Applied Research and Technology Transfer: International Experiences for National Application

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The travel program typically comprises:

- **Contemporary Scholars Conference (CSC):** a one-week global orientation focused on leadership, connection and globally-relevant agribusiness topics
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Applied Research and Technology Transfer: International Experiences for National Application

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Supported by Fundação MS

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Alex is a biologist, holding a Master's degree in Plant Biology and a PhD in Crop Production. He currently serves as Executive Director of Fundação MS, an applied agricultural research institution based in Mato Grosso do Sul, Brazil — which also sponsored his participation in the Nuffield program.

He has experience in business management, communication and marketing, and strategic leadership, as well as in agricultural research and technology transfer — the latter being the core focus of his Nuffield study.

His research aimed to understand agricultural research systems around the world and to generate recommendations for his state and for Brazil.

Over the 18 months of the Nuffield program, Alex visited Australia, Zimbabwe, England, the Netherlands, Georgia, the United States, Poland, and France, in addition to Brazil, where the Contemporary Scholars Conference (CSC) was held in 2024. During these travels, he engaged with farmers, visited farms, industries, large corporations, research and extension institutions, as well as major agricultural events and exhibitions.

This report presents a compilation of the key findings from this journey, concluding with clear recommendations on applied research and agricultural technology transfer for Brazil and for Mato Grosso do Sul, his home state.

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I love you.

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Executive Summary

This report analyses how applied agricultural research and the effective transfer of knowledge contribute to productivity, resilience, and the economic viability of farming systems, and how these lessons can be used to strengthen Brazilian agriculture. The analysis is based on the author's experience as a 2024 Nuffield Scholar, including participation in the Contemporary Scholars Conference (CSC), held in Brazil, the Global Focus Program (GFP), and a series of individual study travels across the Americas and Europe.

Brazilian agriculture has been built on scientific research (Embrapa, 2022). The rapid adaptation of crops and systems to tropical conditions required practical solutions developed under real production environments. This problem-oriented research culture has enabled Brazil to become one of the world's leading agricultural producers. However, increasing system complexity, higher capital intensity, climate variability, and growing sustainability demands indicate that simply increasing productivity is no longer sufficient — continuous evolution is required.

The CSC held in Brazil was a defining starting point for this journey. Hosting scholars from around the world in Mato Grosso do Sul allowed Brazil to showcase the scale of its agribusiness, the diversity of its production systems, and its advances in sustainability. It also became clear how little this reality is still understood internationally. The post-CSC tour to the Pantanal reinforced that Brazilian livestock systems can successfully combine production, environmental conservation, and social value when properly managed and effectively communicated.

The Global Focus Program highlighted how different countries organize applied research and its connection with farmers. Australia demonstrated highly pragmatic systems, where farmers themselves fund research, define priorities, and expect clear returns on investment. Models based on industry levies and strong linkages between research institutions, universities, and industry create a continuous cycle between problem identification, experimentation, and on-farm adoption.

In contrast, England presents systems where applied research is strongly linked to public policy, environmental regulation, and subsidies. While these models provide support to farmers and deliver environmental outcomes, they also illustrate how production decisions can become overly driven by regulatory compliance, often at the expense of agronomic optimization. Poland revealed a technically advanced agricultural sector operating under political and land-use constraints that directly affect long-term planning and investment. Zimbabwe and Georgia offered an even stronger contrast, demonstrating that without institutional stability, governance, and capacity building, even strong technical knowledge struggles to generate lasting impact.

Across all regions visited, a consistent pattern emerged: applied research delivers greater value when it is organized around systemic problems, rather than isolated by crop or products. Where research focused on reducing yield variability, improving soil and water resilience, managing biotic pressures, and integrating sustainability with economic outcomes, farmer adoption was higher and results were more consistent.

The individual travels further deepened this understanding. In the United States, visits to the Corn Belt, major agricultural exhibitions, and universities reinforced the importance of extension models that translate technical results into economic decision-making. In Washington State, irrigated systems in arid environments demonstrated how water management and technology can stabilize production and enable both intensive and conservation-oriented systems. Poland provided a clear view of regenerative agriculture at scale, variety testing systems, and governance challenges of large farming operations within a shifting political landscape. England highlighted innovative uses of livestock for environmental management, heavily subsidized organic systems, and the growing role of renewable energy and biomethane in agriculture. France offered a global perspective on private agricultural research, particularly the rapid expansion of biological products and the central role of Brazil as a key market for development and adoption of these technologies.

A critical insight from these experiences is that sustainability alone does not generate value unless it is measurable, comparable, and linked to economic outcomes. Many countries are advancing towards simple, auditable indicators that connect soil management, nutrient efficiency, and system resilience to access to credit, insurance, and markets. Brazil already applies many of these principles — notably through the Climate Risk Zoning model (Embrapa, 2025) — but often lacks structured metrics and consistent communication to fully capture this value.

For Brazil — and particularly for Mato Grosso do Sul — the opportunity lies not in replicating foreign models, but in refining its own strengths. Applied research must evolve from a logic focused solely on generating large volumes of agronomic data to delivering clear decision-making frameworks that integrate technical performance, costs, risks, and long-term system stability. Strengthening the connection between research, economics, and extension will be key to increasing farmer adoption and trust.

The Nuffield experience provided a unique external lens to reassess Brazilian agriculture, revealing not only areas for improvement but also the true strength of the country's existing assets. The lessons drawn from this journey aim to support farmers, research institutions, and policymakers in strengthening applied research as a strategic tool for agricultural development — ensuring that productivity, resilience, and sustainability advance in an integrated way within an increasingly dynamic global context.

Chapter 1 – General Considerations on Applied Research in Brazil

This chapter provides an overview of applied research within the context of Brazilian agriculture, highlighting its role in the development of tropical production systems and its influence on farmers' decision-making. By analyzing its evolution, it seeks to understand how Brazil has structured a research model focused on solving practical problems, as well as the current challenges in expanding its impact.

In addition, the chapter discusses the key factors that shape the effectiveness of applied research in the country — including the origin of research demands, funding mechanisms, and knowledge transfer processes — establishing the foundation for the comparative analysis with other international systems throughout this report.

1.1 Applied Research and Tropical Agriculture: Building a Problem-Oriented System

The trajectory of Brazilian agriculture is deeply linked to the consolidation of applied research as a driver of productive transformation. Unlike temperate-climate countries, where many agricultural systems evolved over centuries under relatively stable conditions, Brazil was required to rapidly develop solutions to produce in tropical and subtropical environments, characterized by high climate variability, highly weathered soils, and intense biotic pressure (Embrapa, 2022).

In this context, applied research assumed an essentially pragmatic role. From the outset, its focus was on solving concrete problems: adapting crops and varieties to different regions of the country, managing soil fertility in low cation exchange capacity (CEC) soils, controlling tropical weeds and pests, defining planting windows, and developing viable production systems in new agricultural frontiers. This trajectory shaped a technical culture oriented towards experimentation under real field conditions and the rapid adoption of results by farmers.

Over recent decades, this model has proven highly effective in driving agricultural expansion and productivity gains. However, as systems have intensified, the complexity of the challenges has also increased. Applied research has evolved from addressing not only "how to produce," but also "how to produce consistently over time," considering climate risks, rising costs, and environmental constraints. This transition defines the current stage of Brazilian agriculture and reshapes expectations around the role of applied research.

1.2 Where Do Research Demands Come From, and How Does Research Influence Farmer Decision-Making

The demands that reach applied agricultural research in Brazil are multifactorial and reflect the diversity of the sector. A significant portion of these demands originate directly from the field, arising from recurring challenges faced by farmers, such as poor crop establishment, increasing resistance of weeds, insects, and diseases, declining input efficiency, soil physical degradation, and growing exposure to extreme climate events.

Other demands are driven by structural changes in the business environment. Brazil's increasing integration into international markets has introduced new requirements related to traceability, sustainability, and the verification of good practices. At the same time, the evolution and domestic constraints of rural credit, agricultural insurance, and financial instruments have increased the need for reliable technical information to support risk assessment and economic feasibility analysis.

In this context, applied research has a direct influence on farmer decision-making. In increasingly capital-intensive systems, poor decisions have an immediate impact on cash flow and farm profitability. Experimental results only become relevant when they help farmers answer practical questions, such as: among the more than 60 commercial products based on glyphosate registered in Brazil (Brazil, 2026), which one is best suited to my conditions? Which maize hybrid offers the highest yield potential in Goiás? And in Rio Grande do Sul? These are the types of questions that applied research must answer in a clear and objective manner.

Although Brazil has a strong foundation of agronomic data, there is still room to improve how these results are presented and disseminated. International experience shows that integrating technical performance with economic analysis significantly increases technology adoption rates. Translating agronomic data into decision-oriented insights — incorporating costs, expected returns, and sensitivity to external variables — is a natural next step to enhance the impact of applied research at farm level.

1.3 Funding, Knowledge Transfer, and the Challenge of Impact

The funding of applied research in Brazil reflects the complexity of the country's agricultural system. Public resources, derived from government budgets and sectoral funds, coexist with private investments from companies, cooperatives, and producer associations. In many cases, this combination enables the implementation of network-based projects, with regional validation and greater reach of results, as seen in Mato Grosso do Sul. In the state, the Soybean and Maize Development Fund (FUNDEMS) is financed through levies paid by farmers and is exclusively allocated to research and development initiatives.

However, this multiplicity of funding sources also brings challenges. Fragmented agendas and reliance on short-term projects can limit the continuity of research addressing structural issues, such as system management, soil health, and adaptation to future climate scenarios. Strengthening medium- and long-term programs, with clear objectives and impact metrics — such as those supported by FUNDEMS in Mato Grosso do Sul and the Grains Research and Development Corporation — remains one of the key institutional challenges for applied research in Brazil. In addition, the disconnect between research institutions and farmers' real demands continues to slow applied development.

Knowledge transfer represents the final — and often weakest — link in the applied research chain. Brazil has developed robust mechanisms for technology transfer, including field days, technical events, specialized publications, and, more recently, digital platforms. While these tools have expanded access to information, they do not, by themselves, guarantee effective technology adoption.

The current challenge is not only to disseminate results, but to organize them in a way that is meaningful for farmer decision-making. This requires regional contextualization, appropriate language, comparison between alternatives, and clarity regarding both technical and economic impacts. Applied research that fulfils this role moves beyond simply generating data and becomes a strategic management tool.

It is from this perspective that this report advances to the analysis of global technological diversity. Observing how other countries structure their institutions, finance research, and connect results to farmers allows the identification of principles and practices that can further strengthen the Brazilian system, while respect its specificities and leverage its historical strengths.

Chapter 2 – Global Technological Diversity and Applied Research Models

This chapter presents the main findings observed throughout the Global Focus Program (GFP) travels and the Individual Research, analyzing how different countries structure their systems of applied research, technology development, and knowledge transfer to farmers. The diversity of institutional, political, social, and economic contexts reveals markedly different models for organizing agricultural research, with direct implications for productivity, sustainability, and the economic viability of production systems.

Rather than describing isolated technologies, the focus is on understanding how these technologies are generated, funded, validated, and transferred, as well as the role of public, private, and industry organizations in this process. Throughout the visits, it became clear that there is no single model of success. Countries with very different production and institutional characteristics have developed their own approaches to structuring agricultural innovation systems. Even so, certain patterns consistently emerge — particularly regarding the predictability of funding, clarity of governance, farmer participation in setting priorities, and the ability to translate knowledge into practical on-farm decisions.

2.1 Australia – Structured Applied Research, Farmer-Led Governance, and Irrigated Agriculture in Remote Regions

Australia was the first country visited during the Global Focus Program (GFP), with a focus on the Kununurra region in the north of the country. This is an extremely remote area, characterized by vast logistical distances, low population density, limited urban centers, and clear infrastructure constraints. Even so, the region has managed to develop a functional, technically advanced agricultural system, highly dependent on planning, built upon a large-scale public gravity-fed irrigation project.

In the 1960s, a dam was constructed on the Ord River, funded by the Australian federal government, giving rise to the Ord River Irrigation Scheme. The increase in water levels enabled full gravity distribution through channels, leading to the formation of Lake Argyle and approximately 50,000 hectares of irrigated land, with expansion potential of up to 100,000 hectares. Water is delivered directly to farm gates and is charged based on both area and volume used. The total investment, estimated at around AUD 500 million since its inception, transformed a region previously dominated by livestock into a new agricultural frontier. In addition, it enabled the maintenance and intensification of livestock systems, the emergence of new activities such as aquaculture, and the installation of a hydroelectric power station supplying the region.

This physical and institutional environment has enabled the development of a highly diversified agricultural system, with crops including cotton, maize, melon, watermelon, mango, sesame, and cover crops. The observed crop rotations were intensive and well planned, leveraging both agronomic and commercial synergies, such as maize–watermelon and watermelon–melon sequences. Production logic is strongly influenced by logistical costs, water access, and the need to identify economically viable crop combinations in a remote environment. Fruit harvesting relies heavily on seasonal labor, often sourced from neighboring countries such as Timor-Leste, demonstrating that system viability depends not only on agronomic technology, but also on labor arrangements and mobility.

From an institutional perspective, Australia presented one of the most robust applied research models observed during the program. Organizations such as the Grains Research and Development Corporation (GRDC) and the Cotton Research and Development Corporation (CRDC) operate as public–private sectoral funds, financed directly through production-linked levies. Farmers contribute proportionally to their output, and these funds are pooled at the national level and complemented by public investment. Governance is a central element: decision-making boards include strong farmer representation, ensuring that research priorities are not defined solely by universities or governments, but also by those facing production challenges daily.

These organizations maintain relatively lean technical teams and operate primarily as coordinating and funding bodies, rather than direct executors of research. Most scientific work is carried out by universities, research institutes, and private companies contracted to deliver specific projects. This arrangement allows for alignment between applied and, when necessary, more fundamental research, always centered around challenges identified as relevant by the production sector. Knowledge transfer occurs through technical reports, extension programs, field days, and other dissemination initiatives. The model fosters alignment with farmers, continuity of projects, institutional stability, and high rates of adoption of technology.

In addition to national-level funds, Australia also relies on regional structures strongly connected to farmers. One example observed in the field was the Northern Australia Crop Research Alliance (NACRA), based in Kununurra within the Ord River Irrigation Scheme area. NACRA operates as a coordination platform for applied research aimed at developing agriculture in northern tropical Australia, linking farmers, universities, companies, and funding bodies — particularly the GRDC. It works with a relatively small group of commercial farmers in the region, approximately 15 to 20 irrigators, who actively participate in defining research priorities and frequently provide areas of their farms for experimental trials. Research is conducted under real local conditions, with trials involving maize, cotton, sorghum, legumes, cover crops, and rotation systems focused on diversification and production efficiency.

Proximity to farmers is one of the defining characteristics of this model. Farmers closely follow trials throughout the seasons and rapidly incorporate results into production decisions. Knowledge transfer occurs through field days, technical visits, and direct interaction between researchers and farmers. Key outcomes observed include the expansion of irrigated maize, advances in cotton-based rotations, evaluation of new crops adapted to tropical environments, and improvements in irrigation and soil fertility management. The NACRA case demonstrates that institutional scale is not necessarily synonymous with impact; smaller, well-connected structures aligned with regional realities can generate significant advances.

The combination of enabling public infrastructure, farmer-oriented governance, predictable funding, and strong interaction between research and farming creates, in Australia, a favorable environment for attracting private capital. In Kununurra, there was even evidence of international groups — including Chinese investors — establishing cotton processing facilities and expanding local processing capacity. The result is a more integrated value chain, with greater value retention within the region.

2.2 United States – Decision-Oriented Applied Research, Universities as the Core of the System, and Irrigation as a Productivity Stabilizer

The United States represents one of the most consistent examples of how applied research, when directly connected to farmer decision-making, becomes a systemic competitive advantage. Throughout the visits conducted in the Corn Belt — particularly in South Dakota, North Dakota, and Iowa — it became evident that the American production system is structured to transform technical data into concrete economic decisions, supported by a strong institutional framework, especially driven by universities.

Large-scale family farming dominates the region. Farms operate with a high level of mechanization, professional management, and rigorous planning. Production decisions are based on historical yield data, cost structures, climate risk, market behavior, and operational predictability. There is little room for improvisation. The system is built on reliable technical information, accumulated over time and translated into practical recommendations.

In this context, universities play a central role, particularly through the land-grant university system, established in 1862. The Iowa State University is a clear example of the integration between education, research, and extension. Research demands often originate from producer associations, which also contribute financially through production-linked taxes or levies. Professors, researchers, and extension specialists respond to these demands with applied projects conducted both in experimental stations and on commercial farms. This ensures that research does not remain confined to academia, but is continuously tested, refined, and communicated under real production conditions.

The funding structure reinforces the system's pragmatic nature. A significant portion of resources comes from production-linked mechanisms, such as checkoff programs, creating a model in which farmers pay, demand, and expect results. There are, of course, criticisms of the system — particularly regarding its compulsory nature, transparency in resource allocation, and auditability — yet it remains a key mechanism connecting production and research.

Knowledge transfer occurs through multiple channels: technical publications, field days, training programs, consulting, and active participation in major agricultural events. Events such as the Dakota Fest and the Farm Progress Show function as platforms for technology validation, environments for comparing solutions, and ongoing spaces for collective learning, where farmers, companies, and researchers interact intensively. These events operate not merely as commercial showcases, but as integral components of the agricultural innovation ecosystem.

An additional highlight of the US experience was the visit to Washington State, which expanded the understanding of irrigation as a tool for production stability. In a naturally arid region, nearly all agriculture is irrigated, with central pivot systems in operation since the 1980s. Water management is highly sophisticated, involving sensors, weather stations, and automated control systems. The foundation of this system lies in public infrastructure and strong legal security regarding water use. As early as 1917, the state established a prior appropriation system, ensuring predictability in access to water resources. In the same year, the Irrigation Branch Experimental Station — now the IAREC of Washington State University in Prosser — was created. Subsequently, the federal government developed the Grand Coulee Dam and the Columbia Basin Project canal system, enabling large-scale water distribution across the region (United States, 2021). The availability of low-cost energy associated with the dam also made it possible to pump water to higher elevation areas.

The observation of highly productive irrigated systems — including no-till potato production, combined with maize rotation — demonstrated that conservation practices can coexist with intensive agriculture when supported by technology, planning, and effective water governance. Irrigation therefore emerged not only as a tool for increasing productivity, but as a strategy for risk reduction and system stabilization.

2.3 England – Public Policy, Subsidies, and Environmentally Driven Research

In England, agriculture is deeply shaped by public policy and subsidy systems. On many of the farms visited, between 60% and 70% of total income comes from government payments linked to environmental stewardship, landscape maintenance, and the provision of ecosystem services, primarily through the Sustainable Farming Incentive (SFI). This fact alone helps explain why applied research and farmer decision-making are so strongly conditioned by the regulatory environment (United Kingdon, 2021).

Following the Second World War, the country adopted policies aimed at rapidly increasing food production, which led to significant environmental impacts. In recent decades, this strategy has been reversed, with a renewed focus on balancing production and conservation. In this context, livestock has become a tool for environmental management, particularly in conservation areas, peatlands, and other sensitive regions. Research in this environment is therefore not focused solely on increasing productivity, but also on enabling systems that meet environmental targets and public policy requirements.

The connection between research, farmers, and public policy is strongly mediated by institutions such as the Agriculture and Horticulture Development Board (AHDB). Funded through mandatory levies paid by producers, alongside significant public resources, AHDB acts as a coordinating body for the UK agricultural sector. Its role extends beyond research: it leads communication campaigns, funds technical studies, engages in policy advocacy, and directly supports farmers in adapting to regulatory requirements. Farmers participate in sector boards alongside technical experts, helping define priority actions for resource allocation. However, the annual spending plan remains subject to approval by ministers of the Department for Environment, Food and Rural Affairs (DEFRA) and devolved administrations, highlighting the strong integration of the system with public policy.

Universities and research centres operate in alignment with these directives, ensuring institutional coherence but also limiting farmer autonomy. The system is highly regulated, and research serves both to improve production efficiency and to enable access to government payments. Organic production plays a significant role, although it faces economic challenges. Organic dairy systems, for example, add value through certification but operate with higher costs and production constraints. Even so, subsidies allow many farmers to remain active, including in less competitive regions.

2.4 Netherlands – Extreme Intensification, Efficiency, and Regulatory Pressure

The Netherlands presents one of the most intensive agricultural systems in the world, despite its limited land base. High production density, particularly in dairy farming, has led to severe challenges related to manure management, resulting in strict regulatory constraints (Zuivel, 2024). In many parts of the country, herd expansion is not permitted due to limitations in waste disposal capacity. Nevertheless, the Netherlands remains one of the world's leading agricultural exporters in terms of value, with strong leadership in agricultural technology and value-added production.

The country stands out for its production efficiency, specialization, strong integration with industry, and focus on high-quality products such as cheeses and organic goods. Industrial processing absorbs nearly all milk production, reinforcing the structure of highly integrated value chains. Universities and technical institutions, such as the Aeres University of Applied Sciences, conduct research focused on sustainability, mechanization, and emission reduction. The Dutch case demonstrates how applied research can sustain highly intensive systems, even under strong regulatory pressure.

At the same time, the Dutch experience highlights clear limitations. No-till systems are not widely adopted, partly due to climate, crop rotation requirements, and agronomic tradition. Rotations typically include potatoes, onions, and maize, requiring frequent soil preparation. Politically, farmers face strong regulatory pressure from the European Union and have limited ability to directly influence these decisions, despite the sector's strategic importance to the country. The Dutch case shows that it is possible to combine high productivity with high regulation, but at the cost of increased complexity, higher production costs, and reduced farmer autonomy.

2.5 Poland – High Productivity, Centralised Validation, and Tensions Between Modernisation, Scale, and Policy

Poland presented one of the most technically robust agricultural systems observed during the study travels, combining high productivity, a strong research base, and an increasing focus on sustainability. At the same time, the country faces political and land tenure tensions that directly affect long-term planning for large-scale farming operations.

The Polish agricultural sector underwent rapid modernisation following the end of the communist regime in 1989 and the country's accession to the European Union in 2004. Despite its high production potential and extensive arable land, Poland still has approximately 1.4 million farmers, of whom only a portion operate at an economically viable scale. Visits to the Top Farms group in the Greater Poland region demonstrated productivity levels comparable to the world's best systems. In some areas, wheat yields reach up to 12 tonnes per hectare, supported by genetic improvement, precision management, and consistent applied research.

From an institutional perspective, agricultural innovation is strongly dependent on state-led validation structures. The COBORU, (*Research Centre for Cultivar Testing* or *Centralny Ośrodek Badania Odmian Roślin Uprawnych*) linked to the Ministry of Agriculture, is responsible for Distinctness, Uniformity and Stability (DUS) testing, Value for Cultivation and Use (VCU) trials, and the official registration of agricultural varieties. No cultivar can be commercialised without formal approval. Following registration, the institution coordinates regional trials through Post-Registration Variety Trials (PDO), evaluating cultivar performance across different regions and generating regional recommendation lists. These lists, together with technical reports, field days, and online platforms, directly guide farmers' decisions. The system ensures standardization, technical rigor, and a strong connection between validation and decision-making, although it also makes the process slower and more dependent on centralized decisions.

To mitigate some of this rigidity, large farming groups collaborate with COBORU by providing land, machinery, and data. This accelerates the generation of relevant information and brings the system closer to real production conditions. Both large and small farmers share common demands related to increasing productivity and profitability, and COBORU's work ultimately benefits both. At the same time, interest in regenerative agriculture and soil conservation is growing. Events such as the BioReaction demonstrated a pragmatic approach, where farmers do not abandon productivity goals but adopt gradual adjustments, including structured crop rotations, cover crops, and reduced soil disturbance.

Beyond the technical dimension, Poland is undergoing significant land restructuring. Since 2016, changes in agricultural policy have sought to strengthen family farming and reduce land concentration. Public land previously leased to large operators has been partially reclaimed and redistributed to smaller local farmers. This process highlights the difficulty of balancing agricultural modernization, social priorities, and internal political pressures — even within a technically advanced system.

2.6 Zimbabwe – Institutional Fragility, Land Reform and Innovation Under Constraint

Zimbabwe represented the strongest contrast observed during the Global Focus Program (GFP). The country underwent a radical land reform process in the late 1990s, involving the expropriation of commercial farms and the redistribution of land to the local population (Scoones, 2010, 2012). The lack of technical capacity, slow political processes, and limited production incentives led to a significant collapse in agricultural productivity. Subsequently, the government introduced a hybrid model, allowing former landowners to return as tenants; however, political and economic instability has remained high.

Longitudinal studies indicate that, despite the initial challenges, some settlements developed processes of investment and capital accumulation, leading to the emergence of a new base of African commercial farmers and a growing segment of medium-scale producers. Nevertheless, overall outcomes remain heterogeneous and continue to be subject to academic debate. Agricultural research capacity is limited, and the use of genetically modified crops is prohibited. In this context, localized initiatives become particularly relevant.

An important example is the Agricultural Research Trust (ART), an applied research organization located in Mazowe, north of Harare. It is an independent institution conducting agricultural experimentation, technology development, and field trials in collaboration with companies, universities, and international research centers. During the visit, one notable initiative was the development of intercropping systems combining maize with Brachiaria, later tested by local researchers. Results indicated that maize productivity was maintained while pasture was established after harvest, generating direct benefits for subsistence livestock systems.

This case demonstrates that even in fragile environments, there remains scope for localized innovation when there are a minimum research base and a strong connection to real production challenges.

2.7 France – Private Agricultural Research, Regulatory Validation, and Brazil as a Strategic Axis

During the visit to France, companies specialized in contract agricultural research were visited, such as Staphyt and Biotek Agriculture. These organizations operate in the execution of field trials and regulatory studies for the development and registration of agricultural inputs. They are part of a well-established network of Contract Research Organizations (CROs), providing services to seed, crop protection, and biological input companies, conducting experiments under controlled conditions and following internationally recognized quality protocols.

The structure and professionalism of these companies demonstrate how the private sector can play a central role in generating reliable agronomic data, supporting regulatory processes, and accelerating the introduction of new technologies into the market. The way these organizations operate reflects a system in which applied research, field experimentation, and regulatory support are highly professionalized and closely aligned with the needs of both industry and farmers.

A key point discussed during the visits was the ongoing transition in agricultural research. After decades of focus on chemical molecules and genetic traits, there is a clear shift — particularly in recent years — towards biological products, integrated management, and solutions compatible with increasingly restrictive regulatory environments. France emerges as a strategic hub in this process, connecting technology development, validation, and global deployment. Companies such as Staphyt and Biotek serve governments and multinational corporations, operating with a high level of specialization and charging premium fees for sophisticated technical services.

During the visits, it became evident that Brazil is viewed as a strategic market, both due to its agricultural scale and its openness to innovation, particularly in biological inputs. Owing to the diversity of production systems, climates, and soils, the country has become one of the main destinations for agronomic validation of new technologies. Many innovations only achieve global scale after being tested under Brazilian conditions, where biotic pressure is high. France therefore represents the link between technological development and global application, while Brazil stands out as a key validation environment. This reinforces both Brazil's relevance and the importance of maintaining strong technical capacity and a predictable regulatory framework.

2.8 Georgia – Land Fragmentation, Institutional Constraints, Sheep Production, and Viticulture

Georgia presents an agricultural system deeply shaped by its recent history. Following independence from the Soviet Union, a large portion of agricultural land was redistributed among the population, resulting in a fragmented land structure. Farms average around 1.3 hectares, limiting production scale, constraining mechanization, and reducing investment capacity. In addition, foreign ownership of land is prohibited, restricting the inflow of external capital and contributing to the slow modernization of the agricultural sector.

This fragmentation is also reflected in the country's limited capacity for research and innovation. Unlike countries with well-established agricultural research systems, Georgia operates within a more dispersed and less structured framework. Research is primarily conducted by the Scientific-Research Center of Agriculture, linked to the Ministry of

Agriculture, alongside universities and projects funded by international organizations. Institutional limitations contribute to low levels of technology adoption and hinder the modernization of rural production systems.

Sheep production plays a significant role in the agricultural system, with a flock exceeding one million head. Management is largely traditional, based on extensive grazing and seasonal transhumance. During winter, animals often graze on public or protected lands, leading to heavy grazing pressure and significant environmental impacts. This system is low in intensity and characterized by limited control over carrying capacity. At the same time, social changes are evident, with younger generations showing less interest in remaining in this activity.

Despite these structural limitations, Georgia has a distinctive and culturally significant wine sector. The country is considered one of the birthplaces of winemaking, with archaeological evidence dating back approximately 8,000 years. Today, there are hundreds of endemic grape varieties, and traditional production methods, combined with the country's natural conditions, result in high-quality wines with a unique identity. This contrast between structural fragility in part of the agricultural sector and cultural excellence within a specific value chain makes Georgia a particularly interesting case.

2.9 Comparative Synthesis – Drivers of Resilient vs. Fragile Agricultural Systems

Comparative analysis across the countries visited shows that the difference between resilient and fragile agricultural systems goes far beyond the availability of technology. The determining factors are institutional, organizational, and economic. Successful agricultural systems tend to share a set of common characteristics: a strong applied research base focused on real farmer challenges, stable funding for innovation, direct connections between research and the production sector, clear governance structures, and the ability to translate technical knowledge into economic decision-making at farm level.

Australia and the United States are clear examples of this logic. In Australia, sector-based funds and regional structures closely connected to farmers ensure institutional continuity and rapid technology transfer. In the United States, universities, extension services, agricultural events, and production-linked funding mechanisms create a robust innovation ecosystem. England and the Netherlands illustrate systems in which research and production operate under strong regulatory and environmental influence, demonstrating how public policy and environmental requirements can profoundly reshape agriculture. Poland highlights the strength of a technically rigorous system closely linked to formal validation, albeit more centralized and influenced by land and political constraints. France and California emphasize the growing role of private research and open innovation as drivers of technological advancement. In contrast, Zimbabwe and Georgia demonstrate how institutional fragility, legal uncertainty, or fragmented production structures limit innovation capacity and compromise sector efficiency.

Across all observed cases, it becomes clear that sustainability, productivity, and agricultural innovation fundamentally depend on stable institutions, consistent applied research, and well-aligned economic incentives. Countries that successfully integrate these elements develop resilient and competitive agricultural systems. Those that fail to maintain institutional stability, regulatory clarity, or strong connections between research and farmers tend to experience reduced efficiency and lower adaptive capacity.

These insights provide the foundation for the next chapter, which focuses on key lessons and strategic recommendations for Brazil.

Chapter 3 - The Role of Public and Private Institutions in Technology Development and Their Connection with Farmers

This chapter aims to understand how different institutional arrangements around the world structure the development of agricultural technologies and, most importantly, how these technologies reach farmers and influence decision-making at farm level.

Rather than analyzing institutions in isolation, the objective is to examine the quality of the connections between research, funding, governance, and technology adoption — elements which, together, determine the effectiveness of applied research.

Throughout the Nuffield program, it became evident that there is no single model of success. Countries with very different productive, economic, and institutional characteristics have developed their own approaches to organizing agricultural innovation systems. However, despite this diversity, certain patterns begin to emerge — particularly regarding the role of farmers in setting research priorities, the predictability of funding, and the ability to translate knowledge into practical on-farm decisions.

In many cases, the difference between more and less effective systems lies not in the level of investment or scientific capacity, but in how institutions are structured to respond to real production challenges. Proximity to farmers, clarity of governance, and efficiency in knowledge transfer consistently appear as critical success factors.

From this perspective, this chapter presents different institutional models observed during the study visits, including farmer-led sectoral funds, regional applied research organizations, universities with strong extension roles, public regulatory structures, and private innovation initiatives.

The analysis of these cases aims not only to describe how each system operates, but, more importantly, to identify which elements help bridge the gap between research and the realities of farming, thereby accelerating technology adoption — a key factor in strengthening the effectiveness of applied research in Brazil.

3.1 Setorial Funds and Farmer-Driven Governance: The Australian Model

Australia presents one of the most robust applied research models observed during the program. Institutions such as the Grains Research and Development Corporation (GRDC) and the Cotton Research and Development Corporation (CRDC) operate as public–private sectoral funds, financed directly through production-linked contributions.

Farmers pay a levy per ton produced, and these resources are channeled into a national fund, complemented by public investment. Governance is a central element: decision-making boards include strong farmer representation, ensuring that research priorities reflect the needs of those directly engaged in production. Research agendas are not defined solely by universities or governments — although both play a significant role — but also by those facing real production challenges daily.

These organizations maintain relatively lean technical teams and operate primarily as coordinating and funding bodies, rather than direct executors of research projects. Most scientific work is carried out by universities, research institutes, and private companies contracted to develop and deliver specific projects.

The RDCs play a central role in defining research priorities, covering both applied and, when necessary, more fundamental research areas where relevant knowledge gaps are identified. This structure enables alignment across different levels of research around shared objectives, largely defined by farmers themselves — even though they may not always fully grasp the scientific, political, temporal, and financial dimensions involved in certain technological advances.

Knowledge transfer takes place through technical reports, extension programs, field events, and other initiatives aimed at delivering results to farmers. This model creates strong alignment with the end user, predictable funding, project continuity, and institutional stability — factors that help explain the high rates of technology adoption observed in Australian agriculture.

3.2 Regional Applied Research Models: The Northern Australia Case

In addition to large national research funds, Australia also relies on regional structures that are highly connected to farmers and focused on adapting technologies to local conditions. One example observed during the field visit was the Northern Australia Crop Research Alliance (NACRA), based in Kununurra, Western Australia, within the irrigated area of the Ord River Irrigation Scheme (Engineers Australia, 2013).

NACRA operates as a coordination platform for applied research aimed at developing agriculture in northern tropical Australia, linking farmers, universities, companies, and research funding institutions — particularly the Grains Research and Development Corporation (GRDC).

NACRA works with a relatively small group of commercial farmers in the region — approximately 15 to 20 irrigators — who actively participate in defining research priorities and frequently provide areas of their farms for experimental trials. The research conducted reflects the specific conditions of the local production system, which is predominantly irrigated, and includes agronomic trials involving maize, cotton, sorghum, legumes, cover crops, and rotation systems aimed at improving production efficiency and diversifying agricultural options in the region. The organization maintains a lean institutional structure and operates primarily as a facilitator and coordinator of projects, contracting universities and research institutions to carry out the technical work.

Proximity to farmers is one of the defining characteristics of this model. Farmers are directly involved in setting priority topics, follow experiments throughout the growing seasons, and rapidly incorporate results into production decisions. Knowledge transfer occurs mainly through field days, technical visits, and direct interaction between researchers and farmers, enabling the rapid dissemination of innovations.

Key outcomes include the expansion of irrigated maize production, advances in cotton-based rotation systems, evaluation of new crops adapted to tropical conditions, and improvements in irrigation and soil fertility management. The NACRA case demonstrates that institutional scale is not necessarily synonymous with impact: smaller structures, closely connected to farmers and aligned with regional realities, can generate significant advances in agricultural innovation.

3.3 Universities as the Core of the System: The United States Model

In the United States, universities play a central role in applied research, particularly through the land-grant university system established in 1862. The Iowa State University is a clear example of the integration between teaching, research, and extension.

Research demands often originate from producer organizations, such as Farmers Unions, which also contribute financially through production-linked taxes and levies. Funding typically ranges between 55–60% public and 40–45% private. Professors, researchers, and extension specialists respond to these demands through applied projects conducted both in experimental stations and directly on commercial farms.

Knowledge transfer takes place through multiple channels, including regular technical publications, field days, training programs, consulting, and active participation in agricultural events. Exhibitions such as the Farm Progress Show and the Dakota Fest function as large-scale platforms for technology validation, where universities, companies, and farmers interact intensively.

This system ensures that research does not remain confined to academia, but is continuously tested, refined, and communicated under real production conditions.

3.4 Levy Boards and Policy-Driven Systems: The England Case

In England, the connection between research, farmers, and public policy is strongly mediated by institutions such as the Agriculture and Horticulture Development Board (AHDB). Funded through mandatory levies paid by producers, alongside a significant share of public funding, AHDB acts as a coordinating body for the British agricultural sector.

Its role extends beyond research: the organization engages in policy advocacy, leads communication campaigns, funds technical studies, and directly supports farmers in adapting to regulatory requirements. In this context, applied research is closely aligned with public policy, particularly in areas related to environmental conservation and subsidy schemes.

Universities and research centers operate in alignment with these directives, ensuring institutional coherence but also reducing farmer autonomy. The result is a highly regulated system in which research serves both to improve production efficiency and to enable access to government payments.

3.5 State Institutions for Registration and Validation: The Polish Experience

In Poland, applied research and innovation are strongly dependent on state-led validation institutions. COBORU is responsible for DUS (Distinctness, Uniformity and Stability) and VCU (Value for Cultivation and Use) testing, as well as the official registration of agricultural varieties in the country.

No variety can be commercialized without COBORU approval, which operates in alignment with European Union catalogues. Following registration, the institution coordinates regional trials (PDO), the results of which are communicated to farmers through official publications and field days.

This model ensures technical rigor and standardization but also makes the system slower and more dependent on centralized decision-making. To mitigate this rigidity, large farming groups such as the Top Farms collaborate directly with COBORU by providing land, machinery, and data, thereby accelerating the generation of relevant information for decision-making.

Both large and small farmers share similar demands, primarily related to increasing productivity and profitability through genetic improvement. In this context, COBORU's work benefits both groups, with visible results — for example, wheat yields in Poland can reach up to 12 tons per hectare under rainfed conditions.

3.6 Global Private Research: France as a Strategic Hub

France began to stand out more clearly in private agricultural research from the 1990s onwards, driven by two major developments: the consolidation of the European agricultural input industry and the introduction of strong tax incentives for corporate R&D. Until then, French agricultural research had been dominated by highly influential public institutions such as the INRAE (formerly INRA) and CIRAD. Companies such as Staphyt and Biotek Agriculture now operate across multiple countries, providing development services, regulatory testing, and technology validation, with strong growth in the biologicals segment.

These companies serve both governments and multinational input firms, operating at a high level of professionalization and charging premium fees for specialized services. During the visits, it became evident that Brazil is regarded as a strategic market, both due to its agricultural scale and its openness to innovation — particularly in biological inputs.

The French model illustrates how private research can complement — and in some cases outperform in terms of agility — public research, especially in a context of rapid technological and regulatory change.

3.7 Incubation, Innovation, and Farmer Integration: The California Example

In the Salinas Valley, known as the "Salad Bowl of the World," one of the largest vegetable production regions in the United States, agriculture has become a natural laboratory for the development of new technologies. In this context, initiatives such as Reservoir Farms have emerged — a platform designed to test, validate, and accelerate technological solutions directly on commercial farms. The model is primarily focused on high-value crops such as strawberries, lettuce, spinach, broccoli, cauliflower, and other labour-intensive vegetables, where the potential for efficiency gains through technology is significant.

The operational logic of these initiatives is driven by rapid experimentation cycles: testing quickly, learning from low-cost failures, refining solutions, and scaling those that demonstrate tangible results. Research takes place directly within the production environment, with extensive use of sensors, automation, agricultural robotics, data analytics, and digital monitoring tools.

Another key element of this ecosystem is its close connection with leading research institutions and universities, such as University of California, Davis, as well as innovation centers and technology incubators located within California's so-called AgTech Corridor. These institutions train professionals, generate scientific knowledge, and frequently collaborate with companies and startups to translate academic discoveries into commercial applications.

As a result, California has established itself as one of the world's leading hubs for agricultural innovation, where technological solutions are developed, tested at commercial scale, and rapidly disseminated to production systems across the globe.

3.8 Institutional Synthesis of the Chapter

The analysis of different institutional models shows that the effectiveness of applied research depends less on the type of institution (public or private) and more on the quality of its institutional design. Successful systems tend to share a set of common elements: predictable funding, governance with farmer participation, a strong focus on real production challenges, efficient knowledge transfer mechanisms, and institutional stability.

Australia and the United States demonstrate how sectoral funds and strong universities can sustain innovative systems. The United Kingdom highlights the influence of public policy and subsidies. France and California emphasize the growing role of private research and open innovation. Poland illustrates the effects of centralized validation structures.

These experiences provide the foundation for the next chapter, which will explore key lessons and insights for Brazil, with a focus on how to strengthen applied research and generate greater value for farmers.

Chapter 4 – Applying Knowledge to Mato Grosso do Sul

Mato Grosso do Sul has consolidated, over recent decades, a highly competitive agricultural system, primarily based on grain production — with emphasis on soybean and second-crop maize — alongside livestock production, increasingly integrated into industrial and export value chains. This model has enabled the state to rapidly expand in scale, productivity, and participation in international markets, while also increasing the technical, economic, and environmental complexity of its production systems.

Recent figures help illustrate this context. According to SIGA-MS, the 2024/2025 soybean season was harvested across approximately 4.5 million hectares, with an average yield of around 52 bags (60kg) per hectare, resulting in production exceeding 14 million tons. Second-crop maize performance was even more expressive, with an average yield of 108.4 bags per hectare over 2.14 million hectares, totaling approximately 14 million tons. From an economic perspective, the Gross Value of Agricultural Production in the state reached approximately BRL$84 billion in 2025, with an annual growth of 18%, reinforcing the central role of agriculture as a driver of the state's economy (Aprosoja MS, 2025).

However, this performance does not eliminate the structural challenges that will define the future competitiveness of the state. The comparison with production systems observed during the Nuffield program helps organize these challenges into clear strategic areas in which applied research plays a decisive role.

The first is risk management and productivity stability. The soybean–second-crop maize system is technically efficient but exposes the production system to significant risks associated with planting windows, climate variability, and volatility in costs and prices. In this context, the challenge is not simply to increase average yields, but to reduce variability, making the system more predictable from both agronomic and financial perspectives. Production systems observed in the United States and Australia demonstrate that decisions such as second-crop adoption and technologies such as maize–grass intercropping, when aligned with environment, timing, and management strategy, can reduce risk and enhance farmers' economic resilience.

The second axis is soil and water as the foundation of resilience. No-till farming is a well-established asset in Mato Grosso do Sul, but the technological frontier lies in its quality and consistency. Functional cover crops, effective crop rotations, the maintenance of living roots, improved water infiltration, and the correction of soil compaction are critical to reducing dependence on inputs and on favorable climatic conditions. Without these elements, systems tend to compensate for structural weaknesses through increased input use, which compromises margins over the medium term.

The third challenge is biotic pressure and declining system efficiency. Experiences from across the Southern Cone highlight a clear lesson: systems that rely on repetitive strategies and a limited set of technological tools lose efficiency over time. The evolution of herbicide-resistant weeds, increasing application rates, and rising control costs are symptoms of this process. In Mato Grosso do Sul, integrated management of weeds, pests, and diseases must be treated as a structural technical strategy, rather than an individual choice limited to more advanced farmers.

The fourth axis is social license and measurable sustainability. Sustainability is no longer merely a set of desirable practices — it has become an economic requirement. Markets, credit, insurance, and public policies increasingly demand simple, auditable, and repeatable metrics. Without clear indicators, the state risks losing its ability to capture value, whether through improved financing conditions or through the reputation of its production systems.

Given this context, the strategic agenda for Mato Grosso do Sul must be pragmatic and system oriented. Developing recommendations tailored to micro-regions and production environments — integrating planting windows, cultivar selection, plant population management, nitrogen strategies in maize, and soil and water practices — is a key step towards reducing risk and increasing system stability. Likewise, structured soil and system programs, focused on cover, functional rotation, and soil physical diagnostics, can deliver consistent efficiency gains without excessive complexity.

Crop–livestock integration, and crop–livestock–forestry systems, emerge as relevant tools where economically viable, particularly as mechanisms for risk diversification and structural soil improvement. The same applies to irrigation, which should be approached less as a strategy for increasing productivity and more as a tool for risk mitigation, supported by demonstration projects that assess water application rates, energy use, economic returns, and governance of water resources.

4.1 Recommendations for Mato Grosso do Sul

Mato Grosso do Sul has a real opportunity to position itself as a tropical showcase for evidence-based sustainable production. Achieving this, however, requires more than broad commitments or generic narratives — it demands replicable results, clear metrics, and decision-oriented communication. The existing scale of research, validation, and knowledge transfer already creates a strong foundation for national and international leadership in this space.

- **Turn sustainability into a measurable economic variable**
  Indicators such as soil cover, crop rotation, nitrogen use efficiency, resistance risk, rational use of crop protection products, and water infiltration must be directly linked to economic instruments, including credit, agricultural insurance, market differentiation, and environmental incentive programs.

- **Transform trial networks into problem-oriented programs**

Research networks should be structured around clearly defined challenges, with explicit targets, measurable deliverables, and decision-oriented outputs. With an extensive network of trials, regionally distributed research units, established technical events, and digital dissemination platforms, there is a real opportunity to organize this agenda in a more structured and impactful way. The state's applied research institutions already hold key strategic assets to support this transformation.

- **Systematically integrate economic analysis into technical results**
  Experiences observed in the United States show that agronomic data becomes significantly more impactful when accompanied by analyses of incremental cost, expected return, risk, sensitivity to price and climate, and break-even points. This type of information directly influences farmer decision-making and brings applied research closer to the realities of agricultural business.

- **Consolidate a continuous extension model combining field presence and digital platforms**
  The integrated use of results portals, artificial intelligence, and in-person events enables farmers to access recommendations continuously, tailored to their production environment and linked to local data. This approach aligns the state with the most advanced decision-support models observed internationally.

- **Build a more intelligent and responsive technical ecosystem using existing data**
  Integration with monitoring systems such as SIGA-MS can support the definition of production environments, the structuring of validation networks, and the generation of alerts related to climate, phytosanitary, and operational risks.

Ultimately, by aligning production data, economic indicators, and sustainability metrics, Mato Grosso do Sul strengthens not only its competitiveness but also its capacity to respond to future market and societal demands. More than increasing output, the goal is to produce better — with lower risk, greater predictability, and higher value creation — which is precisely the role that applied research must fulfil in the state.

Chapter 5 – Lessons and Insights for Brazil

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This chapter consolidates the key lessons drawn from the Nuffield program, based on the analysis of different international models of applied research and their connection with farmers. Rather than simply describing these experiences, the objective is to translate them into practical reflections on how Brazil can strengthen the organization of its agricultural research system and increase value creation at farm level.

Based on the evidence collected, the chapter seeks to identify the elements that differentiate more efficient systems — particularly in terms of governance, funding, execution, and knowledge transfer — and to discuss how these factors can be adapted to the Brazilian context.

5.1 Conclusions: How to Strengthen Applied Research and Increase Value Creation for Brazilian Farmers

The experiences throughout the Nuffield program demonstrated that Brazil's main challenge does not lie in a lack of technical knowledge or productive capacity. On the contrary, the country has a strong scientific base, highly adaptable farmers, and a diversity of production systems that few nations possess. The core issue lies in how knowledge is organized, funded, validated, and ultimately translated into decision-making at farm level.

The comparison across the countries visited reveals clear patterns. Where applied research performs best, it is not treated as an end, but as an integrated part of the production system. It originates from real-world problems, is funded predictably, governed by producers, and tested under real operating conditions. These elements consistently appeared in contexts as diverse as Australia, the United States, the United Kingdom, France, and the Netherlands, and are explained below:

- **The origin of research agendas**
  In the most effective systems, research priorities are not primarily defined by institutions or researchers, but by farmers themselves, in an organized manner. Problems emerge in the field — whether related to productivity, cost, management, climate risk, or regulatory requirements — and research is structured accordingly. In Brazil, in many cases, the opposite logic still prevails technologies are developed first and then offered to farmers, who decide whether to adopt them. This approach results in lower adoption rates and reduces the real impact of applied research.

  Although Brazilian agricultural research has historically been led by public institutions such as Embrapa, in recent decades many important innovations have been driven by the private sector and by farmer demand. A clear example is the advancement of biological inputs for pest and disease control, largely developed and scaled by private biotechnology companies and increasingly adopted in soybean and maize production systems.

- **Development of digital agriculture platforms**

This includes remote sensing tools, agronomic data analytics, and real-time management recommendation systems, which are widely developed by agtech startups and technology companies. In addition, the private sector has played a central role in the development of biotechnology in soybean and maize, such as genetically modified cultivars with insect resistance and herbicide tolerance — technologies that have transformed Brazilian production systems over recent decades, enabling significant gains in productivity, management efficiency, and operational performance.

- **Funding predictability**

Models such as Australian sectoral funds and UK levy boards demonstrate that the continuity of applied research depends on recurring, production-linked funding managed under clear governance structures. The reliance on short-term funding calls and unstable budgets — still common in Brazil — limits medium- and long-term projects and hinders the development of consistent technical teams. Where funding is predictable, there is planning, depth, and the ability to take technological risks.

This predictability is directly linked to governance. In virtually all successful systems observed, farmers play a central role in decision-making structures. They participate in defining priorities, monitoring results, and evaluating returns on investment. This creates a virtuous cycle: research better reflects real needs, and farmers develop greater trust in the outcomes. Strengthening this farmer-driven governance is essential to bring Brazilian research closer to on-farm realities.

- **The importance of conducting research in real production environments**

This was a recurring theme throughout the visits. An example in the United States was in California, where much of the technological validation takes place directly on farms, at operational scale. This reduces the gap between experimentation and adoption, increases credibility, and accelerates the uptake of innovations. Although Brazil already uses farmer-partnered trials, there is still significant room to expand this model, particularly in more complex and heterogeneous systems.

- **The distinction between public and private research is less relevant in mature systems**

What matters is complementarity. Universities, companies, and farmers work together within clearly defined roles, supported by contracts, intellectual property frameworks, and a shared focus on results. In France and the United States, private research plays a strategic role, particularly in validating products and emerging technologies, while public institutions ensure scientific foundations and human capital development. For Brazil, the challenge is not to choose between public or private, but to build more effective cooperation models.

- **Knowledge transfer**
  In the countries visited, communication is not treated as a secondary step. Agricultural exhibitions, field days, regular technical publications, and structured extension programs are integral parts of the research system. Research is only considered successful when it leads to practical adoption. In Brazil, there remains a significant gap between data generation and its transformation into useful, decision-oriented information — particularly in terms of language, format, and timing.

- **Institutional stability as a decisive factor for innovation**
  Experiences in Poland, Georgia, and Zimbabwe demonstrate how land insecurity, frequent policy changes, and legal uncertainty discourage investment and hinder technological progress. In contrast, countries with stable and predictable rules enable long-term planning by both farmers and institutions. Brazil, despite its challenges, holds an important comparative advantage in this regard, which must be preserved and strengthened.

- **International communication**
  During technical events in England and across Europe, there was a recurring sense of surprise regarding the reality of Brazilian agriculture. There is a clear gap between what Brazil actually practices in terms of sustainability and how it is perceived internationally. This communication gap is not merely a matter of image, but of competitiveness, market access, and regulatory influence.

Ultimately, these lessons converge into a central conclusion: Brazil does not need to reinvent its applied research system — it needs to reorganize it. The essential elements are already in place: technical capacity, engaged farmers, production scale, and system diversity. Progress depends on aligning governance, funding, execution, and knowledge transfer around real, measurable challenges.

5.2 Recommendations: How to improve applied research and technology transfer in Brazilian agriculture

The Nuffield program provided an integrated perspective on how applied research either supports or constrains agricultural development across different institutional, economic, and social contexts. More than comparing countries, the experience made it clear that the defining factor is not the level of technology itself, but how knowledge, decision-making, and governance are connected to farmers.
Brazil stands out globally for its ability to produce at scale in complex tropical environments, with high levels of technical efficiency. This is the result of decades of investment in applied research focused on solving real problems, enabling crop adaptation, viable production systems, and the consolidation of the country as an agricultural powerhouse. However, international comparison shows that the next leap in

competitiveness will not come solely from more technology, but from better organization of research, knowledge transfer, and decision-making systems, including:

- **Applied research delivers greater value when organized around systemic problems, rather than individual crops or products**
  Where research proved most effective, it addressed structural questions: how to reduce yield variability, how to manage soil and water to increase resilience, how to maintain input efficiency over time, and how to make sustainability measurable and economically relevant. These elements appeared consistently across the most advanced systems, regardless of institutional model.

- **The importance of decision-oriented languag**e
  Across nearly all countries visited, the most influential research and extension systems are those capable of translating technical results into clear economic implications. Farmers do not decide based solely on maximum yield, but on incremental cost, risk exposure, and long-term stability. In this regard, Brazil has a strong technical base but still has room to advance in systematically integrating agronomy and economics into decision-making.

- **Recognizing the gap between practiced and communicated sustainability**
  Brazil generally operates highly efficient agricultural systems from an environmental perspective, particularly in terms of land use, crop–livestock integration, no-till systems, and preservation of native vegetation. However, international experience shows that this reality is poorly understood abroad. This represents not only a communication challenge, but also a tangible loss of value in terms of market access, credit, and global recognition.

In conclusion, this report reinforces that the future of Brazilian agriculture — and particularly of states such as Mato Grosso do Sul — depends less on reinventing applied research and more on refining its organization, focus, and communication. Brazil has already demonstrated the technical capacity to produce under complex conditions. The next step is to transform this knowledge into more stable systems, better-informed decisions, and clear evidence of sustainability and economic viability.

The Nuffield program played a transformative role in this process. It provided an external perspective on Brazil, enabling comparison, critical reflection, and, above all, recognition of strengths that are often overlooked internally. More than a series of travels, the program was a continuous exercise in analysis, comparison, and synthesis. The conclusions and recommendations presented here are not an endpoint, but a call to action: to strengthen applied research as a strategic tool for agricultural development, keeping farmers at the center of decision-making and knowledge as the foundation for an increasingly competitive, resilient, and globally recognized agricultural sector.

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