1,668 and 1,542 €, respectively). The difference of carcass price among breed crosses was not so large, both for bulls and heifers, and ranged from 4.49 to 4.53 €/kg for bulls and 5.51 to 5.52 €/kg for heifers. Carcasses of bulls and heifers from BB sires and HF dams showed the best added value (1,194 and 1,168 €, respectively). Furthermore, carcasses of young bulls and heifers from BB sires and HF dams highlighted the best daily value (2.94 and 2.44 €/d, respectively). In conclusion, the best performance has been achieved by crossbreeds from BB sires and dual-purpose dams (especially SI), whereas the two dairy dam breeds (especially HF) showed the best added value and daily value increase.

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*** The content of the texts and their spelling-grammar suitability are entirely those of the author.**

7- Conservação *In Situ* de Raças Bovinas Locais do Pantanal e do Cerrado

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Introdução

O texto a seguir contém algumas informações e pretende apresentar o conceito de conservação de recursos geneticos animais (RGAs) sob suas diferentes formas, situar o leitor sobre o contexto histórico da introdução de bovinos no Brasil colonial e, finalmente, relatando sobre o que vem sendo desenvolvido nas ultimas décadas, quem está envolvido na conservação in situ de raças bovinas locais e quais seriam as perspectivas futuras para esse tema, nas regiões de Pantanal e Cerrado.

Conservação

De acordo com a Convenção sobre Diversidade Brasileira (BRASIL, 2000), a conservação *in situ* pode ser definida como a conservação, manutenção e a reconstituição de populações viáveis de espécies nos seus ambientes naturais, no caso de espécies domesticadas e cultivadas, nos ambientes onde desenvolveram seus caracteres distintos. Isso permite a continuidade de processos evolutivos e de todos os agentes envolvidos, num contexto de ecossistema. Entretanto é um método oneroso pois depende do manejo e monitoramento constantes de grandes áreas, o que não significa, necessariamente, que ocorra a conservação de toda variabilidade genética. A conservação ex situ, por outro lado, envolve a manutenção do recurso genético ou parte do mesmo utilizando-se biotecnologias apropriadas para conservação de tecidos, germoplasma e embriões tendo um papel fundamental na preservação desse material para pesquisas diversas e utilização em programas de melhoramento genético e recuperação de espécies em diferentes condições de risco. Entretando, isso implica na paralisação dos processos evolutivos e pode ser bastante oneroso e vulnerável a manutenção de grandes quantidades de material genético.

Uma terceira opção seria a conservação on farm, que pode ser considerada uma estratégia adicional à conservação in situ, principalmente como uma das formas de conservação genética da agrobiodiversidade, utilizando variedades crioulas mantidas por comunidades locais e/ou tradicionais. A manutenção desse material envolve recursos nativos e exóticos adaptados às condições locais. Outra particularidade é que estas variedades crioulas, mesmo deslocadas de suas condições naturais, continuam evoluindo pois que estão permanentemente submetidas à diferentes condições edafoclimáticas.

As três formas de conservação supracitadas são complementares e formam, estrategicamente, a base para a implementação de três grandes objetivos: conservação da diversidade biológica; uso sustentável dos seus componentes e repartição dos benefícios derivados do uso dos recursos genéticos.

Os bovinos chegaram primeiramente na América em 1493, provenientes da península ibérica, em sua maioria originários do sudeste da Espanha. Desembarcaram no território hoje conhecido como República Dominicana e Haiti. Entretanto, Colombo desembarcou seu gado nas Ilhas Canárias, que havia sido comprado no Norte da Espanha. Posteriormente levaria esses animais para as Américas.

Há controversias a respeito da introdução do gado bovino no Brasil, alguns historiadores afirmam que as primeiras cabeças de gado bovino foram introduzidas na região Nordeste (Pernambuco e Bahia) em 1535 por Tomé de Sousa, vindas diretamente da ilha de Cabo Verde, embora Santiago (1960) cite que Martim Afonso de Sousa j[a houvera importado bovinos, provenientes da Ilha da Madeira e de Cabo verde, para a capitania de São Vicente em 1534.

Essas raças chamadas de crioulas, nativas, locais ou naturalizadas reproduziram-se nos diferentes campos naturais do Brasil, adaptando-se ao novo ambiente Em 1958, Athanassof descreveu 13 raças Crioulas no Brasil: Caracu, Igarapé, Pedreiro, Tourino, China, Mocho Nacional, Lageano, Pantaneiro, Junqueira, Franqueiro, Pé-Duro e Malabar. No Brasil do século XXI restaram somente cinco raças localmente adaptadas, destas quatro em risco de extinção.

O bovino Caracu fixou-se inicialmente em Minas Gerais e, posteriormente, em São Paulo. No início do século XX, a raça tinha boa expressão na agropecuária brasileira. Em 1900, possuía o maior efetivo populacional dentre as raças locais, mas por estar abandonada corria o risco de desaparecer. Hoje o Caracu está distribuído praticamente em todo o território nacional, encontra-se fora de risco de extinção e tem competido em igualdade com raças especializadas em qualidade e produtividade. Entretanto, as informações sobre o gado Junqueira são escassas, desenvolveu-se no interior de São Paulo, por volta dos séculos XVIII e XIX e atualmente estima-se que não haja mais do que cem cabeças no Brasil.

Dentre as raças em risco de extinção encontra-se a raça Crioulo Lageano, habitante do sul do Brasil e adaptada às variações climáticas características da região, que correspondem a extremos de frio e calor. Em 2004 foi registrada a Associação Brasileira de Criadores de Bovinos da raça Crioulo Lageano (ABCCL), que possui aproximadamente 27 associados que detém um rebanho de aproximadamente 800 animais. Em 2008 foi registrada como raça pelo Ministério da Agricultura Pecuária e Abastecimento (MAPA).

O gado Curraleiro, também conhecido como Pé-Duro, adaptou-se as regiões de clima semi-árido e posteriormente chegou ao Cerrado, sendo, portanto, muito rústico e resistente. Atualmente, o gado Curraleiro está distribuído principalmente nos estados do Maranhão, Piauí, Tocantins e Goiás e estima-se que existam mais de 5.000 animais dessa raça. A Embrapa Meio Norte possui um núcleo de preservação em São João do

Piauí, onde os animais são mantidos no habitat onde se desenvolveram e foram submetidos à seleção natural. Foram registradas duas associações de criadores e a partir de 2008 iniciou-se o processo para registro da raça junto ao MAPA resultando na fusão dessas associações, denominada então de Associação Brasileira de Criadorea da raça Curraleiro Pe-duro, sediada no estado do Piaui.

O bovino Pantaneiro é a raça localmente adaptada, que descende dos bovinos de raças ibéricas introduzidos na planície pantaneira a partir de 1543, com o trânsito de colonizadores espanhóis, e seus rebanhos, que passavam por essa região a caminho do Peru. No século XVIII, animais de origem Portuguesa chegaram ao Pantanal durante o período mais intenso de povoamento da região, provenientes de capitanias vizinhas.

Responsáveis pela atividade pecuária local até o inicio do século XX, teve sua população drasticamente reduzida com a introdução de raças zebuínas na região.

Para que este material genético fosse conservado, em 1984 foi implantado o núcleo de conservação do bovino Pantaneiro na Embrapa Pantanal. Hoje o rebanho total dessa raça está estimado em menos de 500 cabeças, são conhecidos e acompanhados, além do rebanho da Embrapa Pantanal, um rebanho particular em Poconé-MT, outro em Rochedo-MS e um terceiro rebanho pertencente à Universidade Estadual de Mato Grosso do Sul (UEMS), em Aquidauana-MS. Há expectativas de recuperação de material genético proveniente de populações aselvajadas que vivem no Pantanal de Mato Grosso.

Os trabalhos com conservação de RGAs tiveram início em 1983 quando a Empresa Brasileira de Pesquisa Agropecuária (Embrapa) incluiu os animais no seu Programa de Conservação de Recursos Genéticos, que até então contemplava apenas a conservação de plantas. Neste Programa, a conservação é realizada por diversos Centros de Pesquisa da Embrapa, Universidades, Empresas Estaduais de Pesquisa, assim como por criadores particulares, esta rede coordenada pelo Centro Nacional de Pesquisa de Recursos Genéticos e Biotecnologia (Cenargen).

Foram criados Núcleos de Conservação in situ em diferentes regiões visando a criação e a manutenção de populações animais naturalizadas, de interesse para a agropecuária. Desde então as estratégias que vem sendo aplicadas priorizam a manutenção da diversidade genética máxima de cada espécie prevendo necessidades imprevistas para o desenvolvimento de sistemas de produção sustentáveis, uma vez que não é possível predizer com objetividade quais características podem ser necessárias no futuro.

Dentre os objetivos da conservação de recursos genéticos animais no Brasil incluem-se o monitoramento rebanhos já existentes e a ampliação dessa população pela conscientização da sociedade sobre a importância da conservação dos recursos genéticos animais, sempre observando princípios de diversidade genética, uso e valoração desse patrimônio. Em termos de pesquisa, as prioridades devem ser dadas à caracterização e avaliação das populações, além da mensuração das diferenças entre e dentro das populações.

Norteados por essas diretrizes, os centros da Embrapa há muitos anos vêm pesquisando vários aspectos referentes à conservação de raças localmente adaptadas. Está bem estabelecida a parceria nos projetos da Rede de Recursos Genéticos da Embrapa, envolvendo todas as unidades descentralizadas da empresa que possuem Núcleos de Conservação in situ ou Bancos de Germoplasma, além de atividades referentes ao Sistema de Curadoria dos mesmos. Existem parcerias estabelecidas, através da Rede de Recursos Genéticos Animais, com mais de 20 universidades, unidades descentralizadas da Embrapa e OEPAS, além de associações de criadores de raças incluídas no programa de conservação.

É bastante evidente que mesmo trabalhando com equipes e raças distintas, os objetivos e metas se mantém muito semelhantes, com estratégias e prioridades peculiares a situação de cada uma das raças bovinas a serem conservadas. Isso tem facilitado a integração entre os grupos e o trabalho em rede, maximizando os resultados e acelerando o processo de conservação em sua totalidade.

A Embrapa Pantanal, desde a implantação do núcleo de Concervação do bovino Pantaneiro tem trabalhado com o registro de informações e divulgação sobre o desempenho zootécnico, dados reprodutivos e características de adaptabilidade dessa raça, além de fornecer material para os trabalhos de caracterização genética e análises genéticas para seleção de alguns marcadores moleculares de interesse para características produtivas. Um segundo núcleo de conservação foi implantado na Fazenda Trijunçãomunicípio de Poconé-MT, em 2003, estabelecendo-se desde então uma parceria na execução de atividades de pesquisa.

A conservação in situ do bovino Curraleiro iniciou-se com os trabalhos de caracterização fenotípica e zootécnica, desenvolvidos pela Embrapa Meio Norte e auxiliados pela Embrapa Cenargen, responsável pela caracterização genética. A iniciativa do Dr. José Herculano de Carvalho, pesquisador da Embrapa Meio-Norte, foi notória e eficiente para manutenção da raça Pé-Duro através de um programa de conservação situado na Fazenda Experimental Octavio Domingues, em São João do Piauí, iniciando o projeto em 1983 com 10 touros e 25 vacas.

Dando continuidade ao trabalho do Dr. José Herculano, o Dr Geraldo Magela Cortes de Carvalho trabalha em conjunto com a associação de criadores em atividades de transferência de conhecimento e tecnologias para a criação e o desenvolvimento dos rebanhos dessa raça. O rebanho da Embrapa Meio Norte participa do projeto Beef Qualy, onde avaliou-se o desempenho e qualidade de carcaça de animais puros e cruzados. Baseado nesses resultado pode-se verificar as possibilidades de incluir esta raça local em programas de cruzamento.

Em contrapartida, a conservação in situ rebanhos Curraleiros existentes no Cerrado começaram em 1997. Com a colaboração da Embrapa Cenargen, foi registrada a Associação Brasileira de Criadores de Curraleiro (ABCCURRALEIRO), sediada em Mara Rosa – GO.

Em 2000 a Universidade Federal de Goiás (UFG) em parceria com as Fazendas Trijunção, implantou nesta propriedade, uma Estação Experimental de Estudo do Gado Curraleiro. Foram adquiridos animais provenientes de criatórios dos estados de Goiás, Tocantins, além do Distrito Federal. Os primeiros estudos da UFG com essa raça, resultaram em dissertações sobre aspectos fisiológicos e comportamentais desses animais. O material genético colhido pela equipe da UFG, desde 2001, vem sendo utilizado na elaboração de dissertações e teses de doutorado na UnB e por pesquisadores da Embrapa Cenargen. Garantindo que os processos de conservação in situ e ex situ sejam complementares

Com o propósito de registro da raça Curraleiro junto ao MAPA, iniciou-se, a partir de 2003, a elaboração de projetos para captação de recursos capazes de atender a essa demanda de exigências. Em 2004, uma parceria do Ministério da Integração Nacional com a UFG resultou no convênio para financiamento do Projeto de Conservação do Gado Curraleiro e Pantaneiro, iniciando assim uma série de atividades que seriam desenvolvidas para ambas as raças e fortaleceriam a parceria da UFG com a Embrapa Pantanal. Esta primeira etapa contemplou as fases de identificação, localização e cadastramento dos animais e dos seus respectivos criadores. Também foram abordados alguns aspectosdreferentes às determinações fenotípicas, genotípicas, bioquímica clínica, caracterização epidemiológica dos criatórios, estabelecimento das condições sanitárias dos rebanhos e caracterização imunológica. Foram instituições colaboradoras Fazendas Trijunção, Fazenda Promissão, Embrapa Cenargen e Cerrados, Universidade de Brasília (UnB), UNESP/FCAV, Campus de Jaboticabal e Associação Brasileira de Criadores de Curraleiro.

Também em 2004 iniciaram-se os contatos com o SEBRAE-GO na tentativa de incorporar o enfoque empreendedor ao contexto da pesquisa. Foi realizado o I Seminário sobre a Raça Curraleira, onde foi abordado diferentes aspectos dos processos de certificação de origem de produtos, como oportunidade de agregar valor e estimular o produtor a criar raças locais.

Em 2006 a UFG foi convidada pelo Ministério da Integração Nacional a esboçar um projeto que correlacionasse o Gado Curraleiro e os Kalungas. Desta parceria nasceu o projeto “Estabelecimento e Manutenção de Núcleos de Criação de Gado Curraleiro”, que permitiu a execução das atividades iniciais de estabelecimento do Núcleo de Criação de Gado Curraleiro no Sítio Histórico e Patrimônio Cultural Kalunga.

A preocupação em avaliar aspectos produtivos e características de qualidade da carne e carcaça de raças localmente adaptadas sempre esteve presente pois sabe-se que são fatores atrativos para o uso desse recurso genético, podendo atender a nichos mercadológicos específicos e programas de cruzamentos genéticos para produção de carne de qualidade.

Em 2008 iniciou-se um projeto, numa parceria Cenargen e UFG, com colaboração da Embrapa Pantanal, para avaliação do desempenho, qualidade de carne, carcaça e marcadores moleculares, de bovinos das raças Curraleiro, Pantaneiro e Nelore. Os resultados foram promissores e apontaram o potencial dessas raças, que apesar de não terem sofrido qualquer processo de melhoramento e seleção genética, apresentaram excelente desempenho.

Em 2009, uma parceria da Universidade Federal de Mato Grosso do Sul e Embrapa Pantanal deu inicio a um projeto para avaliar o crescimento, desempenho, qualidade de carne e carcaça de bovinos Pantaneiros criados a pasto. Esse trabalho está em andamento, com o apoio de um parceiro da iniciativa privada que implantou um núcleo de criação no município de Rochedo, onde também, estão sendo desenvolvidas atividades de pesquisa relacionadas ao uso de fertilização in vitro (FIV) para ampliação da população e desempenho de animais cruzados na região de Cerrado.

As estratégias de pesquisas adotadas pela Embrapa Pantanal e parceiros atendem ao desenvolvimento das atividades e cumprimentos das metas da Plataforma Nacional de Recursos Genéticos, coordenada pela Embrapa Cenargen. Isso tem possibilitado, além da manutenção do rebanho da Fazenda Nhumirim, a ampliação e fortalecimento de parcerias institucionais, interessadas nessa temática. É o caso da Universidade Estadual de Mato Grosso do Sul, Campus de Aquidauana, que implantou, em 2009, um núcleo de criação de bovinos Pantaneiro, com a finalidade de avaliar o potencial de produção leiteira da raça.

Diante de tantas características que favorecem o trabalho multidisciplinar e interinstitucional, da similaridade das dificuldades e demandas para a pesquisa com RGAs, foi proposta e aprovada, em 2010, da

Rede de pesquisa "Caracterização, conservação e uso das raças bovinas locais brasileiras: Curraleiro e Pantaneiro, liderada pela Dra. Maria Clorinda Soares Fioravanti (UFG). A rede é composta por nove subprojetos, coordenado por pesquisadores de diferentes instituições e aborda diferentes aspectos da conservação e uso dessas raças: caracterização genealogica e filogenética, manejo sanitário, reprodutivo e genético, produção de leite, validação de métodos para caracterização racial, padrões fenotípicos, produtivos e implantação do processo de indicação geográfica – IG (Figura 1).

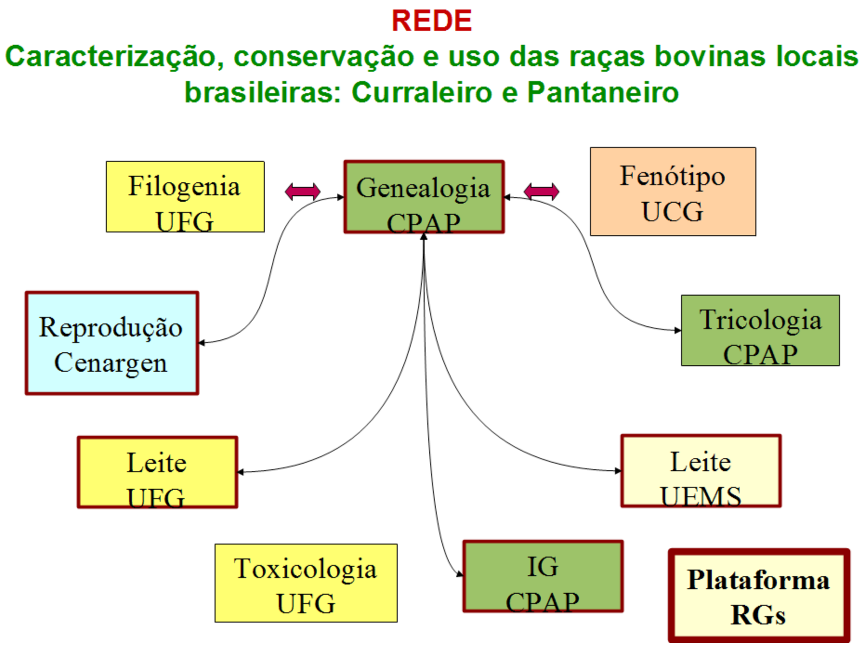

Figura 1. Fluxograma de subprojetos e instituições líderes da Rede - Caracterização, conservação e uso das raças bovinas locais brasileiras: Curraleiro e Pantaneiro.

Os desafios e dificuldades para levar adiante a conservação de RGAs pode ser apontados como: falta de políticas públicas aplicadas ao tema que incentivem a criação de raças locais, dificuldades de trânsito e multiplicação de material genético para manejo das populações, restrições que dificultam comercialização e uso dos RGAs mantidos como patrimonio do Estado, falta de recursos específicos para manutenção dos núcleos de criação e campos experimentais na Embrapa, falta de identidade dos criadores com raças locais brasileiras, falta de empreendendorismo por parte do setor agropecuário.

Os bons exemplos de conservação e uso de RGAs vem de situações onde os criadores se organizam e se dedicam a promover e trabalhar por determinada raça, como em qualquer atividade pecuária. Como ocorreu com a raça Retinta na Espanha, as ovelhas Segureñas, o Caracu ou o Criolo Lageano. É um trabalho em parceria com a pesquisa, onde a informação científica orienta o produtor e valida aquilo que ele pretende fazer, mas que em momento algum pode fazer isso por eles.

As perspectivas apontam para a comprovação da importância da valorização dos RGAs locais como recurso fundamental a ser mantido e ampliado. As raças locais não devem ser estigmatizadas como improdutivas, inúteis ou mesmo tratadas como um produto para exposição em zoológicos. A exemplo do que ocorreu com o Caracu e que vem sendo desenvolvido com o Crioulo Lageano, é possível fazer uso sustentável e lucrativo de RGAs, incluindo a abertura de alianças mercadológicas e sua aplicação em setores pouco explorados como o Turismo, controle de predadores ou manejo ambiental.

No Brasil muito pouco esforço prospectivo direcionado para analisar o futuro dos recursos genéticos e programas de melhoramento genético animal tem sido desenvolvido. A própria visão "oficial" do Ministério da Agricultura e Desenvolvimento Agrário sobre a importância das raças bovinas locais sofreu mudanças muito recentemente, com a compreensão que devem ser reconhecidas raças de interesse nacional (atual redação da lei) e não somente as raças de interesse econômico (antiga redação da lei). O governo, as instituições de pesquisa, bem como a sociedade de um modo geral, necessitam de informações que não estão disponíveis no momento, portanto devem ser sistematicamente produzidas no país. Estudos prospectivos acompanhados de definição de mecanismos de prioridade, inclusive sob a forma de políticas públicas, em conjunto com análise custobenefício serão valiosas para orientar as decisões sobre a organização e a gestão dos recursos genéticos animais e os futuros programas de melhoramento no Brasil.

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8- Considerations of Collagen Effects on Meat Tenderness

Gelson Luís Dias Feijó[1]
Eduardo Francisquine Delgado[1]

Previous Knowledge

A recent review about the role of intramuscular connective tissue in meat texture (NISHIMURA, 2010) gives us a considerable good perspective of the early studies related to the collagen effects on meat tenderness. The paper "Manipulating meat tenderness by increasing the turnover of intramuscular connective tissue" (PURSLOW et al., 2012) presented at the Meat Science and Muscle Biology Symposium, New Orleans, Louisiana, is another motivating source for the topic. So, this presentation fetches parts of these two papers to pinpoint aspects of the collagen effects on meat tenderness.

Fact 1. The structure, composition and amount of intramuscular connective tissue (IMCT) vary tremendously between muscles, species and breeds, and certainly contribute to meat texture.

Consideration 1.1. Controlled reduction of the connective tissue contribution to cooked meat toughness is an objective that would have considerable financial impact in terms of added product value.

[1] Collagen in Meat Quality Research Group Leaders.

Fact 2. With animal growth, collagen crosslinks become more stable, and the structural integrity of IMCT increases. These changes increase the mechanical properties of IMCT, contributing to the toughening of meat.

Consideration 2.1. The IMCT has a greater thermal shrinkage temperature than other connective tissues such as tendon due to its greater content of heat-stable crosslinks, and there is an increased endothermal transition temperature of IMCT with increasing animal age. This correlates to a reduced solubility of collagen in muscles from older cattle, pigs, and sheep on heating to 77°C for 1 h.

Consideration 2.2. In the absence of long times of stewing to solubilize IMCT, the collagenous contribution to toughness of meat cooked to internal temperatures of 60 to 80°C is, therefore, thought to owe much to the heat stability of IMCT.

Consideration 2.3. The amount of intramuscular connective tissue in a muscle appears connected to its in vivo function, so reduction of the overall connective tissue content is not thought to be a viable target. However, manipulation of the state of maturity of the collagenous component is a biologically viable target; by increasing connective tissue turnover, less mature structures can be produced that are functional in vivo but more easily broken down on cooking at temperatures above 60°C, thus improving cooked meat tenderness.

Consideration 2.4. Intramuscular fat deposits, mainly in the perimysium between muscle fiber bundles, result in marbling. This causes the remodeling of IMCT structures and reduces the mechanical strength of IMCT, contributing to the tenderization of beef.

Fact 3. Given the large influence of IMCT on meat texture, further elucidations of molecular mechanisms which change the structural integrity of IMCT during chronological ageing of animals and postmortem ageing of meat are needed.

Case 3.1. Variations in the amounts and heat stability of collagen in the

Longissimus thoracis muscle within and between 15 breeds of European cattle have been shown (Christensen et al., 2011), but although these variations can be related to the texture of raw meat, no correlation with cooked meat toughness was found.

Fact 4. The IMCT has been thought to be rather immutable compared to myofibrils during postmortem ageing of meat. However, recent studies have shown the disintegration of IMCT during postmortem ageing of meat and its relationship to tenderization of raw meat, although its contribution to cooked meat is still controversial.

Consideration 4.1. IMCT is undoubtedly degraded in postmortem storageof meat, but whereas this degradation weakens the IMCT in raw muscle, no differences in strength of the IMCT from aged (or conditioned) and unaged meat are found after cooking to temperatures above 60°C.

Fact 5. The different muscle fiber composition of different muscles eaten as meat may influence the potential for manipulation of their connective tissue turnover.

Consideration 5.1. Although the content and composition of IMCT in meat does undoubtedly contribute to cooked meat toughness and vary between muscles and with animal age, the lack of an easy means of manipulating the IMCT content and its contribution to cooked meat toughness has meant that the principal focus of research into variations in meat tenderness has been on the proteolysis of myofibrillar proteins postmortem, taking the view that the IMCT component in any one muscle represents a relatively fixed background toughness in animals of similar age.

Consideration 5.2. Although the amounts and composition of IMCT may be quite closely related to the growth and in vivo function of each muscle, there is one aspect of its composition that does appear to be an opportunity for manipulation, namely its state of maturity newly synthesized collagen is mechanically and thermally stabilized by divalent cross-links. Due to the exceptionally long residence time of collagen in the body, these divalent cross-links are gradually replaced by trivalent (i.e., mature) cross-links with increasing maturity of the animal, resulting in a greater thermal stability of collagen at temperatures above 60°C and, hence, greater contribution to cooked meat toughness.

Consideration 5.3. An increase in newly synthesized collagen may, therefore, dilute the mature crosslink content and be expected to decrease the IMCT contribution to cooked meat toughness. Increasing the turnover of IMCT therefore seems like a legitimate target for manipulating meat toughness.

Consideration 5.4. As muscles grow postnatally by hypertrophy of the muscle fibers, the endomysial IMCT networks that surround each fiber and the perimysial networks surrounding each muscle fiber bundle or fascicle must be remodeled; these networks must be enlarged so as not to restrict muscle growth. Dietary manipulation of animal growth rate is, therefore, perhaps the most obvious treatment to examine first in terms of manipulating IMCT turnover. As expected if greater muscle growth rate is related to a greater amount of IMCT turnover, Sylvestre et al. (2002) found increased MMP-2 activity and an increase in the proportion of total collagen that is heat-soluble in both LM and semimembranosus muscles from lambs showing a greater growth rate when fed hay plus concentrate, as opposed to lambs fed hay alone.

Consideration 5.5. These varying results indicate that the assumption that greater animal growth rate should always result in less heat-stable collagen in the IMCT of all muscles is simplistic, and that the real situation is a more complex interplay of nutritional level and other stimuli. This indicates that increased nutrients affect collagen deposition and turnover differently in specific muscles.

Some Preliminary Results Obtained by the Group

Three experiments were realized. The first one was designed to evaluate the meat quality variability in Nelore cull cows ranging from five to fourteen years of age. In the second, Nelore cull cows were distributed into two treatments: keeping weight and body condition during the dry season or regaining weight and body condition after the dry season. And the last one was the comparison of Nelore cull cows gaining 1.2 or 0.6 kg during their fattening period under feedlot condition.

Experiment 1

Table 1 - Descrição das fases da qualificação de tecnologias

Variable	N	Mean	Deviation	Min.	Max.
Age (years)	40	8.2000000	3.4058773	4.0000000	14.0000000
Live weight (kg)	40	488.6000000	37.9688131	424.0000000	570.0000000
Carcass weight (kg)	40	235.5375000	22.3088425	182.0000000	281.0000000
Conformation	39	9.5641026	1.8034305	7.0000000	13.0000000
Maturity	39	5.3846154	2.0341219	2.0000000	8.0000000
Color	40	3.9375000	0.9071475	0	5.0000000
Marbling	39	9.0512821	4.1227783	3.0000000	17.0000000
External fat (mm)	39	9.9002564	5.2240836	3.4900000	22.5300000
Carcass lenght (cm)	39	135.2820513	4.0242601	124.5000000	145.0000000
l* value	40	3277.98	420.8023394	1000.00	3934.00
a* value	40	2424.67	291.1336890	1000.00	2805.33
b* value	40	1588.60	204.0405751	1000.00	2011.00
FShear L. dorsi t1	39	9.4485897	2.2779459	5.6746667	14.0600000
FShear L. dorsi t14	39	6.6587209	1.4807357	4.0513333	10.7926667
FShear Semitend. t1	39	7.2685496	1.0105123	4.3521667	9.2408333
FShear Semitend. t14	37	6.3463018	0.6289493	5.1048333	8.0643333
FShear T. brachii t1	37	8.1563694	1.0537752	5.4868333	10.2553333
FShear T. brachii t14	39	5.6805513	0.9310302	3.3936667	7.8475000

Experiment 2

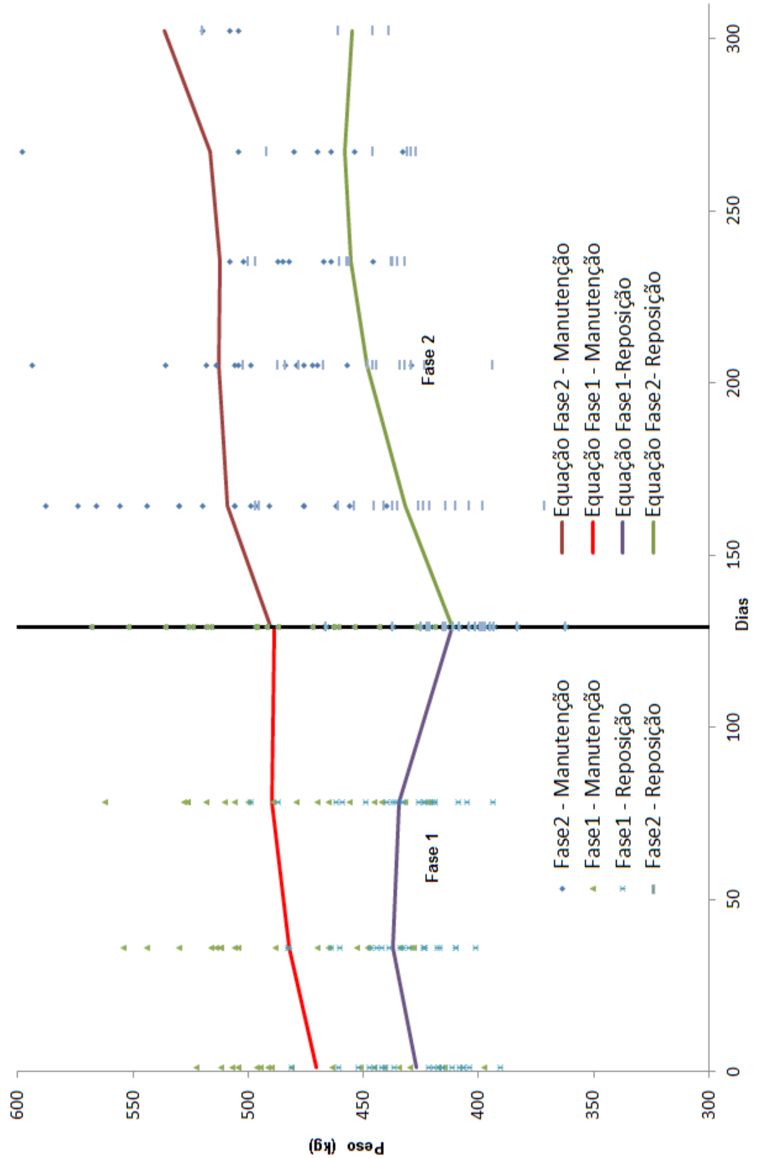

Figure 1. Live weight of Nelore cull cows under two strategies of food supplementation.

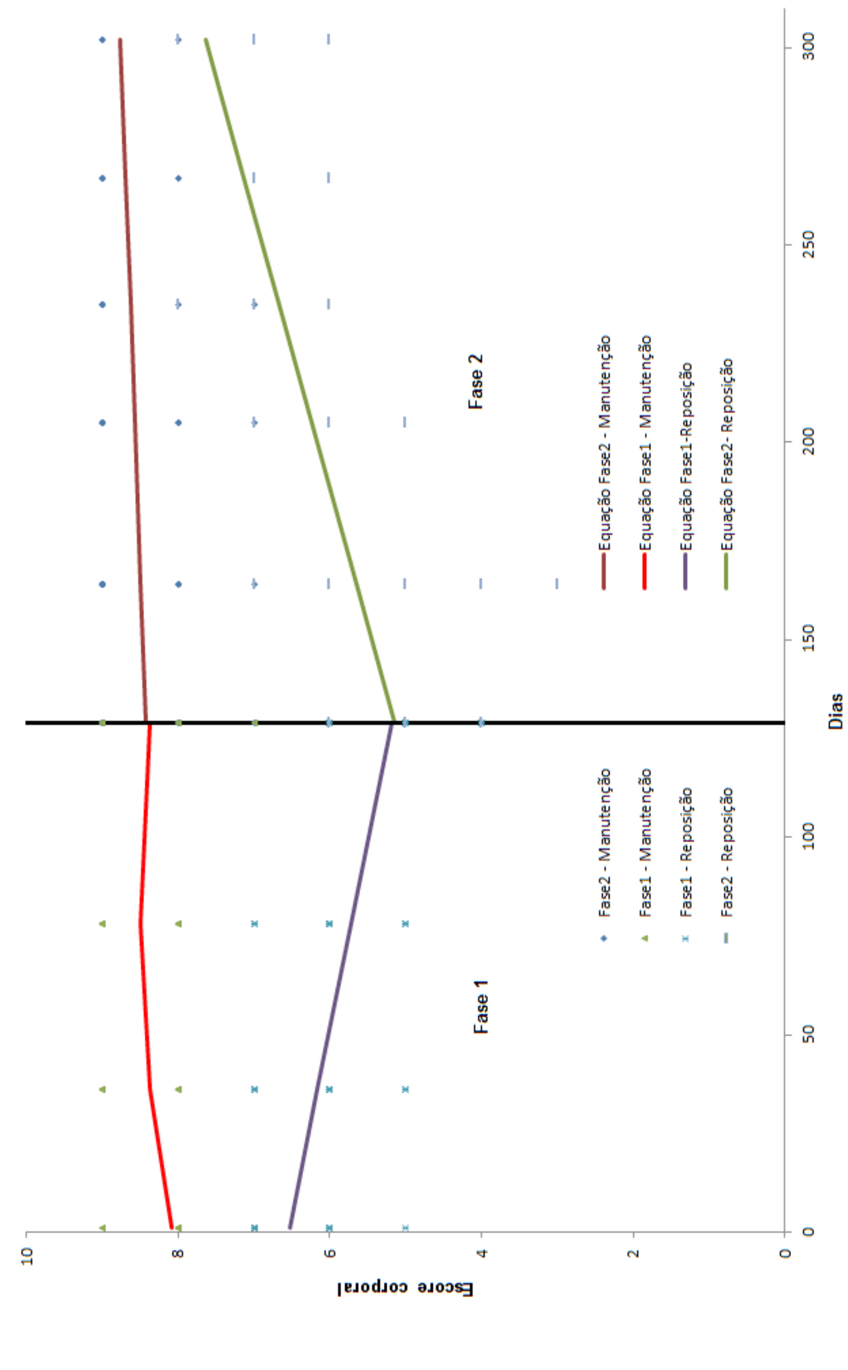

Figure 2. Body condition of Nelore cull cows under two strategies of food supplementation.

Table 2. Miofibrilar fragmentation index in meat from Nelore cull cows

Miofibrilar fragmentation index (MFI)			
	LD	**TB**	**ST**
Treatments			
Compensatory¥	28,51	31,32	32,14
Maintenance#	29,95	29,22	34,61
Ageing			
0	23,48a	24,53a	30,92
21	34,99b	36,01b	35,83
EPM	0,28	0,34	0,22
Effects			
Treatments (T)	ns	ns	ns
Ageing (A)	**	**	ns
T*A	ns	ns	ns

** (P<.01); * (P<.05); ns: no significant; [ab:] Means with different letters differ (Tukey P<.05).

Table 3. Intramuscular collagen contents in Nelore cull cows.

	Muscle					
	L. dorsi		***T. brachii***		**Semitendinous**	
	Total	Soluble	Total	Soluble	Total	Soluble
Treatment						
Maintenance	2,37	17,40	3,36	11,40b	3,68	8,81
Compensatory	2,28	16,52	3,18	14,95a	3,65	8,85
Ageing time						
Day 1	2,27	13,35b	3,02	12,01	3,52	8,76
Day 21	2,37	20,57a	3,52	14,34	3,81	8,90

** (P<.01); * (P<.05); ns: no significant; [ab:] Means with different letters differ (Tukey P<.05).

Table 4. Correlation (upper values) and significance level (lower values) between collagen contents and shear force in Nelore cull cows.

Shear force at time T→	LD T0	LD T21	ST T0	ST T21	TB T0	TB T21
Total collagen T0	0,169	0,096	0,013	-0,311	0,196	0,024
	0,317	0,571	0,938	0,058	0,238	0,886
Total collagen T21	0,178	-0,009	0,095	-0,308	0,138	-0,068
	0,293	0,958	0,569	0,060	0,438	0,703
Soluble collagen T0	0,114	0,118	0,183	-0,314	0,133	0,024
	0,504	0,487	0,278	0,059	0,433	0,890
Soluble collagen T21	-0,146	-0,039	-0,027	0,110	-0,171	0,107
	0,387	0,812	0,875	0,515	0,340	0,554

Experiment 3

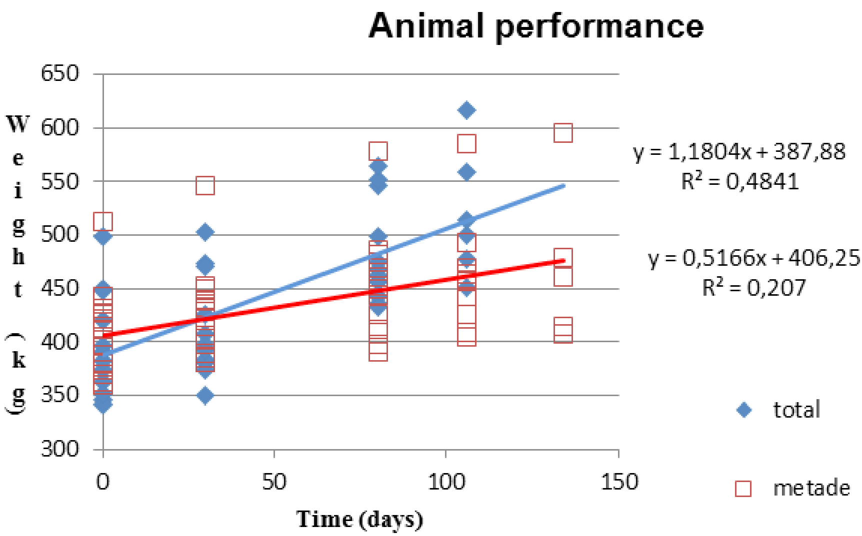

Figure 3. Live weight of Nelore cull cows under two strategies of food supplementation.

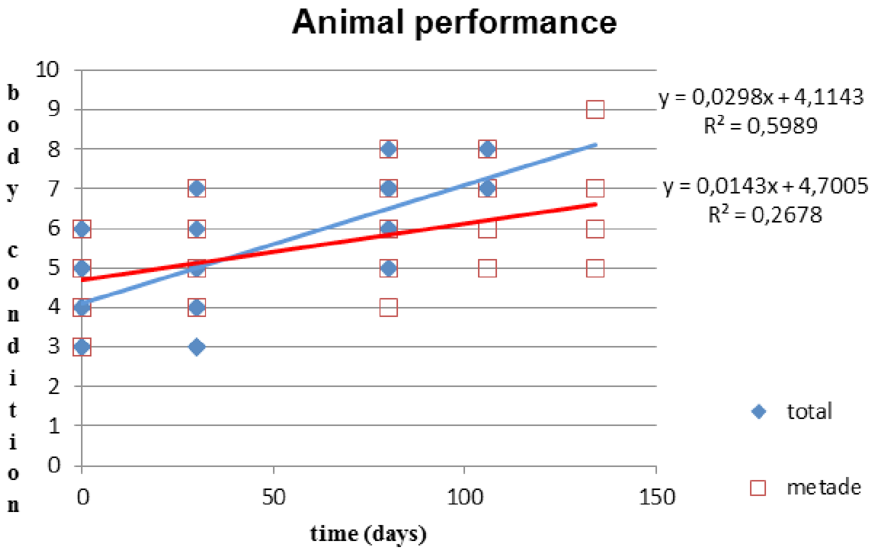

Figure 4. Body condition of Nelore cull cows under two strategies of food supplementation.

Table 5. Meat quality of Nelore cull cows under two live weight gain rates

Variable	Slow	Fast	P<
Shear force-LD	6,826	6,955	0,8268
Shear force-ST	6,547	6,754	0,5410
Shear force-TB	6,188	6,306	0,7748
Muscle L* value	37,715	40,094	0,0181
Muscle a* value	23,812	25,139	0,0111
Muscle b* value	15,113	16,665	0,0071
Fat L* value	72,877	70,639	0,1304
Fat a* value	18,295	18,782	0,6760
Fat b* value	33,697	25,962	0,0006
Croma (muscle)	28,208	30,163	0,0087
Croma (fat)	38,460	32,153	0,0021
Hue (muscle)	0,565	0,585	0,0075
Hue (fat)	1,070	0,955	0,0031

Perspectives for the Future

Skeletal muscle development is a highly organized process regulated by complicated interactions between muscle fibers and their environment, the IMCT. During embryonic development, IMCT forms synchronously with muscle fibers. During postnatal development, IMCT must be reconstructed with muscle hypertrophy and intramuscular fat deposition. These structural changes affect the mechanical strength of IMCT and contribute to variation of meat texture. Thus, the turnover of IMCT must be a future target for manipulation of meat texture.

Postmortem ageing increases collagen extractability from muscle, degrades PG components of the IMCT, disintegrates the structure of the IMCT network, and significantly reduces the strength of IMCT in raw meat, although it is still controversial whether these IMCT changes in raw meat are related to cooked meat toughness. Further elucidations of precise mechanisms by which IMCT disintegrates during postmortem ageing will give a better understanding of the control of meat tenderness after slaughter.

The reduction of the connective tissue contribution to meat toughness is a commercially valuable goal. Some alternative approaches to achieving this include the use of recombinant technologies to engineer enzymes for use as meat tenderizers that specifically target the IMCT component. Although there has been some progress toward this, the engineered enzymes have not always shown the desired preference for collagen or elastin as a substrate (Yeh et al., 2002; Wang et al., 2006).

The fact that some proteolysis of IMCT does occur postmortem, but that this does not affect toughness after cooking to 60°C or above, indicates that those collagenous structures that are the most susceptible to proteolysis are also those that are most easily broken down by heating, and perhaps it is the mature collagen structures that are both resistant to postmortem proteolysis and to cooking. If this is true, then the refined target of a recombinant enzyme technology should focus on collagen fibers with a high content of mature cross-links.

The idea of the collagenous component of meat forming some immutable "background toughness" is clearly a notion that can be challenged, and the stimulation of connective tissue turnover by the natural enzymes within the living meat animal presents a tangible avenue of reducing the effects of IMCT on cooked meat tenderness by reducing the proportion of collagen that is stabilized by mature cross-links. The range of studies highlighted clearly shows that fibroblasts in muscle, and also muscle cells, react to a variety of stimuli by increasing the activity of enzymes that will break down intramuscular connective tissue and increasing the synthesis of new collagen. These responses to individual stimuli in simple cell culture models demonstrate in principle that there is a capacity to manipulate IMCT turnover and begins to indicate some of the signaling pathways involved. The potential effects of any in vivo treatments based on these factors on meat tenderness can be assessed in future studies, but it is clear that the complex interaction of multiple factors in the living animal may be expected. In particular, phenotypic differences between fibroblasts in different muscles and different proportions of muscle fiber types in different muscles can be expected to be a complicating factor. It is increasingly clear that a treatment applied to the whole animal may produce very different effects on meat quality in different muscles of the carcass.

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9- Development of New Eco-Efficient Cultivars of Forage Grasses

Liana Jank[1], Cacilda Borges do Valle[1], Rosangela Maria Simeão[1], Sanzio Carvalho Lima Barrios[1], Geovani Ferreira Alves[1]

Introdução

Brazil has the largest commercial beef herd in the world (205 million heads of cattle in 2009 (IBGE, 2011) equivalent to 14.8 % of the world's herd (FAOSTAT, 2011). Since 2004, Brazil is the main beef exporter in the world, with a competitive advantage due to cattle production done almost exclusively on pasture, thus attending the market concern for food and feed security.

The considerable status of the Brazilian cattle industry in the world is the result of favorable soil and climatic conditions for cattle rearing, the use of continuously improved cattle breeds adapted to tropical conditions, and finally the solidity of forage introduction, evaluation and selection programs, which resulted in the release of highly adapted and productive forages.

Cultivated pastures are the basis for the Brazilian beef production, and occupy an area of 101.4 million hectares (IBGE, 2011). Together with the native pastures this area is equivalent to that of all the area planted to permanent and temporary crops plus planted and natural forests. Although several forage grass cultivars are commercially available, the majority of these are of apomictic reproduction,

[1]Embrapa Gado de Corte.

thus genetically homogeneous constituting large extensions of monocrops. This poses a threat to national security due to the possibility of a break in resistance to pests and diseases or the emergence of new ones. Also, around 50 percent of the pastures in the country are in varying stages of degradation (Dias Filho, 2007). The Brazilian government has proposed different strategies and extension measures in a program to tackle this problem and counts on the results from research and experimentation to broaden this program. Therefore, the release of new cultivars benefits both the diversification of planted pastures and the recovery of degrades ones to continue to impact animal production in Brazil. The impact on the environment is of large magnitude due to the extent of area covered by pastures. New released cultivars must then necessarily be better than the commercially available ones in terms not only of production, quality, and adaptation, resistance to pests and diseases but also eco-efficiency.

Global climate changes predict an increase of extreme events such as intense storms and drought, increases in temperature and accumulation of greenhouse gases in the atmosphere. All of that may affect not only agribusiness in the tropics but also cattle production in many ways. Some crops may not be planted in the future and some areas may be abandoned for cultivation. The intensification of beef production systems based on pastures that present more plasticity and higher nutritional value, will certainly adapt better to the predicted changes in temperatures and water availability, and contribute to the mitigation of the effects of climate changes and the emission of greenhouse gases, by increasing the efficiency of carbon absorption and fixation, and reducing methane and nitrous oxide emissions (Valle, 2011).

The development of eco-efficient cultivars follows the same pathway as the development of cultivars done historically, however some additional experimentation needs to be included to test for drought, shade, cold and waterlogging and increased nutritional value.

Forage Breeding

For a forage breeding program to be successful the availability of genetic resources of the species under study is a must. Most forage cultivars thus far used in Brazil are naturally occurring wild ecotypes introduced in the country from Africa or selected from large germplasm collections (Hacker and Jank, 1998). Embrapa Genetic Resource and Biotechnology in Brasilia, DF, coordinates a national platform of genetic resources, composed of network projects of animal, crop and microorganisms, involving activities of collection/introduction, characterization and conservation of the genetic resources. Embrapa Beef Cattle in Campo Grande, state of Mato Grosso do Sul, coordinates the forage project which includes 14 forage legume and grass germplasm banks. Embrapa Beef Cattle is in charge of the germplasm banks and breeding programs on two grass genera: *Brachiaria* spp. (signal grasses) and *Panicum maximum* (guineagrass), the two most widely used in the tropical world and very expressive in Brazil which together occupy more than 80% of the Brazilian cultivated pastures. Embrapa Dairy Cattle in the state of Minas Gerais, has breeding programs and the bank of *Pennisetum* spp. (elephant grass) and is importing the germplasm of *Cynodon* (bermudagrass and stargrass); Embrapa South-East Cattle in the state of São Paulo has the bank of *Paspalum* spp., and Embrapa Semi-Arid in the state of Pernambuco, the bank of *Cenchrus ciliaris* (buffelgrass).

Panicum maximum was intensively collected in East Africa in 1967 and 1969 by the French Institute of Research for Development (Former ORSTOM - Office de la Recherche Scientifique et Technique d'Outre-Mer) (Combes and Pernès, 1970). Embrapa Beef Cattle received this collection of 426 apomictic accessions and several sexual plants through a cooperation agreement with ORSTOM in 1982. This collection represents the natural variability for the species. *Brachiaria* was also extensively collected in East Africa in 1984-5 by the International Center for Tropical Agriculture - CIAT (Keller-Grein et al., 1996). However, important species such as *B. mutica* has not been collected at its center of origin in West Africa and Uganda, the site of origin of the most important *B. decumbens* cultivar (cv. Basilisk) was also not visited thus the existing collection cannot be considered totally representative of the natural diversity. Embrapa Beef Cattle received almost 500 accessions from CIAT between 1988 and 1992.

Before a breeding program is undertaken, some basic information such as reproductive mode, ploidy level and chromosome behavior, cross compatibility between species, etc. need to be determined. Of the ongoing breeding programs at Embrapa, most forages reproduce by apomixis except for *Pennisetum*, *Andropogon* and *Cynodon*, which reproduce by alogamy. Apomixis is a clonal propagation by seeds, in which plants identical to the mother plant are produced in the progeny, thus a pasture of an apomictic species is always uniform. In apomixis of the apospory type, parthenogenesis occurs inside the ovary, where all four cells in the meiotic tetrad abort and one or several non-reduced cells from the nucellus develop into embryo-sacs. Pseudogamy then occurs, where the pollen only fertilizes the polar nuclei in the central cell but not the somatic egg cell, which is then an exact copy of the mother plant. Apomixis in forages are determined by a gene or group of genes in a simple inheritance and the progeny of a cross between sexual x apomictic plants yields sexual and apomictic plants in the ratio 1:1. The advantage of this system is that if an excellent apomictic hybrid arises in the first generation, it may be released, since its hybrid vigor will be fixed generation after generation.

At the Center of Origin of apomictic species, sexual plants can usually be found and these are the plants responsible for generating novel variability, thus the importance of collection in the centers of origin. These plants form gametes sexually and cross normally with other sexual plants. These plants are generally diploid in nature and their chromosome numbers need to be matched to the ones in the apomicts for progeny to be generated. This has been the case of *P. maximum* (Savidan et al., 1989), *B. ruziziensis*, *B. brizantha* and *B. decumbens* (Simioni and Valle, 2009). Exception to this rule is *B. humidicola*, in which the sexual plant found in nature is a hexaploid with a different basic chromosome number than the other *Brachiaria* (Valle et al., 2009).

Breeding methods used for hybrid production and novel cultivar development include intra and inter-populational recurrent selection and are depicted in Figure 1. Each cycle takes three years but superior apomictic hybrids may already be multiplied (seed increase) and enter regional trials to verify G x E adaptation.

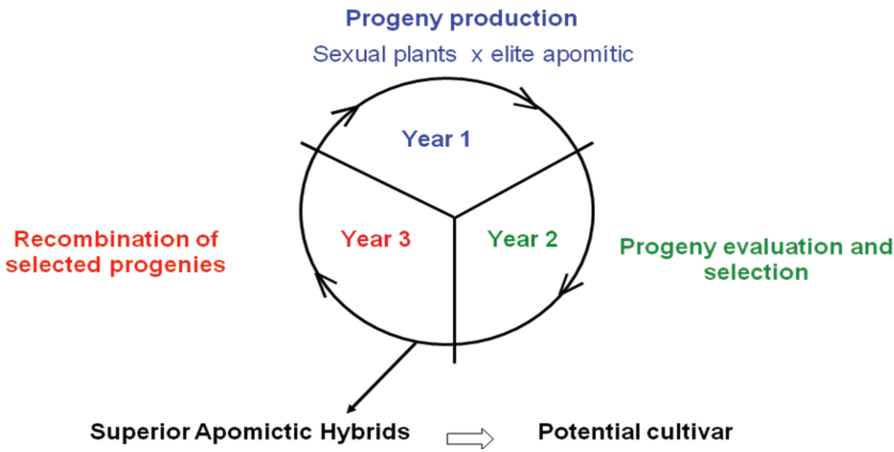

Figure 1. Scheme of recurrent selection for the production of superior apomictic hybrids towards cultivar development.

Cultivar Development Pathway

The economical importance of forages can only be accessed when transformed into animal products such as milk, meat, hide and leather thus forage breeding is more complex compared to crop breeding. The merit criteria are not straightforward as in grain crops where yield and quality are measured directly on the product of breeding (hybrids, cultivars). The evaluations need to be carried out by a coordinated team of experts, over a wide range of ecosystems to ascertain G x E interaction and involves time-consuming and costly evaluations under grazing (Jank et al., 2011).

The cultivar development pathway used at Embrapa Beef Cattle is shown on Figure 2. The scheme consists of plot evaluations of accessions from germplasm collections or progenies of hybrids, followed by regional trials and finally animal performance trials in pastures prior to release (Jank et al., 2005). All the phases depend on seed increase. From the first to the last phase, parallel experimentation is undertaken to evaluate and select the accessions and/or hybrids for resistance/tolerance to drought, water-logging, shade, cold, aluminum, diseases and pests, depending on the priorities of each genus/species and designated biome for which the cultivar is being developed. Thus, selection for eco-efficiency is done as a continuum at all phases.

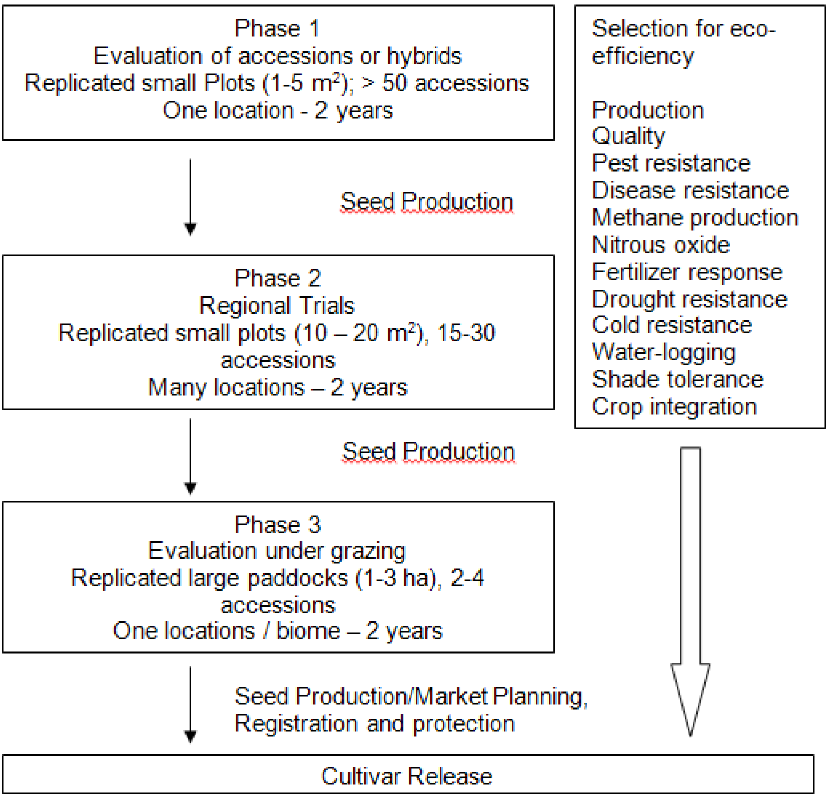

Figure 2. Cultivar development pathway at Embrapa Beef Cattle.

Molecular tools being used in breeding programs of crops like rice, maize and sugar-cane, are helping to identify genes of tolerance to abiotic stresses as waterlogging and drought and select plants. The DREB (Dehydration Responsive Element Binding Protein) patented by JIRCAS (Japanese International Research Center for Agricultural Sciences), is being used in these crops to increase drought tolerance and may have direct application in forage breeding programs. With the ever rising temperatures in the world, plants which will grow and produce with more water use efficiency are essential for feeding the world and maintaining sustainable cattle production systems in the future.

Selection for tolerance to waterlogged soils is also extremely important viewing climate change, since this condition should arise with the increase in temperatures. Nowadays, *Brachiaria humidicola* is the main forage and almost the only one adapted to waterlogged soils. Other than that, this forage also has the capacity of inhibiting nitrification, which is the process that contributes to the emission of nitrous gas to the atmosphere once N fertilizer is applied or urine falls over the soil. This gas is a much more potent greenhouse gas compared to carbon dioxide. The roots of *B. humidicola* release substances which inhibit nitrification by affecting the nitrification bacteria without affecting negatively other soil microorganisms. Therefore, the release of nitrous oxide from the soil is impeded without affecting other processes of organic matter decomposition and absorption of nutrients by the plants (Valle, 2011). Work to identify genotypes, genes and the process involved are still pending and need to be undertaken in Brazil.

Toxic aluminum in acid soils of the tropics is another limitation. Several crops have been studied and some genes of tolerance identified. Some of the tropical forages have adaptation to varying levels of aluminum (*Brachiaria* is highly tolerant, *Stylosanthes* and *Panicum* is moderately tolerant) and have become model plants to isolate and transfer this process to crops.

Cultivar Releases

The release of tropical forages in Brazil is regulated by the Ministry of Agriculture, Livestock and Food Supply. A two-year evaluation under cutting and a further two-year evaluation under grazing in comparison to a standard released cultivar are necessary to receive the authorization for release and commercialization in the country. An experiment of Distinctiveness, Homogeneity and Stability (DHE) is also necessary to apply for cultivar protection and to receive the benefits of royalties over the commercialization of seeds.

Embrapa has invested in tropical forage collection, introduction, characterization and breeding since the 1970's. In 1984, a *B. brizantha* accession received from Zimbabwe was released commercially as cv. Marandu. This cultivar became the number one cultivar in land extension and seed commercialization until today due to its productivity, adaptation, ease of management, seed production and resistance to spittlebugs. It is estimated that 35% of the seeds commercialized in the country are of this cultivar. However, problems of pasture death due to cv. Marandu's poor adaptation to waterlogged soils have been arising, mainly in the north of the country and new cultivars are being recommended (Barbosa, 2006).

Brachiaria is the most commercialized genus in Brazil, followed by *P. maximum* cultivars. They are responsible for approximately 80 % and 10% of the commercialized seed in the country, respectively.

From the *Brachiaria* germplasm, three cultivars have been released: *Brachiaria brizantha* cv. Xaraés in 2003 and cv. BRS Piatã in 2007. Cultivar Xaraés is more productive and results in higher weight gains per area due to its higher animal carrying capacity. It is also later flowering allowing for a longer period of grazing in the rainy season. Cultivar BRS Piatã has a higher nutritive quality and results in higher live weight gain per animal. It is also more tolerant to waterlogged soils than cv. Marandu and yields more live weight gain in the dry season. *Brachiaria humidicola* cv. BRS Tupi, released in 2011, is a new option for waterlogged soils and has shown better animal performance, especially in the dry season when compared to common *B. humidicola*. It also establishes faster (3-4 months) than common which takes about 6-7 months to be used as pasture.

Three *P. maximum* cultivars have been released from the germplasm: cvs. Tanzania, Mombaça and Massai in 1990, 1993 and 2000, respectively. The first two accessions total 10% percent of the seed market in the country and are being exported to 26 other Latin American countries. Cultivar Tanzânia is of medium size, 80% more productive than the traditional cv. Colonião, and more easily managed in comparison with other cultivars of the same species. Cv. Mombaça is 130% more productive than Colonião, and is extensively used in intensive production systems with rotational pasture management and for fattening cattle on pasture. Cv. Massai, in contrast, is very short, maximum 90 cm height, with thin leaves and is used for pasture diversification and grazing of cattle, horses, sheep and goats. It is the most efficient P user in less fertile soils compared to the other cultivars of this species (Jank et al., 2008, Jank et al., 2010).

Final Considerations

Tropical forage breeding is a very young science worldwide. Breeding of legumes was undertaken in Australia and CIAT in the early 1970's but has been discontinued. Brazil is really the only country feverishly breeding tropical forages. Only in the last three decades, the germplasm collections were organized, accessions characterized, data documented and seeds conserved in the short and long terms. The collections under the care of breeders, guarantees that the accessions will be used in the breeding programs. Breeding efforts have been intensified in Brazil in the last years, by the hiring of new breeders and association with the private industry for financial assistance. The programs are now maturing and the pipeline should yield interesting new genotypes as a routine from now on. Progress is expected in the next years, with the development of new and adapted technology in breeding, the development of superior new cultivars and consequently the expansion of the cattle industry. The tropical world should benefit from the release of new cultivars in the following decades.

Breeding targets have been to increase yield and quality in the past years, since tropical grasses, in general, present broad adaptation in Brazil. However, breeding should move towards selection for specific conditions and uses, as the climate is changing and mitigation is necessary. Thus, selection of forages for adaptation to biotic and abiotic stresses such as drought, waterlogging, aluminum tolerance, nitrification inhibition, decreased lignin concentration, is very important. Also, nowadays other needs for forage grasses arise, such as breeding for ethanol and energy production.

The use of improved forages, selected and bred for increased quality, through increased digestibility and soluble carbohydrates, will result in an increased voluntary intake by the grazing animals, and a decrease as great as 28% in the emission of green-house gases may be expected. The potential of mitigation in the emission of green house gases through breeding of tropical forage species remains practically unexplored, and this approach may be very successful.

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10- Effect of Cellulase and Xylanase on *in Vitro* Digestibility of Asparagus Browse, Corn Stover and Peanut Hull for Utilization by Ruminants

Edis Macias[1], Carlos A. Gomez[1]

The improved use of crop residues for ruminant feeding is a promising alternative in several countries worldwide. This is the case in Peru and Ecuador for asparagus browse, corn stover and peanut hulls which are unconventional feed sources of high availability for possible use by livestock (FAO, 2010). In Peru the availability of asparagus browse and corn stover for 2010 was 645,204 and 5’753,520 Tons respectively (www.minag.gob.pe) while in Ecuador it was estimated about 7,948 tons of peanut hulls for 2002 (www.agroecuador.com).

The use of enzymes will rise worldwide during the next 5 years at a considerable rate reaching an annual increase of 6.3%, mainly for use in animal feeding and the food/beverages industry (www.allaboutfeed.net). There have been studies on the effect of applying exogenous enzymes (cellulases and xylanases) demonstrating an enhancement of feed degradation in the rumen due to a synergism with the enzymes of rumen microorganisms (Morgavi et al., 2000). It appears this is dependent on the fiber characteristics of the feed. Therefore, it justifies the evaluation of fibrolytic enzymes in relation to improvement of dry matter digestibility of specific fibrous feeds and its related effects on methane emissions.

There are various potential advantages of using fibrolytic enzymes including improvement of nutrients digestibility, elimination of antinutritional factors as well as contribute to the environment by reducing the volume of manure production and reducing excretion of phosphorus and nitrogen. Although the responses in milk production, weight gain and feed conversion efficiency have been satisfactory the response has also been inconsistent, particularly when evaluated with different feeds (Beauchemin and Holtshausen, 2010).

The overall objective of a running research project funded by FAO/IAEA and conducted at Universidad Nacional Agraria La Molina, Peru is to evaluate the effect of applying cellulase and xylanase on the chemical composition and *in vitro* digestibility of asparagus browse, corn stover and peanut hulls for use by cattle.

Asparagus browse (10.9% crude protein, 66% NDF, 44% ADF and 0.92 Mcal NEL / kg DM) compares better in chemical composition than corn stover (5.7% crude protein, NDF 79.1%, 48.7% ADF and 0.80 Mcal NEL / kg DM. Regarding peanut hulls that is frequently used in the coast of Ecuador during periods of low availability of forage if of lower nutritional quality compared with the previous two fiber sources (6.9% crude protein, NDF 94.9%, 74.5% ADF and 0.33 Mcal NEL / kg MS)

Table 1. Meat quality of Nelore cull cows under two live weight gain rates

	Crude Protein (%)	Organic Matter (%)	NDF (%)	ADF (%)	NEL Mcal/kg DM
Asparagus browse	10,9	86,3	66,0	44,0	0,92
Corn stover	5,7	88,8	79,1	48,7	0,80
Peanut hulls	6,9	95,7	94,9	74,5	0,33

At present initial assessment has been finalized determining the effect of applying three cellulase levels: C-2000, C-4000 and C-8000 IU / kg DM (IU = International Units are micromoles of glucose produced/ ml / min) on In vitro dry matter digestibility (IVDMD) of those fiber residues in comparison with a control treatment. For corn stover C-8000 treatment has superior IVDMD of 54.6% (Pr: 0.0021) in comparison with the control with IVDMD of 48.2%. In the case of asparagus browse a significant effect was also observed for C-8000 (IVDMD 52.6%) compared to the control (50.7% IVDMD) (Pr: 0.0424). IVDMD of Peanut hulls were lower with better digestibility values for C-2000 (IVDMD 20.6%) compared with IVDMD of 17.9% for the control group (Pr: <, 001).

Further work will be conducted assessing xilanase and xilanase plus cellulose effects on in vitro dry matter digestibility and rate of gas production of the same fiber resources for cattle feeding. Results of the present research will improve our understanding of rumen utilization of fiber feeds and identity potential for enzyme application in ruminants production systems.

Table 2. Effect of cellulose application on In vitro Dry matter digestibility of corn stover, asparagus browse and peanut hulls

	Corn stover	Asparagus browse	Peanut hulls
Cellulases level (C)			
C- 0 IU/Kg DM	48,172 [b]	50,728 [b]	17,950 [c]
C-2000 IU/Kg DM	50,557 [b]	52,068 [ab]	20,578 [a]
C- 4000 IU/Kg DM	50,073 [b]	51,485 [ab]	20,275 [ab]
C- 8000 IU/Kg DM	54,642 [a]	52,675 [a]	19,388 [b]
Incubation time (T)			
At 24 hours	44,792 [b]	48,755 [b]	18,256 [b]
At 48 hours	56,929 [a]	54,723 [a]	20,840 [a]
p. value			
Cellulases level (C)	0,0021**	0,0424*	<,0001**
Incubation time (T)	<,0001**	<,0001**	<,0001**

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*** The content of the texts and their spelling-grammar suitability are entirely those of the author.**

11- Genetic and Feeding Strategies to Modify Lipid Composition of Milk and Meat from Small Ruminants

Marcello Mele[1], Giuseppe Conte[1], Andrea Serra[1]

Introdução

Evidences from human feeding and epidemiological studies together results from clinical trials suggest a potential for alteration in FA composition of the diet to reduce CHD risk. In particular, saturated FA (SFA) and trans FA (TFA) are indicated as the main dietary factor risk, whereas unsaturated FA decrease the risk. According to the WHO dietary guidelines, the total intake of SFA and TFA should be lowered while the intake of omega-3 FA should be encouraged, in order to reduce the risk of cardiovascular disease (Scollan et al., 2006). Since foods from ruminants provide a significant part of total fat and SFA intake in many countries (Givens, 2008), a strong reduction of meat and dairy products is often proposed as a strategy to decrease the intake of SFA. This approach however is not likely to produce benefits, because meat, milk and dairy products are key sources of essential nutrients (calcium, iron, vitamin B12, etc.), easy digestible proteins with a balanced amino acid profile and also supply cis-monounsaturated FA (MUFA) and other potential beneficial substances such as conjugated linoleic acid (CLA) and branched chain FA (Hulshof et al., 1999). Small ruminant sector, moreover, plays a fundamental social

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and economic role in several developed and developing countries. Therefore, optimization of the FA composition of meat and dairy products could have major public health benefits. Several feeding strategy, mainly based on the dietary supplementation of unsaturated vegetable oils such as linseed, sunflower and soybean, have been proposed in order to improve the fatty acid composition of meat and milk fat from lambs (Bas et al., 2007; Bessa et al., 2007; Mele et al., 2011; Zervas et al., 2011).

Fatty acid composition of milk and meat, however, is significantly affected also by endogenous factors such as physiology status, age, breed, which lead to individual variation in milk fat content and composition. Recently, several research efforts have been devoted to the study of the role of genetics in fatty acid composition of meat and milk from ruminants, showing significant effects of polymorphisms related to gene involved in lipid metabolism.

The present review, in the first part, deals with the most effective feeding strategies applied to small ruminants in order to enhance the healthfulness of milk and meat fat, subsequently the potential contribute of genetic improvement is discussed.

Effect of Dietary Lipid Supplementation on Milk Fatty Acid Composition in Sheep and Goat

Milk from sheep and goat is naturally rich in polyunsaturated fatty acids (PUFA, mainly linoleic, alpha-linolenic and conjugated linoleic acid) when grazing is the prevalent dietary regimen of lactating animals. At the same time, the content of SFA in milk is lower during the grazing season than when animals fed diet based on roughages and concentrate. As a consequence, in the Mediterranean area cheese fat is richer in PUFA during the spring and autumn season than in summer and winter season (Figure 1).

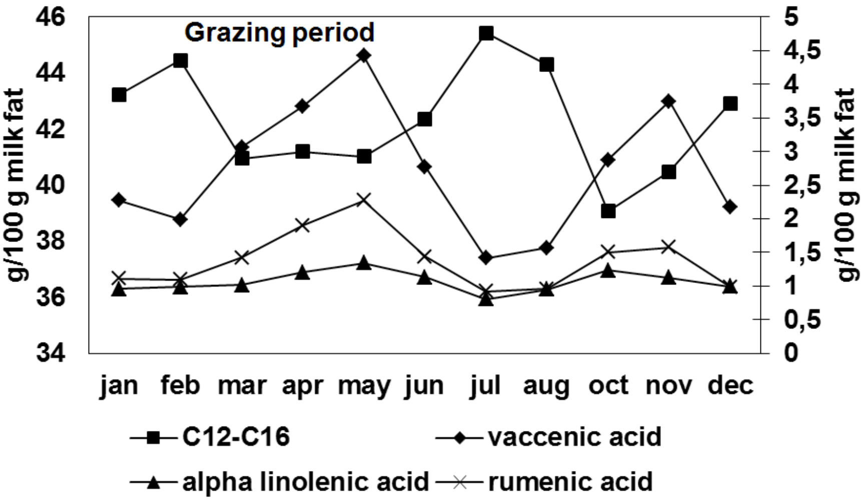

Figure 1. Temporal changes of selected fatty acid composition in Pecorino cheese fat.

When pasture is not available, the addition of adequate lipid sources (more than 3% of dry matter intake) to ruminant feeds can change the composition of milk FA, whose profile reflects that of the diet, being affected by rumen biohydrogenation and activity of rumen microorganisms (Chilliard et al., 2007). In general, lipid sources rich in polyunsaturated FA (PUFA) cause a decrease of medium chain FA (MCFA) and branched chain FA content and an increase of C18 FA content in milk. The consequent decrease in the saturated:unsaturated FA ratio and increase in the concentration of unsaturated C18 FA improves milk fat quality. In contrast, butyric acid percentage in milk fat is rarely affected by lipid supplements, probably because this FA is partly synthesized by metabolic pathways different to that of acetyl-CoA carboxylase (Chillard et al., 2007). Linseed, soybean, sunflower and olive are the main sources of unsaturated plant lipids (as seeds or as protected or unprotected oil) tested in the diet of lactating small ruminants (Chilliard et al., 2003; Mele, 2009).

When comparing data from several studies (Figures 2 and 3), dietary inclusion of linseed (as oil or seed), as a source of alpha-linolenic acid (LNA), caused an increase of CLA, VA and LNA. Among plant oils rich in 18:2 n-6, soybean and sunflower oils are the most frequently studied sources. These lipid sources markedly increase milk CLA, VA and LNA content, especially when included in the diet as unprotected oil (Mele et al., 2006; Chilliard et al., 2007; Hervas et al., 2008; Mele et al., 2008) (Figures 2 and 3).

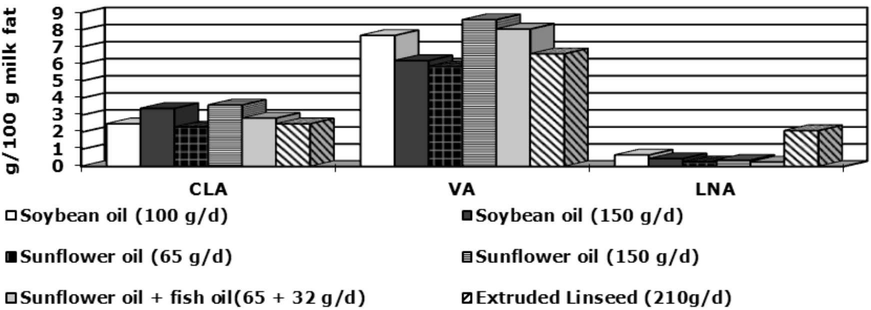

Figure 2. Plant lipid supplementation in the diet of dairy ewe: effect on conjugated linoleic acid (CLA), vaccenic acid (VA) and alpha-linolenic acid (LNA) content of milk. Adapted from Mele and Banni, 2010. Each bar corresponds to a mean treatment value observed in a single study.

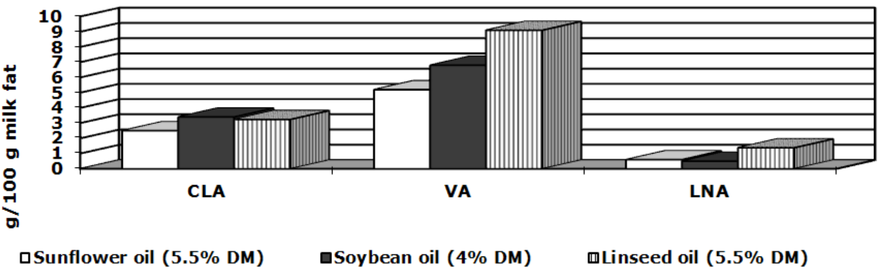

Figure 3. Plant lipid supplementation in the diet of dairy goat: effect on conjugated linoleic acid (CLA), vaccenic acid (VA) and alpha-linolenic acid (LNA) content of milk. Adapted from Mele and Banni, 2010. Each bar corresponds to a mean treatment value observed in a single study.

The inclusion of the same amounts of unsaturated plant oils in the diet allows to reach higher levels of CLA and VA in dairy goats milk than in dairy sheep milk. For example, the same concentration of CLA and VA in milk fat was obtained by the use of soybean oil or sunflower oil at 4% or 5.5% of dry matter intake in dairy goats or sunflower oil at 6.0% of dry matter intake (150 g/d of sunflower oil) in dairy ewes (Figures 2 and 3).

When regressing the milk CLA content against the dietary lipid (soybean or linseed oil) intake data from several studies on dairy ewes (Luna et al., 2005, Mele et al., 2006; Zhang et al., 2006; Mele et al., 2007; Gomez-Cortes et al., 2008b), the levels of CLA in milk linearly increased as the amounts of vegetable oil in the diet increased (Figure 4). However, responses varied depending on the nature of the basal diet (i.e. hay, silage, grasses, legumes) and on the forage:concentrate ratio in the diet. In general, when the amount of concentrate did not exceed 50% of total dry matter intake, the inclusion of unsaturated vegetable oils in the diet favoured the accumulation of VA in the rumen, with an increasing secretion of CLA in milk (Mele et al., 2006; Chilliard et al., 2007).

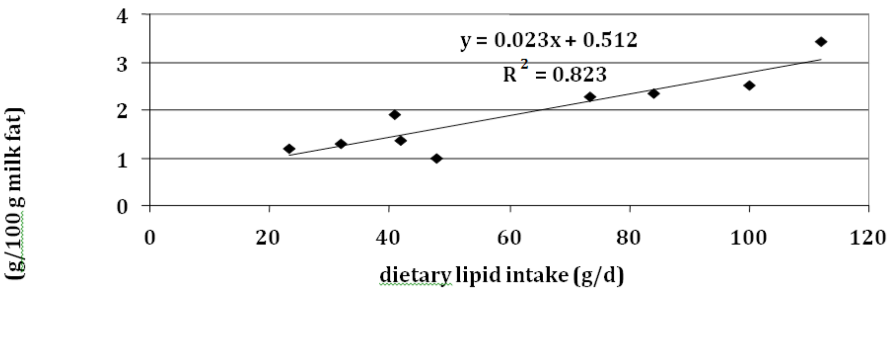

Figure 4. Relationship between daily lipid (soybean or linseed oil) intake and milk CLA content in dairy sheep. Adapted from Mele and Banni, 2010. Each point corresponds to a mean treatment value observed in a single study.

Among animal sources, fish oil is more effective than plant oils in enhancing CLA, VA and omega-3 FA in milk fat, especially when fish oil is fed in combination with oil supplements rich in linoleic acid (Figure 2). Also the use of marine algae in association with sunflower oil enhanced CLA, VA and long-chain PUFA n-3 in milk from dairy ewes, but in this case a large increase of trans-10 C18:1 was also observed (Toral et al., 2010). In dairy goats, adding 1.1% of fish oil in the diet doubled milk omega-3 FA (Cattaneo et al., 2006). Similar results were obtained also in dairy ewes (Kitessa et al., 2003). A common effect observed after the inclusion of an unsaturated lipid source in the diet of small ruminants is the increase of trans FA other than that of VA in milk fat. The highest increases of trans FA were observed when the diet of dairy ewes was supplemented with soybean oil at 6% of dry matter intake or with soybean oil plus marine algal oil, which caused an increase of the content of trans-10 C18:1 in milk higher than 200% and 400%, respectively (Toral et al., 2010). A significant increase of trans C18:1 content in milk fat also occurred, even if to a minor extent, in response to linseed (as oil or extruded seed) supplementation (Mele et al., 2007, Gomez-Cortes et al., 2009). Interestingly, in sheep milk high levels of trans-10 C18:1 are usually accompanied by similar or even higher contents of VA, whereas in cow milk these two FA are inversely related, so that the trans-10 C18:1 content may largely exceed that of VA (Shingfield and Griinari, 2007).

Effect of Dietary Lipid Supplementation on Milk Fatty Acid Composition in Sheep and Goat

Similarly to milk, the rearing system significantly affects the FA composition of meat in both sheep and goat species. In particular extensive rearing systems based on grazing resulted in lambs or kids characterized by a slightly inferior fatness degree in relation to those supplemented with concentrate, since the amount of carcass fat depots is related positively with the energy intake (Zervas et al., 2011).

Meat from grazing animals, however, is characterized also by higher amounts of omega-3 FA and CLA content, if compared with concentrate--fed animals, providing that concentrate composition did not include PUFA sources (Aurousseau et al., 2004). However also the age of slaughtering may results in significant differences in meat fatty acid composition. In the Mediterranean areas two kind of meat production may occur: lambs and kids may be slaughtered before the weaning (light carcasses) and the age of slaughtering is less than 45 days; in alternative lambs and kids are slaughtered when they are nearly 3 months old (heavy carcasses). In the first case the feeding regimen is based only on natural milk and the FA composition is directly related to the FA composition of milk (Nudda et al., 2008; Serra et al., 2009). As a consequence, changes in milk FA composition due to dietary manipulation leads to similar changes also in the FA composition of meat from suckling kids or lambs (Nudda et al., 2008). In the case of heavy lambs and kids, dietary lipid supplementation is the main feeding strategy in order to improve the meat fatty acid composition, although, recently also alternative strategy based on the use of plant secondary products in the diet have been proposed (Vasta et al., 2009; Brogna et al., 2011). As regard dietary lipid supplementation, the use of linseed (as seed or oil) seems to be a very effective strategy to improve omega-3 and CLA content of meat fat, with positive effect also on the ratio omega-6/omega-3, which was significantly reduced (Table 1).

Table 1. Effect of extruded linseed supplementation (20% on dry matter) on meat FA composition (g/100 g total lipids) in heavy lambs (Mele et al., unpublished)

Fatty acid	**Diet**		**P<F**
	C	**L**	
SFA	33.92	31.51	0.30
MUFA	33.86	32.77	0.07
TFA	4.24	8.56	<0.001
PUFA	6.49	9.50	0.04
PUFA ω-6	4.80	4.45	0.64
PUFA ω-3	0.83	1.90	<0.001
ω-6/ ω-3	6.00	2.00	<0.001

Potential Contribute of Genetics to the Modification of Meat and Milk FA Composition

Genetic improvement requires genetic variation, a mechanism of selection and an economic incentive for the improvement. Regarding the first point, in the last 15 years breed and individual variability in milk FA composition have been documented in sheep (Tsiplakou et al., 2006; Tsiplakou et al., 2008; Signorelli et al., 2008;). Fewer evidences are available in dairy goat (Zan et al., 2006; Goetsch et al., 2011). At present, only one study in Churra dairy sheep has been carried out on quantifying the amount of additive genetic variance involved in the determination of the FA profile of milk from small ruminants. Results of this study suggested that low additive genetic variation is involved in the determination of the FA composition of milk fat in Churra sheep under current production conditions, which results in low values of heritability (Sanchez et al., 2010). However, as suggested also by the authors, in dairy sheep production systems indoor feeding and pasture continuously alternate during the lactation period, generating additional variation. Therefore, the very low values of genetic parameters reported in the study from Sanchez et al. (2010) were a consequence of the non-considered extra variation source (feeding regimen), which was included in the residual terms of the model, reducing the magnitude of the estimated genetic parameters.

Studies on dairy cattle reported higher values of genetic parameters for milk FA composition, probably as a consequence of more comparable feeding regimen across the dairy herds considered (Mele et al., 2007; Soyeurt et al., 2007). In dairy sheep, Carta et al., (2008) analysing milk FA composition of an experimental Sardinian x Lacaune back-cross population, reported that a certain amount of additive genetic variance is available for selection purpose for most FA. In fact, the values of sire variance, which represents the proportion of variability due to genetic differences among sires, ranged from 5% to 20%. However, further studies are needed in order to implement the above information also in other dairy sheep populations.

The developing of specific selection indexes aimed to improve the nutritional properties of milk could be supported by the new insights about potential candidate genes able to affect a significant quote of the milk FA variability. Increasing evidences indicate the Stearoyl-CoA Desaturase (SCD) gene as one of the possible sources of FA variation in milk. SCD gene codes for the homonymous enzyme that plays a key role in mammary lipid metabolism, because it introduces a double bond at the Δ9-position in a large spectrum of FA. Its most important substrates are acyl-CoA of C14, C16, C18, and trans-11 C18:1, which are converted into C14:1 n-5, C16:1 n-7, cis-9 C18:1, and cis-9, trans-11 CLA. More than 70% of the cis-9, trans-11 CLA of ruminant's milk is produced in the mammary tissue by the activity of SCD.

In ewe, SCD locus has been mapped on the chromosome 22 and, recently, Garcia-Fernadez et al., (2009) reported the complete coding sequence of SCD gene. No polymorphisms were found within the coding region of the SCD gene, whereas the analysis of non coding region revealed 4 SNP located in the promoter region, intron 2, and intron 3. Interestingly, the most polymorphic SNP was that in the promoter region of the gene and preliminary results seemed to indicate a significant effect of the SNP polymorphisms on milk FA composition in Assaf and Churra breeds (Garcia-Fernadez et al., 2010). Subsequently, the same research group, analysing 11 genetic markers localized on OAR11 in a commercial population of Spanish Churra sheep, revealed four significant QTL at the 5% chromosome-wise level influencing contents of C10:0, C12:0, CLA and PUFA respectively.

Fatty acid synthase gene has been evaluated as a putative positional candidate for those QTL affecting C10:0 and PUFA contents (Garcia-Fernadez et al., 2010). Miari et al., (2009) sequencing a large part of the SCD gene in an experimental Sardinian x Lacaune back-cross population found only one SNP at the intron 4 (3295 C>T), that was recovered only in one family with a significant high content of CLA in milk fat. Since the found SNP was in a non coding region of the SCD gene, the authors suggested that the found mutation could be in strong linkage with the causative one. In goat, only the sequence of cDNA has been published and the SCD locus has been mapped on the chromosome 26. The complete sequencing of the cDNA revealed that the coding region is followed by an unusually long 3' UTR sequence, deriving from a single exon, in which a polymorphism, due to a deletion of a nucleotide triplet (TGT), was detected (Bernard et al., 2001). As regard meat FA composition, few studies are available about genetic effects in sheep and goat. In lamb meat, the values of heritability range between 0.19 and 0.6, showing a significant additive genetic variance (Karamichou et al., 2006; Mortimer et al. 2010).

Conclusions

The application of feeding strategies is undoubtedly the most efficient way to modifying milk and meat FA composition in order to enhance the healthfulness of food from small ruminants. As regard genetic effects, more studies are needed in order to properly evaluate the values of genetic parameters, the genetic association between FA and other traits, especially in the meat production. However, data from dairy and beef cattle suggest that a genetic variability may play an important role also in the small ruminant sector.

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12- Genetics applied to beef production in Brazil

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Introduction

Brazil is the world's second country on beef production and the first in exported volumes, with around 1.6 million metric tons in carcass-equivalent exported in 2010 (ANUALPEC, 2011). This position was reached mainly due to Brazilian's ability to establish efficient production systems under tropical conditions. Several factors added up to this success, remarkably cattle genetics.

In order to effectively contribute to production systems improvement, genetics must be well aligned with the other system's components like environment, nutrition, animal health, management and beef market.

Brazilian beef production mainly is based on grazing systems. National beef herd is mostly composed by Zebu breeds (*Bos taurus indicus*) and their crossings, which are well adapted to tropical conditions.

To reach current standards, cattle genetics has undergone through substantial changes since first cattle arrived in Brazil, brought by European colonizers 500 years ago. Here is presented a brief description of these changes, the current situation, perspectives and challenges for the future of the beef cattle genetic improvement in Brazil.

Cattle Genetics in Brazil: from Colonial Times to Current Days

According to Euclides Filho (2009), in the Brazilian history, the importance of cattle ranching begins with the colonization bringing specimens from the Iberian Peninsula (*Bos taurus taurus*). These animals were brought for traction, initially for wood transport, and later on they became essential for sugar-cane mills and for leather and jerk beef industries. The latter had a large contribution on economic development of Southern Brazil. Cattle ranching strongly served for North-Western frontier expansion, but in the first three centuries there was practically no systematic breeding and cattle husbandry was essentially for traction, food and clothing.

Animals brought from Europe had a crucial role on development, but as time went by, hostile environmental conditions led to production performance reduction of these animals (EUCLIDES FILHO, 2009). According to Alencar (2004), the adaptation process and several crossings originated different Brazilian breeds such as Curraleiro, Franqueiro, Caracu, Mocho Nacional, Crioulo Lageano and Pantaneiro. For this reason, in late 19th Century and early 20th, a demand for better performing animals raised. In this time, arrived in Brazil the first Zebu animals from India, mainly specimens of Nelore, Gir and Guzera breeds.

The first half of the 20th Century was marked by the first initiatives regarding cattle genetic improvement. A process of empiric selection was initiated. Main goal was to fix racial characteristics linked to beauty and morphology. At this time, the first experimental stations dedicated to animal selection and crossbreeding evaluations were created.

After the period of biologic evaluation and characterization, in the 1940s an initiative was started to consolidate a national breed with high--yielding with adaptability. As a result, the so called synthetic breeds were generated, as Canchim (Charolais + Zebu), Ibagé (current Brangus: Angus + Zebu), Tabapuã and Indubrasil, the Brazilian Zebus. In 1951 the first performance trials began under coordination of João B. Villares, aiming to identify superior animals. This moment marked the beginning of selection focused on performance recording, which dominates genetic improvement programs until today.

Early in the 1960s were made the last large animal imports from India. From that point starts the consolidation of Zebu breeds as the main genetic resource for beef production in Brazil. At the end of that decade, trials for productive and reproductive performance were organized by the National Program for Animal Improvement (PRONAMEZO). It was thereafter started the Control and Development of Performance Recording Program (CDP) for Zebu breeds and the Cattle Improvement Program (PROMEBO) for Taurine breeds.

According to Euclides Filho (2009), the 1970s were marked by the structuration of modern animal genetic improvement. In the 1980s, due to the pioneer initiative of scientists from the Brazilian Agricultural Research Corporation - Embrapa, at the Beef Cattle Center, genetic evaluation using mixed model equations were started. They began with a sire-model evolving to animal-model as computational resources also evolved. Between the late 1980s and mid 1990s were created the first well defined beef cattle genetic improvement programs, such as Geneplus-Embrapa Program. In the 1990s there was a strong tendency to use crossbreeding for beef production in Brazil. However, results at farm level were controversial, reducing its adoption by extensive cattle ranchers.

Nowadays, genetics used for beef production in Brazil are basically Zebu. From an estimated herd of 175 million head (ANUALPEC, 2011), about 80% of the animals are Zebu or have strong influence of Zebu breed. Nelore predominates by far over the other breeds. This breed is exceptionally well adapted to the Brazilian conditions, remarkably for heat and parasites tolerance, excellent maternal ability and the capacity to efficiently use tropical forages, usually with low nutritional value for the most of the year. It is also important to notice breeders efforts to genetically improve the Nelore and promote it in the market throughout the years.

Currently in Brazil the Taurine breeds contribute mostly for crossbreeding systems, being purebred animals used almost only in the Southern States, where climate is temperate. In these areas the british Taurine breeds, such as Angus (Aberdeen and Red) and Hereford as well as their composites Brangus and Braford predominate. Regarding the continental Taurine breeds, their utilization is less significant and mostly occurring in the Southern part of the country. Their utilization for crossbreeding is also substantially less than the british breeds. The use of tropical-adapted breeds like Caracu and Senepol, as well as the composite breed Canchim (5/8 Charolais + 3/8 Zebu), Braford (5/8 Hereford + 3/8 Zebu) and Brangus (5/8 Angus + 3/8 Zebu) have increased in the last decade. The main reason for such thing is the possibility of using their sires for natural service, which is used in around 93% of the beef cattle ranches in Brazil (ASBIA, 2012; ANUALPEC, 2011).

Beef Cattle Genetic Improvement in Brazil

Brief Description: Beef Cattle Genetic Improvement Programs and Genetic Evaluation

Beef cattle genetic improvement programs in Brazil are organized in such a way where breeders or breed associations contract a specialized institution, public or private, which is in charge of managing recording and storing data, as well as proceeding genetic evaluations and providing reports with results. These institutions also play a major role on advising farmers for choosing breeding strategies in order to optimize genetic progress.

Several traits are adopted as selection criteria in Brazil, which are related growth, sexual maturity and reproductive efficiency as well as carcass quality and adaptation to environment. Criteria related to growth have great importance in the Brazilian beef cattle genetic improvement programs. For example, the main Nelore genetic improvement programs place a weight of 60% for these traits within their suggested selection indexes, even though economic analysis indicate that reproduction should receive more attention. In the other hand, Brazilian beef industry, as a whole, pays ranchers almost only based on amounts of beef produced, having no significant rewards for quality.

In the technical aspect, most of the genetic improvement programs adopt the methodology of Henderson's mixed models equations under an animal model. Two-trait analyses are preferred using weaning weight as anchor trait. Results of genetic evaluations are made available for ranchers through specific software from each program, as well as customized spread sheets and summaries.

The largest genetic evaluation performed in Brazil is carried out for the Nelore breed within the Zebu Genetic Improvement Program, as a partnership between the Brazilian Association of Zebu Breeders (ABCZ) and Embrapa, which, in 2011 accounted with more than 3.7 million animals evaluated.

Challenges and Perspectives

Competitiveness and sustainability are key concepts in modern society, imprinted in all sectors of economy, including the beef cattle production chain. Being competitive and sustainable means being efficient in the use of resources available. Therefore, genetic improvement in synergy with the other components of the production system has to be tuned up with this new reality.

The current socio-economic scenario in which Brazilian beef cattle industry is inserted demands a high level of efficiency from all its active stakeholders, with tendencies to increase even more. Some of the main factors that strongly influence this scenario are: competition with poultry and pork, which are far ahead of the beef sector in the aspect of yield efficiency; competition for land with crops, especially sugar cane, soybeans and maize and finally the growing pressure from society for environmentally friendly products. This leads to the need of beef cattle systems yielding larger volumes, with better quality in less area and less environmental burden. This is only possible with environmental and production efficiency. The integrated crop-livestock-forest systems are gaining impulse nowadays exactly because they are fully aligned with this tendency. Cattle genetics can make a great contribution in this process. In this sense, it is vital that challenging selection criteria be incorporated in the selection process, as for example, feed conversion efficiency, meat tenderness and resistance to parasites (diseases). Brazilian research institutions are already committed to turn this into reality. Advances in bovine genomics and its adoption (e.g. genomic selection) will substantially contribute to include these new criteria in genetic improvement programs.

With the tendency of intensification for production systems, the use of crossbreeding between Zebu and Taurine breeds will also increase, consolidating as a strong farming strategy. Fixed-Time Artificial Insemination (FTAI) will play a major role in this process, since its protocols are becoming more efficient at lower costs. It is important to remark that access to FTIA by ranchers will strongly influence the dynamics of cattle genetics in Brazil, since it will allow widespread use of crossbreeding with Taurine breeds as well as greater dissemination of high quality genetics in the national herd.

Final Comments

Genetics is a valuable tool for establishing economically and environmentally efficient beef production systems. The big past, current and future challenge for scientists is to develop and apply technologies that allow using and improving genetic resources in an optimized way, satisfactorily responding to demands of our fast growing society throughout the time.

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13- Impacts of Cattle Ranching on Greenhouse Gas Emissions and the Brazilian International Commitments

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Introdution

Until the 1960s Brazilian cattle ranching was based on natural grasslands, mainly in prairies and savannas. From that point on, a remarkable expansion of sown pastures occurred, especially in the Cerrado (savanna type vegetation) and rain forest biomes, increasing also yields to supply increasing demand. Establishing the first sown pastures in these biomes caused original vegetation displacement and expressive use of fire. A gradual loss of carrying capacity on these pastures after some years of its implementation has been a constant process in these agroecosystems. According to Martins et al. (1996), beef yields decrease 6% per year on degraded systems.

From the 1980s, but especially in the 1990s, degraded pastures reclamation and clearing new areas were carried out introducing *Brachiaria brizantha* cv. Marandu and in some cases new cultivars of *Panicum*

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maximum and *Andropogon gayanus*. For the current decade, Ferraz (2008) foresees a scenario of reducing grazing areas because of cash crops and biofuels expansion. But the author expects maintenance or a slight increase on herd numbers. This tendency is justified by more intensive use of technologies and consequently higher yields on remaining pastures. Higher yields will be possible by higher use of inputs for grass fertilization, better husbandry techniques and supplementary feeding, as well as an expressive expansion of integrated cattle-crop-forest (iLPF abbreviated in Portuguese), or agrosilvopastoral systems.

Impacts of Cattle Ranching on Greenhouse Gas Emissions (GHG)

In Brazil, cattle ranching is responsible for around 22% of anthropogenic emissions of GHG. However, if emissions related to land use change and deforestation are added, this proportion rises to around 80% (Brasil, 2009), being a strong reason for developing mitigation mechanisms.

Brazilian beef cattle industry has the largest commercial herd in the world, being one of the largest exporters, with a great potential for expansion in terms of land formally available and in terms of improvements on production processes. This position causes a certain competition in the international beef market, leading sometimes to nontax barriers for the Brazilian product. Constraints to Brazilian beef which were mostly due to sanitary barriers are becoming environment related barriers, including arguments about deforestation, land use inefficiency and GHG emissions (Steinfeld et al., 2006).

Regarding GHG emissions from cattle, as a whole, estimates are more uncertain than from other sectors, because of higher system's complexity, especially related to the animal component. As a consequence, in Brazil there are not many trials carried out with animals, either beef or dairy, in feedlots or grazing systems. These trials, besides being pioneer, they are of great relevance for showing results that diverge from reference values from IPCC (1996) regarding enteric methane emissions from bovines (Berndt, 2010). Local data contributes for more realistic estimates of GHG emissions from the cattle sector. Brazil has currently no life cycle assessment, land use and energy intensity from beef production systems. However, Sweden (Cederberg et al., 2009) and the United Kingdom (Defra, 2008) carried out independent inventories of the Brazilian cattle industry.

Considering the GHG emissions issues and the negative consequences that they can have for the national beef industry, emphasis has been given on improving yields and increasing environmental efficiency of production systems, trying to avoid problems on beef trade. These initiatives go from local research and development to national and international politics, establishing well-structured, wide ranging programs.

Institutions involved on research and development for the cattle industry are focused on national demands. In the case of beef cattle ranching and global warming, it is known that scientific progress on forages development has a major influence on GHG mitigation by improving production processes (Euclides et al., 2010). Barioni et al. (2007), regarding methane emissions from Brazilian beef cattle sector, foresees for the period between 2007 and 2025 a substantial improvement on beef production efficiency, with an increase of 7.4% on national herd and 29.3% on slaughter rates, resulting in a 25.4% increase on beef production and only 2.9% increase on methane emissions with a resulting decrease of 18% on methane emission per unit beef produced. In the other hand, projections from E. Assad and H. S. Pinto for the national cattle sector, compiled by Deconto (2008), indicate that a 3°C increase on temperature (average expected increase by IPCC until 2100) could cause loss of 25% on pastures carrying capacity for beef cattle, which would be equivalent to 20% to 45% increase on production costs. This loss would occur mainly because of 30 to 50 days increase on seasonal dry period over the areas currently appropriate for grazing.

To improve current situation and to prevent future problems, cattle systems with modern husbandry techniques have been developed in Brazil, especially by Embrapa (Brazilian Agricultural Research Corporation). One of the main focuses of research is degraded pastures reclamation, adoption of more intensive grassland management and integrating cattle-crop-forest systems (iLPF), since all of them have a great potential for GHG mitigation (Almeida et al., 2011). This potential is due to high biomass production of tropical forages with efficient use of nitrogen fertilizers as well as accumulation of organic matter in the soil by improved grazing systems (Oliveira, 2007; Segnini et al., 2007; Primavesi, 2007; Oliveira et al., 2011). Also the introduction of a tree component in the system greatly increases carbon sequestration. A number of studies on grazing ecosystems in Amazon, Cerrado and Coastal Forest biomes support these assumptions. Results indicate that pastures can accumulate carbon in the soil as much as or even more than local natural vegetation, but degraded pastures loose C stocks initially accumulated (Cerri et al., 2006; Jantalia et al., 2006; Segnini et al., 2007).

Trials with several variations of iLPF systems demonstrate that the forest component provides several benefits that reflect in general improved efficiency of land use (Carvalho et al., 2001; Macedo, 2009), however, the positive impacts microclimate variables as well as carbon sequestration increase their use potential under a climate changing scenario. Silvopastoral systems with 250 to 350 eucalyptus trees per hectare, for harvest between eight to twelve years, can yield 25 m3/ha/year of wood (Ofugi et al., 2008), this corresponds to an annual C sequestration rate of about 5 tons/ha or 18 tons/ha of CO2 eq. This would be the equivalent to the emissions of 12 adult bovines. However, trials fully evaluating C balance in these systems are scarce in Brazil.

As a consequence of the commitments made by the Brazilian Government in 2009 at the COP-15 in Copenhagen, about climate change, a program for voluntary reduction of GHG emissions by the agricultural sector has been put in place in Brazil. It is called the ABC Program, which in Portuguese stands for low carbon agriculture. This program will make available low interest credit and technical support for reclamation of 15 million hectares of degraded pastures in Brazil. The program foresees also the implementation of 4 million hectares of iLPF systems until 2020 (Brasil, 2010). According to Cerri et al. (2010), these goals are feasible with current available technologies, however, effective governmental investments are essential to support the sector.

Finally, putting together solid public incentive, advances in international negotiations and considering the potential for C sequestration by iLPF systems as well as other benefits from the tree component in the system, like diversification, farmers income and improved animal performance through animal welfare, the beef cattle sector has an unique opportunity to consolidate itself as a large supplier of sustainable goods and environmental services.

According to Almeida et al. (2011), progress in this subject demands assessments of GHG balances involving anthropic emissions and C sequestration and these systems. For such, Embrapa in cooperation with other national and international research institutions and universities, having support from sponsoring public and private agencies, launched in 2011 the Pecus Network Project. This multidisciplinary network will carry out repeated essays in the six Brazilian Biomes (Amazônia, Caatinga, Cerrado, Pampa, Pantanal and Mata Atlântica) having a temporal and spatial analysis in order to deal with the complexity of simultaneous interactions in the compartments “soil-plant-animal-atmosphere” and their relations with Brazilian cattle production systems. These trials will provide results with a better approximation degrees (tier), allowing to avoid the use of inadequate standards (default) for the Brazilian conditions. All this will contribute to assure the Brazilian status of major global player on sustainable food supplier.

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14- International Genetic Evaluation of Dairy and Beef Cattle

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International Genetic Evaluations of Dairy Cattle

The increasing trade of dairy bull semen has led to the increase of genetic links among countries (Powell et al., 1994; Interbull, 2001). Nonetheless, using without conversion the genetic evaluations made by one country to evaluate bulls from another country is not a good way to compare animals. The differences in breeding objectives and genetic levels across countries may lead to different performances of genetic materials in different environments. In 1983 the International Bull Evaluation Service (Interbull, Sweden) was established by the European Association for Animal Products (EAAP), the International Dairy Federation (IDF), and the International Committee for Animal Recording (ICAR) in response to the need for universal comparison criteria of animals across countries.

Conversion Equation. In 1981 the IDF recommended the following regression for estimating genetic merit of bulls in importing countries: $EBV_{IMP} = a + b(EBV_{EXP})$, where the intercept (a) was the difference in

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base between the two countries and the scaling factor (b) was the ratio of standard deviations of evaluations in the two countries (Powell and Sieber, 1992). The method of conversion equations was improved by Interbull using the Goddard (1985) and Wilmink et al. (1986) procedures. Conversion equations were replaced by the multiple-trait across county evaluation (MACE) method, but they are still estimated, using the international genetic evaluations instead of the national genetic evaluations as starting values.

Multiple-trait Across Country (MACE). In 1985 Shaeffer developed the first BLUP based method for international genetic evaluation of sires (MCE). To solve the problem of some improbable assumptions of MCE (i.e. genetic correlations across countries set to one), Schaeffer, in 1994, extended the MCE model to a MACE. MACE uses deregressed national EBV as input values to predict international breeding values for bulls of all participating countries. In MACE, similar traits evaluated in different countries are considered different traits. Therefore, it is possible to consider different heritability value for each country and genetic correlations less than one. Moreover, bulls could rank differently in different countries because genotype by environment interaction is allowed.

Over the last 18 years the international evaluation method was implemented by adding a time edit for the birth date of bulls to ensure that the base populations are similar for all countries (Weigel and Banos, 1997; de Jong, 2003). The effective daughters contributions (Fikse and Banos, 2001) replaced the number of daughters as weighting factor. In 2004 the procedure to estimate genetic correlations was reviewed (Wilmink and Fikse, 2004). In 2012 the sire-dam pedigree replaced the sire-maternal grandsire pedigree to decrease problems related to phantom groups (Jakobsen and Dürr, 2012). Other improvements are development and implementation of multiple-trait MACE (Nilforooshan, 2011) and inclusion of genomic information in the evaluation of dairy breeds (VanRaden and Sullivan, 2010; Sullivan et al., 2011; Zumbach et al., 2011).

The first international evaluation took place in August 1994 and included milk production data from the European Nordic countries for the Holstein and Ayrshire breeds. Nowadays, international genetic evaluations of dairy bulls are performed with MACE three times a year. The MACE evaluation includes 6 breeds and 39 traits grouped in 7 major trait groups for 31 countries (Interbull, 2012).

International Evaluation of Beef Cattle

In the last decades the international exchange of genetic material has grown and the interest of breeders to compare domestic and foreign bulls has increased the need for an international genetic evaluation of beef cattle. Comparison of beef cattle is more complex than that of dairy production: most of beef cattle populations in Europe are country specific, the use of artificial insemination is limited with a consequent reduction of genetic links across countries, and the framing systems are more heterogeneous (Journaux et al., 2006).

Interbeef Project. In 2001 the Irish Cattle Breeding Federation (ICBF) coordinated a project to develop the first international European beef evaluation (EUBEEVAL). The project showed feasibility and benefits of a common genetic evaluation between France, Ireland and UK and convinced ICAR to choose Interbull as operational unit for international beef genetic evaluation (Journaux et al., 2006).

Interbeef project started in 2007 in collaboration with ICAR, ICBF, the French National Institute for Agricultural Research (INRA), the British Meat and Livestock Commission (MLC) and the Nordic Cattle Genetic Evaluation (Denmark, Sweden and Norway). The aims of Interbeef were: 1) provide a forum for sharing knowledge on recording and genetic evaluations, 2) maintain guidelines and standards for beef cattle performance recording, 3) conduct international surveys relevant to beef cattle performance recording, 4) develop a system for routine international genetic evaluation of beef breeds, and 5) facilitate the use of genomic selection (Wickham and Dürr, 2011).

Selecting Traits. In 2009 a questionnaire was sent to Interbeef member organization to find out what would be the economically important traits to be included in the Interbeef project in addition to weaning weight trait (Forabosco et al., 2009). The results of the survey showed that carcass weight and carcass conformation together with calving difficulty were considered the most important traits by the participating countries (Forabosco et al., 2009).

International Genetic Evaluation of Beef Cattle Breeds. The first attempt of an international genetic evaluation of Chaolais breed for weaning weight in Europe, namely France, Great Britain and Ireland, was illustrated by Renand et al. (2003), where an animal model with maternal genetic and permanent environmental effects was used. In 2005 Phocas et al. investigated three strategies for the international genetic evaluation of weaning weight of Limousine breed of France and Australia/New Zealand. The models were: 1) an animal model on raw performance data with genetic correlation below one, heterogeneous residual and genetic variances across countries, 2) the same animal model applied to pre-corrected (for fixed effects) performance data, and 3) a sire model on deregressed proof (the MACE approach used in dairy cattle; Phocas et al., 2005). Renand et al. (2003) and Phocas et al. (2005) demonstrated the practicality and desirability of using an animal model with raw performance (Wickham and Dürr, 2011).

Interbeef Genetic Evaluation for Adjusted Weaning Weight for Charolaise and Limousine. In the first international beef evaluation done by Interbeef (Venot et al., 2009a; Venot et al., 2009b) the adjusted weaning weight trait, recorded by 5 countries (Denmark, France, Ireland, Sweden and United Kingdom) for 2 breeds (Limousine and Charolais), was evaluated simultaneous. The Interbeef work consisted of data preparation: editing of datasets and validation of identification of animals, construction of pedigrees, genetic parameter estimations and breeding values estimations.

Data and pedigree. Only calves born since 1988, with known herd, birth date and dam, and with adjusted weaning weight within 3 standard deviations from the mean were taken into account (Venot et al., 2009a).

First of all, the preparation of pedigree consisted of checking and validating the international identification numbers of animals. Within each country, the foreign animals were detected and sent to their relative country of origin for validation. The validated animals were added to a central cross reference file that gives correspondence between national and international identification for the foreign animals used abroad (Venot et al., 2009a). After the validation, all pedigrees were merged into a common "Interbeef pedigree" file (Venot et al., 2009) and checked again to correct any inconsistencies (i.e. wrong country of origin).

The largest dataset was provided by France (more than 80,000 Charolais and 50,000 Limousine animals with weights per year), whereas the smallest dataset was provided by Denmark and Ireland (Venot et al., 2009a). The link between countries was very low for both breeds: the number of common bulls was 171 and 393 for Charolais and Limousine, respectively, and most of them were used in only two countries (Venot et al., 2009a).

Genetic parameter estimation. For each breed, genetic parameters have been estimated within country. A sire model was used for the estimation of the variance components, where direct genetic effects and maternal permanent effects were estimated. The results were then transformed to fit the animal genetic evaluation model (Venot et al., 2009).

The direct heritability ranged from 0.26 (Sweden) to 0.50 (Ireland) for Charolais breed, and from 0.26 (Grand Britain) to 0.43 (Denmark) for Limousine breed (Venot et al., 2009). The genetic correlations between countries didn't converge for several countries due to low connection between countries. The direct genetic correlations were above 0.75 for both breeds, but the accuracy was limited, with standard errors around 0.15 for the majority of correlations (Venot et al., 2009).

Joint genetic evaluation. The international genetic evaluation was run with software developed by INRA and the Institute d'Elevage. An animal model, containing only direct genetic effect for each country associated with country specific maternal permanent environmental effect to correct for a global maternal effect, was used (Venot et al., 2009b).

The genetic trend of sires with at least 10 progeny showed a higher genetic progress for Limousine (between 15 and 30 kg in 20 years) than for Charolais (less than 20 kg). The first Interbeef list of bulls showed that all participating countries were represented in the best top rank (10% of the best bulls). Moreover, the correlation between pseudo-national EBV (different from the real national EBV due to some particularities of national models that could not be included in the Interbeef model) and Interbeef EBV are very heigh for most countries (Venot et al., 2009b).

The Interbeef services could be an important instrument for beef producers to make more informed decisions about the use of international seed stock. To enhance the international beef evaluation a high level of data quality and data exchange between national and international organization is essential. (Wickham and Dürr, 2011).

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15- Italian beef cattle breeding schemes: Piemontese, Chianina, Marchigiana, Romagnola, Maremmana and Podolica

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The Italian Beef Cattle Production Context

Italian beef cattle production chain is segmented into two main rearing systems, discerned by the agricultural environment where these are settled up. Herds rearing cows and suckling calves can be found in the more marginal lands, while fattening farms are located in areas where agriculture is more intensive. The main factor discerning the possibility of production intensification (i.e. creating big farms were hundreds of calves are fattened) is the concentrates availability, mostly corn.

This is the main reason determining the crowding of fattening farms in the Northern flat area of Italy (although these farms are located wherever conditions are fulfilled). Suckling herds are spread across the Central and Southern regions of Italy, given the orography (prevalence of hills) and the climate (harsh during the summer) which makes difficult to grow corn intensively.

Italy is not self-sufficient in terms of meat consumption, as approximately 40% of meat consumed in Italy is imported (ISMEA, 2011). Moreo-

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ver, given the high number of calves slaughtered, and therefore considered as reared in Italy, there is the need to import weaned calves to be fattened in Italian farms. Production of weaned calves is not convenient in Italy outside of the marginal areas, where the low-input rearing system allows low costs for the suckling herds. For this reason, breeding dairy and dual purpose cows with beef bulls has been shown to be a valid support to national meat production (Dal Zotto et al., 2009).

Two categories of beef meat production are predominant in Italy: vitello a carne bianca (veal calf) and vitellone (young bull). Purebred dairy calves or crossbred dairy calves with beef bulls are mostly marketed as veal calf. Limousine and Charolaise individuals are marketed as young bulls, and also calves from the six authoctonous beef cattle breeds of Italy: Piemontese, Marchigiana, Chianina, Podolica, Romagnola and Maremmana.

An Overwiew of the Italian Beef Cattle Breeds and Rearings Systems

After World War II the progressive leave of population from rural areas to big cities and industrail conglomerates, and the involment of machinery in agriculture has lead to a profound mutation in the use of cattle. Cattle breeds which were involved in farms for draft power have started to be bred for meat (or milk production, or following a dual purpose goal). The six above mentioned breeds (Piemontese, Marchigiana, Chianina, Podolica, Romagnola and Maremmana) have taken part of this revolution. Now these breeds can be considered as a result of the peculiar interaction between the land where they were bred and the culture of the population which bred them. In other words, breeds can be considered a cultural and biodiversity heritage, as they were shaped into a specific region (meant as cultural environment) of the Italian peninsula.

Rearing systems evolved with the cultural environment as well. Tie stalls were the most popular till the 50s, but, when animal draft power lost of importance, loose housing became more and more popular, due to the lower cost involved and the increasing size of herds. In recent years, given the abandon of many marginal areas, spring and all-year-long pasture have become a very valid alternative to loose housing for the suckler cows.

Feeding of suckler cows is based on pasture and hay, with some addition of concentrates or corn silage during winter. Calves suckle till six months of age, then they are weaned and fed in small feedlots. The slaughter age for the young bulls ranges between 16 and 24 months, with weights between 500 and 900 kgs. Heifers are usually slaughtered earlier, between 14 and 18 months, with a slaughter weight of 300-600 kgs. Carcass yield (meant as the percentage of the live weight which is represented by the hot carcass) is between 58% (Maremmana and Podolica) and 70% (Piemontese).

Today the six breeds account for more than 300,000 heads. The most represented breed is Piemontese (61% of total), followed by Marchigiana (13% or total), Chianina (12%), Podolica (7%), Romagnola (5%) and Maremmana (2%).

Piemontese - The Piemontese breed is a medium sized beef breed which is characterized by a very lean meat. Indeed, it shows a low quantity of intra and inter-muscolar fat, and meat appears lean and tender, with a coarse texture. The young bulls are ready for slaughter at 550-650 kgs of a weight, being around 15-18 months old, the females are slaughtered about 350-450 kgs when they are about 14-16 months old. The gastronomic culture is oriented to earlier slaughter individuals compared to the other Italian aitochtonous breeds. Considering their size, the weight gain of Piemontese cattle is high, with peaks of 1.4 kg per day, despite the relatively low feed intake. Just the low feed intake leads the indexes of feed conversion ratio into extremely high values and confers to the Piemontese breed a feeding efficiency which is definitely superior to all the other beef breeds. The slaughter yield is very high, on average 67-68% in the 18 months old young bulls, with peaks of 72%, due to the extremely thin skeletal apparatus and reduced gastrointestinal apparatus (which leads to the low feed intake). Piemontese shows a top carcass conformation: highest frequence is for the S and E classes of the S-EUROP classification. The milk production of the Piemontese is sufficient to suckle the calf till its sixth month, as consequence of the double-purpose selection to which the breed underwent in the last decades. Moreover, it is common to wean the calf after the colostrum intake. Cows are then milked and milk is used to produce tipical DOP cheeses. The high efficiency of Piemontese for meat production is related to the muscular hypertrophy due to a high allelic frequency mutation in the miostatin coding sequence (Albera A. et al., 2001) better known as the 'double muscling' factor. It is evident in buttocks and thighs, and it is comparable to the Belgian Blue breed. Piemontese is reared moslty in the Piemonte region (North-Western area of Italy), but some farms are present also in the rest of Central-Northern Italy.

Marchigiana - This breed originated from the Podolica strain, which reached Italy from Asia through the Barbarian invasions. The ancient strain was crossbred with Chanina and Romagnola till 1928, when morphological and functional selection was schemed in order to improve workability. The breed underwent selection for meat production after World War II. Nowadays the breed is characterized by thinness of skin and scheletal apparate. The great muscolar development is evident particularly in the buttocks and thighs, and some individuals show 'double muscling' factor.

Calving and suckling are natural, given the good maternal aptitude. Calves weight on average 45 kg at birth. The great growth capacity leads the best specimens to a weight gain peak of 2 kg a day. The cows weigh between 700 and 900 kg while males range from 1200 to 1500 kg. Being a precocious breed, it reaches its ideal slaughter weight at the age of 15-16 months, for a yield as high as 67%. The Marchigiana breed is widespread throughout Marche, Lazio, Abruzzo and Campania.

Chianina - The Chianina, an ancient breed that dates back to Umbro-Etruscan times, has been raised in Umbria, Tuscany and Latium for over twenty-two centuries. The peculiar characteristic of this breed is the somatic gigantism: bulls can size 1,500 kg in weight, with a height of two meters at withers. This breed shows a typical dolichomorphic structure, and calving is completely spontaneous. Growth potential in the best subjects can exceed 2 kg a day. Ideal slaughter weight is 650-700 kgs (16-18 months of age), for an yield of 64-65%. Chianina beef is famous for the particularly big loin steak (fiorentina steak), which can exploit its size due to the somatic gigantism.

Podolica - Its origin can be traced to the Bos Taurus Primigenius, the ancient forerunner of all the cattle breeds that descended from the Podolica. It has been present in Italy for a very long time and still represents an example of successful biological adaptation to a hostile environment. The breed is widespread over a rather vast area that includes all of southern Italy. As a result, this has caused a great deal of variability in its size and in the colour of its coat, which can range from white to dark gray with black pigmentation. A robust and frugal breed comparable to the Maremmana, it is capable of exploiting grazing harsh areas covered with shrubs and stubbles. Cows can yield enough milk to surplus calf necessity, so that in some areas is used to make highly prized soft cheese (“Caciocavallo Silano”). Adult bulls weigh from 600 to 800 kgs.

Romagnola - This breed is charaterized by a well developed muscolarity and a brachimorphic structure. This breed’s short sturdy legs and strong feet have made it an ideal grazing animal. The Romagnola has an outstanding growth capacity that is comparable to the Chianina and Marchigiana, being slaughtered when bulls reach a weight of 650 - 700 kg, at the age of 16-18 months. Average slaughter yield is 62-63%. The Romagnola is raised in the provinces of Forlì, Bologna and Ravenna.

Maremmana - Maremmana breed shares its origins with the Podolica breed, and reports an equivalent adaptation to harsh environments. The Maremmana is in fact an extraordinarily rustic and long-lived breed that can reach an age of 15-16 years. Despite of the difficult environment where it is reared the breed do not show any problem in milk-producing capacity, confirming the breed’s frugality. Adult females weigh about 600-800 kg whereas the males reach a weight of 1000-1200 kg. This breed is widespread in Tuscany and Latium.

Breeding Schemes of the Six Italian Beef Cattle Breeds

Selection of the six Italian beef cattle breeds is operated by two different associations ANABORAPI (Associazione Nanionale Allevatori Bovini di Razza Piemontese) and ANABIC (Associazione Nazionale Allevatori Bovini Italiani da Carne, for Marchigiana, Chianina, Romagnola and Podolica).

Selection schemes are focused on the improvement of productive traits (i.e. growth rate, live fleshiness and bone thinness) and functional traits (calving ease, maternal aptitude, longevity, adaptation to pasture).

It should be noticed how calving performance (affecting viability of calves, fertility of cows and animal welfare) are particularly relevant for specialized beef cattle breeds (Albera A., 2006), also for the consumers' perception of products. Longevity in beef cattle is an important economic trait as well: this trait when included in a breeding scheme increases profit and also has a positive impact on the well-being and welfare of the animal (Forabosco et al., 2006).

Breeding scheme of the Piemontese breed - Due to the duoble muscle factor, the current breeding goals for the Piemontese breed are beef production and calving ease. Selection is performed in two stages: male calves are performance tested for beef production traits, young bulls are then progeny tested for direct and maternal calving ease on the basis of birth (direct calving ease) , calving performance (maternal calving ease) of their progeny. (Albera A., 2006). Moreover, cows are evaluted for type traits (Mantovani, 2010).

Given the negative genetic correlations between direct and maternal calving ease (Carnier et al., 2000), and the unfavourable correlations between ease of birth and meat production, ANABORAPI has decided to express the overall genetic value into two differen selection indexes: 'linea allevamento' and 'linea carne'.

The selection for the 'linea carne' is aimed to the enhancement and the muscularity of the subject, with particular regard to the verification of the genotipe of the subject for the mutation in the myostatin gene. The high heritability of the meat traits and the ability to assess it directly on the candidate allow to use the performance test.

Here, about 215 calves per year are tested, born from planned matings and chosen according to their pedigree total merit index. The test starts around the 50th day of life of the calf until the twelfth month of life of the calf. During this period the increase in weight is recorded, and at the end of this test the morphological correctness and conformation are assessed via linear description of six regions for muscularity and one for thinness.

Maternal calving ease is obviously not detectable on male subjects, and shows a low heritability, so that the progeny test is made necessary. However, even for the 'linea allevamento' we are interested in the first place detect the attitude to the production of meat of the subject, so we resort to performance test conducted at the station for calves candidates. For the calving ease the bull genetic merit cannot be calculated at the end of the performance test. Therefore some doses of semen are distributed on the population in order to plan matings to test both the direct and maternal calving ease. Ease of birth of the progeny of the bull represents direct calving ease, and the ease of giving birth to their calves is the maternal calving ease assessed on the daughters of the candidate bull. Once all these informations are collected all the breeding values for the bull can be calculated and the bull's semes is admitted to sale. It is clear how the assessment of maternal calving ease elongates the generation interval, but this appears nowadays the only was to select for this trait.

With the data acquired with the scheme the two different breeding values are calculated (meat line called 'linea carne' and herd line called 'linea allevamento') including all the traits but with different weights, depending on the emphasis you want to give the single trait in that index (table 1).

Table 1. Weights (%) assigned to the different traits for the computation of total merit index in the Piemontese breed

	Bulls		Cows	
	Linea carne	Linea allevamento	Linea carne	Linea allevamento
Daily gain	14	14	10	10
Muscolarity	20	20	14	14
Direct calving ease	40	20	40	20
Maternal calving ease	20	40	20	40
Legs	6	6	4	4
Type traits			12	12

Only the best 30-40 candidate sires are approved for artificial insemination (analyses on semen quality will be carried out.). The best individuals for the 'linea carne' merit index will have progeny destinated to slaughter, while those female individuals showing high genetic merit for the 'linea allevamento' will be lead to the reproductive career.

Breeding scheme of the Marchigiana, Chianina and Romagnola breeds - ANABIC is currently testing candidate bulls for Marchigiana, Chianina, and Romagnola through performance test. Every month 5 calves from each breed are chosen from planned matings accordingly to their pedigree index and morphological correctedness. The candidates are reared in standard conditions for 24 weeks, from the sixth to twelfth month of age.

Calves selected undergo erythrocyte and karyotype analyses to check the presence of genetically transmittable diseases and Robertsonian translocation. Calves are introduced to the perfomance station after weaning, i.e. around the 5th month of life. After a month of quarantine the test begins, bulls are double weighted every 21 days and average daily gain is calculated.

At end of test linear evaluations of muscularity and skeletal development and conformation are carried out. Measures can be grouped into 'muscularity', 'body size', 'feet and legs' and 'skeletal thinness'.

Different genetic merit indexes are produced. A 'growth index' weights the breeding value of the candidate before the start of the performance test (30% of total merit) and the growth in performance test (70%). This growth index breeding value is added to the 'muscolarity' breeding value coming out from the morphological evaluation at the end of test (50% to each breeding value) to built the 'indice selezione toro' (bull selection index) which represents the msot important tool of selection for the paternal line. Moreover, in order to emphasize the characteristics peculiar to each breed (skeletal thinnes for Marchigiana, somatic gigantism for Chianina, muscolarity for Romagnola), a 'morphological index' is calculated assigning different weights to the above mentioned groups of morphological measures:

Marchigiana: 40% muscolarity, 30% body size, 20% skeletal thinness, 10% feet and legs.

Chianina: 30% muscolarity, 60% body size, 10% feet and legs.

Romagnola: 50% muscolarity, 40% body size, 10% feet and legs.

Only the top 20% of the bulls are admitted to artificial insemination, while the remaining will be directed only to natural fertilization, if they have achieved a minimum score of 82 points aat morphological evaluation. For young bulls approved for artificial insemination a check is conducted for semen characteristics (volume, concentration, progressive motility, head abnormalities, tail abnormalities, midpiece abnormalities, detached heads, total abnormalities) and testicular measurements (scrotal circumference, testicular length, testicular diameter).

ANABIC provides also a 'cow selection index', were the sire bull selection index and the morphological index (assessed on the animal itself) are combined with equal weight.

Different sudies study have been conducted for the possibility of using progeny (reared on commercial farms) carcass yield for the genetic evaliation (Tiezzi F., 2008, Sbarra F., 2011). Results showed that progeny tests carcass yiled was not really related to performance test growth, but it's mostly imputable to drawbacks in modelling. Anyway, positive genetic trends result both from progeny and performance genetic merit.

Breeding scheme of the Maremmana and Podolica breeds - Maremmana and Podolica are rustic breeds and they have always been reared using summer grazing or open pasture system (97% of the overall number of farms and animal. The organisation of the performance test is the same of the other three Italian Cattle breeds: six months of duration with nine weightings at 21 days intervals and final linear evaluation. Because of the different type of environment and breeding system, the aim of Maremmana and Podolica selection plan is to increase productivity while preserving the ability to be raised in tough conditions typical of their territories.

For rustic breeds such as Maremmana and Podolica, bulls are selected through average daily gain during the test (50%) and the final score of morphological evaluation (50%), giving more emphasis to the morphological correctedness which allows the preservance of adaptability to pastures and harsh environments. Genetic connections remain the biggest problem for these breeds if carcass yiled is evaluated on farm: given the null use of artificial insemination, the most of the sires have progeny on a single herd, and this makes practically impossible to disentangle genetic and environmental effects.

Conclusions

The paper described the six Italian autochtonous beef cattle breeds and defined their breeding schemes. Breeds are reared into very different conditions across the whole Italian peninsula, different enphasis is to be given to the traits to selected for. The Piemontese breeding scheme appears to be the more complex, as both meat productivity and rearing efficiency are measured directly, through progeny and perfomance tests. The breeding schemes for the Marchigiana, Chianina and Romagnola breeds is focused on the performance test to assess the candidate's meat productivity, while functionality is assessed indirectly through a very detailed type evaluation. For the Maremmana and Podolica breeds perfomance test is conducted the same way as the three former breeds, but more enphasis is given to the traits related to difficult environment adaptation.

Results are evident for all the breeds. Piemontese shows positive genetic trends both for meat yield and reproductive perfomance (ANABORAPI), although for the latter the genetic gain is weaker, due to the lower heritability. Marchigiana, Chianina and Romagnola show strongly positive genetic trends, both for performance test and for progeny test, the same is reported for Maremmana and Podolica, despite the difficults in determining genetic and environmental effects.

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16- Meat Production in Brazil, Farming Systems, Market and Future Strategies

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Abstract

In this article, Brazilian beef market and farming systems are briefly described to provide readers with an overall view of this important industry to the Brazilian economy. Initially, figures concerning the beef production and exports, followed by a review on historical facts that determined the actual development of Brazil's beef industry are presented. Next, farming systems are described, contrasting modal (most frequent) and technologically-based systems, with emphasis on the Brazilian Savannah (so-called Cerrado) region. Finally, some strategies are appointed.

Introduction

Brazil is an important player at the international meat market and may become even more important due its potential to respond to the increasing demand for animal protein. At the farm gate level, farms are learning fast how to work within sustainable frameworks; although challenges remain as to how small and medium farms can get easier access to technologies. At the processing level, Brazil counts on a highly modern industrial park. The main difficulty to overcome is the lack of coordina-

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tion and mistrust in the beef supply chain. Retailers and importers, in turn, have been imposing a series of restrictions, both price and quality related that translate as drivers that farmers need to consider when establishing or carrying their farming systems. Other issues such as the political environment, both domestically and abroad, the economic crisis, the overvaluation of the Brazilian Real, among others, also influence the environment in which the beef sector is operating. Brazil's ability to address these issues rapidly and to put forward strategies to overcome barriers will ultimately determine its competitiveness and its leading role in the world's meat market.

Meat Production and Market in Brazil

In 2009, the beef cattle production reached 6.7 million metric tons, placing the country as the second largest beef producer in the world, behind the United States of America (IBGE, 2009). From the total produced, 86% supplied the domestic market, with the remaining 14% being exported. Despite an export decrease of almost 10% compared to 2008 (ABIEC, 2010), Brazil remained ranked as the world's leading exporter in 2009 (IBGE, 2009). According to FAPRI (2010), this fall in Brazilian exports was due to an overall weak demand worldwide and volume restrictions determined by the European Union. However, the same source estimates that Brazil will keep its leading export position for the next decade, increasing 6.4% from its current market share of 33%.

According to ABIEC (2010), fresh meat represented 75% of the total beef exports in 2009, with Russia, Iran and Hong Kong being the main importers. The exports of processed meat represented 13% and of edible offal 12%; the United States and United Kingdom were the main importers of the former, while Hong Kong imported mainly the latter. The average export price in 2009 was US$ 3,300/t, resulting in some US$ 4 billion of exports sales.

In the domestic scenario, historical unbalanced distribution of income has been a major factor limiting beef consumption, given meat's high income-elasticity (IEL, CNA, & SEBRAE, 2000). However, government policies to alleviate hunger and improve social welfare systems have created opportunities for a higher consumption of beef amongst Brazilians as a result of better income distribution over the last years. For instance, the ratio between the per capita family income of the 20% richest and 20% poorest reduced from 24.3 to 17.8 between the years 2001 and 2009 (IBGE, 2010). Additionally, the percentage of families earning up to five minimum wages per month decreased from 63 to 60 between 1999 and 2009. At the same time, the Brazilian per capita beef consumption increased from 37 kg/inhabitant in 1999 (FNP, 2007) to 41 kg in 2009 (FAPRI, 2010). This 41 kg per capita consumption contrasts with Argentinean per capita consumption of 64 kg but was similar to the USA consumption of 40 kg and higher than the Australian consumption of 35 kg (FAPRI, 2010).

In response to increasing demand, both domestically and internationally, the Brazilian beef industry has been expanding. For instance, Steiger (2006) estimated that between 1994 and 2005, Brazil increased its national herd by 24%, export volumes by 450%, and export values by 385%. Several factors contributed to such an expansion, including: continued availability of natural resources, competitive export prices due to favourable exchange rates and lower production costs compared to Brazil's main competitors (TIRADO et al., 2008, p. 14), increase of the domestic demand (STEIGER, 2006, p. 107), and disease outbreaks in other countries, such as Foot-and-Mouth disease (FMD) in Argentina in 2000 and Bovine Spongiform Encephalopathy (BSE) in Europe, United States and Japan (POLAQUINI et al., 2006). In 2005, Brazil also faced a downturn in international beef market given outbreaks of FMD in Mato Grosso do Sul State (STEIGER, 2006).

Some structural factors have had a significant influence on the industry performance in recent decades, particularly after the 1960's. At that time, agricultural policies based on subsidised credit, minimum prices and import substitution were established and agricultural research and extension had massive investments (CHADDAD & JANK, 2006) supporting the beef industry in various ways. The establishment of the Brazilian

Agricultural Research Corporation - EMBRAPA - in 1973, and its Beef Cattle Research Unit, in particular, in 1974, along with increased investments in research within federal universities was key for technology development aimed at the beef sector (CHADDAD & JANK, 2006). Among major contributors to the diffusion of the new technologies were public rural extension services like the Technical Assistance and Rural Extension Corporation - EMATER - and the Coordination of Integral Technical Assistance of São Paulo State - CATI (POLAQUINI et al., 2006).

The deregulation of the agricultural sector and the liberalization of the Brazilian economy in the 1990's impacted significantly on the beef industry. A higher competition for international markets and the regulatory systems established in these markets, allied with a drastic reduction in government subsidies and support, resulted in major structural changes throughout the entire beef supply chain. To keep up with these changes and remain competitive, beef farmers engaged in more technologically-based systems (EUCLIDES FILHO, 2004), investing in tropical pastures, genetically improved cattle breeds, mineral supplementation and many other technologies. As a result, there was a considerable improvement in productivity. For instance, the average slaughter age has reduced from 54 to 38 months (STEIGER, 2006). According to FAPRI (2010, p. 330), further improvements in productivity, among other factors, are expected, maintaining Brazil's competitiveness and leadership in the international beef trade.

Nonetheless, the Brazilian beef sector also faces some challenges due to its uncoordinated beef supply chain that may compromise its international leadership, if not properly addressed. Some 2.7 million farms with cattle as the main or the secondary activity (IBGE, 2009), 800 slaughterhouses, 798 leather processors and 7,562 shoes companies (MDIC, 2004), among other actors, make up the Brazilian beef supply chain. According to Vieira, Capacle and Belik (2006), the relationship among these actors is often marked by informality and mistrust. Vertical integration of production is rare (JANK, 1996 as cited in VIEIRA et al., 2006, p. 10), although some strategic alliances among beef producers, slaughterhouses and retailers have been increasing. One consequence of the lack of coordination of the beef supply chain is the difficulty in establishing and running traceability systems. In Brazil, traceability is partial, being compulsory only for beef producers and slaughterhouses accredited for exports (SOUZA-MONTEIRO & CASWELL, 2004). The faulty communication between retailers and the processing sector, according to Jank (1996 as cited in VIEIRA et al., 2006, p. 15), leads to uncoordinated actions by producers, who lack a full understanding of consumers' specific demands, both nationally and abroad. Therefore, a better coordination among the various components of the beef supply chain seems urgent (EUCLIDES FILHO, 2004; STEIGER, 2006; TIRADO et al., 2008).

Some initiatives in this direction started to happen as a result of consumers' demands for food quality and safety. Disease outbreaks in livestock of various countries raised consumers' awareness of, and concerns about, how food is produced, packed, transported, distributed and served. Environmental concerns also contributed to this increasing demand for information regarding agricultural products. Players in the beef sector are responding accordingly to this new momentum, focusing on producing meat with particular attributes that are demanded by different markets and on developing beef quality assurance schemes that benefit all stakeholders (MALAFAIA et al., 2007; SYLVANDER et al., 2006). This context made room for the establishment of the Brazilian traceability system (i.e. SISBOV) and other initiatives such as origin designation programs (e.g. Pantaneiro veal, Camapuã calf), brands (e.g. Primo Corte, Organic beef), among others.

Beef Farming Systems

Beef farming in Brazil occurs in diverse agro-ecological systems, which bring different challenges for farmers. In response, beef production systems vary accordingly, encompassing farmers' diverse objectives, socio-economic conditions, cultural background, resources, and constraints among other factors. Given this diversity, several criteria have been used to characterize and analyze beef production systems. The prevailing dietary system and level of inputs determine whether the beef farming system is intensive, semi-intensive or extensive. Cezar et al. (2005) present a comprehensive review of these beef systems. According to the authors, intensive systems rely on intense use of working capital, particularly for feed purposes. Within this system, cattle are fed all year round in feedlots with high levels of concentrates or finished under highly productive pastures supplemented by concentrates or silage. In semi-intensive systems, pasture is the main source of feed, which is combined with alternative protein and/or energy sources to complement the diet, usually during the dry season. Some level of pasture maintenance is often observed in these systems. In contrast with the previous two, extensive systems are commonly characterized by low input of working capital and large areas (COSTA, 1998) usually established with low quality perennial pastures, both native and sown (CEZAR et al., 2005). Under this system, cattle remain in an exclusive pasture-based regime.

According to Cezar et al. (2005), extensive grazing has been the prevailing regime in some 80 percent of beef farms throughout the country. The semi-intensive system has been predominantly found in central-southern Brazil, although it can be observed in a small proportion in the North and Northeast regions. Mato Grosso do Sul, Mato Grosso, Goiás and São Paulo States account for 90% of the total semi-intensive production in Brazil. These States also hold most of the intensive beef systems. Cavalcanti and Camargo (2007), analyzing the 50 largest Brazilian feedlots in 2006, noted that these were mainly located in the States of São Paulo (34%), Goiás (28%), Mato Grosso (18%), Mato Grosso do Sul (16%) and Minas Gerais (4%). Goias ranked first in terms of herd size under feedlot systems (48% of the total animals).

Despite the historical prevalence of extensive systems, there has been a constant increase in cattle finished under intensive and semi-intensive systems. In 2005, 2.3 million head were finished in feedlots and 2.6 million head (FNP, 2007) finished in semi-intensive systems, which represent an increase of 179 % and 940%, respectively, compared to 1992. These figures indicate the process of farming intensification that beef farms are going through. According to Euclides Filho (2000), this process is likely to continue as the increasing beef demand and the higher competition in global markets call for more efficient and sustainable use of resources, leading farmers to invest in technology.

Another way to define beef systems in Brazil considers the phases they involve: cow/calf, rearing and fattening. These phases can be carried separately or combined, as Cezar et al. (2005) and Michels et al. (2001) described.

• Cow/calf: all weaners are sold at 7 to 9 months of age, with some yearling heifers selected for breeding purposes. Heifers may also be sold as breeding cows to other farmers.

• Cow/calf and rearing: it differs from (a) in that store steers are sold at 15 to 18 months of age to other farmers.

• Cow/calf, rearing and fattening: the so-called 'complete cycle' system is the most common beef farming system. Within this system, cattle are sold to slaughterhouses at ages ranging from 15 up to 42 months, depending on the production system.

• Rearing and fattening: farmers buy weaners, rear and sell them finished to slaughterhouses. Ages at slaughter depend on the production system, particularly the dietary system.

• Fattening: traditionally it involves the purchase of 24 to 36-month cattle to be finished.

A special case of interest when it comes to beef production systems is the Brazilian Cerrado, where most cattle production happens. With an estimated area of 200 million hectares, of which 55 million are sown pastures, most of the Brazilian Savannahs (75%), the so-called Cerrado, cover the Central Brazil (CEZAR et al., 2005; COSTA, 1998). A tropical climate prevails in the Cerrado region, with an average temperature of 22 to 24oC (CORRÊA, 1994, cited in COSTA 1998). The soils are generally infertile and acidic (CEZAR et al., 2005; COSTA, 1998). The wet season is from October to April, when 80% of the annual precipitation (1,300–1,950 mm) occurs. The dry season (from May to September) is considered the main physical-biological bottleneck for grazing systems in this region (COSTA, 1998).

Prevailing beef systems in the Cerrado region were described by Costa et al. (2005) and Pereira et al. (2005). Using panel data with experts (beef producers, researchers, extension agents and inputs salesperson), these authors identified respectively the modal beef production systems in Goiás (GO) and Mato Grosso do Sul (MS) States, both in the Cerrado region. A summary table with the main results is presented below (Table 1).

Table 1. Description of prevailing beef systems under Cerrado conditions

State	GO	MS	MS
Micro-region	Vale do Araguaia	Campo Grande	Dourados
General description			
Climate Precipitation (mm Temperature (oC)	 1,650 20 - 25	 1,470 19 - 24	 1,410 18 - 25
Total farm area (ha)	1,440	1,500	1,000
Area of sown pastures (ha)	1,152	1,200	800
Sown species	*B. brizantha* *B. humidicola* *A. gayanus*	*B. decumbens* *B. brizantha* *B. humidicola*	*B. decumbens* *B. brizantha* *B. humidicola* *P. maximum* Tanzania
Carrying capacity (AU/ha/year)	0.8	0.6	0.7
Grazing system	Continuous	Continuous	Continuous
Supplementation at the dry season1	M: Protein supplement F: Urea	-	-

Herd (AU)	922	719	560
Activities	Complete cycle	Complete cycle	Complete cycle
Buildings & Machinery (US$)2	221,891	238,348	207,486
Performance indicators			
Age at first calving (months)	37	44	38
Calving rate (%)	70	60	60
Death rate until weaning (%)	5	6	8
Male weight at weaning (kg)	160	150	155
Female weight at weaning (kg)	150	135	145
Age at slaughter (months)	40	45	45
Male weight at slaughter (kg)	495	490	470
Female weight at slaughter (kg)	345	390	360

[1] Mineral mix is provided on a regular basis in all regions; M: male and F: female. 2 Based on local market prices in August, 2005; exchange rate 1USD = 1.986BRL
Source: adapted from Costa et al. (2005) and Pereira et al. (2005)

In general, the typical farms in GO and MS presented low productivity, with prevailing extensive systems as suggested by the systems' low carrying capacities. According to Costa et al. (2005) and Pereira et al. (2005), natural mating usually with no defined breeding season was common, with calving rates varying from 60% to 70%. None of the typical farms had technical support. Formal planning and record keeping were not common, except for tax purposes. However, advancements were also noticed. The use of more productive grass species in all farms, such as *Brachiaria brizantha* and *Panicum maximum*, and cattle supplementation on the farm in GO suggest improvements on cattle nutrition. The age at slaughter ranged from 40 to 45 months across farms.

Besides the typical farms found in the Cerrado region, technologically-driven farms are becoming more frequent and growing in importance when meat quality and exports are taken into account. An example is beef farms participating in the Best Management Practice Program – BMPP- or members of the Association of Producers of Young Steers from Mato Grosso do Sul – APYS/MS. Both initiatives promote good farming practices and the use of technology (PEREIRA, 2011). Pereira (2011), studying innovative beef farmers in Mato Grosso do Sul State who participated in BMPP or APYS/MS, noted that these farmers adopted, on average, 60% of the 45 selected technologies. The author argued this adoption rate was considerably higher than the rates shown in the 2006 Brazilian Agricultural Census. Considering the census, only 29% of farmers adopted cattle supplementation, 6% artificial insemination, 1% embryo transfer and 5% agricultural terracing while for the innovative beef farmers these figures increased to 81%, 63%, 11% and 65%, respectively (PEREIRA, 2011; p. 166).

The prevailing farming system amongst innovative farmers was the complete cycle, encompassing the cow/calf, rearing and finishing phases. Combined rearing and finishing, but without breeding, was also important, with exclusive cow/calf (8%) and exclusive finishing systems being less frequent. The average farm was 2,784 ha with 1,749 ha of pasture and 2,540 cattle. The vast majority established a breeding season, using superior genetic bulls, and tested bulls for fertility and cows for pregnancy, culling the empty ones. Rotational grazing was the most common pasture management, with silage and legume-grass mix being less frequent. Additionally, most farmers used supplementation during the dry season and half of them finished cattle in feedlots, which characterized, predominantly, a semi-intensive system. An outstanding observation was farmers' adoption of managerial technologies. On average, 6 of the 11 technologies analyzed were used by these farmers, including technical records, animal identification, managerial software, financial control and, to a lesser extent, formal planning and cost analysis (PEREIRA, 2011). These farming systems, therefore, not only contrasted to the reality shown in the census, but also to the modal farms described in Costa et al. (2005) and Pereira et al. (2005). They represent some of the more advanced farming systems present in the Brazilian Cerrado.

Future Strategies

Further development of the Brazilian beef sector depends on the country's ability to improve the sanitary control and inspection by authorities, widely implement traceability systems, expand the number of accredited farms to export (EUCLIDES FILHO, 2004; STEIGER, 2006; TIRADO et al., 2008), encourage more transparent relationship between farmers and slaughterhouses with the establishment of contracts (VIEIRA et al., 2006) and achieve top meat markets, promoting Brazilian meat internationally (STEIGER, 2006). At the farm gate level, the expansion of sustainable beef production systems is also crucial (EUCLIDES FILHO, 2004).

Some opportunities and strategies for the Brazilian beef sector over the next decade were identified by a multidisciplinary group, including representatives from the Brazilian Government, Embrapa, universities, producers associations, funding agencies, meat processing sector, researchers, extension personnel, restaurants, retailers, veterinarian industry, rural consultants among others (EMBRAPA GADO DE CORTE, 2008). A summary is presented below, showing some directions likely to be taken by the Brazilian beef sector:

• Systems intensification for productivity and efficiency enhancement, using genetic improvement strategies, pasture management and better sanitary control;

• Increase of integrated systems, particularly crop-livestock-forest or livestock-forest, where possible;

• Higher adoption of strategic supplementation, as well as higher use of agroindustry residues for this purpose (along with energy production and fertilization);

• Recovery of degraded pasture as a strategy to mitigate greenhouse gas emissions and to contain further herd expansions towards the Amazon;

• Spread of Good Agricultural Practices, including managerial practices such as planning and control;

• Better coordination of the beef supply chain to add value to meat products, with the establishment of new strategic market alliances, launch of meat brands and development of origin designation programs, for instance;

• Consolidation of the Brazilian Traceability System;

• Development of new vaccines and disease diagnosis protocols to identify and control (and possibly freed Brazilian cattle from) the main diseases; and

• At last, but not least, a restructuring of beef farming systems to operate under a sustainable framework, with incentives (including credit) to uptake low carbon emission practices and higher penalties for farmers disregarding it.

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17- Methane Gas in Cattle Production, and Alternatives to Measure Its Emissions and Reduce Its Environmental and Productive Impact

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Introduction

Climate change is one of our biggest environmental, social and economic threats. Most of climate change can be attributed to the greenhouse gas emissions (GHG) caused by human activity. These gases are atmosphere components that trap solar energy reflected by the earth's surface as infrared radiation, increasing global temperature (IPCC, 2007). The most important atmosphere components are carbon dioxide (CO_2), methane (CH_2), and nitrous oxide (N_2O).

It has been calculated that global warming potentials are of 1 for CO_2, 23 for CH_2, and 296 for N_2O, (Mosier et al., 2006). One of the main sources of these gases are the biological processes present in activities such as livestock, in which the main source of methane gas emission is cattle; and the main source of N_2O are the different culturing plowing of fertilizing pasture fields and crops, which are carried indiscriminately and with no dosage technical criteria or application frequency.

One of the main triggers of livestock-related global climate change is the

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high level of deforestation. Over time these areas generally end up being occupied by cattle. This expansion has been related to forest loss and fragmentation, and to the creation of landscapes with pasture monocrop mosaics, agricultural crops and forest fragments (Kaimowitz, 2001).

Another trigger for livestock-related climate change is the enteric methane emission by animals, since it represents 30.28% of greenhouse effect gas emission in Colombia. This reduces the animal´s energy efficiency, because it represents between 6% and 7 % of the diet's gross energy. Enteric methane emission has also a great impact on the environment.

Thus, livestock as a widely developed economic activity in Colombia constitutes an important source of greenhouse gases (GHG). On the other hand, at a global level there is a growing development of markets which stimulate the trade of green products and the establishment of production systems, sustainable in time and beneficial for the environment.

Nevertheless, livestock is considered as the widest spread agricultural economic activity in Colombia, occupying 39.4% of the national territory compared to permanent crops, which occupy 1.66%.

The Colombian Agricultural Survey shows that livestock activity is present in 38'944.373 Ha, which corresponds to 34% of the Colombian territory, including around 8 million Ha of undergrowth and weeds. In what is considered as the agricultural border (51'131.284 Ha), which corresponds to 44.8% of the national territory, livestock activity occupies 76% (FEDEGAN, 2006).

According to San Agustín Codazzi Geography Institute (ICAG) of Colombia, from 38.3 million hectares currently used for livestock, only 19.3 million are adequately assigned. By calculating use differences, it can be inferred that out of the 19 million of the remaining hectares, 10 million should be assigned to the forestry sector, and 9 million should be assigned to agriculture. Taking this into account, the Plan Estratégico de la Ganadería 2019 (Livestock Strategic Plan 2019) has the goal of returning 10 million Ha to nature (FEDEGAN, 2006). To achieve this goal, production systems must be 'intensified' to obtain a higher productivity per unit of area in order to satisfy the growing population's demand for animal protein.

In searching for more biologically and economically sustainable production systems, silvo-pasture systems (SSP) are a short and long-term alternative. Tree introduction in pastures offers good quality fodder to animals (especially if they are pulses), and also has potential to increase animal production (meat and milk). Trees could be used as windbreaker barriers, live fences, erosion controllers, and soil fertility improvers.

Additionally, trees offer different products such as fuelwood, wood, and fruit. They generate environmental services such as carbon fixation in soils and vegetation, and reduction or mitigation of enteric methane emission by cattle. They also increase biological biodiversity and help to conserve water sources, thus providing producers with higher incomes, and a higher economic stability (Giraldo, 2000).

Silvo-Pasture Impacts on Fodder and Livestock Productivity

In Colombia, silvo-pasture has demonstrated its potential to improve animal production in high tropics as well as in low zones, with different soil fertilities and silvo-pasture use. This potential is documented because of the increases in fodder quality parameters of soil pastures when they grow under the canopy of trees, represented in higher raw protein content and digestivity, and less cell wall. Additionally, there are increases between 4.5% and 12.3% in daily milk production per cow, and increases between 9% and 49%in milk production per area, depending on tree density per hectare.

Despite an animal load increase between 12.5% and 39%, soil compaction decreases between 21% and 57%. In addition, in these silvo-pasture systems for intensive milk production in high zones, the economic income for cattle raisers increase between USD 1166 and USD 3088/ Ha for high and low tree density respectively, because of the sale of wood to be used as peg. Expenses decrease by 219USD/Ha due to the absence of fertilizers and pest chemical control. Bird fauna biodiversity linked to silvo-pasture (represented in the number of species) increases by 50%.

In Colombian low-tropic zones, the increase in animal meat production varies between 18.6% and 226% in the daily profit from young bulls' weight. This depends on animal load, tree density, and the regions' adaphoclimatic conditions. This is reflected in the meat/year/ Ha production, which increases around 80%, from 314 to 564 kg/Ha/ year; and around 361%, from 54kg Kg/Ha/year to 249 Kg/Ha/ year. Load capacity is improved between 43% and 120%, but compaction decreases between 9% and 38%, depending on animal load, tree density, and soil topography.

This better performance in animal production is due to the less climatic stress received by the animals thanks to the microenvironment created by silvo-pasture. Under tree canopy, environmental temperature is 4.5°C less in SSP than in full sunshine. Also, solar radiation quantity received by animals in pasture at noon is much lower (90% less) when they are in SSP.

Those two environmental characteristics, which are favorable to animal behavior, have an influence on their physiological parameters due to the stress caused by adverse environment. Thus, respiratory frequency is lower in silvo-pasture (30.3 resp./min) compared to the area without trees (35.3). Both situations: lower environmental temperature and less solar radiation perceived by cattle in silvo-pasture, positively affect consumption since this one was higher (2.3% of live weight) in the SSP, compared to the control (without trees), which was 2.0% PV. Also, bird fauna diversity (number of species) related to silvo-pasture increases by 75% in hot climate zones of low tropics in Colombia.

Silvo-Pasture Impacts in Carbon Capture

Besides the biophysical, productive and biodiversity advantages offered by SSP, the environmental services that these systems could provide in the short and medium term are important, especially carbon capture as greenhouse effect (GHG) and its potential to be incorporated in global carbon market. Carbon stock measurements in different SSP compartments (soils, trees, and pastures in the aerial part as well as in the radicular part) for three different sites of the high and low tropics in Colombia are shown in Figure 1.

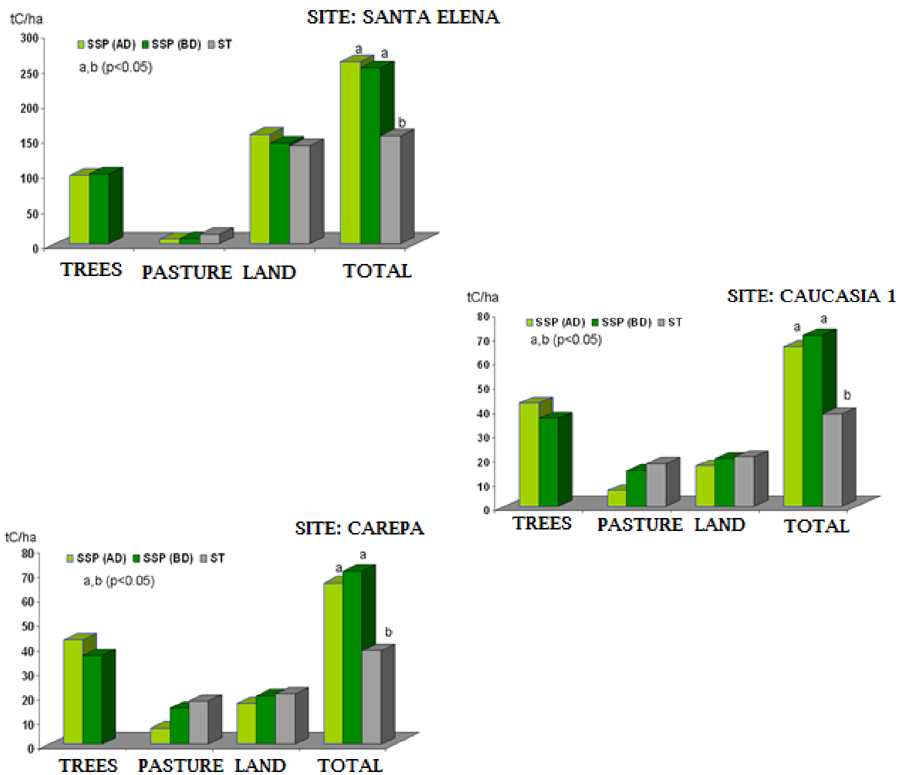

Figure 1. Carbon capture (tC/Ha) in six-year old silvo-pasture, in three sites of high and low tropics in Colombia.

Carbon stock captured in different SSP compartments (soils, trees, and pastures in the aerial part as well as in the radicular part), for different sites of high and low tropics in Colombia, varies between 66 and 260 $tCO_{2(e)}$, depending on the site and on the tree density. The annual average increase (AAI) of carbon in aerial biomass of trees in the high tropics (2538 amsl) is 31.7% higher in high densities of trees, and 57% higher compared to low tropic sites.

Carbon stocked in aerial part as well as in roots showed a clear tendency to reduce when there were increases in plantation density due to the competition between tree roots and pasture. Growth and renovation cycle of roots are two significant components in carbon capture in pastures. The evaluation of roots' dynamic is an important element to understand the role they play in carbon capture (Fisher and Trujillo, 2000). This situation has not been clarified in silvo-pasture systems through research in tropical conditions. That is why quantitative information on rooting variability depending on time and site under the imposed use is needed, in particular about pasture density (pasture frequency and pressure). This would allow to develop models on soil--plant-animal relation in silvo-pasture systems subjected to consumption and to animals' footsteps, since radical biomass is reduced with defoliation, and with defoliation intensity and frequency (Giraldo, 2000).

Silvo-Pasture Impacts on Enteric Methane Emissions by Cattle

Methane production by ruminants is considered one of the main metabolic activities executed by rumen's microbial consortium (mainly archaea, bacteria and protozoa). It is the result of microbial fermentation of fibrous material in the gastro-intestinal tract (McCaughey et al. 1997), in anaerobic conditions, with relatively low temperatures (between 38 and 40°C), and a pH close to neutrality (6.8 - 7.2). Nevertheless, not all the organic matter is converted into CH4 and CO_2. In ruminants, great quantities of volatile fatty acids (VFA) are found -around 60mM for acetate, 20mM for propionate, and 10mM for butyrate (Fonty and Morvan, 1996), which supply around 70% of ruminant's energy needs

(Jouany, 1991).

Johnson and Johnson (1995) indicate that there are two main factors responsible for methane production variation. The first is fermented carbohydrate quantity in the rumen-reticulum, which implies several diet-animal interactions that affect balance between fermentation rates of those carbohydrates and their passage rate.

The other mechanism is the relation of volatile fatty acids (VFA) produced, which regulates hydrogen production and the subsequent methane production. The most impacting aspect in methanogenesis is the relation acetic acid: propanoic acid. If this relation reaches 0.5, the energy loss can be 0%. But if all the carbohydrates were fermented in acetic acid and propanoic acid were not produced, energy loss could reach 33%. Acetic: propanoic relation can vary between 0.9 and 4. Therefore, loss per methane varies widely (Johnson and Johnson, 1995).

Methane is produced by methanogenic organisms -the Archaea- which is a microbial group filo-genetically different from eubacteria (real bacteria). Methanogenic Archaea include: *Methanobrevibacter ruminantium*, *Methanobacterium formicicum*, *Methanomicrobium Mobile* (Weimer, 1998). These methanogenic archaea constitute a special kind in ruminal population due to the role they play in regulating total fermentation by eliminating H_2. Co_2 reduction with H_2 is the primary method by which CH_4 is produced in rumen. However, some methanogenic bacteria such as *Methanosarcina barkerii* use methanol, methylamine, and acetate to produce CH_4. By keeping H_2 concentration low through CH_4 formation, methanogenic bacteria promote growth of other bacterial species, and allow a more efficient fermentation (Yokoyama and Johnson, 1993).

CH_4 is mainly belched and exhaled by cattle, but energy still present in CH_4 is lost or used for keeping body temperature (Wattiaxu and Armentano 1998). It has been determined that this lost energy can be between around 2 and 12% of the total gross energy ingested (Hungate 1966, Gingis 1998, Yanaguita et al. 2000). This percentage depends on animal type, age, and weight, as well as on fodder quality and quantity ingested by the animal (Vermorel, 1997). This loss can be reduced through feeding strategies such as using inhibitors of microbial metabolic groups, i.e. ionophores, tannins or lipids. But to determine the impact of these sorts of strategies, it is necessary to know the emission dimension of our tropical environment.

Methodologies for determining methane production and emission are important because they allow to know the significant contribution made by livestock production to GHG emission, especially carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (Shibata and Terada, 2009).

Different techniques to determine methane emission in a wide range of situations have been developed all around the world. In vitro or in vivo techniques have resulted from them. The latter have a higher cost since they require animals to be adapted and maintained, results take more time, and equipment is more expensive. On the contrary, in vitro techniques are less expensive, faster, and they can define some specific factors.

To measure gas volume and composition, chromatography of gases, photo-acoustic infrared spectrometry, mass spectrometry, or infrared absorption spectroscopy is used. Of those methods, gas chromatography is the most used to determine CH_4 because it is less expensive (Johnson and Johnson, 1995).

Closed techniques can be found among in vivo alternatives for quantifying methane emission by cattle. They are based on determining the total airflow in the system and the concentration difference in the inhaled and exhaled air. Among closed techniques, calorimeter room of open flow and closed flow, box in the head, and facial mask, stand out. The advantage of these techniques is that they allow to determine CH4 concentration and volume in real time. Nevertheless, these techniques incur high expenses in equipment building and maintenance; and training and changing animal’s eating habits. So these techniques do not represent free pasture animal conditions (Johnson and Johnson, 1995; Klein and Wight, 2006; Carmona et al, 2005).

Another procedure is the tunnel technique, an adaptation of closed techniques in which in a polyethylene tunnel having two orifices – one for input and the other one for output- the airflow, as well as the methane concentration at air input and output, are measured (Lockyer and Jarvis, 1995). Some research works have proved that this technique presents lower values compared to calorimeter room, maybe due to humidity and temperature variations present in this technique, which are very difficult to control (Murray et al., 1999).

The methodology for quantifying methane emission by cattle, for pasturing animals, is quite laborious and expensive; that is why many researchers have tried their best to establish empiric relations between food metabolizing energy value and CH_4 production by cattle. Thus, it has been suggested that CH_4 (g/d) production can be predicted as a linear function of dry matter ingested by the ruminant (Moss, 1992). Also, this production is directly related to carbohydrate quantity apparently digested. On the other hand, Blaxter and Clapperton (1965) propose that CH_4 production can be predicted as the relation between the amount of gross energy digested and the animal´s maintenance energy. But none of these methodologies have yielded satisfying results probably due to the many factors affecting these emissions, particularly interactions among different types of food (Moss, 1992).

The sulfur hexafluoride or SF_6 technique uses SF_6 as gas marker. It is based on the use of a (non-isotope) marker, which allows to “track” CH_4 molecule behavior and distribution. SF6 used as non-isotope marker gas has a behavior similar to that of the methane, as an inert gas placed in the rumen that, through a controlled release, can be a CH_4 emission marker (Johnson and Johnson, 1995). Some authors suggest that this technique has the capacity for determining between 93% and 98% of methane compared to metabolic rooms (De Ramus et al, 2003). Nevertheless, other reports show great variability in measurements in animals and, sometimes, differences regarding other techniques. Those differences can be due to different gas marker permeation rates (Lassey et al, 2001; Pinares-Patiño and Clark, 2008).

The sulfur hexafluoride or SF_6 technique consist of three components: a) a permeable tube containing SF_6 introduced in the rumen; b) a Teflon membrane controlling SF_6 release through the permeable tube; and c) the analysis of CH_4 and SF_6 concentrations in the collected samples. The air coming out through the nostrils contains breathed and belched gases, which are swept to a PVC tube. Inside this tube there is a canister, which is usually placed around the animal's neck. SF_6 and CH_4 concentrations are analyzed using gas chromatography (Johnson and Johnson, 1995).

In many countries, methane emission has been made based on equations from Intergovernmental Panel on Climate Change (IPCC, 2007), assuming pasture consumption, gross energy, and pre-determined percentages of gross energy conversion into methane, without differentiating between pastures and supplement supply. This generates inventory over-valuated or under-valuated data of enteric methane by cattle. These data are not compatible with the pasture types or the feeding and production systems in the country, making difficult to focus on actions and priorities for implementing mitigation measures with global impact.

On the other hand, the simplest in vitro systems to study rumen fermentation, and therefore methane concentration, consist in tubes or bottles in which food with rumen liquid is incubated in anaerobiosis conditions at a 39°C temperature, using non-renovated cultures of rumen microorganisms (NRCRM). Those systems can be hermetically sealed, or provided with a valve for fermentation gas release, in which gas pressure and volume are measured (Theodorou et al., 1994). This technique- known as gas technique- has recently been standardized for Colombian height tropical conditions (Giraldo et al., 2006).

These systems are conceived to study fermentation with short term incubations (52 hours maximum) and/ or to determine accumulated gas production including methane and other secondary metabolites resulting from fermentation. Those metabolites are obtained at the end by product accumulation in the process of rumen fermentation (López and Newbold, 2007). The advantages of this kind of analysis are the equipment's low cost, and the possibility of making simultaneous analysis and of specifying some anaerobic enteric fermentation mechanisms in ruminants (Giraldo et al., 2007).

Recent information indicates that in vitro technique of non-renovated cultures of rumen microorganism (NRCRM), by using gas technique, can accurately determine methane emission for different diets for ruminants, and it is comparable with SF6 *in vivo* technique (r = 0.93 and 0.90) after 48 hours of *in vitro* rumen fermentation in different tests reported by Bhatta et al., (2006). Another alternative of in vitro system is non-renovated cultures of rumen microorganism of long duration (NRCTMLD), by using semi-continuous flow fermenters, RUSITEC (Czerkawski and Breckenridge, 1977).

By using gas technique and pasture consumption determination, it is possible to determine enteric methane emission by cattle. On the other hand, carbon capture quantification in silvo-pasture allows to estimate a balance of equivalent carbon. Results show a balance of positive carbon and over 60% higher in silvo-pasture, compared to areas without pasture or trees in Colombia.

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18- Molecular Tools in the Conservation and Enhancement of Locally Adapted Bovine Breeds

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Introduction

Animal domestication began approximately 12,000 years ago and since then a large group of subpopulations has developed. This was a function of the adaptation of the different animal species to different environmental conditions when they accompanied man during his migration into new territories. The existing variances between these subpopulations, called breeds, and the variance within each of them, represent the genetic diversity found in domestic breeds. Some of them, although have similar appearance and traits, underwent different selection pressures due to climate, endemic parasites, illnesses, diet and criteria decided by man (Mariante & Egito, 2002).

The decrease in the genetic variability could lead to a reduced ability of species to survive in the face of environmental changes or demographic fluctuations. Thus, there are no doubts about the need to conserve the genetic variability in domestic animals but it is known that the conservation of locally adapted cattle breeds depends on its insertion in existing production systems either through their genes or their products.

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In Brazil, the locally adapted bovine breeds descend from the Iberian animals, brought by the Portuguese settlers soon after the discovery of the country in 1500. These animals spread all over the country and through random crosses and by interaction with the environment became adapted to the pressures typical of the different Brazilian ecosystems (Egito et al., 2006). Within the last one hundred years, however, the genetic integrity of such locally adapted breeds has been increasingly threatened by the rapid growth of commercially high productive breeds, most of them selected in temperate regions, and crossbreeding practices. Even so, they gradually replaced the locally adapted breeds to such an extent, that the latter are, in most cases, in danger of extinction (Mariante & Egito, 2002).

In recent years, these local cattle breeds have increasingly become a matter of great interest. They represent an invaluable repository of locally adapted gene complexes that evolved through a combination of natural selection to extreme and variable abiotic and biotic stresses together with moderate, if any, directional selection pressure, genetic drift and local patterns of interbreed gene flow (Notter, 1999; Mariante & Egito, 2002; Egito et al., 2007).

They may contribute to the national cattle industry with its high prolificacy and reproductive efficiency, small size, heat tolerance, and natural resistance to diseases and parasites, especially in less favorable environments (cost x benefit relationships), or using traits of interest for introduction into commercial breeds (Mariante et al., 2008). Studies have demonstrated the link between locally adapted cattle breeds and heat stress tolerance (Bianchini et al., 2006) as in many cases, thermotolerant lines or breeds are not associated with those ones that suffered intense and highly productive selection processes (Hansen, 2011).

In these contexts, population studies using molecular tools may offer useful information for the conservation and management of Animal Genetic Resources (AnGR) such as the evolution of the breeds, the development of gene pools and the magnitude of genetic differentiation (MacHugh et al., 1997, Bruford et al., 2003). Breeds with a unique evolutionary history may possess valuable genes and when used in breeding programs generate heterotic gain.

Molecular tools in the conservation programs

National AnGR conservation programs should use the association of phenotypic data, molecular polymorphisms and adequate statistical methods which reflect the real condition of a population. This fact alone justifies the effort used in the characterization of these populations, as the cost of projects of this type is very high and should be considered in making rational decisions to avoid the duplication of efforts in the maintenance of breed samples, which may be the same. On the other hand, it is necessary to ensure the genetic variability of a breed, to avoid that unique traits are lost, which may be culled during the conservation process (Egito et al., 2006; Hanotte & Jianlin, 2005).

The estimate of genetic uniqueness of a breed or population is usually obtained measuring genetic distance and building a simple phylogenetic tree which expresses the relationships between the different populations graphically (Barker, 1994). This is useful in making rational and objective decisions on choosing which populations should be studied in more detail.

Genomic analyses could give more knowledge on wild ancestors which originated the breeds as well as the localization and timing of the domestication events. Processes such as mutation, genetic drift, gene flow and natural selection, which influenced the variation between the genomes and populations, may also be studied (Bruford et al., 2003). Using the variation pattern at a specific locus within the populations, important demographic factors for diversity conservation may be deducted (Kantanen et al., 2000).

Techniques which help in parentage analysis and in the genetic identification of an individual may be used for successful implementation and monitoring of in situ conservation programs (Hanotte & Jianlin, 2005). This information can be used to direct matings in order to maintain genetic variability; to choose individuals which are genetically less similar for the formation of a conservation nucleus; and to analyze the efficiency of the work carried out on the maintenance of variability of conservation nuclei over the years (Egito et al., 2005). Thus, molecular tools can be used to facilitate maintenance of rare genotypes of livestock that contains sets of genes that could be important in the future for enhancing adaptation to specific environments (Hansen, 2011).

The mean number of alleles, as well as expected (He) and observed (Ho) heterozygosity are commonly calculated parameters to check within breed diversity (Hanotte & Jianlin, 2005). Genetic diversity indices, such as mean heterozygosity of a population, may be used to check the level of inbreeding of a herd while genetic similarity indices between individuals may be used to choose matings to maintain genetic variability in conservation nuclei (Egito et al., 2006).

Different statistical methods may be used to measure genetic variability of a population, depending on different hierarchical structures. These are based on the frequency and variance of alleles in the populations. One such parameter is the FST (Wright, 1951), which describes the general diversity of a population due to hierarchical levels of endogamy. This coefficient varies from 0 (identical alleles in the population) to 1 (populations with different fixed alleles), with high FST values indicating a great difference in allelic frequency in the studied populations.

The precision of genetic distance measures is due to the number of independent alleles measured. Similar results are obtained when few loci with many alleles are used, or vice-versa (Kalinowshi, 2002). Other factors such as true distance between populations, the heterozygosity at each locus and number of animals sampled in each population as well as the statistical model used may influence this precision (Barker, 1994; Nagamine & Higuchi, 2001).

Markers with bi-parental inheritance such as microsatellites may answer questions on a whole population or an individual. Mitochondrial DNA (mtDNA) and the Y chromosome are essentially haploid and transmitted by one parent, and offer complementary information on the analyzed population. While mtDNA contains information on the maternal contribution to the population being analyzed, the Y chromosome offers information on the paternal contribution, reflecting different aspects of the biology and history of a population (Egito et al., 2006).

Microsatellites have rapidly become the preferred marker for studies of population structure, as they show traits which are useful in projects involving AnGR. They are abundant on the genome and have been widely discussed, show a high degree of polymorphism, are easily automated and various loci may be analysed at once. The diversity observed with this type of marker is due to genetic drift and mutation.

Several reports on genetic distances and relationships of cattle breeds using mtDNA, Y-chromosome and autossomal microsatellite markers have shown that most breeds can be promptly differentiated due to significant differences in haplotype or allele frequency distributions. Phylogenetic analyses based on genetic distances have also shown that the genetic relationships of present-day breeds are generally consistent with historical origins (Ibeagha-Awemu & Erhardt, 2005; Kantanen et al., 2000; MacHugh et al., 1997; Egito et al., 2007; Ginja et al., 2009, 2010). DNA markers have provided a robust method for detecting introgression or crossbreeding events between the taurine and indicine subspecies that display marked patterns of differentiation (Egito et al., 2007).

Studies carried out with mtDNA, on four naturalized breeds suggest the existence of a new lineage of taurine mtDNA of African origin

(Miretti et al., 2002). Although an African lineage has been found in Iberian breeds (Cymbron et al., 1999), consistent with the demographic history of the Peninsula, this lineage differs from that found in higher frequency in the Brazilian breeds (Egito, 2007).

With the use of molecular tools it was possible to see that the introduction of zebu genes in the locally adapted bovine breeds was due to the sire. The mtDNA is exclusively of taurine origin (Egito, 2007) while in some individuals an acrocentric chromosome can be found, characteristic of animals of Bos taurus indicus origin (Issa, 2005). Among the local Brazilian breeds, the Caracu shows the least genetic diversity (Serrano et al., 2004; Egito et al., 2007). Caracu is the only Brazilian local breed that participates in Breeding Programmes. The breeds closer to the Nellore were the Creole Lageano and Pantaneiro (Serrano et al., 2004; Egito et al., 2007).

Besides answering breed/population level questions the availability of large batteries of microsatellite markers have prompted the genetic analysis at the individual level to determine its most likely origin. Individual based analyses have allowed the assignment of single animals to a breed/population or the estimation of the animal most likely ancestral composition, especially when the phenotypic differentiation between breeds in question is difficult and pedigrees are unavailable or ambiguous (Baumung et al., 2004). Assignment tests have been proposed to trace the origin of livestock products as traceability of individuals to their source breed is becoming important in global and domestic trade to assure food safety and brand authenticity (Ciampolini et al., 2006). A number of statistical methods and computer programs have been developed to assign individuals to populations (Cornuet et al., 1999; Pritchard et al., 2000). All methods make use of the large amount of information that is available from the genotype data at several markers for each individual and estimates the likelihood of the data conditional to the hypothesis of the animal belonging to each one of the possible ancestral populations. The individual is then assigned to the population/breed from which its multilocus genotype is most likely to have been derived (Hansen et al., 2001) together with an estimate of the relative proportions of each participating ancestral population or breed.

Molecular Tools in the Enhancement of Local Breeds

Along with the discovery of the basic genetic diversity distribution within and between these breeds using neutral markers, it is important to note that studies have begun on the identification of SNPs (Single Nucleotide Polymorphisms) in genes of economic interest, as well as the development of mapping studies and markers associated linked to production traits (Mariante et al., 2009).

Studies with candidate genes have been used, related to both meat and milk production, in an attempt to integrate naturalized breeds in the market (Egito et al., 2004a, 2004b; 2008; Carvalho et al., 2009a, 2009b). These markers can be used in early life for selection purposes or to demonstrate the existing potential in these populations so helping to encourage their development and sustainable conservation. The calpain and thyroglobulin - TG5 genes (related to meat tenderness) and DGAT1 (diacylglycerol O-acyltransferase), PIT1 and K-casein (related to the production, as well as percentage of fat and protein in milk) (Lin et al., 1992; Winter et al., 2002) were analysed in cattle breeds created in Brazil (Lara et al., 2005a and 2005b; Egito et al., 2004a and 2004b).

Molecular markers, related to organoleptic traits in meat may be used in breeding schemes for Brazilian breeds, especially on a wide scale such as in the Nellore, to improve meat quality (Egito et al., 2006), as breeds of zebu origin have a lower degree of marbling, reflecting a meat that is less tender (Marschall, 1999). Gene introgression of favourable alleles can be done through classical genetic techniques by crossbreeding and then selecting offspring for the desirable allele while backcrossing to the parent line or, alternatively, one can use in the future, transgenic techniques to introduce entirely new genes into a population (Hansen, 2011).

The presence of allele 3 of the TG5 gene, related to a higher degree of marbling in meat (found at a 43% higher level in the naturalized breeds when compared with the Nellore, the main beef cattle breed in Brazil) shows the potential that naturalized breeds have for the meat industry in relation to products of higher quality and added commercial value (Egito et al., 2004b). The CPAN2A allele of calpain, related to meat tenderness (Smith et al., 2000), was found at a 43% level in naturalized breeds compared to 10% in beef cattle zebu breeds (Lara et al., 2005b).

In Creole Lageano, a locally adapted bovine breed raised in Planalto Sul Catarinense used mainly for beef, several studies were conducted aiming the promotion and development of this locally adapted breed and to help the genetic management of breeding herds. The frequencies of favorable alleles related to milk and marbling characteristics showed that this breed has potential for dairy purposes and can be used, in the future, as a double purpose breed (Carvalho et al., 2009).

Others characteristics related to resistance and adaptability to the environment are also being studied in local bovine breeds, such as heat tolerance and resistance to ecto and endoparasites. These traits are extremely important and may act indirectly into food production. The introduction of favorable alleles to adaptive and rusticity in commercial populations could be an advantage in Brazilian breeding programs. Studies related to the discovery and validation of molecular markers related to thermal stress and resistance to endoparasites are being developed in partnership with Embrapa, partner breeders and Universities.

The ability to genotype animals through identification of SNPs at specific loci has created new opportunities for genetic selection. Genome-wide association studies to identify QTL (quantitative trait loci) and causative mutations are becoming increasingly powerful tools and commercial SNPs chips with more dense coverage are being developed and became available (Weller & Ron, 2011; Hansen, 2011).

Final Considerations

An extraordinary range of molecular tools is becoming available for studies involving the conservation of populations and their use. The type of marker to be used depends on the problem to be investigated and the size of the sample, the specificity of the marker and its information content. The knowledge of the nature, function and content of genetic information has been generated in an increasingly dynamic and fast way. Nowadays, the available technology for genome sequencing on a large scale has led to the discovery and an accumulation of information in public databases without precedent.

Studies have shown that although all Brazilian locally adapted breeds have the same origin and may be considered distinct genetic entities (Serrano et al., 2004; Lara et al., 2005a; Egito et al., 2007), some have similar phenotypes, such as the Curraleiro and Pantaneiro. There is also a wide genetic variability in all breeds, independent of the molecular marker used, which reinforces their potential for use in breeding programs.

Conservation and promotion of the sustainable use of livestock genetic resources has to be understood as part of a complex process. In this context, molecular markers are important tools that can be used in the conservation in order to study and management of Animal Genetic Resources (AnGR) and could be used to enhance their use and promote the formation of new flocks and breeds of interest. The difference between the extinction and recovery of a locally adapted breed could be the use or not that they might have been. It is important to find a niche market for each one, reinserting them in production systems. After a long period of natural selection, there is no doubt that the local cattle breeds may have important adaptive alleles that can contribute favorably to the existing system of production and sustainability of the planet.

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19- Nanosensors in favour of sustainability

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Introduction

"From the stone age, to iron, to steel, to plastics, nanotechnology is the next quantum shift." Keith Thomas, CEO of Vive Nano

Advances in science and technology could offer potential solutions for all the challenges facing agriculture, human health, enviroment issues and sustainable use of resources. Besides that, many technologies in the nano scale or the nanotechnologies being developed have the potential to increase farm productivity reducing enviromental and resource costs associated to agricultural production. It means increasing yields with the same or fewer inputs and protecting enviromental quality [CHEN, 2011].

It is envisioned that the convergence between nanotechnology, biotechnology, plant science, animal science, crop and food science/ technology will lead to revolutionary advances in the next 5-10 years, according to a recent report organized by the World Technologies and Services (WTEC), after workshops titled "Long-term impacts and future opportunities for nanoscale science and engineering", which occurred in four continents [DIALLO, 2011]. The chapter titled "Nano-

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technology for Sustainability, Environment, Water, Food, and Climate" gives emphasis on some applications which can be found in many other reports available for consultation. They are:

• Reengineering of crops, animals and microbes at the genetic and cellular level;

• Nanobiosensors for identification of pathogens, toxins, and bacteria in foods;

• Identification system for tracking animal and plant materials from origination to consumption;

• Development of nanotechnology-based foods with lower calories and with less fat, salt, and sugar while retaining flavor and texture;

• Integrated systems for sensing, monitoring, and active responsive intervention for plant and animal production;

• Smart field systems to detect, locate, report and direct application of water;

• Precision and controlled release of fertilizers and pesticides;

• Development of plants that exhibit drought resistance and tolerance to salt and excess moisture, and;

• Nanoscale films for food packaging and contact materials that extend shelf life, retain quality and reduce cooling requirements.

Nanoscale science, engineering and technology hold an exciting and broad scientific frontier that will have significant impacts on nearly all aspects of the global economy, industry, and people's life in the 21st century. Nanoscale sciences reveal the properties, processes, and phenomena of matters at the nanometer (1 to approximately 100 nm) range [KULZER, 2004]. Various nanomaterials are attractive probe candidates because of their small size and correspondingly large surface-to-volume ratio; chemically tailorable physical properties, which directly relate to size, composition, and shape; unusual target binding properties; and overall structural strength [MERKOÇI, 2007].

Nanomaterials such as metallic nanoparticles or carbon nanotubes binded with biomolecules are being used for several bioanalytical applications. Electroanalysis is taking advantages from all the possibilities offered by nanomaterials with the objective of designing the label-free affinity-based probing concepts. It can establish alternative methods to the already existing ELISA-based immunoassays. With these characteristics, the analyte on the probe is easy to be detected by conventional electrochemical methods or similar to biosensor building technologies.

This first sight on the potentiatiality of this new world has shown how to achieve the societal and enviromental needs for sustainability. Nanoscale manufacturing will provide the means for sustainable and safe development: less material, less water, less energy and less manufacturing waste for manufacturing [ROCO, 2003]. Recent advances in materials science and chemistry have produced a huge advance in nanoparticle technology, with wide implications in the field of agriculture. Following, it is given some examples showing how the “quantum shift” is possible.

Nanotechnology in future agriculture

Many nanoscale carriers, including encapsulation and entrapment, polymers and dendrimers, surface ionic and weak bond attachments and other mechanisms may be used to store, protect, deliver, and release by control of desired agriculture chemicals in crop production processes. One of the advantages of nanoscale delivery vehicles in agronomic applications is its improved stability against degradation in the environment, thereby increasing its effectiveness while reducing the amount applied and alleviate the environmental consequence [JOHNSTON, 2010].

Biotechnological research has been focusing on improving plant resilience against various environmental stresses such as drought, salinity, diseases, and others. Genomes of crop cultivars are currently being extensively studied. The advancement in nanotechnology--enabled gene sequencing is expected to introduce rapid and cost effective capability within a decade [BRANTON et al., 2008]. One of the approaches is the use of mesoporous nanoparticles capable of deliver DNA and chemicals into plants [TORNEY, 2007]. The most advantageous feature of the mesoporous nanostructure is its potential to deliver different biogenic species simultaneously to the target sites and releases the encapsulated chemicals in a controlled fashion. Current applications of nanotechnology to biology have been mainly focused on animal science and medical research. Here, Torney et al. demonstrated that their versatility can also be applied to plant science research to aid further investigation of plant genomics and gene function as well as improvement of crop species.

Other example describes some recent studies that have shown nanoscale cellulosic nanomaterials that can be obtained from crops and trees. It opens up a whole new market for novel and value-added nano biomaterials and products of crops and forest. For example, cellulosic nano crystals can be used as light weight reinforcement in polymeric matrix as nanocomposite [AZEREDO, 2011].

Concerning animal health, many animal diseases cause substantial losses in agricultural animal production. Some of the more significant diseases include bovine mastitis, tuberculosis, respiratory disease complex, Johne’s disease, avian influenza, and porcine reproductive, foot-and-mouth disease and respiratory syndrome (PRRS). The World Health Organization (WHO) presented a not too optimistic scenario for costs and negative impact in the lack of animal health on the human health, specialy in developing nations or developed world. On average, one newly identified animal infectious disease has emerged each year for the past 30 years of which approximately 75 percent have been zoonotic (e.g., mad cow disease; Avian influenza; H1N1

Influenza; Ebola virus; Nipah virus) [WHO, 2005]. Zoonotic diseases not only cause devastating economic losses to animal producers, but also impose serious threats to human health [CHEN, 2011]. Under this background, two important tools, detection and intervention, might be integrated to the animal disease management strategy, which is critical to significantly reducing losses or threats from the disease, and/or eradicating it, or preventing its introduction into the animal production.

Nanotechnology offers numerous advantages in detection and diagnostics of several pathogens, including high specificity and sensitivity, simultaneous detection of multiple targets, rapid, robust, on-board signal processing, communication, automation, convenient to use, and low cost. Besides, the uses of portable, implantable or wearable devices are particularly welcome in routinely field applications. The sensitivity is required as early detection is imperative. So that quick, simple and inexpensive treatment strategies can be taken to solve the situation.

In intervention, nanotechnology based drugs and vaccines can be more effective in treating/preventing the diseases than current technologies, thus reducing cost. Precise delivery and controlled release based on nanostructures (particles, emulsion, lipids) encapsulating drugs leave little trace in the animal waste and the environment. In this way, the increasing concern of antibiotic resistance, and decrease health and environmental risks associated with the use of antibiotics is alleviated. The targeted delivery and active nanoparticles may enable new drug administrations that are convenient, fast, non-intrusive to animals, and cost valuable. The effectiveness of new drug delivery technology platforms must first be established using pharmacokinetic and pharmacodynamic studies in vivo to investigate the relationship between dose, drug concentration at the site of action, and drug response. We believe that nanosensing tools developed for diagnostic purposes can be very helpful to these studies.

Nanosensors applied to animal health

Good animal health has a great influence on the productivity around the world. In Brazil this issue is not different. Bovine diseases cause important losses to the economy of our country every year. Traditional laboratory techniques used to isolate, culture, and identify organisms are labour, intensive and expensive, and they require considerable capability and equipment. The indirect enzyme-linked immunosorbent assay (ELISA) is one of these techniques commonly used in serological diagnosis of most of diseases.

Antibodies is first immobilized on a solid surface then are used to capture analyte molecules in solutions. Enzyme labelled antibodies, binding to the captured analyte molecules, quantifies the number of analyte molecules on the surface (Fig. 1). It has been widely used for detection and quantification of biological agents (mainly proteins and peptides) in the biotechnology industry and it has been applied in clinical diagnosis, and food safety and environmental analyses [GIL, 1999]. However, conventional ELISA involves a tedious and labour--intensive protocol that often results in large errors and inconsistent results. The process requires a series of mixing, reaction, incubation and washing steps. It often takes many hours to perform one assay due to the long incubation times for each step. These long incubation times are seemed due to inefficient mass transport of the antigen/antibody from the solution to the surface, whereas the immunoreaction itself is a fast process [KAKUTA, 2006].

The development of methods targeting the direct monitoring of antibody–antigen interactions is particularly attractive. The design of affinity-based probing concepts and label-free assay are the objective of much current research, on the way to establish alternative methods to the already conventional existing [PRODROMIDIS, 2009]. In this context, many researchers have recently geared their efforts towards the development of rapid methods using nanostructured modifications under gold electrodes and impedance measurements. The advent of the technology, named immunosensors, has brought in new and promising approaches. Immunosensors provide an opportunity to gain new insight to create sensitive and simple immunoassay devices in the detection of antigens or antibodies [LAZCA, 2007; LUPPA, 2001; THAVARUNGKUL, 2007]. The immunosensor is now considered as a major development in the immunochemical field.

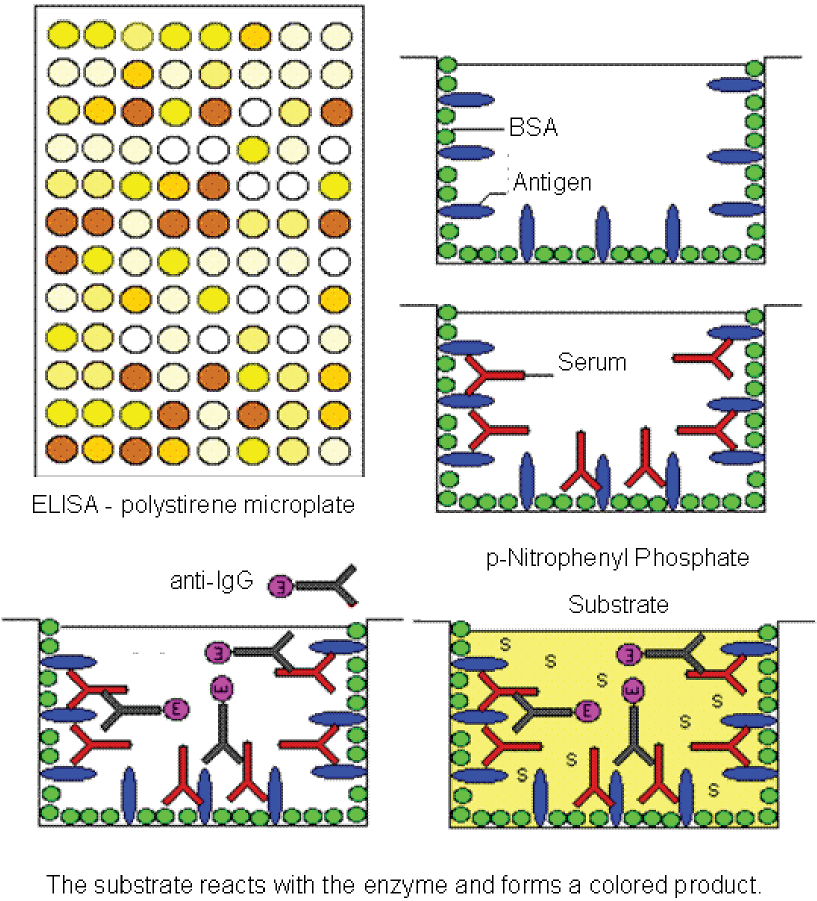

Figure 1. Scheme of Indirect Enzyme-Linked Immunosorbent Assay.

Biosensors or immunosensors, which is named here for detection of pathogens, are devices that take advantage of the high specificity of biological reactions for detecting target analytes, even if there is a very low concentration of the tested material. They couple a biological recognition element (specific to the target analyte) with a physical transducer, a device powered by one system that then supplies power (usually in another form) to a second system, that translates the bio-recognition event into a measurable effect, such as an electrical signal, an optical emission or a mechanical motion [CARRASCOSA et al, 2006].

Summed to this, electroanalysis is taking advantages from all the possibilities offered by nanomaterials with the objective of designing the label-free affinity-based probing concepts. And electrical biosensors or immunosensors have been developed with the characteristics described above but using the same scheme of ELISA method.

Electrical biosensors can be further subdivided according to how the electrical measurement is made, including voltammetric, amperometric/coulometric, and impedance sensors. Voltammetry and amperometry involve measuring the current at an electrode as a function of applied electrode-solution voltage; these approaches are DC or pseudo-DC and intentionally change the electrode conditions. In contrast, impedance biosensors measure the electrical impedance of an interface in AC steady state with constant DC bias conditions. Most often, this is accomplished by imposing a small sinusoidal voltage at a particular frequency and measuring the resulting current; the process can be repeated at different frequencies [DANIELS, 2007]. The current-voltage ratio gives the impedance. This approach, known as electrochemical impedance spectroscopy (EIS), has been used to study a variety of electrochemical phenomena over a wide frequency range [MacDONALD, 1987].

Since pioneering works of Newman (1986) and Bataillard (1988) on the concept of capacitive, or impedimetric based immunosensors, a lot of work has been done in this specific area. During the last decade, impedance spectroscopy has been widely used for probing various types of biomolecular interactions (immunosensors, DNA hybridization, rapid biomolecular screening, cell culture monitoring) and relevant literature has been broadly reviewed [BERGGREN, 2001; DANIELS, 2008; GUAN, 2004; KATZ, 2003; K'OWINO, 2005]. Impedimetric immunosensors could potentially be used for qualitative purposes, such as the detection of protein, DNA and bacteria, pregnancy tests, allergy screening tests, etc.

The simple way to describe an impedance biosensor is if the impedance of the electrode-solution interface changes when the target analyte is captured by the probe (a nanostrutuctured surface prepared to receive a biomolecule), EIS can be used to detect that impedance change. Alternatively, the impedance or capacitance of the interface may be measured at a single frequency. Impedance measurement does not require special reagents and is ready to label-free operation.

When the substance binds with the biological component, the transducer produces a signal proportional to the quantity of the substance. So, if there is a detectable concentration of bacteria, protein or other biomolecule (used as target analyte) in a particular sample (animal serum or food) the biosensor will produce a detectable signal change indicating that the animal is positive for a certain disease or the food is unsafe to eat. This change is related to the formation of the immunocomplex in the electrode interface. Additionaly, new materials such as carbon nanotubes, nanowires, nanofibres, quantum dots and nanoparticles are being explored for their use as nanosensors or to modify surfaces in order to increase surface to volume ratio [JOSEPH, 2009; SHIPWAY, 2000]. Metallic nanoparticles have been used to modify the electrode surface with the aim of impedance signal amplification. With this technology, mass amounts of food or a large number of serums can be readily checked for their safety of consumption or for a better sanitary control.

Nowadays, besides all the development in this field, it still remains two big challenges: build a device that in a direct way is able to analyze very low (picomolar to femtomolar) levels of a great number of chemical and biochemical substances in areas such as environmental monitoring, industrial and food processing, healthcare, biomedical technology, and clinical analysis of human or animal samples. Another one is to build a portable device with low cost.

Conclusions

Electrochemical biosensors have existed for nearly fifty years and seem to possess great potential for the future. Only in the last ten years, with the advances in nanotechnology and nanomaterials science, it has been possible to develop devices with high sensitivity, fast response and low cost as alternative for the conventional immunoassays. This technology gains practical usefulness from a combination of selective biochemical recognition with the high sensitivity of electrochemical detection, due to the addition of nanoparticles in its design. Thanks to current technological progress, such biosensors are going to be very advantageous for some sophisticated applications in addition to the ones had mentioned, portability, rapid measurement and use with a small volume of samples. And under this same progress related to miniaturization, we believe that portable and multiplexed devices will be available and contribute for the agricultural sustainability.

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*** The content of the texts and their spelling-grammar suitability are entirely those of the author.**

20- New Ecological and Epidemiological Situation of Stable Fly (*Stomoxys calcitrans*) in Consequence of Ethanol Productions by Sugarcane Mills in Mato Grosso do Sul State

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Introduction

In the stable fly, *Stomoxys calcitrans* L. (Diptera: Muscidae), is a hematophagous parasite witch attack especially horses and cattle and, in specific situations, can parasitize other mammals, including humans. For cattle direct losses ranging from 10 to 30% reduction in weight gain or even 50% reduction in milk production. The bite of this insect is very painful. Due to the intermittent feeding habit, this fly is also described as an important mechanical vector of several diseases for cattle and horses.

Outbreaks of the stable fly (*S. calcitrans*) have been causing losses to livestock producers located near sugarcane mills in southern Mato Grosso do Sul. The sugarcane mills are often pointed by local producers as the primary source of these outbreaks, some also joined the farmers in combating this scourge. However, the real causes of outbreaks are not clearly known and important aspects of the biology of *S. calcitrans* in this unique agro-ecological system must be investigated. In possession of such information will be possible to develop effective control programs.

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In other regions, like Africa, Australia, Costa Rica and the United States, some by-products of agriculture are known substrates for the development of stable fly´s larvae. Some of these products stand out from the crop of pineapples, vegetables, hay, peanuts and sugarcane. However, the problem occurs when these byproducts of crops are left on the field, accumulated for its decomposition, or when they have wrong management. The obvious solution to the problem would be to adopt correct practices for handling these products, but sometimes this solution depends on technologies not yet known. Even the adoption of recommendations already available may come up against the lack of interest or technical guidance. Therefore, the management practices of some agricultural crops must be reviewed to ensure that their products are removed from the field or have then a more appropriate allocation. Moreover, it is necessary for such management practices, with health purpose, bring benefits to the farmer and for the sugar industry so that its implementation is feasible and occurs effectively by the various actors of the problem.

Specifically, in Brazil, the production of cane sugar is booming due to the great incentives offered to ethanol fuel. The number of plants and the area they occupy systematically grow resulting in progressive increase of by-products generated. At the same time, recent years have been characterized by unusual weather conditions, mainly in central Brazil. In 2008, the state of São Paulo, outbreaks of *S. calcitrans* were described as arising from the use of filter cake and stillage resulting from the processing of sugarcane and used as fertilizers in the fields. In 2009, outbreaks were widely reported by media in the central and southeastern areas of Brazil near the sugarcane mills. However, it is not possible to determine with certainty the source of the problem, mainly due to lack of information on this new agro-ecological situation that now presents itself. Considering the investment policy to stimulate the growth of the biofuels industry must remain, then increases in generation of by-products and potential problems can be expected to grow.

Application of insecticides to control this fly has variable results, have high cost and produce undesirable environmental impact. Another alternative fly control is the burning of by-products which can serve as a substrate for development, but this practice is gradually being reduced by law, and should definitely be banned in next 2 years. The use of traps for adult fly is a measure of monitoring and control used in other countries, but its efficiency depends on the epidemiological and environmental conditions of each region as well as the size of the infested area, should be tested before their large-scale application. Despite the potential success, even partial, of the above measures, the best contribution to the solution of this problem seems to be the identification and elimination of breeding sites of the fly.

In this context, the comprehensive study on the bio-ecology of the fly is extremely important for further development of an "integrated management program for control of fly-stables" and minimizing the damage it causes constitute an important contribution to sustainable growth to the Brazilian`s ethanol industry and livestock.

"State of the Art"

The life cycle of *S. calcitrans*, among other aspects of biology, has been extensively studied. However, the substrates of reproduction of the fly can vary considerably. The scientific literature describes the locations for the development of the flies as rich in organic matter decomposing, fermenting, coupled with high humidity. As classic examples can be cited, uneaten feed and straw beneath the troughs, Restil sugar mills and vinasse / stillage (Marcondes, 2001, Guimaraes et al. 2001; Guimarães, 1983, 1984, Koller et al., 2009). There are also reports of litter or chicken manure, silage and straw fodder as good substrates for oviposition and development of fly larvae (Koller et al., 2009). In other regions of the world's agriculture from various substrates, such as fruit or grain which remains humid, have been described as sites for larval development (Kettle, 1995). Broce et al. (2005), there are reports of outbreaks in the United States when they began the use of hay rolls in cattle feedlots. In the state of Sao Paulo large quantities of larvae have been observed, in the areas where use of filter cake and stillage (by-products resulted from alcohol and sugar production) as fertilizers. The sugarcane straw resulting from mechanical harvesting was also diagnosed as a substrate for breeding of flies, particularly when moistened by the stillage that is applied as fertilizer. These facts led to the conclusion that this fly outbreaks that occurred in União and Planalto Paulista, in São Paulo state, which severely hit cattle and horses, resulted from the use of these products in combination with high rainfall and high temperatures in January and March 2008 (Gomes, 2009; Oda, Arantes, 2009). In the municipality of Resende, RJ, Badini et al. (2003) included the byproducts of beer and distilleries as probable breeding sites of the fly. In the state of Mato Grosso do Sul, until recently, no problems had been reported involving the Stable fly, and this fact alone explains the lack of local research on this parasite. However, in the last two years there were some reports in the regional media and complaints from ranchers about these flies in southern of Mato Grosso do Sul. Technical visits were made since then and larvae of *S. calcitrans* where founded at composting area of filter cake. During the visits, was reported by staff of the mills that the flies were attracted by the stillage, a fact that still must be investigated (Koller et al., 2009).

Although it seems evident the contribution of plants to provide an ideal environment for the development and multiplication of flies in large scale, it is also clear that the climatic and environmental conditions are related. In years when the outbreaks occurred were unusual weather conditions for those periods, which probably contributed to the environmental imbalance and, consequently, the appearance of outbreaks (Koller et al., 2009). Apparently the development of flies is facilitated by increasing the volume of precipitation in early spring (Guimarães, 1984; Bittencourt, 1998; Marcondes, 2001). That is, when high humidity and temperature combine to form favorable conditions, and finding fly oviposition substrate and larval development, outbreaks appear. The few studies on seasonality in Brazil were conducted over short periods (approximately 1 year) or were not specific for *S. calcitrans* (Zimmer et al. 2010; Rodriguez-Batista; Leite, 1997, Mari, 2006). Thus, little information about the seasonality of the fly is available. Some studies show consistent results demonstrating a positive correlation between temperature and humidity on the population increase of *S. calcitrans*, thereby indicating that a greater number of flies are found in spring and early summer. Subsequently the population level remains elevated as long as the rainy season (Kasai, 1990; Bittencourt, Borja, 2000; Rodriguez-Batista et al., 2005). These studies were conducted in south and southeastern Brazil and according to Rodriguez-Batista et al. (2005) the differences between them show that each state (region) of the country possess particular climate that influence the fluctuation of the fly populations. The study of seasonality to the local conditions should generate specific knowledge of the conditions encountered in the development of the fly-stables in Mato Grosso do Sul.

Chemical control of flies can be an indispensable alternative pest when it becomes an important economic problem. However, some factors are limiting the use of systemic insecticides. Today, concern about environmental contamination as opposed to sustainable development argues against the systematic use of pesticides due to obvious environmental contamination resulting from it use (Moraes, 2007; Hogsette, 1999, Bale et al., 2007). In addition, chemical control of *S. calcitrans* directly on cattle is less efficient, due to the short time that the fly remains on the animal and its habit of focusing on the lower animals´ body parts (ventral region and limbs). The cost of chemical control should be a limiting factor, besides the environmental factor, especially in factories and plantations that have large areas to be treated. One of the major problems resulting from the control based on the use of chemicals is the rapid emergence of resistance in the population (Hogsette, 1999, Barros et al., 2007). There are only a few published studies of stable fly resistance to insecticides in literature (Cilek and Greene, 1994; Marcon et al. 1997; Pitzer et al. 2010). Low levels of permethrin resistance were found in several field populations of the stable fly in Florida, and laboratory selections of a stable fly strain established using the field collected flies led to a three-fold increase in resistance level (Pitzer et al. 2010). In the case of *S. calcitrans* in Brazil, the issue of resistance needs to be studied, since the populations of this fly have been exposed to the chemical bases used to control other arthropods such as the horn fly (*Haematobia irritans*). The state of resistance *S. calcitrans* to control Products available in Brazil is still not properly known.

Moreover, in emergency situations and, especially, while other non-chemical alternatives are not available, the use of insecticides can be of great value to quickly reduce the fly population to an acceptable level, minimizing potential economic losses.

Since the use of insecticides should not be the best way to control the fly-the-stables, the strategies turned to other forms of control is of utmost importance. Several authors consider that the best target to attack for effective control of fly-stables, are their breeding sites (Guimarães, 1983; Foil; Hogsett, 1994; Solsby, 1987, Koller et al., 2009). Thus, more studies are needed to determine and characterize these new breeding sites, because of recent changes in stablefly´s ecology and epidemiology created by sugarcane mills combined with climate change and the increase of the creations in feedlots. In other hand, different organisms have been studied for use to controlling flies (biological control), such as the use of parasitoids and entomopathogenic fungi (Malik et al., 2007).

Some work has been performed in Brazil with the objective to search for parasitoids with potential for use in programs of integrated control of flies (Marchiori et al., 2000, 2001, 2007). Parasitoids were found microhymenopterans *Muscidifurax raptor*, *Nasonia vitripennis*; *Pachycrepoideus vindemmiae* and *Spalangia* sp. To Skovgard and Jespersen (1999) using natural enemies, particularly parasitoids, to control *S. calcitrans* and *Musca domestica*, is quite promising. The authors also reported *M. raptor* and *Spalangia cameroni* as the most promising species for use in control strategies in the field (billboards) and indoor (indoors), respectively. Despite successes found in laboratory tests, the practical use of the parasitoids is difficult for three main reasons: a) specimens released leave the place (emigration), b) climatic conditions are not favorable to the parasitoid, and c) the parasitoid species chosen is not well adapted to parasitism of the fly that you want to control (Skovgard; Nachman, 2004). In a study conducted on three farms in Denmark, which was established in the biological control of flies using Spalangia cameroni, the results were satisfactory for the control of Musca domestica and S. calcitrans (Skovgard; Nachman, 2004). Currently, studies involving parasitoids of S. calcitrans in Brazil are scarce and therefore it is necessary to further investigations about it.

Another line of research to be investigated with a view to biological control of the pest in question includes the entomopathogenic fungi. In this context, researchers have studied the use of *Beauveria bassiana* and *Metarhizium anisopliae* for control of fly-stables (Moraes, 2007, Moraes et al. 2010; Mari, 2006, Bernal, 2003). According to Moraes (2007) the fungus *M. anisopliae* has a deleterious effect on the eggs of *S. calcitrans*, but shall be used in biological control of the fly only if the fungus is applied directly over the eggs. Mari in 2010 showed similar results. Moreover *B. bassiana* was found ineffective against the fly-stables. Some factors should be considered to explain the effectiveness of fungi, such as variations of the fungi tested (different strains) and the conditions under which they are tested (Moraes, 2007, Moraes et al., 2010). In this sense, the environmental conditions where the fungus is used are of great importance to its effectiveness in controlling flies, since the fungus requires moist environment and low solar radiation. Considering these factors, research should be conducted to isolate pathogenic strains most of the natural environment, not only capable of infecting the insect to be applied, but also to survive at the application site for a long time, if possible, settling permanently in place. The identification of breeding sites of flies in the mills and other rural properties allow you to carry out searches by entomopathogenic fungi, as well as other natural enemies of these flies. Once determined these sites, management strategies and use of these products will be evaluated and / or suggested to prevent that continue to serve as places suitable for fly development.

The use of traps for the control of *S. calcitrans* has been used successfully in specific situations (Kaufman et al., 2005). Several types or variations / adaptations of traps to catch flies (*M. domestica* and *S. calcitrans*) are commercially available, and most of them employ some type of adhesive to hold the flies (Taylor, Berkebile, 2006). For the capture of *S. calcitrans*, traps that use the colors blue, yellow and black has proved efficient and has the potential to be used to control flies (Mari, 2006) (USDA). In Brazil, these traps have yet to be tested under the environmental conditions of each region and in different situations encountered (plants, crops, feedlots, dairies), so that is proven or not its efficiency.

In Brazil, the Beef Cattle production has great economic importance in similar level to bio-fuel as ethanol. For its sustainable growth specific research concerning the influences around both, cattle and ethanol industries, should be performed.

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21- Sostenibilidad de la Producción de Vacunos en los Andes del Perú

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Introduction

La ganadería vacuna en el Perú es principalmente familiar y está ubicada en la zona altoandina andina entre 3000 a 4000 msnm bajo condiciones en las que no existen muchas otras alternativas de ingreso familiar. Investigación realizada en una zona andina representativa como parte del Proyecto ProPoor initiative de FAO haciendo uso del un análisis bioeconomico de dicho sistema indica que el manejo de pasturas (naturales y cultivadas) es uno de los principales factores que determina su competitividad (García y Gómez, 2006). Además la ia incidencia de pobreza aun es alta en el Perú siendo los pobladores rurales altoandinos los más afectados por dicha situación.

Evidentemente con el cambio climático se presenta un reto adicional principalmente explicado por su efecto sobre la disponibilidad de agua agravando la duración y/o magnitud de la época seca del año. Se estima que la mayor pérdida económica relacionada a ganadería por efecto del cambio climático en los siguientes 10 años estará en los sistemas ganaderos de la zona andina (Gómez y Fernández, 2009).

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Las decisiones de política pública sobre uso de áreas comunales de pastos también tendrán efecto sobre la sostenibilidad de producción de vacunos. Trabajos realizados bajo liderazgo de ETH Zurich han demostrado que variedades de especies forrajeras diferentes a las de uso predominante para secano como las especies anuales Hordeum vulgare L. cv. UNA 80 y Triticosecale Wittm presentaron mayores rendimientos de Materia seca a la fertilización y que Avena Sativa L. presento bajas concentraciones de Fibra detergente neutra y mayor valor de Energía metabolízale (Bartl et al, 2009).

Por otro lado, con el propósito de determinar el efecto de la calidad de dieta y altitud sobre la performance del ganado, vacas Brown Swiss y Criollas adaptadas a la altura fueron mantenidos a 200 y 3600 msnm. Las dietas fueron época seca (DS), época lluviosa (RS) y una óptima (OP). El consumo de MS y la producción de leche corregida por energía se incremento con la calidad de la dieta, este ultimo casi se duplico en ambos genotipos de ganado cuando se cambiaba DS por OP. Esto sugiere que tanto el ganado criollo adaptado como el mejorado ambos responden favorablemente a estimulo nutricional con mayor productividad (Bartl et al, 2008).

Con el propósito de evaluar el impacto económico de dichas alternativas forrajeras se hizo uso de un modelo de programación lineal. Se estimo que la introducción de cebada mejorada para producción de heno aumenta el ingreso bruto en 1257 US$/año para productores que tenían ingresos mayormente de ganadería.

En el Perú el 51% de las emisiones nacionales de metano provienen principalmente de ganado vacuno en Sierra. Muy iniciales consideraciones se tiene ahora sobre estrategias de mitigación de emisiones metano. Parece ser que un mejor manejo ganadero es la propuesta con mayor impacto y viabilidad de implementación.

Es importante entonces estimar la carga ambiental de la producción de leche haciendo uso de métodos más integrales como del análisis de ciclo de vida (LCA). Bartl et al, (2011) reporto comparativo entre el sistema de producción andino a base de pastos naturales suplementado con Rye grass / trébol (2.57 kg leche /vaca/día) vs. sistema de costa a base de forraje de maíz y concentrado (19.54 kg leche / vaca /día). El sistema de sierra produjo más metano (178 vs 31 g / kg leche) mientras que el sistema de costa tuvo mayores salidas en emisiones de dióxido y monóxido de carbono así como metales pesados y pesticidas. Potencial de calentamiento global, la acidificación y la eutrofización eran más altos para producir 1 kg de leche en sierra que en la costa.

El producir innovación y cambio en los sistemas ganaderos requiere también definir factores que afectan la toma de decisiones incluyendo el uso de herramientas para facilitar dicho proceso en el cual las metodologías participativas pueden ser favorables. Bienz (2011) realizo con ganaderos de zona altoandina una evaluación del modelo CLIF desarrollado con soporte de CIRAD (Francia) que parece promisorio para dicho proceso.

Esta presentación revisa las trabajos anteriores en relación a sostenibilidad de la producción de vacunos en la zona altoandina del Perú concluyendo que existen intervenciones que la favorecen como apropiadas labores de extensión y la implementación mayor de pastos mejorados y lo relaciona con estrategias de mitigación de metano.

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22- Stocktaking of Enteric Methane Emissions Produced by Cattle in Cold Climate Livestock Systems in Antioquia, Colombia

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Introduction

One of the problems faced currently by our planet is the global warming due to greenhouse effect caused by the accumulation of heat-trapping gases in the atmosphere (Soliva and Hess, 2007). The greenhouse effect is caused by gases called "greenhouse gases" -GHG of which methane is considered second in importance after carbon dioxide [CO_2] (Wuebbles and Hayhoe, 2002). Atmospheric concentrations of methane have increased by approximately 150% since pre-industrial [Table 1], although recently there has been a slowing down in the growth trends (FAO, 2009).

Methane released into the atmosphere by domestic ruminants is considered one of the three most important sources worldwide (Johnson et al., 2007). It is estimated that domestic ruminants are responsible for 27% of the total emission of anthropogenic methane (Johnson and Johnson, 1995, Khalil, 2000). Given its impact on the environment, methane production by the animal industry is the focus of increasing attention (Chandramoni et al., 2000).

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Table 1. Past and current concentration of important greenhouse gases

Gas	Pre-industrial concentration (año 1750)	Current tropospheric concentrations	Global warming potential
Carbon dioxide (CO_2)	277ppm	382 pmm	1
Methane (CH_4)	600 ppmm	1728 ppmm	23
Nitrous oxide (N_2O)	270-290 ppmm	318 ppmm	296

Fuente: (FAO, 2009).

Methane Emissions Produced by Cattle

The successful adaptation of ruminant to pasture-based systems is mainly due to its ability to digest structural carbohydrates in plants. This function which is performed by the symbiotic microflora present in the reticuloruminal system leaves methane as a byproduct which is driven mostly through belching reflex. It is estimated that 87% of the methane production takes place in the rumen and 13% remaining in the hindgut. Of the latter, approximately 89% is absorbed into the blood and expired through the lungs (McCaughey et al., 1999) which would indicate that about 98% of methane produced by ruminants may be valid for the through the mouth and nostrils.

According to Johnson and Johnson, cattle can produce between 250 to 500 liters of methane per day (Johnson and Johnson, 1995). Other authors reported that cattle produce around 150 to 420 Lt per day while sheep between 25 to 55 liters per day (Czerkawski, 1969, Holter and Young, 1992, McAllister et al., 1996). It is estimated that the formation of methane represents a loss of 7 to 10% of the gross energy consumed by ruminants (Moss and Givens, 1993), depending on the level of feed intake, diet composition and digestibility of dietary energy. According to others reports, the energy loss due to methane production can be of 2% in animals fed diets rich in grains and about 12% in animals fed low quality forages. That energy that is being lost should be channeled to improve the industry productivity and reduce global warming (Johnson et al., 2007). Methane released by enteric fermentation can amount to 86 million tons per year (FAO, 2009). The total amount of anthropogenic methane is estimated at 320 million tons of methane / year (Van Aardenne et al., 2001).

Johnson and Johnson suggest that the two main factors responsible for variations in methane production are: the amount of carbohydrate fermented in the reticulorumen, which involves various diet-animal interactions affecting the balance between the rates of fermentation of these carbohydrates and its passage rate. The other mechanism is the ratio of volatile fatty acids [VFA] produced, which regulates the production of hydrogen and subsequent methane production. The factor of greater impact on methanogenesis is the acetic acid:propionic acid ratio. If this ratio reaches 0.5, energy loss can be 0%. But if all carbohydrates were fermented to acetic and propionic acid did not occur, energy losses could be as high as 33%. Acetic: propionic acid ratio can vary from 0.9 to 4, therefore is expected methane losses vary widely (Johnson and Johnson, 1995).

The characteristics of food fermentation in the rumen can be studied by in vivo methods, *in situ* and *in vitro*. Measuring methane emissions from grazing ruminants, it is quite difficult and extremely costly as it involves the use of highly specialized equipment and materials as is the technique of sulfur hexafluoride [SF6]. Alternatives such as the use of equations, which predict manner not very accurate methane emissions, has not been standardized and validated for the conditions of our country.

Among in vitro techniques, the gas production technique permit quantify the extent and kinetics of food degradation through the volume of gas produced during fermentation process (Theodorou et al., 1994). One advantage of this procedure is that the course of the fermentation and the role of the soluble components of the substrate can be quantified (Pell et al., 1997).

The estimation of emissions of greenhouse gases is mandatory and must be reflected in the National Inventory of Emissions to the atmosphere. To this end, the Intergovernmental Panel on Climate Change (IPCC) issued comprehensive guidelines for estimating methane yields in each country, which consists simply in applying the methane emission factor (IPCC, 2006) to each type of livestock in the country of interest, without differentiating the type of food (concentrates, fodder, grazing or confinement) and according to the national cattle inventory estimate the emissions produced by this activity in every region of the planet. But the IPCC states that the production of methane from ruminant origin is affected by multiple factors, making it necessary to establish guidelines for each country to measure such emissions and to obtain a more precise estimate. It is necessary, therefore, generate information and conduct research on emission inventories and mitigation strategies, especially in tropical regions where the proportion of the loss of carbon from methane is relatively high.

In summary, the production/emission of methane by domestic ruminants represents not only an economic problem but also environmental. However, some important advances, there remains a large gap in information related to the volume of emissions and the effectiveness of mitigation strategies particularly in tropical regions where a high proportion of domestic ruminants are kept (Soliva and Hess, 2007).

In Colombia the potential impact of its livestock in the global warming through methane gas emission is unknown by which measurement of methane emissions is warranted. In order to achieve this aim we propose using dairy cattle farms located in the highland tropics of Colombia as a model to establish the Methane Emissions Inventory based on internationally methodological approach accepted for this purpose, such as gas technique (Theodorou et al., 1994).

The overall objective of this research is to estimate the inventory of enteric methane emissions produced by dairy farms cattle of different regions of Antioquia, Colombia, by using the technique in vitro gas production. The methodology followed will be initiated by sampling forage and supplements in five different altitude areas of the western Andes of Department of Antioquia to which will be determined its chemical characterization (DM, OM, CP, NDF, ADF, ash, and lignin). Additionally, tests such as the extent of ruminal fermentation in vitro using cultures of rumen microorganisms not renewed (CNRMR) of short duration (24 and 48 hours) in which a sample of gas after the concentration is taken for quantifying methane production by gas chromatography will be done. Voluntary intake of forage through agronomic direct method (Lascano, 1990) will also be carried out. Finally, the inventory of methane emissions discriminated by region will be calculated, based on the inventory of cattle by region. The results will be expressed as tons of CH_4 emitted from ruminant enteric fermentation (liters of methane/Kg fermented forage). The study has as main objective tests and suggests a model to estimate the inventory of enteric methane produced by cattle of the dairy farms located in the highland tropics of Colombia.

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23- Strategies for Sheep Meat Production in the Central Region of Brazil

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Introduction

The central region of Brazil has shown significant agricultural development since the 1980s. The Brazilian savannas, known as the “Cerrado”, comprise the second largest biome found in Brazil. Over 80 million heads of cattle are raised in the Cerrado. Although present on many farms that exploit livestock, the raising of small ruminants suffers from lack of technology based on scientific evidence to support farmers in the decision to initiate sheep production on a commercial scale. Breed, pasture, number of ewes and area required to obtain profitable results are among the major questions. A few favorable conditions support the development of the sheep industry in the Brazilian Midwest: the current location for raising livestock.

First of all, it is possible to raise both cattle and sheep in similar farming conditions. While the beef market is consolidated and its exports expand, lamb could fill any eventual gap in the internal market, serving customers eager for new tastes. Sheep farming can be more efficient due to the shorter production cycle (gestation period of five months, lambing interval of eight months; lambs ready for slaughter within 90-100 days),

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high incidence of twin pregnancies, increased beef production per area, among other advantages. Another relevant factor is the advance of sugar cane culture in pastures, which will reduce the space for extensive livestock production, requiring smaller modules with efficient and good agricultural practices. The limited opening of new agricultural areas, imposed by social, economic and environmental conditions, will require new models of production systems. Such restrictions will promote the adoption of integrated crop-livestock-forest systems which improve soil conditions, generate benefits such as pastures with higher nutritional value, respond to demands of better food quality and enhance profit margins by increasing the efficiency of land use.Many alternative technologies for handling and management are available to producers who want to explore the sheep business. The main factor between different systems is the period of the year in which the mating and lambing will occur, as well as the herd managing procedures adopted in each one.

Positive results are obtained when the ewe has a good field performance and individual quality of lambs is verified, resulting in a higher number of lambs born and weaned, finished for slaughter as early as possible, with a low production cost. Nevertheless, technical viability is undoubtedly essential for planning the activity.

Management AspectsSheep may be submitted to different production systems and a few management aspects must be controlled during implementation, such as:

Forage availability – farm planning is necessary for maximum utilization of available forage, since feeding with grains usually comprises 50-60% of the total cost of lamb meat production. Food consumption is higher during late pregnancy and early lactation. The farmer must be able to reduce these costs by handling sheep in pastures as much as possible throughout the year.

Manpower available – sheep industry associated with other economic activities is desirable from the standpoint of management, concentrating the breeding season when manpower is not required.

Lamb price – fluctuation occurs normaly throughout the year, therefore, it could be more profitable to produce lambs during the market increase, which often occurs in late spring and early summer, at the end of the year, during the holydays.

Herd size – small flocks of ten to fifty sheep are generally not profitable because they tend to be handled incorrectly. The main reason is that there is no work machinery, so the financial results per hours worked is not maximized. On very small properties, animals are raised for subsistence matters. There is no minimum herd size, however, sales must cover fixed costs (manpower, taxes, depreciation of infrastructure, etc.) and variable expenses (mineral salt, maintenance of pastures, supplementation, etc.) and generate profit.Choice of appropriate breed for the region – the farmer must have an eye for business when choosing the appropriate breed and its production characteristics, the demand for which is determined by the regional market. Local climate characteristics (temperature extremes, rainfall, mean annual temperature) must also be taken into account.

Constraints Imposed by Animal Nutrition and Health

In tropical regions such as in Central Brazil, gastrointestinal nematode infections have been identified as the biggest problem for the lamb industry. Indeed, if environmental conditions favor pasture production, it will equally favor high infestation rates by infective gastrointestinal nematodes in pastures. In this challenging environment, lambs greatly suffer from infections, reaching high mortality rates and low body weight gain. Furthermore, inappropriate and frequent use of antihelmintics have led to parasite resistance to almost all s. Understanding the nutritional requirements of sheep and cycle pasture production, forage availability can be adjusted (SILVA SOBRINHO, 2007).Nevertheless, the availability of forage to the pregnant ewe and finishing lamb are coincident with the decline in quantity and quality of the pasture. One feature of the climate in Central Brazil is the existence of a dry period during five/six months of the year. Without adjusting forage production by irrigation, fodder conservation, integrated crop-livestock-forest systems and pasture supplementation, it would be difficult to meet the nutrition requirements of both categories in a grazing system based exclusively on pastures.

Caring for the Ewe

Flushing

Reproductive efficiency depends largely on proper nutrition before and during the breeding season. Well-nourished pregnant ewes tend to increase prolificacy, which could be expressed as a larger number of pregnant females, more multiple births, greater lamb birth weight and, consequently, lower mortality at birth and weaniing (SORMUNEN-CRISTIAN; JUAHIAINEN, 2001; MORI et al., 2006), although inconsistent results are found in relation to finishing lambs (SORMUNEN-CRISTIAN; JUAHIAINEN, 2002; ZUNDT et al., 2006). Results show that pregnancy rate is related to ovulation rate, conception and embryo mortality (GUNN et al., 1984).

Using nutritional flushing in wool sheep, Mori et al. (2006) did not observe higher lambing or twin pregnancy rates, however, authors used low nutrient levels in relation to body weight (around 1%). Older ewes were more prolific, with birth rates of 1.22 (8 teeth) when compared to those with six teeth (0.96). Using 270g/head/day of soybean meal in nutritional flushing of Sarda ewes, Molle et al. (1995) obtained higher ovulation and prolificacy rates when compared to controls. Fertility (expressed as the number of lambs born per ewe, after 34 days exposure with intact males) was also higher for nutritional flushing in mid-pregancy, followed by long duration- , short duration-flushing and control.

Flushing can be achieved by placing females with body condition score >3 in pastures of high nutritional value, sown (e.g. millet) or managed (nitrogen fertilization, high presence of leaves) for this purpose or by providing an additional energy source composed of 350 to 450 g corn grain/head/day.

Supplementation with a High-protein Diet

According to Macedo et al. (2000), parasitism is undoubtedly the largest challenge to beef and lamb production in countries situated in tropical climates, mainly because lamb and ewe share the same grazing paddock even after the weaning period. In this system, the phenomenon known as “peripartum”, which consists of an increased number of gastrointestinal nematode eggs shed in the faeces by ewes in late pregnancy and lactation. This phenomenon is the greatest cause of low performance and high mortality within 45-75 day old lambs, when lambs consume a significant amount of pasture and parasite eggs are eliminated by the ewes (OTTO et al., 1994). Parasite control is extremely difficult in this case (OTTO et al., 1997), which most commonly occurs when the flock has a limited grazing area.Worms decrease animal productivity by reducing intake, digestibility and the absorption of ingested nutrients (COOP; KYRIAZAKIS, 2001). Disturbances in protein metabolism and reduced absorption of minerals, especially phosphorus, are significant. The magnitude of these effects is influenced by the size of the worm burden and helminth species present in the host gastrointestinal tract (VAN HOUTERT; SYKES, 1996). Regulatory functions of immunity towards parasite populations are influenced by host nutrition since they have lower priority in the allocation of resources when compared to maintenance functions such as growth and reproduction. Therefore, a nutrient increase could provide an increase in host tolerance to the parasitic load (COOP; KYRIAZAKIS, 2001).

The ability to acquire immunity and express resistance or tolerance to nematodes is genetically inherited and is variable between and within breeds. The different performances between resistant and susceptible/tolerant individuals is also influenced by intensity and frequency of animal exposure to parasites as well as diet quality, especially protein (AMARANTE , 2004).

Several studies on the interplay between nutrition and parasitism have been published (VAN HOUTERT; SYKES, 1996; COOPS ;

KYRIAZAKIS 1999; COOP; KYRIAZAKIS, 2001). Nutrition can influence development and parasitism in different ways, increasing the ability of the host in mitigating the adverse consequences of parasitism (tolerance) or increased resistance, limiting the establishment, fecundity and persistence of the parasite in the host population (COOP ; KYRIAZAKIS, 2001).

These studies have demonstrated that extra supply of food, especially protein, increases resistance and allows the animal to recover the productive performance.

Kahn et al. (2003) evaluated the effect of protein supplementation at the peripartum in Merino ewes resistent to nematodes and an unselected strain, both maintained on pasture. Both groups showed an increase in EPG peripartum, but in the resistant ewes, the EPG was significantly lower than in unselected ewes, during the experimental period. Protein supplement decreased EPG pre-lambing, however, the benefit from supplementation was greater in unselected ewes. Lambs from selected ewes were heavier at birth ($P < 0.04$) than resistant ewes, but lighter than lambs from resistant ewes at weaning. Authors concluded that both genetic selection and high protein supplementation are effective strategies to increase the resistance to nematode infection during the peripartum.

Mixed Sheep-Cattle Grazing

Mixed grazing with sheep and cattle might optimize the use of forage resources based on differences in grazing behavior between these ruminants, as verified in native pastures (NOLAN; CONNOLLY, 1977; ARAÚJO FILHO; CRISPIM, 2002). Mixed grazing can be done simultaneously or in successive periods, depending on the objectives, management, and the species involved. According to Carvalho et al. (2005), mixed grazing also improves the use of forage.

Thus, two basic principles govern the integration between beef cattle and sheep: the complementarity of these species when grazing simultaneously and lower infestation due to intake of species-specific helminth larvae. This advantage diminishes when the pasture is composed of a smaller number of forage species because the possibility of choice reduces, and when bovine/ovine proportion is not ideal because competition for the fodder is stimulated. The more efficient utilization of forage occurs when using the proportion of five sheep for each cattle per hectare (CARVALHO et al. 2005).

Integrated grazing has provided a 24% increase in meat production when compared to exclusive cattle production, and 9% for sheep only (REIS, 2011). pasture decontamination reduced endoparasite infestation in both species. This occurred because the most common gastrointestinal nematodes are species-specific (BIANCHIN; CATTO, 2008) and because L3 larvae are located in the lower profile of the pasture (POLI et al., 2008).

Rotational grazing is another good strategy from an agronomic and livestock standpoint because it allows the optimization of forage use in grazing areas and mantains herd sanitary control. Thus, the concomitant use of rotational grazing with sheep and cattle is a more effective tool in controlling verminosis as compared with exclusive sheep grazing. Sheep grazing is usually recommended after cattle, with periods of occupation ranging from one to five days, depending on the number of available paddocks and, at least, a 30 day resting period for the regrowth of grasses.

Fernandes et al. (2004) found a decrease in the frequency of antihelmintic application in ewes throughout the year through mixed sheep--cattle grazing. According to authors, of the 115 doses administered during the year, only 38 were applied to ewes in the sheep-cattle grazing treatment and 77 in the treatment without cattle. This result demonstrates that integration systems can be an important tool in the prevention of gastrointestinal helminths, mainly in sheep, avoiding the massive use of anthelmintics.

Caring for the Lamb

Changing Husbandry Practices

The diseases caused by infestation with gastrointestinal nematodes are closely related with the birth and weaning months or seasons throughout the year. Until puberty, animals are highly susceptible to worms. Age and nutritional status, as well as the alternatives of grazing management, will interfere in the degree of immune defense.

When breeds with successive estrus cycles throughout the year are used in husbandry systems, an advance of the breeding season is made possible so that lambs are born during the dry season. This strategy is recommended when stored forage is sufficient for the entire period. The native genetic group present in Central Brazil denominated Pantaneiro, presents this reproductive characteristic, among others.

Studies have been carried out using the Pantaneiro sheep in Central Brazil environmental conditions (COSTA; GONZALEZ, 2011). Management practices are based on the advance in the breeding season, in which sheep kept at pasture, with synchronized estrus, are placed with rams in November. In this case, forage produced in abundance during the rainy season is used, peripartum occurrs early in the dry season and supplementation can be carried out if the available forage is not sufficient to maintain body condition. Births occur in April while weaning occurrs in June (80-85 days) with lambs weighting 18-20 kg. Lambs are finished in different systems. Thus, lambs that are more susceptible to worms are born a period which is adverse for L3 larvae and grow up in the fall. During this season, temperatures are high enough to keep lambs warm and lactation provides adequate nutrition. Diets rich in nutrients allow lambs to be finished in five months at 28-30 kg. Some alternative finishing systems are described below.

Feedlot

Feedlot provides advantages to the farmer and is an alternative when the meat produced reaches a high market value because of its dual purpose in contolling worms and increasing weight gain.

Catto et al. (2011) compared two lamb finishing strategies in late autumn which included feedlot and supplemented animals maintained at pasture. Using the latter finishing system, animals did not reach the level of infestation of up to 500 EPG, eliminating use of vermifuges, bringing economic advantages to farmers and providing food safety to consumers.

Rearing and fattening of lambs under field conditions faces technological difficulties such as the use of lower nutritional value forage (Brachiaria spp) and the occurrence of photosensitization. It is common thought among sheep farmers that, in the feedlot system, food (concentrated and stored forage) increases costs. However, Otto et al. (1997) made a profit of R$ 236.10 for lambs finishing in pasture (1.0 ha), and R$ 1,435.50 for feedlot lambs fed with corn silage in areas of equal size.

Creep-Feeding

The practice of supplementation is used both in an attempt to supply the nutritional deficiencies of pasture and to provide a balanced diet to animals. Various possibilities for use of supplements may be applied in lamb rearing, since early slaughter age is reached, leading to reduced consumption of forage. Creep feeding is a strategy of food supplementation provided during growth phases, whose main objective is to wean heavier lambs and improve the body condition of primiparous females and thin ewes, so that they reach the end of lactation in a better condition. It is a practice used with concentrated feed, vitamin and mineral supplements, reducing the stress resulting from weaning, because this system partly replaces milk with forage. Moreover, the supplement administered in creep feeding increases the availability of forage for ewes.

Weight gain can be estimated to increase in 10 to 20%, according to Neiva et al. (2004). Testing four systems for lamb production, Bernardi et al. (2005) showed that animals supplemented through creep feeding and a confined system reached a slaughter weight of 28 to 32 kg in 84 days, which was higher than systems supplemented with mineral salt only and mineral salt plus protein. Lambs performed 290-310 g/day on average for the first two treatments and 250 -270 g/day for the last two treatments.

Integrated Crop Livestock Systems

Forages produced in integrated crop-livestock systems (ICLS) usually have higher nutritional value, due to improved soil fertility, thereby improving nutrition of lambs, which have high demand for food. The system is based on consortiums between crop and pasture seeding together. The grain is harvested in summer and remaining pasture is used for grazing animals in fall. This pasture is used until spring, when grazing animals are removed and the residue is used as straw for no--till cropping of soybean, corn, sorghum or cotton.

In areas of crop rotation, various options for lamb finishing systems are possible. In the case of Central Brazil, pastures formed in March following soybean harvests, provide proper nutrition to the pregnant ewes in the final third of gestation and during lactation. Thus, ewes mated in October/November give birth in March/April in favorable nutritional conditions in pastures formed in ICL systems. Areas cultivated in late summer with corn/Brachiaria or sorghum/Brachiaria intercropping can be used for the weaning of lambs in June-July, following the harvest of corn or sorghum. These lambs would be finished by mid-September, freeing this area for growing crops or for the reproduction season in spring.

In regard to ICLS, additional health aspects exist, favoring lamb termination. Lambs in these systems present low gastrointestinal infestations, since the pasture remains grazing-free for long periods (6-8 months), thus reducing worms. Lower termination costs are expected when compared to feedlot, offering technological alternatives for sheep expansion in Central Brazil.

ICLS diversifies agribusiness activities and provides certainty for investment, the price of grain suffers larger variations than that of sheep, allowing the farmer to decrease cropping risks. These systems have other advantages, such as intensification of sheep production through the renewal of degraded pasture, which leads to higher stocking rate during part of the year, thereby augmenting productivity indexes (SALTON; KICHEL, 1996), increasing soil fertilization, maintaining soil moisture, producing pastures of higher nutritional value, and providing crop and pasture residues that increase soil organic matter.

Research with sheep/grain systems it Central Brazil is scarce despite significant continued growth in sheep herd over the last two decades. Given the above, it appears that some alternative techniques for the production of lamb meat have been designed, which can now be improved with special attention to studies on the economic viability, allowing the farmer to make choices in an objective manner.

Concluding Remarks

There is great potential in the growth of sheep husbandry in the central region of Brazil, considering the possibilities for maintaining both meat and crop production together along with the presence of skilled technicians. Profitable sheep farming in the region will require specific technological solutions for sheep production in a tropical climate, especially in regard to nutrition-based tropical forages. Research seeking to overcome technological barriers “inside the farm gate” must be incremented. The development of techniques involving integrated systems aiming at efficient husbandry on pastures and crop-livestock-forest systems, the use of industrial crossbreeding for finishing lambs, improving forages with higher nutritional value and animal breeds adapted to tropical conditions are indispensable tools for raising the competitiveness of sheep and offering attractive alternatives to farmers, making the sheep industry a more profitable and professional activity.

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*** The content of the texts and their spelling-grammar suitability are entirely those of the author.**

24- Sustainability Indicators: The Case of the Pantanal

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Introduction

The Pantanal wetland is located in central western Brazil (80%) extending into part of Bolivia and Paraguay. It is a large sandy depression periodically inundated predominantly local rainwater in the eastern part and by the rivers overflow in the middle and western regions, with temporal and spatial variability of its inundated areas, generating an extensive aquatic-terrestrial transitional area, carrying on a biodiversity controlled by the pulse regime (Junk et al., 1989; Neiff et al.,2000). Its economy is based mainly on cattle ranching, fishing and lately ecotourism, with cattle ranches comprehending about 95% of the region. Thus, one of the main challenges to maintain the good level of the ecosystem conservation is to produce beef cattle in a sustainable manner to avoid substantial environmental impacts as well as to develop adequate livestock management practices associated with marketing strategies to aggregate values to beef products from Pantanal (Santos et al., 2011). According to Peden et al. (2007), to achieve a sustainable livestock it is necessary to improve watering and grazing practices to avoid degradation of land and water resources.

[1] Embrapa Pantanal.

Sustainability has become a slippery word (North and Hewes, 2010). Concepts of sustainability vary widely according to interests, sometimes used only in one-way sense, i.e. economic. Considering that sustainability is defined as the ability of a system to continue or to maintain its productivity when subject to disturbance along the time, measures of resilience and sensitivity is adequate in agroecosystem analysis (Smith and McDonald, 1998). According to Rafaelli et al. (2005), ecosystem sustainability should reflect an ecosystem's capacity for renewal in the face of disturbance, i.e. stability or resilience. Although the resilience concept is often applied for ecosystem, this concept also is applied to social and economic aspects. Adger (2000) define social resilience as the ability of groups or communities to cope with external stresses and disturbances as a result of social, political and environmental changes, while Briguglio et al. (2006) define economical resilience as the ability to recover from or adjust to the negative impacts of external economic shocks. However, socio-economic resilience can be linked to ecological resilience (Adger, 2000). The resilience concept has been widely debated. In this work, we consider resilience as an ongoing process rather than a recovery to a (pre-existing or new) stable equilibrium state, including the adaptability concept that focuses on the adaptive cycle model from Panarchy Theory (Simmie and Martin, 2009). However, it is difficult to identify a single measure of resilience and sensitivity encompassing all dimensions (Smith and McDonald, 1998) to evaluate sustainability.

Sustainability is a multi-dimensional (ecological, economic and socio--cultural) and multi-scale concept (micro, meso and macro) (Smith and Smithers, 1993). In the Pantanal wetland, livestock production is an essential economic aspect at the ranch level (income) and an important economic and social sector at the regional and national level (food sufficiency). For the Pantanal, the ranch has been adopted as the basic management unit, which interacts with different scales (Santos et al., 2008; Bryant and Johnson, 1992).

The Pantanal have a complex landscape providing multiple material and immaterial goods. According to Wiggering et al. (2006) these landscapes can be defined as multifunctional landscape with two groups of outputs: commodity output (CO) and non-commodity (NCO) output. In the Pantanal, ranches' commodity outputs involve mainly calves' production while non-commodity involve environmental services such as water provision, fishery, climate and floods regulation, biodiversity, cultural and social identity (Figure 1).

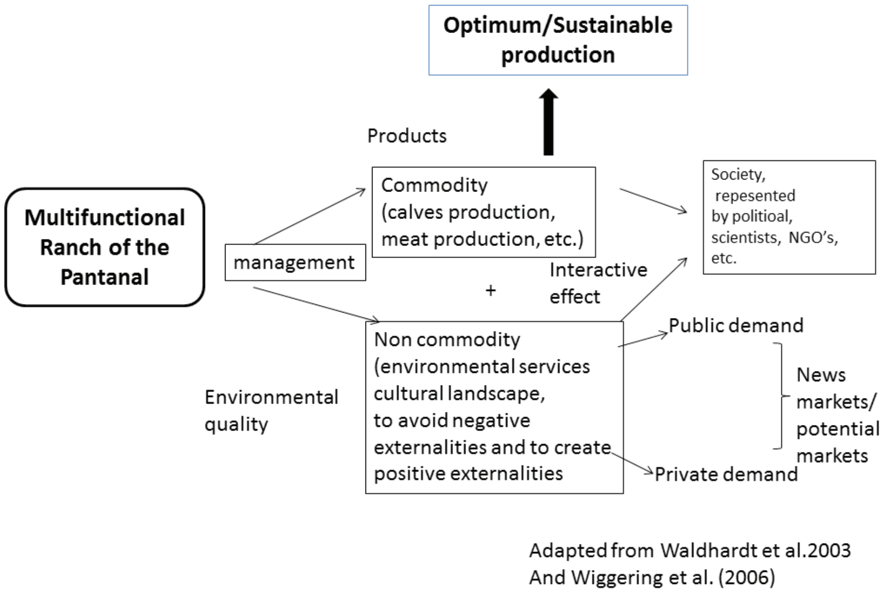

Figure 1. Diagram model to illustrate a multifunctional/sustainable ranch of the Pantanal

However, in general, there is scarce knowledge on quantifying the capacity of ecosystems and landscapes to provide goods and services whose supply depends on ecosystem healthy, functioning and scale. Thus, it is important to define indicators describing how much of the service/goods can be potentially used in a sustainable way (Groot et al., 2010). The same can be stated about scientific information of Pantanal floodplain ecological functioning, as well as indicators of the impact of the livestock management practices on sustainability (Santos et al., 2011).

Due to the complexity of the system it is necessary to develop tools to evaluate and monitor the sustainability of different ecosystems of the region in a holistic manner (Santos et al., 2011). The sustainability of a production system may depend on both impacts resulting from the system itself and the impacts of factors external to it (Cornforth, 1999). Rigby et al. (2001) constructed indicators to evaluate the sustainability in farm level using `inputs` instead impacts. However, impact evaluation is more desirable but requests monitoring tools. Another interesting measure is "eco-efficiency" which measure how efficiently the ecosystems services are being used. For that, research should be developed to subsidy polices to improve natural resource use efficiency, such as support for resource efficiency, eco-tax reform, sustainable practices initiatives and others (UNESCAP, 2008). However, there are necessity of evaluation and monitoring tools as data envelopment analysis-DEA (Zhou et al., 2008).

In the literature there is a number of sustainability assessment methods and tools based in indicators (Rigby et al., 2001; Icaga, 2007; Lermontov et al. 2009; Calheiros et al., 2011), being considered the most suitable methods (Smith and McDonald, 1998). The use of sustainability indicators quantifies and simplifies a set of complex systems, making it accessible to all users and helping the decision-makers understand complex systems (Reed et al., 2004; Jia and Wang, 2009). However, these indicators are currently in phase of definition and selection.

The selection of sustainability indicators depends on the objectives either the evaluation of the potential effect of land management or the past effects of land management. Frameworks for assessing the sustainability serve to integrate indicators in a meaningful way such as the International Framework for Evaluating Sustainable Land Management (FESLM), a reactive tool that focuses on sustainability of existing land management and land uses (Smith and McDonald, 1998). On the other hand, Meadows (1998) suggested the approach of Daly (1973) summarized by Daly's diagram where the base of a triangle is the natural capital supporting the entire planet. Natural capital is studied and converted in technologies (intermediate means) that define the productive capacity of the economy. The intermediate ends are the goals of the governments and economies. The ultimate end at the top of the triangle is the well-being of people. Conversely, the capitalist world is more concerned in generate indicators from the middle of the pyramid; although, sustainable development should focus on the bottom and the top of it, respectively the health of the nature and the well-being of the people. For this, the integration of the triangle from bottom to top requires science, education, ethics and efficient political and economic systems that can be measured and integrate real human welfare, environmental integrity and the ratio between the two.

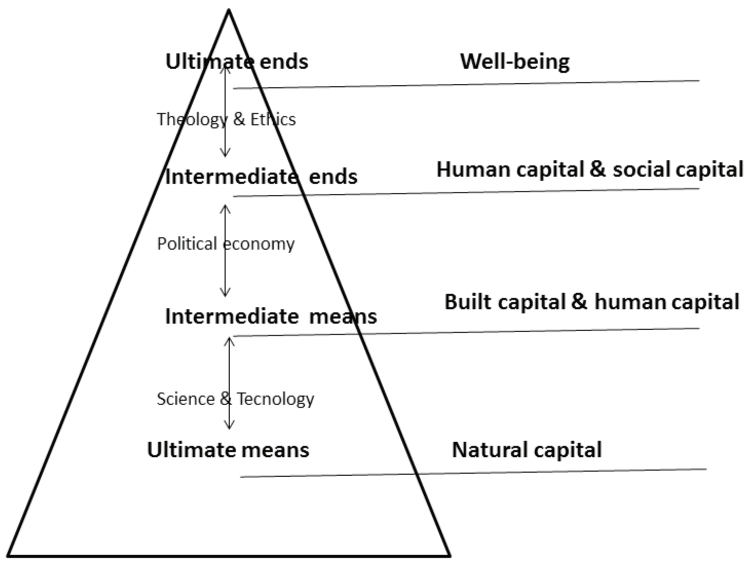

Figure 2. Daly's diagram adapted from Meadows (1998).

Framework for Assessing the Sustainability of Pantanal's Ranches Using Indicators

Grounded in the above approach, a framework for assessing the sustainability of Pantanal's ranches has been proposed, and named "Fazenda Pantaneira Sustentável" (FPS) or "Sustainable Pantanal Farm" - SPF.

For the development of this tool the following assumptions were considered:

• The design and management of ranches in the Pantanal are complex and therefore require a multi-disciplinary and holistic approach;

• Evaluation of ranches require a combination of quantitative indicators and qualitative assessments;

• Evaluation can increase the interaction between the decision-makers and scientific information and, therefore, improve the quality of policy making in the context of the conservation of the Pantanal;

• Over time, with alternating of politicians and responsible for administrative agencies, that means different point of views from decision-makers, as well the possible adoption of new management practices by the farmers create the necessity of adaptation due to the uncertainty about proposed indicators. Thus this tool must be dynamic i.e. the process should be interactive and continuous. Besides that, with the advance of scientific knowledge new indicators may be developed.

According to Meadows (1998), the models and indicators will always be incomplete, but the important is begin and the task is reduce the uncertainly along time. Thus the SPF is an adaptive management tool aimed to construct a system of indicators which can be used to monitor and evaluate the impact of the livestock managing practices on sustainability of each ranch unit and to design or define management practices compatible with the sustainability goals and improvement of ranch performance, overlooking the conservation of Pantanal ecosystem as a whole.

Attributes, Indicators and Thresholds

Firstly, the main attributes and aspects related to livestock in the Pantanal were defined by researcher's multi-disciplinary team:

1) Pasture productivity and quality conservation;

2) Landscape and biodiversity conservation at different scales;

3) Water resources;

4) Livestock management;

5) Economic viability;

6) Social suitable standards;

7) Property suitability for livestock ranching (evaluate separately).

Each of these eight attribute index, formed by a set of indicators, was defined based on detailed literature review, field studies and experts opinion. Establishing which indicators fit better and in a practical way as well the respective thresholds for each indicator has been one challenging task. Several approaches were used to estimate thresholds for each indicator. In some situations, due to a lack of consistent studies on some aspects, a proxy indicator was adopted.

The process of selection and validation of indicators has been performed by 3S methodology (self-validation, scientific validation and social validation) described by Cloquell-Ballester et al. (2006).

Fuzzy methodology

Then, fuzzy logic methodology was used to aggregate the indicators based on rule-setting process. This technique enables modeling uncertainty aligning with the holistic nature of sustainability that is nebulous (Phillis and Andriantiatsaholiniaina, 2001).

Fuzzy System is a framework based on the concept of fuzzy set theory (FS) proposed by Zadeh (1965), as an extension of the classical set theory, where each element of a class have degrees of membership, within the interval (0,1). Thus, the same element can belong to more than one class where boundary-class relationships are based on overlaps between region boundaries.

Moreover, much of the knowledge on sustainability and its indicators is not categorized, being derived from producer experience and experts in each work field. Fuzzy modelling also facilitates the mathematical formalization through linguistic parameters, which give rise to rule-based and knowledge-based systems. The modelling adopted in the SPF was proposed by Mamdani (1976), which propose a fuzzy inference system (FIS) for decision making represented by IF “A” THEN “B” linguistic rules expressed through FS.

Mamdani’s fuzzy inference method can be decomposed in three stages. In the first stage, each variable of the model receives a crisp input that is then converted in linguistic variable (fuzzy field). In the second stage, linguistic variables are applied in each rule resulting in implication values for each rule. Finally, in the third stage, each implied value is aggregated and generated a crisp output, processes called defuzzification.

Fuzzy models were developed to make up the SPF framework aggregating indicators by attribute and dimension. For each indicator it was defined a FS (linguistic terms, i.e. Missing, Low, Moderate, High), and for each attribute and dimension, a rule-base relating indicators to sustainability. Each model has as output variable a sub index. Theses sub indices are aggregated by bottom-up approach to generate a final index of ranch's sustainability.

An inference system was constructed in the Internet (Lima et al., 2011). The user or decision maker can view and execute each model, where each indicator has its respective protocol. This system also permits to view the indicators by radars graphs (Figure 3). In each attribute or dimension is possible to identify unfavorable and favorable aspects (impact) as well as to recommend sustainable farming practices to correct unfavorable aspects.

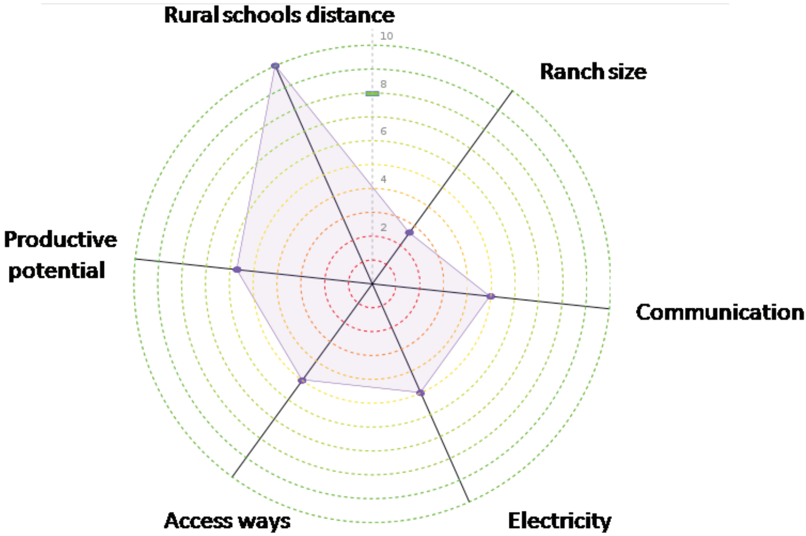

Figure 3. Example of output chart generated by SPF framework showing the indicators of the attribute: property suitability for livestock ranching.

Emergy Analysis

In addition, sustainability evaluation by emergetic analysis is also interesting in the Pantanal wetland, because what is known about the parts of a process from agroecosystem unity, for instance, can be combined in a synthetic way, by means of representation based on simplified models and diagrams (Odum, 1995, Ortega, 2006).

The emergy methodology is an important tool to evaluate the sustainability of many kinds of agricultural system and livestock. The final result of an emergy evaluation is a set of indicators. This methodology was applied in traditional farming located at Pantanal. System's diagram of the livestock production system to region was constructed. The main emergy flows are renewable sources, non-renewable sources and inputs from the economy as purchased goods and services. The goal was to evaluate the sustainability and show the importance of the presence of cattle to maintain the equilibrium of the ecosystem. The results showed that livestock management uses a very large proportion of renewable resources, thus, the emergy evaluation found the use of approximately 98% of renewable energy. Cattle has the important function of controlling the fires on the region and thus it preserves the local fauna and flora which was valued by the emergy methodology at $ 441,38 per hectare of preserved landscape. Even using a large portion of renewable resources and preserving the environment, the costs for maintaining this system is very expensive, mainly due to issues of logistics. Thus, alternatives must be discussed, such as designing seals of certified quality and environmental preservation to add value to beef products, encouraging the continuation of the traditional livestock in the region and hence the ecological balance (Takahashi et al., 2009).

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