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Will the Cows and Chickens Come Home? Perspectives of Australian and Brazilian Beef and Poultry Farmers towards Diversification

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Abstract: Farmers across the world face criticism on environmental and animal welfare concerns, as well as are increasingly being affected by climate change. We explored the willingness of cattle and poultry producers in Australia and Brazil to consider alternative enterprises and diversification of their businesses. Twenty-seven farmers, 14 from Australia and 13 from Brazil, current or former beef or poultry producers, were interviewed to explore their perspectives about making such changes. The interviews were qualitatively analysed using Atlas.ti to generate key insights. Although the farmers were actively interested or had engaged in alternative enterprises, they recognised these presented a less certain future if they had been previously contracted to large companies. Some were critical of their respective governments and former contract companies for lack of assistance in finding suitable alternative enterprises. Farmers showed inconsistent recognition of the current challenges of animal production in relation to climate change. Our results indicate that most farmers are open to diversifying, but they face many challenges that have serious connotations. Public policies, knowledge transfer and a secure demand for alternative products emerged as major influential factors for Australian and Brazilian farmers in a fast and just transition from meat cattle and chicken raising to alternative activities.

Keywords: beef; climate change; environmental; sustainability; business challenges; plants; poultry



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1. Introduction

The animal farming sector is increasingly criticised for excessive use of land, water and grains suitable for feeding humans [1], negatively impacting food security, as well as for greenhouse gas emissions contributing to climate change, overuse of antibiotics leading to the spread of antimicrobial resistance, and poor welfare of animals within the farming systems [2–4]. Studies with regenerative animal farming represent attempts to improve this scenario (e.g., [5]); however, there is uncertainty regarding the ability of such improvements to mitigate the situation.

Furthermore, the future of farmers around the world is becoming increasingly uncertain because of climate change impacts and other environmental challenges [6]. Within the prevailing market economy, globalisation, government policy and new technology development, combined with other economic and social forces, are at the forefront of changes in animal production systems, influencing traditional business models, supply chains and patterns of employment [7]. Current market forces are driving increased demand in some animal production systems, most notably poultry, which is resulting in widespread

environmental problems and causing ecological degradation [8]. These challenges are bringing a pressing need for a move toward diversification of animal enterprises, aiming at producing quality food, building rural capability and meeting environmental and animal welfare goals.

Animal farmers are often from the lower end of socioeconomic development and need support if they are to make changes to their enterprises without severe hardship [9]. The transformation of the food production systems involves a complex and systemic process where social and institutional factors play a significant role. Efforts to accelerate changes are better served when aligned with social and political processes [10] and associated with the idea of leaving no one behind [11]. In practice, this means building alliances, dialogue, and trust around the food system development, ensuring good governance and a suitable regulatory environment to achieve the desired outcomes.

Animal farmers may resist change, including attempts to help them migrate to more sustainable enterprises. Bryant and van der Weele [12] reported the polarization that occurred in the Netherlands in 2019, when more radical animal farmers, who did not believe in dialogue, reacted with violent protests against the government's initiative to steer the sector towards more sustainable production. Most farmers (73%) denied the problem of nitrogen emissions, and young farmers embraced radical actions in a "Farmers' Defence Force". Any previous willingness to make animal farming more sustainable disappeared. Therefore, there seem to be benefits from a better understanding of the whole sector, including the farmers' perspective.

Animal farmers may be categorised into three groups, based on psychological analysis [13]: fatalists, traditionalists and entrepreneurs. This is related to farmers' personal and work outcomes and also business success. Small farmers are more likely to be fatalists, owning and selling less livestock, less well educated, but technically just as competent as the larger farmers. Diversification of enterprises provides some security, whereas reliance on intensive monogastric production uses a lot of resources and exposes farmers to business risks [14].

New technology combined with a digital, connectivity-fuelled transformation [15] can help accelerate a transition to healthier food production systems, where alternative proteins play an increasing role [10]. The transformative power of such new technology depends on the economic and political context, societal needs and overall socio-economic conditions. Strategic investments are sought and highlight the potential contribution of the private sector in driving the adoption of alternative enterprises [16]. There is also a need to establish regulatory frameworks and market structures to ensure alignment with the objectives of public policies.

We sought to understand how animal farmers perceive these issues and capture their willingness to participate in alternative enterprises, as well as to identify their ideas about how to effectively implement such diversification. The views of cattle and poultry farmers from two of the world's key food-producing countries, namely Australia and Brazil, were studied regarding the current market, as well as opportunities and challenges of diversifying into other products. Brazil has approximately 2.9 million chicken farmers, with 1.4 billion meat chickens, as well as 2.5 million beef cattle farms of all sizes with 232 million cattle [17,18]. Australia has about 800 chicken meat farms and 19,400 beef cattle farms, with 24.4 million cattle that have an estimated value of agricultural operations of AUS 40,000 or more [19,20]. Studies in South America have shown that the risk of disease causes significant stress to the many smallholders, many of whom lack basic sanitation facilities [21].

Our research aimed to understand the perceptions of beef and poultry farmers about potential diversification or leaving the animal industry under existing pressures [22]. We wanted to understand their current situation and gauge the effects of potential changes in the market as a result of, for example, climate change and society's increased awareness and demands regarding animal ethics. An improved understanding of the issues may ultimately assist farmers in these sectors to better leverage or create opportunities.

2. Materials and Methods

The term “beef farmer” was chosen, rather than cattle farmer, to describe farmers who raise cattle animals only for meat, not including dairy farmers. “Poultry farmer” includes farmers commercially raising any kind of birds (e.g., broiler chickens or ducks) for meat or eggs. We utilised qualitative analysis of in-depth interviews and focus groups with farmers conducted in Australia and Brazil to understand animal farmers’ motivation and perceived opportunities and challenges to diversify their current enterprises into alternative agricultural systems. Their participation in the research project was voluntary, with no direct monetary or other benefits and with the option to exit the study at any point if they no longer wished to be part of the research. All participants were asked to provide formal consent for their participation in either focus groups or in-depth interviews.

The interviews and focus groups were audio- or video-recorded and then transcribed verbatim. All information provided in the recordings was anonymised. Transcripts were analysed using the qualitative data analytical software Atlas.ti, (23) (<https://atlasti.com/>) by highlighting the essential quotations that corresponded to certain coded categories. The software used artificial intelligence (AI) to create an analytical system of nodes for coding and interpreting the collected data. It also prepared appropriate quotations from the coded data. The AI assisted operational coding, but as researchers we analysed and interpreted the results. Atlas.ti uses OpenAI’s Generative Pre-trained Transformer (GPT) model for open and descriptive coding, trained with scientific texts and interview transcripts in Cloud-based learning. The Concept tool eliminates superfluous words and discovers the main concepts presented in the data. It has the ability to automatically look for synonyms and inflected forms of a word. It was chosen because it favourably compares with other popular analytical software [23].

Farmers were invited to participate based on the selection criterion of being current or former poultry or beef cattle farmers with at least three years of experience in the industry. Additionally, the participating farmers had to have considered leaving the animal production industry or have already left the industry within the last two years. The final criterion was for the participants to be adults of at least 18 years of age and currently either an Australian or Brazilian national. In Brazil, given the positive state of animal production at the time of the interviews, no participants could be found who were considering a change in their animal production activities; however, we interviewed farmers who shared their opinions about diversification of their activities to include non-animal food chains and new scenarios that may affect them in the medium or long term. The situation in Australia was different, with many farmers considering alternative opportunities.

The key questions used during the in-depth interviews and focus group meetings (Table 1) were based on a protocol agreed upon between the research team in Australia and Brazil. The Australian and Brazilian teams held five preliminary meetings to determine this protocol and piloted it on two farmers. It included general questions related to the business (e.g., challenges and opportunities), and then the questions distinguished between farmers who had made the change (e.g., about their motivation and support received for the change) and those who were considering doing this (e.g., about influences and factors that might contribute towards a change). The questions were only used as guidance, and a free flow of the conversation was encouraged. During the interviews, additional questions were asked if necessary to clarify what was said or to obtain extra information as appropriate for the planned research outcomes.

Farmers were invited to participate in the study after we obtained their details either by word of mouth or from a range of farm-industry and other related bodies. In Australia, these included the New South Wales (NSW) Farmers’ Association, Queensland United Egg Farmers, Western Australian Farmers’ Federation, Runnymede Farm (a hobby farm producing pasture-raised eggs and grass-fed beef), the North Australian Pastoral Company (NAPCO), Farm Transitions Australia, Humane Society International Australia, Agribiz Pty Ltd., AgHiTech Ltd., Food Futures, the Royal Society for the Prevention of Cruelty to Animals Australia and the Wildlife Land Trust. Similarly, in Brazil, we contacted animal

farmers' and other agricultural associations as well as non-governmental organisations (NGOs) involved with animal causes, such as the Forum Nacional de Proteção e Defesa Animal, Animal Equality Brazil, Mercy for Animals Brazil, Brazilian Vegetarian Society (SVB) and Sinergia Animal Brazil.

Table 1. Guiding questions for interviews with individual or focus-group beef or poultry farmers in Australia and Brazil.

Opening questions	Tell us about yourselves. What types of farms do (did) you have, and how long have you been in business?
General questions	What are the key issues nowadays farmers are facing? What do you think are the perspectives for the industry—short-term and long-term? What are the opportunities for your business?
For farmers who had made the change and had transitioned to other types of production	What motivated you to make the change? How long have you been considering the transition? Did you make any changes to your animal business to improve it before the transition, and when and why? Did anyone or any organisation have a particular influence on your decision to make the transition? Did anyone or any organisation have a particular influence on your planning for the transition? What encouraged you to change your cattle/poultry farming business? Was it easy? How diversified is your business? Did you receive any support, and from whom?
For farmers who had not decided to make a change but were thinking about it	What will motivate you to make the change? Describe the care you take of your animals. What will influence you toward making a change in your current business? What will encourage you to make a transition? What will it take? (e.g., climate change, economic, methane production etc.) What will discourage you from making the change? (e.g., risk, economic concerns etc.) Are there any subsidies or other incentives for switching to other activities for transforming your business into a plant-growing business, and will you be willing to switch and why? Would you be willing to make a change to reduce any risk? What would that be? Have you thought about diversification toward production with a lower environmental footprint from what you are currently producing? Are you aware of any agri-food technological and innovation solutions that could be beneficial for your business?
Concluding question	Would you like to add something else that is of importance to be mentioned and wasn't discussed?

Initially, we planned to interview 15 farmers from each country in two focus groups: one group of farmers who had transitioned away from poultry or had considered this, and one who had transitioned away from cattle or had considered this. However, due to the difficulty in finding interviewees with the desired profile and willingness to participate, most of the interviews occurred individually. Despite this change in methodology, e.g., replacing focus groups with individual interviews, we believe there was no loss of content, and we were able, in this way, to preserve individual farmer confidentiality. We aimed for a saturation of the information with progressive interviews and considered this achieved when with each subsequent interview we received had content that repeated the opinions of farmers previously interviewed.

The participants in the study were all current or former poultry or beef farmers. In Australia, two focus groups with two farmers in each and 10 individual interviews were conducted between August 2022 and May 2023. The interviewees were farmers from New South Wales, Queensland and Western Australia, representing a broad range of Australian conditions. In Brazil, the results were obtained through eight individual interviews and two groups—one with two and the other with three participants—of current or former poultry or beef farmers. The interviews in Brazil were conducted between June 2022 and March 2023. All Brazilian participants were in the south of the country, except for one farmer in the State of Sao Paulo in the southeast region of Brazil. Table 2 provides detailed characteristics of the farms owned by the participants.

Table 2. Type of animal production, location and size of farms in Australia and Brazil.

Farmer #	Type of Production	Location	Size
<i>Australia</i>			
1	Poultry and beef	New South Wales	279 ha, 10 sheds
2	Poultry	New South Wales	129.5 ha, 6 sheds (100,000 chickens)
3	Poultry and beef	New South Wales	20 ha
4	Poultry	New South Wales	26 ha, 13 sheds
5	Beef	New South Wales	182 ha
6	Beef	New South Wales	67.5 ha
7	Beef and sheep, conservation	Queensland	58 ha
8	Beef	New South Wales	486 ha
9	Beef	Western Australia	235 ha
10	Former cattle, sheep and poultry transformed into conservation area as wildlife sanctuary	New South Wales	129.5 ha
11 and 12	Former sheep and cattle farm transformed into conservation as wildlife sanctuary	New South Wales	40 ha
13 and 14	Former sheep and cattle farm transformed into conservation as wildlife sanctuary	New South Wales	57 ha
<i>Brazil</i>			
15	Poultry	Parana	4 sheds
16	Former poultry	Parana	n/a
17	Former poultry	Parana	n/a
18	Poultry and crops	Parana	0.18 ha (shed size)
19	Former poultry, now crops	Parana	0.12 ha (shed size)
20	Cattle and crops	Parana	1000 ha
21	Cattle and crops	Rio Grande do Sul	8600 ha
22	Cattle	Rio Grande do Sul	1970 ha
23	Cattle and crops	Parana	358 ha
24	Cattle and crops	Parana	358 ha
25	Former cattle, now crops	Parana	8500 ha, 2500 ha used for crops
26	Cattle and crops	Sao Paulo	324 ha
27	Cattle and crops	Santa Catarina	400 ha

The interviews lasted approximately 1–1.5 h each and followed the same structure, starting with an open-ended question seeking information about the farm location, size,

type of farm and years in business. Then, the conversation approached key issues that farmers were currently facing and their perspectives on both the industry and their own businesses. This was followed by questions about what had motivated or encouraged them to make a change toward diversification or what was likely to do so in the future (Table 1).

Although the interviews were led by the interviewers, the interviewees were frequently invited to make comments as they wished. The interviews were conducted and recorded in English and Portuguese in Australia and Brazil, respectively, to maintain the quality of the conversation, giving opportunities for the participating farmers to communicate in their native language. All collected data were then transcribed. In addition to performing the interviews, the researchers familiarised themselves with the dataset through careful reading of the transcripts to identify the main emerging topics. The transcripts were then loaded into the Atlas.ti 23 software for further analysis. These generated themes based on the material from the interviews and focus groups. The main themes suggested by the AI were cross-checked with the previously identified themes by the researchers. This helped confirm the main points which, according to the farmers, may reduce risk and identify whether they considered it possible to organize and implement diversification. Results are presented in figures and tables. The quotes from Brazil were translated from Portuguese into English.

3. Results and Discussion

The study achieved saturation with 27 participants in total, 14 Australian and 13 Brazilian farmers.

3.1. Australia

The responses of the participating Australian farmers gravitated around six major themes: the agriculture industry, environmental conservation, business challenges, human behaviour, obstacles to diversification and future concerns. All participants were aware, to a different extent, that successful farm diversification requires thorough planning. They also reported realistic assessments of personal objectives, skills, resources and market prospects. However, most respondents were either not prepared to make the step toward a business change or, if they had taken such a step, they were in the establishment stage. The participating farmers who were more advanced in their diversification practices were those who had moved into conservation.

3.1.1. Agriculture Industry

Choosing the most suitable form of diversification was a critical decision for Australian farmers. They willingly and repeatedly shared the many obstacles they faced. Climate change-related issues, lack of opportunities due to discontinuation of animal and agriculture industry contracts, loss of interest by the family toward their existing business practices, and absence of suitable land or sufficient investment were among the many factors influencing their decision to either keep the existing businesses or try to diversify toward something new (see Table 3). Similar issues were identified in relation to the increasingly warming Australian climate and the effects of the recent tougher climatic conditions on the practices and profitability of Australian farms [24,25].

The structure of the existing farm business was stated as one of the major challenges. Three of the poultry farmers reported many efforts without a clear outcome. After their contracts for growing broiler chickens were discontinued, they faced distress. All participating farmers were open to change and examined in detail the current status of their farms. Whilst aiming at finding ways to transform their current activities, they noticed that there were not many opportunities available, particularly as they did not receive any support from the government or local councils. The situation is emblematic of Australian poultry farmers being forced from the industry and currently struggling to operate in an increasingly consolidated market [26]. When supplying to a major poultry company, they were not reimbursed, nor was another business avenue offered. There was a lack of

affordable business opportunities to generate reliable income. The Australian Competition and Consumer Commission (ACCC) investigation of the country's biggest chicken meat processors' concession practices [27] points in the same direction.

Table 3. Number of mentions for a specific term related to agriculture industry during the conversations with the 14 Australian farmers interviewed between August 2022 and May 2023.

Term	#	Term	#	Term	#
Agriculture	54	Investment	4	Duck breeding	2
Entrepreneurship	15	Monopoly	4	Regenerative agriculture	2
Small-scale farming	14	Income diversification	3	Challenges	2
Land management practices	9	Sustainable agriculture technique	3	Industry changes merger	1
Economics	8	Tree conservation	3	Medicinal marijuana	1
Business management planning and strategy	7	Fruit tree growing	2	Hydroponics	1
Business opportunity, growth and development	7	Farm diversification	2	Horticulture	1
Livestock breeding	4	Aquaculture	2	Mushroom growing	1

Three farmers had already explored and implemented other activities, such as converting broiler chicken sheds into laying hen sheds or trying new activities, such as aquaculture, hydroponics, and raising ducks. All these were small-scale family businesses trying to diversify into new successful enterprises. Careful consideration of the new enterprise(s) was believed to help in reducing risk and securing prosperity for them and their families. To minimise the risk, these three poultry farmers were looking for a low level of initial investment into diversification.

"I'm doing some duck eggs. . . [to] have some income coming in. And I was leasing a processing plant that was close to me, but unfortunately people that own that have moved on and they've sold it; so, I'm back to square one again." (Poultry and beef farmer, NSW)

A similar objective was behind the duck and aquaculture alternatives. These businesses represented the farmers' tendency to choose a form of diversification that was both technically feasible and potentially able to quickly generate a steady income.

"Well, we looked at the eggs business and also. . . looked at doing ducks in a fairly big scale for not much investment, but it would be something we need to contemplate doing because there's no duck processing in the north of Sydney." (Poultry farmer, NSW)

"We could make ducks without spending a fortune on our farm, but we will need money for processing plants and hatchery and some start-up money. . . , but you. . . could be left with nothing if there are no markets, and again devaluation in your assets. . . is what could happen, but at least you could start with little using what you've got. . ." (Poultry and beef farmer, NSW)

The long list of small-scale farming enterprise activities without substantial initial investment mentioned by some of the farmers was notable, but so were the obstacles.

"We looked at many things. Fish farming. . . is very costly, (fish have) a short fresh life and are very hard to sell. Also, we had a few plans for mushroom farming and the other idea was for farm tourism. We could reload our broilers sheds and turn them into caravan storage and self-storage. But. . . it happened that you can't do this on your own property, because it is. . . a rural area and if you want to do this you've got to get it rezoned. . ." (Poultry farmer, NSW)

Two poultry farmers explained that the monopoly and the big agribusiness' purchasing power were creating an unlevel playing field. If they had to merge, and this is particularly what the smallest farms were facing, they were likely to go out of business. A similar fate faces many Australian farmers [28]. The issue is of concern for small independent farmers who have seen big conglomerates absorb competitors with government support. This monopolistic behaviour does not allow them to start a new business. Similar negative feelings were shared about the failure to get grants to support new business ventures.

"We are open to any options whatsoever, we need guidance. We've looked at... medical marijuana... flowers... mushrooms... maybe we can look at other plant-based options... but it seems for everything to start you need capital... There's one guy... he did a trial [of mushrooms] and he said it looks viable. But he didn't have the money to get the equipment to be able to produce these mushrooms, because it's just so expensive." (Poultry farmer, NSW)

The lack of resources is something that all farmers saw as a major barrier to achieving positive results for their future enterprises and ideas.

"We want to do a hatchery... we haven't got the infrastructure yet but... we have between us... \$50 million worth of chicken-growing infrastructure in this region. The monopolist that discontinues our contracts is doing absolutely nothing and we can't utilise what we currently have because of lack of available investments... You take chickens and grow them up to 16 weeks and they as hens start to lay eggs, this is a business for a lifetime. You haven't got to spend a lot of money on changing your existing sheds to use them for egg production. You just need two or three million to get into it. But it is questionable... whether you can compete against the big boys, as small farms like us are not the same as Sunny Queen eggs or Steggles who've got most of the markets." (Poultry and beef farmer, NSW)

According to the answers, reliance on self-sufficiency was the only way to support the new ventures which farmers were trying:

"... well, together [with] my parents we are in the cattle business... They pay our loan back to the partnership on adjusting the land, the cattle are... what's kept us going..." (Poultry and beef farmer, NSW)

Some of the farmers were very proud of their cattle ranching and the other agricultural activities they were involved in, as well as of the farmers and people supporting their businesses:

"We have lots of supporters which is great... Extensive livestock production industries were and still are vital to the national economy of Australia... It is a leading source of agricultural income... It will be stable. People will not be going to stop eating meat. Also, the industry is constantly trying to meet the increasingly high welfare standards which are without any specific ground and are also quite challenging sometimes." (Beef farmer, NSW)

Another farmer perceived the idea of looking after different animals as a viable option for regular income:

"I was primarily a poultry farmer when we bought the farm, but we added some cattle to... have a stable income because it didn't involve a lot of money, but you need sustainable livestock to... keep you going and... we also have additional benefits from the cows—they keep the grass mowed." (Poultry and beef farmer, NSW)

A thorough investigation of the farm diversification options was also influenced by the interests of other family members, especially the younger generations.

"There are some real opportunities for me for agricultural and horticultural development I can build upon and most importantly I am away from cattle

farming which lately was quite intense and even a bit heartbreaking, especially during droughts and unintended slaughter times. My grandchildren were very upset of the whole situation and actually this was my breaking point to give up. . . my cattle farming and look for a change. . . It was scary at the beginning, but the grandchildren are who made my move. . . easy.” (Beef farmer, NSW)

Five farmers felt that any potential expansion of the activity they had just started to diversify their existing business should occur gradually. The reasons for this were to minimise the risk and to use the ability of the current business to either support a new idea with no substantial financial input or to generate cash flow to back the expansion.

“Every new business requires some kind of financing. Planting a few citrus trees is one thing, but to turn this into a business, there must be at least hundred trees. . . I think that even if I decide to start growing citrus, and especially mandarins. . . I will never give up my cattle farming as they could secure the financing of my business.” (Beef farmer, NSW)

One beef farmer found moving to a citrus growing business would not only help him to secure some cash flow but also to develop good personal relationships with his grandchildren:

“Moving to Riverina. . . , I did my homework well. Despite the risk, . . . I wanted to cement my relationship with my grandchildren and to be their favourite grandpa again. . . I am not thinking of this as a transition as I am still probing but my chances are pretty good if played well. The region is Australia’s largest citrus-growing region.” (Beef farmer, NSW)

Others were relying on the existing environmental resources to support their new business entrepreneurship ideas:

“Availability of water to support irrigated agricultural produce is a major economic driver for me to start my farm in the Western Riverina. . . We were struggling in Goulburn with the regular water supply. Because of irrigation, it is possible for rice processing, wineries, citrus processing, sugar plums, tomatoes and more recently I started developing an almond-packing shed. I am trying a bit of everything. . . Rice and horticulture producers make up I heard around 90% of the farm businesses here. You can see it as diversifying. . .” (Beef farmer, NSW)

Four farmers reported misunderstanding by the existing government institutions and municipalities when financial support was sought. In some cases, they described their situation as very difficult:

“Investment corporation, . . . to try and get a little bit of capital. . . I don’t meet the criteria, being a starter and a small farmer. They are monopolists. I’ve tried and. . . I’ve been to the. . . rural financial counselling service for New South Wales. . . We do cash flows and things like that, but they just seem to be not supportive. . . We keep hitting brick walls with local government and then councils don’t really want to know you because you’re not big enough to compete with. . . monopolists.” (Poultry and beef farmer, NSW)

One farmer was using regenerative farming [29] to achieve better business opportunities, including being able to build resilience to climate change challenges.

“Regenerative farming, I think, will help me improve my long-term livelihood as a small-scale farmer and conserve resources. I added it to my chicken growing and this helped me. . . It will reduce costs, and improve crop yield due to the rotation and also the crop quality, which I think will give me better resilience. . . if my chickens are infected with bird flu or anything. With COVID-19 these things are a worry. This will help me survive market volatility and also any extreme climate events—droughts, or flood. . . It. . . could open some new green income

streams for me. . . It is difficult to survive as a farmer these days if you don't think of something else you can do to help yourself." (Poultry farmer, NSW)

Overall, all farmers were concerned about the future of their agriculture businesses. There were only a few who had tried to build resilience by switching to other products, such as fruit trees and aquaculture or by adopting regenerative farming. The majority of farmers were of the opinion that their businesses were still viable despite challenges related to land management practices. They were not considering major changes, particularly as they were finding it difficult to raise capital for any new ventures. As Table 3 shows, after "agriculture" with 54 citations, "entrepreneurship" attracted the highest number of mentions, followed by "small-scale farming" and "land management practices".

3.1.2. Environmental Conservation

In the context of climate change and other environmental challenges, agriculture has become a complex business. Most Australian participating farmers were aware of the sustainability issues they were facing and the hardships they may bring (see Figure 1). The changing natural elements increase the vulnerability of the agricultural sector and, at the same time, emphasise its reliance on nature and the land. In fact, farmers increasingly face difficulties when trying to adapt to new climatic circumstances, a complex adaptation that often also has to be fast. Farmers in Australia are already exposed and have had first-hand experiences with extreme weather events, such as droughts and floods, which affect the livestock [30–32], reducing the Australian farms' average annual profitability by 22% over the 20 years to 2020 [25]. Wildfires are similarly threatening their livelihoods and animal welfare.

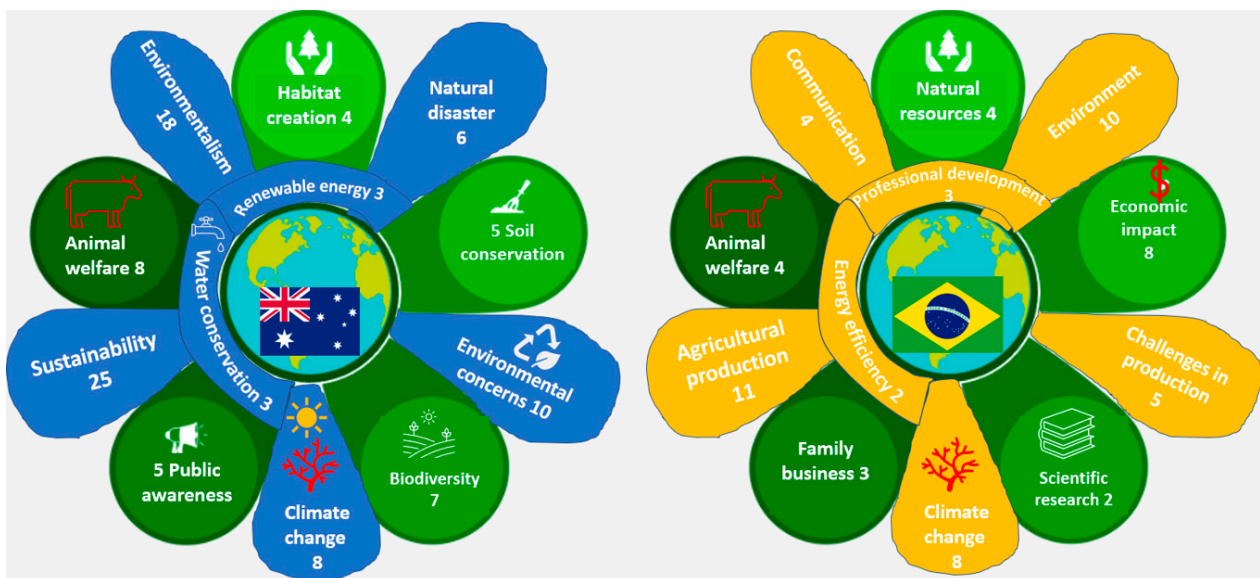


Figure 1. Number of mentions related to environmental conservation, animal welfare and associated aspects during the conversations with the Australian and Brazilian farmers interviewed in 2022–2023.

Farmers stated agriculture's sensitivity to climate change, the complexity and vulnerability it brings to them, their families and the livestock. One of the participating beef farmers vividly described:

"Mainly climate. We know livestock production is already affected and will be affected by changes in temperature. . . Flood, drought, you name it, we are experiencing it on our backs. . . in the Southern Tablelands and Southern Highlands region. Sometimes the post-drought effects are catastrophic. . . Other things like staff shortages, especially in the COVID times, was a big issue. . . , transport logistics problems [too]. . . We all need to improve our farmer bushfire preparedness to

be ready to deal with fire events. Lately they seemed a lot. . . This causes complex issues, mainly welfare issues with the animals. These are unforeseen disease. . . problems with trade and even environmental catastrophes.” (Beef farmer, NSW)

Another farmer also expressed similar environmental concerns but also linked them to animal health and the spread of diseases:

“As farmers we’re worried about many things, from cattle tags, shortage of feed resources, clean water, extreme heat and drought, fertiliser, vaccines, to low productivity and potential outbreaks like foot and mouth disease, IBK [infectious bovine keratoconjunctivitis], ringworm, Q fever, chlamydiosis, leptospirosis, campylobacteriosis, salmonellosis, listeriosis. You have to be ready to deal with any of these. It’s. . . hard sometimes, especially if you are forced to run a family business you inherited. . .” (Beef farmer, NSW)

Not having control over environmental changes and the unpredictable elements dictating weather patterns were central issues for six interviewed Australian farmers.

“Lots of weather changes. . . unpredictable weather patterns, drought, flood, fighting with the environment. . . soil erosion, whatever comes. . . plus lack of money, declining production prices. . . big companies’ competition. . . These are not. . . factors you can control yourself. There are many uncertainties.” (Poultry farmer, NSW)

Five Australian farmers expressed an opinion about the indispensability of the cattle industry, in particular, due to the country’s love for meat, irrespective of any environmental and climate change challenges. This was put within the context of the high demand for Australian meat locally and internationally because of its good reputation.

“If we leave aside the weather problems that farmers have to deal with, I think the prospects for the development of the sector are great. Beef is one of the most preferred [meats] by consumers in Australia. . . I find it very hard to imagine them replacing it with anything else.” (Beef farmer, NSW)

“We have a small share, I think it was around 15–16% of the global beef production. But one of the best meats. We have a reputation for being clean and disease-free industry. I think the role of the livestock will be still huge.” (Beef farmer, NSW)

“You have to have a good knowledge of your soil, water and plants’ function to produce healthier animals and healthier food. Everybody is looking for meat these days. . . for good, juicy, healthy meat. I am happy with my production. We sold quite a few tonnes for China and for the Middle East.” (Beef farmer, Western Australia)

Another farmer felt similarly:

“The beef cattle industry right now. . . is booming. Absolutely booming—two and three times more than what we were getting about three to four years ago. People like eating meat and also Australia is exporting meat.” (Beef farmer, Queensland)

Responses often implied that the interviewed farmers may not yet be prepared for diversification from their existing animal practices. On the other hand, while acknowledging the environmental challenges, potential solutions to adapt to climate change were not evident.

It was also revealed that some farmers denied the role of animal production in causing climate change; they wanted to talk about their own farms’ contribution to mitigating future climate change. One farmer acknowledged that the climate was changing but not that cattle were at all responsible. He believed that the change in the climate is completely due to natural cycles.

“Environmentally, cows and farmers are working together. . . The climate, . . . the drought, the flood, does seem to be changed over the years as we don’t appear to get proper seasons anymore. I disagree that cattle are significant greenhouse gas producers as many are stating. . . They are better than us. . . They are our babies.” (Beef farmer, NSW)

Although denying climate change, the same farmer changed his opinion later in the interview about the cattle’s contribution to greenhouse emissions, showing inconsistency or perhaps a lack of information about the climatic burden the animal industry brings to the environment.

“Apart from the greenhouse gases contributing to some climate change issues, cattle are fine. . . I am just sharing my opinion based on years of experience.” (Beef farmer, NSW)

Any new agriculture business diversification was perceived by respondents as dependent on respect for the environment, the land and the soil. One farmer referred to this care as due diligence. Growing plants was seen as directly related to the agricultural conditions, while livestock was perceived as less dependent on the land.

“I was thinking of growing cannabis. It seems profitable. I was thinking to secure a planting permit to satisfy all regulations. You need fertile land, irrigation, and a good climate to grow it. But also, you have to do your due diligence in protecting agricultural land.” (Beef farmer, NSW)

Four farmers were involved in activities resulting in a reduction in the footprint of their agricultural practices, with potential positive outcomes for climate change mitigation.

“I just put [a] few years back some solar panels on the barn roofs. This is one way I found efficient to reduce the heating cost of my poultry units by generating heat using renewable energy. . .” (Poultry farmer, NSW)

The health of farm animals was also an issue of concern for some farmers, particularly given the challenges of market prices and the provision of good living conditions. Farmers also reacted to the rejection by potential consumers of livestock animals raised in intensive conditions.

“I am not growing my chickens on a factory farm. They are ‘eco-chickens’. . . I have to be looking at. . . my chicken potentially to be carriers of disease, salmonella, food safety pathogens, different pests. . . many issues you have to be careful about. On top of this I am fighting with the elements, the production cost and also selling prices. Everybody wants to eat cheap food, but no one knows how difficult it is to raise a chicken. . . I always want to be upfront when I am thinking about transition. . . You really need to think about the hardship when you start to grow something completely different and. . . the financial risk you take on in converting your existing business into something else. I preferred to leverage it by adding something in like my idea with the veggies growing to help me with what I already have.” (Poultry farmer, NSW)

“My business is going well. Of course, there are many issues with grazing and pasture, I heard some of the farmers have not so smart practices, some. . . have inadequate veterinary care, causing their livestock to become sick or even die from infection and injury. I am regularly doing everything I need to avoid all of these bad practices.” (Beef farmer, Western Australia)

“I’m very aware of the green movement. . . I was one of the first people to go to land-care meetings so we can (claim). . . Landcare as an organization. That influenced me very much.” (Former beef farmer, NSW)

For Australia (see Figure 1), after “sustainability” with 25 citations, “environmentalism” attracted the highest number of mentions, followed by “environmental concerns”,

“climate change” and “animal welfare”. The overall impression from the conversations with the farmers was that they are well-aware of the environmental challenges and risks to which their business is exposed. However, market demand dictated their business practices to a certain extent. Disease outbreaks and the spread of infections were issues of concern. Environmental challenges are intertwined in a sustainability agenda which often puts economic viability first.

3.1.3. Business Challenges

Most Australian farmers shared that much of their concern was rooted in business-related challenges and issues (see Table 4). Some found it very challenging for their business to keep going due to the increasing power of big companies and enterprises:

“I have a four-shared farm with my parents. They are mixed farms with cattle, . . . beef cattle and poultry. Two years ago, we lost our contract for the poultry broiler production to Inghams. . . There’s been no opportunity to go to another processor. . . It’s all about the big guys, all about monopolistic development.” (Poultry and beef farmer, NSW)

A poultry farmer described investment struggles as a big business challenge that needs to be overcome before getting back into business.

“We found it extremely difficult because we’ve just lost our income that had 12 months-notice and then it’s been very hard to find another business to replace the poultry farming. A transition to something different. . . and what we can do with tunnel-ventilated shared shed spaces that have been specialised for broiler chickens and we’ve spent a lot of money to get it to that high-standard. . . We’ve looked at additional high and low investment. We’ve been to a lot of consultancies—from agriculture firms to inviting big companies and advisers to come down and look at our sheds. . .” (Poultry farmer, NSW)

Table 4. Number of mentions related to business challenges and associated aspects during the conversations with 14 Australian farmers interviewed between August 2022 and May 2023.

Term	#	Term	#
Entrepreneurship	19	Economic opportunity	6
Business/small business	17	Business expansion and growth	5
Diversification	10	Market competition/trade	5
Risk-taking and management	10	Income diversification	4
Financial constrains	10	Government bureaucracy, policy and regulations	4
Investment	9	Monopoly	4
Business strategy/development	9	Barriers to entry	4
Business planning and realisation	9	Market demand	4
Innovation	7	Tourism industry	3
Logistics	6		

Many of the challenges reported were related to economic concerns. Farmers expect to have access to some kind of government, including the local council, subsidies and the lack of such opportunities were reported as barriers for small businesses to be established and potentially thrive.

“In our situation with no income it’s very hard to get any support. We’ve been to government bodies, we’ve been everywhere and we’re still sitting here. . . with our poultry sheds empty—poultry sheds that have been devalued by 80%. And [there is] no real solution on how to get them back up and viable. . . I run a small

farm but due to the restraints on capital I can't make it viable overnight, because I just cannot borrow more money" (Poultry and beef farmer, NSW)

Farmers shared that they were struggling after diversifying their business in the expectation of potential benefits. They initially thought diversification would be suitable to pursue as a new business opportunity.

"I thought there would be some subsidies from the regional government for oranges' growers, but there was not much there. As the majority of the oranges are grown up in farming families rather than corporate farms, growers are guaranteed service under the provisions of the Riverina Citrus. I am still trying to figure out how growers like me can remain financially viable." (Beef farmer, NSW)

Another related challenge is finding the right business with respect to local characteristics and climatic conditions.

"Our climate zone is not the best one. We have hot dry summer, cool winter. Farmers like me are relying merely on the rain they get, and the amount of water in their dams or streams. Soil is also not the best. . . mostly variable, including deep yellow sands, gravels, clay loams and heavier clay soils. What can I say? Lots of issues that need to be addressed. Plus, drought in the summer. Rain cannot get into the soil because it is so compacted, the vegetation has been removed from the cattle grazing and even there are some rainy moments the water runs away quickly before it can get into the soil." (Beef farmer, Western Australia)

Farmers expressed their worries about financial constraints. Finding funds for new agricultural or other activities was seen as challenging and often as impossible. Some farmers received help from their family members, but financial health still remained a concern.

"My son gave me some money after he sold his car. He wanted us to invest in something different. He is not such an avid cattle farming lover, . . . he is quite a horticulturalist. . . Whatever he plants is going pretty well." (Beef farmer, Western Australia)

"Working with bio stimulants was an interesting opportunity that was presented to me by my neighbour. . . The bio stimulant. . . helped the crop to develop greater resilience and increased biomass, but I thought it requires too much effort as you needed to apply it twice a year. . . for lessening the fertiliser applications, but I thought. . . it is too much effort for a cattle farmer like me. Regenerative agriculture was something I came up with. . . I like it a lot and it helps me improve the quality of the soil. It actually happened: bugs, fungi, bacteria, and all the other little creatures are now in my soil. It's rich and concentrated. I can't say I am an expert, but I'm still learning and understanding things. Regenerative agriculture is a continual journey of passion and observation. It really helps preventing the loss of topsoil and builds up the organic matter." (Beef farmer, NSW)

After "entrepreneurship" with 19 citations (see Table 4), "small business" attracted the highest number of mentions, followed by "diversification", "risk taking and management" and "financial constraints". Farmers are concerned about their ability to maintain good income given the lack of access to subsidies and other financial support, as well as the presence of competition with bigger industrial enterprises, often referred to as monopolists. The benefits of regenerative agriculture were highlighted, particularly in the context of poor soil quality, in many cases as a consequence of cattle grazing.

3.1.4. Human Behaviour

Human behaviour, including emotions and behavioural factors, appeared as one of the main themes. The farmers expressed concerns about different internally- and externally-driven factors which influence them mentally, physically and socially, as well as impacting

the broader social environment (see Table 5). According to Better Health Channel Victoria [30], expressing distress and difficulties is related to dealing with grief, especially when losing the farm, and it is seen as a loss of identity and betrayal to the previous generation and family. Farmers are dealing with various juxtapositions of reality and their own feelings that often could have serious consequences. Multiple issues were discussed by the Australian farmers, such as feelings of insecurity, frustration, confusion, disappointment, stress, struggle, trauma and scepticism caused by their current life as farmers and due to the changing Australian agriculture context. Similar issues, described as the mental health consequences of surviving in a tough climatic environment and the constant struggle of rebuilding physically, financially and emotionally, were addressed in the National Farmer Wellbeing Report [33]. Many of the participating farmers described this context as uncertain and challenging, difficult and with high expectations that put pressure on them.

Table 5. Number of mentions related to human behaviour and emotions and its associated aspects during the conversations with 14 Australian farmers interviewed between August 2022 and May 2023.

Term	#	Examples
Emotional influences	19	Frustration, regret, confusion, disappointment, guilt Passion, resilience, responsibility, hopefulness Pride, knowledge Scepticism, stress, betrayal Struggle, survival, trauma Attitudes, expectations
Social influences	11	Challenges, difficulties, limitations, obstacles Insecurity, risk, neighbourly disputes Interest, expectations Regulations, preference
Motivational influences	10	Skills, occupation, adjustment, acknowledgement Success, achievement, attention to detail, fairness Self-doubt, self-efficacy

At the same time, farmers said that they needed to overcome many obstacles, regulations, limitations, risks and even social constraints, such as disputes with neighbours. The situation makes it difficult for Australian farmers to remain passionate about their current operations, be resilient and responsible, using their knowledge. This also makes it challenging to remain proud of their business operations, and many described the changing situation with mixed feelings of regret and confusion.

Despite the scepticism felt towards the new technology coming to disrupt existing agricultural practices, they still wanted to remain hopeful about their farming future. They believed that staying in business, keeping up with the required skills and new trends, being attentive to details and remaining self-efficient and adaptable to face all upcoming challenges would help them adjust and be successful.

Often the decisions farmers needed to make involved many factors, including primarily family members, existing business prospects and future opportunities. They believed that their feelings betrayed everything they had, the cattle, their grandchildren and their past. In addition, the feeling of no certain future seemed to further pressure them.

“Yes, it started as something funny, when the grandchildren named all the cows which I never did before. At the beginning I thought it will be cool, but then when you kill Johnny, one of the cows that had my name, you start thinking twice before you kill Betty, a cow named after my wife. It’s becoming a personal affair. . . . It wasn’t pleasant at all. . . , it wasn’t fun anymore. I couldn’t sleep, couldn’t live like that, feeling the guilt that was inculcated by my grandchildren in me. I just needed a change. I needed to get rid of my cattle business. I needed to find something new to do.” (Beed farmer, NSW)

The same farmer explained the decision as not an easy one but very emotional and heartbreaking for him and his cattle, but the stake was bigger and more rewarding:

“I wasn’t scared to start something new, just because I had to do it for my grandkids. . . It was a bit risky as I didn’t know what to expect, but I had nothing to lose. . . I would rather keep the connection with the grandchildren than fight with them. I made a mistake with my younger son forcing him to be a cattle farmer like me and he ran away to be a lawyer. With his kids we kind of bond together and whatever they see (in) the future I want to see it with their eyes.” (Beef farmer, NSW)

Another farmer described:

“The pushier cows would get some [food at the feedlot] and the skinnier ones were getting skinnier and skinnier and started dying on the property. So, . . . this huge sway of running bamboo that my mother, advisedly and unknowingly planted. . . came in handy during that drought. . . The cattle would be eating it because it was green. . ., but I’m. . . old. I’m 70 now. . . I fell over at one point, nearly stabbed myself through the stomach with sharp bamboo. And I thought. . . why bother? . . . I had no worries transitioning my land to being a conservation block. Yeah, because of my attitude to animals. I’m not a money hungry person. . . I think you’ve got to treat animals with respect.” (Former beef farmer, NSW)

Other respondents tailored their behaviour toward exploring new directions with passion, hopefulness and expectations, such as attracting bird watchers and composers to come and visit their farms. There were also new opportunities, such as, for instance, the transition to a sanctuary.

“The sanctuary is on 100 acres. We transformed it from cleared sheep and cows’ paddocks to a haven for birds, and just in the last few couples of years for composers.” (Former beef farmer, NSW)

One farmer shared his insights about finding something that would help solve the potential struggle for the animals, the family and the business.

“What tipped the balance of everything was the drought of 2019. . . There was not a blade of grass anywhere. . . then I turned it into the sanctuary. . .” (Former beef farmer, NSW)

“Emotional factors” attracted the highest number of citations—19 (see Table 5), followed by “social factors”—11, and “motivational factors”—10. The feelings that dominated were disappointment and disenchantment with the farmers’ existing agricultural practices that impact their personal lives but also the social environment where they live. It was interesting to observe that to cope with the negative emotions, some farmers had turned their properties into conservation land and had transitioned to running environmental sanctuaries.

3.1.5. Obstacles to Diversification

The farmers identified eight major obstacles to potential diversification (Table 6), with uncertainty mentioned by almost all of them. They explained:

“Farm diversification, I think, is something that is becoming more common these days. . . to build some sort of economic resilience for farming families. . . When making a diversification, you should consider the impacts of this diversification on your own family. This is why many farmers are hesitant to pursue any changes to what they’re used to do. . . they faced so many bravery-requiring things that other people will never imagine in their lives. . . but they want to do this period of adjustment from one thing to another slowly. This is the same with our case converting half of our land to a conservation area and the other still continuing to be the home of a small cattle herd and a few sheep. . . Diversification at the farm

level excludes simple land-use change like in our case changing from growing cattle to regeneration and land conservation, but rather refers to something that is. . . the addition of an enterprise like growing cattle and trees to attract birds and other native species. . . You need to think of the off-farm income, and this should be examined carefully.”(Former beef farmer, NSW)

Table 6. Number of mentions related to obstacles to diversification in relation to Australian farmers obtained during the interview process in 2022–2023.

Term	#	Term	#
Uncertainties	13	Lack of knowledge	7
Finances	10	Regulatory/licensing	4
Technologies	8	Collaborations	4
Government support	8	Contract terminations	3

Some of the farmers expressed scepticism about being successful in implementing a potentially new business.

“I thought about changing into something different as I am getting older. . . , but I am hesitant as I don’t have the knowledge to start something new. . . . Starting something new is not at all easy, especially when you have been taking care of your cows all your life, and you know nothing else. And now you have to do something completely different.” (Beef farmer, NSW)

Many farmers shared that they had already started thinking in the direction of potential opportunities for business diversification, for example:

“If I add on the cannabis business I may grow because of the demand, (I) could create some jobs as cannabis is quite hand-intensive. . . . These are just thoughts at the moment; I haven’t done anything along this idea yet.” (Beef farmer, NSW)

New technology was seen by one of the farmers as something to worry about; however, he was not convinced and preferred to look at what he perceived as more serious issues, such as human population growth and hunger, particularly the demand for meat.

“Not sure what to expect. I heard from people like me that the cattle industry will shrink substantially. . . . that we will be out of business. But I think it will not happen. . . . They constantly threaten us with new technologies that would bury the industry, but all this is just empty talk. They also talk about meat grown in labs. . . . We have so many meat-hungry mouths to feed and there’ll always be consumers thirsty for meat. . . .” (Beef farmer, NSW)

Age was mentioned as a constraint to gaining knowledge about something new that could potentially be developed as business diversification. It was seen by one of the Australian farmers as a serious barrier.

“I am afraid whether the new thing I decide to start will give me the same level of satisfaction I am receiving working around my cattle herd. When you did what you do for ages you just can’t switch quickly.” (Beef farmer, NSW)

The same farmer saw products of new technologies, such as plant-based meat alternatives, as giving him and his peers a slight challenge, but he trusts the demand for conventional meat will remain an obstacle against meat industry diversification.

“Now. . . lately I’ve heard they make some plant-based imitation meats. It is not meat at all and cannot be a. . . meat. . . . It can’t in any way replace meat. We will always have cattle herds, look after them and produce good meat.” (Beef farmer, NSW)

Lack of finances and financial support from different government or private institutions was outlined as a major obstacle to starting a new business in any potential diversification.

“I assume I will need lots of investment, I will need money from the government, council, or at least some financial support to start up. Also, the citrus trees will take some time to grow and there is no guarantee they will be fruiting. These are all risks. . . if I pursue with this business plan.” (Beef farmer, NSW)

Initially seen as a barrier to diversification, new technology was perceived by three farmers as a lifesaver, despite experiencing doubts and maintenance difficulties at the beginning of its use.

“I was using a drone I bought two years ago to monitor the figs growing from the house. It was a nightmare to deal with it. . . Later it did a good job, and I am still using it to monitor the trees. I was thinking of placing some cameras around. . . not resource-efficient and maintenance-efficient too, like the drone after all the troubles.” (Beef farmer, Western Australia)

After “uncertainty” with 13 citations (see Table 6), “technology” attracted the highest number of mentions, followed by “finances” and “government support”. The farmers were reluctant to fully embrace the uncertainty that comes with diversification but were likely to make progress with adapting to the benefits of new technologies. They wished for a better economic environment that could reduce the risk associated with new ventures.

3.1.6. Future Concerns

The farmers conveyed the idea that they have been examining some of the biggest problems they will be facing in the future. These are captured in Table 7 and represent a long list that continues the current range of concerns but also adds new aspects.

Table 7. Number of mentions related to future concerns and their aspects during the conversations with 14 Australian farmers interviewed between August 2022 and May 2023.

Term	#	Term	#	Term	#
Uncertainties	12	Risk-taking	6	Retirement planning/aging concerns	4
Career change, opportunities	7	Lack of clarity, control, guidance	6	Missed opportunity	4
New skillset and expertise shortage/staff shortage	7	Anti-alternatives/technology skepticism	5	Decision-making	4
Self-reliance and improvement	6	Fear of the unknown/resistance to change	5		

The Australian farmers’ responses suggest that some of the current business challenges are also becoming relevant issues that make them worry about the future:

“Also land prices, feed, fertiliser, seed and pesticides continue being the biggest cost for us, the Australian beef farmers. I can see lately the farm cash incomes declined. It has never been huge for the livestock farms. But I am satisfied. . . I love my cows. They are still personally and financially rewarding for me. . . Our farm gives us everything we need to care about our family. The only thing is that I worry about the future.” (Beef farmer, NSW)

The chances for a career change and new business opportunities were seen as potential prospects by two farmers.

“I think I would look into investing in functional foods, but unfortunately don’t have the funds to do so. That’s why I’d rather die as a cattle farmer. The problem is that everything in agriculture is terribly labour-intensive. . . If my children could be by my side, to support me, I would grow something else, fruit trees, citrus, mandarins, or something like that.” (Beef farmer, NSW)

Although six farmers perceived potential avenues for change, these possible positive outlooks were veiled with concern, uneasiness and uncertainties.

“I want to experiment with how I can influence the local climate, what we can change as a community with the existing system and go toward regenerative farming and then growing some crops, veggies perhaps. I think this is the only opportunity I have as a farmer to continue my business and look after my family without facing some financial bankruptcy in the future. . . But I worry. . . I just need to focus on creating more avenues for income to avoid any financial difficulties in the future. But no one can guarantee you this.” (Poultry farmer, NSW)

“It was quite difficult during COVID times. . . Everything is all about risks and hard work. We wish to start new things but often you experience things that at the beginning and halfway through make you to reconsider and to step back. . . It’s really difficult especially when you start something you’ve never done before.” (Former beef farmer, NSW)

Technological advancements and new agriculture-supporting gadgets were also discussed by the participating farmers. Some were fascinated by what new technology had to offer. However, new technology may still not be a truly exciting prospect for them due to their lack of knowledge and uncertainties.

“They are many new technologies that I believe will solve our agriculture. We had some people coming over offering us some drones to look after the cattle herds from a distance. I found it interesting but. . . why should I get involved in technologies I don’t know. . . They say there are software support teams if something wrong happens, but this support team will want money to support you. It’s always with money involved in and lots of uncertainties. . . If you don’t have them, you do less or nothing.” (Beef farmer, NSW)

One of our participants, a former farmer who has already diversified, viewed the complexity of the situation as an opportunity for the new generations.

“I think farmers are facing many things. They also can access the environmental conditions which are worsening because we destroyed nature at a rate that we shouldn’t. This is why the drivers which are potentially encouraging diversification are creating opportunity for family involvement in the current business, which is actually rare as the new generation is not voluntarily willing to be involved in the farming practices of their parents. . . So, creating opportunities for the children, siblings and partners, spouses should be around creating better prospects for lifestyle choices. . . They create something new, interesting, outside the farm and this is actually an ideal opportunity for spreading the potential financial risk. “ (Former beef farmer, NSW)

After “uncertainty” with 12 citations (see Table 7), “new skillset and expertise shortage/staff shortage” attracted the highest number of mentions, followed by “career change” and “opportunities”. Many Australian farmers belong to an older generation which makes taking risks and switching to new business opportunities more challenging. The future for them looks relatively bleak [34], although some see optimism in embracing the new technologies and diversifying.

3.2. Brazil

The first point observed was the need to refine our approach to Brazilian farmers. We were initially inviting them to participate in a survey about transition; however, it was identified that, given the positive situation of animal production in Brazil at the time of the interviews, diversification was a more interesting issue for potential participants. Both cattle and poultry farmers had stable demand for their products and saw no business reason for transitioning. However, they viewed diversification favourably as a way to reduce risk and make better use of their land. To engage in diversification, they needed

knowledge about the new product and its supply chain, as well as the market and demand for the new product (codes related to ‘Knowledge and professional growth’, ‘Interest in learning and research’ and ‘Research’ had more than seventy repetitions). Some mentioned the demand when referring to liquidity, while others stated the need for partners for land leasing. Overall, our results show that without these two key points, knowledge and market, farmers were not likely to diversify.

Regarding knowledge, many emphasised the importance of public policies to address this issue, frequently highlighting the major role of the Brazilian Agricultural Research Corporation (EMBRAPA), while the relevance of other institutions was also acknowledged. Public policies related to financing were stated; however, respondents considered this issue as less significant. According to the Brazilian respondents, rather than relying on external financing to make their business viable, farmers prefer to learn how to achieve this themselves.

Respondents stated alternative proteins as a niche product. They did not see them as substitutes for traditional products but rather as complementary, considering the growing global population, the socioeconomic challenges, the small market share of alternative proteins, and the belief that these products will become more prevalent only in the long term for future generations. Newton and Blaustein-Rejto [35] obtained a similar understanding in a study of American farmers, with alternative proteins perceived as complementary to conventional meat and, therefore, with less resistance to their development. An additional common point highlighted was the view of technology as an opportunity for either improving land utilisation or providing tools to enhance their business.

Despite these common points (see also Figure 1), Brazilian beef and poultry farmers had their own clear differences. Thus, their perspectives are presented separately, as well as opportunities and challenges, including the alternative protein market, grouped into the main themes observed in the interviews.

3.2.1. Chicken Farmers

For chicken farmers, the main themes were agribusiness (see Table 8) and diversification challenges and opportunities (see Table 9).

Table 8. Number of mentions related to the term agribusiness and its aspects during conversations with five Brazilian chicken farmers interviewed between June 2022 and March 2023.

Term	#	Term	#	Term	#
Economy	6	Interests and preferences	2	Technology	2
Family responsibility	6	Uncertainty	2	Stress	2
Work and animal welfare	6	Agricultural and livestock production	2	Family farming	2
Business	4	Investment	2	Finances	2
Financial difficulties	3	Innovation	2	Work	2
Animal production	3	Rural development	2		
Change	3	Agriculture	2		

From the interviews, we identified two different situations. Two broiler chicken farmers were working with the agroindustry for the development, growth and professionalisation of the production. These producers were positive in relation to their current situation as animal farmers.

“We actually received a proposal to join a project from the agroindustry, where they would promote the construction of larger poultry houses. So, our transition from a smaller system, from a family company to . . . a family property to a more entrepreneurial property, emerged back in 2012.” (Poultry farmer, Parana)

The other situation was represented mainly by smaller producers, who faced difficulties with the agroindustry and, because of that, left animal production activities to seek other activities.

“It was a time when it was profitable, not like today. . . people are already giving up here in the region at least, but at the time when I was working with the company, there was partnership. . . with a company here in the region. . .” (Former poultry farmer, now crops, Parana)

Regarding environmental issues, respondents perceived their intensive broiler chicken production as an effective and sustainable system with advanced technology and low input requirements. When discussing this topic, farmers mentioned some principles aimed at reducing waste and optimising resource utilisation, which can be considered within the scope of a circular economy [36].

“Maybe a large-scale sustainable production, right? Let’s seek an alternative sustainable way to produce protein for everyone, which generates the minimum possible impact, the minimum waste, so that we can make the most of the environment, space and place. So that it’s not necessary to cut down all the trees, for example, in the Amazon, to grow soybeans.

. . . we have highly efficient production systems. Therefore, we can use less feed, less soy, less corn to produce the same kilogram of meat in systems that are often not conventional, are more technical systems. So, from my perspective as a farmer, we are. . . engaged in sustainable production because we can produce a lot of food, a lot of protein in a small space. . .”(Poultry farmer, Parana)

Frequent investments in facilities are required by the agribusiness industry to ensure the ongoing quality of production and improve the welfare of the animals. Given the strong presence of agribusiness in Brazilian poultry production, where most poultry houses are integrated into a company, ensuring revenue before the animals arrive at the property, such improvements become a requirement. For the farmers who do not have enough finances available, diversification may be an opportunity.

Table 9. Number of mentions related to diversification and its aspects during conversations with five Brazilian chicken farmers interviewed between June 2022 and March 2023.

Term	#	Term	#	Term	#
Agriculture	13	Work and animal welfare	4	Decision making	3
Family farming	10	Rural development	4	Entrepreneurship	3
Work and animal welfare	6	Challenges and prospects in the sector	4	Planning	2
Economy	8	Agricultural and livestock production	4	Fish farming	2
Change	5	Interests and preferences	3	Research ethics	2
Work environment	5	Public policies	3	Financial limitation	2
Production	4	Investment	3		

When talking about diversification, the most cited words by current or former poultry farmers were agriculture, family, work and economy (see Table 9). For small-scale farmers who have already made a financial effort to acquire their poultry house, additional investments often become unfeasible. Thus, we observed difficulties for small farmers to continue production, leading them to sell the farm or switch to another activity.

For the interviewed former poultry farmers, the main factor influencing their choice of a new activity was some previous experience, either personal or within the family. In a

case where the new activity was not successful, the lack of study and planning regarding the new activity was mentioned.

“Everything I’ve learned is that whether it’s animals or plants, a person needs to conduct a thorough study of what they will need so that. . . you don’t have to stop producing due to a lack of investment.” (Former poultry farmer, Parana)

However, some farmers saw agribusiness and its extension workers as excellent partners because, in addition to ensuring purchases, they provide knowledge through extension services. The extensionists were seen as professionals who brought knowledge and technology to farmers. Knowledge along with guaranteed sales appeared as important factors for diversification, and integrating them into public policies may assist farmers who are willing to change.

“What discourages entry into such a system—of alternative proteins—is related to the market,. . . the lack of sales security. . . The opportunity of optimising the space we had there with a different production was raised, but there was no guarantee of purchase. . . I think we need public policies that provide both economic and extension incentives. We lack extension and knowledge. . .” (Poultry farmer, Parana)

Public policy was highlighted as the main factor for diversification, including efficient mechanisms for bringing knowledge to farmers, enabling them to learn how to proceed with alternative farming and take ownership of that knowledge.

“I believe that, in relation to farmers, there is still a lack of knowledge, extension services, and guidance on how to do things. Access to this knowledge is crucial because I ask myself: if I didn’t know, how would I proceed? As a result, people end up falling into the comfort of animal production. They think: ‘It’s fine as it is, I won’t make any changes.’ This aspect of public policy and extension services is still lacking in our country. . . The implementation of advanced farming techniques in poultry houses is only possible because we have people promoting and supporting it in the field every day. Without such support, there would be no progress. Therefore, I believe that public policy should come first. It’s not about giving someone a fish; it’s about teaching them how to fish.” (Poultry farmer, Parana)

Another point mentioned regarding diversification into other products was the restriction of space, as many available areas are preserved or protected, and there was reluctance to risk the current financial return due to the existing production of both poultry and soybean crops.

“We don’t have the means to buy more land. We would like to have more land for cultivation, but the prices are very high, and it’s difficult to find available land for sale. It’s challenging to sell land, . . . because there is a lot of vegetation, and nowadays, deforestation is prohibited. We stick with what we have. . . That’s why I believe in taking good care of what we have because if not, we would have to rent additional land, which would be costly and reduce our profits. It’s important to do our best with what we have in order to maximize our harvest.” (Poultry and crops farmer, Parana)

Due to the characteristics of the sector, poultry farmers saw themselves more as flexible and less as conservative because they had made transformations in their production methods over the past years to adapt to industry requirements. This, in turn, brought more technology and knowledge, resulting in professionalisation within the sector through the active participation of extension workers.

There is an opportunity to support small farmers who are seeking new activities, as they lack the financial capacity to continue investing in the way demanded by the agriculture industry. In order to pump-prime some success stories and potentially create a virtuous cycle, it is necessary to conduct in-depth studies on alternative production methods for different locations, as well as to establish structured demand and implement public

policies to disseminate knowledge to farmers. By doing so, we may be able to reintegrate those who had left food production so that they can contribute to the development of the country and the food sector. The contribution to a more sustainable supply chain may be increased by applying concepts such as a circular economy, as responses suggested that producers may be open to this approach.

According to Newton and Blaustein-Rejto [35], the biggest barriers to transition occur among chicken and pork farmers, as they have unfavourable contracts with large companies. However, this was not observed in our research, despite the strong allegiance to ‘the poultry industry’ among our chicken farmers. Opportunities for diversification among small broiler chicken farmers were mentioned if they were unable to continue animal production due to the investment requirements imposed by the industry. This observation aligns with the research conducted by Morais-da-Silva et al. [37] in Brazil, which suggests that small properties may face greater challenges due to their limited economies of scale and, consequently, less competitive advantage in a restricted market.

3.2.2. Beef Farmers

For beef farmers, the main themes were environment and animal production (see Table 10), views on alternative protein (see Table 11) as well as diversification challenges and opportunities (see Table 12). The majority of cattle farmers engaged in both crop and animal activities, primarily with soybeans, wheat and oats. Therefore, they already had some form of diversification in order to practice good land management and make the most of the available space.

Table 10. Number of mentions related to environment and its associated aspects during conversations with the four Brazilian cattle farmers interviewed between June 2022 and March 2023.

Term	#	Examples
Agriculture	13	Agricultural production, agriculture, agribusiness
Environment	10	Environment, environment/animal protection, environmental impact, environmental preservation
Financial aspects	7	Financial resources, financial concerns, economic instability, economic problems, economics, energy efficiency
Climate change	5	Climate, climate change, instability
Communication difficulties	4	Communication difficulties, communication in agriculture, opinion analysis
Personal development	3	Personal development
Family business	2	Family business

The farmers remained open to further diversification of products in order to seek optimal land utilisation, as some farmers indicated that cattle production was not particularly prosperous. While the farmers perceived cattle production as a *secure* source of income, the financial returns were seen as not necessarily very favourable. The cost of inputs was a significant problem affecting profitability in the business, although the correlation with environmental impacts was not always obvious. Most cited words in this field are presented in Table 10, and although some are not very specific, farmers’ statements were very clear, for instance:

“... thinking about the production chain as a whole, I end up betting that the greatest difficulty now is environmental instability. It’s the instability caused by global warming that brings more frost, more drought, and then suddenly a month of rain, which theoretically is good because it’s raining, but it’s not good to be flooded. ... And then this snowball effect begins, and that’s what is causing the instability of profitability...” (Cattle and crops farmer, Parana)

The issue of the impact of cattle on the environment was mostly seen as inconclusive by the respondents. Divergences in the results of scientific studies were mentioned, and additional research was regarded as necessary, as farmers suspected that using proper forms of management and vegetation that do not degrade the pasture was likely a solution.

“In relation to livestock and agriculture, agribusiness, there is a great difficulty in our communication when there is, let’s say, criticism towards the agribusiness sector, which, like any sector, has people who do well and people who do poorly. But we know that this discussion, unfortunately, is biased. . . Speaking of pasture, we know that the type of grass planted has a specific height, and the management of the pasture should be based on maintaining an optimal leaf area index to intercept 95% of light. It has been proven, back in 2002 during the International Meat Congress, that there have been a series of studies. . . showing that systems that respect the proper entry and exit heights and efficiently manage pastures have a much greater degree of mitigation of emissions. . .

When we talk about the environment, people often say, ‘Oh, the pastures are degraded. . .’ Indeed, in extensive extractive systems, pastures do get degraded. However, the path to follow is not degradation but rather maintenance. After all, it is much more expensive to restore a pasture than to maintain it. . .” (Cattle and crops farmer, Rio Grande do Sul)

In the same line of thought, a farmer suggested that for assessing the impact of alternative proteins, the complete life cycle of the product, that is, its entire chain, should be considered.

“ . . . Which of the chains consumes. . . more natural resources? Because, whether we like it or not, the production of, for example, peas, when it comes to plant production, needs to be extremely efficient due to the area it occupies. . . There is a lot of research to be done in this regard. . . it requires serious, focused projects that evolve gradually. And yes, the discussions are often framed as choosing between one or the other, but in reality, I believe there is a consolidated model that is a commercial model and is delivering meat, and for any new or alternative model to succeed, it needs a structured chain, production systems, and knowledge. . . .” (Cattle and crops farmer, Rio Grande do Sul)

When discussing their production, one of the interviewees mentioned that they engaged in extensive farming in order to maximise the use of waste, demonstrating a concern for efficient production. This concept again aligns with the principles of the circular economy.

“We do not engage in confinement operations within our family. However, we have worked with some clients, focusing more on the utilization of waste, which aligns with our approach. . . Until four years ago, before we began our collaboration, they incurred costs to either burn or produce a certain amount of energy from these by-products.” (Cattle and crops farmer, Rio Grande do Sul)

Many farmers stated their appreciation for and care of animals, emphasising the importance of using animal welfare practices that positively impact livestock’s health and quality of life. However, they still viewed animals as necessary for the supply of protein. In other words, they were aware of animal sentience and animal ethics, but this awareness was not significant enough to make them switch to other activities. Alternative proteins were seen as complementary to, rather than a complete substitute for, conventional meat production systems.

“And it was really interesting because, recently, my father has also embraced this approach. . . We could see that the animals weren’t comfortable. So now we have a completely different system, and many people question it. . . But they have said to me, “Oh my God, how you’ve changed!” . . . And my father is passionate about cow-calf operations. He says, “How can we treat the mothers and calves

the way you used to?” It really upsets him. And I believe in the law of return, you know? After we started increasing our good practices, everything seemed to flow much better. We had much lower mortality rates, far fewer problems. . . It’s really difficult because we, who have studied all the principles of animal welfare, shouldn’t have to explain or justify it. It’s their right. Unfortunately, to convince someone. . . you always have to focus on the financial aspect.” (Cattle and crops farmer, Santa Catarina)

“ . . . there used to be rough handling of the cattle, often poking and such, but now we use flags as a form of signalling. So there has been a complete shift in culture and handling practices, and it’s better for everyone. The cattle are much calmer and easier to work with. This is how we work now, with a great deal of care and respect for the animals. . .” (Cattle and crops farmer, Rio Grande do Sul)

In common with the perception of poultry farmers, alternative proteins were considered complementary products rather than substitutes by the interviewed cattle farmers. This view tends to reduce resistance to the entry of alternative proteins within the agribusiness chains. In the current market, participants saw them as niche products that will gradually penetrate consumers in the coming generations, while animal production will remain. Newton and Blaustein-Rejto [35] reported similar perceptions in their research with American farmers and identified alternative proteins as an addition to traditional ones that will fulfil a portion of the growing demand for food protein. Therefore, according to such a perception, the growth of alternative proteins tends to offer more options for rural farmers in terms of markets and production methods.

“So, it will evolve, it will become cheaper, I have no doubts about that. . . , but there are still many years ahead, there’s still a long way to go. There’s a lot of chicken to be produced, a lot of pork to be produced, a lot of cattle to be produced. . . and fish as well, before this alternative has a more significant space in the market. I believe I won’t see that. Maybe my children will see it, but I don’t see it as a competing product from a market standpoint.” (Cattle farmer, Rio Grande do Sul)

Regarding future generations, farmers perceived an increasing concern about animal ethics and that our descendants will be more inclined to consume alternative proteins in a responsible manner.

“ . . . there are two aspects to consider here: the younger generation has a greater concern for animal welfare and fewer prejudices. They are more open to adapting to new realities, technologies, and products. Therefore, there is still an opportunity for alternative proteins because these young individuals will want to protect animals and may not want to consume meat obtained through traditional means when there is an alternative available. These young people will become the adults of tomorrow, with increased financial capacity and influence as decision-makers or influencers in the purchasing process.” (Cattle farmer, Rio Grande do Sul)

In addition to market considerations, a need for the structuring of the alternative protein supply chain was stated. Farmers also questioned whether the alternative products are truly less harmful to the environment.

“ . . . I believe there is a market for everyone, but what concerns me is the issue of supply chain organisation. . . It is not easy to organise, and that’s where the challenge lies. I think it’s unlikely that plant-based meat will compete with beef. In my opinion, it’s more of a niche business, and those who are willing to embrace it will buy it, even though it comes at a higher cost. However, one aspect that still needs further discussion is the water consumption involved in the production of alternative proteins. We need to analyse the entire life cycle and determine which of the two options causes less contamination. Because we are aware of the

ideology surrounding animal welfare, but it is important to determine how much of it is driven by desire or reality?!” (Cattle and crops farmer, Rio Grande do Sul)

Farmers perceived alternative proteins as complex products, and some believed focusing on basic food production to be more effective for addressing food insecurity. As there are productive areas in Brazil, in their opinion, the ideal is to produce food in a simpler way while alternative proteins become viable in the future.

“... we are eight billion people, and seven and a half billion people are still experiencing hunger. So how are we going to address the needs of all these people? That’s my concern. We have productive areas, not only in Brazil but also in other countries. We have regions that can produce simpler things to feed people, rather than focusing on cultured meat or alternative proteins. That’s my perspective, as someone with a lot of information and technical knowledge, although I don’t have a PhD. It comes down to basics like beans and rice. We need to consider practicality in addressing hunger, and the development of cellular meat and alternative proteins is indeed highly sophisticated. They may have more potential in the future.” (Cattle farmer, Rio Grande do Sul)

In a study conducted with Brazilian experts, one of the opportunities identified for alternative proteins was greater access to protein and, consequently, hunger reduction [38]; however, the likelihood of taking opportunities required engaging with the new production chains for alternative proteins. Some respondents believed that there would still be a lot of work to structure this market, especially in developing or underdeveloped countries, where basic concerns take precedence.

“... there will be a lot of work to be done to carve out a space in the market, especially in developing countries, or more accurately, in underdeveloped ... countries. Of course, in Germany, the United States, Canada, Japan, it’s a different story.” (Cattle farmer, Rio Grande do Sul)

For farmers who showed an interest in diversifying their products, including alternative proteins or other options with lower environmental impact, the issue of demand and market was crucial. While there may be markets with high potential, for a farmer to diversify, a concrete demand for the product must exist.

“I see that if we have other opportunities in the future and someone says, “Look, is there something we can do here that can generate income? Should we do it or not?” What I would like to have, is an already generated demand. I think that creating a market first, then creating demand, and then going after those customers is much more complicated than already having a generated demand and saying, “Hey, I have a product here for you. . . I will produce it with quality for you.” (Former cattle, now crops farmer, Parana)

Alternative proteins are still seen by respondents as a lifestyle choice rather than a habit among Brazilians, despite beans being a staple protein source in the country. The strong perception of specific lifestyles is represented in Table 11, where “vegetarian” was by far the most common term. This is controversial, as consumption intentions for specific meat alternatives are considerably higher for meat-eaters than vegetarians and vegans in Brazil [38]. According to respondents, the consumption of alternative products needs to be further developed and more widely spread throughout the country because, when compared with animal farming, the risks for grain farming are higher.

“... the market has a need for alternative protein sources, but there isn’t yet a culture around it. It seems to be more of a lifestyle choice that doesn’t integrate into the everyday life of Brazilians. We already have important protein sources like beans, soybeans, and even rice as an alternative protein source. However, when we consider diversifying and investing, there is a risk of entering a market that doesn’t yet recognise these alternatives as protein sources. In the agricultural sector, I have a greater level of certainty and a more established business plan

compared to the grain sector. We are more susceptible to risks in the latter case.”
(Cattle and crops farmer, Sao Paulo)

Table 11. Number of mentions related to alternative proteins and their aspects during conversations with four Brazilian cattle farmers interviewed between June 2022 and March 2023.

Term	#	Examples
Vegetarian diet	12	Vegetarian diet
Market and business development	11	Market view, economy, market risks, market need, business development, business growth
Critical vision	6	Critical view of academia and scientific research, critical vision, criticism of vegetarianism, doubt, need for more studies and data, personal opinion (negative)
Socioeconomic challenges	3	Socioeconomic challenges
Sustainability	3	Sustainability
Financial investments	2	Financial investments
Social inequality	2	Social inequality

One of the farmers mentioned an increase in the number of vegetarians. As their family also owns a farm hotel, they have noticed a growing demand for meatless meals, but not to the extent of eliminating meat-based meals.

“We can feel it at the hotel because, well. . . the frequency of guests requesting vegetarian options, gluten-free options, and so on, has increased. Quite significantly! We didn’t have anything before, and now we have enough to constantly be thinking about it. . . It’s not a lot yet, but it’s definitely noticeable.” (Cattle and crops farmer, Parana)

Regarding diversification, the importance of studying and acquiring knowledge about new products was frequently mentioned (Table 12). In addition, participants believed that diversification would occur gradually, as good results resonate with other producers and convince them by example, especially because many properties are still managed by older generations. Thus, the importance of achieving positive results from the early diversifications was emphasised, as they will influence the decision of other farmers, creating a virtuous cycle. Another study conducted in Brazil on the transition to alternative proteins reached a similar conclusion, stating that the change will be gradual due to the cultural connection with animal production and the lower price of these products in Brazil as compared to other countries [39].

“So, could it become half cattle and half alternative crops? It’s possible! But not next year. And it really won’t be! There needs to be a whole process of persuasion. . . and there’s another thing as well, the generational issue. Who are the big farmers? Are they young people? No. They’re still the grandparents of the young ones, some of them are the parents of the young ones. So, everything new that we bring here takes about one to three years to convince, to show that somewhere else is convincing, you know? . . . So, expecting to make these changes in less than 10 years, people can’t do it because there’s resistance, because the landowners themselves have always done it this way. And their parents, grandparents, and great-grandparents have also always done it this way. . .”(Cattle and crops farmer, Parana)

Table 12. Number of major codes related to diversification and its aspects during conversations with eight Brazilian cattle farmers interviewed between June 2022 and March 2023.

Term	#	Examples
Knowledge	54	Knowledge and professional growth, interest in learning and research, research, knowledge sharing, interest in learning, need for knowledge, university role, need for technical guidance, learning, educational limitations, need for technical knowledge, technical knowledge, knowledge appreciation, knowledge transfer, lack of knowledge
Financial aspects	33	Investment, economy, planning, financial investments, financial concern, difficulty in investment, economic challenges, economic opportunities, cost optimisation, risk of financial loss, financial evaluation, financial investment, financial planning
Agriculture	31	Agriculture
Public finances	25	Public finances, challenges of rural extension, distrust in public policies, criticism of government financial subsidies, rural transformation, financial aid, financial incentive, government financing
Sustainability	20	Sustainability, environmental sustainability, environment/animal protection, environmental preservation, environment
Uncertainty/risks	20	Uncertainty, insecurity, security, challenge, risk, scepticism
Market and business development	17	Business development, market, market difficulties, entry barriers, risk of financial loss, financial, financial difficulty, business growth, financial market, business plans, market development, market view
Entrepreneurship	15	Entrepreneurship
Socioeconomic challenges	11	Socioeconomic challenges
Technology/innovation	11	Technology, innovation
Participation	8	Participation

When it comes to examples, an unsuccessful diversification experience into soybeans was reported, as well as the resistance that emerged regarding the product. Therefore, diversification must be well-studied, planned and executed so that it favours the farmers and, consequently, the virtuous circle mentioned above becomes possible.

“We started without my uncles. . . In 2000, they tried to plant soybeans, but it didn’t work out. . . . Today, different varieties have been introduced, more resistant ones, but they still have a trauma from that experience. So, we decided to lease the land to third parties. . . Now, it’s these third parties who plant. . . All the soybean fields are managed by them, and they pay us a rent for it and also provide us with winter pasture that they plant.” (Cattle and crops farmer, Rio Grande do Sul)

With the goal of risk reduction, the changes are likely to be implemented in stages, testing them on a portion of the land and evaluating the returns. This method is similar to what companies do with pilot projects when testing new products and business ventures, seeking validation of the business model before making intensive investments.

“Indeed, you can’t take too many risks. So, again, why did I say, ‘Oh, it won’t happen in the medium term’? In my opinion, it can certainly happen, but in the long term, because people will need time to test planting beets on 10 hectares, maybe even a combination of peas, chickpeas and beets. A diversified crop. Beautiful! To me, that’s the pinnacle of agricultural technology because you’re mimicking nature. You’re promoting diversity, and you won’t have pests in the same quantity as you would with monoculture. . . You won’t need as many pesticides, or perhaps none at all. . . People first need to be convinced that it will be profitable. . . There has to be demand. And demand needs time to mature and grow, right? Then, there will be a period for farmers to start considering it as a

good idea because they need to see other brave farmers. . . making money from it. . . And then there's the time for them to start on a small scale and gradually increase to a larger scale. Yeah. . . that will take a few years." (Cattle and crops farmer, Parana)

Different models were suggested when it comes to knowledge and information. These include partnerships with other farmers and educational institutions, the dissemination of brochures, articles and research conducted by government agencies, as well as the development of a specific product business plan. It is crucial to have studies and research available so that farmers can create successful business plans, thereby reducing their risks and uncertainties. Having professionals who can guide and support this transition is also necessary to multiply successful cases. Farmers are comfortable with the demand for their current activities, so to step out of their comfort zone and take on additional challenges, they need data and facts demonstrating that making such a change is worthwhile. Newton and Blaustein-Rejto [35] also identified the role of universities, research organisations, government agencies and NGOs in maximising the benefits and minimising the risks associated with the growth of the alternative protein sector. In Morais-da-Silva et al.'s study [37], the opportunities for alternative proteins in Brazil were discussed, including the supply of inputs for plant-based meat and plant ingredients for cell-based meat, with peas and chickpeas highlighted as commonly consumed plant-based ingredients but produced in limited quantities in the country.

"EMBRAPA [the Brazilian Agricultural Research Corporation] needs to publish numerous articles, conduct various studies, and universities should also conduct multiple studies. . . It has to be done! You need to establish partnerships with farmers. We have tried in various ways to involve the university in our farm, but they don't come." (Cattle and crops farmer, Parana)

"When there are brochures and publications being released about chickpea production or even lab-grown meat production, showing you invest this much and get this much in return. And you sell it to this market, and you need to be cautious about this particular bias, or maybe a certain pest, you know, these kinds of things that can happen, and it won't deviate much from that because we have been studying this for 50 years. . . and we have extensive research spanning 10 years, right? So there's a level of security and ease. . . But now, I don't understand. . . how can we achieve scalability, right? The farmers will always be like, "Whom do I talk to in order to learn?" I want to do it. I'm someone who wants to do it. But whom do I talk to?" (Cattle and crops farmer, Parana)

"I worked at BRF and also worked at Coca-Cola. And it was like this, they already came with the project set up, of course it's a different company, but they have that. . . If you have a certain problem, I have a solution for it. They are in their comfort zone, while we, at a much smaller scale, are in ours, and that's what makes us afraid to take risks. With cattle, or with soy and corn, when there is a problem, we know what to do. So, in a new diversification, a new crop, you start thinking: what if I encounter a problem? Who do I turn to for help?" (Cattle and crops farmer, Santa Catarina)

When it comes to the issue of diversification into new products, agricultural crop production is mentioned as being more susceptible to external variables and, consequently, more uncertain than animal production.

". . . If you raise a calf, you can manage it much better because then you can put it in confinement, do other things that don't solely depend on nature and the land's response there, right? . . . We're anxious to know, 'Is it really worth it for me to switch if I sometimes don't have as reliable partners in my region, for example, like I do for sugarcane?' I don't have a partner for alternative sources to lease, for example, or even someone to join forces in production, but there are many

people. . . I've talked to my neighbours, we're starting to learn. And then you say, 'Hey, you can make better use of it. There's idle land.' And then everyone asks, 'But how? How do we start?' I even thought about talking to the sugar mill itself, which deals with soil rotation, and see if I can already expand to crops in those areas with less investment, through trial and error initially." (Cattle and crops farmer, Sao Paulo)

In addition, the issue of crop failure was also mentioned. Despite crop production representing an opportunity to avoid loss, the uncertainty and insecurity of working with a different activity were emphasised by the farmers, who also highlighted the importance of the choice of product due to the investment and effort involved. Once again, the importance of success when undertaking diversification was stated.

"... to have effectiveness and reduce loss, which for me as a nutritionist is heart-breaking to see many farmers experience significant crop failure, and that loss cannot be recovered. Today, there are some alternative methods being implemented, but it's one of the factors that often hinders the consideration of investing in diversification due to fear of the risks involved and the potential crop failure until it reaches the end consumer. . . We see the potential to implement agriculture, but we are afraid, 'What should we plant?' Because sometimes, we may end up shooting ourselves in the foot. We also have to consider whether we should invest right away in irrigation, which can be an investment that may require changing our focus later on. Therefore, these points of effectiveness in production are indeed sensitive areas that require careful attention." (Cattle and crops farmer, Sao Paulo)

However, despite the risk of failure being more commonly associated with crop production, climate change may increasingly affect animal production. This is so because the price of inputs directly affects the profitability of animal farming.

"In reality, I think there will always be risks in both, right? . . . In animal farming, there are risks related to diseases, reproductive cycles, droughts, and when they occur, we have to act quickly and provide the necessary support. These are essentially the same incidents that can also happen in crop farming, which heavily relies on climate conditions, such as droughts." (Cattle and crops farmer, Parana)"

"This year it seems even more unpredictable due to global warming and the greenhouse effect. The winter has been irregular so far, even in October. There have been frosts in September when we should be planting, which is completely different from what we expect during the rainy season. We depend on the climate for both animal and crop farming activities. . ." (Cattle and crops, Parana)

The choice of a new product to work with requires considering the increasingly frequent environmental impacts. It was mentioned that after two years of crop failure with coffee, one of the farmers switched to soybeans.

"... In 2006 and 2007, we had consecutive years of severe frost. After I had prepared the coffee plantation for the next season, another frost came and destroyed everything again. When the second frost hit, the decision to quit coffee production was definitive. . . So, when I saw this situation and witnessed the emergence of new technologies for soybeans with good profitability. . . , I just weighed the options and decided to abandon coffee and start with cash crops." (Cattle and crops farmer, Parana)

In other words, there are farmers who are seeking diversification, but they still lack the ability to identify which products to pursue and how to make the change. This stresses the need for regional or local solutions, especially in vast countries such as Brazil.

“... I see these moments as opportunities to seek different technologies, to establish partnerships, and to engage with people who have more knowledge than us. I believe that innovation also involves being open to research institutions, companies, and individuals who can contribute their expertise. ... I think the solution is regionalised and specific to each case. It's not useful to assume that there's a universal solution that will solve everyone's problems because it doesn't work that way. What makes sense for our reality here may not make sense for the reality in Londrina or Roraima, and so on.” (Former cattle, now crops farmer, Parana)

When questioned about carbon credits, some farmers perceived them as an opportunity, but they are still in their early stages. There is a belief in their potential, but the market is not regulated yet, and, for now, it lacks practical effectiveness as a business.

“How does a company that demands carbon neutrality or something similar from its suppliers come into play? However, it is still in its early stages. I see that the opportunity is significant because we have a lot of land to use, and we know that sustainable practices can be leveraged. But until there is a market for it, we are somewhat limited because there may not be legal or economic support for such initiatives yet. However, it is indeed a possibility that we are considering!” (Former cattle, now crops, Parana)

Farmers highlighted the technological advancements in Brazilian agriculture, thanks to the work of institutions such as Embrapa. Their involvement in the development of alternative proteins was seen as essential.

“... agriculture is often compared to the evolution of medicine, especially because my father is a doctor. Areas where planting soybeans seemed unimaginable in the past are now possible due to the genetic development of seeds, varieties, and irrigation systems. The work of institutions like EMBRAPA and research institutes is crucial in this regard.” (Cattle and crops, Rio Grande do Sul)

Regarding public policies, respondents believed that rather than providing financial subsidies or tax reductions, the most effective approach is through initiatives that promote knowledge, both research and extension. This includes important partnerships with universities and development agencies.

“[subsidies] are valid. But I am not in favour of such strategies. I prefer that universities go to the producers and invite 'let's do a joint research project that will improve your business'. I believe this is more productive, more solid in the long run than subsidies, less costly to the government and to the country.” (Cattle, Parana)

An important challenge mentioned was the lack of labour in both animal and plant agriculture. Public policies may help through actions to promote human development. These policies include training programs that educate individuals on proper seed handling and planting techniques, addressing a specific concern mentioned regarding plant agriculture. In Morais-da-Silva et al.'s study [39], opportunities within the new alternative protein chains are highlighted, and one of them is the potential for improved qualifications, higher wages and better working conditions for workers. Additionally, new job opportunities may arise as a result of the development of alternative protein production, particularly in the early stages of the supply chain. By implementing policies that prioritize the development and qualifications of the workforce, the agricultural sector can address the issue of labour scarcity and create conditions that are more favourable for workers, ultimately benefiting the entire industry.

“This question is very simple to solve, to answer... It's human resources... Human resources are the biggest challenge we face. To assemble a team... to assemble a committed team, it's really difficult... There are people who have the technical skills, I'm not talking about formal qualifications, but who have technical knowledge and who are willing to be committed to the project, willing

to do things the way they are established to be done, and who are honest and committed.” (Cattle, Rio Grande do Sul)

In summary, this research identified that Brazilian farmers are open to diversifying their production with inputs for alternative proteins, carbon credits and others. However, they are not willing to take unnecessary risks. Some important points for the development of the alternative protein market were identified. First, it seems important to develop public policies that involve important research organizations. In addition, the main issues of demand, liquidity, financial return and suitability of the region’s soil and climate must be identified. The farmers mentioned peas, chickpeas and beans, but this does not mean that they are the best products to invest in. A detailed study by competent organisations is necessary to evaluate both the operational and financial aspects of the product. The market and supply chain for the new products must be established. Finally, the sharing of information and success stories in a way that reaches the farmers seems essential, as some statements mentioned the isolated knowledge and information, in addition to the physical isolation that farmers face.

Technology may be perceived as a great ally, both in current production, such as new machinery that allows for cultivation in previously unviable areas, as well as in terms of traceability of production, i.e., identifying the origin of the product, how it was cared for, and which inputs were used, thus providing more control and value to the product. Additionally, the application of biological solutions contributes to maintaining biological activity and soil moisture. However, there seems to be a gap between the real problems faced by farmers and what researchers and companies believe to be their problems. As a result, many solutions produced by research may not be effective. Listening to the farmers and considering their thoughts and expectations is one important contribution of this study. Such a contribution seems essential to help guide technological studies by encompassing a broader sense of hearing those who possess on-field knowledge and are involved in day-to-day production. Farmer knowledge includes perspectives on the market, expectations and challenges for the future, all of which are intrinsically associated with decisions regarding our food production systems. In a survey of Dutch farmers in 2018, approximately 80% felt undervalued by society [12]. Our interviewees similarly felt that their problems were not understood.

“And I see that there is a significant gap between the actual problems faced by rural properties, which can be solved through technology, and what companies and urban areas imagine to be the problems of farmers. As a result, they sometimes end up solving problems that don’t actually exist.” (Former cattle, now crops, Parana)

This finding calls our attention to the type of future research and, consequently, the outreach activities that are produced, especially considering priorities for an effective acceleration of the transition to alternative protein production systems. In addition, our results can contribute both to clarifying the importance of public policies and to selecting their most relevant goals.

4. Diversification for Australian and Brazilian Farmers

The study results indicate that producers in Brazil and Australia shared similarities in their pursuits of diversification, despite facing many different situations. They all expressed their feelings of uncertainty, lack of knowledge and doubtful relationship with the technology while thinking of approaching new things (Figure 2). In Brazil, producers find themselves in a favourable position where their production is financially viable and does not require diversification. The latter is seen as a way to increase their business options, reduce risk by adding an alternative and make better use of their land. An exception was small chicken producers, reflecting the fact that this agribusiness sector prefers to concentrate production by scaling up production and reducing costs. These

producers had their contracts terminated, and, like the farmers in Australia sharing the same destiny, they sought other activities, often without much initial planning.

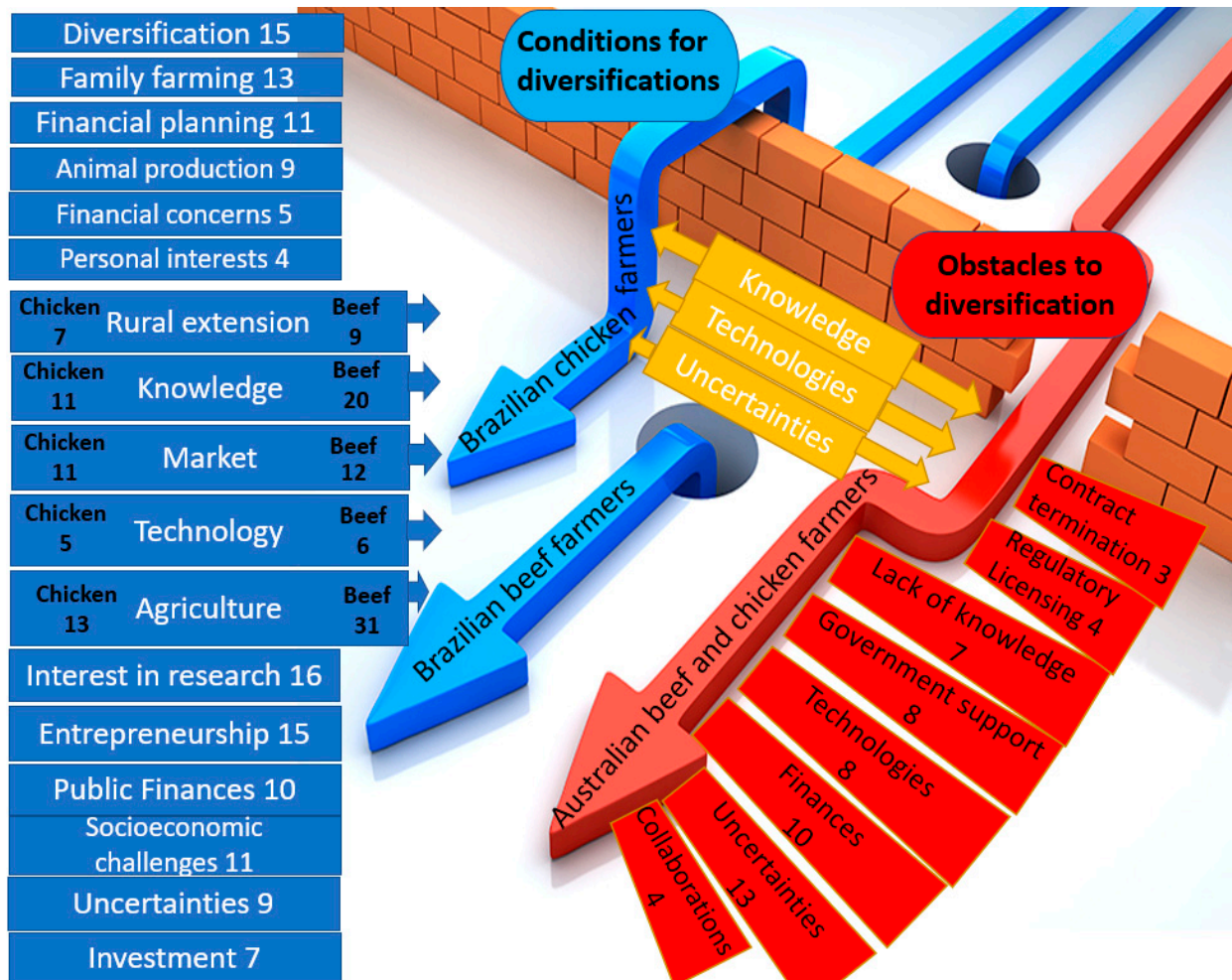


Figure 2. Diversification aspects among Australian and Brazilian farmers. Number of mentions related to the term obstacles to diversification in relation to Australian farmers and conditions for diversification in relation to Brazilian farmers obtained during the interview process 2022–2023.

In both Australia and Brazil, when identifying a new activity, farmers tended to look and engage with options that required less investment and involved some level of prior knowledge and experience. In Brazil, producers relied on family or previous knowledge related to the new activity. In a similar vein, in Australia, the focus seemed to be on other animal-related activities, such as laying hens and other birds (e.g., ducks). For them, animal production required less adaptation of their existing facilities, and they could easily utilise their preliminary knowledge of animal handling, reducing the risk of their diversification. However, they did not elaborate on the environmental advantages or disadvantages of their new endeavour, which was often not the best solution for sustainability and financial viability.

Another common theme was the preference for gradual diversification. The approach was similar in both countries and was evident in different circumstances, including among producers who had already lost their contracts (e.g., the poultry farmers in Australia) and producers who were willing to diversify their activity (e.g., farmers in Brazil). This mentality was clearly present, especially among producers having some financial security gained from their existing production. Their diversification-related stress was even greater, as most farms and animal production capacity had been in the family for several genera-

tions. The associated knowledge base was considered important and intrinsic, occurring through the natural process of being a farmer. It was considered necessary to acquire knowledge about the new pursuit without jeopardising the existing activity that supports the family's livelihood. Therefore, gradual diversification was seen as facing less resistance and, therefore, preferable.

A third point identified in the research is related to financing. The approach was quite different between participating Brazilian and Australian farmers regarding financial incentives. In Brazil, when asked about public policies and the importance of financial incentives to support new enterprises, producers emphasised their importance but suggested that having the knowledge was more crucial for success. Financial incentives were seen in Brazil as an external factor, and the business had to be financially viable first and foremost. In Australia, knowledge was seen as not as important as the availability of financial assistance. Farmers, especially those who had already lost their contracts and businesses, were constantly seeking loans but without success. Traditionally funding is difficult to obtain in Australia, with the country having the lowest level of farm subsidies in the OECD and a low level of government and consumer support for the overall agriculture sector [40].

Financing for activities that have not been well studied and planned can even complicate the farm's situation. Therefore, support to assist producers should occur before this stage, with a structured projection of new activities that are adapted to the local context, financially viable, and with a low environmental impact. For this purpose, producers should have access to the necessary knowledge, not only in relation to the activities they would like to embrace and develop but, most importantly, to whom to look for support in times of adversity. In this context, the Brazilian Agricultural Research Corporation (EMBRAPA) was mentioned several times as a successful organisation to generate knowledge. Regarding the Australian producers, the same lack of knowledge was related to the fear of new technologies. In Brazil, technology was mentioned more positively as an ally to improve production and financial returns. Finally, to be financially viable, the activities must be established based on demand and markets, and it is also important to identify the required investment and how to obtain it.

5. Conclusions

Farmers in both Australia and Brazil provided some evidence that they had pursued alternatives to their existing or former cattle or poultry or mixed enterprises. In some cases, this had been forced by a failure of the big agricultural industry to support farmers with contracts to produce the animals for sale to the companies. However, there was concern that the farmers did not have the collective purchasing power to be competitive in new enterprises and feared that new enterprises might not bring long-term revenue to match that of their existing enterprises. There was criticism of the lack of support from the government and the companies that they supplied to in their quest to find new enterprises, mainly in Australia. Farmers showed inconsistent recognition of the current challenges of animal production in relation to climate change. Quantitative research is now needed, as Australia and Brazil both have livestock industries of worldwide significance, and our survey was not designed to be representative. Livestock industries in other parts of the world are also facing similar challenges, and both qualitative and quantitative investigations to determine farmers' options to diversify should be pursued.

Overall, our results suggest that most farmers are open to diversifying their enterprises, but they face many challenges that have serious connotations. Supportive public policies, efficient knowledge transfer and a secure demand for alternative products emerged as major factors perceived by Australian and Brazilian farmers as necessary for a fast and just transition from meat cattle and chicken raising to alternative activities.

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