Supply chain approach to sustainable beef production from a Brazilian perspective

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Abstract

In spite of becoming an important player on the international beef market recently, Brazil will have to be prepared for an increase in global competition, in overseas market subsidies and expansion of technical barriers in order to consolidate its position. Thus, the various sectors, which form the beef, supply chain need to be more efficient and exhibit greater competitiveness. Under these circumstances, the use of technology becomes one of the most important factors in overcoming such barriers. However, even though technology might be the solution, success is highly dependent on its effective utilization. Thus, it is necessary to adapt the development and use of such technologies to the consumer needs and acceptance level. In this context, the effective introduction of Brazilian beef into the world economy and increased beef consumption by the internal market in the next decade will depend on the ability of production systems and other sectors of the beef supply chain to provide healthy products, to utilize non-renewable sources in a sustainable manner, to assure people’s welfare, to increase its share of the internal market, and to contribute to better social equity. The quality of the final product will also be an important asset and, in this respect, it should be pointed out that the use of meat products with potentially harmful residues would suffer intensive restriction. Additionally, it will become increasingly necessary for production systems to be structured for lower environmental risk. These trends should grow and rapidly encompass the whole beef and hide productive chains. Under this new scenario, a holistic approach should dominate the beef agribusiness, especially, the production systems which will be structured in a sustainable basis.

It is important to mention that eventually the proposed production system could be transformed in an organic one. However, in order to apply this approach in organic farming, one should address the conversion carefully, moving forward step by step. During the adaptation process, it is crucial to dedicate a sufficient effort training personnel and establish a new way of producing beef. Preference should be given to areas in which climate conditions provide an environment requiring few adaptations.

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1. Introduction

Beef production in tropical and subtropical areas is potentially competitive in the world beef market. It might play an important role on this sector; mainly if
barriers, which decrease their competitiveness, can be overcome by the beef supply chains on these areas. One of the most important general constraints is the lack of ability to provide good quality beef year round, based on sustainable beef production systems. Part of this problem is a result of the rain pattern, especially on subtropical areas. On the one hand, the predominant climatic conditions result in a lack of forage (quality and quantity) during the dry period. While on the other hand, it allows for the establishment of productive beef systems based on grazed pastures even though feed supplementation during the dry season is necessary. Such conditions are a tremendous advantage for competing in markets where natural foods are in high demand mainly because it assures animal welfare and is in harmony with the environment.

However, it is necessary to organize and to align all segments of the beef supply chain towards common objectives and goals. The most important goal should be to offer high-quality food for the consumers. The food supply chains based on agricultural products have received a lot of attention lately and are responsible for the extraordinary position occupied by agribusiness in the Brazilian economy over the past 2 years. This is a result of a positive commercial balance registered in the country as a consequence of the significant performance by the agricultural and agro-industrial sectors. However, the Brazilian position is not consolidated on the world scene. For that to happen, an improvement in the performance of several sectors needs to be promoted, especially those sectors, which form the supply chains, based on animal production and animal products. This need is reinforced by reactions in other countries and which have as a consequence the strengthening of competition for international markets, an increasing of subsidies and expansion of technical barriers. Thus, the various supply segments need to become more efficient and exhibit greater competitiveness. Under such circumstances, the use of technology becomes one of the most important factors for overcoming such barriers. However, even though technology might be the solution, success is highly dependent on its effective utilization. Thus, it is necessary to adjust the development and use of such technologies to the consumers’ need and to their acceptance level.

In this context, recent progress in the area of functional genome and the development of so-called genetic modified organisms deserves to be mentioned since they are responsible for increased awareness in relation to food and health safety. Such discussions have included the participation of an increasing number of different segments of society worldwide and have been of fundamental importance for strengthening the growing trend among consumers for food, which besides offering good nutritional qualities, must be free of any residue, contamination or agents that can cause disease or health problems. Furthermore, they need to be produced in sustainable food chains that also respect animal welfare.

Thus, the effective introduction of Brazilian beef onto world economy and the increase of beef consumption by the internal market, over the next decade will depend on the ability of the production systems and other segments of the beef supply chain to provide a healthy product, to utilize the non-renewable sources in a sustainable manner, to assure the people’s welfare, to increase its share of the internal market and to contribute for better social equity.

2. Modern approach and present situation

Livestock is an important component of human society and for hundred of years has helped mankind, not only as food but also for work and in providing clothes and leisure. However, only recently have animals been stretched to increase production. In the second half of the last century, production per se was substituted by productivity and, most recently, by efficiency of production. Such efficiency encompasses not only economical aspects but also requires environmental conservation, social concern and better use of animal and plant genetic resources. Thus, today, efficiency of itself is not enough. The final quality product offered by supply chains needs to be competitive, socially fair, environmentally safe and profitable, i.e. sustainable supply chains in the broadest sense. All these transformations have gained strength, especially, due to the return of some important diseases, which were supposedly eliminated like the outbreaks of foot and mouth disease in Europe.
and Argentina, and the surge of BSE, or mad cow
disease in Europe.
This situation, and the high amount of subsidies
provided by developed countries to agricultural
products, indicates that the only possibility for Brazil
both competitively and in the international market, is
to offer products with some differentiation of quality.
These products should display quality, such as
intrinsic food factors (flavor, juiciness, tenderness,
appearance, etc.) and also other aspects related to the
environment and to low risk for human health. It is
within this scenario that the Brazilian beef supply
chain should be structured.
Globalization has put a lot of pressure on the whole
Brazilian economy as well as on beef cattle activity.
As a result of these new demands, the ranchers have
had to rearrange their business and to establish a new
paradigm, which is to produce with efficiency. The
exposure of several markets around the world to
global competitiveness in the last few years, declared
efficiency and effectiveness as synonymous to sur-
vival. In other words, being efficient is the only way
to stay in business. Thus, in order to satisfy these
demands, all productive sectors have adapted, inno-
vated and learned how to use a holistic approach.
Competitiveness is fundamental for Brazilian beef
cattle and products need to be of high quality and have
a fair price.
According to Euclides Filho et al. (2000a), several
points must be considered to set up important changes
along the Brazilian beef supply chain. The author
points out the increased age of the Brazilian pop-
ulation, which is causing changes in eating habits and
will influence the agricultural sector with the demand
for healthy and different foods. Other influence will
be the transformation in family work patterns with
wife and children participating in housekeeping, the
tremendous growth in the consumption of other type
of meats, and the significant change in consumer
behavior of eating out. In this context, beef quality is
foremost, reflecting directly in better skilled labor in
all sectors of the beef supply chain.
It is also necessary to point out that the use of
products, which leave residues in meat, will suffer
intensive restriction. Besides, it will become increas-
ingly necessary to structure production systems on
lower environmental risk. Such trends will grow and
rapidly encompass the whole beef and hide productive
chains. Under this new scenario, a holistic approach
will dominate the beef agribusiness, especially the
production systems which will be structured in a
sustainable basis.
The possibility of Brazil becoming a major world
provider of beef and hide in the next few years should
be also mentioned with a positive effect on the
country’s income. However, for this to happen, it is
crucial that requirements relating to human and animal
health be undertaken.
All these factors require both a change in the
concept of the final product and in the adaptation of
the beef supply chain. The definite inclusion of
Brazilian beef in the world economy and its strength
in the internal market will happen only if the systems
of production and the other sectors of the beef supply
chain are able to provide healthy and high-quality
products to the consumers, to utilize in a sustainable
form the non-renewable resources, to assure people’s
social welfare, to increase participation in the external
market, and to contribute to the improvement of the
social equity. In other words, it is necessary for all
segments to focus on the main goals and to work as a
team.
In this context, the adjustment or the balance of the
three factors, genotype–environment–market, is an
important strategy not only for accomplishing these
objectives but also for establishing new concepts for
the sector. It is important to note that as soon as the
beef cattle sector, especially the production systems,
internalizes the global concept of the supply chain; it
will start to produce high-quality food and not fat
cattle. However, in order to satisfy these demands, it is
necessary to face some challenges which might be
classified as follows: the challenge related to research
/scientific and technological advances or adjust-
ments), the challenge related to governmental policies
and technology dissemination, and the challenge
related to marketing. Therefore, the solution for these
problems requires a set of well-orchestrated strategic
actions in these different areas. Thus, a good under-
standing and thorough study of the whole supply
chain is necessary. The complexity of the problem and
the importance of the scientific and technological
sector in finding solutions throughout the whole
supply chain clearly indicate the need for scientific
and technological development as an important
component of the beef production process.
3. Scientific and technological development and beef supply chain

In the context of the beef supply chain, the demands for science and technology and innovation are the most important tools available to promote the necessary modifications. Thus, it is imperative that scientific and technological development becomes part of the beef production process. Based on this, Embrapa Gado De Corte (2000) designed the processes of the beef supply chain as presented in Fig. 1. Scientific and technological development are treated as part of the supply chain and a mechanism is developed for monitoring so that the processes provide important overall benefits. This approach allows for the alignment of several dimensions that form the beef agribusiness: it provides an effective integration between the public and private sector, it represents an important tool for effective technology dissemination, it provides an important mechanism for identification of constraints and/or opportunities, which should be approached by technology development, it contributes to diminishing the time between scientific and technological development and its insertion in the agribusiness, and allows for the study for better understanding of beef consumer profiles.

4. Traceability and certification

According to the modern concept of food production, it is important to assure the traceability of food throughout the process. This trend is becoming a requirement, especially in countries of the European Union, but it should be more prevalent and universal.

Such a requirement is a result of the so-called green revolution, with movements all over the world, aimed to reducing damage to the environment. Such movements required new quality regulating mechanisms that encompassed environmental performance as a component of the production process. An increase in rules and protocols for certification and environmental laws followed in the 1970s. Thus, labels for identification organic products became common and the need for food safety was the origin of the protocols called Hazardous Analysis and Critical Control Points (HACCP).

It was also during the 1970s that activities for Integrated Pest Control were intensified in Europe, which later resulted in the general term Integrated Production. Since the 1980s, a new paradigm became important: sustainability and total quality. The concern about ingestion of contaminated food grew in the population during the last decade.

The speed of disseminating information has contributed not only to the increase in discussion and concern about health but also to make known the environmental consequences of activities, products and services involved in producing and processing food. The evolution of concepts and greater consumer consciousness has induced the incorporation of strategies, which aim to monitor production throughout the process. This has resulted in the new methodologies of Evaluation of Product Life Cycle. Such changes have been accompanied by increased access of the population to environmental education programs, which are responsible for changes in the way people think of economical development and the environment. These changes also affect criteria choice and the differentiation in the way products are produced with increasing preference for those from

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**Fig. 1. Component processes of the beef supply chain. Source: Adapted from Euclides Filho et al. (2002b).**
environmentally correct supply chains, which are also socially fair. Therefore, the interaction between health–environment–price becomes an important factor in analyzing choice with a clear tendency in favor of food with good appearance, preferably without preservatives, produced with no chemical and without risk to the environment.

Therefore, the consumers require mechanisms that ensure safety with relation to food consumption. This demand leads to the need of traceability throughout the supply chain. It is also necessary that this process be transparent. In this context, the standardization of concepts and actions became a matter of strategic importance for the beef sector and for the country. Such standardization should provide a mechanism for guaranteeing food with warranty of origin, produced under environmental and social respect, and safe for consumption. It is crucial to establish processes, in all sectors of the beef supply chain, which are well structured, and are simple and easy to be implemented. Additionally, they should be structured to be monitored and to allow conformity analysis.

In such context, the adjustment of the three factors, genotype–environment–market is an important strategy not only for accomplishing these objectives but also for establishing a new concept for the sector. It is important to note that as soon as the beef cattle sector, especially the production systems, internalizes the global concept of the supply chain, it will start to produce high-quality food and not fat cattle.

5. Good practices for beef production

One of the most important steps in structuring a competitive beef supply chain is to incorporate the so-called “good practices” for beef cattle production, which will provide the necessary steps for producing beef according to the consumers demands, emphasizing environmental aspects and social concerns as well as profit orientation. According to Euclides Filho et al. (2002a), these good practices should be introduced in modules and will be the first step for installation of the production system—HACCP. They might also include orientations and/or adjustments in the most important components of the production system, including items related to choice of the area, cattle management and social aspects.

5.1. Choice of the area

Beef cattle production takes place in all Brazilian regions. However, because of the demands of modern society, which impose care of environment and especial attention to the social aspects, it is recommended that the establishment and development of beef cattle should occur under strict observation of Brazilian legislation relating to legal reserves and to areas of environmental protection. It is also important that beef cattle enterprises (small, medium and large) follow agriculture-zoning recommendations. Therefore, it is important to point out that an inadequate choice of the area will result in decreasing profitability of the system, contributing for breaking environmental integrity, which in turn will reflect in social and environmental deterioration.

5.2. Animals

The use of proper animal types is essential for the success of the business. Non-observance of such an adjustment might result in an inviable production system, which in turn will contribute to degradation of pastures and soil erosion.

5.3. Pastures

Pastures are the main source of feed for beef cattle. Its correct establishment, its recuperation/renovation and its management are vital factors for competitiveness of the production system. Incorrect establishment and improper management will hamper environmental conservation and will decrease the offer of high-quality product. The use of inadequate feeding will prejudice competitiveness and might result in animals not reaching the standards required by modern beef supply chains, which are oriented towards quality of final product.

5.4. Feeding

Inadequate feeding will prejudice competitiveness of the production system and result in animals not reaching the standards required by modern beef
supply chains, which are oriented towards quality of final product.

5.5. Animal management

Besides complementing the importance of pastures and feeding, adequate animal management assures its welfare, the safeness of the personnel responsible for its management and the traceability and certification of final product.

5.6. Health management

Following the recommendations for correct sanitary management is one way of assuring competitiveness in beef cattle production. Otherwise, it will be impossible to trace the animal and to certify the production. Besides, an inadequate sanitary program put the health of final consumer at risk and that of the personnel involved in animal management. It is also important to mention that the improper use of chemical products might result in soil and water contamination with undesirable economical and environmental consequences. Improper installations, besides putting animals and personnel responsible for the animal management at risk, contributes to reduced competitiveness and hampers hide and beef quality.

5.7. Installations

Improper installations, besides putting animals and personnel responsible for animal management at risk, contributes to reduced competitiveness and hampers hide and beef quality.

5.8. Social

Satisfaction of all personnel involved in the management of the property, its own welfare and that of its family are fundamental in maintaining the competitiveness of the production system. In this context, the operator becomes the most important factor of the production system. In this holistic view, it is important to establish effective interactions among the different sectors either governmental or private, in order to structure a better organization (associations, cooperatives, experiences groups) of those who own small and medium size herds looking to move into the beef market.

6. Main constraints of the Brazilian Beef Supply Chain

According to Euclides Filho et al. (2000a), there are certain difficulties, to be overcome in order to increase Brazilian competitiveness in beef production in internal and external markets and to develop the right conditions so that this can happen in the whole country and not only in some enterprises. Those authors classified such constraints in three categories: (i) scientific development, (ii) technology dissemination and (iii) political decisions.

6.1. Scientific development

Under this category, the most important factors are:

- To search for technological alternatives, which are able to assure the production of high-quality beef year round.
- To carry out studies for improving the quality of beef products and by-products.
- To develop studies related to de-hiding, management, preparation and finishing the hide in order to improve its quality.
- To study pre-slaughter management alternatives (including transportation) and post-slaughter in order to improve beef quality and, mainly, hide quality.
- To develop strategies for control/prevention of the most important animal diseases, aiming at the reduction or elimination of pathogens and chemical contaminants in the production systems.
- To carry out studies or new alternatives for cuts and/or ready-to-eat dishes based on beef.
- To develop alternatives for establishing competitive integrated beef and milk production systems.
- To develop studies to better understand the relationships between soil–plant–animal.
- To develop economical alternatives for maintaining fertilization of pastures.
- To develop alternatives for pastures management, whether associated with irrigation or not, feed supplementation under grazing conditions and
feedlot, and improving the competitiveness of production systems.

- To develop alternatives for controlling the most important diseases, which impairs the competitiveness of beef cattle production.
- To develop technological alternatives to increase the competitiveness of agro-pastoral production systems.
- To develop studies for providing information to adjust genotype (genetic group)–environment (ecosystem, production system, regional social, cultural and economical differences)–and market.
- To implement studies for developing indicators of degradation of the production systems, mainly pasture degradation, and alternatives for environmental certification.
- To carry out studies to support the development of animal breeding programs, focusing on early conception, early fattening, adaptability and quality of final product (meat tenderness, functional food, etc.), assuring competitiveness, besides the efficiencies of production and reproduction, not only of the production system, but also of the other segments of the beef supply chain.

For example, there is a need to develop studies to better understand the relationships between traits like weight, weight gain, early fattening, reproductive precocity with mature size and economical/biological efficiency of the system of production. Additionally, there is a need to promote a joint effort to develop integrated actions among animal breeding areas with reference to nutrition, reproduction, physiology and molecular biology. These actions should promote studies in: (i) change in growth curve, (ii) change in level of food intake, (iii) increase in the maturity rate, (iv) reduction on metabolic rate or in the amount of energy needed for maintenance, (v) change in the capacity of caloric losses, and (vi) resistance/tolerance to parasites or diseases. It is important to evaluate the results and possible interactions with other economically important traits. These might be tackled by the new bio-techniques, especially, with respect to genetic markers associated to such traits.

With product quality, studies should be aimed at: (i) production of beef with low level of fat, especially, some fatty acids and cholesterol; (ii) capitalization on the potential benefits of some fatty acids such as conjugated linoleic acid (CLA); (iii) deeper knowledge of fatty acids, mainly for better understanding their metabolisms; (iv) knowledge of lipid composition of the most important animal genotypes; (v) knowledge of the effects of feed on the composition of such fatty acids; and (vi) improvement in the possibility of producing so-called nutraceutical food.

6.2. Technology dissemination

As far as technological dissemination is concerned, the most important factors mentioned by Euclides Filho et al. (2000a) were:

- Effective dissemination of existing knowledge and technologies for different production systems, with emphasis on animal welfare, environmental conservation, pasture management, animal breeding, animal nutrition, and animal health.
- To train all personnel, from different sectors of the beef supply chain, including those who deal with cattle, data collection, and health management and also those responsible for the property administration, including the slaughter house administration, handling and preparation of the intermediate and final products, and organization of the sector responsible for the distribution.
- To eradicate or control diseases, which hampers the export of beef with emphasis on foot and mouth disease.
- To develop and/or improve strategies of integrated control of parasites and/or diseases, assuring greater productivity and better quality beef and hide.
- To develop campaigns to explain and help improve quality, not only of beef but also of by-products and hide.
- To develop campaigns to inform the population on the nutritional value of beef and the importance healthy nutrition.
- To liaise with the several sectors that form the beef supply chain.
- To organize small and medium size slaughterhouses and processing industries based on economical studies in order to add value to the farmer’s products.
- To create mechanisms to accelerate access to general information about markets, statistics, costs, etc.
6.3. Political decisions

Under this heading, the author ranked the following important factors:

- To train personnel responsible for technical assistance in order to disseminate technologies and monitor production systems.
- To strengthen or to implement partnerships that assure the effective transfer of technologies to the various sectors of the beef supply chain.
- To effectively establish a carcass classification system.
- To stimulate programs and production systems which integrate beef with agriculture exploitation.
- To stimulate programs and production systems, which integrate beef with milk exploitation.
- To adopt measures which will reduce the large number of non-officially slaughtered animals.
- To reduce or to eliminate the export fees.
- To review tax burden and interest rates.
- To support installation/adjustments of beef industrial enterprises.
- To develop programs oriented towards promotion of beef, with emphasis on external markets.
- To adopt policies oriented towards pasture renovation and recuperation.
- To spread the utilization of agricultural zoning maps.
- To expand the work on zoning maps in order to subsidize a rational exploitation according to the potential of each region.

Euclides Filho et al. (2002b), after analyzing the animal supply chains in Brazil, compiled 16 general constraints or opportunities, which must be overcome or developed in order to establish a modern and competitive beef supply chain (Table 1).

7. Advantages of the supply chain approach

It is not difficult to realize, after careful analysis of what was discussed, that the supply chain approach could become an important element in the whole process of beef production. The importance of considering the process of scientific and technological development as an inherent part of this food chain should be emphasized since it could be a fundamental auxiliary tool for global understanding of productive

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Table 1
Global constraints and/or opportunities verified at different sectors of beef supply chain, according to direction, dimension and axis

<table>
<thead>
<tr>
<th>Constraint and/or opportunity</th>
<th>Directiona</th>
<th>R&amp;D holistic approach</th>
<th>Economic and environmental sustainability and animal welfare</th>
<th>Social equity</th>
<th>Quality of final product</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Non-taxable barriers</td>
<td>X</td>
<td></td>
<td>X</td>
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<tr>
<td>(2) Conflicts among sectors of the supply chain</td>
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<td>X</td>
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<td>X</td>
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<td>(3) Inclusion of small and medium size producers</td>
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<td>X</td>
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<td>X</td>
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<td>(4) Access to information</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>(5) Labor specialty</td>
<td></td>
<td>X</td>
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<td>X</td>
<td></td>
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<tr>
<td>(6) Production management and organization</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>(7) Technical assistance</td>
<td></td>
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<td>(8) Capital/credit</td>
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<td>X</td>
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<tr>
<td>(9) Bio-economical efficiency of the production system</td>
<td>X</td>
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<tr>
<td>(10) Attendance to market niches</td>
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<td>X</td>
<td></td>
<td>X</td>
<td>X</td>
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<tr>
<td>(11) Degraded pasture or in process of degradation</td>
<td>X</td>
<td>X</td>
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<td></td>
<td>X</td>
</tr>
<tr>
<td>(12) Environmental degradation</td>
<td>X</td>
<td>X</td>
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<td>X</td>
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<tr>
<td>(13) Infrastructure of the several segments of the chain</td>
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<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>(roads, slaughterhouse, etc.)</td>
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<td>X</td>
<td></td>
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<td>X</td>
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<tr>
<td>(14) Traceability</td>
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<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>(15) Certification</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
<td>X</td>
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<tr>
<td>(16) Meat and hide quality</td>
<td>X</td>
<td>X</td>
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Source: Euclides Filho et al. (2002b).

a In this table, the constraints and the opportunities were classified only based on the directions.
chains and for the exercise of holistic actions. Besides, this approach creates several opportunities for research and development, since:

- They are an important instrument for identification of constraints and/or opportunities, which need political or technological solutions.
- They contribute in reducing the time between knowledge acquisition and technological development and between its inclusion in the proper sector of the food supply chain, thereby increasing the effectiveness of research.
- They allow for studies of beef-consumer profile, which could result in increased accuracy of actions taken and solutions achieved and also in the possibility of increasing beef consumption.
- They provide the opportunity for inclusion of small and medium size herds into the global market.
- They focus on the various dimensions, which form the agribusiness viable and at the same time they induce shared commitments.
- They facilitate interaction between the public and the private sectors.
- They represent an important tool for effective technology dissemination.

It is important to mention that eventually the proposed system of production could be transformed in an organic one. However, to apply this approach in organic farming, one should approach the conversion cautiously, moving forward step by step. During adaptation, it is crucial to dedicate sufficient effort in training personnel and establishing the new method of producing beef. Preference should be given to areas in which climate conditions provide an environment, which requires few adaptations.

According to the Brazilian Organic Beef Association, there are approximately 210,000 animals being farmed organically in the country. If 2 ha pasture/animal are required, it is estimated that there are at least 420,000 ha of pasture under organic beef production. Eight percent of the herds are located in the central part of the country mainly in the States of Mato Grosso and Mato Grosso do Sul.

**References**

