

The expected social impact of cultivated and plant-based meats in Brazil

Analysis of social opportunities and challenges for the country



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This report was prepared by:

Dr Rodrigo Luiz Morais-da-Silva
Professor Germano Glufke Reis
Professor Carla Forte Maiolino Molento

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EXECUTIVE SUMMARY

Context and objective

The meat production chain has been identified as one of the main industries that contribute to the increase of environmental and related problems. Whether due to the emission of polluting gases, advances in environmental preservation areas, the number of non-human animals slaughtered, and the high production costs inherent, new ways of producing meat products are gaining prominence. Currently, in alternative meats, cultivated and plant-based meat have been the main bets in this transition scenario.

Some projections indicate that alternative meats will reach a large portion of the total meat production in the world in the next two decades. Economic and market analyzes have advanced considerably to assess the main costs and opportunities involved. Environmental analysis also points to substantial advantages for alternative meats over conventional meats. However, the social dimension has not been receiving the same prominence.

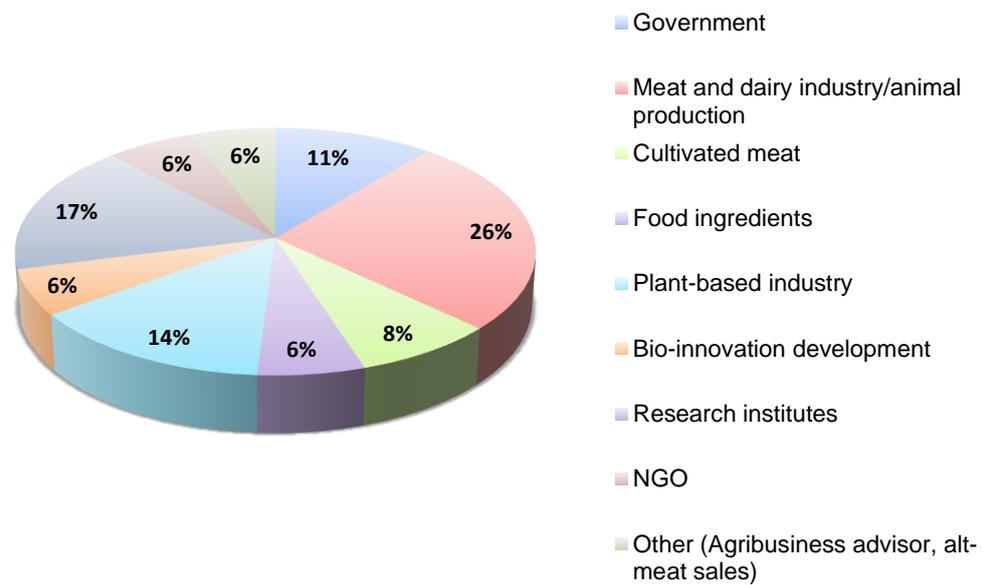
Understanding the main social challenges and opportunities that this transition may represent is fundamental, especially in highly dependent countries on the meat production sector. Therefore, considering the need for advancement in understanding the impact that society and non-human animals will possibly face, this research aims to study the social impact that the entry of cultivated and plant-based meats may have in Brazil. The country was chosen because it has an important role in the global livestock value chain; it is one of the major meat producers and therefore it is expected to be impacted by the entry of alternative meats in the chain.

Methodology

This study builds on the forecasts of a panel of specialists with extensive knowledge of the Brazilian meat and agribusiness sectors and the alternative-protein industry. We sought to include experts with various backgrounds and professional experience in major meat processing companies, government bodies, farming, entrepreneur activity, research institutions, among others. So, the respondents were carefully chosen mostly because of their broad understanding of the significance the

meat chain has for the country, because of their potential in thinking strategically about the impacts of alternative meats in this chain, and, more importantly, their capability of offering valuable insights on several aspects of the potential social impacts. Thus, we develop in-depth interviews with 35 specialists. Figure 1 shows the areas of the interviewees' domain.

FIGURE 1: Overview of the affiliation of the 35 interviewed specialists, from March to May 2021.



These specialists were asked about the main opportunities and challenges in the social dimension that alternative meats would bring to Brazil. A set of relevant social dimensions came up from the interviews and were thoroughly addressed (Table 1).

TABLE 1: Addressed social dimensions

Opportunities for agricultural producers
New job opportunities
Qualification of the workforce
Salary
Working conditions
Entrepreneurial opportunities
Access to proteins
Healthier products

Ethics regarding non-human animals
Reduction of demand for conventional meat producers
Unemployment
Low qualification of livestock labor
High price of the alternative meats
Difficulties in consumer acceptance

In addition to the interviews, data from national and international databases were used, such as Brazilian Institute of Geography and Statistics (*IBGE - Instituto Brasileiro de Geografia e Estatística*), the Center for Advanced Studies in Applied Economics (*CEPEA - Centro de Estudos Avançados em Economia Aplicada*) and Food and Agriculture Organization of the United Nations (FAO).

Main results

Cultivated and plant-based meats are expected to exponentially increase in Brazil, an opinion consistently expressed by all interviewed stakeholders. On the other hand, the reduction of conventional meat production is expected to be limited compared to the global forecasts (Gerhardt et al., 2020; Witte et al., 2021). The growth of the meat market as a whole is projected by our respondents to be allocated much more to alternative meats, but they tend to remain as an additional market to conventional products in the coming decades. This scenario of the massive presence of conventional meats on the market may change for the next generations, in which the environmental appeal and animal welfare, combined with the price competitiveness of cultivated and plant-based meats, may strongly influence consumer behavior in favor of changes in consumption. The main points about the experts' perception of the replacement of conventional meats are presented in Table 2.

TABLE 2: How the conventional and alternative meat markets are expected to evolve in Brazil.

The alternative meat market is expected to be large in Brazil.
The decrease in the production of conventional meats is expected to be low in the next few decades, in Brazil.
The conventional meat is not poised to lose much share of the total market in the next few decades.

The alternative meat market will be mostly positioned as a complementary option for meat consumers, in addition to conventional meat products. Thus, significant substitution is not forecasted for the coming years.

The alternative meat market will have a high percentage of growth in providing a new meat option to consumers.

Considering the long term, conventional meats will considerably decrease their production due to the growth of alternative meats, mainly to meet the expectations of future generations.

Considering the project scenario for the conventional and alternative meats presence in the Brazilian market, our study reveals the following social opportunities: i) opportunities for agricultural inputs producers, who will be able to expand their crops production for vegetables ingredients; ii) new jobs opportunities along the chain (ingredients, cultivated meat processing, e. g.); iii) the qualification of the workforce to meet specific and more technologically advanced demands; iv) the possibility of increasing wages through the creation of chains with higher added value, in comparison with the current chain where the average wages of rural workers is around half the national average; v) the possibility of improving the working conditions of the conventional industry, constantly exposed to physical and psychological risks; vi) greater opportunities for new entrepreneurs along the chain, since the trend is towards greater decentralization for supplies of ingredients, culture medium, machinery and equipment, for example; vii) the possibility of ensuring greater access to food for people with less purchasing power as soon as technologies evolve and industrial costs decrease; viii) the offer of products with a higher degree of healthiness, since the characteristics of alternative products may change to meet this requirement; iv) opportunity for ethical consideration with non-human animals, slaughtered in huge quantities daily. These opportunities are also shown in Table 3.

TABLE 3: Social opportunities related to alternative meat entering the meat chain.

Agricultural inputs producers are likely to expand their production.
New job opportunities in stages of the chain (e.g., ingredients, cultivated meat processing).
Human capital development.
Wage increases in certain chain stages.
Working conditions improvement.
New businesses and new ventures are likely to be created along the chain
Greater access to food

Higher degree of healthiness of alt-protein products
Improvement in non-human animals' ethical conditions

Our data also revealed social challenges with the entry of alternative meats in the Brazilian scenario: i) the reduction in demand from conventional meat producers, which may cause several social and economic impacts throughout the chain, especially in production and slaughter stages. In addition, small livestock producers are expected to be affected first because of the low gains in scale and the high costs involved; ii) as a result of the potential decrease in demand for conventional meat, unemployment in specific stages of the chain is expected to be representative; iii) the qualification of the workforce is another challenge to be faced, both concerning people who may lose their jobs in generally less qualified stages of the chain, and in the level of qualification required in the alternative protein chains; iv) the relatively high prices of plant-based meat available currently in Brazil and the expected high price of cultivated meat products are challenges that can hinder the accessibility of people with less purchasing power; v) finally, the acceptance of the consumers about alternative meats is also a challenge, which involves mainly socio-cultural factors, but also issues such as the taste and texture of new foods. These challenges are also shown in Table 4. However, in the opinion of the interviewed experts, the social challenges inherent to alternative meats are not isolated; they are part of a larger group of consequences of innovations and social transformations. Thus, social problems, such as rural exodus and unemployment from processes that are less intense in labor, are larger processes already occurring in Brazil.

TABLE 4: Possible social challenges related to alternative meat entering the meat chain.

The reduction in demand may cause financial losses.
Small conventional meat producers may be affected first, mainly due to low scale gains and high production costs.
Losses of job in the animal-raising and slaughter stages of the chain.
Lack of education among human resources may be a barrier to enter the new chain.
High prices and low-income may restrict the access of people to alt-protein.
Consumer resistance.

The main challenges with the entry of cultivated and plant-based meats are concentrated in the initial stages of the chain, which may face major challenges in the transition. The consumption stage may also have challenges, mainly related to consumer resistance and the expected high prices. However, the opportunities and challenges emanating from the data collected are not deterministic. How Brazil perceives and decides on the level of engagement with the new industry may change the way in which people perceive the resulting social impacts. Our analysis proposes some opportunities and threats due to a high and low level of engagement in Brazil. In general, alternative meats pose similar social challenges in both cases but vary considerably in opportunities. While a high level of engagement may bring several opportunities to the country, such as taking advantage of opportunities in the new market and the chance to become a major global supplier of vegetable ingredients, a low level of engagement will likely bring few positive social elements.

Recommendations

Based on the outcomes of the interviews and secondary data, this study also developed some recommendations for Brazil to be more likely to seize opportunities, mitigate social challenges and accelerate the engagement of actors toward the development of alternative meat chains in the country. These recommendations are intended to offer general guidance to local, regional and policy initiatives. For us, (i) Several public policies may be created based on a national plan that considers the main potential and needs of the country. (ii) From this national plan, local or regional plans could consider the particularities of each location to contribute to the national plan. (iii) The creation of innovation hubs in Brazil could also help to strengthen the ecosystem, mainly by creating environments for discussions and co-creation among the main regional players involved in the alternative meat ecosystem. (iv) Universities and research institutes may also receive incentives, mainly incentives for research and innovation in partnership with the industry. (v) Human resources may be trained to work in the different phases of the chain in transition, and (vi) farmers, especially those running small farms, may be supported to work in the new chain as well. (vii) Finally, wide-ranging educational campaigns, including governmental initiatives could help clarify the consumer's main doubts concerning the consumption of alternative meats. These main recommendations are shown in Table 5.

TABLE 5: Recommendations for greater engagement by Brazil in the alternative meat market

Construction of a national plan for the development of the alternative meat chain in Brazil that considers the country's potential and needs.
Development of local and regional strategic plans and roadmaps focusing on the development of the alternative meat industry in the country.
Creation of innovation hubs in order to accelerate the development and offer of alt-protein products in Brazil.
Support for research and innovation from universities and research institutes in collaboration with industry.
Investments in the development of human capital that is capable of entering the several stages of the new cultivated meat chain.
Public policies to support local farmers, especially the smaller ones, in the industry in transition.
Broad education campaigns, including governmental initiatives, to sensitize Brazilian consumers about the benefits of alternative meats.

1 INTRODUCTION

Brazil has one of the largest populations in the world, estimated at more than 211 million people in 2020 (IBGE, 2020a), and one of the largest economies, ranking ninth in 2019 with a GDP (Gross Domestic Product) of USD 1.8 trillion (World Bank, 2021). One of the main economic sectors that contribute to this position is agribusiness. Activities related to agriculture, livestock and their derivatives represented 26.2% of total Brazilian GDP in 2020 (CEPEA-CNA, 2021).

Animal production, including the entire protein chain and crops for animal feed production, is one of the main groups of the agribusiness sector. Brazil produced more than 10 million tons of beef in 2020, ranking second among the largest producers in the world. The United States leads the list with a production of 12.3 million tons, while the European Union was in the third position with a production of 7.8 million tons in the same period (USDA, 2021). Brazil is the leader as beef exporter in recent years, reaching 2.5 million tons in 2020 (USDA, 2021). Brazil also stands out as the third world largest producer of chicken meat, with 13.5 million tons produced in 2019; and as the fifth largest pork producer, with 4.1 million tons in the same year (FAO, 2021a).

The representativeness of the agribusiness sector brings other significant statistics to Brazil. The number of people involved in agricultural and livestock activities was 15,105,125 in 2017 (IBGE, 2017), the latest available data. Considering that Brazil's employed population in 2017 was 92.1 million (IBGE, 2018), the individuals involved in the agricultural sector represented around 16%.

The number of non-human animals involved in these activities is extremely high. Official data show that Brazil slaughtered 5.993.890.480 birds and 29.585.593 cattle in 2020 (IBGE, 2021) and the expectation is that these numbers will grow in the coming years. The effective population of cattle in Brazil is approximately the same as people, reaching 214.893.800 animals in 2019 (IBGE, 2021).

1.1 PROBLEM AND GOAL

Although the record numbers of agribusiness and the importance of the sector for the Brazilian economy are recognized, some questions remain open. According to FAO data (Gerber et al., 2013), about 14.5% of the greenhouse gas emissions (GHG) come from livestock. The consumption of water resources is also a problem with

conventional meat. Palhares et al. (2021) estimate that water consumption for the production of 1 kg of beef in Brazil varies between 29,923 and 32,569 liters, considering green, blue, and grey water footprint, in addition to other specificities of the Brazilian beef production chain. Furthermore, the advancement of cattle ranching over forest areas, the excessive use of spaces for cattle ranching on pastures and the ethical issues concerning the suffering and slaughtering of animals are increasingly pressuring for changes in the conventional meat chain. In this context, alternative proteins have become prominent in the last decade, especially in recent years. Alternative meat involves a set of products based mainly on plants, cell culture and precision fermentation. These innovative products have the potential to replace traditional proteins and the problems arising from them, such as the low sustainability and animal welfare indicators of the conventional chains.

Some studies have investigated the environmental impacts of substitutes for conventional meat and argued about the various gains and challenges linked to this innovation (Fresán et al., 2019; Sinke & Odegard, 2021; Smetana et al., 2015; Tuomisto & Teixeira De Mattos, 2011). In general, these studies report greater gains in environmental terms compared to the production of conventional meat. Sinke and Odegard (2021), for example, show that the environmental impact with the use of renewable energy in cultivated meat production is 93% less than that of beef, 53% in relation to pork and 29% in relation to chickens. In terms of animal protection, gains seem undisputable (Heidemann et al., 2020).

In addition, the consumer market is also pushing for changes. The study by Valente et al. (2019) involving highly educated consumers in two Brazilian cities, revealed that 63.6% of participants would eat cultivated meat and that the main driver of the decision was animal welfare. According to a survey conducted by GFI Brazil (2020) in partnership with the IBOPE Institute, Brazilian consumers, in general, who declare themselves flexitarians went from 29% in 2018 to 50% in 2020. These information demonstrates that the change in consumer behavior should drive new types of proteins in the country, mainly for the consumption of new generations.

Nonetheless, if the goal is to become more sustainable and ethical in food production, considering environmental, animal ethics and consumer preference issues is certainly not enough. The social dimension is also a relevant component to be considered. However, social effects are complex and rarely achieve the same precision as predictions for other dimensions. They cannot be analyzed under a direct

cause-and-effect relationship amongst variables. The conceptualization of social impact is comprehensive and includes everything that affects people (F Vanclay et al., 2015) or a significant improvement or worsening in the quality of life of people in any community (Dietz, 1987). In addition, social impact tends to be less deterministic than other aspects, as the social consequences of an innovation rely heavily on choices by each society potentially affected by it.

Even with this complexity, exploring the possible impacts that alternative meat may bring to societies worldwide is essential. In currently available literature, only a single study (Newton & Blaustein-Rejto, 2021) explores in-depth the social and economic consequences of alternative meat, and it is focused in the United States. The study reveals some opportunities for livestock farms and rural communities, some general challenges and the potential role that universities, government agencies and non-profits organizations can play in the new meat chain. However, Newton & Blaustein-Rejto (2021) indicate that further studies are warranted, especially considering points not covered in their research. They also mention the need for research in different contexts, as social elements differ considerably according to the country in which they are inserted.

Thus, considering the arguments above, this research aimed to **study the social impact that the entry of alternative meat may have in Brazil**. Recognizing the social impact resulting from the expected substitution of conventional meat products, even if partial, is relevant for predicting their effects, whether positive or negative, and for choosing the most appropriate strategies to maximize benefits and avoid or minimize disadvantages.

1.2 REPORT STRUCTURE

This research report presents the methodology used in this study, an analysis of the future of the alternative meat market in Brazil from the point of view of the experts consulted, the results in terms of opportunities and social challenges, a subsequent analysis considering the expected social results from a high or low degree of Brazil's engagement, and the conclusions and recommendations.

2 METHODOLOGY

For the development of this study, we used a qualitative exploratory approach. Qualitative research is indicated to use for in-depth studies of social phenomena that are not well-known and to answer “how” and “why” questions about specific and complex research issues (Merriam, 2009; Yin, 2013). As a research strategy within the qualitative domain, we used interviews with experts to obtain primary data and documentary research as the source of secondary data.

2.1 DATA COLLECTION

Our primary data collection involved in-depth interviews with experts in the field of proteins, both conventional and alternative. Collecting data through expert opinion is generally used when there is little or no previous information on the topic under study (Haleem et al., 2019). This approach establishes a primary orientation in a substantially new field, clarifying the problem under discussion (Bogner & Menz, 2009). Research that involves experts' points of view may help anticipate the understanding of future technologies (Haleem et al., 2019) and generate information about ongoing or prospective changes and their consequences (López et al., 2020). This approach was also used by Newton and Blaustein-Rejto (2021) to study the social and economic impacts that alternative proteins may bring to United States in the future.

Considering these methodological justifications, this study was based on the perspective of specialists to explore the possible social effects that alternative proteins may bring to Brazil. We opted for an exploratory and in-depth approach to obtain most of the opportunities and challenges that the country may encounter in the future. The specialists interviewed were selected from a list of participants in a meeting on the future of agribusiness in Brazil, organized by the Federal Government's Ministry of Agriculture, Livestock and Supply. These participants were invited to participate in our study and later indicated additional names of experts in the sector to participate as well. Thus, we interviewed 35 experts in the meat chain in Brazil, from the government, private sector including various stages of the conventional and alternative meat chains, research bodies and third sector organizations (Table 6).

TABLE 6 - Interviews for the study on the expected social impact of alternative meats in Brazil, through online meetings in the period of March to May, 2021^a.

N.	Area	Type of organization	Interviewee's position	Interview time (min)
1	Government	Ministry of Agriculture, Livestock and Supply	Director	41
2	Government	Ministry of Agriculture, Livestock and Supply	Plant-based specialist	41
3	Government	Secretariat for Economic Development	Head Startup Ecosystem	25
4	Government	Public financier of research projects	Superintendent	42
5	Private sector	Animal feed ingredients industry	Regional Manager	60
6	Private sector	Animal feed ingredients industry	Coordinator of Sales	42
7	Private sector	Cattle farm	Farmer	28
8	Private sector	Cultivated meat startup	Director and Founder	20
9	Private sector	Cultivated meat startup	Vice President of Product & Market Development	59
10	Private sector	Cultivated meat startup	Scientific Director	39
11	Private sector	Chemical and pharmaceutical industry for animal production	Sales Executive	51
12	Private sector	Chemical and pharmaceutical industry for animal production	Product manager for health of farm animals	30
13	Private sector	Chemical industry in the food industry	Regional Business Director	41
14	Private sector	Dairy industry	Research and Development Director	33
15	Private sector	Food ingredients industry	Head of Innovation	44
16	Private sector	Meat Processor Company	Director of innovation and new business	43
17	Private sector	Meat Processor Company	Researcher	28
18	Private sector	Meat Processor Company	Innovation and New Business Global Director	57
10	Private sector	Plant-based industry	International Marketing Director	91
20	Private sector	Plant-based industry	Research and Development Manager	43
21	Private sector	Plant-based startup	Research and Development Director	32
22	Private sector	Plant-based startup	Director and Founder	41
23	Private sector	Plant-based startup	Marketing Analyst	36
24	Private sector	Resale of alternative food products	Owner	46
25	Private sector	Sustainable agribusiness consultant	Director	32

26	Research	Public Research Institute in Economics	Program Director	51
27	Research	Public Research Institute in Agriculture and Livestock	Researcher	71
2	Research	Public Research Institute in Agriculture and Livestock	Researcher	43
29	Research	Public Research Institute in Agriculture and Livestock	Researcher	62
30	Research	Public University	Professor and researcher in cultivated meat	40
31	Research	Public University	Researcher and professor in dairy innovation chain	45
32	Third sector	Association in the field of bio-innovation industries	Director	36
33	Third sector	Association in the field of food Innovation	Managing Director and Founder	38
34	Third sector	NGO in sustainable food production	Director	80
35	Third sector	NGO in sustainable livestock	Sustainable Agribusiness Specialist	59

^aApproved by the Ethics Committee for Research with Humans, protocol number 38617320.0.0000.0102.

The interviews were conducted using a semi-structured script. We sought to investigate the main social opportunities and challenges that our expert interviewees perceived as potential realities for Brazil due to the introduction of alternative meats. The interview script was organized considering all stages of the meat chain, such as inputs, production, processing and distribution, and consumption. The interviewees were asked to indicate and explain possible social impacts for all these stages.

In addition to interviews with experts in the field, we also used official data from various databases to explore general information about Brazilian meat production and marketing sectors. Most of the data were public; however, in some cases, specific data were requested via official letter. The main sources involved were the Brazilian Institute of Geography and Statistics (*IBGE - Instituto Brasileiro de Geografia e Estatística*), the Institute for Applied Economic Research (*IPEA - Instituto de Pesquisa Econômica Aplicada*), both linked to the Brazilian Government, the Center for Advanced Studies in Applied Economics (*CEPEA - Centro de Estudos Avançados em Economia Aplicada*), linked to the University of São Paulo (USP). We also used data from organizations representing the meat chain, such as the Brazilian Association of Meat Exporting Industries (*ABIEC - Associação Brasileira das Indústrias Exportadoras de Carnes*).

In some cases, we used data from international institutions, such as the Organization for Economic Co-operation and Development (OECD), the World Bank, and the Food and Agriculture Organization (FAO), mainly for aggregated data related to Brazilian agricultural meat sectors.

2.2 DATA ANALYSIS

After data collection, both from interviews and secondary sources, all documents were inserted into the Atlas.ti qualitative analysis software. We used the qualitative content approach (Mayring, 2014), in which we searched for meanings about what the alternative protein sector represents for Brazil from our interviewees' point of view. Our coding was emergent, in which the main dimensions of social impact, such as opportunities and challenges, were signaled as they emerged in the data.

3 EXPERTS' PREDICTIONS ABOUT THE FUTURE OF ALTERNATIVE MEATS IN BRAZIL

Before addressing the social impact that alternative meat can bring to Brazil, it is relevant to highlight the market projections pointed out by our specialists. Most of them stated that the decrease in the production of conventional meats will be low in the coming decades. For our specialists, the plant-based meat and the cultivated meat market will be added to the conventional meat market, at least in the coming decades. It is expected that the projected percentage of growth in the meat market will be captured by alternative meats, which means that no sharp decrease in conventional meat production is likely to occur in short to midterm timeframes. Even in organizations operating in the alternative meat market, both startups and large companies, the opinion was the same. In general, entrepreneurs and top-level managers working in the plant-based and cultivated meat segments in Brazil believed that the conventional market will remain very representative in the coming decades. For the most part, the alternative market will have a high percentage of growth in providing a new meat option to consumers. However, with the expected increases in demand, conventional meat is not poised to lose much space in the total market, in terms of absolute numbers. In summary, the reduction in conventional meat production is expected to be small in the coming decades according to our alternative meat experts.

Although the perception of most interviewed experts was in the direction of no sharp decrease in absolute conventional meat production, global forecasts widely publicized point to more accentuated replacement. The predictions from the consulting firm A.T. Kearney indicate a drop of 3% per year in conventional meat production, even considering the growth in world demand for beef (Gerhardt et al., 2020). The predictions of the RethinkX organization are even bolder, and expect meat and dairy producers will collapse in the United States by 2035, when the demand for their products is expected to drop by 90% (Tubb & Seba, 2021). The Boston Consulting Group and Blue Horizon forecast shows that in 2035 11% to 22% of the set of proteins consumed, such as meat, seafood, eggs and dairy products, may come from alternative processes; the percentage variation will depend mainly on technological and regulatory advances (Witte et al., 2021).

After freely questioning our interviewees on how they thought about the future of the meat market, we highlighted these predictions for them. Even though, most of

them did not change their opinions and continued considering that there will be only a small decrease in conventional meat production in Brazil in the coming few decades. The main arguments used to justify their positions were the population growth and the increase in demand due to the rise in income, especially in developing countries. Cultural factors related to the consumption of conventional meat were also widely used. In addition, our interviewees pointed out the low costs of conventional meat production in Brazil, especially in the chicken and pig chain, as an important factor to distance the country from the global projections mentioned above. The main reasons cited were the great availability of land and natural resources, the experience with livestock production, as well as the characteristics of cattle production on pastures and the high level of technification in the production of Brazilian pork and poultry. According to our interviewees, these factors will help preserve Brazil's conventional meat production market, at least for the next few decades.

When we asked about a more extended period of time, involving new generations in the future, some of them changed their thoughts. Thus, our specialists in both the conventional and alternative meat chains consider mainly that the technological advancement of alternative meats and the consideration of animal ethics for the new generations may put the alternative proteins in a more advanced position in relation to conventional meats.

Once clarified this question of expected demands, our analysis is broadly based on perceptions about opportunities in a short period of time, such as the following few decades, and for some issues long-term opportunities and challenges, including options for the next generations, are considered. We also asked our interviewees about the social consequences of a hypothetical replacement of meat according to the main predictions mentioned above. Thus, we were also able to understand their views concerning a degree of higher replacement than that perceived by most of them.

4 SOCIAL OPPORTUNITIES

The opportunities perceived from the data analysis led our research to nine groups, involving the opportunities for agricultural producers, the new business opportunities, the qualification of the workforce, the possibility of increasing salaries, the improvement of working conditions, the opportunities entrepreneurs, the possibility of greater access to proteins, the possibility of healthier foods and animal ethics with fewer individuals involved.

4.1 OPPORTUNITIES FOR AGRICULTURAL PRODUCERS

Brazil is recognized as one of the largest producers of grains globally, ranking first in exports of soybeans, maize and green coffee, for example (FAO, 2021b). Several factors contribute to these records, such as land availability, abundance of water, favorable climatic conditions and experience in agricultural production. Our interviewed experts based themselves on these conditions to argue that Brazil may be a significant player exporting vegetable ingredients for the plant-based chain in the future. All interviewees argued that this may be a massive opportunity for Brazilian socioeconomic development.

Some changes may be required concerning the type of vegetable grown. Our experts, in general, believed that soy may be one of the most used protein sources, but that its production will need to be improved for human consumption, which probably includes more significant control over pesticide use. Other vegetables may also gain prominence, such as several species of beans, some of which are already grown on a large scale in the country. Other vegetables, like peas and chickpeas, can also be produced. Several interviewees believed that the country's rich flora biodiversity might be relevant in the search for new ingredients to supply the plant-based meat industry. Some of these innovative ingredients are already being investigated by research institutes, universities and industries. For our specialists, the opportunity to become a major supplier worldwide can help the country to develop.

The potential of ingredients from agriculture is not restricted to plant-based products but also includes specific supplies for cultivated meat. Amongst the main potential uses of crops highlighted by the experts are their role as components of cell culture medium, as scaffolding structures for cell growth, and more directly in the final

phases of the production of mixed meats, which may be composed by partly plant-based and partly cell-based material. However, although promising, the proposal for using new vegetable ingredients in the cultivated meat industry is in its early stages of research.

As social results, the increase in the diversity of agricultural production and the expected increase in total production may generate several opportunities for agricultural producers. Our interviewees said that this new scenario may generate new business opportunities for rural producers. These products are likely to have added value as they will be directed to human food products. Some experts mentioned that agricultural production in Brazil currently favors mainly large producers, with modern structures and running production systems based on monocultures. With the opportunity generated by the demand for ingredients for alternative meats, the circumstances may support changes that benefit smaller properties that work with special products for human consumption.

The increase in demand for variety in vegetable products will be a great marketing opportunity for Brazil. Currently, the country is one of the largest exporter of plant-based commodities globally (FAO, 2019) and will likely take advantage of this experience to increase its exports in this sort of value chain. Potentially, the expected increase will require an expansion in labor for agriculture, which traditionally is less demanding than urban job positions concerning the education level of workers.

4.2 NEW JOB OPPORTUNITIES

Considering the entry of alternative proteins, additional job opportunities can be generated along the entire chain. In the ingredient production stage, the favorable conditions for agriculture in Brazil may be relevant for the country to adopt a prominent position in offering inputs for producing different types of ingredients. These potential ingredients for plant-based meats include, for example, sources of protein and vegetable fat. For cultivated meats, the ingredients may involve vegetable components for culture media and for products made by a direct combination of cultivated and plant-based elements. Thus, people working in agriculture in the current model, based mainly on the ingredients for animal feed production, may have other possibilities.

The new opportunities may open space for jobs that require low formal education. In the last national census of the Brazilian agribusiness sector (IBGE,

2017), of the total of agricultural producers, 15% never attended school; 14% attended school only enough to know basic reading skills, and 43% attended at most the first part of fundamental education or five years of school. In addition, 23% declared that they were not able to read and write. In this way, an expanded chain of ingredients may help employing a significant number of people with low education level in the agricultural sector and may be helpful to create jobs for those in need of opportunities. These employment opportunities may pressure institutional actors, especially the government, to invest more in education. Companies may also exert pressure for a greater degree of qualification of these people to meet their demands for human resources.

People with higher levels of education may also work in the first stage of the chain. Again, considering the number of people involved in agricultural production, about 5.6% of them have a university degree and 0.29% have a master or a doctorate degree. These people can work in more advanced roles, related to the coordination and application of new techniques for producing the newly required ingredients.

However, although our experts were enthusiastic about these job opportunities that alternative proteins may bring, many challenges are yet to be overcome. Currently, Brazil is a leader in producing commodities, but not in processed products with higher added value. For this reason, our experts believed for the most part that employment opportunities in agriculture may be relevant but will depend on a series of changes.

Considering the stages of animal production and slaughter in the traditional meat chain, the employment difficulties may be greater than the opportunities in the case of a high degree of substitution. However, our specialists do not expect an expressive replacement of conventional meat within the next decades in the specific case of Brazil. In this case, the impact on job losses within the production and slaughter stages may not be relevant.

The meat processing step, in turn, may have an increase in employment opportunities, according to our experts. The number of jobs within the factories tends to increase considerably in a low degree of substitution. Considering alternative meats as an additional market and considering the expected high demand for them, the total production volume is likely to increase considerably. To meet this increase, the number of workers demanded in the area will also increase. This forecast of increased production and job openings was considered likely by most of our specialists.

Even considering high degrees of substitution, our specialists believed that there will be no significant reduction in employment opportunities in the processing stage. As for plant-based meat, our experts explained that it is a typical factory, in the style of existing food factories. Thus, the factories of plant-based products would bring job opportunities for both qualified and less qualified people. As the large conventional meat processing companies in Brazil already offer plant-based products on the market, our specialists hope that these holdings will be relevant in the future. Thus, even in the event of a high degree of substitution, people working in conventional meat processing can potentially act in the processing of plant-based products as well.

However, according to our experts, the demand for working people may decrease in the case of cultivated meat. Since the process is more innovative and is developed within bioreactors, with likely lower requirements for human manipulation, job opportunities tend to be mainly for more qualified people. These skilled people may come from different areas, such as veterinary and animal sciences, food engineering, biotechnology, etc. Thus, the new chain of cultivated meat seemed to offer space for more qualified people in the technical stage of meat production. Afterwards, for packaging and storage of cultivated meat and support activities, job positions may also include less qualified people.

In the distribution stage, considering a low substitution rate for alternative meats, the need for people working with distributive processes may increase due to the overall increase in production. If a more considerable substitution occurs, people working in the distribution of conventional meats may be relocated to the distribution of alternative meats, since the three forms (conventional, plant-based and cultivated meat) are likely to need a refrigerated distribution chain with similar concerns.

Therefore, employment opportunities will be more significant in the stages of ingredient agriculture, processing and distribution stages. The stages of production and slaughter of animals are the most likely to be affected when a high degree of substitution is considered. As alternative meats are not expected to replace traditional meats rapidly and decisively in Brazil in the coming decades, according to our experts, employment opportunities are expected to increase.

4.3 QUALIFICATION OF THE WORKFORCE

Innovations in the production of alternative meats can benefit the qualification of workers in this area. Most of our interviewees considered that the probable demand for more qualified employees may pressure people to seek for increasing their skill levels. This boost may be even more evident in future generations, who are likely to pursue forms of meeting more demanding attributes for job positions. According to the interviewed experts, the qualification required to work in the alternative meat chain does not need to be strictly filled by university degrees, requiring many more years in formal education; it may also involve technical vocational education for various positions.

Nevertheless, our experts signaled that improving the workforce's qualification is related to public policies that facilitate this process. Governments, in different spheres, can assist this process by creating and offering various courses in the areas of agribusiness and food production specifically dedicated to the new available positions. Private institutions can also assist by offering courses in this area to the population who can afford such training.

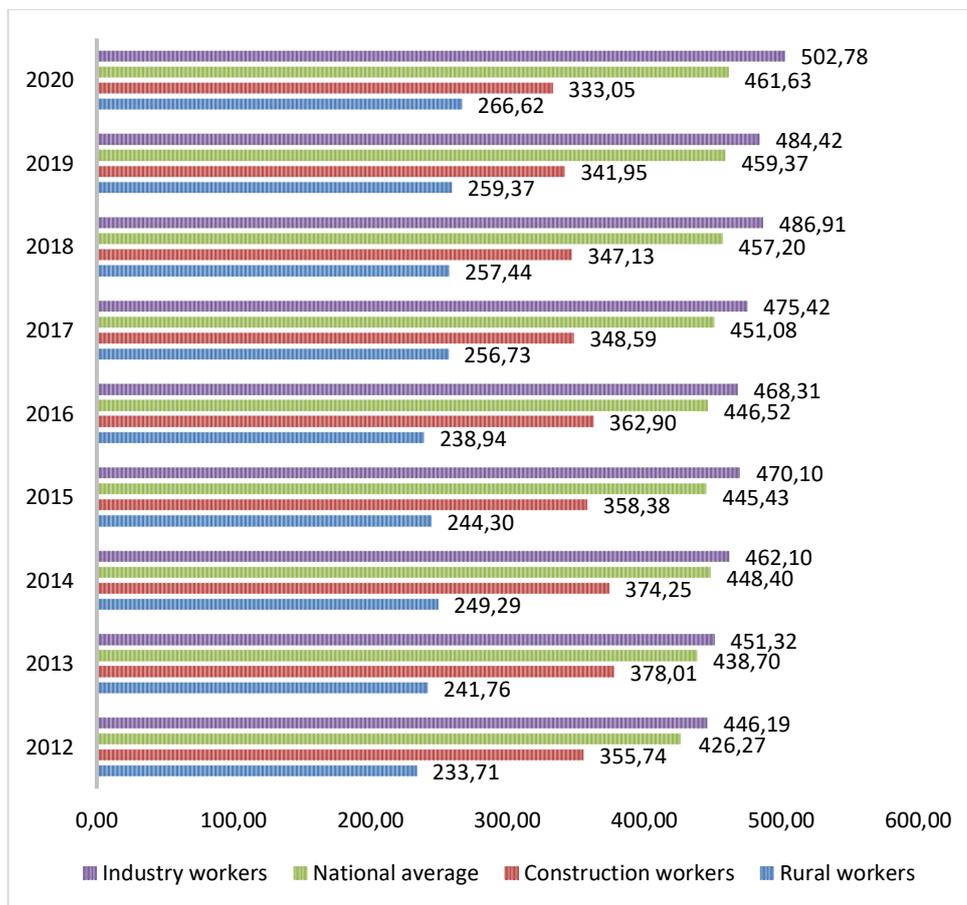
At the technical level of training, the highest qualification of the workforce may include technical and professional courses in agribusiness, agroecology, chemistry, food production, industrial quality, among others. Professionals in these areas are likely to be demanded by both alternative meat chains. At the high level, our experts signaled a growing demand for professionals in food engineering, biotechnology, biology, animal science, veterinary, agronomy, chemical and production engineering, among others, which are all educational programs well established in Brazil. In general, our experts believe that there is no need to create new undergraduate programs to meet the demand for labor, both for plant-based and cultivated meat production. There is instead a need to create specialization courses for areas within alternative meats, such as cell culture and cell tissue engineering.

Our experts also mentioned qualification needs for areas not related to meat production. The areas of technology for machinery and equipment production, such as bioreactors and process control, such as electronic, software and data engineering, were considered relevant. In the business area, the need for people qualified in the areas of marketing, strategy and innovation management to work in the alternative chain in development was also mentioned.

4.4 SALARY

Creating new opportunities for rural workers, incorporating them into the plant-based or the cultivated meat chains can be an opportunity to improve their income. Official data show that the average income of rural workers is almost half the national average and lower than the average wages in the construction and industrial sectors. Figure 2 shows that income growth has been small from 2012 to 2020, maintaining the vast difference between earnings.

FIGURE 2 - Comparison between monthly incomes of Brazilian workers from 2012 to 2020 in US dollars



* Values originally in Brazilian reais but converted to US dollars at the rate of May 26, 2021 (US\$ 1 = BRL 5.31). Source: IBGE (2021)

These data demonstrate that the rural worker incomes in Brazil differ strongly from urban occupations. These data show that the current situation is far from ideal, it is indeed challenging. Thus, new opportunities, such as those arising from alternative meats, may mean the possibility for improvements in the field.

Most interviewees believed that alternative meats may mean more opportunities for a significant number of people in the rural area, especially if Brazil becomes a major producer of ingredients. However, if this promise is not fulfilled and the degree of conventional meat substitution for alternatives is high, a series of problems can impact these people, who work in the rural area, mainly in livestock.

Better payments can also be allocated to people who work in later stages of the chain, such as processing. This possibility will probably depend on the qualification of those involved.

4.5 WORKING CONDITIONS

Working in the conventional meat production chain is associated to risks for workers. These risks are present in the various stages of the chain, from inputs, through meat production, to slaughterhouse and processing. In a list of 674 economic activities officially recognized in Brazil, those related to the meat chain occupy a prominent position in the incidence of occupational accidents (Table 7). However, these numbers are probably higher since many accidents at work are not formally reported to the national control bodies (Takeda et al., 2018).

TABLE 7 – Ranking of functional activities with the highest incidence of occupational accidents per 1000 employees

Ranking	Economic activities related to the meat production chain	Incidence per 1,000 employees
4	Cattle slaughter	67.27
25	Slaughter of Swine, Poultry and Other Small Animals	40.09
35	Meat Products Manufacturing	35.94
107	Tanning and Other Leather Preparations	25.37
117	Animal Feed Manufacturing	24.69
267	Wholesale Meat, Meat Products and Fish	16.16
401	Pig Breeding	10.44
579	Cattle Breeding	4.70

Source: DataPrev – Brazilian Government (2021)

From the activities relevant to our discussion, the one with the highest incidence of risks is the slaughter of animals, occupying the fourth and twenty-fifth place in all economic activities, depending on conditions associated to the animal

species involved. The main risks for workers in slaughterhouses and meat processing industries are physical, such as noise, low temperatures and contact with sharp objects, chemical, such as contact with chemicals that are harmful to human health, biological, such as contact with bacteria and parasites, and ergonomic, generally related to repetitive efforts (Marzoque et al., 2021).

A study developed in Brazil found that of the 26 functions analyzed in a slaughterhouse, two were classified as high risk, 21 as moderate risk and only three were within the low-risk group (Reis et al., 2015). Considering activities with high and moderate risk, the same study concluded that most workers were vulnerable to ergonomic risks due to repetitive movements, which can generate musculoskeletal disorders related to the work of upper limbs. Another study on accidents at work in slaughterhouses and chicken meat processors in Brazil shows that 37% of accidents at work were caused by cutting off some part of the body and 35.6% by bruises (Takeda et al., 2018).

Consideration of working conditions also include the mental and emotional suffering of workers in slaughterhouses. A Brazilian study noted that slaughterhouse workers have a different level of stress depending on the sector in which they operate. The employees with the highest level of stress worked in cutting, receiving, evisceration, packaging and freezing, in order of most stressful, than employees in other sectors who did not work in the operational part of the slaughterhouse (Hutz et al., 2013). The same study compared its results with that of other economic sectors. It concluded that slaughterhouse workers had higher mental illness averages than other employees who worked in stressful conditions. This situation has consequences in cases of anxiety, depression and mental maladjustment (Hutz et al., 2013).

In addition to the mentioned stressful situations, working in a slaughterhouse can have complex implications for workers. Killing and dismembering animals on a large scale is commonplace suffering for slaughterhouse workers, resulting in emotional disorder and ethical conflicts (Dillard, 2008). One study compared the physical and psychological well-being of slaughterhouse workers with 43 other jobs. The study results indicated that direct and routine contact with the death of other living beings helps to explain lower levels of well-being in this group (Baran et al., 2016). The same study also suggests that the situations faced by these workers lead them to consume greater amounts of alcohol, to feel more tired and to show less desire to maintain the same function in two years.

Thus, creating new forms of alternative proteins for human consumption can mean relocation, even if partial, of people exposed to these risks that involve loss of physical and mental health in some cases. In conclusion, the impact of alternative meats to working conditions seems to be highly positive for one stage of the production process, which is critical amongst functional activities studied.

4.6 ENTREPRENEURIAL OPPORTUNITIES

Our experts believe that alternative meats can open space for various business opportunities for entrepreneurs. In plant-based meat, as its process occurs from multiple ingredients, such as different sources of vegetable proteins, texture, flavor and aroma, the tendency is for the process to be more decentralized than the conventional meat chain. With that, entrepreneurs could specialize in a type of ingredient and offer it to the processing industry. Some of our interviews believe that the decentralization of the system supplier is happening at the moment. The trend is that new opportunities are created for entrepreneurial from startups and other organizational forms.

Thus, different opportunities can be opened for different producers who seek to meet the diversity of preferences of Brazilian and foreign consumers. Some of our interviewees pointed out that the decentralization of the plant-based network is already a reality in Brazil, as several brands already exist in the market, compared to the domination of few brands in the conventional meat market.

In the case of cultivated meat, several entrepreneurial opportunities are also expected. In the same way as vegetable meats, opportunities in the cultivated meat market may involve ingredients, such as cultivation medium, flavor, aroma, vitamins, scaffold, among others. So, the trend is that entrepreneurial opportunities are numerous for suppliers of ingredients for cultivated meat.

Regarding entrepreneurial opportunities in the production of cultivated meat, it took our interviewees in two ways. Some considered that the decentralization should be great, mainly regarding the various world-leading startups. Others considered that the complexity of the cultivated meat production process, the regulatory environment under development, the high costs of investments involved and the interest of sizeable Brazilian meat processors should be consistent barriers for startups and their entrepreneurs. Some respondents believe that a small number of startups could gain

space in the Brazilian market for cultivated meat. Most of them will have difficulty operating in the market or will be acquired by large meat processors.

Thus, for our specialists, entrepreneurial opportunities must be greater in the alternative protein chain than in the conventional chain. These opportunities must be more accessible for entrepreneurs to enter the plant-based chain and more complex for entrepreneurs of cultivated meat.

4.7 ACCESS TO PROTEINS

Accessibility to food is a big challenge occurring worldwide, but especially in developing countries. According to FAO (2020) data, about 47.7 million people were undernourished in Latin America and the Caribbean in 2019, and this number is expected to reach 66.9 million in 2030. For comparison, in the world, the total number of people on the map of hunger is expected to reach 841.4 million in 2030, revealing that providing the means for these people to feed themselves is an urgent matter for Latin America and the world.

Some recently published indicators (IBGE, 2020c) support the understanding of the complexity of the social dimension in Brazil. The number of people in the situation of poverty, considering the daily income of up to U\$ 5.5, in Brazil corresponds to 24.7% of the population. This percentage corresponds to more than 50 million Brazilians who have difficulties meeting their basic needs, such as food, transportation and clothing. Within the country, poverty indicators vary by region. While in the Northeast and North regions, 42.9% and 41.6% of the population are in poverty, in the Southeast, in the Centre-West and the South, with respectively 15.8%, 15.3% and 11.3%, the percentage is lower. Although the data show the extreme social fragility of Brazil, the average meat consumption is high in the country. Table 8 shows the comparison among Brazil, the average of OECD member countries and the world average:

TABLE 8 - average meat consumption

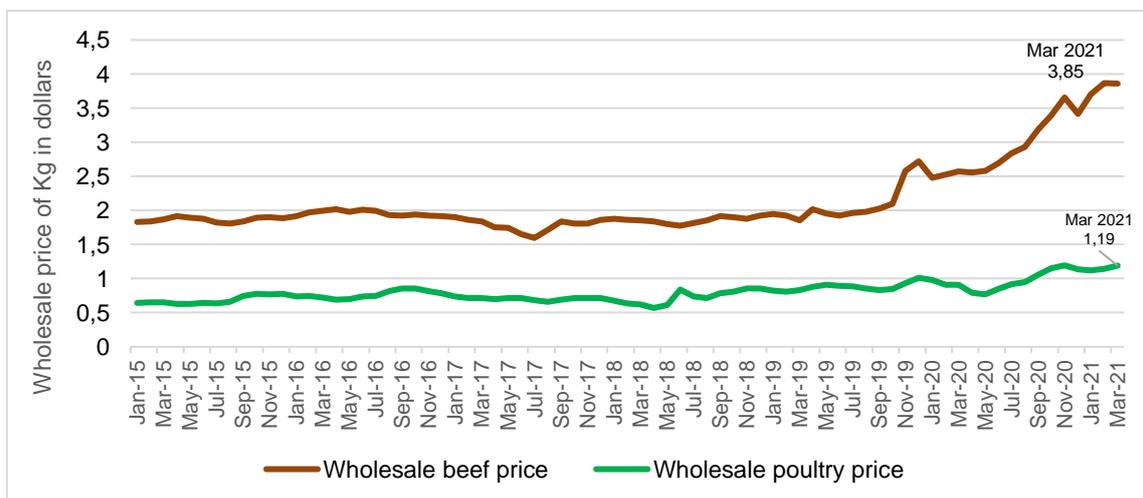
Meat consumption - Kilograms/per capita (2019)			
	Brazil	OECD	World
Poultry	40.3	31.3	14.7
Pork	12.8	23	11.1
Beef	25.2	14.5	6.4

Source: OECD (2021)

Although the higher values of meat consumption, the average covers some disparities. An official survey (IBGE, 2020b) conducted between July 2017 and July 2018, with more than 45 thousand Brazilians, sought to understand household consumption pattern compared with economic gains. Dividing the sample into four quartiles, ranging from the lowest income (first quartile) to the highest (fourth quartile), the research concluded that 33% of Brazilians in the first quartile consumed beef in the last 24 h, compared with 42.1% in the fourth quartile. Pork was consumed by 5.7% of the first quartile members, against 6.6% in the fourth quartile. Regarding birds, the positions are reversed: 33.1% of Brazilians in the first quartile ingested poultry meat in the last 24h, compared with 28% in the fourth quartile. Thus, the data suggest that meat consumption tends to vary according to income. People with higher income levels consume more beef, which is more expensive, and people with lower income levels consume more chicken, which is cheaper. Thus, although there is a high average consumption of meat in the country, such consumption varies considerably depending on the average income.

It is also important to highlight that these 2017-2018 survey results did not include the increase in the prices of beef and chicken, for example, which almost doubled in the last two years (CEPEA, 2021a). This raise combined with the decrease in income due to the COVID-19 pandemic have probably aggravated the disparity in Brazilians' meat consumption. Figure 3 show the evolution of beef and chicken prices in recent years.

FIGURE 3 - Wholesale price of beef and chicken in Brazil in US dollars from 2015 to 2021.



* Values originally in Brazilian reais but converted to US dollars at the rate of May 26, 2021 (US\$ 1 = BRL 5.31). Source: CEPEA (2021a)

The prices of beef in the last two years have risen and remain high in Brazil. According to CEPEA (2021c), several circumstances help explaining this upward trend, including the devaluation of the Brazilian real facing the US dollar, which makes exports more attractive to meat producers; the increase in external demand, especially from China; and a lower supply of cattle on the part of producers. The increase in the price of beef was felt by Brazilian consumers, who increased the consumption of lower price proteins, such as chicken, pork and eggs. The increase in demand for these products, concomitantly with the rise in exports, pushed the price of chicken meat, for example, higher than its average for the last five years. However, the increase in demand does not directly reflect on the profit margins of producers, since several inputs are quoted in dollars and had their prices increased in recent years.

Considering the relevant increase in prices and the prospects for further increases in the future, access to conventional proteins as a source of human food is increasingly challenging in Brazil. All of the interviewed specialists believed that alternative meats can be promising answers to the problem of protein accessibility in Brazil as well as in the world. The main idea in the responses referred to “the more availability of proteins, the better for people.” However, most of them believed that, at the moment, alternative proteins do little to improve the accessibility of food.

The main argument for plant-based meat not to contribute to protein security was the price, which is substantially higher than conventional beef products, for cuts not considered premium. If the comparison involves chicken meat, the discrepancy is much more significant. The relationship between available plant-based options and eggs is “impractical”, according to a specialist interviewed. In addition to the price, the availability of plant-based products remains low in Brazil, mainly concentrated in larger urban centers and some specialist stores in some smaller cities.

In the cultivated meat instance, the promise of lower prices and great availability exists and was commented on by most interviewees. However, according to our experts, this promise seems far from the reality in Brazil, since the costs involved in cultivated meat production are currently exceedingly high. One fact commented on by some of the respondents was the promise of the BRF-Aleph Farms collaboration to take cultivated meat to Brazilian supermarkets at competitive prices in 2024. This newly released news left some experts surprised and hopeful that cultivated meat may be a solution for access to food in Brazil.

Thus, although alternative meat does not yet contribute significantly to the access of the disadvantaged population to the protein market, the interviewed experts believed that this will change. With higher number of options, accessibility to proteins may be greater and fairer for all social levels in the future.

4.8 HEALTHIER PRODUCTS

Healthiness was considered by several of our interviewees as one reason that will cause people to start consuming alternative meats. This motivation will depend, among other determinants, on the degree of real healthiness found in the new foods. Some entrepreneurs interviewed in the plant-based area believed that not all products available on the market are healthy, although they sell this idea. The pressure for lower prices can cause ingredients to be exchanged for others of a lower price, but often also less healthy for human consumption. On the other hand, the promises of more nutritious foods, compared to conventional meats, were considered by the majority among our specialists.

In cultivated meats, the promise of healthier foods was also claimed by most respondents. As the types of elements that will integrate into commercially cultivated meat products can be intentionally chosen, with a much higher tailoring ability as compared to conventional meats, certain types of compounds that are harmful to human health can be avoided, such as excess saturated fats.

Another point mentioned by the interviewees was the addition of vitamins and minerals required by a population in a specific country or region. In the event of known deficiencies, government regulations can encourage minimum values for specific supplements. This solution was also commented as potentially useful for countries in generalized poverty, war situations or environmental catastrophes. Thus, the new possibilities for supplementation in cultivated and plant-based meats can be an asset for a diversity of situations.

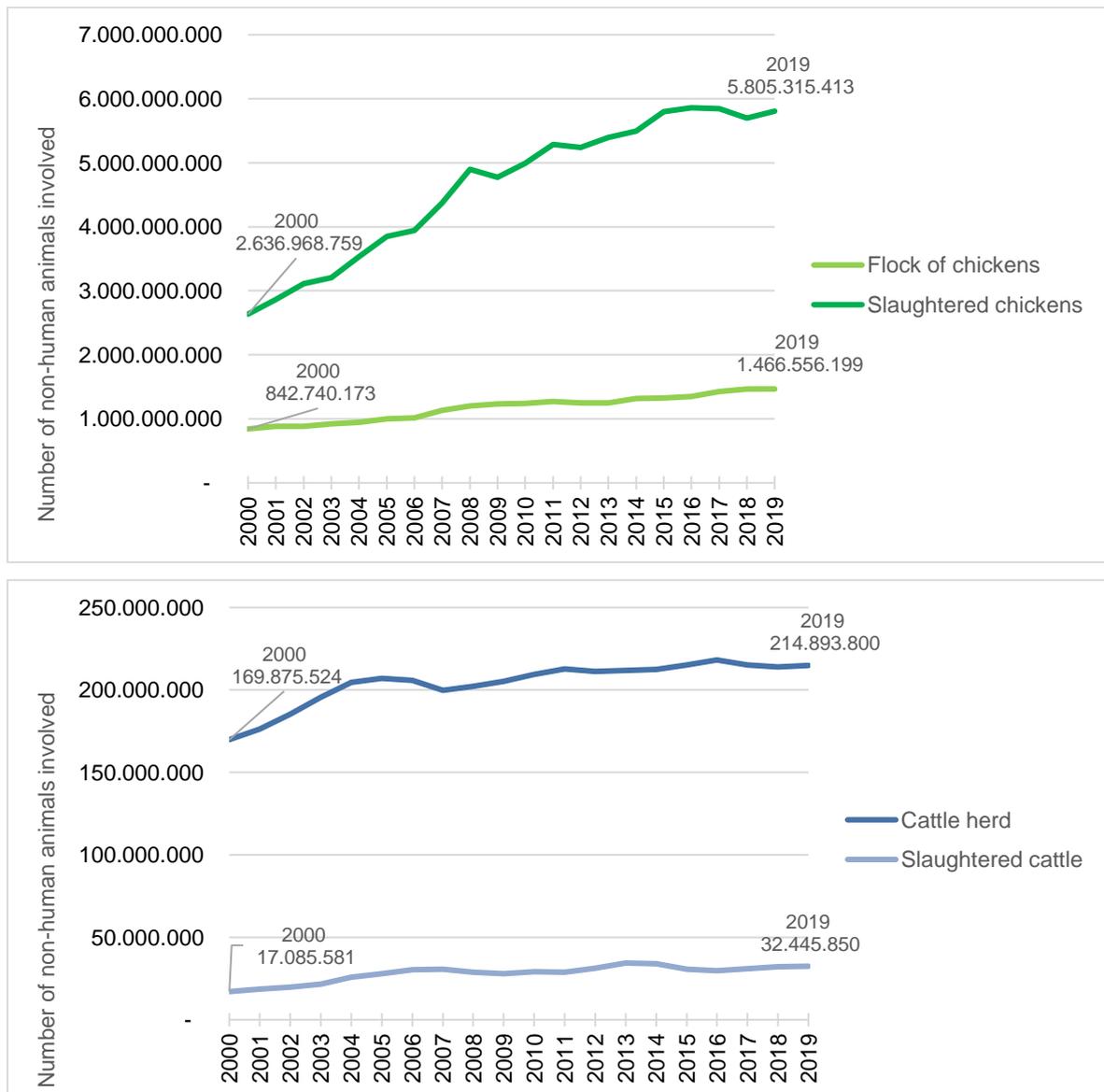
The research by Gómez-Luciano et al. (2019) helps explain the importance of healthiness and other related requirements for Brazilian consumers. The authors compared consumer preferences in alternative meats in the United Kingdom, Spain, Brazil and the Dominican Republic. The first two countries were more willing to replace conventional meat with alternatives than the last two. However, Brazil was the country in which more people (86.8% of respondents) considered increasing their probability

of buying cultivated meat in case of health, safety and nutritional content were guaranteed.

4.9 ETHICS REGARDING NON-HUMAN ANIMALS

An important opportunity related to the entry of alternative proteins in Brazil is in the field of animal ethics. As one of the biggest producers and exporters of conventional meat products, the country maintains a large number of animals. The data in Figure 4 show the evolution of cattle and chicken numbers since 2000 in Brazil:

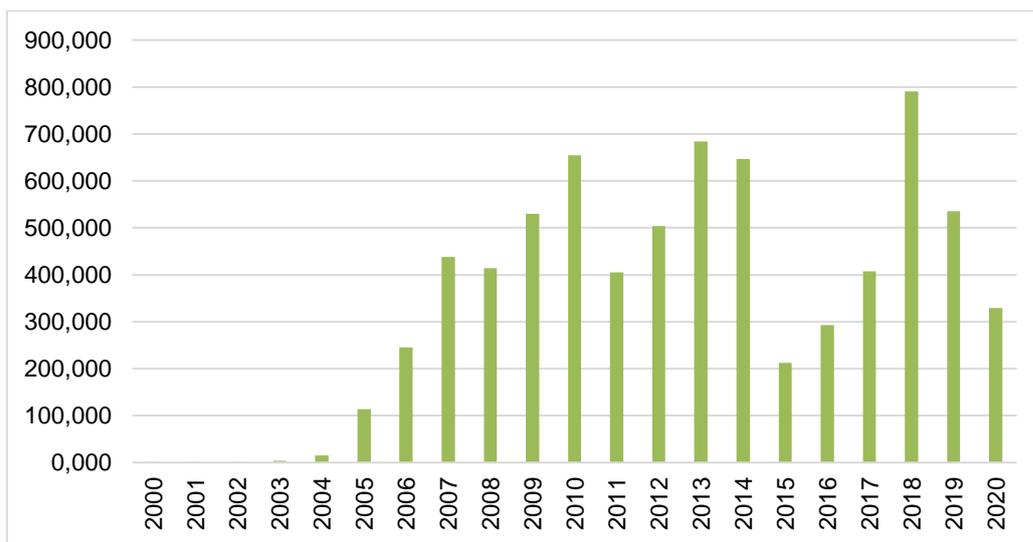
FIGURE 4 - Population and slaughtered chickens and cattle from 2000 to 2019 in Brazil



Source: IBGE (2021)

An additional situation inherent to ethics and animal welfare is the export of live animals. This form of export involves several criticisms because the animals may be subjected for a period of weeks to terrible on-board conditions of crowding, faeces and urine, feed contamination, low air quality, sea sickness and injuries from difficulties to stand, amongst other factors. In addition, the conditions offered to these animals in transfers are also questioned. Figure 5 shows that the peak of these exports was in 2018 when approximately 800 thousand cattle were exported live.

FIGURE 5 – Live bovine animals exported (in number of individuals) from 2000 to 2020 in Brazil



Source: Brazilian Association of Meat Exporters (Abiec) and Ministry of Industry, Foreign Trade and Services (Comex Stat).

The numbers of non-human animals involved in the food production system can potentially be reduced in the event of a significant substitution of conventional meat with alternatives. However, in the opinion of most specialists, this substitution is not likely to happen in the coming decades, mainly due to the expectation of growth in the demand for proteins in the world and cultural factors. For them, the number of animals slaughtered must remain constant, with a slight decrease at most. In fact, this seems an initial true gain for animals, if the other possibility were that all the increases in meat demand would be supplied for by conventional meat. This scenario may change for the next generations, as younger people begin to realize the relevance of the ethical issues involved in animal production and slaughter for human consumption, especially when other food alternatives are available. For the specialists, the younger

generations, such as generation Z, already demonstrate opinions that consider animal ethics, and this is likely to become more accentuated for the generations yet to come.

The respondents largely believed that the concern for animal welfare already exists among consumers, although it is not strong enough to abruptly change their purchasing patterns. Animal producers and processing industries, in general, also have this perception. However, according to experts, the biggest motivation for producers is the economic benefit and productivity that animal welfare can bring to their businesses.

Considering the changes in consumer behavior of the younger and next generations, the entry of alternative proteins is expected to be a relief for animal ethics issues. Some studies have already shown that concern for animal welfare and ethics is one of the main reasons for reducing conventional meat consumption (Clonan et al., 2015; De Backer & Hudders, 2015; Hagmann et al., 2019). The refusal to consume meat can be a motivation to consumption of alternative meats. Valente et al. (2019) demonstrated that concern with animal welfare and ethics is one of the main motivations for purchasers to consume alternative meats in Brazil. Other studies at the international level also point out that this concern is one of the main drivers for consuming alternative meats (Bryant & Sanctorum, 2021; Circus & Robison, 2019; Michel et al., 2021).

5 SOCIAL CHALLENGES

The challenges perceived from the data analysis led our research to five groups, involving the reducer of conventional producer demand, the unemployment, the low qualification of livestock labor, the high prices of alternative meats and the difficulties in consumer acceptance.

5.1 REDUCTION OF DEMAND FOR CONVENTIONAL MEAT PRODUCERS

One of the leading social challenges when considering the entry of alternative meats in Brazil is the decrease in demand for the producer of conventional meats. For most of interviewees, the entry of these proteins does not directly mean a sharp reduction in the market for conventional meats, as explained earlier in this report. Thus, the social impact felt is likely less than the expected impact of a high substitution percentage, as indicated by some comprehensive forecasts.

If the replacement in Brazil follows the boldest international forecasts, the respondents believed there would be a significant challenge for the Brazilian agribusiness sector. As a major global producer country, Brazilian producers will likely suffer from falling sales and our interviewees believed that the beef production chain would be impacted first. Several factors explain the likely greater first impact on the beef chain, such as the perception of higher negative environmental impacts, the high production costs involved, the long period until animals reach slaughter weight and the lower carcass yield as compared with the pig and poultry chains. In addition, considering the possibility of partial replacement of conventional beef production by alternatives, producers may be differently affected according to their production sizes. Some of our specialists indicated that the scale gain is high and of great importance in the cattle production chain, mainly due to the possibility of diluting the high production costs. Thus, smaller producers are likely to be the first to suffer from the drop in sales.

Respondents believed that the chicken and pork chains are likely to be affected only later. In general, these two chains in Brazil use more technology in their processes, even small producers are integrated with large processors, carcass yields are higher, their prices to the final consumer are lower and their environmental impact is also lower as compared to cattle production. These factors that ensure greater competitiveness for chicken and pork tend to slow down any replacement. According

to respondents, this is important because, unlike the bovine chain, these two chains are formed mainly by small and medium-sized properties. Thus, it may take a longer time to adapt to a new scenario of high substitution.

Our findings about the expected drop in production by conventional producers also corroborate the literature that expects this to also occur in the United States. However, the study of Newton & Blaustein-Rejto (2021) reveals that in the United States small producers are expected to have little impact since most of them do not have animal production as their main source of income. Large producers, on the other hand, would be more affected in the event of a large decrease in demand for conventional meat. In Brazil, as was presented, experts believe that the opposite should occur in the country.

Concern for conventional meat producers may also be an influence from the consumer's point of view. A survey conducted in the United States concluded that the concern about the negative effects that alternative proteins may have on conventional meat producers can be impeditive for the advancement of these new products (Wilks & Phillips, 2017). The study by Bekker et al. (2017) presented that consumer debates about cultivated meat also involve social factors, such as concern about the social effects for farmers. Consumer concerns may also include thoughts associating cultivated meat with a world without farmers and farm animals, leaning more towards dark and high tech scenarios; however, cultivated meat may inspired new perspectives on old meat practices, new designs for protein practices and new views on who we are in relation to food, animals and our environments (van der Weele & Driessen, 2013). For example, van der Weele and Drissen (2013, p. 657) studied the concept of the "pig in the backyard", in which consumers may have the company of farm animals in their homes, creating a sense of community; the animals would have a "long and happily ever after" life providing small amounts of cells for the family to grow. In addition, the uncoupling of meat from domestic animal raising and killing will likely free land currently used for meat production, either for keeping the animals or for growing crops for animal feed production. This, in turn, may relate to increased populations of animals of non-domestic species (Heidemann et al, 2020). Thus, the likely scenario to emerge from cultivated meat may actually include a closer and kinder relationship with animals, liberated from the current tension that is inherent when animals are raised to be killed for food.

5.2 UNEMPLOYMENT

A high substitution in the consumption of conventional meat with alternative meats may bring problems for Brazil concerning the jobs offered by the conventional sector. The data in Table 9 show the number of people involved in different stages of the meat chain in Brazil, an industry that employs close to 3.8 million workers. This amount is equivalent to approximately 4.4% of the total 86.1 million working people in Brazil (CEPEA, 2021b).

TABLE 9 - Number of people involved in selected livestock activities

People involved with inputs for livestock	
Animal feed (ration)	99,356
Veterinary Medicine	18,309
	117,665
People involved with livestock	
Cattle (beef and milk)	1,974,456
Pigs	109,244
Poultry	262,633
Other animals	134,970
Fisheries and aquaculture	397,827
	2,879,130
People involved in livestock-based agribusiness	
Slaughter of animals	521,537
Dairy products	261,332
	782,869
Total	3,779,664

Source: CEPEA (2021b)

Although most experts believed that alternative meats will create an additional market, if a high degree of substitution occurs in a short period of time, as per published estimates (Gerhardt et al., 2020; Tubb & Seba, 2021), many job positions may be lost in Brazil. For our specialists, the occurrence of a high and fast migration to alternative meats may constitute a “big problem” for the job market in the agribusiness sector in Brazil. However, it is essential to emphasize that the rural exodus process in Brazil is not recent and is a result of several motivators, such as the mechanization of on-field activities and the chances for better opportunities and life quality in an urban lifestyle.

Thus, the entry of alternative proteins may further reduce existing job openings, but it is not an isolated process.

People who lost their jobs can probably migrate to agricultural activities if there is an increase in demand for these products. If they are unable to relocate, the chances of moving to cities seem great. This may generate an increase in the indicators of urban social problems, such as the increase in the number of unemployed in Brazilian cities and an increase in the number of irregular and low-security housing. On the other hand, alternative proteins bring a paradigm shift in terms of meat production that may carry new possibilities for urban food production activities.

5.3 LOW QUALIFICATION OF LIVESTOCK LABOR

People who may become unemployed due to a decrease in conventional livestock activities are likely to face difficulties in reallocating to markets other than in agriculture, mainly due to their low qualification. The experts reported that the livestock workforce has traditionally been less qualified, which is another facet of the low attention these workers receive. Although this situation has evolved, the number of people with low qualification in this scenario remains much higher than that of qualified people. Table 10 shows the percentage of people within each chain of animal production or slaughter and their levels of qualification.

Table 10 - Levels of professional qualification in livestock

	Cattle	Pig	Poultry	Slaughter
No formal instruction	7%	11%	3%	1%
Incomplete primary education	53%	49%	41%	25%
Complete primary education	11%	12%	12%	9%
Incomplete secondary education	6%	2%	8%	8%
Complete secondary education	18%	22%	24%	38%
Incomplete higher education	1%	1%	2%	7%
Complete higher education	4%	3%	9%	11%

Source: CEPEA (2021)

The secondary data seem to confirm what the experts have identified concerning the workforce in livestock. Considering animal production, most people have a low level of education. Most of the people involved in cattle (60%) and pig

productions (60%) were unable to complete the first cycle of studies, i.e. nine years of education. In chicken production, 44% of the people involved are at the same level. In the slaughter of animals, the rates are slightly better, probably due to the requirements for job positions in the processing industry.

Thus, in general, people involved in animal production are likely to find it difficult to seek employment opportunities in areas other than agriculture. The fact that only 18%, 22% and 24% of the workers in the beef, pork and chicken chains have completed the second educational level, corresponding to twelve school years, shows the intrinsic difficulties for them to find urban job positions, as this level of education is often required for jobs in operational functions in Brazilian cities.

The experts interviewed expressed concerns about the job opportunities that would be required to serve a large contingent of people in the event of a sharp decline in conventional meat production. Most of them saw only opportunities in agriculture for these people, who would still depend on an increase in demand for these products. Thus, the low qualification of the workforce of livestock workers becomes a major challenge for Brazil in the case of an unemployment wave in the meat production chain.

5.4 HIGH PRICE

The price of current and potential alternative meats was a frequent point of concern for the interviewed specialists. For them, the plant-based meat available on the Brazilian market is currently barely accessible for most of the population. Prices are above the average for conventional meat products, except for prime cuts. If we compare it with secondary products based on conventional meat, such as sausage, hamburgers and chicken fingers, the prices are even more disproportionate. One of the interviewees of a large company, who works with plant-based products, argued that food made with quality ingredients, healthy for human consumption and with low environmental impacts is unlikely to compete in prices with conventional meat in the short term.

In the case of cultivated meat, this concern is even greater due to the high costs involved, as well as the complexity of the production process. The experts believed that the time needed to reduce prices is long and, even with time, the focus for these products may not guarantee the lowest price in the meat area. Two entrepreneurial startups of cultivated meat with some relation to the Brazilian market

believed that the focus will be on consumers strongly committed to animal or environmental ethics issues, generally belonging to social classes with higher income. The only mention of lower prices in the field was the announced BRF-Aleph Farms partnership, which the experts saw with hope for changes in the current course of maintaining high prices.

Thus, in general, our specialists believed that high prices will remain a significant social challenge for the alternative meat market in Brazil. Time may decrease costs and, consequently, the price for end consumers of all social classes, but the experts believe that the chances of this happening in the short term are small. This concern about price has also been pointed out in the literature as one of the possible barriers to increased consumption of alternative meats (Bekker et al., 2017; Verbeke et al., 2015; Wilks & Phillips, 2017), including in Brazil (GFI, 2020).

5.5 DIFFICULTIES IN CONSUMER ACCEPTANCE

In addition to price as the main factor limiting the consumption of alternative meats in Brazil, other characteristics may be placed as barriers. Experts thought that the main challenge will be the cultural factor for both types of alternative meats, as Brazil is known as “the country of the barbecue”. For them, meat occupies a prominent place in any celebration for Brazilians. They believed that this passion for meat will be the main deterrent, as many consumers do not yet consider alternative meat as “real meat”.

For the specific case of plant-based meat, barriers to consumption may also include memories of vegetarian meat based on soybeans sold decades ago in Brazil. This type of meat became known as “soy meat” and associated with an unfriendly flavor which was vastly different from traditional meat, as some of our interviewees recalled. Thus, moving away from this image will be crucial for the acceptance of consumers. In addition, the “ultra-processed” food label in Brazil refers to unhealthy foods that may generate prejudice among consumers. Finally, even with the developments achieved in recent years, flavor and texture may remain be a barrier to consumers more adept at the characteristics of conventional meats.

For cultivated meat, the label “laboratory meat” remains in the minds of some consumers, who see this type of meat more as a chemical product than a food item.

Some experts also commented that the cultivated meat might generate fears of being unhealthy and cause illness in consumers because it “is not natural”.

Therefore, our experts have argued about several factors that can mean barriers to consumer acceptance. Although the cultural factor is the biggest one, other elements were also highlighted as essential from the point of view of our interviewees, such as flavor, aroma and texture.

The literature has also highlighted social issues as influencing the acceptance of consuming alternative meats. Michel et al. (2021) realized that eating alone brought greater acceptance for alternative meats than when food includes other people who can judge the new behavior. The need for increments in specific items of alternative products was also highlighted, such as concerns about price (Bekker et al., 2017; Slade, 2018), flavor and texture (Tucker, 2014; Verbeke et al., 2015), doubt of classification between natural and artificial (Bekker et al., 2017; Laestadius, 2015) and food neophobia (Siegrist & Hartmann, 2020).

6 SOCIAL IMPACTS AND THE LEVEL OF ENGAGEMENT WITH THE PRODUCTION OF ALTERNATIVE MEATS IN BRAZIL

The social impact assessment involves clarifying the consequences of a current or proposed action for people (Becker, 2001). Because it is not based on the causal relationship between variables and exact measures, as is generally considered in economic and environmental assessments, but on personal attitudes and behaviors expected, social forecasts can change considerably over time (Dreyer et al., 2010). People can react in different ways to the changes imposed, making it impracticable to detail all dimensions related to social impact (Frank Vanclay, 2002). Furthermore, how institutional players handle changes can transform the way a change impacts people.

Thus, based on the social impact that the entry of alternative meats may bring to Brazil, the analysis was expanded to include how different degrees of engagement from institutional players can influence future scenarios. The proposed engagement is part of the macro level, which consists of the engagement of governments, large companies, startups, universities, non-profit organizations, consumers, etc. Our two basic scenarios include the expected social impacts for high and low levels of macro system engagement.

According to most of our experts, currently Brazil does not have a comprehensive agenda to take advantage of the opportunities and mitigate the challenges of alternative meats at the national level. Although the country has presented some advances in initiating discussions at the governmental level and in starting to prepare for the development of the necessary regulations, these advances are recent and not yet robust. Private players, however, have shown greater prominence. The experts consulted believed that the current participation of Brazil in the scenario of alternative meats is due mostly to the performance of the private sector. However, the private sector will find challenges to proceed in the absence of a broad public policy agenda involving other institutional actors.

When asked about Brazil's placement in an international scenario of expressive growth in the production and consumption of alternative meats, most experts mentioned that Brazil is behind other countries. At most, the country is trying to follow the advances of other nations, but far from a leading position. Thus, in a scenario of certain advances and various barriers for alternative meat in Brazil, exploring its possible consequences based on the levels of engagement of players in the institutional environment is promising.

Contemplating the potential social impacts considered by the consulted experts, in Brazil's high engagement in alternative proteins, social opportunities may be varied. The first major opportunity is likely related to the increase in demand for farmers dedicated to produce human food. Agriculture production will provide ingredients for the plant-based chain and inputs for the cultivated meat medium. The opportunities for farmers may also extend to forest collecting communities. These people are part of needy populations in forest areas in Brazil. Some of them have been working as suppliers of products collected from the forest for various industries, as for example the supplying of some ingredients for the activities of a plant-based startup in Brazil. Opportunities in the field may increase the number of job positions. These options may shelter people who work in agriculture considering a scenario of high replacement of the conventional chain for the alternative options. These new job opportunities are also expected at later stages in the meat chain, such as processing and distribution, which will also be required for alternative protein chains.

As a result of the increase in available employment positions, the workforce qualification may evolve to meet the needs of the training industry. This change will likely also be reflected in salary increases for these workers. The human resources

needed for the new industry will include possibilities for both people with a medium education and people with higher education. Working conditions may also improve, as currently most people working in agriculture have a lower salary than the national average and are exposed to various occupational hazards and accidents. People who work in the slaughter of animals are also, in general, exposed to multiple physical and emotional risks at work. Thus, a potential partial replacement of the conventional chain by the alternative may improve working conditions for those currently working in animal production.

Opportunities in a scenario of high engagement with alternative proteins may also include a greater degree of accessibility to products and healthiness. Access may be improved as more options for meat products will be offered to people, which will likely lead to a greater degree of price competitiveness. The healthiness of alternative proteins, as guaranteed by future regulations, may also positively impact the social dimension.

Finally, the number of animals involved in meat production tends to decrease and this may be considered a positive social factor. This decrease would occur mainly with the probable drop in exports of conventional meats from Brazil and a probable decrease in sales for the domestic market, even if it comes from imported alternative meats.

The challenges of a high engagement seem related the reduction of the demand for conventional meat from Brazilian producers. This challenge also likely leads to a reduction in jobs, especially in the stages of animal farming and slaughter. The low average qualification of the workforce involved in the initial stages of meat would undoubtedly be a challenge for these people to find new job opportunities. In addition, even with a high engagement with alternative proteins, it is expected that their price will remain high in the short and medium terms. Another challenge is consumer acceptance of alternative products, mainly related to socio-cultural issues and specific flavor and texture aspects.

Considering a low engagement level with alternative proteins in the country, the opportunities that this new market can bring to Brazil are substantially reduced. However, there may still be some availability of alternative products, mainly obtained through importation, and access to healthier foods. It is expected that the number of non-human animals involved in food production will also be reduced due to the decrease in production levels.

The challenges resulting from a lower degree of engagement seem to involve reducing demand for conventional meats for two reasons. The first is the drop in exports, as abroad the demand for alternative products will not be affected by the level of engagement in Brazil, following its trend regardless of the internal Brazilian scenario. Some announced forecasts for this trend (Gerhardt et al., 2020; Tubb & Seba, 2021) involve a significant degree of substitution in the next two decades. The second challenge is the possibility of increasing consumption of alternative meat via importation. Therefore, the consumption of plant-based products or cultivated meat seem poised to grow, both internally and externally, even in a scenario of low engagement with the sector in Brazil.

With the drop in demand for conventional meats produced in Brazil, the employment of some people in this chain, especially in the farming and slaughter of animals, is likely to be compromised. In addition, not joining the production of alternative proteins will further reduce job positions that would arise with the development of the new industry.

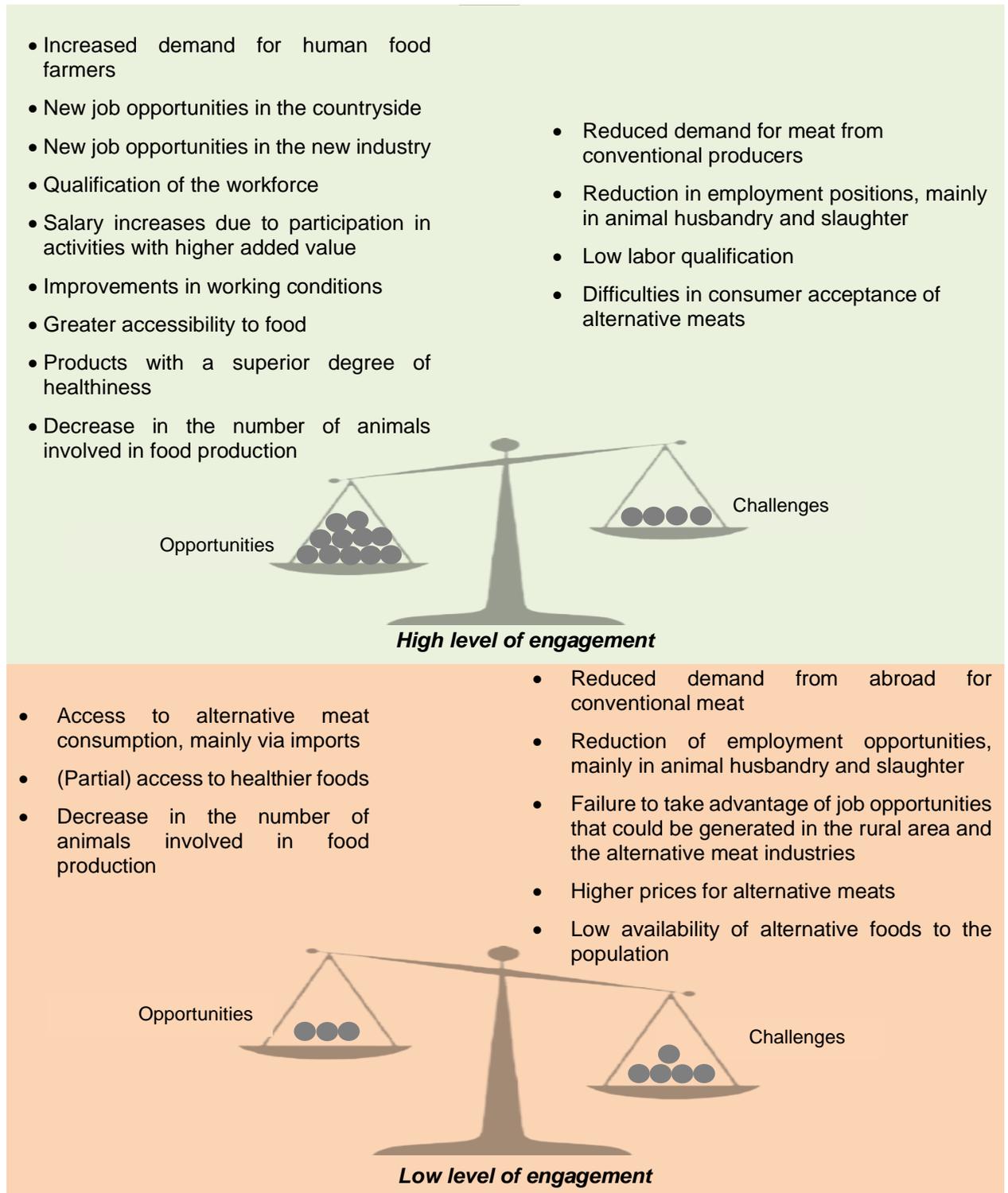
As for the consumer, the social challenges due to the low engagement would be related mainly with lower availability of alternative meat products. Brazilian consumers, in this case, may also experience higher prices for these products, since there would likely be a low degree of national competition, leading to less pressure for reducing costs.

Therefore, considering the opportunities and challenges for Brazil, different scenarios may be outlined depending on the degree of engagement with the alternative meat production chain. Figure 6 expresses an analysis of high and low degrees of engagement in alternative proteins and their effects on the social impact raised with the experts consulted. It demonstrates that the degree of engagement tends to bring serious social consequences to Brazil, significantly influencing the balance between opportunities and challenges.

Regardless of engaging or not in the alternative protein chain, some challenges seem inexorable. These negative consequences result from the potential change in the global consumer market that is announced to come and cannot be controlled by the level of investments in the new industry. Thus, even if the change is smaller than those foreseen by Gerhardt et al. (2020), Tubb and Seba (2021) and Witte et al. (2021), Brazil will face proportional consequences, even if the country opts for a low level of engagement. In fact, a low level of engagement tends to add more challenges to the

social scenario. On the other hand, it is for the list of opportunities that the level of engagement brings the biggest impact to the social aspects of alternative meats. A high level of engagement seems related to a longer list of opportunities as compared to the low level, both considering the domestic market and exports.

FIGURE 6 - Social opportunities and challenges for Brazil with a high or low level of engagement



7 CONCLUSION AND RECOMMENDATIONS

This research studied the social impact that the entry of alternative meat may have in Brazil. For this, we used primary data with 35 specialists from conventional and alternative protein chains, other players in the food sector, and secondary data from official sources.

The results, divided into opportunities and challenges, brought several insights that may be important for the country's future concerning alternative meats. In general, there seems to be more opportunities, mainly due to the various possibilities that the alternative chain represents for farmers dedicated to the production of ingredients, entrepreneurs involved in different production phases, as well as greater chances of access to proteins for a greater number of people and the decrease in the number of animals slaughtered. The main challenges involve the decrease in animal production, which will likely mainly affect the small producer with difficulties in obtaining scale gains, the fall in employment positions in the animal farming and slaughtering jobs, the current high alternative protein prices and issues of acceptance of alternative meat consumption.

Even with these expected results, the variation in how people perceive opportunities and threats can be considerable. Our results have allowed us to expand the analysis and explore how either a high or a low degree of engagement with the new industry can change the social consequences for the Brazilian population. In general, most the challenges do not vary with the country's decision regarding level of engagement, since the changes in the meat market are poised to occur regardless of the degree of engagement of isolated institutional actors or countries. The opportunities that can benefit the Brazilian population depend much more on the degree of engagement. Participating in the new chains and taking advantage of the country's potential competitiveness, especially considering the experience with food production and the abundance of environmental resources, i.e., deciding for a high level of engagement, has the main effect of enriching the list of social opportunities.

To benefit from social opportunities and mitigate the chances of a significant negative impact with the entry of alternative proteins in Brazil, this study presents some recommendations. These recommendations were developed based on the opinions of the experts interviewed, who freely argued about possible strategies to be adopted for

Brazil in terms of expected social impacts, as well as our own perceptions about the study results.

Although the set of institutional actors, including large food processing companies and start-up entrepreneurs, have a strong influence on the expansion of the alternative protein market in Brazil at the moment, public policies may guide the market towards increasing the chances of taking advantage of opportunities and reduce the expected negative impact. Thus, our first recommendation is associated with public policies to develop a broader plan for Brazil. National planning could consider the country's potential, such as experience in agriculture, as well as national needs, such as integration into a global food supply chain with greater added value and the development of products more suited to country's needs and conditions. Related to this national plan, local and regional plans could be developed because they might work better to suit the particularities of each region of Brazil.

Public policy may also seek inspiration from entrepreneurship and innovation ecosystems where alternative meats are advancing rapidly. With this, innovation hubs may create a space for discussions and co-creation among the different players, especially if they are closely related to universities and research institutes. These sites focused on the collaboration of multiple agents to advance innovation and entrepreneurship in the protein chain may stimulate new ventures through incubation and acceleration programs. In addition, these spaces may strengthen relations between the various players in the ecosystem, such as governments, industries, universities and research institutes, as well as potential entrepreneurs in the area.

National public policies to encourage research and innovation with universities and research institutes may also help in the development of alternative meats in Brazil. These organizations may receive incentives to develop new research on different parts of the new protein chain in formation. Potentially, local vegetables may be investigated for their use in plant-based proteins and cultured meat. Brazilian researchers have already given this approach, but public policies to support research will draw the attention of other research centers to intensify the discoveries. The focus on research and innovation will open a new market for Brazil to supply the domestic market for ingredients and become a global supplier. In addition to ingredients, the research may involve other parts of the chain, such as means of cultivation, structures, food impressions, product health, energy savings, among others.

Public policies related to education may be implemented on two fronts. The first involves creating or expanding technical courses that will serve as a basis for people who are qualified to work in the alternative meat chain. The second form of public policy strategies involves the need to readjust part of the grades of higher education courses related to the agribusiness sector to encompass the specificities of alternative meats. The creation of specialization courses will also be stimulated so that people already graduated can learn technical and management aspects of the chain that is being formed. These courses at their various levels may help reduce the chances of unemployment for people with livestock activities, as well as expand the possibilities for more people to be able to work in this new industry. In addition, training people helps to supply specialized labor to existing industries, which already have needs for qualified human resources, as well as for those who must be trained.

Regarding farmers, especially those running small farms, in the conventional agricultural and livestock activities, existing institutions linked to the government may help the transition to a model of greater presence in the alternative meat chain. Support for these people would involve training, technical consultancy support, research to find national and low-cost ingredients that may be produced by local producers, among others. These strategies will benefit existing producers, as well as potential actors, to take advantage of the opportunities that should occur in the field.

In the domain of consumers, collective policies from players in the alternative meat ecosystem may help clarify constant uncertainties and prejudices regarding new foods. Social marketing campaigns have already demonstrated the main benefits of these products. Although, they could be intensified, seeking to provide consumers with more information to make their purchasing decisions consciously. Addressing environmental and animal welfare benefits as well, in addition to just nutritional and flavor, may also be fruitful.

We hoped that the results in this report can contribute for actors in the institutional environment, particularly public policy makers, to make informed decisions leading to more social opportunities and less challenges for the Brazilian society. Although the focus of this study was Brazil, other large food-producing countries, especially developing nations, may find our analysis useful for their own expected social impacts.

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