



LIVELIHOOD TRANSITIONS IN LOW- AND MIDDLE- INCOME COUNTRIES

FROM ANIMAL AGRICULTURE TO ALTERNATIVE PROTEINS

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ABSTRACT

As alternative proteins (e.g., plant-based and cultivated meat) scale up, there is growing interest among many stakeholders in a transition away from animal agriculture. However, it is unclear what the consequences of a transition might be for livestock farmers and rural communities. A transition towards alternative proteins could bring considerable risk (e.g., loss of livelihood or income) for people currently involved in animal agriculture. However, it could also generate many opportunities (e.g., new markets, greater demand for high-value crops). Identifying these opportunities and risks could help to avoid the worst outcomes for farmers and to maximize the potential benefits. Highlighting opportunities could also help to reduce resistance to the development of alternative proteins, and to generate broader support for a transition.

This Guidance Memo asks two related questions. First, what is known about the nature and scale of the risks and opportunities that might be involved in a transition? We answer this question with a particular attention to Brazil. Second, what is known about the ways in which frontline persons could help facilitate a transition? We answer this question by examining case studies and perspectives globally. The Guidance Memo generates insights as to whether and how it is possible for commercial livestock producers and other people involved in the animal agriculture sector in low- and middle-income countries to transition to alternative livelihoods and sources of income, if and when there is a dietary and market shift away from animal proteins and towards alternative proteins.

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1. Background



1.1. What are alternative proteins?

Alternative proteins are an emerging set of food technologies that could provide new sources of meat, dairy, and seafood in addition to or in place of animal-derived products. Alternative proteins include plant-based, cultivated, and fermented proteins, all of which aim to closely replicate the taste, texture, and experience of consuming animal products¹⁻³. Plant-based proteins are derived from crops: meat products include the Impossible and Beyond brands, and there are countless plant-based dairy products now widely available to consumers in many countries¹. Cultivated proteins are grown from animal cells in bioreactors, without the need to kill the animal from whom the cells were taken. They have been produced at pilot scales but are not widely commercially available, although Eat Just began selling cultivated chicken in Singapore in 2020². Fermented proteins are produced from microorganisms grown in a bioreactor tank. Fermented proteins currently available to consumers include protein-rich products developed from fungi, such as Quorn's meatless alternatives, or functional ingredients produced via genetically modified yeast, such as Perfect Day's animal-free milk protein³.

Proponents of alternative proteins hope that these technologies could contribute to shifts away from animal agriculture and in doing so reduce the negative impacts of protein production on the environment⁴⁻⁷, public health⁸⁻¹⁰, and animal welfare^{10,11}. Such impacts depend in part on whether and to what extent the production and consumption of alternative proteins scales up to account for a meaningful proportion of the total protein sector (Box 1).

1.2. A transition away from animal agriculture and towards alternative proteins?

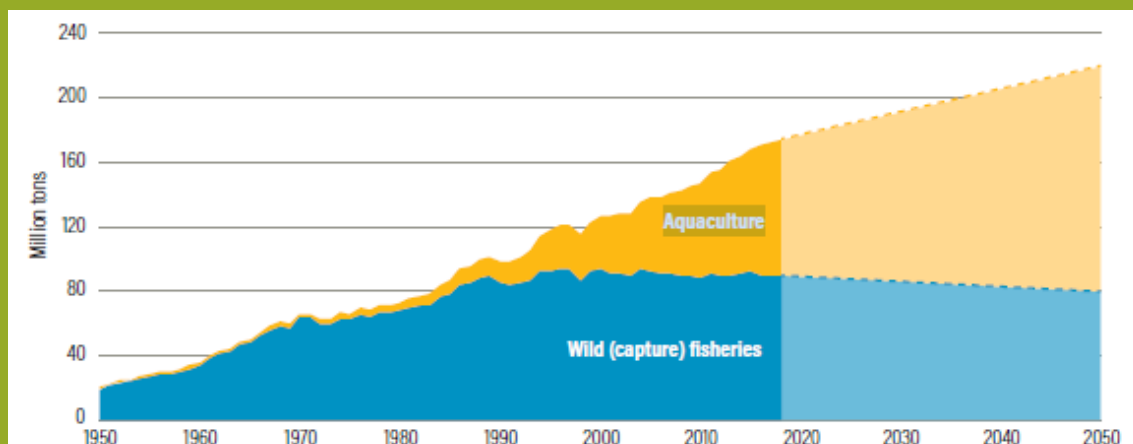
Many stakeholders and commentators are increasingly interested in the possibility of a *transition* away from a food system where meat, milk, and other protein sources are derived principally from animal agriculture and towards a world where such proteins could instead be derived in part, principally, or wholly from an alternative protein sector¹²⁻¹⁴. From local to national levels, conversations and actions about transitions

BOX 1: WILL ALTERNATIVE PROTEINS SCALE UP AND DISPLACE ANIMAL AGRICULTURE?

There is considerable uncertainty about the degree to which alternative proteins will scale up. First, there is uncertainty about how quickly the production of alternative proteins can scale and when products might be accessible and cost-effective to consumers at national or global scales⁷⁷⁻⁷⁹. Second, there is uncertainty about if the production of alternative proteins can reach a sufficient scale to actually displace (and substitute for) consumer demand for animal products⁸⁰. It is unknown how quickly, if at all, alternative proteins will actually compete with animal products for consumer demand. Instead, alternative protein products might just help to meet the growing global demand for protein. Global demand for animal products is growing quite dramatically, as a consequence of both 1) growing populations and 2) growing per capita demand as incomes rise and more people can afford to buy meat and other animal products⁸¹. Overall, the Food and Agriculture Organization of the United Nations estimates that total meat demand will increase by about 50% by 2050 relative to 2013³⁹. This additional demand could be met either by producing more animal meat, or by producing alternative proteins including plant-based and cultivated meat. It is probable that until the rate of production of alternative proteins outpaces growth in total protein demand, the alternative protein sector will grow alongside conventional animal agriculture without significant impacts upon it (e.g., few farmers' livelihoods will be threatened). A historic analogy might be that of aquaculture, or fish farming, which has grown to account for well over half of the world's total fish supply since the 90s, but has not significantly decreased the volume of wild-caught fish, simply because total fish demand has also grown significantly⁸² (Fig. 1).

FIGURE 1

Since the early 1990s, aquaculture has increased to meet the growing demand for fish without dramatically reducing the volume of wild-caught fish. Might alternative proteins similarly increase to meet the growing demand for protein without dramatically reducing the number of farmed animals?



Source: Searchinger et al. 2018 Creating a sustainable food future: a menu of solutions to feed nearly 10 billion people, World Resources Institute. Historical data, 1950-2016; FAO. Projections to 2050: assumes 10 percent reduction in wild fish catch from 2010 levels by 2050, linear growth of aquaculture production of 2 Mt per year between 2010 and 2050.

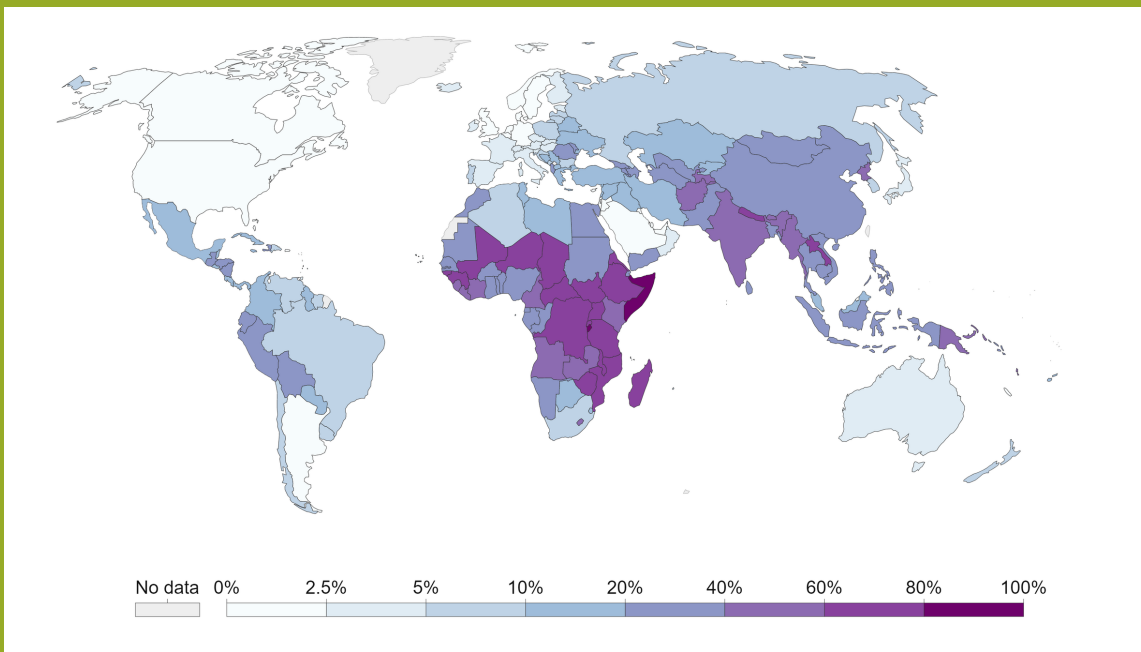
are being led by a range of actors (e.g., 50by40, 2020; Pyett et al., 2019; Vivid Economics, 2021). These stakeholders are variously motivated by the potential benefits that such a transition could offer to farmers, farmworkers, rural communities, ecosystems, animals, and the climate.

1.3. Implications of a transition for rural producers

If alternative proteins scale up to account for a meaningful share of the protein sector, there are important and unresolved questions about what the implications might be for rural producers (i.e., ranchers, livestock farmers, and crop farmers) around the world^{10,15,18}. There could be risks or threats for those who currently depend on animal agriculture, either by raising livestock or producing animal feed or other inputs. There could also be opportunities both for current farmers and other members of rural communities who could benefit from a new alternative protein sector.

1.4. Transitions in LMICs could present unique opportunities and challenges

The animal agriculture sector in many low- and middle-income countries (LMICs) differs in important ways from many high-income countries. These differences in structure may present unique opportunities and challenges and may also mean that transition models and initiatives developed in high income countries may not be readily transferable to LMICs or at least may need to be adapted. There are multiple characteristics of the animal agriculture sector that may influence the nature and viability of transitions in LMICs. First, the proportion of the workforce employed in agriculture tends to be higher in LMICs (average 32% in 2019) than high-income countries (average 3%)¹⁹ (Fig. 2).

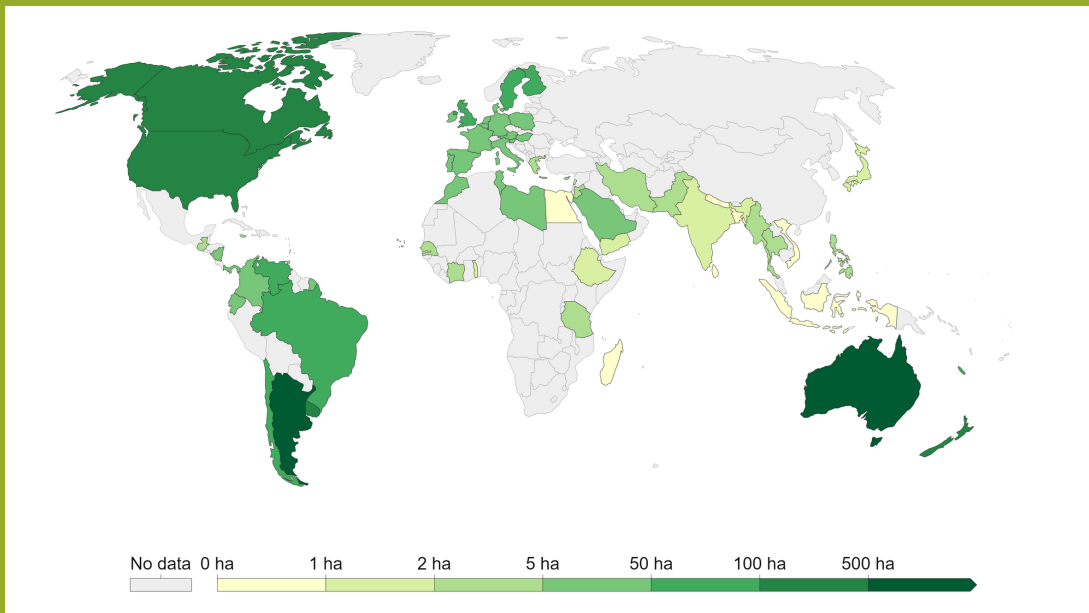
FIGURE 2**Share of the labor force employed in agriculture, 2019.**

Source: Our World in Data based on International (via the World Bank) and historical sources.
OurWorldInData.org/employment-in-agriculture

As such, a much larger number of people would be affected by a transition away from animal agriculture in many LMICs. Second, the average farm size tends to be smaller in LMICs (average 31 ha) than high-income countries (average 149 ha)²⁰ (Fig. 3). If smaller farms are less wealthy, they may be less likely to have access to capital or credit and may find it harder to adapt, diversify, or transition. Third, large-scale intensive animal agriculture tends to be less prevalent in LMICs than in high-income countries. An estimated 99% of farm animals in the US²² and 73% of farm animals in the UK²¹ are raised in intensive conditions. In contrast to high-income countries where an average 43% of farms are smallholders (< 2 ha), many LMICs are characterized by a larger proportion of smallholders (average 63% of farms), many of whom maintain more extensive farming systems with lower animal production intensity²⁰ (Fig. 4).

FIGURE 3

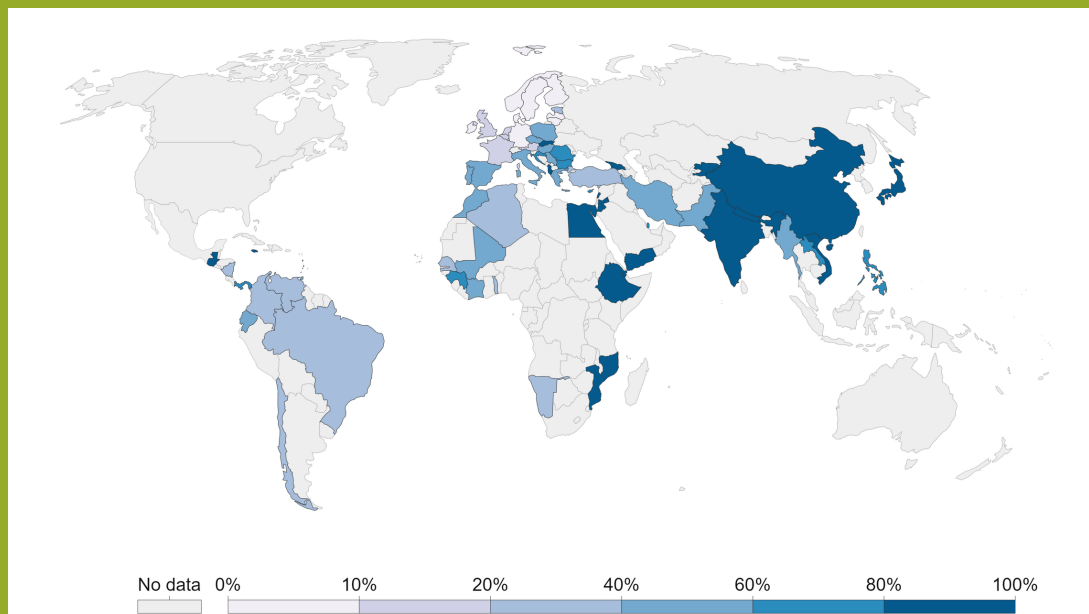
Average farm size, 2000.




Source: Lowder et al. 2016. The number, size, and distribution of farms, smallholder farms, and family farms worldwide. World Development. OurWorldInData.org/farm-size

FIGURE 4

Share of farms that are smallholders, 2005. Smallholder farms are defined as those with an area less than two hectares.



Source: Lowder et al. 2016. The number, size, and distribution of farms, smallholder farms, and family farms worldwide. World Development. OurWorldInData.org/farm-size

An aerial photograph of a dense, lush green forest. A dark, winding road or path cuts through the trees, curving from the upper right towards the lower left. The sunlight filters through the canopy, creating a mix of bright green and deep shadows. The overall scene is vibrant and natural.

2. What is known about the risks and opportunities that might be involved in a transition towards alternative proteins?

2.1. Why Brazil?

Brazil is an important case study country for thinking about the emergence of alternative proteins and transitions away from animal agriculture²³. First, it is a globally significant producer of animal agriculture products. In 2020, Brazil was the world's second largest producer of beef (after the US) and the leading beef exporter²⁴, and was also the largest producer of soy²⁵. Second, animal agriculture in Brazil has significant environmental impacts, including being associated with widespread deforestation in the Amazon and Cerrado biomes²⁶⁻²⁹. Third, Brazil is the focus of considerable investment for alternative proteins³⁰. Therefore, much of this Guidance Memo focuses on Brazil. However, much of the content and many of the lessons learned may be highly relevant to other low- and middle-income countries.

An emerging alternative protein sector could offer a number of opportunities for farmers, ranchers, and rural communities, as well as a number of risks or threats. These potential social and economic impacts of alternative proteins have been studied in the context of the US¹⁸, Germany³¹, and Brazil³². **Here, we synthesize the findings of these studies, with a particular focus on factors specific to the case of Brazil.**

2.2. Opportunities for rural producers

2.2.1. Opportunities for crop-growing farmers

2.2.1.1. Growing ingredients for plant-based meat

Plant-based meat products often demand high-protein crops, such as soy, peas, and mung beans. Increasing demand for these crops could present new income streams and/or opportunities for diversification for farmers who already grow them or who adopt their production as part of their rotations¹⁸. Since many high-protein crops for plant-based meat are nitrogen-fixing legumes, adoption of these crops could also deliver environmental and economic benefits through reduced fertilizer use¹⁸.

Brazil is well-poised to become a key producer and supplier of crop inputs for plant-based meat, in terms of both traditional and novel crop inputs³². Since 2019, the country has been the largest producer of soybeans globally²⁵ with a vast infrastructure to support production, processing, and export of soy. Soy agriculture in Brazil has been associated with significant environmental costs²⁹ but soy is likely to have a greater conversion efficiency as an input for plant-based meat than as animal feed^{33,34}. In addition, many stakeholders are interested in diversifying the range of plants used in plant-based meat to additionally include some of the many species that are indigenous and/or endemic to Brazil's Amazonia and Cerrado biomes (e.g., Brazil nuts, babaçu, cupuaçu)³⁵.

2.2.1.2. Growing feedstock for cultured meat

There is some uncertainty around what inputs will be needed to produce cultivated meat. But at minimum the sector is likely to demand amino acids and sugars, and one possibility may be to derive these from traditional crops¹⁸. Again, Brazil's position as a leading producer of soy and also of sugarcane and corn could position its farmers well to take advantage of emerging market demand. Brazil is the leading producer of sugarcane and the third largest producer of corn²⁵, with a well-developed infrastructure to refine these crops into ethanol^{36,37}. Some of this infrastructure could perhaps be leveraged to support the production of inputs for cultivated meat.

2.2.2. Opportunities for ranchers and livestock farmers

2.2.2.1. Genetic material for cultured meat

Cultivated meat will likely depend on the maintenance of small herds of animals as the original source of cells¹⁸. Heritage breeds and other high-value livestock could be particularly in demand. If Brazil develops a strong cultivated meat sector, it is likely that companies would want to source animal cells domestically. However, this opportunity would likely benefit only a very small number of producers.

2.2.2.2. Bioreactors on farms

One possible model of cultivated meat production that has garnered attention is that of localized, on-farm production. Such a model would involve small-to-medium-sized bioreactors on farms, operated by farmers themselves^{18,38}. Barriers to such a model might include the potentially high costs of investing in the technology, and acquisition of the technical skills needed to operate the bioreactors¹⁸. These concerns are likely to be particularly prohibitive in Brazil and other low- and middle-income countries.

2.2.2.3. High-animal welfare farming

While some proponents of alternative proteins have called for a complete end to animal agriculture¹⁴, it remains unlikely that a complete transition to non-animal derived sources of protein will occur in the foreseeable future³⁹. However, some experts have speculated that alternative proteins could reduce demand for commodity meat while also leaving intact a market for higher-welfare, less intensive animal farming that focuses more on added values such as being local, organic, or from family farmers¹⁸. About 90% of beef in Brazil is raised entirely in pasture-based systems rather than being finished in industrial feedlots²⁸, and so if Brazilian ranchers can decouple pasture-raised beef from deforestation they could be relatively well-positioned to take advantage of such market differentiation⁴⁰.

2.2.2.4. Co-production

Some companies are combining animal meat and alternative meat into blended or hybrid products⁴¹. Such products may have lower environmental impacts and could reduce the number of animals in the agricultural system. Several of the world's largest meat processing companies are either headquartered in Brazil (e.g., JBS, Marfrig, Minerva) or have a significant presence in the country (e.g., Cargill, Tyson). Many of these companies have invested in alternative protein companies or are developing their own lines of alternative protein⁴². To the extent that these lines include hybrid products, this could open new markets for animal livestock producers.

2.2.3. Opportunities for rural communities

2.2.3.1. Jobs in production facilities

Alternative protein production facilities could generate new jobs for people living in rural communities¹⁸. Some of these jobs could be commensurate in skill requirements to those in slaughterhouses and could thus prove a viable alternative. It is also likely that such jobs would be considerably safer and less exploitative than in slaughterhouses^{18,32}. In Brazil, cattle slaughterhouse work ranks the 4th highest in terms of occupational accidents per capita, and other livestock slaughter is 25th most dangerous³². A reduction in animal slaughter would remove many people from these jobs.

2.2.3.2. Food security

If alternative proteins were to become more affordable, more widely available, and/or have better shelf life than animal meat, they could contribute to food security goals¹⁸. Given the high levels of food insecurity and poverty in Brazil and other LMICs, including in many rural areas, widespread availability of alternative proteins could be a societal benefit³².

2.2.3.3. Other uses for land

If alternative proteins scale up sufficiently to displace animal agriculture, the total amount of land needed to produce protein may be dramatically reduced^{43,44}. One possibility is that spared land could be used for other purposes, including carbon sequestration and habitat restoration⁴⁴. Commentators have speculated about payments for environmental services programs or other incentive-based initiatives that could reward land owners and help compensate for lost revenue from agricultural production^{45,46}. Brazil is well-placed to implement such programs, with a relatively long history and experience with PES and similar programs⁴⁷. In Amazonia, PES programs have been widely implemented to incentivize forest conservation, including under the banner of Reducing Emissions from Deforestation and forest Degradation (REDD+) initiatives⁴⁸. In the Atlantic Forest, significant effort and funding is being invested in restoration projects⁴⁹. As such, programs that reward landowners to restore former pastureland (or cropland that was used for animal feed production) could have potential financial and ecological benefits in Brazil.

2.3. Threats for rural producers

2.3.1. Threats for crop-growing farmers

2.3.1.1. Difficulties in transitioning or diversifying

Transitioning or diversifying into new forms of agricultural production can be expensive and difficult. Adopting new crops into a farm's production can require additional knowledge, capital, and supply chain access¹⁸. Peas and chickpeas are not currently grown in significant quantities in Brazil²⁵. Additionally, the plant-based meat industry might demand pesticide-free crop production, which would represent a significant change in production practices for many farmers. In Brazil, many farmers find it challenging to access the tools they need to adopt more sustainable practices⁵⁰. In particular, poor access to credit is a pervasive barrier to the adoption of more sustainable practices and new technologies for many Brazilian farmers⁵¹. Extension services could help to alleviate some of these concerns⁵², but are unlikely to be available at the scale needed for dramatic shifts among large numbers of farmers.

2.3.2. Threats for ranchers and livestock farmers

2.3.2.1. Cattle ranchers

In the US, many cow-calf cattle ranchers are small operations (<200 head) whose owners have other sources of income and are not dependent on the financial viability of their operation¹⁸. In Brazil, however, the sector is characterized by a large number of smallholders and a small number of high-volume ranchers^{53,54}, most of whom are strongly dependent on the health of the industry. As such, smaller livestock producers may suffer the biggest and earliest losses, if alternative protein scales up and displaces animal agriculture³².

2.3.2.2. Chicken and pig farmers

In the US, individual livestock producers may be at greatest risk from a transition to alternative proteins. Many are in significant debt, and many are bound into

contracts with large meat corporations in vertically integrated supply chains⁵⁵. There are few obvious alternative uses for their land or their infrastructure¹⁸. In Brazil, smaller livestock producers may also be in the worst position, for the reasons stated above. Additionally, small producers and farmworkers may have limited technical expertise and a low level of education, which could limit their ability to explore alternative livelihoods³².

2.3.3. Threats for rural communities

2.3.3.1. Unemployment

In many low- and middle-income countries, a significant proportion of the population is engaged in agriculture (Fig. 2). In Brazil, about 9% of the labor force (9.76 million people) were employed in agriculture in 2019¹⁹. In contrast, in the US only about 1.4% of the labor force worked in agriculture in 2019. Any reduction in the productivity of the animal agriculture sector will have more profound implications³² for employment and community wellbeing in Brazil and other LMICs than in countries where a smaller number of people work in the rural economy.

3. What is known about the ways in which frontline persons could help facilitate a transition?



3.1. Why should frontline persons engage with transitions?

3.1.1. Maximizing opportunities requires being proactive

The development of alternative proteins and the discussion of transitions away from animal agriculture are both at relatively nascent stages. Engaging with these trends early could be important in enabling frontline workers (e.g., funders, donors, activists, non-profit workers, governments) to behave proactively rather than reactively towards emerging opportunities and risks. Any stakeholder who wishes to ensure the best-possible outcomes for humans, non-human animals, and the environment needs to first be informed and aware of changes that could occur, and then may have opportunities to influence those changes¹⁸.

3.1.2. Maximizing opportunities requires engagement

Stakeholders can choose to engage in the new alternative protein sector and in the arena of transitions, to actively try to secure positive change for farmers and ranchers, or they can choose not to engage. Some authors³² convincingly argue that the former option is the more rational choice. They reason that many of the potential opportunities depend on stakeholder engagement in order to be realized. But the challenges will present themselves regardless. So, stakeholder engagement could help to maximize the benefits, and may mitigate some of the negative impacts. But failure to engage would not prevent the negative impacts but would also mean failing to capitalize on the opportunities.

3.1.3. Other factors may necessitate change

Even if alternative proteins fail to scale up, agricultural transitions may occur as a consequence of other factors. For example, climate change might force or necessitate shifts away from (or at least significant adaptations within)

animal agriculture if the sector becomes riskier, more costly, or less certain⁵⁶. As a second example, in many countries the proportion of the labor force employed in agriculture has dropped dramatically: e.g., in Brazil from 20% in 1991 to 9% in 2019¹⁹. Finally, the average age of farmers in many places continues to rise^{57,58}. Such dynamics might motivate frontline persons to engage with the challenges of rural transitions, even absent a burgeoning alternative protein sector.

3.2. What examples exist of frontline persons actually trying to facilitate transitions, and what lessons have been learned?

Many stakeholders have explicitly demonstrated interest in proactively engaging with the potential opportunities and challenges that may face farmers and ranchers in light of an emerging alternative protein sector and a possible transition away from animal agriculture. From governmental policy, to company partnerships with farmers, to non-profit led transition programs, a range of stakeholders have acted in ways that try to encourage and/or help farmers to transition or diversify. We searched the peer reviewed and gray literature for examples of such cases. We constructed a table of illustrative examples that we encountered (Appendix Table 1). We reached out to many of these organizations to request interviews and talked with representatives of several of these projects. We detail two case studies below (Boxes 2-3) and describe the pertinent characteristics of the range of initiatives here.

3.2.1. Governments

On a national scale, some governments have proposed large-scale shifts away from animal agriculture. For example, the Dutch government has reportedly proposed to reduce livestock numbers in the Netherlands by one third buying out farmers⁵⁹. The Danish government announced significant funding to increase the production of plant-based foods⁶⁰.

In the United States, Senator Cory Booker introduced the Farm System Reform Act, a \$100 billion fund proposed to voluntarily buyout farmers who run Concentrated Animal Feeding Operations but who are interested in transitioning to other agricultural operations including pasture-based livestock operations, specialty crops, and organic commodity farming⁶¹.

3.2.2. Private sector

Some private companies have created opportunities for farmers to grow crop inputs for alternative proteins. For example, the oat dairy company Hälsa is working with dairy farmers to diversify their production by cultivating oats for their products (Box 2). The plant-based dairy and cheese company Miyoko's is developing a dairy farm transition program that supports dairy farmers to shift to growing specialty crops that the company will buy for their supply chain and to support research and development⁶². Oatly, another oat dairy company, has a similar initiative to support livestock farmers in Sweden and animal feed farmers in the United States transition to growing oats for their product line (Box 3). Finally, some individual farms and businesses have transitioned, including Elmhurst 1925 (formerly Elmhurst Dairy), which transitioned in 2016 from a dairy operation to producing cashew, almond, oat, and hemp milks⁶³.

3.2.3. Non-profit organizations

Multiple non-profit organizations are working with individual farmers or lobbying for legislation that would support livestock-raising farmers to transition to alternative production systems. For example, the animal-welfare organization Mercy For Animals has helped individual farmers abandon chicken farming and adopt hemp or mushroom production⁶⁴. Brave New Life Project, a community-based non-profit in Colorado, USA, has founded an employment assistance program which offers 1-on-1 employment assistance and other services to workers struggling to transition out of the animal agriculture industry⁶⁵. The Rancher Advocacy Program works with individual ranchers to help them create a viable transition plan to convert their ranch to a range of alternatives, including a farm sanctuary or a business that supports the production of plant-based foods or renewable energy⁶⁶.

The Agricultural Fairness Alliance (AFA) is a nonprofit that advocates for fairness in US agricultural policy. The AFA has proposed draft legislation for the “Farm and Ranch Mobility Solutions Act” a pilot program modeled on the work of the Rancher Advocacy Program, which would offer financial support to small- or mid-sized farmers or ranchers to offset the costs associated with diversifying and transitioning a farm to plant-based production⁶⁷.

3.2.4. Financial sector and donors

The financial sector is also increasingly demonstrating interest in these issues. A recent report called for public and private investment in alternative protein innovation, as a means to address climate change¹⁷. In 2019, the private foundation the Stray Dog Institute convened a collaborative working group to inform the development of a strategic report to serve as a “roadmap that would establish the need for farm transformations, explain the barriers to success, and identify several of the best strategies for change” (Stray Dog Institute, 2021). Similarly, in a report mapping the drivers of investor interest in diversifying the protein sector, the investor group FAIRR called upon companies to “engage their supplier community to mitigate the impacts on farmer livelihoods”⁶⁹. Most recently, in a report establishing a framework for a sustainability transition in food and agriculture, the investment banking group JPMorgan Chase & Co highlighted alternative proteins as potential solution to food insecurity and emissions reductions, and advocated for a strategic assessment of socio-economic threats to agriculture and food-related workers that could be posed by a transition to alternative proteins⁷⁰.

3.2.5. Lessons learned

Our review revealed ***relatively few examples of farmers and ranchers having actually transitioned out of animal agriculture into alternative protein production.*** A few cases (e.g., Hälsa, Oatly) exist of farmers diversifying their production to include products for plant-based proteins in addition to their production of livestock or animal feed. Additionally, very little is known about the circumstances that support transitions, and the factors that make transitions more or less viable and likely. As such, more cases are needed, and more lessons need to be shared, in order to understand whether and how it is possible to support livestock farmers to transition away from animal agriculture completely.

We also found ***no examples of transition programs supporting farmer transitions away from animal agriculture in low- and middle-income countries.***

Adapting transition models that were developed in high income countries to implement in LMICs could pose significant challenges due to relevant differences in the animal agriculture sector⁷¹. Such differences include the percentage of the population dependent on animal agriculture¹⁹, average farm size²⁰, the prevalence of smallholder and pastoralist production⁷², and access to supply chains and commercial markets⁷³. Further research is needed to determine how these and other differences in the animal agriculture sector affect the viability of farmer transitions in LMICs.

Our interviews revealed some potential challenges. First, **economic viability** may be a barrier to transitions in many cases. For example, the Farm Transformers initiative founded by the Blue Horizon International Foundation in 2017 was ultimately unable to successfully support chicken farmers in a transition away from animal agriculture due to economic constraints imposed by the binding contracts and related debt incurred by the American chicken farmers the initiative worked with⁷⁴. Second, many farmers who raise livestock **lack the knowledge** of how to produce crops or pursue a viable alternative employment opportunity. As a result, livestock farmers interested in transitioning are typically required to invest their personal time and resources into pursuing learning opportunities or job retraining⁷⁴. Third, many farmers may experience **skepticism or judgment** from neighboring farmers in the initial stages of transitioning or diversifying their farm. Although the farmers and transition program managers we spoke with indicated that this dubiousness shifted to curiosity or interest once the transition model's viability was demonstrated, this initial skepticism or judgment from neighbors may preclude farmers from considering the possibility of transitioning^{75,76}.

Our interviews also revealed a number of unanticipated benefits experienced by farmers after transitioning or diversifying their farm or ranch to integrate plant-based production. Relative to dairy production, plant crop cultivation is much **less labor intensive**. The dairy farmer involved with the Hälsa transition program noted: "The attractive thing about the oats is that once you get them in the ground and see them it's kind of hands off till harvest time...with the milking herd [labor is required] seven days a week"⁷⁷.

Farmers involved in the Oatly transition program noted similar attractive reduced labor benefits, and also **expressed excitement about growing food for human consumption**. Our interviewee expressed: “they are excited to be growing food, they've been growing feed or seed for fuel for so long, but, to be able to like go to the grocery store and buy Oatly and feed it to their families and say ‘My oats might be in this!,’ that's what we hear pretty frequently”⁷⁶. Farmers growing oats as a diversified form of production while continuing to keep animals on their farm noted additional **benefits of an integrated crop-livestock farming system**. For example, livestock and dairy farmers are able to use manure as a source of organic fertilizer, and oat straw, a co-product of rolled oat production, can be used as livestock bedding.

3.3. What is the range of ways in which frontline persons could influence transitions?

In addition to the ways in which some stakeholders have already engaged in the emergence of an alternative protein sector and a possible transition away from animal agriculture, many other potential opportunities exist. We discuss some of these below, disaggregated by sector. We do not make specific recommendations, per se. The alternative protein sector is too nascent, and there is too much uncertainty around transitions, to be able to offer concrete recommendations. Rather, we wish to point to relatively specific ways in which stakeholders could try to influence the system, while remaining relatively agnostic about which of these they should try, in the absence of robust evidence.

3.3.1. Universities and research institutions

- There is a need to model the potential impacts (positive and negative) that alternative proteins may have on rural livelihoods, and to measure those impacts as they manifest as alternative proteins scale up. Impacts are unlikely to be homogeneously distributed, and so specific attention should be paid to geographic heterogeneity, differentiation across demographic groups, the magnitude of impacts, and the timescale over which impacts unfold.

- There is also a need for knowledge and understanding of the efficacy of actions that support transitions. Rigorous impact evaluations of government- and non-profit policies and programs could help identify factors that facilitate and constrain transitions and could reveal the relative effectiveness of alternative strategies to support farmers, ranchers, and rural communities through times of change.

3.3.2. Governmental agencies

- Federal and state governments could invest in alternative proteins (e.g., by funding research; funding technology development; developing infrastructure; ensuring regulatory clarity; creating a level playing field by removing perverse subsidies; and supporting markets for plant-based, fermented, and cultivated proteins).
- Governments could adopt legislation and fund programs that support transitions. This could include actions that remove barriers (e.g., farmer debt forgiveness) as well as those that create opportunities (e.g., retraining; stimulating job creation in rural areas; incentivizing land transitions through tax credits or payments for environmental services programs).
- Governments could consider policies that support human wellbeing in the face of dramatic and widespread changes in workforce and unemployment (e.g., universal basic income).

3.3.3. Non-profit organizations

- Non-profit organizations could support farmer transitions (e.g., through extension, retraining, support through transition periods, and accessing new markets).

- Non-profit organizations may also have a role in advocating for policies that support transitions.
- Non-profit organizations could catalyze transitions (e.g., by facilitating communication and dialogue between stakeholders; retraining and supporting farmers; and representing the interests of the emergent industry).
- Cooperatives and extension agents may have a role to play in helping farmers and ranchers adapt to changing markets (e.g., through field demonstration days, retraining, and technical assistance).

3.3.4. Funders

- Philanthropists and other donors could support any of the activities listed above, including research on the impacts of alternative proteins on rural livelihoods, and policies and programs that support livelihood transitions.

An aerial photograph of agricultural fields, showing rows of crops and a winding path. A dark green rectangular overlay is positioned in the center of the image, containing the section header in white text.

4. Conclusions

Characterizing the opportunities and risks associated with a protein transition is necessarily speculative, given the nascent nature of the alternative protein sector. It is therefore difficult to state with any certainty how likely any one outcome is, or on what timescale or magnitude it would transpire if it did occur. Nonetheless, thinking through and systematically generating awareness of possible outcomes (both positive and negative) is a necessary if insufficient step towards being able to guide frontline persons towards actions that could secure the best-possible futures for farmers. Being proactive rather than reactive may be critical in harnessing opportunities and avoiding the worst risks. The sheer number of people working in animal agriculture globally makes the scale of this challenge enormously difficult. But if the best-case assertions of proponents of the alternative protein sector manifest, there could be enormous benefits to people, animals, and the planet.

Box 2

CASE STUDY: HÄLSA FOODS

Description of the case

Hälsa Foods is a plant-based company specialized in organic oatmilk products. The company is based in the United States. The company's co-founders launched a farm initiative (the Dairy-to-oat conversion program) that aims to help US dairy farmers diversify their production by growing organic oats for human consumption. The initiative uses Scandinavian oat cultivation techniques to minimize environmental impacts. The farm initiative's pilot partnership began in 2020, with a collaboration between Hälsa Foods and the owners of a 250-cow organic dairy farm in upstate New York. As of February 2022, the pilot partnership is nearing completion of the experimental stage, which involved the use of test fields to determine the oat variety and the practices most suited to local conditions. The third harvest of their selected oat variety is scheduled for summer 2022. It will likely be 2023, the fourth year from the start of the farm initiative until oats grown on the pilot farm are used in Hälsa Foods products.



Photo Credit: Hälsa Foods

Lessons Learned

SUCCESS FACTORS

The farm was selected for the pilot project for a few important reasons. Foremost, they were a dairy farm actively looking to diversify to growing plant-based food. In light of recent declines in demand for dairy products and increases in demands for plant-based dairy alternative products, the farmers viewed the opportunity to grow oats for Hälsa Foods as a pathway to diversified production that could help bring economic resilience to their livelihoods. Hälsa Foods' Dairy-to-oat conversion program aims first and foremost to help dairy farmers diversify into growing premium oats. Second, Hälsa Foods was seeking a farm that would grow premium organic oats to their Scandinavian standards. Most oats growing in the U.S. are grown for feed and are low quality and therefore do not meet Hälsa Foods' specifications. Third (though less unusually), the farm had available certified organic arable land that was suitable for growing oats. Finally, the farmers were open-minded and possessed an optimistic attitude that was attractive to the co-founders, who were interested in forming a partnership with farmers who they would enjoy working closely with. This open-mindedness and optimism was readily apparent in our interview with one of the pilot farmers, who described to us his interest in diversifying his farm: "I'm a dairy farmer by heart, but my passion is agriculture, so, if I can still grow a product within agriculture that can provide consumers with a wholesome product I'm all ears" . He believes that dairy farmers can view the rise in demand for plant-based dairy products "as a threat or an opportunity" and that, although some farmers may not be open to considering a transition towards diversification because they "want to [continue to] do the same thing," he chose to see the growth in demand for plant-based dairy alternatives as a potential opportunity.

The initial success of the project on the pilot farm has also enabled by various factors, including:

- **The company's ability to absorb overhead financial costs of the transition.** With the support of their investors, Hälsa Foods has been able to absorb the overhead financial costs of purchasing seeds, financing nutritional quality tests, and contracting Scandinavian researchers with expertise in oat production.
- **Providing the farmers with knowledge on how to grow crops and technical assistance.** Scandinavian researchers were contracted for the program to aid the farmers in the process of identifying an oat variety suitable for the climatic conditions and optimizing their methods of oat cultivation.
- **The reduction of capital costs for equipment.** The farmers were able to use equipment they already possessed or borrow equipment from neighboring farmers for planting and harvesting oats.
- **Initiating the project at a small scale.** The program was piloted at an experimental level of production without an immediate pressure to incorporate the oats grown on the pilot farm into the company's products.

CHALLENGES AND LIMITATIONS

This initiative represents diversification into plant-based food production, but not a transition away from animal agriculture. The farmers selected for the pilot farm initiative transitioned from growing organic crops for animal feed to growing organic oats for human food consumption and have continued to produce organic dairy at the same capacity as they did prior to starting the project. They are not currently reliant on oat production as a source of income, and the possibility of downsizing their dairy production operation will depend on the success and potential expansion of their production of organic oats. The climate of upstate New York and unexpected weather events have been the most significant challenges experienced by the pilot project farmers to date, and their ability to consistently produce a reliable quantity of organic oats will depend on their ability to successfully adapt Scandinavian oat cultivation techniques to the climate of upstate New York.

SCALING UP

Hälsa Foods hopes to expand their farm initiative. Their vision is to form localized production systems modeled on cooperative organic oat cultivation in Scandinavia where small family farms grow organic oats in close proximity (within 80 miles) of the mill where they are dried and processed. Details of the pilot project were published in local media outlets; consequently, there has been significant interest from neighboring dairy farmers in joining the program. Hälsa Foods anticipates easily identifying an additional 40-50 dairy farmers interested in diversifying their production to grow organic oats for the company.

Box 3

CASE STUDY: OATLY

Description of the case

Oatly is a Swedish oat dairy company that has become the global leader in sales of plant-based milk alternatives. In 2019, Oatly's North American team founded a farmer transitions initiative based in the Midwestern United States to explore whether it could be economically or environmentally beneficial to work with farmers to source food grade oats from the United States, rather than from Canada (the current source of the majority of their oats). As part of the transition program and monitoring process, participating farmers are required to underseed their oat crops with a nitrogen fixing cover crop, and to monitor the effects of the transition on soil health, water quality, and nitrogen usage. The company put emphasis on building a close relationship with the farmers from the initial stages of the project. As our interviewee stated: "One important thing for us was saying, you know, this is not for public relations purposes, we're here to actually see what could happen if a company committed to thinking about increasing acres for the benefit of farmers and figuring out what the exact right role is for us here"⁷⁶.



Photo Credit: Oatly

To recruit farmers into the program, Oatly partnered with Practical Farmers of Iowa (PFI) and the Sustainable Food Lab (SFL). These two organizations proactively reached out to the company because they were running pilot projects incentivizing corn and soy farmers to grow animal feed crops as a third crop rotation. They were interested in partnering with Oatly to expand their program and assess the potential of using food grade oats as an alternative crop to animal feed. To ensure that the oats grown by transitioning farmers would be incorporated into their supply chain, Oatly also partnered with the global grain manufacturer Grain Millers.

Lessons Learned

SUCCESS FACTORS

In 2019, Oatly recruited four farmers into the program, and as of 2021 they have scaled to fifteen farmers. Their program has been successful in retaining farmer engagement, and they are beginning to assess the impact that the oats and cover crop rotation has had on the farm's soil health, water quality, and nitrogen use.

A number of factors have facilitated the transitions program, including:

- **Ensuring that there is a guaranteed market for the crop.** Through their partnership with Grain Millers, Oatly was able to assure farmers engaged in their transitions program that their oats would have a guaranteed market. Grain Millers has an agreement to help farmers find a secondary market if the oats are not up to food grade quality.
- **Establishing payment for farmers via a cost share.** Through a Conservation Innovation Grant from the USDA to PFI and SFL, farmers in the program are provided \$25 an acre as an incentive to plant oats on the third year of a crop rotation, under-seeded with a cover crop.
- **Maintaining a close relationship with the farmers involved with the program.** Oatly has received direct feedback from farmers that they appreciate their efforts to maintain a close personal relationship by frequently checking in, visiting them on the farm, and sending a care package with their products at the beginning of the growing season.

CHALLENGES AND LIMITATIONS

First, our interviewee highlighted the significant communication challenge of working with farmers to discuss the potential financial and soil health benefits of incorporating oats as a part of a three-year crop rotation. Second, most Oatly factories accept oats via rail but most US grain millers transport oats by truck, resulting in an infrastructure mismatch that could inhibit their ability to scale the initiative. Finally, ensuring that the oats are not cross-contaminated with gluten is a challenge for food-grade oats.

SCALING UP

Our interviewee stated that the future of the program will depend in large part on its potential environmental impact, and in particular the potential to reduce the application of nitrogen fertilizer. Oatly plans to build on the initial stages of the project to strategize effective communication approaches that effectively incentivize farmers to minimize their nitrogen application during the two years in which the farmers are growing corn and soy crops.

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6. Appendix

TABLE ONE: EXAMPLES OF NON-PROFIT AND PRIVATE-SECTOR TRANSITION PROGRAMS AND INITIATIVES

We included transition programs initiated by nonprofits and private companies with the objective of promoting and supporting farmers transitions away from animal agriculture to an alternative agricultural production. We excluded farm to farm-sanctuary cases, (draft) legislation, and governmental initiatives.

TABLE 1. EXAMPLES OF NON-PROFIT AND PRIVATE-SECTOR TRANSITION PROGRAMS AND INITIATIVES

Transition Project	Organization	Organization Type	Location	Objectives	Outcomes (as of March 2022)	Additional information
TransFARMation project	Mercy for Animals	Non-profit	United States	To help farmers transition their industrial animal-agriculture operations to plant-focused farms raising crops for human consumption.	The project has worked with at least six farms to transition.	https://thetransfarmationproject.org/
Rancher Advocacy Program	Rancher Advocacy Program Transition Hub	Non-profit	United States	To help farmers create a viable transition plan to convert their farm or ranch to a business aligned with the production of renewable energy or plant-based production.	The program has formed an international network of thought leaders, solution investors, food companies, and ranchers. The founders have helped mentor at least one farm interested in transitioning away from cattle ranching.	https://rancheradvocacy.org/
Hälsa Dairy-to-Oat Farm Conversion program	Hälsa Foods	Private Company	United States	To recruit dairy farmers interested in diversifying their production to grow oats for their company.	Currently in the pilot stage of the program partnering with one dairy farm in upstate New York.	https://halsafoods.com/about-halsa/
US Oat Pilot Program	Oatly	Private Company	United States	To help farmers transition their industrial animal-agriculture operations to plant-focused farms raising crops for human consumption.	The project has worked with at least six farms to transition.	https://thetransfarmationproject.org/
Farmer Seeking Farmers	Oatly	Private Company	Sweden	To support livestock and dairy farmers who are willing to increase the proportion of crops they grow for human consumption.	11 farmers are currently participating, and work is being done to map current farm situations and identify options to identify best ways to make progress.	https://www.oatly.com/things-we-do/initiatives/farmer-seeking-farmer

Transition Project	Organization	Organization Type	Location	Objectives	Outcomes (as of March 2022)	Additional information
Farm Transition	Refarm'd	Non-profit	Switzerland & United Kingdom	To aid farmers in transitioning to plant-based milk production while keeping dairy cows as sanctuary animals.	This initiative has been paused due to restructuring of the business.	https://en.refarmd.com/
Changing Farming	Farm Forward	Non-profit	India	To identify and fund programs supporting chicken farmers to maintain or adopt higher animal welfare farming practices.	A grants program that has supported producers in South Asia to resist industrial farming and adopt better practices.	https://www.farmforward.com/
Farm Transformers Initiative	Blue Horizon International Foundation	Non-profit	United States	To build sustainable, plant-based business solutions for farmers transitioning out of animal farming.	The program was unable to identify transformations that were economically feasible: most transitions were based on donations; and farmer debts and contracts were prohibitive.	https://bluehorizon.org/farm-transformers/



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